Multiple Choice Questions in Regional Anaesthesia

Rajesh Gupta
Dilip Patel

Second Edition

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Dedicated to my parents
Rajesh Gupta

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Anatomy and Physiology of Acute Pain

1

1. Characteristics of acute pain:
   (a) Acute pain is associated with temporal reduction in intensity.
   (b) Acute pain serves no adaptive purpose.
   (c) Inflammatory pain is classified under nociceptive pain.
   (d) Visceral pain does not radiate in dermatomal pattern.
   (e) Primary hyperalgesia is seen at the site of injury.
2. Gate control theory of pain:
   (a) Sensory fibres stimulate second order spinal neurons.
   (b) Both large and small diameter afferents can activate transmission cells in the dorsal horn.
   (c) Substantia gelatinosa regulates the gate.
   (d) Increased activity in small diameter fibres increases the suppressive effect of substantia gelatinosa cells.
   (e) Central sensitisation within the substantia gelatinosa unlocks the dorsal horn gate and facilitates transmission.
3. Mechanisms of pain:
   (a) Direct nociceptive activators cause transduction.
   (b) Nerve growth factor has no role in pain sensitisation.
   (c) Peripheral sensitisation causes primary allodynia and primary hyperalgesia.
   (d) Secondary sensitisation has no role in neuropathic pain.
   (e) "Wind up" phenomenon relates to increased postsynaptic response to central input.
4. Transduction seen in pain:
   (a) Involves supra-spinal mechanisms
   (b) Calcium channels are involved.
   (c) Primary hyperalgesia is associated with potassium currents.
   (d) CGRP is involved with mechanical and thermal hyperalgesia.
   (e) Increased IL-β results in allodynia.

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5. Conduction in pain:
   (a) Is transfer of action potential from peripheral nociceptive endings via nerve fibers.
   (b) Aβ fibers are non-noxious.
   (c) Initial response to pain is by C fibers.
   (d) Axonal conduction results in release of excitatory amino acids.
   (e) Sodium channels play a major part.
6. Characteristics of pain transmission:
   (a) It is the transfer of noxious impulses from primary nociceptors to cells in the spinal cord dorsal horn.
   (b) Wide dynamic range neurons respond only to noxious stimuli.
   (c) Excitatory amino acids are involved.
   (d) Both AMPA and KAR receptors initiate voltage mediated priming of NMDA receptors.
   (e) Increased prostaglandin E in extracellular and intracellular area is responsible for transcription dependant central sensitisation.
7. Modulation of pain:
   (a) It is the mechanism of pain suppression within spinal, dorsal horn and supra-spinal levels.
   (b) It is mediated by endogenous analgesic compounds.
   (c) Potassium ion flux is involved.
   (d) Modulatory effects of norepinephrine are mediated by polysynaptic alpha adrenergic receptors.
   (e) Neuraxial clonidine effect is mediated by alpha adrenoreceptors.
8. Cortical reception of acute pain:
   (a) Thalamocortical connections are responsible for sensory qualities (throbbing or burning).
   (b) Limbic system is associated with persistent pain.
   (c) Frontal cortex has a role in learned avoidance.
   (d) Insular cortex is primarily responsible for acute noxious stimulation.
   (e) Opioid induced metabolic suppression involves ipsilateral thalamus and amygdala.
9. Transition from acute to chronic pain:
   (a) Central sensitisation involves activation of NMDA receptors.
   (b) Transcription independent sensitisation can be seen following trauma.
   (c) Downregulation of AMPA receptors can lead to extended pain stimulus.
   (d) Wind up phenomenon is reversible.
   (e) Transcription dependent sensitisation involves alterations in dorsal root ganglion.
10. Peripheral sensitisation:
   (a) Can be increased by increasing efficacy of transducing ion channels.
   (b) Voltage gated ion channels are not involved in sensitisation.
   (c) Neurogenic oedema is contributed by decrease in substance P.
   (d) Extracellular signal regulated kinase is involved in receptor mediated hypersensitivity.
   (e) Mainly involves Aδ and C fibers.

11. Hyperalgesia;
    (a) Is a part of the triple response in acute injury.
    (b) Primary hyperalgesia is due to increased sensitivity of Aβ receptors.
    (c) Allodynia is not mediated by interleukins.
    (d) Secondary hyperalgesia is seen at the spinal level.
    (e) Secondary hyperalgesia is antagonised by inhalational anaesthetics or parenteral opioids.
12. Sympatho-adrenal response to acute injury:
    (a) Manifests as three different stages.
    (b) Highest elevations of sympathetic amines are seen in elderly.
    (c) May be deleterious in coronary artery disease.
    (d) Increased muscle spasms may be seen.
    (e) Hypercoagulation may be seen.
13. Neuroendocrine response to acute injury:
    (a) Increase in anabolic steroids are seen.
    (b) Increased incidence of infections is seen.
    (c) Neuroendocrine response is by decrease in interleukins.
    (d) Immunoglobulin synthesis may decrease.
    (e) Shock may be initiated by β-endorphin.
14. Effect of injury to target organs:
    (a) Perioperative ischaemia mostly occurs within 24 h.
    (b) Myocardial oxygen requirements are decreased.
    (c) Pain following operation on upper abdomen and thoracic musculature is effort dependent.
    (d) Surgically induced pain may cause pulmonary complications in 70% of patients.
    (e) Decrease in functional residual capacity is associated with increase in shunt.
15. Effect of injury to target organs:
    (a) There is increased incidence of deep venous thrombosis and pulmonary embolism.
    (b) Continued alterations in regional blood flow result in sympathetic dystrophy.
    (c) Activation of microglia and neuronal apoptosis may contribute to plastic changes.
    (d) Pain at site of surgery predisposes to persistent pain.
    (e) Limbic cortical response is associated with anxiety and depression.
16. Patient variables influencing acute pain management:
    (a) Advancing age can increase toxicity of opioid administration.
    (b) Visual analogue scale is most effective for detecting age differences in post-operative pain.
    (c) Patient controlled analgesia can be used in paediatric patients as young as 4 years for post-operative pain.
    (d) Ethnicity plays a major role in analgesic response to patient controlled analgesia.
    (e) Females experience more pain in immediate post-operative period than males.

17. Variables affecting acute pain management:
    (a) Patients with passive coping styles consume more morphine.
    (b) Age is an independent risk factor for early post-operative pain.
    (c) Superficial procedures are less painful.
    (d) Pre-emptive analgesia is beneficial even if used only in preoperative period.
    (e) PCA morphine dose is based on body weight.
18. Variables influencing acute pain management:
    (a) Low levels of CSF β endorphin predict a high requirement for postoperative PCA.
    (b) Females respond better to morphine than males in postoperative period.
    (c) Activity of CYP2D6 enzyme is responsible for variations in metabolism for dextromethorphan, tramadol and codeine.
    (d) Buprenorphine is the opioid of choice in renal failure patients.
    (e) Morphine is the only opioid which is safe in liver failure patients.
19. Psychosocial factor associated with acute pain:
    (a) Anxiety has least effect on postoperative pain as compared to depression and anger.
    (b) Pain anxiety symptom scale is validated for acute postoperative pain prediction.
    (c) Kinesiophobia increases the risk of postoperative pain.
    (d) Pain catastrophising increases the incidence of postoperative pain.
    (e) Distraction may help decrease distress in persons experiencing acute pain.
20. Psychological interventions for acute pain:
    (a) Distraction works better in children than adult population.
    (b) Distraction is better than local anaesthetics in managing pain on injections.
    (c) Cognitive behavioural therapy has no role in acute pain.
    (d) Hypnosis can cause reduction in acute pain.
    (e) Virtual reality is effective in acute pain management.

Answers

1. T F T F T
   Acute pain has a protective function as opposed to chronic pain which serves no adaptive purpose. Nociceptive pain is defined as noxious perception resulting from cellular damage following surgical, traumatic or disease related injury. Visceral pain radiating in a particular dermatomal pattern is known as referred pain. It is due to convergence of noxious input from visceral afferents activating second order cells that are normally responsive to somatic sensation.

   Treede RD, Meyer RA, Raja SN, et al. Peripheral and central mechanisms of cutaneous hyperalgesia. Prog Neurobiol. 1992;38(4):397–421.
2. T T T F T
   Sensory fibres stimulate dorsal horn transmission cells or wide dynamic range neurons. Large sensory fibres can activate inhibitory substantia gelatinosa cells.

Increased activity in small diameter fibres decreases the suppressive effect of substantia gelatinosa cells and opens the gate. Peripheral nerve injuries also open the gate by increase small fiber activity and decrease large fiber inhibition.

Melzack R, Wall PD. Pin mechanism: a new theory. Science. 1965;150(699):971–9.

L- light touch mechanoreceptors, S-small diameter unmyelinated pain fibers, SG- substantia

Gelatinosa, T- wide dynamic range neurons

3. T F T F T

Direct activators like potassium, hydrogen ions, ATP and bradykinin causes transduction at peripheral nociceptor ion channel receptors. Nociceptor sensitizers include PGE2, nerve growth factor, bradykinin. They decrease the threshold of activation of ion channel receptors on nociceptor terminals. Secondary sensitisation plays a major role in inflammatory and neuropathic pain. Repetitive stimulus of unmyelinated C fibres can result in prolonged discharge of dorsal horn cells causing wind up.

4. F T T T T

Transduction is the response of peripheral nociceptors to noxious stimuli. Noxious stimuli are converted into a calcium ion mediated electrical depolarisation. Cellular damage is associated with release of intracellular hydrogen and potassium ions. Receptor G-protein complex strengthens inward sodium flux and weakens potassium currents and increased nociceptor excitability causing primary hyperalgesia. Calcitonin gene related protein is 37 amino acid peptide found in the peripheral and central terminals of more than 50% of c fibers and 35% of Aδ fibers.

Ji RR, Woolf CJ. Neuronal plasticity and signal transduction in nociceptive neurons: implications for the initiation and maintenance of pathological pain. Neurolobiol Dis. 2001;8(1):1–10.

5. T T F T F

Largest diameter fibers Aβ and are myelinated. The conduction velocity is 30–50 m/s. Aδ fibers transmit the pain initially, are thinly myelinated with a conduction velocity of 5–25 m/s C fibers are unmyelinated, have a delayed latency and with conduction velocity of <2 m/s. neuronal type calcium channels are in nerve endings and causes a rapid influx of calcium when stimulated.

Fiber type	Function	Diameter (μm)	Myelination	Conduction velocity (m/s)
Type A				
Alpha (α)	Proprioception, motor	12–20	Heavy	70–120
Beta (β)	Touch, pressure	5–12	Heavy	30–70
Gamma (γ)	Muscle spindles	3–6	Heavy	15–30
Delta (δ)	Pain, temperature	2–5	Heavy	12–30
Type B	Preganglionic autonomic	<3	Light	3–15
Type C				
Dorsal root	Pain	0.4–12	None	0.5–2.3
Sympathetic	Postganglionic	0.3–1.3	None	0.7–2.3

6. T F T T T
Second order neurons are of two types- nociceptive specific neurons located in lamina 1 and respond only to noxious stimuli and wide dynamic range neurons which are present in lamina V and respond to both noxious and non-noxious stimuli. Glutamate aspartate is an excitatory amino acid and activates AMPA (ionotropic amino-3-hydroxyl-5 methyl-4 propionic acid) and kainite receptors. NMDA activation, wind up and central sensitisation are responsible for clinical hyperalgesia. Increased intracellular and extracellular prostaglandin E and nitric oxide are responsible for central sensitisation.

Woolf CJ. An overview of the mechanisms of hyperalgesia. Pulm Pharmacol. 1995;8(4–5):161–7.

7. T T T T T
Modulation is mediated by the inhibitory action of endogenous analgesic compounds (enkephalins, norepinephrine, GABA) released from spinal interneurons and terminal endings of inhibitory areas from locus ceruleous. Balance between excitatory mediators and the inhibitory effects of endogenous analgesics adjusts potassium ion flux and firing frequency of dorsal horn cells.

8. T T T F T
Projections from limbic cortex activates motor cortex, hypothalamus and pituitary gland mediating persistent pain. Frontal cortex and amygdala mediate fear, anxiety, helplessness, learned avoidance associated with acute pain. Primary somatosensory cortex is mainly responsible for acute noxious stimuli while insular cortex is responsible for pain anticipation. Increased blood flow in the parietoinsular cortex corresponds to the physical sensation of pain and its intensity (pain thresholds).

Besson JM. The neurobiology of pain. Lancet. 1999;353(9164):1610–5.

9. T T F T T
Central sensitisation requires activation of spinal and supra-spinal NMDA receptors and increased intraneuronal calcium ion influx. It is divided into transcription dependent and independent and later represents neurochemical and electrical alterations seen in trauma. Upregulation of AMPA receptors leads to increase in synaptic efficacy and firing rate of dorsal horn cells. This leads to tactile allodynia which outlasts the conditioning stimulus for hours e.g. sunburn. Wind up is a form of transcription independent central sensitisation that is rapid and reversible.

Rygh LJ, Svendsen F, Fiska A. long term potentiation in spinal nociceptive systems. How acute pain may become chronic. Psychoneuroendocrinology. 2005;30(10):959–64.

10. T F F T T
Transducing ion channels primarily determine response specificity. Sensitisation occurs by modifying voltage gated channels to reduce firing thresholds and increase the response to supra-threshold stimuli. Increase in substance P and calcitonin gene related peptide (CGRP) causes neurogenic oedema (redness, warmth, oedema and pain). Thermal hyperalgesia is attenuated by ERK inhibitors.

Bhave G, Gereau 4th RW. Posttranslational mechanisms of peripheral sensitisation. J Neurobiol. 2004;61:88–106.

11. T F F F F

Acute surgical traumatic injury may cause increased blood flow (flare), tissue oedema (wheal), sensitisation of peripheral nociceptors (hyperalgesia). Hyperalgesia refers to altered state of sensibility in which intensity of discomfort associated with repetitive noxious stimuli is increased. Primary hyperalgesia involves Aδ and C nociceptors. Allodynia refers to painful perception of ordinarily non noxious stimuli e.g. touch and pressure. It is mediated by IL-1β and IL-6. Sensitizers like substance P and noradrenaline are released causing an increase in sensitivity. Secondary hyperalgesia is the adaptive facilitatory change seen in spinal cord, brainstem and limbic system. Secondary hyperalgesia has wide dynamic range neurons exhibiting enhanced sensitivity for prolonged periods. It is not antagonised by inhalational anaesthetics or parenteral opioids.

Raja SN, Meyer RA, Campbell JN. Peripheral mechanisms of somatic pain. Anesthesiology. 1988;68:571–90.

Primary hyperalgesia	Secondary hyperalgesia
Seen 30–60 min after injury	Develops later
Lasts for several hours or days	Shorter duration
Seen in the area of injury	Seen in the area surrounding the injured area
Non-painful stimuli perceived as painful	Pain is more than normal
Mechanism	
Decreased pain threshold	Convergence facilitation

12. T F T T T

Sympatho-adrenal response manifests in three stages. Initial stage is flight/fight reaction which allows rapid withdrawal from the traumatic event. It is followed by "resistance stage" which maintains blood flow to critical areas. The third is the "exhaustion stage" which limits mobility and improve tissue repair. Sympathetic amines are increased following extensive procedures and in younger individuals. Sympatho-adrenal response may increase oxygen requirements and may cause worsening of coronary artery disease. The response decreases microcirculatory blood flow to non-essential areas causing impaired wound healing, increased visceral spasm, visceral/somatic ischaemia and acidosis. Platelet activation may be increased and may accelerate coagulation.

Breslow MJ. Neuroendocrine responses to surgery. In: Breslow MJ, Miller CF, Rogers MC, editors. Perioperative management. St. Louis, MO: Mosby; 1990.

13. F T F T T

Increased secretion of catabolic hormones is seen e.g. cortisol, glucagon, growth hormone and catecholamines. Anabolic steroids are decreased like insulin and

testosterone. There is increased tendency for infections because of impaired immunocompetence secondary to decreased Ig synthesis and impaired phagocytosis. Neuroendocrine response is increased by interleukins esp. IL-6 and IL-1β which increases ACTH and cortisol levels. B endorphin is an endogenous opioid neuropeptide. It is an agonist of the opioid receptor with affinity for μ receptors.

Chernow B. Hormonal response to a graded surgical stress. Arch Intern Med. 1987;147:1273–8.

14. F F T T F

Perioperative ischaemia occurs between 1 and 3 days. Poorly controlled pain contributes to it. Oxygen requirements are increased while oxygen supply is decreased. Vital capacity is the first parameter to change (40–60%) after thoracic surgery (within 3 h). Decrease in functional residual capacity is associated with progressive arterial hypoxaemia and increase in functional residual capacity causes improvement in physiological shunt.

Ali J, Weisel RD, Layig AB. Consequences of post-operative alterations in respiratory mechanics. Am J Surg. 1974;128:376–82.

15. T T T T T

Injury causes increased stress response (increased catecholamines and angiotensin) which increases the platelet-fibrinogen activation and increased coagulable state. Pulmonary embolism is associated with 20–30% mortality. Risk factors for persistent pain include pain at the site of injury, young population, psychosocial abnormalities, genetic susceptibilities.

Mannion RJ, Woolf CJ. Pain mechanisms and management: a central perspective. Clin J Pain. 2000;16(suppl):144–56.

16. T F T F T

Plasma levels of albumin are decreased with increase in age which causes increase in fraction of unbound or active drug and may cause toxicity. Average postoperative morphine requirements can be calculated as:

$$24 \text{ hour morphine requirement}(\text{mg}) = 100 - \text{age}(\text{years})$$

Most validated scale for detecting age differences in post-operative pain are McGill pain questionnaire and present pain intensity. VAS has insufficient sensitivity. (*Gagliese L, Weizblit N, Ellis W. the measurement of post-operative pain: a comparison of intensity scales in younger and older surgical patients. Pain. 2005;117:412–20*). PCA can be used in children. (*Marchetti G, Calbi G, Vallani A. PCA in the control of acute and chronic pain in children. Paedr Med Chir. 2000;220:9–13*). Ethnicity plays a major role in response to oral analgesics but not PCA. Females experience more pain than males in post-operative period. (*Aubrun F, Salvi N, Coriat P. Sex and age related differences in morphine requirements for post-operative pain relief. Anesthesiology. 2005;103:156–60*).

17. T T T F F

Highly aggressive and angry patients tend to consume more morphine than passive patients. (*Bachiocco V, Morselli AM, Corli G. Risk factors for early post-operative pain includes age, preoperative neuroticism, sensitivity to cold*

pressure-induced pain. J Pain Symptom Manage. 1993;8:205–14). Thoracotomies, nephrectomies, spinal fusion, upper abdominal surgery, amputation are more painful than herniorrhaphy. Pre-emptive analgesia is not much beneficial if the regional anaesthesia technique is not continued in the postoperative period. (*Soler Company E, Faus Soler M, Montaner Abasolo M, et al. Factors affecting post-operative pain. Rev Esp Anestesiol Reannim. 2001;48:163–70*). Age is a better predictor than weight for PCA morphine dosage. (*Macintyre PE, Jarvis DA. Age is the best predictor of postoperative morphine requirements. Pain. 1995;64:357–64*).

18. T F T T F

Females respond better to nalbuphine (κ opioid agonist) than morphine (μ agonist). (*Gear RW, Miaskowski C, Gordon NC, et al. The kappa opioid nalbuphine produces gender and dose dependent analgesia in patients with postoperative pain. Pain. 1999;83:339–45*). Haemodialysis does not affect buprenorphine levels allowing for stable analgesia and is the drug of choice in renal failure patients. Liver failure mostly affects oxidation while morphine metabolism follows glucronidation which is less affected. Morphine clearance is decreased and oral bioavailability is increased. Methadone is contraindicated in liver failure. (*Tegeder I, Lotsch J, Geisslinger G. Pharmacokinetics of opiods in liver disease. Clin Pharmacokinet. 1999;37:17–40*).

19. F T T T T

Anxiety is the most important factor predicting postoperative pain. State anxiety significantly contributes to the prediction of pain. Pain anxiety symptom scale has four subscales- fear, cognitive anxiety, somatic anxiety, escape/avoidance. (*McCraken LM, Zayfert C, Grass RT. The pain anxiety symptoms scale: development and validation of a scale to measure fear of pain. Pain. 1992;50:67–73*). Kinesiophobia is excessive and irrational fear of movement and injury/reinjury. Catastrophising is tendency to ruminate on and magnify pain sensation and to feel helpless when confronted with pain. Increased activity is seen in brain areas related to anticipation of pain (medial frontal cortex and cerebellum). (*Pavlin DJ, Sullivan MJL, Freund PR. Catastrophising: a risk factor for post-surgical pain. Clin J Pain. 2005;21:83–90*).

20. T T F T T

Distraction produces significant reduction in distress and increase in coping behaviour. (*Cohen LL, Blount RL, Cohen RJ. Comparative study of distraction versus topical anaesthesia for paediatric pain management during immunisations. Health Psychol. 1999;18:591–8*). Cognitive behavioural therapy is effective especially in reducing behavioural distress. Hypnosis causes reduction in acute pain along with decrease in drug usage and haemodynamic stability. (*Long EV, Barbaum KS, Fainluch S, et al. Adjunctive self-hypnotic relaxation for outpatient procedures: a prospective randomised trial with women undergoing large core breast biopsy. Pain. 2006;126:155–64*). Hypnosis causes decrease in involuntary sympathetic response to pain, increase in endogenous opioid release, change in brain activity (anterior cingulate gyrus) and inhibition of pain at spinal cord.

Anatomical and physiological characteristics of nerve fibers:

Nerve type	Function	Diameter	Conduction velocity (m/s)	Myelination	Sensitivity to local anaesthetics
A fibres					
Aα	Motor	12–20	70–120	+++	++
Aβ	Touch, pressure	5–12	30–70	+++	++
Aγ	Proprioception, muscle tone	1–4	15–30	++	+++
Aδ	Pain, temperature	1–4	12–30	++	+++
B fibres	Preganglionic autonomic	1–3	3–15	+	++
C fibres	Postganglionic autonomic, pain, temperature	0.5–1	0.5–2		+

Assessment and Monitoring of Pain

2

1. Acute pain assessment:
   (a) Visual analogue scale is equally effective as numeric rating scale and verbal categorical rating scale (VRS).
   (b) Faces pain scale is well validated.
   (c) Assessment of pain during mobilisation is more effective for pain control than at rest.
   (d) Mechanical allodynia is assessed by von frey filaments.
2. Visual analogue scale:
   (a) Uses a 10 cm line with end point descriptors.
   (b) Measures subjective characteristics or attitudes that can be directly measured.
   (c) Is inferior to likert scale.
   (d) Can be used in the assessment of parameters other than the pain.
   (e) Can be used to compare pain intensity between two individuals.
3. Verbal numerical rating scale:
   (a) Assessment is by a number between 0 and 10.
   (b) Pain intensity is not adequately measured.
   (c) There is low interchangeability between the scales.
   (d) Not useful in language barriers.
   (e) No special instruments are required.
4. Assessment of acute pain:
   (a) VAS is superior than NRS and VRS for assessment of pain intensity.
   (b) The scales only measure patient's subjective feeling of pain intensity.
   (c) Four point VRS underestimates the most intense pain as compared to VAS.
   (d) Faces pain scale can be used in infants.
   (e) Categorical pain scales measure accurately pain intensity.
5. Brief pain inventory:
   (a) Has 9 items in inventory.
   (b) Is of benefit in younger population only.
   (c) Can be used for research purposes.

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(d) Is only used for non cancer pain.
(e) Can be used in patients with disability related pain.

6. Visual analogue scale:
   (a) Is validated for clinical use.
   (b) Is a form of likert scale.
   (c) Easy to administer.
   (d) Scale can only be used face to face.
   (e) Is better than verbal descriptor scale.
7. Numerical rating scale:
   (a) Horizontal VAS may be more useful in elderly population.
   (b) Disadvantage is less psychometric properties.
   (c) NRS is more effective when shown visually along with asking the patient to rate verbally.
   (d) Is not used in people who cannot read or write.
   (e) Gold standard for pain measurement is self reporting.
8. Wong Baker FACES pain rating scale:
   (a) Can be used only in paediatric patients.
   (b) Is of use in patients with cognitively impaired.
   (c) Is based on age, gender and culture.
   (d) May give falsely high scores.
   (e) Revised faces scale was developed for preschool and school going age.
9. Assessment scales for patients who cannot self report:
   (a) Checklist of non verbal indicators has high sensitivity.
   (b) Pain assessment in advanced dementia scale is used in patients with advanced dementia.
   (c) Abbey pain scale measures only acute pain.
   (d) Elderly pain causing assessment 2 measures both persistent and acute pain.
   (e) Mobilisation observation behaviour intensity dementia pain scale is used for those having musculoskeletal pain.
10. Pain assessment in critically ill:
    (a) Endotracheal tube suctioning causes severe pain.
    (b) The most painful procedure in intensive care is turning of the patient.
    (c) Under treatment of procedural pain is common.
    (d) FLACC is of use in critically ill patients.
    (e) Behavioural pain scale (BPS) is better than critical care pain observation tool (CPOT).
11. Pain assessment in intellectually disables patients:
    (a) Intellectual disability is based on IQ measurement.
    (b) Pain thresholds is lower than normal controls.
    (c) Adults with mental retardation have more acute than chronic pain.
    (d) Moaning during manipulation is an indicator of severe pain.
    (e) Pain and discomfort scale (PADS) is highly sensitive.
12. Pain assessment in schizophrenia:
    (a) Insensitivity to pain is common in patients.
    (b) More post operative complications seen than normal population.

(c) Response to experimental pain is diminished.
(d) Pain insensitivity may be seen as a familial trait.
(e) Pain is mostly a part of hallucination.

13. Pain assessment in post traumatic stress disorder:
(a) Symptoms take long time for resolution.
(b) Autonomic instability may be a useful marker of pain.
(c) Early treatment helps in the management.
(d) Patients are less sensitive to heat stimuli.
(e) May be seen with fibromyalgia.

Answers

1. F T T T
Verbal rating scale is less useful. It should be used only as a coarse screening instrument. Four point VRS instrument underestimates intense pain as compared to VAS. (*Breivik EK, Bjornsson GA, Skovland E. A comparison of pain rating scale by sampling from clinical trial data. Clin J Pain. 2000;16:22–8*). Faces pain scale is validated for more than 3 years of age. (*Hicks CL, Von Baeyer CL, Spafford PA, et al. The faces pain scale revised: toward a common metric in paediatric pain measurement. Pain. 2001;(93):173–83*). Von frey filaments are made up of nylon hairs, of the same length but will different diameters to provide different range of forces especially from 0.008 gms force up to 300 gms force.
2. T F F T F
Visual analogue scale uses a 10 cm line with no pain at left end of line and worst pain imaginable marked at the right end. The characteristics cannot be measured directly. VAS have superior material characteristics than discrete scales such as likert scale. (*Grant S, Aitchison T, Henderson E, et al. A comparison of the reproducibility and the sensitivity to change of visual analogue scales, borg scales, and likert scales in normal subjects during submaximal exercise. Chest. 1999;116(5):1208–17*). VAS can be used in assessment of parameters other than pain like assessment of loudness and annoyance of acute and chronic tinnitus. (*Adamchic I, Langguth B, et al. Psychometric evaluation of visual analogue scale for the assessment of chronic tinnitus. Am J Audiol. 2012;21:215–25*).
3. T F T T T
One-dimensional scales are least suited to assess pain intensity.
4. F F T F F
VAS is equally effective as NRS and VRS is least effective. The scales also measure unpleasantness of pain and impact of pain on function. (*Breivik EK, Bjornsson GA, Skovlond E. A comparison of pain rating scales by sampling from clinical trial data. Clin J Pain. 2000;16:22–8*). Faces pain scale can be used for more than 3 years. (*Hicks CL, Von Baeyer CL, Spafford PA, et al. The*

faces pain scale-revised. Toward a common metric in paediatric pain management. Pain. 2001;93:173–83). Categorical scales are good as a coarse screening test, whereas accurate pain assessment is by NRS or VAS.

5. T F T F T
   Brief pain inventory measures pain severity and rates level of pain interference with 7 key areas of function (general activity, mood, walking ability, normal work life, relation with people, sleep and enjoyment of life). Brief pain inventory can be used in elderly population. It can be used for cancer pain, cardiac surgery, traumatic stress, diabetic neuropathy. (*Evdemoglu AK, Koc R. Brief pain inventory score identifying and discriminatory neuropathic and nociceptive pain. Acta Neurol Scand. 2013;128(5):351–58*).
6. F T T T F
   Visual analogue scale is validated for research only and not for clinical use. Though it is easy to administer, the scoring is time consuming and takes time. Patients make more mistakes with visual analogue scale (*Peters ML, Patijin J, Lame I. Pain assessment in younger and older pain patients: psychometric properties and patient preference of five commonly used measures of pain intensity. Pain Med. 2007;8(7):601–10*).
7. F F T F T
   There are two types of VAS—horizontal and vertical. Vertical VAS is more useful in patients with narrowed visual field, elderly, those having difficulties with horizontal scale. Numerical rating scale has good psychometric properties as compared to verbal descriptor scale, horizontal VAS, vertical VAS. NRS has higher reliability in illiterate patients when compared to VAS or verbal rating scale (*Ferraz MB, et al. Reliability of pain scales in the assessment of literate and illiterate patients with rheumatoid arthritis. J Rheumatol. 1990;17(8):1022–4*).
8. F T F T T
   Adults also prefer the scale because of the cartoon like features.
9. F T F T T
   Checklist of nonverbal indicators uses six behaviour items in cognitively impaired older adults. Fifty percent of patients have no indicators of pain so sensitivity is low. Pain assessment in advanced dementia scale measures breathing, negative vocalisation, facial expression, body language and consolibility. Abbey pain scale is an informant based tool that measures pain intensity in late stage dementia and measures acute pain, chronic pain and acute or chronic pain. MOBD scale guides a patient through five structured activities (mobilisation of both hands, both arms, both legs, turning in bed, sitting at bedside).
10. T T T T F
    Mean pain intensity during endotracheal suctioning is 4–5 where as some patients report up to 7–8. (*Puntillo KA. Dimensions of procedural pain and its analgesic management in critically ill surgical patients. Am J Crit Care. 1994;3(2):116–22*). Painful procedures in intensive care include turning, wound drain removal, wound care, tracheal suctioning, central line placement,

femoral sheath removal. Under treatment of procedural pain is seen up to 63%. (*Puntillo KA, et al. Practice and procedures of analgesic intervention for adults undergoing painful procedures. Am J Crit Care. 2002;11(5):415–29*). Face, legs, activity, cry, consolibility scale. Other measures include behavioural pain rating scale, behavioural pain scale, non verbal pain scale, critical care pain observation scale. CPOT is better than BPS as it evaluates 4 domains instead of 3. Behavioural pain scale includes facial expression, movements of upper limbs, compliance with ventilation. CPOT also addresses both ventilated and non ventilated patients whereas BPS only addresses ventilated patients.

11. T T F T T

An IQ of 50–70 is mild cognitive impairment, 35–49 is moderate cognitive impairment, 20–34 is severe cognitive impairment and less than 20 is profound impairment. Disables patients are more sensitive to some types of pain. Adults with mental retardation have more chronic than acute pain on a daily basis. (*Bodfish J, et al. Issues in pain assessment for adults with mental retardation. From research to practice. In: Oberlander TF, Symons FJ, editors. Pain in developmental disabilities. Baltimore, MD: Paul H Brookes*). Indicators for severe pain include crying during manipulation, painful facial expression, swelling, screaming, not using affected body part. PADS is sensitive to nonverbal signs of pain in adults with severe intellectual disability and is sensitive to everyday pain, acute pain response, chronic pain and effect of treatment on acute pain.

12. T T T T F

Post operative complications are seen more in schizophrenic patients like respiratory failure, deep venous thrombosis. They report less post operative pain and consume less than 60% of analgesic medication. Response to experimental pain is diminished. (*Polvin S, Marchand S. Hypoalgesia in schizophrenia is independent of antipsychotic drugs: a systemic review of experimental studies. Pain. 2008;138(1):70–8*). Pain insensitivity may be seen as a familial trait (*Singh MK, et al. Pain insensitivity in schizophrenia: trait or state marker. J Psychiatr Pract. 2006;12(2):90–102*).

13. F T T T T

PTSD is an anxiety disorder that can occur following an extremely traumatic event that involves being threatened by or witness to a situation that involves death or injury. The symptoms begin within 3 months and 50% recover with 3 months. Early treatment has a protective effect especially with propranolol. (*Pitman RK, et al. Pilot study of secondary prevention of post traumatic stress disorder with propranolol. Biol Psychiatry. 2002;51(2):189–92*). Patients are less sensitive to heat stimuli. They respond more to suprathreshold heat and mechanical stimuli. (*Geuze E, et al. Altered pain processing in veterans with post traumatic stress disorder. Arch Gen Psychiatry. 2007;64(1):76–85*). PTSD like symptoms may be seen with in fibromyalgia (*Cohen H, et al. Prevalence of post traumatic stress disorder in fibromyalgia patients: overlapping syndromes or piost traumatic fibromyalgia syndrome. Semin Arthritis Rheum. 2002;32:38–50*).

Pharmacology

3

1. Characteristics of non opioid analgesics:
   (a) Regular daily use of NSAIDs is better than opioids.
   (b) Non opioids should not be given with opioids at the same time.
   (c) NSAIDs do not cause gastric ulcers if given rectally or parenteraly.
   (d) Antacids with NSAIDs are effective in reducing gastric ulcers.
   (e) NSAIDs affect bone healing for longer period of time.
2. Non-steroidal anti-inflammatory drugs:
   (a) First line analgesics for acute nociceptive pain.
   (b) Single dose of these drugs may be effective.
   (c) Are more effective for somatic nociceptive pain especially involving inflammation.
   (d) Combination of two NSAIDs gives better results.
   (e) Can contribute to opioid sparing effect.
3. Adverse effects of NSAIDs:
   (a) Chronic usage may lead to tolerance.
   (b) Risk factors for liver injury include poor nutrition.
   (c) Advanced age is a risk factor for NSAID induced gastro intestinal adverse effect.
   (d) COX-2 selective NSAIDs have no effect on bleeding time.
   (e) Depression is a known risk factor for acetaminophen toxicity.
4. Adverse effects of NSAIDs:
   (a) High acetaminophen usage is associated with decrease in renal function.
   (b) Acetaminophen is better than NSAIDs for analgesia in renal disease.
   (c) Acetaminophen use may cause hypertension.
   (d) Acetaminophen may be associated with anticoagulant effect.
   (e) Acetaminophen is COX-1 selective.
5. Adverse effects of NSAIDs:
   (a) Long term therapy causes gastrointestinal complications in 80% of patients.
   (b) Nabumetone is the non selective NSAID mostly involved with gastric injury.

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(c) Gastrointestinal complications are more if the medications are used for more than a year.
(d) Helicobacter pylori increase the risk of peptic ulcers with concomitant use of NSAIDs.
(e) COX-2 selective NSAIDs are associated with cardio vascular complications.

6. Adverse effects of NSAIDs:
   (a) Misoprostol is well tolerated in elderly population.
   (b) H2 antagonists are beneficial in patients with Helicobacter pylori infection.
   (c) Ulcer relapse rate is more with misoprostol than omeprazole.
   (d) COX-2 selective NSAIDs along with proton pump inhibitors is more effective than COX-2 alone.
   (e) Celecoxib is associated with less mucosal breaks.
7. Adverse effects of NSAIDs:
   (a) Increased risks of cardiovascular side effects are seen with rofecoxib and valdecoxib.
   (b) COPD is a risk factor for cardiovascular events with COX-2 inhibitors.
   (c) Stroke seen is more common in females.
   (d) Cigarette smoking is protective for cardiovascular events in BSAID users.
   (e) Obstructive sleep apnoea is a modifiable risk factor.
8. Adverse effects of NSAIDs:
   (a) Rofecoxib increases cardiovascular events.
   (b) Valdecoxib is associated with cutaneous hypersensitivity.
   (c) Meloxicam has a better side effect profile.
   (d) Elderly patients taking aspirin should avoid NSDAIDs.
   (e) Celecoxib is contraindicated in bleeding disorders.
9. NSAID effect on renal system and vascular system:
   (a) COX-2 is present in glomerulus and afferent arteriole.
   (b) NSAID induced renal toxicity mostly occurs in use during post operative period.
   (c) Endogenous renal prostaglandin synthesis does not have significant role in maintaining GFR and renal blood flow.
   (d) Heart failure and chronic kidney disease are absolute contraindications for NSAID therapy.
   (e) Celecoxib treatment has the lowest incidence of cardiovascular adverse effects.
10. Topical NSAIDs:
    (a) Are not available in patches.
    (b) Works by inhibiting NMDA and sodium channels.
    (c) Therapeutic effect is due to absorption in systemic circulation.
    (d) Bioavailability is 50–60%.
    (e) Gels are more effective than creams.
11. Topical NSAIDs:
    (a) Diclofenac 1.3% patch causes decrease in pain, morning stiffness in acute pain.

(b) Topical diclofenac has no role in osteoarthritis.
(c) Topical diclofenac is more effective than oral diclofenac in morning stiffness.
(d) Piroxicam topical preparation is better choice for osteoarthritis than diclofenac.
(e) Ibuprofen cream can help in analgesia post DC cardioversion.

12. Acetaminophen:
(a) Increase of the dosage more than 1000 mg adds little to analgesia.
(b) Is safe to use in liver disease.
(c) Liver function tests should be performed.
(d) Has no gastrointestinal effect.
(e) Should be used with caution in G6PD deficiency.

13. NSAIDs for acute and chronic pain:
(a) Ibuprofen at a dose of 400 mg cause both analgesic and anti-inflammatory effect.
(b) Celecoxib efficacy is increased by giving maximum dosage in divided doses.
(c) NSAIDs with longer half life have a slower onset of analgesia.
(d) Caution is required in older population.
(e) Analgesia occurs after few weeks of usage.

14. Ketorolac:
(a) Is effective for severe pain in combination with other analgesics.
(b) An initial loading dose is required.
(c) Duration of analgesia is extended if given by intramuscular route.
(d) Most frequent side effect is headache.
(e) Renal failure is a contraindication.

15. Adverse effects of NSAIDs:
(a) Acetaminophen does not cause hematologic abnormalities.
(b) Aspirin should be stopped 5 days preoperatively.
(c) Increased risk of bleeding with ketorolac is seen with advanced age.
(d) NSAIDs should be avoided in renal failure irrespective of half lives.
(e) COX-2 selective NSAIDs inhibit healing more than nonselective NSAIDs.

16. Mechanisms of opioid analgesia:
(a) Therapeutic opioids activate endogenous pain modulating systems and produce analgesia.
(b) Endogenous opioids inhibit pain via the descending modulatory systems.
(c) Opioids decrease the influx of calcium.
(d) Opioids inhibit GABA system leading to pain transmission.
(e) Opioids can cause produce analgesia following local administration.

17. Opioid receptor sites:
(a) Three types are seen.
(b) Antagonists reverse opioid side effects.
(c) Mu receptors are free of respiratory depression.
(d) Most opioids bind to mu receptor sites.
(e) Nalbuphine is a pure mu agonist.

18. Pharmacokinetics of opioids:
    (a) Oral bioavailability of morphine is more than parenteral administration.
    (b) Bioavailability is increased in hepatic dysfunction.
    (c) Hydromorphone has 100% bioavailability by intravenous route.
    (d) Lipid solubility increases bioavailability.
    (e) Protein bound drug is devoid of pharmacological activity.
19. Pharmacokinetics of opioids:
    (a) Morphine metabolites are active.
    (b) Prodrugs are pharmacologically active.
    (c) CYP450 is the only enzyme system responsible for metabolism of opioids.
    (d) CYP450 enzyme system is important for opioid metabolism.
    (e) Poor metabolisers do not get desired analgesic effect.
20. Pharmacokinetics of opioids:
    (a) Liver is the primary organ for elimination.
    (b) Terminal half life is the same as distribution half life.
    (c) Creatinine clearance can alter with age.
    (d) Drug half life increases with age.
    (e) Long term opioid analgesic treatment is based on steady state concentration.
21. Opioid efficacy and potency:
    (a) Receptor occupancy which is required for an agonist to produce a response is inversely proportional to its intrinsic efficacy.
    (b) Efficacy is the same as potency.
    (c) Increased potency means increased therapeutic effect.
    (d) Opioids do not have analgesic ceiling.
    (e) Opioids are the first line of medications for neuropathic pain.
22. Opioid tolerance:
    (a) Continued exposure to the drug is the main cause.
    (b) Tolerance develops due to addiction.
    (c) Tolerance develops more quickly in younger individuals than in older patients.
    (d) Sedation levels are used to monitor opioid induced respiratory depression.
    (e) The first indication of tolerance is decrease in analgesic effect.
23. Opioid tolerance:
    (a) Tolerance to the analgesic effects of opioids is absolute.
    (b) Pain can diminish adverse effects of opioids.
    (c) Drugs that act at the same receptor can produce different levels of tolerance.
    (d) Incomplete cross tolerance is due to different selectivity for the receptor subtype.
    (e) New opioids used in opioid rotation should be increased by 20–50% in dosage for maximum effect.
24. Opioid tolerance:
    (a) Opioid tolerance can develop as early as 7 days of continuous use.
    (b) Develops only on intravenous opioids.

(c) Opioid tolerance patients should have background infusion in PCA post operatively.
(d) Tolerance to side effects develops earlier than analgesia.
(e) Dose of opioids required by opioid tolerant patient with cancer pain is not increased.

25. Physical dependence:
(a) Can be seen with other drugs than opioids.
(b) Is associated with withdrawal.
(c) Can be avoided by avoiding abrupt cessation or administration of an opioid antagonist.
(d) Onset of withdrawal symptoms is independent of half life.
(e) Opioid weaning is dependent on the duration of opioid intake.

26. Breakthrough pain:
(a) Is mostly a continuous type.
(b) Is similar to incident pain.
(c) End of dose failure is treated by decreasing the dosage of opioids.
(d) Most common type of breakthrough pain is neuropathic pain.
(e) It decreases the quality of life.

27. Treatment of breakthrough pain:
(a) Is always pharmacotherapy.
(b) Mostly opioids are prescribed on as required basis.
(c) Oral opioids are the drugs of choice for breakthrough pain.
(d) Transmucosal and intranasal routes are better than oral route.
(e) Intrathecal opioids can be given for breakthrough pain.

28. Patient demand dosing of opioids:
(a) Requires active patient participation.
(b) Is only effective for breakthrough pain.
(c) Risk of under treatment is seen.
(d) There is no risk for under treatment in dementia.
(e) Patient controlled analgesia is a method of as required dosing.

29. Patient controlled analgesia:
(a) Is based on nurse's interpretation of pain.
(b) Can be used for procedural sedation.
(c) Only opioid analgesics can be used.
(d) Better pain control is seen.
(e) Can be used in children.

30. Morphine:
(a) Is a pure mu agonist.
(b) Is first line medication for neuropathic pain.
(c) Cognitive decline is seen with opioid use.
(d) Has good lipid solubility.
(e) Intramuscular morphine is the ideal route.

31. Morphine:
(a) All the metabolites of morphine are active at opioid receptors.
(b) M3G is implicated in opioid induced hyperalgesia.
(c) M3G produces less side effects than morphine.

(d) Morphine has longer duration of action.
(e) Dosage of oral route is the same as intravenous route.

32. Codeine:
(a) Efficacy of codeine increases as the dosage increases.
(b) The ideal route to administer is intramuscular route.
(c) Is a prodrug.
(d) Metabolism depends on the presence of cytochrome P4502D6.
(e) Is not secreted in the breast milk.

33. Codeine:
(a) Is absorbed from gastrointestinal tract.
(b) Tolerance does not develop.
(c) Sudden abstinence is life threatening.
(d) Hypogonadism can occur in male patients.
(e) Has an inherent antitussive effect.

34. Fentanyl:
(a) Ventilation may be difficult on rapid intravenous administration.
(b) Is less potent than morphine.
(c) Lipophilicity decreases the absorption.
(d) The patch's efficacy is dependent on steady state.
(e) Can be given by intrathecal route.

35. Fentanyl:
(a) Transmucosal route is used in opioid tolerant patients.
(b) Works at both Presynaptic and post synaptic levels.
(c) Steady state is achieved with patch after 12 h.
(d) Patches need to be stored at room temperature.
(e) Transmucosal Fentanyl is ideal for breakthrough pain.

36. Methadone:
(a) Can be given intrathecally.
(b) Can be used as patient controlled epidural analgesia.
(c) Acts only at mu receptors.
(d) Pharmacokinetics is similar to morphine.
(e) Is metabolised by hepatic pathway.

37. Methadone:
(a) Oral bioavailability is lesser than morphine.
(b) Has toxic metabolites.
(c) Causes inhibition of reuptake of serotonin and nor epinephrine at central synapses.
(d) Is ideal for sublingual and topical administration.
(e) Elimination is primarily via faeces.

38. Sufentanil:
(a) Less lipid soluble than Fentanyl.
(b) Quality of analgesia via epidural route is better than Fentanyl.
(c) Can be used intraspinally.
(d) Can be used as a patch.
(e) Can displace buprenorphine from its binding sites.

39. Opioid therapy:
    (a) Weight has direct correlation with analgesic requirements.
    (b) Opioid initiating dose should be lowered in elderly.
    (c) Equianalgesic chart is helpful when switching from one drug to another.
    (d) Breakthrough pain may require boluses of op to every 15–30 min.
    (e) Dose of breakthrough pain is normally 20–30%.
40. Opioid therapy:
    (a) Titration is aimed at finding the lowest possible effective dose.
    (b) Increase in breakthrough doses is an indicator for increasing sustained release medication.
    (c) Multimodal therapy leads to less titration of opioids.
    (d) Fentanyl is ideal for acute titration of post operative pain.
    (e) Short acting drugs should be used in conjunction with long acting medicines.
41. Patient controlled analgesia:
    (a) Can be given only via the intravenous route.
    (b) Large doses with long lock out period are ideal.
    (c) Analgesia requirement increases with age.
    (d) Use of opioid infusions in opioid naive patients is not recommended.
    (e) PCA by proxy is safe.
42. Adverse effects of opioids:
    (a) Are dose dependent.
    (b) Dose reduction should be 50% to avoid side effects.
    (c) Constipation is due to delayed gastric emptying.
    (d) Opioid agonists are helpful in refractory constipation.
    (e) Risk factors for constipation include advanced age, immobility, abdominal disease, concurrent medications.
43. Adverse effects of opioids:
    (a) Bulk laxatives are ideal for treating opioid induced constipation.
    (b) Initial treatment in constipation is a combination treatment.
    (c) Continuous thoracic epidural can prevent paralytic ileus.
    (d) Opioid antagonists induced withdrawal symptoms is maximally seen with naloxone.
    (e) Post operative ileus is true obstruction.
44. Adverse effects of opioids:
    (a) Routing nasogastric decompression should be used in paralytic ileus.
    (b) Oral intake should be started as early as possible to prevent ileus.
    (c) Excess fluids can decrease gastro-intestinal motility and increases ileus.
    (d) Laparoscopy technique can reduce ileus.
    (e) Opioids should be avoided in post operative ileus.
45. Adverse effects of opioids:
    (a) Nausea usually develops after weeks of opioid treatment.
    (b) Female sex is a risk factor for opioid induced nausea and vomiting.
    (c) Incident pain is associated with higher incidence of post operative nausea and vomiting.

(d) Single drug antiemetic prophylaxis has a high success rate.
(e) Prophylactic antiemetics should be given to all patients.

46. Adverse effects of opioids:
(a) Billiary spasm by opioids can increase pain.
(b) Meperidine has no effect on sphincter of oddi.
(c) Pruritus is an uncommon complication.
(d) Pruritus can be measured on a numerical scale.
(e) Post operative opioid induced Pruritus patients have well controlled pain.

47. Adverse effects of opioids:
(a) Intravenous patient controlled analgesia has the highest incidence of hypotension.
(b) All opioids cause bradycardia.
(c) Incidence of hypotension can be minimised by administering opioid slowly.
(d) High incidence of urinary retention is seen in post operative period in elderly men.
(e) Addition of local anaesthetic to opioids intrathecally can decrease the evidence of urinary retention.

48. Adverse effects of opioids:
(a) Tolerance to opioid induced urinary retention is seen.
(b) Myoclonus is rare in patients taking opioids.
(c) Myoclonus is seen mostly with Meperidine.
(d) Mental status changes may be seen in majority.
(e) Post operative delirium occurs in older patients.

49. Adverse effects of opioids:
(a) Poorly managed pain is a risk factor for post operative pain.
(b) Meperidine causes most amount of post operative delirium.
(c) Fentanyl PCA has less cognitive impairment post operatively than morphine PCA.
(d) Opioids cause sedation due to its anticholinergic activity.
(e) Donezepil is useful in opioid induced sedation.

50. Adverse effects of opioids:
(a) Severe respiratory depression may be seen.
(b) Post operative hypoxaemia is oxygen saturation less than 95%.
(c) Tolerance to respiratory depression is seen.
(d) Respiratory depression is maximally seen 2–3 days after the surgery.
(e) End tidal CO2 is an early indicator of impending respiratory depression.

51. Addiction of opioids:
(a) High risk is seen after the post operative period.
(b) Physical dependence can be seen within hours of administration.
(c) Tolerance is appropriately treated by decreased opioid dosage.
(d) Increase in opioid dosage can cause increase in pain.
(e) COX-2 inhibitors can prevent opioid induced hyperalgesia.

52. Adverse effects of opioids:
(a) Immune function is suppressed as early as 2 weeks of opioid initiation.
(b) Long term opioids can cause hypogonadism.
(c) Pain in persons with addictive disease is undertreated.

(d) Methadone maintenance treatment should be continued in surgeries requiring opioids.
(e) Adding opioids to patients with history of addiction problems may lead to relapse.

53. Opioid use in special conditions:
(a) Meperidine is ideal in pregnancy.
(b) Infants may show addiction behaviour born to mothers who take opioids.
(c) Meperidine is contraindicated in lactating mothers.
(d) Most painful procedure responsive to opioids in intensive care unit is simple turning of the patient.
(e) Increased dose of analgesics and sedatives are associated with shortened survival.

54. Adjuvant analgesics:
(a) Are reliable in providing pain relief on its own.
(b) Are only effective for neuropathic pain.
(c) Can be used for acute pain.
(d) Are more time consuming.
(e) Treatment of depression may give pain relief.

55. Adjuvant analgesics during pregnancy:
(a) Steroids should be avoided during first trimester.
(b) Anticonvulsants are safe during pregnancy.
(c) Usage of phenytoin has high incidence of teratogenic effect.
(d) Local anaesthetics dose may be decreased in pregnancy.
(e) Tricyclic antidepressants are not recommended in pregnancy.

56. Multimodal analgesia:
(a) Has a major role in acute pain and post operative pain.
(b) Achieves pain relief with minimal side effects.
(c) May help in treatment symptoms related to pain.
(d) May cause increase in side effects.
(e) Most adjuvant medications have hepatic metabolism.

57. Clonidine:
(a) Is an alpha-2 agonist.
(b) Can be used via neuraxial route.
(c) Transdermal patch is useful in post operative pain.
(d) Causes sedation.
(e) Transdermal patch can be cut into pieces.

58. Ketamine:
(a) Can be used for post operative pain.
(b) Can be used for treating acute opioid induced hyperalgesia.
(c) Perioperative Ketamine decreases opioid usage and complication rate.
(d) Has better analgesic profile in depressed patients in acute pain.
(e) Epidural route is the preferred route for post operative pain management.

59. Mode of local anaesthetics:
(a) Blocks impulses by inhibiting sodium channels.
(b) Local anaesthetics cause complete neural blockade.
(c) Has analgesic effect when given systematically.

(d) Cocaine belongs to amide linked local anaesthetics.
(e) Local anaesthetics may cause vasodilatation or vasoconstriction depending upon concentration.

60. Local anaesthetics:
(a) Cocaine is the most potent vasodilator.
(b) Cocaine causes only vasoconstriction.
(c) Lidocaine causes its action by inhibiting the reuptake of nor epinephrine.
(d) Local anaesthetics have great absorption by oral route.
(e) Tracheal administration uptake is as rapid as intravenous route.

61. Local anaesthetics:
(a) Distribution is higher in highly perfused organs.
(b) Skeletal muscle has the highest concentration of local anaesthetics during distribution.
(c) Half life is the time required for a 50% reduction in the blood levels.
(d) Local anaesthetics do not cross blood brain barrier.
(e) Ester local anaesthetics are hydrolysed by the enzyme pseudo cholinesterase.

62. Metabolism of local anaesthetics:
(a) Chlorprocaine is the most rapidly hydrolysed ester local anaesthetic.
(b) Rapidly hydrolysed local anaesthetics are least toxic.
(c) Allergic reactions seen are more due to parent compound.
(d) Atypical form of pseudo cholinesterase is rare.
(e) Primary site of metabolism of amide local anaesthetics is liver.

63. Metabolism of local anaesthetics:
(a) Prilocaine metabolism may involve lungs.
(b) Amide local anaesthetic metabolism is not affected by conditions affecting liver.
(c) Prilocaine causes methemoglobinaemia.
(d) Lidocaine administration can cause sedation.
(e) Esters are completely hydrolysed in the plasma.

64. Systemic actions of local anaesthetics:
(a) Excitement may be seen in central nervous system.
(b) Local anaesthetics have anticonvulsant properties.
(c) Numbness of tongue is due to direct depressant effects of CNS.
(d) Sedation may be seen as part of toxicity.
(e) Increased PCO2 levels increase the toxicity.

65. Systemic actions of local anaesthetics:
(a) Local anaesthetics causes CNS excitation though block of inhibitory pathway in cerebral cortex.
(b) Local anaesthetics increase the pain reaction threshold.
(c) Cardiovascular system is more susceptible to toxicity than central nervous system with local anaesthetics.
(d) Depression of myocardium is seen.
(e) Cocaine is the only local anaesthetic causing vasoconstriction.

66. Systemic actions of local anaesthetics:
    (a) Local anaesthetics cause hypertension.
    (b) Local anaesthetics cause long term skeletal muscle changes.
    (c) Local anaesthetics cause relaxation of bronchial smooth muscle.
    (d) Local anaesthetics may cause neuromuscular blockade.
    (e) Malignant hyperthermia is an absolute contraindication.
67. Mechanism of action of local anaesthetics:
    (a) Augments conduction by decreasing large transient increase in permeability to sodium.
    (b) Local anaesthetics interact directly with voltage gated sodium channels.
    (c) Local anaesthetics decrease propagation of action potential.
    (d) Local anaesthetics bind to sodium channels.
    (e) Local anaesthetics are more active when applied externally to membrane.
68. Mechanism of action of local anaesthetics:
    (a) Sodium channel comprises of proteins.
    (b) Beta subunit is the largest.
    (c) S4 transmembrane helix is dormant with no active role.
    (d) Amino acid residues in short segments of p loop are the main determinants of ion conductance and selectivity of channels.
    (e) Sodium channels inactivates within a few seconds.
69. Mechanism of action of local anaesthetics:
    (a) Amino acid residues for local anaesthetic binding are found in S6 segment (T) domains.
    (b) Resting nerve is more susceptible to local anaesthetic.
    (c) Frequency dependence of local anaesthetic depend on the rate of dissociation from the receptor site in the pore of sodium channel.
    (d) Large fibers are blocked before small fibers.
    (e) Node of Ranvier has no role in nerve blockade.
70. Factors affecting local anaesthetic action:
    (a) Local anaesthetic salts are acidic.
    (b) Unprotonated species is necessary for sodium channel interaction.
    (c) Unprotonated form possesses anaesthetic activity.
    (d) Vasoconstriction may increase the toxicity of local anaesthetic.
    (e) Vasoconstrictor addition may cause delayed wound healing, tissue oedema and necrosis.
71. Effects of local anaesthetic on organ systems:
    (a) Local anaesthetics cause central nervous system depression.
    (b) Local anaesthetic increase cardiac excitability.
    (c) Local anaesthetics relax smooth muscles.
    (d) Hypersensitivity is seen equally between ester and amide local anaesthetics.
    (e) Local anaesthetic effect termination on intrathecal administration is because of esterase enzyme.
72. Cocaine:
    (a) Is an ester of benzoic acid.
    (b) Causes local vasoconstriction.

(c) High toxicity is because of decreased catecholamines reuptake.
(d) Acts by shrinking of mucosa.
(e) Is available as 1%, 4% and 10% solution.

73. Lidocaine:
(a) Is an ester local anaesthetic.
(b) Is absorbed from respiratory tract.
(c) Iontophoretic system is used for dermal procedures.
(d) Metabolites have no anaesthetic activity.
(e) Can be used as an antiarrythemic agent.

74. Bupivicaine:
(a) Is an amide local anaesthetic.
(b) Is structurally similar to Lidocaine.
(c) Provides more motor than sensory anaesthesia.
(d) It dissociates rapidly from sodium channels after binding.
(e) L-bupivicaine is less cardio toxic.

75. Topical local anaesthetics:
(a) Dibucaine is a quinolone derivative.
(b) Dyclonine has a rapid onset of action.
(c) Dyclonine is used in over the counter medications.
(d) Pramoxine has high history of cross sensitivity.
(e) Pramoxine can be safely used in eyes.

76. Use of local anaesthetics:
(a) Peak plasma levels are directly related to amount of local anaesthetic agent.
(b) Subcutaneous infiltration is associated with lowest blood levels.
(c) Epinephrine increases the duration of action of local anaesthetic when applied topically.
(d) Topical Lidocaine is helpful in joint pain.
(e) EMLA can provide anaesthesia to a depth of 5 mm.

77. Infiltration anaesthesia:
(a) Can be used for intra abdominal structures.
(b) Epinephrine increases the duration of infiltration analgesia.
(c) The dosage of local anaesthetic can be increased by adding epinephrine.
(d) Does not provide satisfactory anaesthesia.
(e) Disadvantage is usage of large amounts of drug.

78. Nerve block anaesthesia:
(a) Intercostal nerve blocks can be used for anaesthesia for anterior abdominal wall.
(b) Proximity of injection to nerve is one variable in onset of block.
(c) Hydrophobicity increases the potency of drug.
(d) Motor fibers are involved first.
(e) Addition of epinephrine can decrease peak plasma concentration.

79. Local anaesthetic:
(a) Cocaine is the only naturally occurring local anaesthetic.
(b) Sodium channels contain two alpha and two beta units.

(c) Local anaesthetics inhibit conduction differently in myelinated nerves than myelinated nerves.
(d) Nodal clustering of channels is essential for high speed transmission.
(e) Gating is a normal phenomenon with sodium channels.

80. Local anaesthetic:
(a) Works by inhibiting sodium permeability.
(b) Use dependence is important for local anaesthetic function.
(c) Potency of local anaesthetics increase with increased molecular weight
(d) Speed of onset slows with increase local anaesthetic lipid solubility and increased pKa.
(e) Local anaesthetic rate of onset is associated with aqueous diffusion rate which declines with increased molecular weight.

81. Local anaesthetics:
(a) Unmyelinated fibers are resistant to local anaesthetics compared with larger myelinated Aδ fibers.
(b) Bupivicaine and ropivicaine are more selective for sensory fibers.
(c) Hydrogen ions potentiate use dependent block.
(d) Spread of neuraxial anaesthesia is more in pregnancy.
(e) Local anaesthetic binding proteins increase with infusions of local anaesthetic.

82. Local anaesthetics:
(a) Amide local anaesthetics clearance is decreased by hepatic disease.
(b) Amide local anaesthetics are not affected by renal failure.
(c) Local anaesthetics only bind to sodium channels.
(d) Seizures due to toxicity arise in amygdala.
(e) Acidosis increases local anaesthetic toxicity.

83. Local anaesthetics:
(a) Liposomes improve the delivery of local anaesthetics.
(b) Liposomal encapsulation increases the duration of action of local anaesthetics.
(c) Local anaesthetic delivery can be done parenteraly.
(d) Depofoam reduces toxicity.
(e) Polymers used for local anaesthetics have high toxicity.

84. Liposomal bupivicaine:
(a) Produces long plasma levels.
(b) Is free of side effects.
(c) Can be repeated within 24 h.
(d) Can be given along with Lidocaine.
(e) Should be deleted with normal saline.

85. SABER Bupivicaine:
(a) Can deliver drug for an extendable period of time.
(b) Exist as viscous liquid.
(c) Absorption is slow when confined to a small surgical area.
(d) Has low toxicity.
(e) The implant should be removed after its exhaustion.

86. Bupivicaine collagen implant:
    (a) It is a collagen matrix impregnated with bupivicaine.
    (b) Collagen helps in controlling the release of bupivicaine.
    (c) Analgesia provided can extend for few days.
    (d) Constipation may be a side effect.
    (e) It is superior to placebo in post operative pain relief.
87. Adjuvant analgesics in regional anaesthesia:
    (a) Inflammation may cause endogenous opioid receptors to move to the site of the injury.
    (b) Inflammation may decrease opioid action.
    (c) Alpha-2 receptors in spinal cord increase pain.
    (d) Clonidine is contraindicated intrathecally.
    (e) Clonidine possesses local anaesthetic properties.
88. Adjuvant analgesics in regional anaesthesia:
    (a) Dexmedetomidine causes more hemodynamic changes than clonidine.
    (b) Clonidine improves tourniquet tolerance.
    (c) Dexamethasone increases the quality and duration of blockade.
    (d) NMKDA antagonist produces peripherally mediated analgesia.
    (e) Neostigmine causes analgesia via muscarinic receptors.

Answers

1. F F F T F
   Most common side effect of opioids is constipation where as NSAIDs cause gastric ulcers, increased bleeding time, cardiovascular side effects. NSAIDs inhibit prostaglandins and reduce protective barrier in gastrointestinal tract, irrespective the route of administration. Topical NSAIDs do not cause gastric irritation. Antacids can reduce gastric distress but can decrease absorption of NSAIDs. NSAIDs affect bone healing for 10–14 days.
2. T T T F T
   NSAIDs are the first line of medications for mild to moderate pain related to tissue injury. Single dose of drugs may be effective except for aspirin which must be taken multiple times per day to provide optimum effect. The drugs are more effective for somatic nociceptive pain especially joint pain. Combination of more than one medication may cause more side effects. (*Kovac SH, et al. Health related quality of life among self reported arthritis sufferers: effects of race ethnicity and residence. Qual Life Res. 2006;15(3):451–60*). NSAIDs contribute to opioid sparing effect by improving analgesia, decreasing side effects.
3. F T T T T
   Chronic usage does not lead to tolerance, physical dependence, and respiratory depression. Risk factors for liver injury include pre existing liver disease, hepatotoxic medications, regular consumption of alcohol. Risk factors for adverse effects include history of prior ulcer, cardiovascular disease, concomitant treatment with steroids, high doses, long term usage and use of high risk NSAIDs

(indomethacin, piroxicam, sulindac). Cox-2 selective NSAIDs like celecoxib have no effect on bleeding time. Risk factors for acetaminophen toxicity include depression, liver disease, alcohol abuse and old age.

4. T T T T T
   High acetaminophen usage is associated with decrease in renal function though it is not seen with high NSAID usage or aspirin usage. Acetaminophen though is better to use in renal disease because of lack of effect on platelet aggregation and low incidence of GI effects. Acetaminophen dose is associated with risk of hypertension. (*Dedier J, Stampfer MJ, et al. Non narcotic analgesic use and the risk of hypertension in US women. Hypertension. 2002;40(5):604–8*). Intravenous acetaminophen causes a dose dependent increase in concentration of arachdonic acid causing anticoagulant effect. (*Munsterhjelm E, et al. Dose dependent inhibition of platelet function by acetaminophen in healthy volunteers. Anesthesiology. 2005;103(5):712–7*).
5. F F F T T
   Long term therapy causes gastrointestinal complications in 15–30% of patients. (*Bombardier C, Laine L, et al. Comparison of upper gastrointestinal toxicity of rofecoxib and naproxen in patients with rheumatoid arthritis. N Engl J Med. 2000;343(21):1520–8*). All nonselective NSAIDs except nabumetone are highly lipophillic and can easily penetrate gastric mucosal barrier resulting in oxidative uncoupling of cellular metabolism causing cell injury and death. Serious complications are most frequent during first 3 months and there is 8% incidence of ulcer development within 1 week of regular NSAID usage. (*Laine L. Approaches to non steroidal anti inflammatory drugs use in high risk patients. Gastroenterology. 2001;120(3):594–606*). The risk of peptic ulcers is increased by 2–4 folds with use of NSAIDs.
6. F T F T T
   Misoprostol is a synthetic prostaglandin used in ulcer prevention and is associated with nausea, abdominal cramps, diarrhoea in elderly population. H2 antagonists have been shown to be beneficial in helicobacter pylori. (*Chan FKL, et al. Prevention of non steroidal anti inflammatory drug gastrointestinal complications—review and recommendation based on risk assessment. Aliment Pharmacol Ther. 2004;19(10):1051–61*). Celecoxib in a dose of 200 mg twice a day is associated with less mucosal breaks.
7. T T F F T
   Inhibition of prostacyclin by COX-2 also reduces the ability of the epithelium to defend against hypertension and atherosclerosis. (*Fitzgerald GA. Coxibs and cardiovascular disease. N Engl J Med. 2004;351(17):1709–11*). Risk factors for cardiovascular events include prior cardiovascular disease, hypertension, rheumatoid arthritis, chronic renal disease, age more than 80 years. Hypertension and diabetes mellitus causes 2–3 fold increase in heart failure and coronary heart disease. Coronary heart disease is higher among women. Both first and second hand cigarette smoke increases the risk for cardiovascular events. (*Hermann M, et al. To the heart of the matter. Coxibs, smoking and cardiovascular risk. Circulation. 2005;112(7):941–5*).

8. T T T T F
   Rofecoxib increases cardiovascular events as has been shown in VIGOR Trial (Vioxx gastrointestinal outcomes research). Meloxicam has less peripheral oedema and weight gain when compared with diclofenac. Celecoxib is the drug of choice in bleeding disorders. (*Visser E. Acute pain and medical disorders. In: Macintyre PE, Walker SM, Rowbotham DJ, editors. Clinical pain management: acute pain. 2nd ed. London: Holder Arnold*).
9. F F T T T
   COX-2 is induced with inflammation and is present in ascending loop of henle, macula densa, afferent arteriole and causes inhibition of sodium reabsorption. CoX-1 is present in glomerulus and afferent arteriole and affects renal homeostasis. Renal toxicity manifests in four ways. Acute ischaemic renal insufficiency which is mostly seen in perioperative period, acute interstitial nephropathy, analgesic associated nephropathy and progressive hypertensive nephropathy. Endogenous renal prostaglandins do not have significant effect for as long as there is normal cardiovascular, hepatic, endocrine and renal function along with adequate sodium and volume. (*Hestrom J, Rosow CE. Non steroidal anti-inflammatory drugs in post operative pain. In: Postoperative pain management: an evidence based guide to practice. Philadelphia: Saunders Elsevier. p. 161–81*). Heart failure and chronic kidney disease are contraindications. (*AGS panel on pharmacological management. pharmacological management of persistent pain in older persons. J Am Geriatr Soc. 2009;57(8):1331–46*).
10. F T F F T
    Diclofenac is available both in gel and patch preparation. The effect is seen due to high concentration of drugs in the tissues. (*Galer BS, et al. Topical lidocaine patch relieves post herpetic neuralgia more effectively than a vehicle typical patch: results of an enriched enrolment study. Pain. 1999;80(3):533–8*). Bioavailability with topical preparation is 5–10% while with oral preparation is up to 70%. Gels are more effective than creams. (*Derry S, et al. Topical NSAID for chronic musculoskeletal pain in the adults. 2016 Cochrane pain, palliative and supportive care group*). Cream is an emulsion of water and oil and is greasier. Gel contains cellulose ethers in water. Gels liquefy on contact with skin and leave a thin film of active medication.
11. T F F F T
    Topical diclofenac is effective in osteoarthritis. It contributes by causing less pain on walking, increased physical function, improved global patient assessments. One percent diclofenac has been very effective in hand osteoarthritis. (*Bookman AA, et al. Effect of a typical diclofenac solution for relieving symptoms of primary osteoarthritis of the knee: a randomised controlled trial. CMAJ. 2004;171(4):333–8*). Topical diclofenac is equally effective as oral diclofenac in morning stiffness. Five percent ibuprofen 2 h before elective cardio version reduces pain and inflammation.
12. T F T F T
    Acetaminophen dose more than 1000 mg adds little to analgesia. (*Motor, et al. Is there a limit to the analgesic effect of pain medications. Disclosures June 17' 2008*). Dosage more than 500 mg/day diminishes gastric mucosal protection.

13. F F T T F
Ibuprofen at a dosage of 400 mg is analgesic and the dosage of 800 mg four times a day is anti-inflammatory. Twice daily dosage of celecoxib may increase cardiovascular side effects and once daily dosing is preferable. NSAIDs with shorter half life have a more rapid onset. (*Halstrom, et al. Nonsteroidal anti-inflammatory drugs in postoperative pain. Post operative pain management: an evidence based guide to practice. Saunders-Elsevier. p. 161–181*). Analgesia occurs within the first week itself.
14. T F F T T
Dose of 30 mg of ketorolac is equal to 10 mg of parenteral morphine. Loading dose should be avoided and it should not be used for more than 5 days. The effect is most when given by intravenous route. Side effects of the medication include headache, diarrhoea, oedema, dizziness, constipation, xerostomia, tinnitus and increased liver enzymes. Ketorolac reversibly and non selectively inhibits COX-1 and 2. It is used for moderate to acute severe pain. The dosage is mostly 60–120 mg in 3–4 divided doses. Mean plasma life is 5–6 h which is increased to 7–8 h in elderly and 6–19 h in renal failure. It should not be used in third trimester and increased incidence of septal heart defects, dystocias, pulmonary hypertension, is seen if given in pregnancy.
15. T T T F T
Acetaminophen does not cause any alterations of haematology, though if given with warfarin causes an increase in INR. Risk factors for bleeding include advanced age (more than 65), higher doses (more than 120 mg/day), and treatment lasting for more than 5 days. NSAIDs with a long half life causes persistent decrease in GFR while with short half life, GFR returns to the baseline. It should be avoided in any patient with a creatinine clearance less than 30 ml/minute. (*Launey-Vacher V, et al. Treatment of pain in patients with renal insufficiency: the World Health Organisation three step ladder accepted. J Pain. 2005;6(3):137–48*). Short term use (less than 2 weeks) of NSAIDs after spinal surgery is safe. Smoking, glucorticoid use and metabolic bone disease increase the incidence of adverse effects. (*Mehta V, et al. Acute pain management for opioid dependence patients. Anaesthesia. 2006;61(3):269–76*).
16. T T T F T
Endogenous opioid receptors are present in midbrain, Periaqueductal grey area, nucleus raphe magnus and rostral ventral medulla. (*Inturrisi CE. Clinical pharmacology of opioids for pain. Clin J Pain. 2002;18(53):S3–13*). Opioids decrease influx of calcium at cellular level and block the release of Presynaptic neurotransmitters especially substance P. Potassium influx is increased causing a decrease in synaptic transmission. Opioids activate GABA system. (*Bridges D, Thompson SWN, et al. Mechanisms of neuropathic pain. Br J Anaesth. 2001;87(1):12–26*). Opioids produce analgesia by binding to the peripheral opioid receptors. (*Zajactkowska R, et al. Peripheral opioid analgesia in laparoscopic cholecystectomy. Reg Anaesth Pain Med. 2004;29(5):424–9*) (Table 3.1).
17. F T F T F
Three major opioid receptors are seen- mu, delta and kappa. Fourth receptor is designated as ORL-1 (opioid receptor like 1). Orphanin FQ is a ligand and

Table 3.1 Opioid receptor binding

Opioid receptors and binding						
Drug	μ	κ	δ	σ	NMDA	α
Morphine	++	+	+	+	–	–
Oxycodone	++	+	+	–	–	–
Fentanyl	+++	–	–	–	–	–
Buprenorphine	+	+	+	–	–	–
Methadone	++	–	+	–	+	+
Tramadol	+	–	–	–	–	+

causes spinal analgesia. Naloxone is an opioid antagonist and can bind to mu site and reverses analgesia and other side effects like respiratory depression and sedation. Mu receptors are associated with respiratory depression while kappa and delta receptors are associated with less or minimal respiratory depression. Most opioids bind to mu receptor sites. (*Gutstein HB, et al. Opioid analgesics. In: Brunton LL, editor. Goodman and Gilman's the pharmacological basis of therapeutics. 11th ed. New York: McGraw-Hill. p. 547–90*). Nalbuphine is a mixed agonist-antagonist opioid analgesic. It binds as agonist producing analgesia at kappa opioid receptor sites and a weak antagonist at mu receptor sites. Other mixed agonist-antagonists include butorphanol, nalbuphine, pentazocine and dezocine.

18. F T T T T
    Oral bioavailability is 20–30%. (*DePinto, et al. Pain management. Anesthesiol Clin North Am 2006;24(1):19–37*). Bioavailability is increased in liver disease as the liver cannot metabolise and excrete drug efficiently. (*Johnson F, et al. Morphine release profile in a formulation containing polymer coated extended release morphine sulphate plus sequestered naltrexene. J Pain. 8(4):S40*).
19. T F F T T
    Morphine metabolites are active and have pharmacologic action. M6G is morphine's metabolite and is analgesic and more potent than morphine. Prodrugs are pharmacologically inactive compounds that are converted to active metabolites. Codeine is a prodrug which is catalysed by CYP2D6 to morphine. CYP450 is the major enzyme responsible for metabolism but UDP-glucronosyl transferases are also involved. UGTs are involved in the metabolism of hydromorphone, morphine and oxymorphone. CYP2D6, CYP3A4 are important for metabolism of codeine, Fentanyl, methadone, Oxycodone, and oxymorphone. (*Holmquist G. Opioid metabolism and effects of cytochrome P450. Pain Med. 2009;10:S20–29*). Seven to ten percent of Caucasians and 1% of Asians are poor metabolisers.
20. F F T T T
    Kidney is the primary organ for opioid elimination. It is also excreted in faeces, breast milk, sweat, saliva, tears, hair and skin. Terminal half life provides and estimate of how fast a drug leaves the body. Distribution half life is the time necessary for a drug to move from blood and plasma to other tissues. Creatinine

clearance analysis is a measure of kidney function. Ageing is associated with decreased body mass, total body water and increased body fat which alters creatinine clearance. (*Cook D, et al. Priorities in perioperative geriatrics. Anesth Analg. 2003;96(6):1823–36*). Clearance of drugs is decreased with age as half life is seen. Steady state of a drug is achieved when the rate of excretion of a drug is equal to the rate at which the drug enters the system.

21. T F F F F

Efficacy is the extent to which a drug works while potency is the dose of drug required to produce a specified effect. All opioid analgesics can produce same analgesia is doses are optimised but also causes increased side effects. (*Bateman, et al. Clinical pharmacology: the basics. The foundation years 2007;3(6):235–9*). Butorphanol's analgesic effect pleatues as the dose is increasing causing analgesic ceiling while morphine has no analgesic ceiling. Opioids are the second line of medications for neuropathic pain.

22. T F T T F

Opioid tolerance can be made by ruling out new pathology, disease progression or lack of adherence to the medication treatment plan. Tolerance is not the predictor for abuse. (*Fine IG, et al. A clinical guide to opioid analgesia. New York: Vendome group, LLC*). Tolerance to respiratory depression occurs earlier than sedation. First indication is decrease in duration of analgesia followed by decrease in analgesic effect.

Tolerance: a state of adaptation in which exposure to a drug induces changes that result in diminution of one or more of the drug's effects over time.

23. F T T T F

Tolerance to the analgesic effects of opioids is variable. There is no arbitrary ceiling beyond which a dose of opioids is unsafe. Patients who are tolerant of side effects can experience a return of side effects if pain lessens or is relieved. (*Porlenas RK. Opioid analgesics. In: Portenoy RK, editor. Pain management: theory and practice. Philadelphia: FA Davis. p. 249–76*). Similar drugs may have different intrinsic efficacy (Intrinsic *efficacy: relative ability of a drug-receptor complex to produce a maximum functional response).* Cross tolerance between opioids exists and it is therefore necessary to decrease dose by 20–50% to prevent side effects.

24. T F T T F

Opioid tolerance can develop especially if they have been on doses greater than 30 mg. Patients requiring the equivalent of and more than 1 mg intravenous morphine or greater than 3 mg/h of oral morphine for greater than 1 month have high grade of opioid tolerance. Opioid tolerant patients should have background infusion for optimum analgesia. (*Rozen D, et al. Perioperative management of opioid tolerance chronic pain patients. J Opioid Manag. 2(6):353–63*). Opioids may be safely titrated to high doses to provide analgesia.

25. T T T F T

Physical dependence is caused by chronic usage of tolerance forming drug, in which abrupt withdrawal can cause unpleasant physical symptoms. It can be seen with alcohol, benzodiazepines, beta blockers, steroids and antidepressants.

Drugs having a long half life like methadone may not cause withdrawal symptoms before 24 h. Opioid weaning starts with administration with half of previous day's total dose and administration for 2 days and then decrease dose by 25% every 2 days until 30 mg/day is activated which can be discontinued after 2 days. (*Miaskowski C, et al. Guideline for the management of cancer pain in adults and children. Glenview, IL: American Pain Society*).

Addiction: a primary, neurobiologic disease with genetic, psychosocial and environment factors influencing its development and manifestations. It is characterised by loss of control, compulsive use, preoccupation and continued use despite harm.

Dependence: it is the need for specific psychoactive substance for its positive effect or to avoid negative effects associated with its withdrawal.

Pseudo addiction: when a patient's pain is not well controlled, the patient may manifest symptoms suggestive of addiction.

Tolerance: increased dosage is required of the substance to produce the original effect.

26. F F F F T

Breakthrough pain is intense pain lasting for 30–45 min. When breakthrough pain is brief and precipitated by voluntary action, it is incidental pain. This is the most common type of pain in cancer patients (50–90%). End of dose failure is characterised by return of pain before the next analgesic dose is due. It is treated by increasing the dosage of scheduled analgesic. Most common breakthrough pain is somatic (38%) followed by neuropathic (18%), visceral pain (4%) and mixed pain (40%).

27. F T F T T

Breakthrough pain can be decreased by the treatment of pathology and that includes pharmacotherapy, surgery, chemotherapy or radiotherapy. Opioids are mostly prescribed on a prn basis. (*Mercante S, et al. Optimisation of opioid treatment for preventing incident pain associated with bone metastasis. J Pain Symptom Manage. 2004;28(5):505–10*). The overlap between time action of oral opioids and breakthrough pain does not match. By the time oral opioids start working, breakthrough pain may have resolved spontaneously (mean time is 35 min). (*Zeppetella G. Opioids for cancer breakthrough pain: a pilot study reporting patient assessment of time to meaningful pain relief. J Pain Symptom Manage 2008;35(5):563–67*). Transmucosal and intranasal route has short duration of action and early peak effect. Intrathecal opioids can be given for breakthrough pain especially for patients where pain is unresponsive to high doses of intravenous morphine.

28. T F T F F

Patient demand dosing is effective for breakthrough pain, intermittent pain and opioid naive patients. (*Coyle N. Pharmacologic management of cancer pain. In: Cancer nursing. 2nd ed; 1995. p. 1035–55*) (Table 3.2).

29. F T F T T

Patient controlled analgesia approach recognises that only the patient can feel pain and knows how much analgesic will relieve it. It can be used for procedural

Table 3.2 Equianalgesic doses of opioids

Equianalgesic doses			
Opioid	IV/IM/SC (mg)	Oral (mg)	T1/2 (h)
Morphine	10	30	2–3
Codeine	130	200	2–4
Fentanyl	0.15–0.2		3–5
Alfentanil	0.75–1.5		1–2
Buprenorphine	0.4	0.8(s/L)	2–3 24 (s/L)
Oxycodone	10	20	2–3
Tramadol	100	150	5–7
Methadone	10	10–20	10–60

pain (*Lehmann KA. Recent developments in PCA. J Pain Symptom Manage. 2005;29(5):S72–89*). Apart from opioids, local anaesthetics and alpha-2 agonists can be used. PCA increase patient satisfaction along with better control. PCA can be used for children older than 4 years (*Wellington J, et al. Patient variables influencing acute pain management. Acute pain management. Cambridge, New York: Cambridge University Press. p. 33–40*).

30. T F F F F
Morphine is not the first line medication for neuropathic pain. It is useful in combination with antidepressants and anticonvulsants. (*Dwarkin, et al. Pharmacologic management of neuropathic pain: evidence based recommendations. Pain. 2007;132(3):237–51*). Morphine has poor lipid solubility and precludes transdermal absorption and poor absorption is seen via sublingual/buccal/vaginal route. (*Ostrop NJ, et al. Intravaginal morphine: an alternative route of administration. Pharmacotherapy. 2001;18(4):863–5*). Morphine when injected intramuscularly is painful and absorption is unreliable.
31. F T T F F
Morphine has two main metabolites M3G and M6G. Only M6G is the active metabolite and produces analgesia. Both metabolites cause toxicity. M3G is implicated in opioid induced hyperalgesia. (*Hemstapat K. Morphine-3 glucuronide's neurotoxicity effects are mediated via indirect activation of NMDA acid receptors. Mechanistic studies in embryonic cultured hippocampal neurons. Anaesth Analg. 2003;97(2):494–505*). M6G causes less sedation and respiratory depression and has slower onset of effect. Morphine has a half life of 2–4 h and has a slow onset of action because of being hydrophilic. Bioavailability via oral route is 20–30% because of first pass metabolism and thats why oral dosage is more than parenteral route. (*DePinto, et al. Pain management. Anesthesiol Clin North Am 2006;24(1):19–37*).
32. F F T T F
A dose of codeine more than 60 mg provides little additional analgesic effect in acute pain. (*Miaskowski C. Patient controlled modalities for acute post operative pain management. J Perianaesth Nurs. 2009;20(4):255–67*). Codeine via the intramuscular route is unreliable and peak occurs 30–60 min after administration.

Ten percent of codeine administered is metabolised to morphine which is the active form. Bioavailability is 20–30% because of first pass metabolism. The presence of P4502D6 divides the patients into intermediate, rapid, ultra rapid or poor metabolisers. Most patients are extensive metabolisers. Codeine is secreted in the breast milk and other drugs administered with it may cause fluctuation of drug levels. (*Susce MT, et al. Response to hydrocodone, codeine, and oxycodone in a CYP2D6 poor metaboliser. Progress in neuro-psychopharmacology and biological psychiatry 2006;30(7):1356–8*).

33. T F F T T
Peak levels of codeine are seen 60 min post administration via oral route. Tolerance develops on chronic usage. Sudden abstinence causes a syndrome lasting for 3–10 days and is not life threatening. It comprises of myalgias, abdominal cramps, nausea, vomiting, yawning, insomnia, piloerection and chills.
34. T F F T T
Chest rigidity is seen with rapid intravenous administration. (*Fukuda K. Intravenous opioid anesthestics. In: Miller RD, editor. Miller's anaesthesia. 6th ed; p. 379–437*). Fentanyl is 100 times more potent than morphine. Lipophilicity makes it ideal for transdermal, oral transmucosal, intranasal and topical patch.
35. T T T T T
Transmucosal Fentanyl is used in breakthrough cancer pain in patients who take at least 25 μg of transdermal Fentanyl/hour, 60 mg of oral morphine, 30 mg of oral Oxycodone/day. Fentanyl works at Presynaptic levels by decreasing calcium influx in primary nociceptive afferents causing a decrease in neurotransmitter. At post synaptic levels, increased potassium efflux is seen causing hyperpolarisation of dorsal horn pain signalling sensory neurons causing a decrease in nociceptive transmission. Transmucosal Fentanyl is ideal for breakthrough pain because of rapid onset of effect and a short duration of action. (*Smith H. A comprehensive review of rapid onset opioids for breakthrough pain. CNS Drugs. 2012;26(6):509–35*).
36. T T F F T
Methadone is a lipophillic opioid and produces less rostral spread than morphine, has a fast onset on analgesia (10–20 min), has a short duration of action (rapidly cleared from CSF). It acts at mu receptors and is also an antagonist at NMDA receptors. Duration of analgesia is equal to morphine (4–8 h) while elimination half life is longer. The drug is metabolised via cytochrome P450 enzyme system.
37. F F T T T
Oral bioavailability is 80–85%. Elimination half life is long and highly variable (5–130 h). (*Lugo RA, et al. Pharamcokinetics of methadone. J Pain Palliat Care Pharmacol. 2005;19(4):13–24*). The metabolites are not toxic and are also likely to cause less constipation. It is ideal for sublingual and topical administration because of lipophilicity. (*Gallaghar RE. Analgesic effects of topical methadone: a report of four cases. Clin J Pain. 2011;21(2):190–2*). Methadone metabolism occurs via liver but some part is metabolised by intestine.

38. F F T T T
Sufenatnil is two times more soluble than Fentanyl. Quality of analgesia via epidural route is as similar as Fentanyl. (*Lilker S. Comparison of fentanyl and sufentanil as adjuncts to bupivicaine for labour epidural analgesia. J Clin Anaesth 2009;21(2):108–12*) (Table 3.3).
39. F T T T F
Ideal body weight or lean body mass is used. (*Burns JW, et al. The influence of patient characteristics on the requirement for post operative analgesia. Anaesthesia. 1989;44(1):2–6*). Opioid initiating dose should be decreased by 25–50% while initiating in elderly. Equianalgesic charts should be used when switching opioids. Dosage of breakthrough pain is 10–15% of total daily dose (Table 3.4).
40. T T T T T
The increase in breakthrough medication for more than 2 doses in a 12 h period should be adjusted in sustained release preparation. Multimodal therapy leads to less titration of opioids. (*Pasevo C. Orthopaedic post operative pain management. J Perianesth Nurs. 2007;20(5):160–73*). Fentanyl is ideal for acute pain because of lipophilicity.
41. F F F T F
Patient controlled analgesia can be given subcutaneously, intravenously and via epidural route. Ideal PCA has small doses of analgesia with short lock out intervals. This helps prevent sedation at peaks and prevent breakthrough pain at troughs. Analgesia requirements decrease with age and initiating dosage should be decreased by 25–50%. (*Gagliese L. Age is not an impediment to effective*

Table 3.3 Intrathecal doses of opioids

Intrathecal opioids			
Opioid	Dose (mg)	Onset (min)	Duration (h)
Morphine	0.1–0.5	15–30	Up to 24
Sufentanil	0.005–0.02	<15	Up to 6
Fentanyl	0.006–0.05	<15	Up to 4
Pethidine	10–25	5–15	Up to 12

Table 3.4 Opioid dosages

Opioid	Oral	Parenteral	Onset (min)	Peak effect (min)	Duration (h)	Half life (h)
Morphine	30 mg	10 mg	PO:30–60 min IV:5–10 min	60–90 15–30	3–6 3–4	2–4
Codeine	200 mg	130 mg (intramuscular)	PO:30–60 min IM:10–20 min	60–90 30–60	3–4 3–4	2–4
Fentanyl		100 µg iv 100 µg/h of transdermal = 4 mg/h of iv morphine	3–5 min (iv)	15–30	2	
Oxycodone	20 mg		PO 30–60	30–60	3–4	2–3

usage of patient controlled analgesia by surgical patients. Anesthesiology. 2000;93(3):601–10). Continuous infusions should not be used in opioid naive patients. (*Pasero C, et al. Safe use of continuous infusion with intravenous PCA. J Perianesth Nurs. 2004;19(1):42–5*).

42. T F T F T
Dose reduction should be about 25% to reduce side effects. (*Yuan CS. Handbook of opioid bowel dysfunction. New York: Hawarth Medical Process*). Constipation is because of delayed gastric emptying and also due to slowed bowel mobility and decreased peristalsis. Opioid antagonist methylnaltrexone is used for opioid induced constipation. Risk factors for constipation include advanced age, immobility, abdominal disease, concurrent medications. (*Hinricks M, et al. Research based protocol: management of constipation. J Gerontol Nurs. 2001;27(2):17–28*). Sleep is affected.
43. F T T F F
Bulk laxatives are contraindicated unless fluid is adequate because of an increased risk of foecal impaction and obstruction. (*Thomas J. Opioid induced bowel dysfunction. J Pain Symptom Manag. 2008;35(1):103–13*). The treatment of constipation is a combination of stool softener (better penetration into stool) and stimulant laxative (induces peristalsis). Naloxone has limited oral bioavailability (3%) and is safe for refractory constipation. (*Meissner W, et al. A randomised controlled trial with prolonged release oral oxycodone and naloxone to prevent and reverse opioid induced constipation. Eur J Pain. 2009;13(9):56–64*). Post operative ileus is characterised by delayed gastric emptying, dilation of small bowel and colon, loss of normal propulsive contractile patterns and inability to pass gas or stool. (*Moore B, et al. Molecular and cellular inflammatory mechanisms in the development of post operative ileus. Semin Colon Rec Surg. 2005;16(4):184–7*).
44. F T T T T
Nasogastric decompression should be used in selective cases of paralytic cases. (*Nelson R. Systematic review of prophylactic decompression after abdominal operations. Br J Surg. 2006;92(6):673–80*). Oral intake should be started as soon as possible. (*Basse L. A clinical pathway to accelerate recovery after colonic surgery. Ann Surg. 2000;232(1):51–7*). Excess fluids should be avoided during and after colorectal surgery. (*Kehlet H. Preventive measures to minimise or avoid post operative ileus. Semin Colon Rec Surg. 2005;16(4):203–6*). Opioids should be avoided and maximum use of regional anaesthesia should be used. Post operative ileus has multiple mechanisms and management includes thoracic epidural analgesia, opioid sparing techniques, mu agonists, laparoscopic techniques, avoidance of nasogastric tube, fluid excess and immobility.
45. F T T F F
Nausea usually develops with initial opioid dosage and subsides within weeks of treatment. Risk factors for opioid induced nausea and vomiting include non smoker, history of nausea and vomiting, nitric oxide, intra and post operative opioids, increased duration of the surgery, type of surgery (laparoscopy, neurosurgery, breast, strabismus, laparotomy, plastic surgery). Incident pain has

strong association with post operative nausea and vomiting. (*Ho KT. Opioid related adverse effects and treatment options. Acute pain management. p. 406–15*). Single drug antiemetic has a high failure rate, therefore combination of two antiemetics is preferred. (*Gan TJ, et al. Society for ambulatory anaesthesia guidelines for the management of post operative nausea and vomiting. Anesth Analg. 2007;105(6):1615–28*). Prophylactic antiemetics should be given to all high risk patients. (*Apfel C. A factor trial of six interventions for the prevention of post operative nausea and vomiting. N Engl J Med. 2004;350(24):2441–51*).

46. T F F T T

Opioids increase smooth muscle tone in the biliary tract especially sphincter of oddi. This causes increase in bile duct pressure. Meperidine produces a dual effect on the biliary tract. At low concentration, it inhibits the response of common bile duct to electrical stimuli. In higher concentration, it produces an excitatory effect and increases spontaneous contraction. Pruritus is a common complication (18–40%) in post operative setting. It is mostly localised in face, neck and upper thorax. It is transmitted by unmyelinated c-fibre nociceptors. Pruritus can be measured by numerical rating scale. 1–3: mild, 4–7: moderate, 8–10: severe itching. (*Jenkins HH. Correlating an 11 point verbal scale to a 4 point verbal rating scale in the measurement of Pruritus. J Perianesth Nurs. 2009 24(3):152–5*).

47. F F T T F

Hypotension is seen because of more than 20% decrease in arterial pressure. Intravenous patient controlled analgesia has the lowest incidence and maximum incidence is seen with epidural analgesia. Meperidine has intrinsic antimuscarinic properties and can increase heart rate. Incidence of hypotension can be minimised by administering opioid slowly, keeping the patient supine and optimising intravenous volume. (*Harris JD, et al. Cancer pain. Pharmacological interventional and palliative care approaches. Philadelphia: Saunders; 2006. p. 207–34*). Urinary retention may need catheterisation in 23% of patients. Addition of local anaesthetics may increase the incidence of urinary retention. It is due to spinally mediated inhibition of parasympathetic outflow.

48. T F T T T

Tolerance to urinary retention is seen and decreasing the opioid dosage is the management. Myoclonus is sudden, brief, involuntary muscle contractions arising from CNS. The incidence is upto 83%. (*Glare P, et al. The adverse effects of morphine: a prospective survey of common symptoms during repeated dosing for chronic pain. Am J Hosp Palliat Care. 2006;23(3):229–35*). Meperidine has a metabolite normeperidine which causes myoclonus. The treatment is administration of clonazepam (0.25–0.5 mg). Mental status changes are seen in 23–83% of population in end stage. (*Casarelt DJ. Diagnosis and management of delirium near the end of life. Ann Intern Med. 2001;135(1):32–40*). Post operative delirium is seen in 10–60% of patients. (*Vaurio LE. Post operative delirium: the importance of pain and pain management. Anesth Analg. 2006;102(4):1267–73*).

49. T T T T T
Both post operative pain and increased pain post operatively are independent predictors of post operative delirium. Mepereidine cause delirium and also has a negative impact on mood. (*Latta KS. Meperidine: a critical review. Am J Ther. 2002;9(1):53–68*). Fentanyl PCA causes less cognitive impairment. (*Herrick, et al. Post operative cognitive impairment in the elderly. Anaesthesia. 1996;51:356–60*). Opioids inhibit RE£M sleep and other aspects of normal sleep due to anticholinergic activity. Donepezil is useful in opioid induced sedation. (*Slatkin N, et al. Donepezil in the treatment of opioid induced sedation: report of six cases. J Pain Symptom Manage. 2001;21(5):425–38*).
50. T F T F T
Opioids can cause severe respiratory depression with breaths less than 8/min. Post operative hypoxaemia is oxygen saturation less than 90% on oxygen more than 6 min per hour. (*Wheatley RG, et al. Hypoxaemia and pain relief after upper abdominal surgery, comparison of intramuscular and patient controlled analgesia. Br J Anaesth. 1992;69(6):558–661*). Tolerance to respiratory depression is seen over a period of days to weeks. Respiratory depression is maximally seen within 12 h and the risk factors include age more than 65 years, COPD, use of hydromorphone. (*Taylor S. Post operative day one: a high risk period for respiratory events. Am J Surg. 2005;190(5):752–6*).
51. F F F T T
Opioids administered in the post operative period have a risk of addiction of up to 1%. Physical dependence is normally seen after 2 weeks of administration. Tolerance involves decrease in one or more effects of opioids. It is treated with increase in dosage of opioids. Opioid induced hyperalgesia involves increase in pain on increasing the dosage of opioids. (*Chu LF, et al. Opioid induced analgesia in chronic pain patients after one month of oral morphine therapy: a preliminary prospective study. J Pain. 2008;7:43–8*). Cox-2 inhibitors prevent opioid induced hyperalgesia by reducing the spinal release of excitatory neurotransmitters. (*Mitra S. Opioid induced hyperlagesia: pathophysiology and clinical implications. J Opioid Manag. 2008;43(3):123–30*).
52. F T T T F
Immune function is usually suppressed after opioid administration for at least 12 weeks. (*Palm S, et al. Does prolonged oral treatment with sustained release morphine tablets influence immune function? Anesth Analg. 2000;86:166–72*). Hypogonadism is seen both in males and females after long term opioids. (*Katz N. The impact of opioids on the endocrine system. Clin J Pain. 2009;25(2):170–175*).
53. F F T T F
Meperidine has a toxic metabolite normeperidine. There are fewer chances of adverse effects (prematurity, still birth), If addictive patients are maintained on treatment program in pregnancy. (*Fajemirokun-odudeyi, et al. Pregnancy outcome in women who used opiates. Eur J Obstet Gynaecol Reprod Biol. 2006; 126(2):170–75*). Infants are incapable of higher level of cognitive recognition and therefore cannot become addicted. (*Stevens*

B. Pain in infants. Pain: clinical manual. 2nd ed. St. Louis: Mosby; 1999. p. 626–73). Meperidine is contraindicated in lactating mothers as it can cause sedation, poor suckling, neurobehavioural delay. (*Bar-Oz B, et al. Use of antibiotic and analgesic drugs during lactation. Drug Saf. 2003;26(13):925–35*). Turning around the patient in intensive care unit is one of the most painful procedures. (*Puntillo KA. Patient's preceptions and responses to procedural pains: results from thunder project II. Am J Crit Care. 2001;10(4):238–51*). Analgesic and sedative usage is associated with shortened survival. (*Sykes N, et al. The use of opioids and sedatives at end of life. Lancet Oncol. 2003;4(5):312–8*).

54. F F T T T
Adjuvant analgesics: any drug that has a primary indication other than for pain but is analgesic for some painful conditions. Adjuvant analgesics have slower onset of analgesia and has more side effects. They are effective both for neuropathic and somatic pain. Anti depressants treat pain partially by alleviating depression (Table 3.5).

55. T F T T T
Anticonvulsants may cause cleft palate, congenital heart disease if given during pregnancy. (*Viscomi CM. Pain management issues in the pregnant patient. Manag Pain. 1998;363–381*). The use of phenytoin during pregnancy leads to 7% incidence of fetal hydantoin syndrome (microcephaly, mental deficiency, craniofacial abnormalities). The dosage required in pregnancy is decreased as a result of increased progesterone and increased sensitivity towards local anaesthetic. Maternal administration of local anaesthetic decreases the tone of muscles in neonates but is seen less with bupivicaine as it binds firmly to plasma proteins. (*Woods AM. Pharmacology of local anaesthetics and related drugs. Principles and practice of obstetric analgesia and anaesthesia. 2nd ed. Baltimore: Williams and Wilkins; 1995. p. 297–323*).

56. T T T T T
Multimodal analgesia provides pain relief with minimal side effects. (*Kehlet H, et al. Persistent post surgical pain: risk factors and prevention. Lancet. 2006;367(9522):1618–25*). It also helps in symptoms other than pain like insomnia.

Table 3.5 Analgesic adjuvants

Perineural adjuncts	Dose	Extended duration	Special concerns
Clonidine	30–300 μg Most common 150 μg	2 h	Bradycardia Hypotension
Dexmedetomidine	1 μg/kg	4–5 h	Bradycardia Hypotension
Dexamethasone	4–10 mg	10 h	Nil
Epinephrine	2.5–5 μg/kg	Nil	Vasoconstriction
Midazolam	50 μg/kg	Unknown	Neurotoxicity
Buprenorphine	0.3 mg	Variable	Nil

57. T T T T T
Clonidine can be used both via epidural and intraspinal route. (*Eisenach JC. Relative potency of epidural to intrathecal clonidine differs between acute thermal pain and capsaicin induced allodynia. Pain. 2000;84(1):57–64*). Transdermal patch can be used for post operative pain. (*Dimou P. Transdermal clonidine: does it affect pain after abdominal hysterectomy. Acta Anaesthesiol Belg. 2003;54(3):227–32*).

58. T T T T F
Low dose Ketamine can be used for post operative pain. Epidural bolus less than 1 mg/kg and an infusion of 1.2 mg/kg/h is used. (*De Kock, et al. The clinical role of NMDA receptor antagonists for the treatment of post operative pain. Best Pract Res Clin Anesthesiol. 21(1):85–98*). Perioperative Ketamine decreases opioid use, complication rate and incidence of post operative nausea and vomiting in 24 h. (*Bell RF, et al. Perioperative ketamine for acute post operative pain. Cochrane Database Syst Rev. (1):CD004603*). Ketamine helps pain management in patients with depression. (*Kudoh A, et al. Small dose ketamine improves the post operative state of depressed patients. Anesth Analg. 2000;95(1):114–8*). Systemic route for Ketamine is more effective as it reduces hyperalgesia.

59. T F T F T
Local anaesthetics block the inward sodium current and suppressed c fibre evoked polysynaptic reflex. (*Tanelian DL, et al. Analgesic concentration of lidocaine suppresses tonic A-delta and c fibre discharges produced by acute injury. Anesthesiology. 1991;74:934–6*). Local anaesthetics can cause both vasodilatation and vasoconstriction. (*Aps C, et al. The effect of concentration in vasoactivity of bupivicaine and lignocaine. Br J Anaesth. 1976;48:1171–4*).

60. F F F F T
Procaine is the most potent vasodilator. Other vasodilators include tetracaine, chloeprocaine and propoxycaine. Cocaine initially causes vasodilatation which is followed by vasoconstriction which is due to uptake of catecholamines into tissue binding sites. Free nor adrenaline causes vasoconstriction. Local anaesthetics have high first pass metabolism so is absorbed poorly except cocaine.

61. T T T F T
Local anaesthetics are distributed more in brain, head, liver, kidneys, lungs and spleen. Skeletal muscle is the largest mass of tissue in the body. Local anaesthetics readily cross blood brain barrier and placenta. (*Kalow W. Hydrolysis of local anaesthetics by human serum cholinesterase. J Pharamcol Exp Ther. 1952;104:122–34*).

62. T T F T T
Tetracaine is hydrolysed 16 times more slowly than chlorprocaine and has the greatest toxicity. Allergies are seen mostly with esters but are related to PABA which is a metabolic product of procaine. Atypical form of pseudo cholinesterase is seen in 1:2800. It causes an inability to hydrolyse ester local anaesthetics and causes increased levels causing toxicity.

63. T F T T T
Biotransformation of amide local anaesthetics is affected in liver disease (hypotension, congestive cardiac failure, cirrhosis). Prilocaine or articaine can produce methemoglobinaemia. Prilocaine causes formation of orthotoludine which causes methemoglobinemia. (*Daly DJ, et al. Methemoglobinemia following the use of prilocaine. Br J Anaesth. 1964;36:737–9*). Lidocaine is metabolised to monoethylglycinexylidide and glycinexylidide which can cause sedation. Procaine is excreted in urine as PABA (90%) and 2% unchanged. Ten percent of cocaine is found in urine unchanged.

64. F T F T T
Local anaesthetics cause depression at higher doses and may cause tonic clonic convulsions. Local anaesthetics like procaine, Lidocaine and Prilocaine have anticonvulsant properties.

Circumoral and lingual numbness is the direct anaesthetic action of anaesthetics. Sedation may be a part of toxicity with Lidocaine and procaine. Dose of local anaesthetic required to produce seizures is markedly diminished in the presence of hypercarbia and/or acidosis. (*Englesson S, et al. The influence of acid base changes on central nervous system toxicity of local anaesthetic agents. An experimental study in cats. Acta Anesthesiol Scand. 1974;18:79*) (Table 3.6).

65. T T F T F
Local anaesthetics cause CBNS excitation. (*Tanaka K. Blocking of cortical inhibitory synapses by intravenous lidocaine. Nature. 1966;209:207*). Local anaesthetics increase the pain threshold and produces analgesia. Local anaesthetics decrease electrical excitability of myocardium, decrease conduction rate and decreased force of contraction. (*Block A. Effect of local anaesthetic agents on cardiac conduction and contractility. Reg Anesth. 1982;6:55*). Ropivicaine causes cutaneous vasoconstriction. (*Kopacz DJ. Effect of ropivicaine on cutaneous capillary flow in pigs. Anesthesiology. 1989;71:69*).

66. F F T T F
Local anaesthetics normally cause hypotension and is maximally seen with procaine by direct depression of myocardium and smooth muscle relaxation. Local anaesthetics cause muscle damage which gets repaired within 2 weeks.

Table 3.6 Toxic levels of local anaesthetics

Drug	Toxic plasma concentration (μg/mL)	Maximum dose for infiltration (mg)	Recommended dose range (mg/kg)
Procaine		500	6–8
Clorprocaine		800	10–12
Tetracaine		20	
Lidocaine	>5	300	3–5
Prilocaine	>5	350	4–6
Mepivicaine	>5	300	3–5
Bupivicaine	>3	175	2–3
Ropivicaine		200	2–3

Local anaesthetics have dual action on respiratory system. Normal levels cause direct relaxation action while overdose causes respiratory arrest. Local anaesthetics causes neuromuscular blockade due to inhibition of sodium diffusion through a blockade of sodium channels in the cell membrane. Malignant hyperthermia is a relative contraindication for the use of local anaesthetics. (*Paasuke RT. Amide local anaesthetics and malignant hyperthermia. Can Anesth Soc J. 1986;33:126–9*).

67. F T T F F
Local anaesthetics decrease conduction and decrease prolongation of action potential. Local anaesthetics bind to both sodium and potassium channels. (*Strichartz GR, et al. The action of local anaesthetics on ion channels of excitable tissues. Local anaesthetics. Berlin: Springer-Verlag. p. 21–53*). Local anaesthetics are active in charged form and are only active when they act on inner surface of membrane. (*Narahashi T, et al. Site of action and active form of local anaesthetics. Neurosci Res. 1971;4:65–99*).

68. T F F T T
Sodium channel is a complex of glycosylated proteins with an aggregated molecular size in excess of 300,000 Da (alpha subunit-260,000; Beta1-beta 4: 33,000–38,000 Da). The alpha subunits are the largest containing four homologous domains (I–IV). Each domain is composed of six transmembrane segments in alpha helical confirmation with an additional membrane remnant pore (p) loop. Gating changes are located in the S4 transmembrane helix. S4 helix is both hydrophilic and positively charged. (*Catterrel WA. From ionic currents to molecular mechanisms: the structure and function of voltage gated sodium channels. Neuron. 2000;26:13–25*). Sodium channel has intracellular loop of protein that folds over the opening and binds to an inactivation gate receptor.

69. T F T F T
Amino acid residues are found in domains I, III and IV of S6 segment. Repetitive stimulated nerve is more susceptible as local anaesthetic gains access to its binding site when sodium channel is in open state. (*Butterworth JF, et al. Molecular mechanisms of local anaesthesia: a review. Anesthesiology. 1990;72:711–34*). Frequency dependent blockade refers to local anaesthetic accessing the sodium channels in activated open state only. Small Unmyelinated c fibers (pain) and small myelinated A-delta fibers are blocked before myelinated fibers (Aγ, Aβ, Aα). Small fibers with closely spaced nodes of ranvier are blocked more rapidly.

70. T F T T T
Local anaesthetic salts are acidic and this increases the stability of local anaesthetic esters and catecholamines are added as vasoconstrictors. Unprotonated species is necessary for diffusion across cellular membranes and cationic species interacts with sodium channels. (*Ritchie JM, Greengord P. On the mode of action of local anaesthetics. Annu Rev Pharmacol. 1966;6:405–30*). Vasoconstriction decreases the rate of absorption thus limiting the rate of drug taken. It dilates skeletal muscle via its actions at β2 receptors and may cause increased systemic toxicity. Sympathomimetic amines increase oxygen consumption of tissues causing hypoxia and tissue damage (Table 3.7).

Table 3.7 Comparison of ester versus amide local anaesthetics

Property	Esters (cocaine, benzocaine, procaine, tetracaine)	Amides (lignocaine, mepivicaine, prilocaine, bupivicaine, ropivicaine)
Bond	Ester type	Amide type
Metabolism	Plasma esterases	Hepatic enzyme N-dealkylation and hydroxylation
Potency	+	+++
Allergic reaction	Common	Rare
Duration of action	Shorter	Longer
Toxicity	+	++

71. F F T F F
Local anaesthetics cause stimulation producing restlessness, tremor and may cause convulsions. Lidocaine may produce dysphoria and euphoria. The site of action of local anaesthetics is myocardium where decrease in cardiac excitability is seen along with decrease in conduction rate and force of contraction. Most local anaesthetics cause arteriolar dilation. Hypersensitivity is seen more with ester than amides. Local anaesthetics containing vasoconstrictors may elicit allergic response to added sulphite as an oxidant. Spinal fluid contains no esterase. Anaesthetic effect persists till local anaesthetic is absorbed in circulation.
72. T T T T T
Cocaine causes vasoconstriction because of inhibition of local norepinephrine reuptake. Cocaine causes topical anaesthesia by shrinking of mucosa.
73. F T T F T
Lidocaine is an aminoethylamide and is amide local anaesthetic. It is absorbed from respiratory tract and gastrointestinal tract. Iontophoretic system is a needle free drug delivery system used for a solution of Lidocaine and epinephrine used in dermal procedures up to a depth of 10 mm. Lidocaine is dealkylated in the liver to monoethylglycine xylidide and glycine xylidide which retains local anaesthetic activity.
74. T T F F T
Bupivicaine is structurally similar to Lidocaine except amine containing group is a butyl piperidine. Bupivicaine dissociates slowly from sodium channels thus increased toxicity. L-bupivicaine is less cardiotoxic. (*Foster RH, et al. Levobupivicaine: a review of its pharmacology and use as a local anaesthetic. Drugs. 2000;59:551–79*).
75. T T T F F
Dibucaine is only used as topical anaesthetic because of high toxicity. Dyclonine is used in sore throat lozenges in cold sores. Pramoxine is too irritating for the eyes.
76. F T F F T
Peak plasma levels are directly related to amount of local anaesthetic agent and area of injection. Highest blood levels are seen with interpleural or intercostals blocks. Epinephrine does not increase the duration of action when applied to mucous membrane due to poor penetration. Effect of topical Lidocaine occurs

in 2–5 min and lasts for 30–45 min. The effect is entirely superficial and does not extend to sub mucosal structures. EMLA is eutectic mixture of Lidocaine (2.5%) and Prilocaine (2.5%). It has a melting point less than the individual component.

77. T T T F T
Infiltration analgesia is the injection of local anaesthetic directly into the tissue with affecting cutaneous nerves. Deeper structures can be infiltrated. Epinephrine decreases peak concentration of local anaesthetics. Dosage can be increased by one third by adding epinephrine. Infiltration analgesia can be done at several levels including subcutaneous, major nerves and at spinal roots.

78. T T T T T
The variables for onset of block are proximity of injection to nerve, concentration and volume of drug, degree of ionisation of drug and time. Increased hydrophobicity is expected to increase the onset by increased penetration into the nerve. Nerves in the outer mantle are involved first which are predominantly motor. Addition of epinephrine can decrease plasma concentration by 20–30%.

79. T F T T T
Local anaesthetics contain an aromatic ring and amine at opposite ends of the molecule separated by hydrocarbon chain with either ester/amide bond. Sodium channels have one large alpha subunit and one or two smaller beta subunits. Alpha subunit is the site of ion conduction and local anaesthetic binding. External surface of alpha units is heavily glycosylated. Myelinated fibers show salutatory conduction while unmyelinated fibers lack it and are resistant to local anaesthetics. Nodal clustering of channels is initiated by Schwann cells in peripheral nervous system and oligodendrocytes in central nervous system. (*Chen-Izu Y, Shaw RM, Pitt GS, et al. Sodium channel function, regulation, structure, trafficking and sequestration. J Physiol. 2015;593:1347–60*). Gating is a process by which channels go from conducting to non conducting. It is due to movement of dipoles in response to changes in potential. (*Freitis JA, Tobias DJ. Voltage sensing in membranes: from macroscopic currents to molecular motions. J Membr Biol. 2015;248:419–30*).

80. T T T T T
Local anaesthetics bind to sodium channels and inhibit sodium permeability. (*Butterworth JF IV, Strichartz GR. Molecular mechanisms of local anaesthesia: a review. Anesthesiology. 1990;72:711–734*). Use dependence means local anaesthetic inhibition of sodium currents increase with repetitive depolarisation. It is required for effectiveness as antiarrythemic or managing pain. (*Strichartz GR. The inhibition of sodium currents in myelinated nerve by quaternary derivatives of lidocaine. J Gen Physiol. 1973;62:37–57*). The potency of local anaesthetics increase with molecular weight and lipid solubility. Larger lipophillic local anaesthetics more readily bind sodium channels. Increased lipid solubility is associated with increased protein binding in blood, increased potency and long duration of action. (*Strichartz GR, Sanchez V, Arthur GR, et al. Fundamental properties of local anaesthetics. II. Measured octanol: buffer partition coefficients and pKa values of clinically useful drugs. Anesth*

Analg. 1990;71:158–170). Aqueous diffusion rate is important for rate of onset for local anaesthetics. (*Broneous F, Karami K, Beronius P, et al. Diffusive transport properties of some local anaesthetics applicable for iontophoretic formulation of the drugs. Int J Pharm. 2001;218:57–62*).

81. T T T T T
Unmyelinated fibers are resistant to local anaesthetics. (*Raymond SA, Gissen AJ. Mechanisms of differential nerve block. In: Schwartz GR, editor. Handbook of experimental pharmacology: local anaesthetics. Springer; 1987. p. 95–164*). Once local anaesthetics gain access to cytoplasmic side of sodium channel, hydrogen ions potentiate used dependent blockade. (*Hille B. Ionic channels IOF excitable membranes. 3rd ed. Sinauer; 2001*). Spread of neuraxial anaesthesia is more in pregnancy due to decreased in thoracolumbar cerebrospinal fluid. (*Fagraeus L, Urban BJ, Bromage PR. Spread of epidural analgesia in early pregnancy. Anaesthesiology. 1983;58(2):184–7*). Local anaesthetic binding proteins increase with infusions of local anaesthetic. (*Thomas JM, Schug SA. Recent advances in the pharmacokinetics of local anaesthetics. Long acting amide enantiomers and continuous infusions. Clin Pharmacokinet. 1999;36:67–83*).

82. T F F T T
Amide local anaesthetic clearance is dependent on hepatic blood flow, hepatic extraction. Clearance is decreased in conditions which decrease hepatic blood flow such as β-adrenergic receptor or H2 receptor blocker, heart or liver failure. (*Tetzlaff J. Clinical pharmacology of local anaesthetics. Butterworth Heinemann; 2000*). Local anaesthetics produce dose dependent myocardial depression due to interference with calcium signalling mechanisms within cardiac muscle. (*McCaslin PP, Butterworth J. Bupivicaine suppresses calcium oscillations in neonatal rat cardiomyocytes with increased extracellular magnesium. Anesth Analg 2000;92:82–88*). 5% Lidocaine is seen to permanently inhibit conduction in nerves. (*Lambert LA, Lambert DH, Strichartz GR. Irreversible conduction block in isolated nerve by high concentration of local anaesthetics. Anesthesiology. 1994;80:1082–93*).

83. T T T T F
Liposomes are nonimmunogenic, biodegradable, non toxic molecules and encapsulates both hydrophilic and hydrophobic materials. (*Kulkarni PR, et al. Liposomes: a novel drug delivery system. Int J Curr Pharm Res. 2011;3(2):10–18*). Liposomal encapsulation causes controlled release to prolong anaesthetic effect. (*Samad A, et al. Liposomal drug delivery systems: an update review. Curr Drug Deliv. 2007;4(4):297–305*). Microscopic, spherical, polyhedral aqueous chambers contains drug and can be released into blood stream (depofoam). (*Angst MS, Drover DR. Pharmacology of drugs formulated with DepoFoam: a sustained drug delivery system for parenteral administration using multivesicular liposome technology. Clin Pharamcokinet 2006;45(12):1153–76*). Depofoam reduces toxicity by reducing peak serum levels of drug. (*Howell SB. Clinical applications of a novel sustained release injectable drug delivery system: depofoam technology. Cancer J. 2001;7(3):219–27*). Polymers are used for

nanoparticles which are used for targeted drug delivery. Poly (lactic-co-glycolic-acid) PLGA is used for local anaesthetics. Its hydrolysis leads to metabolite monomers- lactic acid and glycolic acid and are easily metabolised by Krebs cycle. (*Dantier F, et al. PLGA based nanoparticles: an overview of biomedical applications. J Control Release 2012;161(2):505–522*).

84. T F F F T
Liposomal bupivicaine produces plasma levels for up to 72 h. Traditional bupivicaine has duration of action of only 7 h. (ISMP. ISMP *calls for safety improvements in use of elastomeric pain relief pumps. Institute for Safe Medication Practices; 2009*). Liposomal bupivicaine produces granulomatous inflammation. (*Richard BM, Ott LR, et al. The safety and tolerability evaluation of DepoFoam bupivicaine administered by incision wound infiltration in rabbits and dogs. Expert Opin Investig Drugs. 2011;20(10):1327–41*). The dose should not be repeated within 72 h. Liposomal bupivicaine should be given at least 20 min after Lidocaine infiltration. It should be diluted with normal saline only and administered through a needle more than 25G.

85. T T F T F
SABER bupivicaine can deliver drug for an extendable period of time. SABER (Sucrose acetate isobutyrate extended release). Bupivicaine is an injectable system that delivers drugs for up to 3 months. (*Hadj A, et al. Safety and efficacy of extended release bupivicaine local anaesthetic in open hernia: a randomised controlled trial. ANZ J Surg. 2012;82:251–7*). Its absorption is rapid. (*Gan T, et al. SABER-bupivicaine reduced pain intensity for 72 hours following abdominal surgery relative to bupivicaine HCL. Presented at 2014 annual meeting of the American Society of Anesthesiologists, Oct, New Orleans LA*). The implant system dissolves in situ. (*Sekar M, et al. Drug delivery of biologics: a controlled release strategy*).

86. T T F T T
Bupivicaine collagen implant is a collagen matrix which is implanted during surgery. (*Cusack SL, et al. The pharmacokinetics and safety of an intraoperative bupivicaine collagen implant for post operative analgesia in two multicenter, randomised double blind placebo controlled pilot studies. J Pain Res. 2012;5:217–25*). Slow resorption of collagen matrix occurs with controlled release of local anaesthetic. It shows a biphasic increase in concentration. Analgesia provided extends for up to 72 h post operatively. The side effects include constipation, nausea, headache, increased liver enzymes and visual disturbances. It is superior to placebo in post operative pain relief. (*Clinical trial NCT02523599. A phase 3, randomised double blind, placebo controlled study to investigate the efficacy and safety of the xavacoll bupivicaine implant after open laparotomy hernioplasty. Innocoll*).

87. T F F F T
Inflammation can take up to 96 h for the endogenous opioid receptors to move to the site of injury. (*Mousa SA, Zhang Q, Sitte N, et al. B endorphins contain-*

ing memory cells and mu opioid receptors undergo transport to peripheral inflamed tissue. J Neuroimmunol. 2000;115:71–78). Alpha-2 receptors exist in the dorsal horn of the spinal cord and stimulation produces analgesic effects by inhibiting Presynaptic release of excitatory transmitters (Substance P, glutamate). (*Fleetwood-Walker SM, Mitchell R, Hope PJ, et al. An alpha 2 receptor mediates the selective inhibition by noradrenaline of nociceptive responses of identified dorsal horn neurones. Brain Res. 1985;334:243–254*). Clonidine can be used intrathecally for analgesia. It mediates analgesia by increasing acetylcholine levels which in turn stimulates mesenteric receptors. (*Baba H, Kohno T, Okamoto M, et al. Muscarinic facilitation of GABA release in substantia gelatinosa of the rat spinal dorsal horn. J Physiol. 1998;508:83–93*). Clonidine produces local anaesthetic properties by inhibiting compound action potentials of C fibers. (*Gaumann DM, Brunet PC, Jirounek P. Clonidine enhances the effects of lidocaine on c-fiber action potentials. Anesth Analg. 1992;74:719–25*).

88. F T T T T

Dexmedetomidine causes fewer changes than clonidine. (*Abdallah FW, Brull R. Facilitatory effects of perineural dexmedetomidine on neuraxial and peripheral nerve block: a systematic review and metanalysis. Br J Anaesth. 2013;110(6):915–25*). Clonidine improves tourniquet tolerance. (*Lurie SD, Reuben SS, Gibson CS, et al. Effect of clonidine on upper extremity tourniquet pain in healthy volunteers. Reg Anesth Pain Med. 2000;25:502–5*). Dexamethasone increases the quality and duration of blockade. (*Johansson A, Hao J, Sjoland B. Local corticosteroid application blocks transmission in normal nociceptive c-fibers. Acta Anesthesiol Scand. 1990;34:335–8*). NMDA antagonists include Ketamine and magnesium. Magnesium reduces onset time and increased analgesic effect when added to local anaesthetics. (*Turan A, Mervis D, Karmanlioglu B, et al. Intravenous regional anaesthesia using lidocaine and magnesium. Anesth Analg. 2005;100:1189–92*). Muscarinic receptors mediate analgesia in the dorsal horn of the spinal cord. (*Gentili M, Enel D, Szymskiewicz O, et al. Post operative analgesia by intraarticular clonidine and neostigmine undergoing knee arthroscopy. Reg Anesth Pain Med. 2001;26:342–7*).

- ***Lipid solubility****:* it is dependent on alkyl group on tertiary amine. It is proportional to local anaesthetic potency, duration of action and toxicity.
- ***pKa****:* the pH at which half the local anaesthetic molecules are in the base form and half in the acid form. Most local anaesthetics have a pKa between 7.5 and 9.0. The closer the pKa to the extracellular pH, the higher the number of unionised ions available. Lignocaine (7.7) has a faster onset than bupivicaine (8.1).

Agents	Chemical formula	Potency	pKa	Protein binding (%)	Onset	Duration
Cocaine	C17H21NO4	–	8.6	92	Moderate	Upto 60 min
Procaine	C13H20N2O2	1	8.9	6	Fast	Upto 60 min
Tetracaine	C15H24N2O2	8	8.5	75	Fast	2–4 h
Lignocaine	C14H22N2O	2	7.7	55	Fast	1–2 h
Bupivicaine	C18H28N2O	8	8.1	95	Moderate to slow	2–4 h
Ropivicaine	C17H26N2O	4	8.1	95	Fast	2–4 h
Etidocaine	C17H28N2O	8	7.7	74	Moderate to slow	2–4 h

Physiological state	Pharmacokinetics	Mechanism	Implications
Foetus/age less than 6 months	Reduced metabolism	Deficiency of CYP3A4	Reduced dosage is required
Elderly	Clearance is decreased	Decreased hepatic mass	Reduced dosage is required
Obese	Terminal elimination half life is prolonged	Increased volume of distribution	Dose titrated according to the weight
Cardiovascular disease	Low volume of distribution and clearance	Decreased hepatic blood flow	Reduced dosage is required
Hepatic disease	Increased half life	Decreased hepatic blood flow	Reduced dosage is required
Renal disease	Unaffected	Metabolised by liver	Clearance is decreased and metabolites accumulate

Analgesics in renal/hepatic impairment		
	Renal disease	Hepatic disease
Opioids	No dose alteration required • Fentanyl • Alfentanil • Oxycodone • Methadone • buprenorphine	Dose alteration not required • Alfentanil • Buprenorphine • Fentanyl • Morphine • oxycodone
	Dose alteration required • codeine • morphine • tramadol	Dose alteration required • methadone • tramadol
	Avoid • pethidine • dextropropoxyphene	Avoid • Pethidine

Complications in Regional Anaesthesia and Acute Pain Medicine

4

1. Trends in complications of regional anaesthesia:
   (a) Risk of complications with neuraxial blocks is more in obstetric patients than general population.
   (b) Spinal hematomas are seen more in obstetric patients than orthopaedic patients with regional anaesthesia.
   (c) Spinal hematoma is mostly due to use of anticoagulants.
   (d) Lidocaine produces more nerve injury due to apoptosis.
   (e) Most common organism for perineural catheter infection is streptococcus.
2. Features of spinal hematoma:
   (a) It is mostly intrathecal.
   (b) It becomes symptomatic within a matter of minutes.
   (c) Only large hematomas develop symptoms.
   (d) Female gender is a risk factor for spontaneous hematomas.
   (e) The incidence of hematomas is more with LMWH than thrombolytics.
3. Risk factors for spinal hematoma include:
   (a) Elderly females are at risk.
   (b) Pregnancy and immediate postpartum period is protective to development of spinal hematomas because of hypercoagulable state.
   (c) Decreased weight, concomitant hepatic or renal disease may increase the incidence.
   (d) Traumatic needle or catheter insertion does not increase the risk of hematoma.
   (e) Warfarin increase the PT in all the patients.
4. Features of spinal hematoma:
   (a) Aspirin treatment does not increase the risk.
   (b) Subcutaneous heparin equally increases the risk of hematoma.
   (c) Common presentation is severe radicular back pain.
   (d) Continuous epidural infusions have more incidence than single shot injections.
   (e) Thrombolytic effect may last for more than 72 h.

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5. Features of anticoagulants:
   (a) Normal coagulation status is achieved with normalisation of PT and INR.
   (b) Factor activity level of 80% is required for near normal haemostasis.
   (c) PT and INR are most sensitive to factors VII and X.
   (d) Platelet aggregation inhibits the action of platelets for its life.
   (e) Eptifibatide inhibition of platelet aggregation lasts for 5 days.
6. Role of herbal medications in coagulation:
   (a) Garlic inhibits platelet aggregation in a dose dependent fashion.
   (b) Gingko effects are reversed with in 36 h.
   (c) Ginseng may increase effect of warfarin.
   (d) Echinacea increases liver toxicity.
   (e) Ginger is a cox-1 inhibitor and has Antiplatelet action.
7. Infectious complications with regional anaesthesia:
   (a) Incidence of shunt meningitis is less than the meningitis after lumbar puncture.
   (b) E. coli is a common cause of meningitis.
   (c) Most epidural abscesses are related to placement of indwelling catheters.
   (d) Increased neuraxial infections are seen in chronically ill patients.
   (e) Epidural related infections are common in obstetric patients.
8. Complications after neuraxial block:
   (a) Most common organism involved is pseudomonas aeruginosa.
   (b) Most common organism for epidural abscess is streptococcus.
   (c) Bacterial filters decrease the incidence of infections.
   (d) CSF findings show increase in sugar in infections.
   (e) Neuraxial blocks can be performed in patients with low grade transient bacteremia.
9. Haemodynamic complications in regional anaesthesia:
   (a) Bradycardia is seen in all patients with neuraxial anaesthesia.
   (b) Cardiac arrest may be due to non hypoxic circulatory conditions.
   (c) Primary reason for hypotension is sympathetic nerve blockade.
   (d) In neuraxial block, SVR is decreased while cardiac output is increased.
   (e) Local anaesthetics can cause bradycardia and hypotension.
10. Hemodynamic complications of regional anesthesia:
   (a) Epinephrine as an additive can cause hypotension.
   (b) Clonidine causes hypotension and tachycardia.
   (c) Vagal afferent fibers are responsible for Bezold-Jarish reflex.
   (d) Increased BMI is a risk factor for hypotension.
   (e) Younger patients are more at risk for developing bradycardia.
11. Management of hemodynamic complications in regional anaesthesia:
   (a) Volume preloading in obstetric patients is helpful in preventing hypotension.
   (b) Colloids have benefit over crystalloids in hypotension.
   (c) Hypotension and bradycardia due to neuraxial block responds to fluid treatment in seconds.

(d) Ephedrine is a pure alpha agonist.
(e) Vasopressin may cause bradycardia.

12. Local anaesthetic toxicity:
    (a) Central nervous system (CNS) is more sensitive than cardiovascular system.
    (b) CNS effects are due to depressant effects.
    (c) Toxicity is seen more in peripheral nerve blocks than with epidural anaesthesia.
    (d) Local anaesthetics bind only to sodium channels.
    (e) Maximum blood concentration of local anaesthetic is seen with intercostal block.
13. Effects of local anaesthetic binding:
    (a) Addition of adrenaline to local anaesthetics decreases peak blood concentrations.
    (b) Local anaesthetics are mostly bound to albumin.
    (c) Protein binding is increased in pregnancy.
    (d) Esters and amides have common mode of elimination.
    (e) Prilocaine causes methemoglobinaemia.
14. Symptoms of local anaesthetic toxicity:
    (a) R (+) isomer causes more CNS toxicity than (S−) isomer.
    (b) Bupivicaine causes more seizures then ropivicaine.
    (c) Bupivicaine has more avidity for cardiac tissue than Lidocaine.
    (d) Myocardial stimulation is seen with local anaesthetics causing arrhythmias.
    (e) Bupivicaine induced cardiac toxicity is resistant to treatment because of increase in cAMP.
15. Cardiac complications of Local Anaesthetics:
    (a) Bupivicaine causes dose dependent prolongation of cardiac conduction.
    (b) Most common arrhythmia seen with bupivicaine is ventricular tachycardia.
    (c) Lidocaine causes more extrasystoles than ropivicaine.
    (d) Ropivicaine produces less ventricular depression than bupivicaine.
    (e) Side effects of bupivicaine is due to R+ enantiomer.
16. Complications of local anaesthetics:
    (a) More levels in plasma are required for bupivicaine than ropivicaine for cardiac toxicity.
    (b) Dosage of epinephrine to treat toxicity is the same for ropivicaine and bupivicaine.
    (c) Ropivicaine is least cardio toxic.
    (d) Lidocaine has antiarrythemic properties.
    (e) True anaphylaxis is seen with amide local anaesthetics.
17. Local anaesthetic toxicity:
    (a) Risk is more in extremes of age.
    (b) Pregnancy is a protective factor for local anaesthetic toxicity.
    (c) Cardiovascular toxicity manifests before CNS toxicity.

(d) Alkalosis increase the risk of convulsions.
(e) LD50 is very sensitive to assess LA toxicity.

18. Preservatives and adjuvants contributing to the toxicity:
    (a) Methyl moiety may add to bacterial contamination in parabens.
    (b) Parabens is bactericidal with no side effects.
    (c) Metabisulphite is an oxidant.
    (d) Metabisulphite decreases the shelf life of mixture.
    (e) EDTA can cause muscle spasm.
19. Additive related local toxicity:
    (a) Phenylephrine acts as a vasoconstrictor.
    (b) Unstable angina is a contraindication for usage of vasoconstrictor drugs.
    (c) Phenylephrine decreases spinal blood flow.
    (d) Dextrose as an additive may cause neurotoxicity.
    (e) Local anaesthetic mixtures are alkaline.
20. Additive related local anaesthetic toxicity:
    (a) Epinephrine is safe to use with tetracaine.
    (b) Epinephrine causes direct neural toxicity.
    (c) Nerve injury is seen more in patients with diabetes or chemotherapy.
    (d) Polyethylene glycol can cause arachnoiditis.
    (e) Clonidine is analgesic on intrathecal administration.
21. Additives related to local anaesthetics:
    (a) Neostigmine causes analgesia.
    (b) Neostigmine does not cause any side effects when given neuraxially.
    (c) Ketamine is safe on intrathecal administration.
    (d) Midazolam cannot be given intrathecally.
    (e) Hyaluronidase is used for ophthalmological anaesthesia.
22. Post dural puncture headache.
    (a) Headache is seen within minutes.
    (b) Cardinal feature is postural in nature.
    (c) Headache is mostly unilateral.
    (d) Large needles cause more incidence.
    (e) Auditory symptoms seen are mostly unilateral.
23. Postdural puncture headache:
    (a) Pain is seen only in the head.
    (b) Diplopia is mostly unilateral.
    (c) Intrathecal catheter insertion is associated with increased headache.
    (d) Symptoms are due to loss of CSF volume.
    (e) Nerves involved are ophthalmic branch of the facial nerve.
24. Postdural puncture headache:
    (a) Visual disturbances are not seen.
    (b) Mostly seen in teenagers and early twenties.
    (c) Thick dural puncture is more prone to more CSF level.
    (d) Previous history of migraine increases the risk of headache.
    (e) Lower opening pressure is a risk factor.

25. Postdural puncture headache:
    (a) Increased symptoms are seen with larger needles.
    (b) Non cutting needles cause more trauma to the dura.
    (c) Needle bevel has no role in genesis of headache.
    (d) Paramedian and oblique approaches have low incidence of headache.
    (e) Preparation solution may cause similar headache.
26. Postdural puncture headache
    (a) Pneumoencephalus responds well to blood patch.
    (b) Lateralising neurologic signs are associated features.
    (c) May precede subdural haemorrhage.
    (d) Bed rest is useful in management.
    (e) Oral caffeine helps in prevention of development of headache.
27. Postdural puncture headache:
    (a) Replacing the stylet prior to needle reversal prevents headache.
    (b) Treatment by epidural saline infusion is free of complications.
    (c) Epidural blood patch prophylaxis decrease the incidence of headache.
    (d) 80% of cases gets resolved within a week with no active treatment.
    (e) Single dose of caffeine is effective in treating headache.
28. Mechanical injury to the spinal cord:
    (a) Most patients with injuries have deficits for more than 3 months.
    (b) Epidural abscess after catheter insertion is rare.
    (c) Adult spinal cord finishes at L4-L5.
    (d) Spinal cord is devoid of sensory innervations.
    (e) Paraesthesia elicited during spinal and epidural needle placement is common.
29. Nerve and vascular injuries in regional anaesthesia:
    (a) Stenosis of intervertebral foramina increases the risk of nerve injury.
    (b) Spinal cord is supplied by spinal radicular arteries.
    (c) Artery of Adamkiewicz supplies cervical spinal cord.
    (d) Needle trauma is the main cause of injury to radicularis magna.
    (e) Particulate steroids can cause blindness.
30. Anterior spinal artery syndrome
    (a) Anterior spinal artery injury causes loss of proprioception.
    (b) Local anaesthetics increase spinal cord metabolism.
    (c) Spinal cord is very sensitive to hypotension causing infarction.
    (d) Most common cause of the syndrome intraoperatively is atherosclerosis.
    (e) Cardiac arrest survivors are at increased risk.
31. Neuraxial injury
    (a) Intrathecal granuloma may form around subarachnoid catheter delivering opioids.
    (b) Epidural lipomatosis may increase the prolongation of neuraxial block.
    (c) Neuraxial anaesthesia increases complications in certain carcinomas.
    (d) Lithotomy position may cause spinal cord ischaemia.
    (e) Is common in young population.

32. Continuous spinal anaesthesia:
    (a) Maldistribution of local anaesthetic is a contributing factor to the complications.
    (b) Neurotoxicity is not seen with Lidocaine.
    (c) Bisulfite added as additive may be neuroprotective.
    (d) 5% Lidocaine +10% glucose administration is neuroprotective.
    (e) The most important factor in neurotoxicity is concentration of local anaesthetic.
33. Local anaesthetic toxicity:
    (a) Vasoconstrictor added to the local anaesthetic solution may increase toxicity.
    (b) Cauda equina syndrome manifests as both bowel and bladder dysfunction.
    (c) Injury is dose dependent.
    (d) High doses of intrathecal local anaesthetic can be treated by CSF withdrawal.
    (e) Addition of epinephrine to intrathecal local anaesthetic does not cause side effects.
34. Spinal cord anatomy
    (a) Vascular supply includes two arteries and one vein.
    (b) Posterior spinal artery is the main arterial supply.
    (c) Anterior and posterior spinal arteries have no communication.
    (d) Arteria radicularis magna is responsible for blood supply to 20–50% of spinal cord.
    (e) Mid thoracic cord has the highest perfusion.
35. Spinal cord vasculature:
    (a) Batson's plexus is present in the upper half of epidural space.
    (b) CSF drainage decreases the risk of spinal cord ischaemia during aortic cross clamp.
    (c) $PaCO_2$ has a linear relationship with spinal cord blood flow.
    (d) Bupivicaine injected intrathecally decreases spinal cord blood flow.
    (e) The dose required to prolong spinal blockade is same for phenylephrine and epinephrine.
36. Risk factors for ischaemic spinal cord injury:
    (a) Most common cause is intrathecal or epidural hematoma.
    (b) Transforaminal epidural injection is free of side effects.
    (c) Particulate steroids may cause ischaemia in lumbar spine.
    (d) Spinal cord is more susceptible to ischaemia than other organs.
    (e) Spinal flexion may increase post operative spinal cord injury.
37. Transient neurologic symptoms:
    (a) Is unilateral and occurs within 24 h of use of 5% Lidocaine.
    (b) May not involve lower back.
    (c) The symptoms resolve within 24 h.
    (d) Neurologic symptoms are not seen.
    (e) Position of the patient during the surgery may contribute to the symptoms.

38. Transient neurologic symptoms:
    (a) Is due to local anaesthetic toxicity.
    (b) Is seen equally with bupivicaine or Lidocaine.
    (c) Increase in dose and concentration of local anaesthetic increase the incidence.
    (d) Less Lidocaine concentration decreases the incidence of symptoms.
    (e) Obesity is a risk factor.
39. Transient neurologic symptoms:
    (a) Pain is seen mostly seen in the feet.
    (b) Radiation of pain down the legs is seen in 10% of patients.
    (c) Motor weakness is a common accompaniment.
    (d) Mepivicaine has fewer incidences of TNS than Lidocaine.
    (e) Trigger point injections can be used as treatment.
40. Peripheral nerve injury:
    (a) Incidence of up to 6% is seen with regional anaesthesia.
    (b) Permanent neurologic injury is rare.
    (c) Peripheral nerve blockade contributes mostly to neurologic deficit.
    (d) Needle trauma and LA toxicity is the main reason for neural injuries.
    (e) Most common nerve damage is seen with brachial plexus blocks.
41. Peripheral nerve injury
    (a) Wallerian degeneration may take 4 weeks to complete.
    (b) Severe injury is mediated by chromatolysis.
    (c) Nerve sprouts as a result of injury are mostly myelinated.
    (d) Axonotmesis resolves completely.
    (e) Male gender is an increased risk factor for nerve injuries.
42. Peripheral nerve injury:
    (a) Pre-existing neural injury increases the risk of injury at the other site.
    (b) Prolonged tourniquet duration is protective against nerve injury.
    (c) Injury can occur because of direct local anaesthetic toxicity.
    (d) Long needles are more prone to cause nerve injuries.
    (e) Elicitation of paraesthesia may increase the risk of nerve injury.
43. Peripheral nerve injury
    (a) Adrenaline as an adjuvant may cause Demyelination.
    (b) Pre existing neuropathies may increase the risk of Lidocaine toxicity.
    (c) Intrafascicular injection may cause fibrosis.
    (d) Perineural application of Lidocaine is toxic equally in both 4 and 1% concentrations.
    (e) Combined mechanical and chemical insult must occur to induce neural injury.
44. Peripheral nerve injury:
    (a) Nerve stimulators for regional anaesthesia do not cause neurologic complications.
    (b) Conduction velocities are not normally affected.
    (c) Denervated muscle may show fibrillation.

(d) Most nerve injuries are neuropraxias.
(e) Surgery within 72 h can help save neural function.

45. Muscle injury during regional anaesthesia:
(a) Tourniquet use may cause immediate damage.
(b) Myotoxicity is a common side effect with local anaesthetics.
(c) Myocytes are more prone to injury during childhood and foetal life.
(d) Regeneration is complete in 3–4 weeks.
(e) Myotoxic effect of local anaesthetics may be beneficial.

46. Myotoxicity:
(a) Local anaesthetic induced toxicity takes 3–4 h to manifest.
(b) Signs of inflammation may be seen with local anaesthetics.
(c) Local anaesthetics may produce conditions like malignant hyperthermia.
(d) Tetracaine may cause release of calcium from channels.
(e) Local anaesthetic may cause injury to mitochondria.

47. Myotoxicity:
(a) Procaine causes the most toxic effect.
(b) Direct intramuscular injection is less detrimental as compared to peri-muscular injection.
(c) Hyaluronidase may be protective for muscle injury in ocular anaesthesia.
(d) EMG may be helpful in diagnosis.
(e) Regional anaesthesia can cause post operative strabismus.

48. Myotoxicity:
(a) Extraocular muscles are less sensitive to local anaesthetic.
(b) Muscle injury is seen more in elderly.
(c) Peribulbar blocks causes less myotoxicity than subtenon blocks.
(d) Treatment of myotoxic injury is rarely required.
(e) Permanent tissue loss may be seen.

49. Pulmonary complications of regional anaesthesia:
(a) There is no effect on FVC after interscalene block.
(b) Lung volumes may be affected for up to 6 h after brachial plexus block.
(c) Respiratory depression has a high incidence with epidural or subarachnoid opiate administration.
(d) Most pulmonary complications are seen with infraclavicluar approach to brachial plexus.
(e) Paravertebral block has a high incidence of Pneumothorax.

50. Pulmonary complications associated with regional anaesthesia:
(a) All the components of the chest wall may be blocked by neuraxial anaesthesia.
(b) Pulmonary function testing is quite sensitive in measuring respiratory changes after neuraxial block.
(c) High epidural anaesthesia abolishes intercostal muscle activity.
(d) Sedation increases respiratory compromise during spinal anaesthesia.
(e) Cervical epidural causes an increase in maximum inspiratory pressure.

51. Pulmonary complications during regional anaesthesia:
(a) Cough is affected with neuraxial anaesthesia.
(b) Oxygen consumption is increased during neuraxial block.

(c) Intrathecal opioids do not interfere with respiration pattern.
(d) Interscalene block causes diaphragmatic paralysis by affecting Phrenic nerve only.
(e) FEV1 and FVC is reduced in brachial plexus block.

52. Complications of regional anaesthesia block:
(a) Brachial plexus block may cause retrograde flow into carotid or vertebral vessels.
(b) Psoas compartment block may extend to subarachnoid area.
(c) Bilateral recurrent laryngeal nerve block is seen with interscalene block.
(d) Spinal anaesthesia may be seen after interscalene block.
(e) Total spinal anaesthesia presents with dilated pupils.

53. Complications of regional blockade:
(a) Right angled approach to skin prevents complications in psoas compartment blocks.
(b) Epidural anaesthesia may lead to bilateral dilated pupils.
(c) Appearance of paralysis and motor weakness is not consistent with local anaesthetic systemic toxicity.
(d) Depth of needle during brachial plexus block does not matter at C6 due to deep sedated location.
(e) Pupils may be dilated in subdural block.

54. Complications of opioids in regional anaesthesia:
(a) Chronic opioid treatment causes less respiratory depression.
(b) Respiratory depression is due to effect on brain stem.
(c) Neonates are resistant to respiratory depression effect of neonates.
(d) Apnoea occurs rapidly on intrathecal administration.
(e) Naloxone is a long acting opioid antagonist.

55. Side effects of opioids in regional anaesthesia:
(a) NSAIDs cause less respiratory depression than opioids.
(b) Patient controlled analgesia is superior in terms of side effects as compared to conventional doses.
(c) Background infusion may increase the risk of respiratory depression.
(d) Opioids may lead to bowel rupture.
(e) Early resumption of oral feeding prevents complications.

56. Side effects of opioids in regional anaesthesia:
(a) Opioids decrease gut motility.
(b) Tone of sphincters is increased.
(c) Bowel effects are dose related.
(d) Opioids induces constipation in the post operative period and can be treated with laxatives.
(e) Opioid antagonists treats opioid induced gastrointestinal complications.

57. Complications associated with continuous epidural anaesthesia:
(a) Bupivicaine and ropivicaine both are suitable for epidural administration.
(b) Site of actions for epidural opioids is systemic and not spinal.
(c) Continuous infusion has been shown to be better than intermittent doses for analgesia.

(d) Post operative nausea and vomiting is common.
(e) Single shot morphine in epidural space causes more post operative nausea and vomiting than continuous Fentanyl epidural infusion.

58. Complications associated with continuous epidural anaesthesia:
(a) Post operative nausea and vomiting is due to activation of chemoreceptor trigger zone.
(b) Dexamethasone has the most consistent benefit for post operative nausea and vomiting.
(c) Pruritus is rarely seen.
(d) Pruritus is due to a central action of opioids during epidural infusion.
(e) Peripheral histamine release plays a major role in epidural induced Pruritus.

59. Complications with continuous epidural anaesthesia:
(a) There is a dose dependent relationship between the incidence of Pruritus and dose of neuraxial opioid.
(b) Fentanyl does not causes Pruritus via epidural route.
(c) Nalbuphine used to prevent Pruritus is free of side effects.
(d) Serotonin antagonists decrease the incidence of Pruritus.
(e) Propofol may be used in the treatment of epidural induced Pruritus.

60. Complications with continuous epidural anaesthesia:
(a) Opioid administration has a low risk of respiratory depression.
(b) Opioids act on the ventral respiratory group in the brainstem.
(c) Lipophillic opioids cause more respiratory depression than hydrophilic opioids.
(d) Thoracic surgery is a risk factor for respiratory depression.
(e) More motor block may be seen with local anaesthetic and opioid combination.

61. Complications associated with regional anaesthesia:
(a) continuous infusion of local anaesthetic alone causes mote hypotension than infusion of opioid alone.
(b) Lumbar epidural catheter placement results in greater motor blockade.
(c) Higher concentration of local anaesthetic solution causes increased motor blockade.
(d) Tunnelling of the catheter eliminates the risk of movement of catheters.
(e) Insertion of the catheter during lateral decubitus position decreases the risk of misplacement of the catheter.

62. Continuous peripheral nerve blocks:
(a) Secondary block failure has a low incidence.
(b) Stimulating catheters increase the accuracy of catheter placement.
(c) Vasculature puncture has a low incidence.
(d) Hematomas may cause prolonged neural injuries.
(e) Epinephrine is used as a marker for intravascular placement.

63. Complications of perineural block:
(a) Perineural catheter during a regional nerve block does not increase the risk of neural injury.

(b) Most common complication during perineural infusion is unilateral placement.
(c) Bilateral catheter site colonisation is infrequently seen.
(d) Low incidence of infection is related to local anaesthetic bactericidal and bacteriostatic properties.
(e) Catheter use should be limited to a maximum of 4 days.

64. Complications of perineural catheters:
(a) Migration of catheter into the muscle is not associated with any complications.
(b) Muscle injury due to local anaesthetic does not cause an increase in creatine kinase.
(c) Perioral numbness may be seen.
(d) Repeated doses of local anaesthetics does not cause muscle injury as against continuous infusion.
(e) Diabetes increase the risk of neural injuries.

65. Complications following local anaesthetic infusion:
(a) Catheter retention is mostly due to knot formation.
(b) Increased duration of catheter insertion increases the risk of retention.
(c) Catheter fragments left inside does not cause any problems.
(d) Ambulatory surgery does not cause any problems.
(e) Catheter tip removal should be documented for safety.

66. Complications with regional anaesthesia:
(a) Female sex is a risk factor for neurologic complications after neuraxial anaesthesia.
(b) Single shot injection has a low risk for infections.
(c) Frequent dressing changes may decrease the incidence of colonisation.
(d) Seizures may be produced by very small amount of local anaesthetic placed intravascular.
(e) Higher nerve stimulator currents may be required in diabetics to produce desired results.

67. Local anaesthetic toxicity:
(a) Toxicity manifests initially as excitation followed by depression.
(b) Amygdala is solely responsible for local anaesthetic induced seizures.
(c) Local anaesthetic induced seizures do not cause long term neurologic deficit.
(d) Most local anaesthetic induced seizures are due to absorption of excessive doses.
(e) Seizures mostly involve facial musculature.

68. Toxicity due to local anaesthetics:
(a) Circumoral numbness is not a central nervous effect.
(b) Plasma protein binding is decreased with alkalosis.
(c) Circulating collapse/CNS excitation ratio is inversely proportional to potency of local anaesthetic.
(d) Local anaesthetics may depress spontaneous pacemaker activity.
(e) Local anaesthetics have biphasic action of mechanism of blood vessels.

69. Local anaesthetics:
    (a) Site of injection has no bearing on concentration of local anaesthetic.
    (b) Rapid absorption is seen after interpleural injection.
    (c) Hypokalemia may augment cardiac toxicity.
    (d) Amiodarone is ideal for treating cardiac arrhythmias.
    (e) Bupivicaine causes myotoxicity by suppressing protein synthesis.
70. Neurologic anatomy of peripheral nerves:
    (a) Capillary blood vessels are embedded in endoneurium.
    (b) Sensory nerves are Unmyelinated.
    (c) Endoneural capillaries have tight junction.
    (d) Peripheral nerves have low blood flow.
    (e) Axonal transport is passive.
71. Peripheral nerve injury:
    (a) Neuropraxia can extend up to few months.
    (b) Axonotmesis is interruption of Schwann cell tubes.
    (c) Neurotmesis is complete transaction of nerve.
    (d) Axonotmesis is difficult to differentiate with neurotmesis in closed injuries.
    (e) Most nerve injuries are mixed injuries.
72. Mechanical nerve injury:
    (a) Intraneural injection causes damage to fascicle.
    (b) Extra fascicular injections do not cause nerve injury.
    (c) Nerve injury may depend upon the local anaesthetic agent used.
    (d) Histological changes include chemical neuritis and intraneural haemorrhage.
    (e) Pain is a reliable sign of nerve injury.
73. Mechanical nerve injury:
    (a) Pain paraesthesia is more reliable than pressure paraesthesia.
    (b) Nerve stimulators completely eliminates the risk of nerve injury.
    (c) Motor response irrespective of current density is appropriate for nerve injection.
    (d) Resistance to injection is greater with smaller needles.
    (e) Intrafascicular injection can cause histological changes in the nerve.
74. Mechanical nerve injury:
    (a) Intraneural injection always causes neural injury.
    (b) Risk of injuries is more with long bevel needle.
    (c) Sharp needles cause less damage than blunt needle.
    (d) Antiemetics can cause damage if injected perineurally.
    (e) Paraesthesia may be a sign of ischaemia.
75. Nerve injury:
    (a) Nerve function is not altered with up to 6 h of Ischaemia.
    (b) Tourniquet induced ischaemia can prevented by limiting time to a maximum of 120 min.
    (c) Peripheral neuropathy due to hematoma is permanent.

(d) Avoidance of excess sedation can prevent neural injuries.
(e) Pre existing neuropathy can increase incidence of nerve injuries.

76. Complications of ophthalmic regional anaesthesia:
(a) Venous hematomas are slow in retrobulbar haemorrhage.
(b) Small gauge needles cause less trauma than large gauge needles.
(c) Inferior temporal quadrant is most suitable for injections.
(d) Local anaesthetics for ophthalmic blocks do not cause systemic toxicity.
(e) Brainstem anaesthesia is a complication.

77. Ophthalmic regional anaesthesia:
(a) Injuries can be prevented by deep seated injections.
(b) Adducted eye is more prone to injury by needle.
(c) Myopic patients are less prone to injury.
(d) Blunt needles causes less penetration.
(e) Chemosis is more common in periconal blocks.

78. Ophthalmic regional anaesthesia:
(a) Incidence of globe perforation is low.
(b) Peribulbar blocks have a high failure rate.
(c) Perforation is seen rarely in myopes.
(d) Hypotony is a risk factor for perforation.
(e) Ocular explosion is a known complication.

79. Ophthalmic regional anaesthesia:
(a) Leads to short lived muscle dysfunction.
(b) Perimuscular injection of local anaesthetic can cause more complications than intramuscular injections.
(c) Increased age is a protective factor for muscular injury.
(d) Superior rectus is most prone to injury.
(e) Persistent strabismus may be seen.

80. Ophthalmic regional anaesthesia:
(a) Diabetes mellitus increases the risk of optic atrophy.
(b) Hyaluronidase should not be used in facial nerve injections.
(c) Local anaesthesia can cause myasthenic like response.
(d) Retrobulbar block provides anaesthesia similar to topical anaesthesia.
(e) Patients on Antiplatelet medications need to stop for 7 days before cataract surgery.

81. Thoracic wall anatomy:
(a) Ribs form one of the sides of paravertebral space.
(b) Paravertebral space is a contained space.
(c) Injection into paravertebral space can spread to contra lateral space.
(d) Intercostals nerve is purely sensory.
(e) Costophrenic sulcus open to accommodate vital capacity lung expansion.

82. Paravertebral block:
(a) Lateral approach always leads to epidural spread.
(b) Medial approach has better results than lateral approach.

(c) An easily advancing catheter confirms paravertebral space insertion.
(d) Epidural spread is commonly seen in paravertebral block.
(e) Short bevelled needle causes less damage than long bevelled needle.

83. Complications with thoracic blocks:
(a) Continuous paravertebral block may cause monoplatythela.
(b) Blood levels are more with intercostal injection than any other site.
(c) Posterior approach to intercostals block is medial to spinous process.
(d) Posterior intercostal space is a narrow space.
(e) Single injection for the desired dermatome is sufficient.

84. Complications of intercostals and interpleural block:
(a) Tissue necrosis is a complication of intercostal blockade.
(b) Pneumothorax is a common complication with intercostals nerve block.
(c) Bilateral intercostal block can cause respiratory compromise.
(d) Intercostals block can cause total spinal anesthesia.
(e) Intercostal injection can lead to acute bronchospasm.

85. Interpleural analgesia:
(a) Can be used for invasive CABG.
(b) Can be provided with the help of percutaneous approach.
(c) Widest space at intercostals space is at the level of angle of ribs.
(d) More extensive block is seen in lateral position.
(e) Pneumothorax is a significant complication.

86. Brachial plexus block:
(a) Incidence of local anaesthetic toxicity is less than other blocks.
(b) Incidence of seizures is high.
(c) Increased age increases the absorbed levels of plasma local anaesthetics.
(d) Liver disease may increase the duration of action of local anaesthetics.
(e) All the binding proteins are decreased in end stage liver disease.

87. Complications of brachial plexus block:
(a) Renal failure increases local anaesthetic toxicity.
(b) Bupivicaine toxicity is decreased in renal failure.
(c) Irreversible neuronal changes are seen in elderly.
(d) Local anaesthetic doses should be reduced for single administration in the elderly.
(e) Pregnant patients are at increased risk of toxicity.

88. Complications of brachial plexus anaesthesia:
(a) Ulnar nerve is commonly injured.
(b) Incidence of tourniquet paralysis is high.
(c) Nerve injury symptoms are immediately seen.
(d) Failure rate of brachial plexus block is more than the neuraxial anaesthesia.
(e) Alkalinisation of local anaesthetics has high evidence for efficacy.

89. Complications of brachial plexus anaesthesia:
(a) Hyaluronidase enhances onset of block.
(b) Heating the local anaesthetic has no effect on duration of action.

(c) Tall thin patients are prone to develop Pneumothorax in supraclavicular block.
(d) Pneumothorax may be asymptomatic.
(e) Plumb-bob technique for supraclavicular block is not associated with pneumothorax.

90. Complications of brachial plexus block:
(a) Phrenic nerve blockade is seen more with supraclavicular approach.
(b) Brachial plexus has not effect on pulmonary functions test.
(c) Surgery in sitting position increases the risk of brachial plexus block.
(d) Interscalene block can cause spinal cord injury.
(e) Total spinal anaesthesia can be seen.

91. Complications of brachial plexus:
(a) Horner's syndrome is indicative of success of the block.
(b) Hoarseness is a known complication.
(c) Bronchodilation is helpful.
(d) Loss of hearing is a known complication.
(e) Transarterial approach may cause loss of pulse.

92. Spinal anaesthesia:
(a) Injudicious use of anaesthetic agent is the most common cause in failure.
(b) Incidence of failure is <1%.
(c) Sprotte needle is associated with maximum failure rate.
(d) Low dose spinal anaesthesia increases the risk of failure rate.
(e) Sensory level is difficult to predict with isobaric bupivicaine.

93. Complications with spinal anaesthesia:
(a) Hypotension is the most common complication.
(b) Pregnant patients are more susceptible for hypotension.
(c) Skeletal muscle paralysis may contribute to hypotension.
(d) Progesterone increases the sensitivity of nervous tissue.
(e) Combined spinal epidural anesthesia is associated with less hypotension than spinal anaesthesia alone.

94. Complications with the spinal anaesthesia:
(a) Decrease in cardiac preload may cause tachycardia.
(b) Elderly patients are more susceptible to bradycardia.
(c) Decrease in ventricular volume causes bradycardia in spinal anaesthesia.
(d) Hypotension during pregnancy does not affect neonates due to auto regulation.
(e) Ephedrine is the vasopressor of choice in pregnant patients.

95. Complications of spinal anaesthesia:
(a) Females are more prone to develop nausea.
(b) Cardiac arrest is rare in spinal anaesthesia.
(c) Cardiac arrest during spinal anaesthesia has better diagnosis than general anaesthesia.
(d) Pain and anxiety can cause urinary retention.
(e) Type of anaesthetic may aggravate urinary retention.

96. Complications of spinal anaesthesia:
    (a) Bupivicaine causes more urinary retention than Lidocaine.
    (b) Small dose opioids intrathecally will not cause urinary retention.
    (c) Lateral insertion of spinal needle causes more nerve damage.
    (d) Paraesthesias are uncommon during needle insertion.
    (e) Elicitation of paraesthesia during needle insertion is a risk factor for persistent paraesthesias.
97. Complications of spinal anaesthesia:
    (a) Backache is extremely common.
    (b) Hyperbaric Lignocaine may cause cauda equine syndrome.
    (c) Transient neurologic symptoms (TNS) start immediately after the administration of spinal anaesthesia.
    (d) TNS is associated with obvious neurological deficit.
    (e) TNS is more seen with lithotomy position.
98. Transient neurologic symptoms:
    (a) Is seen only with Lidocaine.
    (b) Concentrated solutions of local anaesthetics causes the symptoms.
    (c) 4% mepivicaine has less incidence of TNS.
    (d) Hyperbaric local anaesthetics mostly affect dorsal nerve roots.
    (e) TNS is seen more with pencil point needles.
99. Transient neurologic symptoms:
    (a) Spinal cord vasoconstriction may be a risk factor.
    (b) Less symptoms are seen with lithotomy position.
    (c) Type of surgery has no effect on TNS.
    (d) Adding vasoconstrictor may decrease the incidence due to less absorption of local anaesthetics.
    (e) Lidocaine is responsible for TNS than bupivicaine.
100. Complications of spinal anaesthesia:
    (a) Headache has a lower incidence.
    (b) Immobilisation during spinal anaesthesia may contribute to the headache.
    (c) Postdural headache is seen mostly in the occipital region.
    (d) Auditory dysfunction may be seen.
    (e) Visual disturbances are never seen.
101. Postdural puncture headache:
    (a) Headache due to traction of cerebral structures.
    (b) Spinal needles should be oriented parallel to prevent incidence.
    (c) Multiple punctures may cause more headache.
    (d) Keeping patient horizontal for long periods of time prevents headache.
    (e) Caffeine can be given intravenously for treatment.
102. Complications of regional anaesthesia:
    (a) Epidural bolus patch should be done as early as possible after the dural puncture.
    (b) Epidural blood patch causes immediate relief of symptoms by sealing the hole in the dura.
    (c) Epidural blood patch has a low success rate.

(d) High success rate is seen with higher volumes.
(e) Epidural blood patch can be repeated with similar success rate.

103. Complications of spinal anaesthesia:
(a) Ondansetron can be used to treat Pruritus.
(b) Cauda equina syndrome is seen more with continuous spinal anaesthesia.
(c) Spinal cutaneous fistula is a known complication of continuous spinal anaesthesia.
(d) Aseptic meningitis is seen due to preservatives in the local anaesthetics.
(e) Broken catheter pieces should be left in situ if patient is on anticoagulation.

104. Complications of epidural blockade:
(a) Electrical current can be used to confirm epidural catheter placement.
(b) Motor response <1 mA may mean catheter is proximal to the nerve.
(c) Pain is more common in extra-axial lesions.
(d) Pain is not seen with dural puncture.
(e) Electromyography can pick up degree of axonal loss immediately.

105. Complications of epidural blockade:
(a) Epidural abscess is a rare phenomenon.
(b) Most common organism in infection is streptococcus.
(c) Neuraxial anaesthesia is contraindicated in HIV patients.
(d) Infections are seen less because of the bactericidal effect of Lignocaine and bupivicaine.
(e) Most common organism in epidural abscess is Staphylococcus aureus.

106. Complications of epidural anesthesia:
(a) Tunnelling the caudal catheter prevents infection.
(b) Obstetric patients are more susceptible to toxicity.
(c) Potency of sedative agents is increased in high spinal anaesthesia.
(d) Subdural space extends into intracranial space.
(e) Subdural injection may cause cardio-respiratory arrest.

107. Complications of regional anaesthesia:
(a) Cardiovascular toxicity may manifest as tachycardia and hypotension.
(b) Change in heart rate is reliable indicator of intravascular local anaesthetic administration in sedated patients.
(c) Acidosis is protective for local anaesthetic toxicity.
(d) Incidence of post dural puncture headache is about 10%.
(e) Pain due to post dural puncture headache is because of trigeminal nerve.

108. Complications of epidural anaesthesia:
(a) Incidence of visual disturbance is low.
(b) Auditory symptoms gets relieved by epidural blood patch.
(c) Dura mater is made up of only elastic collagen fibers.
(d) Elderly patients are at greater risk for post dural puncture headache.
(e) Caffeine is the definite treatment for post dural puncture headache.

109. Complications of epidural anaesthesia:
(a) Success rate for repeat epidural blood patch is low.
(b) Blood patch works by mass effect.
(c) Less blood is required for blood patch in thoracic region.

(d) Facial palsy can be seen because of epidural blood patch.
(e) Dextran-40 can be used for post dural puncture headache.

110. Complications of epidural anaesthesia:
(a) Epidural anaesthesia is contraindicated in patients with coronary artery disease.
(b) High thoracic epidurals do not interfere with ventilatory response.
(c) False loss of resistance is common in elderly population.
(d) Higher failure rate is seen in obstetric population.
(e) Younger age is a risk factor for back pain after epidural.

111. Complications of epidural anaesthesia:
(a) Pruritus is due to central nervous system involvement only.
(b) Pruritus is a dose dependent phenomenon.
(c) Dexamethasone has better evidence for post operative nausea and vomiting than other antiemetics.
(d) Intravenous nalbuphine may help with opioid mediated urinary retention.
(e) Younger age is a risk factor for back pain after epidural.

112. Complications of peripheral nerve block:
(a) Brachial plexus has a lower failure rate.
(b) Peripheral nerve stimulators increase safety by decreasing the required volume of local anaesthetic solutions.
(c) Ultrasound frequency mostly used for nerve blocks is between 10 and 14 MHz.
(d) High concentration of local anaesthetics can cause permanent nerve damage.
(e) Local anaesthetics cause permanent muscle damage.

113. Complications of peripheral nerve block:
(a) Anticoagulation in the post operative period does not increase the risk of hematoma after peripheral nerve block.
(b) Sterile gloves decreases the infection rates even in absence of hand washing.
(c) Lithotomy position cause more injury to the nerves.
(d) Deflation of tourniquet every 90–120 min can decrease the incidence of nerve injury.
(e) Extensive joint distension is a risk factor for nerve injury in arthroscopy.

114. Complications of intravenous regional anaesthesia:
(a) Myocardial toxicity is because of negative ionotropic effects of local anaesthetic.
(b) Central nervous system toxicity is more predictable than cardiac toxicity.
(c) Increased plasma Lidocaine can cause vasodilatation.
(d) Lidocaine is more toxic than ropivicaine.
(e) Prilocaine should be avoided because of formation of methemoglobin.

115. Complications of peripheral nerve blockade:
(a) Chlorprocaine causes pain on injection.
(b) Intravenous block with guanethedine can cause apnoea.
(c) Opioids alone are equally effective in intravenous regional anaesthesia.

(d) Upper limb tourniquets are more prone to leakage.
(e) Toxicity due to deflation is due to local anaesthetic levels in the arterial system.

116. Complications of peripheral nerve block:
(a) Tourniquet pain is reduced by Lignocaine priming.
(b) Neuromuscular dysfunction is rare with tourniquet use.
(c) Prilocaine and Lidocaine are ideal for intravenous regional anaesthesia.
(d) Adequate exsanguinations before inflation of tourniquet decreases local anaesthetic toxicity.
(e) Adequate time should be given after local anaesthetic injections in bier's block to minimise toxicity.

117. Complications of paediatric regional anaesthesia:
(a) Loss of resistance with air is ideal for confirmation of epidural space.
(b) Risk of dural puncture is more in infants than older patients.
(c) Infections are mostly caused by corynebacterium in neuraxial anaesthesia.
(d) Obstruction to passage of epidural catheter is more in infants.
(e) Incidence of post dural puncture headache in children is low.

118. Complications in paediatric regional anaesthesia;
(a) Blood patch is contraindicated in paediatric population.
(b) Plasma levels of 4.0 μg/mL of bupivicaine are toxic.
(c) Warning signals during toxicity are absent in paediatric population.
(d) Cardiac toxicity is rare.
(e) Clonidine increases analgesia without much side effects.

119. Complications of obstetric regional anaesthesia;
(a) Headache develops in only 25% of patients with dural puncture.
(b) Post dural puncture headache is accompanied by nausea and vomiting.
(c) Cerebral vasoconstriction can treat dural puncture headache.
(d) Serious complications are rare with blood patch.
(e) Hypotension seen after neuraxial block is because of decreased cardiac output.

120. Complications in obstetric regional anaesthesia:
(a) Colloids are better than crystalloids in preventing hypotension in neuraxial blocks.
(b) Leg elevation is the most important non-pharmacological measure to prevent hypotension.
(c) Combined spinal epidural leads to less incidence of instrumental delivery.
(d) Increased incidence of post dural puncture headache is seen with combined spinal epidural.
(e) Intrathecal opioids increases the risk of fetal bradycardia.

121. Complications in obstetric regional anaesthesia:
(a) Neuraxial anaesthesia is associated with reactivation of *herpes simplex labialis.*
(b) Respiratory depression with neuraxial opioids may be seen for more than 24 h.

(c) Respiratory depression is seen more with obese patients.
(d) Subdural block presents as unusually high block.
(e) Subdural block causes dense block of sacral dermatomes.

122. Complications of obstetric regional anaesthesia:
(a) Most nerve injuries associated with neuraxial anaesthesia are reversible.
(b) Transient neurologic symptoms are seen more with bupivicaine.
(c) Pregnancy offer protection against transient neurologic symptoms.
(d) Cauda equine syndrome is rare following neuraxial blockade in obstetrics.
(e) Micro catheters increase the risk of cauda equina syndrome.

123. Complications of regional anaesthesia in obstetrics:
(a) Large volumes of epidural local anaesthetics can cause spinal cord Ischaemia.
(b) Combined spinal epidural is associated with increased risk of meningitis.
(c) Onset of epidural abscess is slower than meningitis.
(d) Risk of permanent neurologic damage is high in epidural hematoma.
(e) Epidural anaesthesia may cause intracranial haemorrhage.

124. Complications of regional anaesthesia in obstetric population:
(a) Intracranial subdural hematoma may present as post dural puncture headache.
(b) Primiparity is a risk factor for nerve injury.
(c) Compression by foetal head can cause nerve palsy.
(d) Nerve injuries are less frequently seen in latter half of the pregnancy.
(e) Most common nerve injury is seen with femoral nerve.

125. Complications of regional anaesthesia in obstetric population:
(a) Obturator nerve palsy may present as weakness of hip abduction.
(b) Paracervical block provides good analgesia during first stage of labour.
(c) Paracervical block has no effect on foetus.
(d) Paracervical block is not associated with nerve injuries in females.
(e) Regional anaesthesia is associated with a reduction in blood loss in both obstetric and non obstetric patients.

126. Complications of neuraxial catheters:
(a) Canulation of epidural vein has a low incidence.
(b) Injecting fluid in catheter during insertion decreases the incidence of venous canulation.
(c) Avoidance of multi-orifice epidural catheters decrease the complications.
(d) Current stimulation of neuraxial catheter can detect accurate placement of the catheter.
(e) Epidural catheters have minimal movement with tunnelling.

127. Complications of neuraxial catheters:
(a) The catheter if knotted after insertion should be left inside.
(b) Knotted catheter should be removed as soon as possible to avoid complications.
(c) Most of the removed catheters can cause infection.
(d) Retained catheters are easy to remove in lateral position.
(e) Bloody taps have a high incidence during insertion of catheters.

128. Complications of neuraxial catheters:
    (a) Catheter insertion should not be done for patients on aspirin.
    (b) Epidural abscess can cause permanent neurologic deficit.
    (c) Most common organism in epidural abscess is Staphylococcus aureus.
    (d) Diagnosis of epidural abscess is by MRI.
    (e) Bupivicaine has better antimicrobial effect than ropivicaine.
129. Complications of neuraxial catheters:
    (a) Incidence of post dural puncture headache is low with continuous spinal anaesthesia.
    (b) Prophylactic blood patch decreases the incidence of post dural puncture headache.
    (c) Injection of drugs other than local anaesthetic have no side effects.
    (d) Paraesthesias are more common in single segment side by side technique than needle through needle technique.
    (e) If the catheter gets broken skin deep, it can be left in place.
130. Complications of neuraxial catheters:
    (a) Preoperative Antiplatelet non steroidal anti-inflammatory treatment does not increase the risk of spinal haematoma.
    (b) Bacterial filters helps in decreasing infection.
    (c) The incidence of post dural puncture headache associated with catheters is minimal in elderly.
    (d) Pleural puncture has high incidence with infraclavicular approach.
    (e) Stellate ganglion block is seen in 100% of patients with interscalene infusion.
131. Complications of neuraxial catheter:
    (a) Reversible hearing loss is seen with continuous brachial plexus infusion.
    (b) Long term plexus anaesthesia can be used for treatment of chronic pain.
    (c) Intercostals injections are not associated with injury to nerves.
    (d) Paravertebral catheters can cause Pneumothorax.
    (e) Femoral nerve injury can occur because of psoas compartment block.
132. Complications in acute pain management:
    (a) Indwelling urinary catheters for prolonged periods increase the incidence of urinary tract infections.
    (b) Patient controlled epidural analgesia is not associated with hypotension.
    (c) Ropivicaine causes more blockade than bupivicaine.
    (d) Lumbar catheters cause more motor blockade than thoracic catheter.
    (e) Lumbar epidural is beneficial in cardiac insufficiency patients.
133. Complications in acute pain management:
    (a) Incidence of convulsions with local anaesthetics is low.
    (b) Short acting opioids are suitable for continuous epidural analgesia.
    (c) Lipophillic opioids can cause late onset respiratory depression.
    (d) Lipid soluble drugs do not spread in CSF and are thus safe.
    (e) Spinally administered lipid soluble opioids causes effect through brain-stem opioid receptors.

134. Complications in acute pain management:
    (a) Fentanyl infusion has a different mechanism as compared to Fentanyl bolus when given neuraxially.
    (b) Motor weakness depends on the level of local anaesthetic administration.
    (c) Patient controlled epidural analgesia has increased incidence of improved analgesia.
    (d) Epidural morphine dosage is the same as that of intrathecal dosage.
    (e) Nausea and vomiting are less frequent with lipophillic opioids.
135. Complications with acute pain management:
    (a) Pruritus with opioids is seen more in pregnancy.
    (b) Urinary retention is due to involvement of lumbar plexus.
    (c) Type of surgery may affect urinary retention.
    (d) Urinary retention with opioids may require catheterisation.
    (e) Intrathecal opioids decrease the incidence of nausea and vomiting.
136. Complications with acute pain management:
    (a) Incidence of respiratory depression is high.
    (b) Ropivicaine is the ideal local anaesthetic for perineural infusion.
    (c) Site of catheter placement can decide the frequency of dislodgement.
    (d) Risk of infection is decreased with femoral catheters.
    (e) Respiratory depression is seen more with patient controlled analgesia.
137. Neurologic injury after neuraxial block:
    (a) Highest rate of complications are seen after urologic surgery.
    (b) Incidence of neurologic injuries is more in epidural than spinal anaesthesia.
    (c) Most common neurologic complication is nerve root damage.
    (d) Most common symptom is sensory deficit after nerve injury.
    (e) Obstetric population is at risk.
138. Risk factors for neurologic injury:
    (a) Large fluid administration into the epidural space can cause transient paraplegia.
    (b) Spinal canal stenosis is a risk factor.
    (c) Cauda equina syndrome is common.
    (d) Regional anaesthesia decreases the risk for spinal cord compression.
    (e) Hypotension is a known risk factor for neurologic injury.
139. Cauda equina syndrome:
    (a) Positioning during surgery may precipitate it.
    (b) Ischaemia is more damaging than compression.
    (c) Mostly involves L5/S1 nerve roots causing saddle anaesthesia.
    (d) Numbness is only seen in the perineum.
    (e) Spondylolisthesis can be a cause.
140. Spinal hematoma:
    (a) Most common cause is needle injury.
    (b) Presents within days of injury.
    (c) Can occur in absence of risk factors.

(d) Incidence after obstetric epidural anaesthesia is less.
(e) Spastic paralysis may be seen.

141. Spinal hematoma:
(a) Mostly presents as acute pain.
(b) MRI is the gold standard for diagnosis.
(c) Complete recovery is seen in only 10% of patients.
(d) Hematomas that develop higher in the spinal cord have better prognosis than lumbosacral region.
(e) Treatment of steroids increase the risk of spinal hematoma.

142. Spinal hematoma: anatomical considerations:
(a) Epidural fat may decrease with epidural injection.
(b) Posterior epidural space is maximum at thoracic level.
(c) Epidural veins are seen in anterolateral region of spine.
(d) Previous epidural injection makes subsequent injections easier.
(e) Previous surgery is a risk factor for spinal hematomas.

143. Anticoagulants and hematoma:
(a) Stress may cause hypercoaguable state.
(b) Platelet function is altered by NSAIDs via inhibition of COX-2.
(c) Aspirin irreversibly inactivates COX-1.
(d) Aspirin only effects platelets by inhibiting COX.
(e) Aspirin has no effect on coagulation other than inhibition of platelet function.

144. Anticoagulants and regional anaesthesia:
(a) Aspirin is not a risk factor for neuraxial hematomas.
(b) Prasugrel is antidote for Clopidogrel.
(c) Efficacy of prasugrel is same as that of Clopidogrel.
(d) INR is reliable in the management of warfarin efficacy.
(e) Warfarin if given within 24 h of neuraxial anaesthesia is safe.

Answers

1. F F T T F

Obstetric patients are younger and healthier and therefore have less risk of developing complications after regional anaesthesia. (*Moen V, et al. Severe neurological complications after central neuraxial blocks in Sweden 1990–1999. Anesthesiology. 2004;101:950–9.*)

Mostly elderly are associated with osteoporotic vertebrae which are enlarged causing narrowing of the spinal canal and risk of hematoma. The main reason for hematomas is patient's use of anticoagulants. (*Kane RE. Neurological deficits following epidural or spinal anaesthesia. Anesth Analg. 1981;60:150–61.*) Lidocaine causes nerve injury mainly by apoptosis. (*Johnson ME, et al. Mitochondrial injury and caspase activation by the local anaesthetic Lidocaine. Anesthetiology. 2004;101:1184–94.*)

2. F F F T F
Spinal hematomas are mostly epidural because of prominent venous plexus. They normally become symptomatic within a matter of days which suggests that bleeding is arterial. (*Vandermeulen EP, et al. Anticoagulants and spinal-epidural anaesthesia. Anesth Analg. 1994;79:1165–77.*) Hematomas caused by LMWH are usually small in volume (less than the blood used for blood patch) and cause symptoms. (*Horlocker TT, et al. Neuraxial block and low molecular weight heparin: balancing perioperative analgesia and thrombo-prophylaxis. Reg Anesth Pain Med. 1998;23:164–77.*) The risk factors for spontaneous hematoma include increased age, female gender, history of GIT bleed, concomitant aspirin use, length of therapy. (*Levine MN, et al. Hemorrhagic complications of anticoagulant treatment. Chest. 2001;119:1085–215.*)

The incidence of hematomas with standard heparin and LMWH is less than 3% while with thrombolytic treatment is 6–30%.

3. T F T F F
Elderly are more at risk especially if they are on LMWH due to increased sensitivity to thrombolytic medications. Hepatic or renal disease may cause increased risk because of increased anticoagulant response. Warfarin increases the PT in patients having heparin resistance secondary to a reduction in antithrombin III. Enhanced prothrombin time responsive to warfarin is seen with elderly (>65 years), females, weight <1000 lb, excessive surgical blood loss, liver, cardiac, renal disease and with Asian ethnicity.

4. F F F F T
Increased risk is seen with traumatic needle placement, starting anticoagulation within 1 h of lumbar puncture and concomitant aspirin therapy. Subcutaneous heparin equally increases the risk of hematoma.

Schwander D, et al. Heparin and spinal or epidural anesthesia: decision analysis. Ann Fr Anesth Reanim. 1991;10:284–96.

Hematomas mostly present with new onset numbness, weakness and bladder or bowel dysfunction. The incidence of hematoma with continuous epidural is 1/3000 while that with single shot spinal is 1/40,000.

Schroder DR. Statistics: detecting a rare adverse drug reaction using spontaneous reports. Reg Anesth Pain Med. 1998;23:183–9.

5. F F T T F
PT and INR both reflects factor VII activity which has a half life of 6–8 h. Factor II and X may still be altered (Table 4.1).

Table 4.1 Half life of blood factors

Half life	
Factor VII	6–8 h
Factor IX	24 h
Factor X	25–60 h
Factor XI	50–80 h

Horlocker TT, et al. Regional anesthesia in the anticoagulated patient: defining the risks: the second ASRA consensus conference on neuraxial anesthesia and anticoagulation. Reg Anesth Pain Med. 2003; 28:172–97.

Near Normal hemostasis needs 40% for factor II, IX, X. PT and INR are resistant to factor II.

INR > 1.2 is seen with factor VII levels of 55% and increases to 1.5 with factor levels of 40%. Ticlodipine and Clopidogrel interfere with platelet fibrinogen binding and subsequent platelet-platelet interaction. Platelet dysfunction is present for 5–7 days after discontinuation of Clopidogrel and 10–14 days with Ticlodipine. Platelet glycoprotein IIb/IIIa receptor antagonists include Abciximab, epifibatide and tirofiban. They inhibit platelet aggregation by interfering with platelet fibrinogen binding and subsequent platelet-platelet activation. Time to normalisation range from 8 h (eptifibatide, tirofiban) to 48 h (Abciximab).

6. T T F T T

Garlic's (Allium sativum) effect is due to sulphur containing compounds. Its component ajoene potentiates effect of platelet inhibition. Gingko belongs to division gingkophyta and inhibits CYP2B6 and CYp3A4 enzymes. It inhibits platelet activating factor. Ginseng prolongs both thrombin time and aPTT. (*Janetzky K, et al. Probable interaction between warfarin and ginseng. Am J Health Syst Phartm. 1997;54:692–3.*) Echinacea belongs to genus of family Asteraceae which is used for treatment of infections. If used for more than 8 weeks, it can cause immunosupression. Ginger inhibits platelets by inhibiting Cox-1. (*Nurtjahja-Tjendraputra, et al. Effective Antiplatelet and COX-1 enzyme inhibitors from pungent constituents of ginger. Thromb Res. 2003;111:259–65.*)

7. F F F T F

Incidence is the same for both the meningitis. (*Eng RHK, et al. Lumbar puncture induced meningitis. JAMA. 1981;245:1456–9.*) E. coli is a common cause of bacteremia but uncommon cause of meningitis. Local anaesthetic solutions are bacteriostatic. Most epidural solutions are due to infection from skin, soft tissues or spine. Risk factors for infections include prolonged catheter in situ, immunocompromised patient, thromboprophylaxis. Epidural infections do not have high incidence in obstetric patients. (*Scott DB, et al. Serious non fatal complications associated with extradural block in obstetric practice. Br J Anaesth 1990;64:537–41.*)

8. T F T F T

Most common organism for epidural abscess is Staphylococcus epidermidis. In infections, CSF shows increased proteins and decreased glucose.

9. F T T F T

Incidence of bradycardia is between 2 and 13% while incidence of hypotension is between 8 and 33%. (*Sharrock NE, et al. Hypotensive epidural anesthesia for total hip arthroplasty: a review. Acta Orthop Scand. 1996;67:91–107*). The main reason for hypotension is sympathetic blockade as has been demonstrated by (*Mark JB, et al. Cardiovascular effects of spinal*

anesthesia. Int Anesthesiol Clin. 1989;27: 31–39). Both systemic vascular resistance and cardiac output are decreased. This is because of inhibition of sympathetic neuronal output to resistance and capacitance vessels. The block has to be above T5 for it to cause effect. (*Butterworth JFT, et al. Augmentation of venous return by adrenergic agonists during spinal anesthesia. Anesth Analg. 1986;65:612–6*). Local anaesthetics can cause dose dependent negative ionotropic effect on cardiac muscles. (*Covino BG, et al. Cardiovascular effects of regional anaesthesia. Effects of anaesthesia. 1985;207–15*).

10. T F T T T
    Clonidine is an alpha-2 agonist and causes hypotension and bradycardia by presynaptic release of norepinephrine release and direct parasympathetic effects. The effect may last for 6–8 h. (*Eisenach JC, et al. Alpha-2 adrenergic agonists for regional anesthesia: a clinical review of clonidine. Anesthesiology. 1984;95:655–74*). In Bazold-Jarish reflex, there is increased parasympathetic activity and decreased sympathetic causing bradycardia, vasodilation and hypotension. It manifests as syncope in patients lying with 60° upright tilt table and administered exogenous catecholamines. (*Mork AL. The Bezold-Jarish reflex revisited: clinical implications of inhibitory reflexes originating in the heart. J Am Coll Cardiol. 1983;1:90–102*). Risk factors for hypotension include Increased BMI, Higher sensory anesthetic level, elderly, General anesthesia and combined spinal epidural anesthesia. The risk factors for bradycardia include younger patient, age less than 50 years, level of block above T6 level. (*Pollard JB. Cardiac arrest during spinal anesthesia: common mechanisms and strategies for prevention. Anesth Analg. 2001;92:252–6*).
11. F F F F T
    Preloading causes prevention of hypotension only for a brief period of time (15 min). (*Lewis M, et al. Hypotension during epidural analgesia for cesarean section: arterial and central venous pressure changes during acute intravenous loading with two liters of Hartmann's solution. Anaesthesia. 1983;38*). The blood pressure and heart rate responds to fluid loading in a matter of minutes. (*Critchley LA, et al. Hemodynamic side effects of subarachnoid block in elderly patients. Br J Anesth. 1994;73:464–70*). Ephedrine is both an alpha and beta agonist acting by direct and indirect mechanisms. It works by releasing norepinephrine.
12. T F T F T
    CNS is more sensitive with more local anaesthetics except with bupivicaine which causes more CVS toxicity. CNS effects are mostly due to excitatory phase (shivering, muscle tremor, clonic tonic activity) followed by depressant effect (hypoventilation, respiratory arrest). The incidence of toxicity is 11/10,000 with peripheral nerve blocks and 3/10,000 with epidural anaesthesia. (*Auroy Y, et al. Serious complications related to regional anaesthesia: results of a prospective surgery in France. Anesthesiology. 1997;87:479–86*). Local anaesthetics also bind to potassium and calcium channels along with NMDA receptors. The levels of local anaesthetics in the blood are seen maximally after transtracheal route followed by intercostals, pericervical, epidural

and plexus. (*Scott DB, et al. Factors affecting plasma levels of lignocaine and prilocaine. Br J Anaesth. 1972;44:1040–9*).

13. T F F F T
    Local anaesthetics are primarily bound to α1-acid glycoprotein and secondarily to albumin. (*Tetzlaff J. Clinical pharmacology of local anaesthetics. Woburn, MA: Butterworth-Heinemann; 2000*). Both protein binding and protein concentration decrease in pregnancy. (*Fragneto RY, et al. Measurements of protein binding of Lidocaine throughout pregnancy. Anesth Analg. 1994;71:158–70*). Ester anaesthetics undergo rapid hydrolysis in blood catalysed by pseudocholinersterase. Amides undergo metabolism in liver. (*De Jong RH. Local anaesthetics. St Louis, MO: Mosby Year Book, Inc.; 1994*). Prilocaine undergoes hydrolysis to O-toluidine causing methemoglobinaemia in a dose dependent manner. A dose of more than 600 mg is required to cause it.
14. T F T F F
    R(+) isomer causes more CNS toxicity(*Aberg G. Toxicological and local anaesthetic effects of optically active isomers of two local anaesthetic compounds. Acta Pharmacol Toxicol. 1972;31:273–86*). Bupivicaine causes fewer seizures than ropivicaine by a factor of 1.3 (*Rutten AJ, et al. Hemodynamic and central nervous system effects of i.v. bolus doses of Lidocaine, bupivicaine and ropivicaine in sheep. Anesth Analg. 1989;69:291–9*). R(+) isomer of bupivicaine binds more with cardiac tissue than the (s−) enantiomer. Local anaesthetics causes myocardial depression by interruption of calcium signalling mechanisms within cardiac muscle. (*Feldman HS, et al. Direct chronotropic and ionotropic effects of local anaesthetic agents in isolated guinea pig atria. Reg Anesth. 1982;7:149–56*). Bupivicaine causes cardiac toxicity by binding to beta adrenergic receptors and inhibiting epinephrine stimulated cAMP formation. (*Butterworth JN, et al. Bupivicaine inhibits cyclic-3′5′ adenosine monophosphate production: a possible contributing factor to cardiovascular toxicity. Anesthesiology. 1993;79:88–95*).
15. T T F T F
    Bupivicaine toxicity is directly proportional to increased concentration and manifests as increased PR interval and QRS duration. (*Hotredt R, et al. Cardiac electrophysiologic and hemodynamic effects related to plasma levels of bupivicaine in the dog. Anesth Analg. 1985; 64:388–9*). Lidocaine has same arrythemogenic potential as Ropivicaine.
16. F F T T F
    More plasma levels are required for ropivicaine (median: 19.8 μg/mL) than bupivicaine (median 5.7 μg/mL). Dosage of epinephrine to treat toxicity is less for ropivicaine. Ropivicaine is the least cardiac toxic. (*Chang DH, et al. Direct cardiac effects of intracoronary bupivicaine, L-bupivicaine and ropivicaine in the sheep. Br J Pharmacol. 2001;132:649–58*). Anaphylaxis is mostly seen with ester local anaesthetics due to its metabolism to para amino benzoic acid. (*Levy JH. Anaphylactic reactions in anaesthesia and intensive care. Boston: Butterworth Publisher; 1992*).

17. T F F F F
Toxicity is seen more both in very young and the very old. This is due to decreased clearance and increased absorption. Pregnancy is a risk factor because of decreased clearance rate and increased concentration of free local anaesthetics. There is also engorgement of epidural veins that can increase toxicity. Central nervous system is more sensitive than cardiovascular in toxicity. Both metabolic and respiratory acidosis increases the risk of convulsions. (*Englesson S, et al. The influence of acid base changes on central nervous system toxicity of local anaesthetic agents. Acta Anaesthsiol Scand. 1974;18:88–103*). Better indicator of toxicity is CC/CNS ratio. It is the ratio of LA dose that produce cardiovascular collapse to the dosage that produce central nervous system toxicity. High ratio indicates good safety margin.
18. F F T F T
Methyl moiety is added to provide antibacterial effect. Methyl moieties are more common than ethyl/propyl varieties. Parabens decreases the microbe load but does not eliminates it and can cause an allergic reaction by its metabolism to para amino benzoic acid. (*Hetherington NJ, et al. Potential for patient harm from intrathecal administration of preserved solutions. Med J Aust. 2000;173:141–3*). Metabisulphite is added to epinephrine containing local anaesthetic as an antioxidant. It increases the shelf life of local anaesthetic mixture. (*Rowlingson JC. Toxicity of local anaesthetic additives. Reg Anesth. 1993;18:453–60*). Ethylene diamine tetra acetate is an antioxidant when given neuraxially. EDTA if given paraspinally chelates calcium and causes spasm. (*Stevens RA, et al. Back pain after epidural anaesthesia with chloroprocaine. Anaestheiology. 1993;78:492–7*).
19. T T T T F
Phenylephrine decreases the systemic blood levels of local anaesthetic and increases the duration of action. Unstable angina is a contraindication for the usage of vasoconstrictors along with poorly controlled hypertension, arrhythmias, uteroplacental insufficiency, MAO inhibitors or tricyclic antidepressant intake. Phenylephrine decreases the spinal blood flow. (*Haidar N. Additives used to limit systemic absorption. Tech Reg Anesth Pain Manag. 2004;8:119–22*). Dextrose is used to adjust baricity and may control effect of LA. Defects in glucose metabolism in the host may be a cofactor in neural injury. (*Kalichman MW, et al. Local anaesthetic induced conduction block and nerve fiber injury in streptozotocin diabetic rats. Anesthesiology. 1992;77:941–7*). Local anaesthetic mixtures are made acidic to maintain the stability of solution.
20. F F T T T
Epinephrine when used in conjunction with tetracaine 1–2% may cause worsening of spinal histopathology. (*Oka S, et al. The addition of epinephrine to tetracaine injected intrathecally sustains an increase in glutamate concentration in the cerebrospinal fluid and worsens neuronal injury. Anesth Analg. 2001;93:1050–7*). Polyethylene glycol is toxic at a concentration less than 3%. (*McQuillan PM, et al. Interventional techniques. In: Raj PP, editor. Pain*

medicine: a comprehensive review. 2nd ed. St Louis: Mosby. p. 286–7).Clonidine inhibits release of substance P and the firing of wide dynamic range neurons in spinal cord dorsal horn. (*Thannikary LJ, et al. Non opioid additives to local anaesthetics. Tech Reg Anesth Pain. 2004;8:129–40*).

21. T F T F T
    Neostigmine is an acetylcholine esterase inhibitor which prevents the breakdown of acetylcholine in the spinal cord. It causes sedation and vomiting in intrathecal injection. (*Kaya FN, et al. Epidural Neostigmine produces analgesia but also sedation in women after caesarean delivery. Anesthesiology. 2004;100:381–5*). Preservative free solutions of Ketamine are safe for intrathecal administration. Repeated doses may cause pathological findings because of benzethonium chloride. (*Errando CL, et al. Subarachnoid Ketamine in swine, pathological findings after repeated doses: acute toxicity study. Reg Anesth Pain Med. 1999;98:1507–8*). Midazolam is a water soluble benzodiazepine that can be used intrathecally with no neurotoxicity. (*Tucker AP, et al. Intrathecal midazolam I: a cohort study investigating safety. Anesth Analg. 2004;98:1512–20*).
22. F T F T T
    Headache takes 12–48 h and up to 5 days to manifest. Headache within an hour of puncture may be indicative of pneumoencephalus. (*Aida S, et al. Headache after attempted epidural block: the role of intrathecal air. Anesthesiology. 1998;88:76–81*). The headache worsens in upright position and improves with recumbency. Headache is mostly bilateral and is mostly occipital (27%) and frontal (25%). It is typically dull aching pressure type. Large needles cause more headaches. (*Halpern S, et al. Postural puncture headache and spinal needle design. Meta-analysis. Anesthesiology. 1994;81:1376–83*). Auditory symptoms are moistly unilateral and include loss of hearing tinnitus, hyperacusis. Loss of lower frequency hearing is seen. (*Spring J, et al. Perioperative hearing impairment. Anesthesiology. 2003;98:241–57*).
23. F T F T T
    Pain is seen in the neck and the shoulders. Diplopia is unilateral in 80% of patients. Intrathecal catheter promotes better sealing of breach in the dura and promotes healing. The symptoms are due to loss of CSF. It is produced at 0.35 mL/min (choroid plexus) and reabsorbed through arachnoid villi. The total volume is 150 mL and headache resolves after the reconstitution of the volume. (*Kunkle EC, et al. Experimental studies on headache. Analysis of the headache associated with changes in intracranial pressure. Arch Neurol Psych. 1942;49:323–58*). Nerves involved in the pain are the facial for frontal pain and IX and X cranial nerves for occipital pain and cervical nerves for neck and shoulder pain. (*Larrier D, et al. Anatomy of headache and facial pain. Otolaryngeal Clin N Am. 2003;36:1041–53*).
24. F T F F T
    Visual disturbances are seen due to transient palsy of the nerves supplying extraocular muscles (III, IV, VI). Mostly lateral rectus is involved due to its long course. (*Nishio I, et al. Diplopia: a complication of dural puncture.*

Anesthesiology. 2004;100:158–64). The headache is seen mostly between 10 and 50 years. It is mostly seen in females. (*Lybecker H, et al. Incidence and prediction of postdural puncture headache: a prospective study of 1021 spinal anaesthesia. Anesth Analg. 1990;70:389–94*). Dura which is thick is protective against puncture. (*Dittman M, et al. Anatomical re-evaluation of lumbar dura mater with regard to postspinal headache. Anaesthesia. 1988;43:635–7*). Unilateral headache and migraine are not associated with increased risk. Bilateral tension type headache is more at risk. (*Hannerz J. Post lumbar puncture headache and its relation to chronic tension type headache. Headache. 1997;37:659–62*). The risk factors include decreased BMI, low CSF substance P concentration, low baseline pain sensitivity.

25. T T F T T

The needles which are non cutting (Whitacre, Sprotte, Gertie Marx) have less incidence of headache than cutting (Quincke). Non cutting needles cause more traumatic dural hole resulting in a better inflammatory healing response. (*Raina MA, et al. An in vitro study of dural lesions produced by 25 gauge Quincke and Whitacre needles evaluated by scanning electron microscopy. Reg Anesth Pain Med. 2000;25:393–402*). To prevent headache, needle should be inserted with the bevel parallel to long axis of spine. (*Norris MC, et al. Needle bevel direction and headache after inadvertent dural puncture. Anesthesiology. 1989;70:729–31*). The solutions used for preparation may cause headache. (*Gurmarnik S, et al. Post dural puncture headache: the betadine factor. Reg Anesth. 1996;21:375–6*).

26. F F T F F

Pneumoencephalus does not responds well to patch and can be diagnosed with CT scan. (*Somri M, et al. Postdural puncture headache: an imaging guided management protocol. Anesth Analg. 2003;96:1809–12*). Signs of meningitis include fever, chills, seizures or change in mental status. (*Liu SS, et al. Spinal meningitis masquerading as postdural puncture headache. Anesthesiology. 1996;85:1493–4*). Early bed rest has no role in resolution of symptoms. (*Sudlow C, et al. Posture and fluids for preventing post dural puncture headache: Cochrane review. In: The Cochrane Review Library. 2004;(4), UK*). Caffeine helps in treatment and not in the prevention. (*Esmaoglu A, et al. Oral multidose caffeine paracetamol combination is not effective for the prophylaxis of postdural puncture headache. J Clin Anesth. 2005;17:58–61*).

27. T F F T F

Replacing the stylet decreases the possibility of arachnoid mater attached to needle pulled away (*Strupp M, et al. Incidence of post lumbar puncture syndrome reduced by reinserting the stylus. A randomised prospective study of 600 patients. J Neurol. 1998;245:589–92*). Epidural saline infusion causes back pain, eye pain and can cause retinal haemorrhage. Prophylactic epidural blood patch decreases total duration of signs and symptoms but not the incidence. (*Seavone M, et al. Efficacy of a prophylactic epidural blood patch in preventing post dural puncture headache in parturients after inadvertent*

dural puncture. Anesthetiology. 2004;101:1422–7). Caffeine is given in more than one dose; each dose is at least 300 mg but is contraindicated in seizures, pregnancy induced hypertension and supraventricular tachycardia. (*Camann WR, et al. Effects of oral caffeine on post dural puncture headache: a double blind placebo controlled trial. Anesth Analg. 1990;70:181–4*).

28. F T F T T
Injuries for more than 3 months last only in 15%. (*Auroy Y, et al. Serious complications related to regional anesthesia. Results of a prophylactic survey in France. Anesthesiology. 1997;87:479–86*). Epidural abscess is seen less after catheter insertion (1:1930–5000). Higher incidence is seen with immunocompromised patients. (*Wang LP, et al. Incidence of spinal epidural abscess after epidural analgesia. Anesthesiology. 1999;91:1928–36*). Mostly caudad terminus is at L1-L2 but can extend to L4-L5. Most anaesthetics will make error by 1 or 2 spaces. (*Render CA. The reproducibility of the iliac crest as a marker of lumbar spine level. Anaesthesia. 1996;51:1070–1*). Sensory fibers are present only in meninges and not in the spinal cord. (*Kumar R, et al. Innervation of the spinal dura: myth or reality? Spine. 1996;21:18–26*). Paraesthesia is seen in upto 6.3% of patients during needle placement.

29. T T F F T
Artery of Adamkiewicz is the largest anterior segmental medullary artery. It arises from aorta between T8 and L1 on the left side (right—30%) and supplies lower thoracic/lumbosacral cord. (*Hoy K, et al. Regional blood flow, plasma volume and vascular permeability in the spinal cord, the dural sac and lumbar nerve roots. Spine. 1994;19:2804–11*). Midline or interlaminar approach of the needle is distant from the artery and so does not cause trauma. The artery passes through intervertebral foramen which is far away from the trajectory. Injury occurs on lateral approach or because of irritation of substances like alcohol or phenol. (*Morishita K, et al. Anatomical study of blood supply to the spinal cord. Ann Thor Surg. 2003;76:1967–1*). Particulate steroids on transforaminal injection blocks circulation to cortex and causes blindness. (*Rathmell JP, et al. Cervical transforaminal injection of steroids. Anesthesiology. 2004;100:1595–600*).

30. F F F T F
Anterior spinal artery syndrome is the sudden painless onset of lower extremity weakness and sensory deficit with preserved proprioception. Local anaesthetics decrease spinal cord metabolism. (*Kuroda Y, et al. Epidural bupivicaine suppresses local glucose utilisation in the spinal cord and brain of rats. Anesthesiology. 1990;73:944–50*). Spinal cord blood flow is auto regulated between pressures of 50–120 mmHg. (*Hickey R, et al. Autoregulation of spinal cord blood flow: is the cord a microcosm of the brain? Stroke. 1986;17:1183–9*).

31. T T T T F
Epidural lipomatosis may cause sustained epidural space pressures from a combination of local anaesthetic and fat stores. (*Guegon Y, et al. Spinal cord compression by extradural fat after prolonged corticosteroid therapy. J*

Neurosurg. 1982;56:267–9). Neuraxial anaesthesia is known to increase the complications in multiple myeloma and prostate carcinoma because of epidural metastasis. (*Loblaw DA, et al. Emergency treatment of malignant extradural spinal cord compression: an evidence based guideline. UJ Clin Oncol. 1998;16:1613–24*). Lithotomy position may cause more complications (*Wills JH, et al. Synovial cysts and the lithotomy position causing cauda equine syndrome. Reg Anesth Pain Med. 2004;29:234–6*) (Table 4.2).

32. T F T F T
Misdistribution of local anaesthetic can cause complications. (*Rigler ML, et al. Distribution of catheter injected local anaesthetic in a model of the subarachnoid space. Anesthesiology. 1991;75:684–92*). Bisulfite has been show to be neuroprotective. (*Taniguchi M, et al. Sodium bisulfite: scapegoat for chloroprocaine neurotoxicity. Anesthesiology. 2004;100:85–91*). Intrathecal Lidocaine and 7.5% glucose is neuroprotective is neuroprotective. It does not affect compound action potential or potentiate conduction failure induce by Lidocaine. (*Hashimoto K, et al. Comparative toxicity of Lidocaine and glucose administered intrathecally in the rats. Reg Anesth Pain Med. 1998;23:444–50*).
33. T T T T F
Vasoconstrictors promote ischaemia, decreased anaesthetic update directly affecting neural tissue. (*Hashimoto K, et al. Epinephrine increases the neurotoxic potential of intrathecally administered Lidocaine in rats. Anesthesiology. 2001;94:876–81*). Cauda equine presents as bowel and bladder dysfunction, perineal sensory loss, lower extremity motor weakness. Repetitive withdrawal (5–10 mL) and replacement with saline solution should be done. (*Tsui BC, et al. Reversal of an unintentional spinal anaesthetic by cerebrospinal lavage. Anesth Analg. 2004;98:434–6*). Epinephrine potentiates sensory impairment and histologic damage induced by intrathecal Lidocaine administration with 2-chlorprocaine is associated with flu like symptoms. (*Smith KN, et al. Spinal 2-chlorprocaine: a dose ranging study and the effect of added epinephrine. Anesth Analg. 2004;98:81–8*).
34. F T F T F
The spinal cord is supplied by two posterior and one anterior spinal artery originating from either vertebral arteries or posterior inferior cerebellar artery. Anterior spinal artery supplies anterior 2/3rd of spinal cord and cauda equina. Posterior spinal artery does not supplies cauda equina. There exists limited communication between anterior and posterior spinal arteries via vasa coronae. They give rise to penetrating arterioles. As there is no anastomosis, this area represents a watershed area. Mid thoracic cord contains less gray matter and fewer neurons and so requires less blood flow. (*Biglioli P, et al. Upper and lower spinal cord blood supply: the continuity of the anterior spinal artery and the relevance of the lumbar arteries. J Thorac Cardiovasc Surg. 2004;127:1188–92*).

Table 4.2 Features of neuraxial pathology

	Needle myelopathy	Needle vascular injury	Anterior spinal syndrome	Epidural hematoma	Epidural abscess	Epidural tumour
Risk factors	Non specific	Paravertebral approach	Atherosclerosis	Anticoagulation	Infection	Metastatic carcinoma
Patient age	Non specific	Non specific	Elderly	Elderly	Non specific	Non specific
Onset	Sudden to hours	Sudden to hours	Sudden to hours	Sudden to hours	1–3 days	Sudden to hours
Motor signs	Weakness to flaccid	Weakness to flaccid	Weakness to flaccid	Increased motor blockade	Increased motor blockade	Weakness to flaccid
Sensory	Variable	Variable	Variable	Increased sensory block	Increased sensory block	Variable
General signs and symptoms	None	None	None	Variable back pain, bowel bladder dysfunction	Fever, malaise, back pain	–
Imaging	MRI may be normal	MRI may be normal	Spinal cord infarction	Extradural compression	Extradural compression	Extradural compression

35. F T T T F
Batson's plexus lies in anterolateral epidural space and runs the entire length of the spinal cord. (*Hogan QH. Lumbar epidural anatomy: a new look by cryomicrotome section. Anesthesiology. 1991;75:767–75*). CSF drainage during aortic cross clamping increases blood flow and reduces risk of ischaemia. (*Uceda P, et al. Effect of cerebrospinal fluid drainage and/or partial exsanguination on tolerance to prolonged aortic cross clamping. J Cord Surg. 1994;9:631–7*). CO_2 reactivity is preserved following spinal cord transaction and is thus a local phenomenon. (*Seremin OU, et al. Control of blood flow in the cat spinal cord. J Neurosurg. 1983;58:742–8*). Bupivicaine decreases spinal blood flow by 37% along with 30% decrease in mean arterial pressure. (*Kozody R, et al. Subarachnoid bupivicaine decreases spinal cord blood flow in dogs. Can Anaesth Soc J. 1985;32:216–22*). The dose required to prolong spinal blockade is 10–20 times greater for phenylephrine than epinephrine. Both are alpha-1 agonists and decrease dural blood flow leading to clearance of local anaesthetics.

36. T F F F T
Transforaminal needle placement can cause serious side effects like spinal cord infarction. (*Ludwig MA, et al. Spinal cord infarction following cervical transforaminal epidural injection. Spine. 2005;30:E266–8*). Particulate steroids may cause ischaemia in cervical spine. (*Baker R, et al. Cervical transforaminal injection of corticosteroids into a radicular artery: a possible mechanism for spinal cord injury. Pain. 2003;103:211–5*). Brain and myocardium are more susceptible than spinal cord for ischaemia. Spinal flexion may increase the incidence of spinal cord injury. (*Brower RS, et al. Conus medullaris injury due to herniated disc and intraoperative positioning for arthroscopy. J Spinal Disord. 1995;8:163–5*).

37. F T F T T
Transient neurologic symptoms manifests as unilateral or bilateral pain that occurs within 24 h after spinal anaesthesia. The symptoms involve buttocks and radiates to both extremities. Lower back may or may not be involved. Symptoms may resolve in 24 h and no neurologic symptoms are seen upon physical examination of imaging. The symptoms are associated with lithotomy position (30–36%), arthroscopy 18–22%), supine position (4–8%). (*Keld DB, et al. The incidence of transient neurologic symptoms after spinal anaesthesia in patients undergoing surgery in the supine position: Hyperbaric Lidocaine 5% versus hyperbaric bupivicaine 0.5%. Acta Anesthesiol Scad. 2000; 44:285–90*).

38. T F F F T
Transient neurologic symptoms are seen due to local anaesthetic, needle trauma, neural ischaemia, patient positioning, pooling of local anaesthetics, muscle spasm and myofascial trigger points. (*Freedman J, et al. Risk factors for transient neurologic symptoms after spinal anaesthesia. Anesthesiology. 1998;89:633–41*). Transient neurologic symptoms are seen rarely with bupivicaine and are more due to direct neurotoxicity with Lignocaine.

Decreasing the concentration of Lidocaine does not decrease the incidence of symptoms. (*Pollock J, et al. Dilution of spinal Lidocaine does not alter the incidence of transient neurologic symptoms. Anesthesiology. 1999;90:445–9*). The risk factors for TNS include obesity, Lidocaine, lithotomy position, knee arthroscopy and ambulation.

39. F F F F T

Pain is mostly seen bilaterally in the anterior or posterior aspect of the legs. The pain is radiated down the legs in 50–100% of patients and is mostly a burning aching and cramping type. (*Pollock JE, et al. Prospective study of the incidence of transient radicular irritation in patients undergoing spinal anaesthesia. Anesthesiology. 1996;84:1361–7*). Motor weakness is not seen and mepivicaine 4% has an incidence of 37%. Trigger point injections may help with the pain. (*Nareira FA, et al. Transient neurologic toxicity after spinal anaesthesia or is it myofascial pain? Two case reports. Anesthesiology. 1998;88:268–70*).

40. T T F T F

The incidence of nerve injury is between 0.1 and 5.6%. (*Aurroy Y, et al. Major complications of regional anaesthesia in France: the SOS regional anesthesia hot line service. Anesthesiology. 2002;97:1274–80*). Most nerve injuries are transient and are self limited. The injuries that persist for more than 12 months are mostly permanent. Most of the neurologic deficit is seen due to spinal anaesthesia (70%) followed by epidural (18%) and Peripheral nerve injury (12%). Most common injury is seen with Ulnar nerve (28%), brachial plexus (20%), lumbosacral nerve roots (16%), and spinal cord (13%). (*Chency FW, et al. Nerve injury associated with anaesthesia: a closed claim analysis. Anesthesiology. 1999;90:1062–9*).

41. T T F F T

Wallerian degeneration is degeneration and phagocytosis of components distal to injury. Macrophages start working in 2 weeks and clears debris by 4 weeks. Chromatolysis is the swelling of the cytoplasm with eccentric displacement of the cell's nucleus. With recovery, oedema subsides and Nissl substance begins to reaccumulate. (*Jobe M, et al. Peripheral nerve injuries. In: Conale ST, editor. Campbell's operative orthopaedics. 10th ed. Philadelphia: Mosby. p. 3221–86*). Nerve sprouts that originate from the nerve injury are mostly Unmyelinated. They may migrate and may form stump neuroma. Axonotmesis leads to damage of axons and myelin sheaths while endoneurium, perineurium and epineurium remain intact and therefore complete recovery is not seen as against the neuropraxia. The risk factors peripheral nerve injury includes male gender, increased age, extremes of body habitus and pre-existing diabetes mellitus. (*Warner MA, et al. Ulnar neuropathy: incidence, outcome and risk factors in sedated or anaesthetised patients. Anesthesiology. 1994;81:1332–40*) (Table 4.3).

42. T F T T F

Double crush phenomenon: patients with pre existing neural compromise may be more susceptible to nerve injury at another site. (*Upton AR, et al.*

Table 4.3 Sunderland classification of nerve injuries

Type of injury	Axonal nerve conduction	Wallerian degeneration	Endoneural tube integrity	Loss of function	Recovery
Type I	Focal interruption	Absent	Maintained	Motor>sensory	Complete resolution (days to weeks)
Type II	Distal interruption	Present	Maintained	Transient motor, sensory dysfunction	Recovery in weeks to months
Type III	Distal interruption	Present	Scarring of endoneurium	Prolonged motor and sensory deficit	Partial regeneration
Type IV	Distal interruption	Present	Fascicle perineurium interrupted	Severe loss of motor and sensory function	Permanent damage
Type V	Distal interruption	Present	External epineurium severed	Severe loss of motor and sensory function	Permanent damage

The double crush in nerve entrapment syndrome. Lancet. 1973;2:359–62). Risk factors for tourniquet induced injury includes trauma, stretch, vascular compromise, hematoma, casts. Long needles cause more injuries than short needles and long bevel (14°) cause more injuries than short bevel (45°). (*Selander D, et al. Peripheral nerve injuries due to injection needles used for regional anaesthesia: an experimental study of acute effects of needle point trauma. Acta Anaesthesiol Scand. 1977;21:182–8*). Elicitation of paraesthesia may increase the risk of nerve injury. (*Moore DC. No paraesthesia-no anesthesia: the nerve stimulator or neither? Reg Anesth. 1997;22:388–90*).

43. T T T F T

Peripheral nerves are supplied by microcirculation (intrinsic) and extrinsic non nutritive feeding vessels. This extrinsic circulation is under adrenergic control and may cause 50% reduction in nerve blood flow and Demyelination. (*Rechtland E, et al. Distribution of adrenergic innervation of blood vessels in peripheral nerve. Brain Res. 1986;374:185–9*). Pre existing metabolic or toxic neuropathies may increase the toxicity. Intrafascicular injection may cause fibroblast proliferation causing perineural thickness and fibrosis. This may lead to scar formation. (*Myers R, et al. Neurotoxicity of local anaesthetics: altered perineural permeability, oedema and nerve injury. Anesthesiology. 1986;64:29–35*). Four percent Lidocaine is more toxic than 1% Lidocaine.

44. F T T T T

Nerve stimulators may cause injuries upto 8%. (*Urban MK, et al. Evaluation of brachial plexus anaesthesia for upper extremity surgery. Reg Anesth. 1994;19:75–182*). Denervated muscle shows fibrillations which are rhythmic potentials from denervated single muscle fibers. They are maximally seen

1–3 months after injury. Surgery performed within 72 h may help recover function. (*Spinner RJ, et al. Surgery for peripheral nerve and brachial plexus injuries or other nerve lesions. Muscle Nerve. 2000;23:680–95*).

45. F F F T T

Tourniquet injury requires 6 h of inflation. Myotoxicity is an uncommon symptom. (*Hogan Q, et al. Local anaesthetic myotoxicity: a case and review. Anesthesiology. 1994;80:942–7*). Only adult myocytes are damaged by local anaesthetics and thus basal lamina, vasculature, neural elements and immature myocytes remain intact. Regeneration is complete within 3–4 weeks. (*Komorowski TE, et al. An electron microscopic study of local anaesthetic induced muscle fiber degeneration and regeneration in the monkey. J Orthop Res. 1990;8:495–503*). Local anaesthetics cause destruction of old cells and thus prompts new growth that provides the therapeutic benefit in trigger point injections of local anaesthetics for myofascial pain. It may also cause growth of new vessels. (*Jejurikar SS, et al. Induction of angiogenesis by Lidocaine and basic fibroblast growth factor: a model for in vivo retroviral mediated gene therapy. J Surg Res. 1997;67:137–46*). Extraocular muscle damage is seen after local anaesthetic injection. (*Salama H, et al. Anesthetic myotoxicity as a cause of restrictive strabismus after scleral buckling surgery. Retina. 2000;20:478–82*).

46. F T T T T

Local anaesthetic toxicity manifests within 5 min. Muscle fibers hypercontract and within 15 min, lytic degeneration of muscle sarcoplasm reticulum and mitochondria is seen. (*Nonaka I, et al. Pathophysiology of muscle fiber necrosis induced by bupivicaine HCl. Acta Neuropathol. 1983;60:167–79*). The myocyte becomes oedematous and necrotic with inflammation with phagocytosis of cellular debris and appearance of eosinophils. (*Pere P, et al. Local myotoxicity of bupivicaine in rabbits after continuous supraclavicular brachial plexus block. Reg Anesth. 1993;18:304–7*). Local anaesthetics cause pathologic efflux of calcium from sarcoplasmic reticulum. It produces contracture and cell destruction via activation of intracellular enzyme systems. (*Pike GE, et al. Effects of tetracaine and procaine on skinned muscle fibers depend on free calcium. J Muscle Res Cell Mobil. 1989;10:337–49*). Local anaesthetic dissipates the potential across mitochondrial inner membrane causing disruptive oxidative phosphorylation. (*Irwin W, et al. Bupivicaine myotoxicity is mediated by mitochondria. J Biol Chem. 2002;277:1221–7*).

47. F F T T T

Bupivicaine causes the most toxicity and procaine the least. (*Foster AH, et al. Myotoxicity of local anaesthetics and regeneration of the damaged muscle fibers. Anesth Analg. 1980;59:727–36*). Risk factors for muscle injury include bupivicaine usage, direct intramuscular injection, addition of steroid and epinephrine. (*Benoit PW. Reversible skeletal muscle damage after administration of local anaesthetic with or without epinephrine. J Oral Surg. 1978;36:198–201*). Use of hyaluronidase for retrobulbar and peribulbar anaesthesia and myotoxicity. (*Jehan FS, et al. Diplopia and Ptosis following injection of local*

anaesthesia without hyaluronidase. J Cataract Refract Surg. 2001;27:1876–9). Electromyography helps in diagnosis of injury after 4 weeks when it shows small, brief, polyphasic motor unit action potentials characteristic of myopathy. Histologic examination is the definite mode of diagnosis (cell lysis, inflammatory infiltrate, myocyte regeneration). The risk factors for post operative strabismus include regional techniques, surgical trauma, nerve palsy and vascular accident. (*Catalamo RA, et al. Persistent strabismus presenting after cataract surgery. Ophthalmology. 1987;94:491–4*).

48. T T F T T

Extraocular muscles are rich in mitochondria and thus less prone to injury. (*Porter JD, et al. Extraocular myotoxicity of the retrobulbar anesthetic bupivicaine HCl. Invest Ophthalmol Vis Sci. 1988;29:163–74*). Subtenon injection has less toxicity than peribulbar or retrobulbar injections and less vascular and neurologic complications. (*Riport J, et al. Regional anaesthesia for ophthalmic surgery performed by single subtenon injection: a 802 cases experience. Reg Anesth Pain Med. 1999;24:S59*). Permanent muscle damage may be seen after the regional blockade. (*Parris WCV, et al. Muscle atrophy following bupivicaine trigger point injection. Anaesth Rev. 1989;16:50–3*).

49. F T F F F

Both FVC and FEV1 are reduced within 15 min after the interscalene block. Lung volumes are affected for up to 6 h after the blockade. (*Urmey W, et al. Effects of bupivicaine 0.5% compared with Mepivicaine 1.5% used for interscalene brachial plexus block. Reg Anesth. 1992;17:13*). The incidence of respiratory depression with neuraxial opioid administration is between 0.07 and 0.9%. (*Murray MF. Monitoring opioids. Reg Anaesth. 1996;21:89–93*). Most pulmonary complications are seen with supraclavicular block. (*Rodriguez J, et al. Infraclavicular brachial plexus block effects on respiratory function and extent of the block. Reg Anesth Pain. 1998;23:564–8*). The incidence of Pneumothorax is highest with intercostals block (0.07–19%), interpleural block (2%) and 0.5% with paravertebral block. (*Lonnqvist PA, et al. Paravertebral blockade: failure rate and complications Anaesthesia. 1995;50:813–5*).

50. F F T T F

Chest wall is composed of rib cage, abdomen and diaphragm. The latter is supplied by Phrenic nerve with origin in cervical region. Epidural anaesthesia upto T5-T6 causes minimal change in FVC and peak expiratory flow. (*Urmey W, et al. Changes in pulmonary function tests during high dose epidural anaesthesia. Anesthesiology. 1990; 73:A1154*). High epidural anaesthesia does not affect scalene and diaphragmatic activity. Sedation causes a decrease in percentage expansion of rib cage and in PO_2. (*Yamakage M, et al. Changes in respiratory pattern and arterial blood gases during sedation with propofol or midazolam in spinal anaesthesia. J Clin Anesth. 1999;11:375–9*). Cervical epidural decreases diaphragmatic excursion along with 40% decrease in maximum inspiratory pressure and 26% decrease in forced vital capacity.

(*Takasaki T, et al. Respiratory function during cervical and thoracic epidural anaesthesia in patients with normal lungs. Br J Anaesth. 1980;52:1271–6*).

51. T F F F T
Cough is affected with neuraxial anaesthesia. (*Steinbrook RA. Respiratory effects of spinal anaesthesia. Int Anesthesiol Clin. 1989;27:40–5*). Oxygen consumption is decreased by 10–20% with neuraxial block and is due to muscle paralysis and decreased metabolism. Intrathecal opioids can cause respiratory arrest. (*Greene N. Physiology of spinal anaesthesia: pulmonary ventilation and hemodynamics. Baltimore: Williams and Wilkins; 1981*). Interscalene block affects C3-C5 nerve roots before Phrenic nerve paralysis and contributes to diaphragmatic paralysis. Brachial plexus block reduces FEV1 and FVC by 20–40%.

52. T T F T T
Retrograde flow during interscalene block may cause convulsions by extending into subarachnoid space. Psoas blocks may extend to spinal area in 0.6% of the patients while epidural extension is seen in 1–10%. (*Macaire P, et al. Le Bloc du plexcus lumbaire est-il dangeroux? Evaluation et treatment de la douleur. SFAR, editor. Pairs: Elsevier. p. 37–50*). Recurrant laryngeal nerve block is seen with interscalene block and is seen more on the right side. The incidence varies from 6 to 12%. Interscalene technique used by Winnie approach may extend to spinal region as the needle used is medially angulated with excessive depth. Dilated pupils seen with total spinal anaesthesia is due to loss of parasympathetic activity from Edinger Westphal nucleus. It is associated with apnoea, flaccid paralysis, hypotension and bradycardia.

53. T F T F T
Capdevila approach is right angled as opposed to Winnie's approach where needle approaches at slightly medial angle. (*Capdevila X, et al. Continuous psoas compartment block for post operative analgesia after total hip arthroplasty: new landmarks, technical guidelines and clinical evaluation. Anesth Analg. 2002;94:1606–13*). Epidural space does not extend into the cranium, medullary signs are not seen. Depth of needle matters as interscalene block is a superficial block as C6 foramen may only be 23 mm away from the skin. (*Lombard TP, et al. Bilateral spread of analgesia following interscalene brachial plexus block. Anesthesiology. 1983;58:472–3*).

54. T T F F F
Acute treatments with opioids are usually in patients who are naive to any treatment and they may be concurrently taking hypnotics and anxiolytics causing more respiratory depression. The respiratory depression is seen due to its effect on brainstem rostral ventrolateral medulla, the area that generates the respiratory effort. Increased risk of respiratory depression with opioids is seen with extremes of age and sick patients. (*Cepeda MS, et al. Side effects of opioids during short term administration: effect of age, gender and race. Clin Pharmacol Ther. 2003;74(2):102–12*). Apnoea rapidly occurs in intravascular administration of lipohillic opioids like Fentanyl. Naloxone is a short acting antagonist, so respiratory depression may return after the effect is over.

Usually it is given as 0.4 mg diluted in 10 mL sodium chloride. (Given in 1 mL increments).

55. T F T T T

NSAIDs has efficacy equivalent to opioids. (*Ballantyne JC. Use of non steroidal anti-inflammatory drugs for acute pain management. Problems in anaesthesia. 1998;10(1):23–6*). PCA has efficacy similar to conventional doses (*Walder B, et al. Efficacy and safety of patient controlled opioid analgesia for acute postoperative pain: a quantitative systematic review. Acta Anesthesiol Scand. 2001;45(7):795–804*). Respiratory depression is increased by patient controlled boluses, concomitant use of sedatives and history of sleep apnoea. Opioids cause constipation which if untreated can cause impaction causing rupture. The evidence suggests that early resumption of feeding prevents opioid related complications. (*Miedema BW, et al. Methods for decreasing post operative gut dysmotility. Lancet Oncol. 2003;4:365–72*).

56. T F T T T

Opioids increase the tone of bowel luminal musculature causing decreased motility, delayed content transit and increased fluid absorption. (*De Scheffer HU, et al. Opioids and the gut: pharmacology and current clinical experience. Neurogastroenterol Motil. 2004;16(4):383–94*). Opioids decrease the tone of sphincters of Oddi and pylorus. This is due to μ and κ receptors in gut's myenteric plexus. (*Kurz A, et al. Opioid induced bowel dysfunction: pathophysiology and potential new therapies. Drugs. 2003;63:649–71*). Opioids prolong ileus and interventions include changing the route of administration, use of oral anticoagulants and opioid sparing. Methylnaltrexone treats opioid induced constipation and alvimopan treats post operative ileus. (*Taguchi A, et al. Selective post operative intubation of gastrointestinal opioid receptors. N Engl J Med. 2001;345:935–40*).

57. T T T T F

Both bupivicaine and ropivicaine are suitable for epidural administration. (*Zaric D, et al. The effect of continuous lumbar epidural infusion of ropivicaine (0.1.0.2,0.3%) and 0.25% bupivicaine on sensory and motor blockade in volunteers. Reg Anesth. 1996;21:14–25*). Opioids cause their action via systemic route when given through epidural route. (*Guinard JP, et al. A randomised comparison of intravenous lumbar and thoracic epidural Fentanyl for analgesia after thoracotomy. Anesthesiology. 1992;77:1108–15*). Continuous infusion is better for analgesia especially with hydrophilic opioids. (*Malviya S, et al. A comparison of continuous epidural infusion and intermittent bolus doses of morphine in children undergoing selective dorsal rhizotomy. Reg Anesth Pain. 1999;24:438–43*). Post operative nausea and vomiting has an incidence of 3–60%. Local anaesthetics based anaesthesia has less incidence (42%) than opioids (60%). (*Block BM, et al. Efficacy of postoperative epidural analgesia. A meta analysis. JAMA. 2003;290:2455–63*). Single shot opioids cause more nausea and vomiting. (*White MJ, et al. Side effects during continuous epidural infusion of morphine and Fentanyl. Can J Anesth. 1992;39:576–82*).

58. T T F T F
Nausea and vomiting is due to activation of chemoreceptor trigger zone and area postrema in the medulla. (*Chaney MA. Side effects of intrathecal and epidural opioids. Can J Anaesth. 1995;42:891–903*). Dexamethasone is effective in a dosage of 5 mg i.v. (*Tzeny JI, et al. Low dose dexamethasone reduces nausea and vomiting after epidural morphine: a comparison of metoclopramide with saline. J Clin Anesth. 2002;14:19–23*). The incidence of Pruritus after neuraxial anaesthesia is 2–38%. Fentanyl causes less Pruritus than morphine. Pruritus is due to central action of opioids at the level of medullary dorsal horn including trigeminal nucleus. (*Szarvus S, et al. Neuraxial opioid induced pruritus: a review. J Clin Anesth. 2003;15:234–9*).

59. T F F F T
Pruritus is dependent on the dosage of the opioid. (*Harman NL, et al. Analgesia, pruritus and ventilation exhibit a dose response relationship in parturients receiving intrathecal fentanyl during labour. Anesth Analg. 1999;89:378–83*). Fentanyl causes Pruritus but incidence is less than morphine. Nalbuphine can cause increased drowsiness and serotonin antagonists decrease the incidence of Pruritus. (*Waxler B, et al. Prophylactic ondansetron does not reduce the incidence of itching induced by intrathecal sufentanil. Can J Anaesth. 2004;51:685–9*). A 10 mg bolus of propofol followed by 30 mg over 24 h help reduce Pruritus. (*Torn K, et al. Effects of subhypnotic doses of propofol on the side effects of intrathecal morphine. Br J Anaesth. 1994;73:411–2*).

60. T T F T T
Opioid administration causes respiratory depression in less than 1%. (*Cashman JN, et al. Respiratory and hemodynamic effects of acute postoperative pain management. Evidence from published data. Br J Anaesth. 2004;93:212–23*). Hydrophilic opioids like morphine and hydromorphone cause early respiratory depression. (*Swenson JD, et al. The effect of distance from injection site to the brain stem using spinal sufentanil. Reg Anesth Pain Met. 2001;26:306*). Risk factors for respiratory depression include thoracic surgery, increased age, increased dosage, concomitant use of opioids and presence of comorbidities. (*Mulroy MF. Monitoring opioids. Reg Anesth. 1996;21(6S):89*).

61. T T T F T
Motor block depends upon the concentration of the local anaesthetic used. (*Hodgson PS, et al. A comparison of ropivicaine with fentanyl to bupivicaine with fentanyl for post operative patient controlled epidural analgesia. Anesth Analg. 2001;92:1024–8*). Tunnelling of catheters though safe may also cause movement of catheters and upto 2 cm movement may be seen. (*Chadwick VL, et al. Epidural catheter migration: a comparison of tunnelling against a new technique of catheter fixation. Anesth Intens Care. 2003;31:518–22*). Both lateral decubitus and sitting position decreases the risk of misplacement of catheter. (*Hamilton CL, et al. Changes in the position of epidural catheters associated with patient movement. Anesthesiology. 1997;86:778–84*).

62. F F T T T
Secondary block failure is seen after catheter insertion and has an incidence of up to 40%. (*Salinas FV. Location, location, location: continuous peripheral nerve blocks and stimulating catheters. Reg Anesth Pain Med. 2003;28:79–82*). Stimulating catheters help in localising accurate placement of catheters. (*Salinas FV, et al. Prospective comparison of continuous femoral nerve block with non stimulating catheter placement versus stimulating catheter guided perineural placement in volunteers. Reg Anesth Pain Med. 2004;29:212–20*). The incidence of vascular puncture is between 0 and 9%. Hematomas require weeks for resolution. (*Ekatodramis G, et al. Prolonged Horner syndrome due to neck hematoma after continuous interscalene block. Anesthesiology. 2001;95:801–3*). Epinephrine is used as a marker for intravascular placement. (*Mulroy MF, et al. Systemic toxicity and cardiotoxicity from local anaesthetics: incidence and preventive measures. Reg Anesth Pain Med. 2002;27:556–61*).

63. T T F T T
Perineural catheters do not increase the risk of neural injury. (*Burgeat A, et al. Evaluation of the lateral modified approach for continuous interscalene block after shoulder surgery. Anesthesiology. 2003;99:436–42*). Most common complication is unilateral placement followed by dislodgement (0–30%). (*Surtherland ID. Continuous sciatic nerve infusion: expanded case report describing a new approach. Reg Anesth Pain Med. 1998;23:496–501*). Bacterial site colonisation is frequent with catheters but infection is rare. (*Cuvillon P, et al. The continuous femoral nerve block catheter for post operative analgesia: bacterial colonisation, infectious rate and adverse effects. Anesth Analg. 2001;93:1045–9*). The local anaesthetics have bactericidal and bacteriostatic properties (*Kampe S, et al. Ropivicaine 0.1% with sufentanil 1 microgram/ml inhibits in vitro growth of pseudomonas aeruginosa and does not promote multiplication of Staphylococcus aureus. Anesth Analg. 2003;97:409–11*). Catheter use should be restricted to a maximum of 5 days to prevent infectious risks. (*Gaumann DM. et al. Continuous axillary block for postoperative pain management. Reg Anesth. 1988;13:77–82*).

64. F F T F T
Bupivicaine induces apoptosis in the muscle fibers and myonecrosis is seen. (*Hogan Q, et al. Local anaesthetic myotoxicity: a case and review. Anesthesiology. 1994;80:942–7*). Muscle injury cause an increase in creatine kinase and is associated with muscle tenderness, pain on stretch, pain on relief with shortening, necrotic myopathy, oedema. (*Zink W, et al. Local anaesthetic myotoxicity. Reg Anesth Pain Med. 2004;29:333–40*). Repeated doses of bupivicaine lead to a marked degree of disruption and vacuolisation of myelin sheaths. (*Kytta J, et al. Effects of repeated bupivicaine administration on sciatic nerve and surrounding muscle tissue in rats. Acta Anesthesiol Scand. 1986;30:625–9.*)

65. T T F T T
Catheter retention is due to knot formation and mostly forms under skin or fascia. It is mostly seen with fascia iliaca, femoral or psoas compartment

catheters. (*Offerdatil MR, et al. Successful removal of a knotted fascia iliaca catheter: principles of patient positioning for peripheral catheter extraction. Anesth Analg. 2004;99:1550–2*). Increasing the distance of catheter length increases the risk of retention. And is mostly seen if more than 5 cm is left inside. Catheter fragments left inside may present as pain. (*Lee BH, et al. Shearing of a peripheral nerve catheter. Anesth Analg. 2002;95:760–1*).

66. T T F T T

Female gender is a risk factor along with osteoporosis and usage of anticoagulants. (*Moen V, et al. Severe neurological complications after central neuraxial blockade in Sweden 1990–1999. Anesthesiology. 2004; 101:950–9*). Most common organism involved in infections is staphylococcus along with enterococcus, gram positive cocci, gram negative bacillus. Frequent dressing changes increase the risk of infections. (*Morin AM, et al. Risk factors for bacterial catheter colonisation in regional anaesthesia. BMC Anesthesiol. 2005;5:1–9*). Seizures may be induced by even small intravascular doses of local anaesthetic (0.5–1 mL). (*Crews JC, et al. Seizure after levobupivacaine for interscalene brachial plexus block. Anesth Analg. 2003;96:1188–90*). Higher nerve stimulator currents may be required as it changes neuroconductivity. (*Sites BD, et al. Ultrasound guided popliteal block demonstrates an atypical motor response to nerve stimulation in 2 patients with diabetes mellitus. Reg Anesth Pain Med. 2003; 28: 479–82*).

67. T F T F T

Toxicity of local anaesthetics blocks inhibitory pathways at the level of amygdala. (*Garfield JM, et al. Central effects of local anaesthetic agents. In: Strichartz G, editor*, *Local anaesthetics, vol. 81. New York: Springer; 1987. p. 253–84*). Amygdala is primarily responsible for local anaesthetic induced seizures but hippocampus is also involved. Normally long term neurologic deficit is not seen especially if the seizures are brief. (*De Jong RH, et al. Diazepam prevents local anaesthetic seizures. Anesthesiology. 1971;34:523–31*). Local anaesthetic induced seizures are mostly due to unintentional injection of local anaesthetic into the vessels and mostly involve face along with distal extremities.

68. T F T T T

Circumoral numbness is seen due to the drug leaving the vascular space and affecting sensory nerve endings. (*Scott DB. Toxic effects of local anaesthetic agents on the central nervous system. Br J Anaesth. 1986;58:732–5*). Plasma protein binding is decreased with acidosis or hypercapnia thus increasing the free drug levels. (*Englesson S. The influence of acid base changes on central nervous system toxicity of local anaesthetic agents. An experimental study in cats. Acta Anaesthesiol Scand. 1974;18:79–87*). Potent local anaesthetics like bupivicaine and etidocaine have a lower circulatory collapse/CNS excitation ratio than less potent aminoamides. (*Concepcion M. Acute complications and side effects of regional anaesthesia (Chapter 23). In: Regional anesthesia and analgesia. Philadelphia: WB Saunders;1996*). At higher doses, local anaesthetics prolong conduction time and depress spontaneous

pacemaker activity. (*Lofstrom JB. Physiologic disposition of local anaesthetics. Reg Anesth. 1982;33–8*). At lower concentrations, local anaesthetics cause an increased tone in vascular beds whereas at higher concentrations, they produce a decrease in vascular tone. (*Blair MR. Cardiovascular pharmacology of local anaesthetics. Br J Anaesth. 1975;47:247–52*).

69. F T F T T

Site of injection alters the rate of absorption and affects blood vessels. (*Rosenberg PH, et al. Maximum recommended doses of local anaesthetics: a multifactorial concept. Reg Anesth Pain Med. 2004;29:564–75*). Most rapid absorption after local anaesthetic injection is seen after interpleural injection followed by intercostal block. Cardiac toxicity is augmented by Hyperkalemia, hypoxemia and acidosis. (*Reis S, et al. Cardiotoxicity of local anaesthetic agents. Br J Anaesth. 1986;58:736–46*). Amiodarone increases intracellular cyclic AMP and calcium via the inhibition of phosphodiesterase fraction 3. Bupivicaine inhibits amino acylation of RNA thus decreasing muscle protein synthesis. (*Johnson ME, et al. Effects of marcaine, a myotoxic drug, on macromolecular synthesis in muscle. Biochem Pharmacol. 1978;27:1753–7*).

70. T F T F F

Peripheral nerves contain fascicles held together by epineurium (external connective sheath). Nerve fibers and capillary blood vessels are enclosed in endoneurium. Perineurium is a multilayered epithelial sheath that surrounds each fascicle. (*Sunderland S. Nerve and nerve injury. Edinburgh: Churchill Livingstone; 1978. p. 31–2*). Both sensory and motor nerves contain myelin. Areas of myelinated nerve fibers are enveloped individually by a single Schwann cell. Blood flow to the peripheral nerves can be high (30–40 mL/100 g/min). Axonal transport is active and depends on oxidative metabolism.

71. T F T T T

Neuropraxia can extend from several hours to few months (6 months). It is the result of blunt injury. And focal Demyelination is mainly seen on histopathology. Axonotmesis is physical interruption of axons but with intact Schwann cell tubes and intact connective tissue. The nerve sheath remains intact enabling regeneration. Neurotmesis is complete transaction of the nerve and leads to Wallerian degeneration from which slow recovery occurs as a result of axonal regeneration. Surgical exploration is the only way to distinguish between axonotmesis and neurotmesis in closed injuries.

72. T T T T F

Intraneural injection is less likely to heal. Extrafascicular injections normally do not cause injury. (*Mackinnon SE, et al. Classification of nerve in juries as the basis of treatment. In: Mackinnon SE, Detton AL, editors. Surgery of the peripheral nerve. New York: Thieme Medical Publishers; 1988. p. 35–63*). The risk factors for nerve injury includes type of local anaesthetic agent, dose of drug and the type of the needle. Histopathologic changes of chemical neuritis can lead to nerve scarring and chronic neuropathic pain. Pain as a result of nerve injury is present only in minority of cases. (*Bhananker SM, et al.*

What actions can be used to prevent peripheral nerve injury. In: Fleisher LA, editor. Evidence based practice of anesthesiology. New York: Elsevier; 2004. p. 228–35).

73. F F F T F

Pain paraesthesia is difficult to interpret. (*Winnie AP. Interscalene brachial plexus block. Anesth Analg. 1970;49:455–66*). Nerve stimulators only provide rough estimate and does not eliminate risk. Motor response in response to stimulation between 0.5 and 1.0 mA is appropriate. (*Raj PP, et al. Aids to localisation of peripheral nerves. In: Raj P, editor. Textbook of regional anaesthesia. New York: Churchill Livingstone; 2002. p. 251–84*). High injection pressures (>20 psi) indicates intrafascicular injection and causes neurologic injury. Intraneural injections (>20 psi) are associated with neurologic deficits and histologic evidence of injury. (*Hadzic A. Combination of intraneural injection and high injection pressures leads to fascicular injury and neurologic deficits in dogs. Reg Anesth Pain Med. 2005;30:309–10*).

74. F T T T T

Intraneural injection is more likely to place local anaesthetic between and not into the fascicles thus avoiding injury. (*Sala-Blanch X, et al. Intraneural injection during anterior approach for sciatic nerve block. Anesthesiology. 2004;101:1027–30*). Risk of injuries is more with long bevelled needle though short bevelled needle when placed intraneurally may cause more mechanical damage. (*Rice ASC, et al. Peripheral nerve injury caused by injection needles used in regional anaesthesia: influence of bevel configuration, studied in a rat model. Br J Anaesth. 1992;9:433–8*). Sharp needles produce cleaner, more likely to heal cuts than blunt needle produce noncongruent cuts and more extensive damage. Antiemetics can cause damage on intraneural injection. (*Gentili F, et al. Clinical and experimental aspects of injection injuries of peripheral nerves. Can J Neurol Sci. 1980;7:143–51*). Peripheral sensory neurons depolarise and generate spontaneous activity in response to ischaemia which may be perceived as paraesthesias.

75. F T F T T

Nerve function takes 6 h to return to normal after 2 h of ischemia. More than that, oedema and fiber degeneration develops lasting for 1–2 weeks. Oxidative injury may start affecting Schwann cells causing apoptosis. Tourniquet induced injury can be prevented by limiting pressure < 150mmHg for a maximum of 90–120 min (*Sharrock NE, et al. Anesthesia for orthopaedic surgery. In: Miller R, editor. Anaesthesia. New York: Churchill Livingstone; 2000. p. 2118–39*). Peripheral neuropathy due to hematoma resolves completely. (*Klein SM, et al. Enoxaparin associated with psoas hematoma and lumbar plexopathy after lumbar plexus block. Anesthesiology. 1997;87:1576–9*).

76. T T T T T

Arterial haemorrhage is rapid causing marked proptosis with immobility of the globe. (*Feibel RM. Current concepts in retrobulbar anesthesia. Surv Ophthalmol. 1985;30:102–10*). Inferior temporal quadrant is more suitable. Blood vessels are small in anterior orbital region. Inferior nasal quadrant is

relatively avascular as against superior nasal quadrant as end ophthalmic vessels are located there. (*Hustead RF, et al. Periocular local anaesthesia: medial orbital as an alternative to superior nasal injection. J Cataract Refract Surg. 1994;20:197–201*). Toxicity of local anaesthetics in ophthalmics occurs because of spread along submeningeal pathway to CNS. Brainstem is a complication of ocular blocks and may manifest as mild confusion, marked shivering, nerve palsies, dysarthria, hemi or quadriplegia and apnoea. (*Nicoll JM, et al. Central nervous system complications after 6000 retrobulbar blocks. Anesth Analg. 1987;66:1298–302*).

77. F T F F T

Avoidance of deep penetration should be avoided and needle should not be inserted more than 30 mm. (*Katsev DA, et al. An anatomic study of retrobulbar needle path length. Ophthalmology. 1989;96:1221–4*). The needle if inserted in the inferior temporal area elevates the globe and causes adduction of the eye. This brings optic nerve closer to tip and makes it more exposed to damage. (*Unsold R, et al. The CT-topography of retrobulbar anaesthesia. Albrecht Von Graefes Arch/Clin Exp Ophthalmol. 1981;217*). Myopic patients have more ovoid globes making it prone to injury especially if associated with axial length >29 mm, causing more staphyloma formation. (*Vohra SB, et al. Altered globe dimensions of axial myopia as risk factors for penetrating ocular injury during peribulbar anaesthesia. Br J Ophthalmol. 2000; 85:242–5*). Blunt needles are as good in penetration as sharp needles. (*Hay A, et al. Needle penetration of the globe during retrobulbar and peribulbar injections. Ophthalmology. 1991;98:1017–24*). Chemosis is more seen with periconal blocks. (*Weiss JL, et al. A comparison of retrobulbar and periocular anesthesia for cataract surgery. Arch Ophthalmol. 1989;107:96–8*).

78. T T F T T

Peribulbar block has a high failure rate (10%). Perforation is common in myopes (1 in 140). (*Duker JS, et al. Inadvertent globe perforation during retrobulbar and peribulbar anesthesia. Ophthalmology. 1991;98:519–26*). Risk factors for perforation include hypotonic eye, poor red reflex, vitreous haemorrhage. Ocular explosion can occur especially in blocks with deep sedation. (*Bullock JD, et al. Ocular explosions from periocular anesthetic injections. A clinical, histopathological, experimental and biophysical study. Ophthalmology. 1999;106:2341–53*).

79. F F F F T

Prolonged dysfunction may be seen (up to 6 weeks) after the regional anaesthesia and the deficit may be permanent in 25% of patients. (*Rao VA, et al. Ocular myotoxic effects of local anaesthetics. Can J Ophthalmol. 1988;23:171–3*). Intramuscular administration of local anaesthesia causes more damage. Increase age is a risk factor for muscular injury. (*Hunter DG, et al. Inferior oblique muscle injury from local anaesthesia for cataract surgery. Ophthalmology. 1995;102:501–9*). Inferior rectus is most prone to injury because of inadequate elevation of needle tip from the orbital floor during attempted intraconal placement.

80. T F T F F
Diabetes increases the risk of optic atrophy (*Carl JR. Optic neuropathy following cataract extraction. Semin Ophthalmol. 1993;8:144–8*). Hyaluronidase should not be used in facial nerve injections. (*Lindqvist TD, et al. Complications of facial nerve block and review of the literature. Ophthalmic Surg. 1988;19:271–3*). Local anaesthetics may cause myasthenic like syndrome. (*Meyer D, et al. Myasthenia gravis like syndrome induced by topical ophthalmic preparations. A case report. J Clin Neuroophthalmol. 1992;210–2*). Retrobulbar blocks better anaesthesia than topical anaesthesia. (*Friedman DS, et al. Synthesis of the literature on the effectiveness of regional anaesthesia for cataract surgery. Ophthalmology. 2001;108:519–29*). Antiplatelet medications need not be stopped before the cataract surgery. (*Shuler JD, et al. Antiplatelet therapy and cataract surgery. J Catarct Refract Surg. 1992;18:567–71*).

81. T F T F T
Paravertebral space is a four sided pyramid made up of bone and articular capsules of rib and the rib which is below. The vertebral body is medial and laterally lies intercostals and intercosto-transverse ligament. The space contains spinal nerve root and intercostals nerve. Paravertebral space is not a contained space and injection into the space can spread cephalad and caudad. (*Purcell-Jones G, et al. Paravertebral somatic nerve block: a clinical, radiographic and computed tomographic study in chronic pain patients. Anesth Analg. 1989;68:32–9*). Intercostal nerve has autonomic, somatic sensory and motor functions. Dorsal ramus provides sensory innervations to the posteromedial structures of the back (synovium, periosteum, fascia, muscles and skin), and motor innervation to the erector spinae muscle. Costophrenic sulcus is an area where costal and diaphragmatic pleura meet and descend in the groove with no lung tissue anterior to T6.

82. T T F T T
Lateral approach leads to epidural spread especially if enough volume is injected. Medial approach has better results than lateral approach with up to 97% success rates. (*Eason MJ, et al. Paravertebral thoracic block-a reappraisal. Anaesthesia. 1979;34:638–42*). Easily advancing catheter in the space means interpleural insertion. (*Mowbray A, et al. Intercostals catheterisation: an alternative approach to the paravertebral space. Anaesthesia. 1987;42:958–61*). Epidural spread is common with paravertebral block and is seen in 70% of patients. Short bevelled needle causes less damage. (*Selander D, et al. Peripheral nerve injury due to injection needles used for regional anaesthesia. Acta Anesthesiol Scand. 1977;21:182–8*).

83. T T F T F
Monoplatythela is unilateral flat nipple seen with paravertebral block. (*McKnight CK, et al. Monoplatythela and paravertebral block. Anaesthesia. 1984;39:1147*). Blood levels are seen more with intercostals injection. (*Tucker GT, et al. Systemic absorption of mepivicaine in commonly used regional block procedures. Anesthesiology. 1972;37:277*). Posterior approach

to intercostals space is at the angle of the ribs, 6–8 cm lateral to the spinous process. (*Nunn JL, et al. Posterior intercostals nerve block for pain relief after cholecystectomy anatomical basis and efficacy. Br J Anaesth. 1980;52:253–9*). Posterior intercostal space is about 8 mm. While doing an intercostal block, one level above and one level below the target should be aimed for.

84. T F T T T
Pneumothorax is seen uncommonly with intercostals nerve block with an incidence of 0.092%. (*Moore DC, et al. Pneumothorax: its incidence following intercostals block. JAMA. 1962;182:1005–8*). Bilateral intercostal blocks can cause respiratory compromise in those with pre-existing pulmonary compliance. (*Casey WF. Respiratory failure following intercostal nerve blockade. Anaesthesia. 1984;39:351–4*). Intercostal block can cause total spinal anesthesia because of proximity of injections to spinal nerve roots. (*Gauntlett IS. Total spinal anesthesia following intercostal nerve block. Anaesthesiology. 1986;65(1):82–4*). Intercostal injection can lead to bronchospasm especially on injection of 8% phenol. (*Atkinson GL, et al. Acute bronchospasm complicating intercostals nerve block. Anesth Analg. 1989;68:400–1*).

85. T T T F T
Interpleural analgesia can be used for invasive coronary artery bypass grafting. (*Mehta Y, et al. A comparative evaluation of interpleural and thoracic epidural analgesia for postoperative pain relief after minimally invasive direct coronary artery bypass surgery. J Cardiothorac Vasc Anesth. 1998;12(2):1262–5*). Most extensive block is seen in supine position. (*Stromskag KE, et al. Distribution of local anaesthetics injected into the interpleural space, studied by computerised tomography. Acta Anaesthesiol Scand. 1990;34:323–6*). Pneumothorax is seen in 2% of the patients. (*Symreng T, et al. Intrapleural bupivicaine–technical considerations and intra-operative use. J Cardiothorac Anesth. 1989;3(2):139–43*).

86. F F F T F
Incidence of local anaesthetic toxicity is high because of large doses used. The incidence of seizures is 1–4%. (*Plerak DJ, et al. Paresthesia vs non paraesthesia, the axillary block. Anesthesiology. 1983;59:A216*). Increased age does not increase the dose absorbed. (*Finucone BT, et al. Influence of age on the uptake of Lidocaine from the axillary space (abstract). In: 4th American-Japanese congress. San Francisco; 1997*). Active hepatitis may increase the duration of action along with cardiac failure, drug therapy and end stage liver failure. (*Covino BG, et al. Handbook of epidural anesthesia and analgesia. New York: Grune and Stratten; 1985*). Alpha-1-acid protein continues to be synthesised even in the presence of end stage liver failure.

87. T T T F T
Lignocaine and its primary metabolite monoethylene glycine xylidine is not influenced by renal failure. Secondary metabolite-glycine xylidine is dependent on renal excretion and may cause CNS toxicity. Alpha acid amino glycoprotein is increased in renal failure and binds bupivicaine and decreases

toxicity. Irreversible neuronal changes are seen in elderly as axonal function deteriorates and amount of fat decrease in neurons. (*Kurrokawa K, et al. Age related change in peripheral nerve conduction: compound action potential duration and depression. Gerontology. 1999; 45:168–73*). Single injections of local anaesthetics do not cause much damage. Dose should be reduced by 10–20% in patients >70 years. (*Finucane BT, et al. Influence of age on the vascular absorption of lidocaine from the epidural space. Anesth Analg. 1987;66:843–6*). Progesterone sensitises the axons to local anaesthetics. Uptake of local anaesthetics is increased due to increased cardiac output. The protein binding is decreased leading to more free levels. (*Santos AC, et al. Does pregnancy alter the systemic toxicity of local anaesthetics. Anesthesiology. 1989; 70:991–5*).

88. T T F T F

Ulnar nerve injury is seen more commonly in general than local anaesthesia (85%). (*Cheney FW, et al. Nerve injury associated with anaesthesia: a closed claim analysis. Anesthesiology. 1999;90:1062–9*). Incidence of tourniquet paralysis is 1:8000 procedures. (*Middleton RW, et al. Tourniquet paralysis. Aust NZ J Surg. 1974;44:124–8*). Nerve injury symptoms are seen during the first week post operatively. Failure rate with neuraxial anaesthesia is 5–10% and is 20–30% with brachial plexus. Alkalisation has no evidence of efficacy. (*Morison DH. Alkalinisation of local anaesthetics. Can J Anesth. 1995;42:1076–8*).

89. F F T T T

Hyaluronidase enhances onset of block only in ophthalmic patients. (*Keeler JF, et al. Effect of addition of hyaluronidase to bupivicaine during axillary brachial plexus block. Br J Anaesth. 1981;53:523–6*). Heating the local anaesthetic solution up to 37° reduces onset of action by about 55%. (*Heath PJ, et al. Latency of brachial plexus block. Anaesthesia. 1990; 40:297–301*). Risk factor for developing Pneumothorax in supraclavicular block includes tall thin patients and is also more on the right side because of cupola of lungs, which is higher on the right side. Pneumothorax is mostly asymptomatic till it involves 20% of the lung and chest tube is required for more than 25%. Plumb-bob technique is not associated with Pneumothorax. (*Brown LD, et al. Supraclavicular nerve block: anatomic analysis of a method to prevent pneumothorax. Anesth Analg. 1993;76:530–4*).

90. F F T T T

Phrenic nerve block is most commonly seen with interscalene approach (67%) and the incidence is up to 40% with supraclavicular approach. Brachial plexus block affects FVC by 27% and FEV by 26%. (*Pere P, et al. Continuous interscalene brachial plexus block decreases diaphragmatic motility and ventilator function. Acta Anaesthesiol Scand. 1992;36:53–7*). Surgery in sitting increases the risk of brachial plexus injury. Interscalene block can cause Brown Sequard syndrome (paralysis and loss of proprioception on the same side as the injury and loss of pain and temperature sensation on the opposite side). (*Winnie AP, et al. Plexus anaesthesia, perivascular techniques of*

brachial plexus block. Philadelphia: WB Saunders; 1983). Total spinal anaesthesia can be seen. (*Dutton RP, et al. Total spinal anaesthesia after interscalene blockade of the brachial plexus. Anesthesiology. 1994;80:939–41*).

Neuraxial anaesthesia following interscalene block			
Signs	Subarachnoid	Subdural	Epidural
Onset of block	Rapid	Delayed for few minutes	Takes up to 20 min
Loss of respiration	++	+	
Pupils	Dilated	Less dilated	No dilation, variable hypotension, bradycardia
Hemodynamic changes	Hypotension, bradycardia		

91. F T F T T

Horner's syndrome is seen in 18–90% of brachial plexus blocks and is not an indication of the success of the block. (*Sukhani CR, et al. Prolonged Horner's syndrome after interscalene block: a management dilemma. Anesth Analg. 1994;79:701–45*). Hoarseness is caused by ipsilateral recurrent laryngeal nerve block. Brachial plexus may cause bronchospasm and is seen due to blockade of sympathetic output. (*Thiagarajah S, et al. Bronchospasm following interscalene brachial plexus block. Anesthesiology. 1984;61:759–61*). Loss of hearing can be seen with the block. (*Rosenberg PH, et al. Auditory disturbance associated with interscalene brachial plexus block. Br J Anaesth. 1995;74:84–91*). Transarterial approach may cause vascular disturbances (*Merrill DJ, et al. Vascular insufficiency following axillary block of the brachial plexus. Anesth Analg. 1981;60:162–4*).

92. F F T F T

Most common reason for failure of block is technical (*Tarkkila P, et al. Incidence and causes of failed spinal anaesthetics in a university hospital: a prospective study. Reg Anesth. 1991;16:48–51*). Incidence of failure is 3–30%. (*Munhall RJ, et al. Incidence and aetiology of failed spinal anesthetics in a university hospital: a prospective study. Anesth Analg. 1988;67:843–8*). Sprotte needle is associated with maximum failure rate because of the large side hole which is elongated and located distal to the tip. (*Tarkkila PJ, et al. Comparison of sprotte and Quincke needles with request to post dural puncture headache. Reg Anesth. 1992;17:283–7*). Low dose anaesthesia does not increase the failure rate. (*Kuusniemi KS, et al. A low dose of plain or hyperbaric bupivicaine for unilateral spinal anaesthesia. Reg Anesth Pain Med. 2000;25: 605–10*).

93. T T T T F

Hypotension is seen in up to 50% of patients. (*Carpenter RL, et al. Incidence and risk factors for side effects of spinal anaesthesia. Anesthesiology. 1992;76:906–16*). Hypotension is defined as systolic blood pressure <85–90 mmHg or a decrease of >25–30% from the preanesthetic value.

Hypotension is caused by depressive effects of local anaesthetics, relative adrenal insufficiency, ascending medullary vasomotor block and mechanical respiratory insufficiency. (*Greene NM. Physiology of spinal anaesthesia. Baltimore: Williams and Wilkins. 1981:112–5*). Progesterone increases the sensitivity of nervous tissue by altering the protein synthesis. (*Bader AM, et al. Acute progesterone treatment has no effect on bupivicaine induced conduction blockade in the isolated rabbit vagus nerve. Anesth Analg. 1990;71:545–8*). Combined spinal anaesthesia causes more hypotension and it is also seen more in elderly, and those block height >T5.

94. F F T F T

Decrease in cardiac output causes bradycardia which is also contributed because of unopposed vagal input. (*Cook PR, et al. Vagal and sympathetic activity during spinal anaesthesia. Acta Anesthesiol Scand. 1990;34:271–5*). Risk factors for bradycardia include younger patients and those with sensory levels above T6 and on beta blockers. (*Tarkkila PJ, et al. Identification of patients in high risk of hypotension, bradycardia and nausea during spinal anesthesia with a regression model of separate risk factors. Acta Anesthesiol Scand. 1992;36:554–8*). Hypotension causes a sudden decrease in ventricular volume causing vigorous ventricular contraction leading to activation of mechanoreceptors causing increased vagal tone. Other causes contributing to the bradycardia include excess sedation, autonomic dysfunction, heart block and athletic heart syndrome. (*Mackey DC, et al. Bradycardia and asystole during spinal anaesthesia: a report of three cases without mortality. Anesthesiology. 1989;70:866–8*). Hypotension during pregnancy for more than 2 min may cause deleterious effects on the neonate. (*Corke BC, et al. Spinal anaesthesia for caesarean section. The influence of hypotension on neonatal outcome. Anaesthesia. 1982;37:658–62*). Ephedrine restores uterine blood flow. Phenylephrine is used in situation where increase in heart rate is not desired.

95. T T T T F

Risk factors for nausea include female gender, opiate premedication, block height >T6, and prior history of motion sickness. Cardiac arrest is seen rarely (2.5/10,000) (*Kopp SL, et al. Cardiac arrest during neuraxial anesthesia: frequency and predisposing factors associated with survival. Anesth Analg. 2005;100:855–65*). Urinary retention is seen with pain, anxiety, trauma to pelvic nerves, large quantities of fluid intake, oedema around bladder neck, elderly male and opiates. (*Pertek JP, et al. Effects of anesthesia on post operative micturition and urinary retention. Ann Fr Anesth Reanim. 1995;14:340–51*).

96. T T T F T

Bupivicaine causes more urinary retention than Lidocaine and detrusor muscle contraction is restored within 7 h. (*Lanz E, et al. Micturition disorders following spinal anaesthesia of different durations of actions (Lidocaine 2% vs bupivacaine 0.5%). Anaesthetist. 1992;41:231–4*). Small dose opioids (Fentanyl 10–20 μg) cause less urinary retention. (*Kuusniemi KS, et al. The*

use of bupivicaine and fentanyl for spinal anaesthesia for urologic surgery. Anaesth Analg. 2000;91:1452–6). Oblique lateral entry into ligamentum flavum may direct the needle into the dural cuff region causing direct trauma to the nerve root. (*Cousins MJ, et al. Epidural neural blockade. In: Cousins MJ, Bridenbaugh PO, editors. Neural blockade, 2nd ed. Philadelphia: JB Lippincott; 1988. p. 253*). Paraesthesias are common during needle insertion (4–18%). (*Hampi K, et al. Transient neurological symptoms after spinal anesthesia. Anesth Analg. 1995;81:1148–53*). Elicitation of paraesthesia is a risk factor for persistent paraesthesia. (*Horlocker T, et al. A retrospective review of 4767 consecutive spinal anaesthetics. Central Nervous system complications. Anesth Analg. 1997;84:578–84*).

97. T T F F T
Backache after spinal anaesthesia is seen in about 20% of patients and the risk factor include long duration of operation causing strain on relaxed muscles. Hyperbaric Lignocaine is known to cause cauda equine syndrome especially with the use of spinal microcatheters. (*Rigler ML, et al. Cauda equine syndrome after continuous spinal anaesthesia. Anesth Analg. 1991;72:275–81*). Transient neurologic symptoms are seen after total recovery from spinal anaesthesia but within 24 h of surgery. It presents as back pain and/or dysesthesia radiating bilaterally to the legs or buttocks after total recovery. TNS is not associated with any neurological signs and mostly moderate pain is seen. (*Pollock JE, et al. Prospective study of the incidence of transient radicular irritation in patients undergoing spinal anaesthesia. Anesthesiology. 1996;84:1361–7*). Transient neurological symptoms are seen more with lithotomy position and outpatient surgery. (*Freedman JM, et al. Transient neurologic symptoms after spinal anaesthesia. An epidemiologic study of 1863 patients. Anesthesiology. 1998;89:633–41*).

98. F T F T T
TNS is seen mostly with Lidocaine (10–37%) but is also seen with mepivicaine, prilocaine and procaine. (*Zaric D, et al. Transient neurologic symptoms after spinal anaesthesia with lidocaine versus other local anaesthetics: a systemic review of randomised controlled trials. Anesth Analg. 2005;100:1811–6*). Decreasing the concentration of Lignocaine from 5 to 2% decreases the incidence. The incidence of TNS is about 30% with Mepivicaine and about 3% with bupivicaine. (*Hiller A, et al. Transient neurologic symptoms after spinal anaesthesia with 4% mepivicaine and 0.5% bupivicaine. Br J Anaesth. 1997;79:301–5*). Dorsal roots are positioned most posterior and are more exposed in the supine position with hyperbaric local anaesthetics. (*Schneider M, et al. Transient neurologic toxicity after hyperbaric subarachnoid anesthesia with 5% lidocaine. Anesth Analg. 1993;76:1154–7*). Pencil tip needles cause sacral maldistribution and cause more incidence.

99. T F F F T
Risk factors for transient neurologic symptoms includes addition of vasoconstrictor, local anaesthetic toxicity, neural ischaemia, patient positioning, needle trauma, use of small gauge and pencil point needles. Increased symptoms

are seen with outpatient surgery and lithotomy position. The lithotomy position stretches Cauda equina and sciatic nerves thus decreasing vascular supply. Early ambulation does not increase the risk. (*Freedman JM, et al. Transient neurologic symptoms after spinal anaesthesia. An epidemiologic study of 1863 patients. Anesthesiology. 1998;89:633–41*). TNS is seen more with knee arthroscopy than inguinal hernia repairs. (*Pollock JE, et al. Prospective study of the incidence of transient radicular irritation in patients undergoing spinal anaesthesia. Anesthesiology. 1996;84:1361–7*). Adding vasoconstrictor increases the risk of TNS. Adding epinephrine to Lidocaine enhances sensory deficits. (*Hashimoto K, et al. Epinephrine increases the neurologic potential of intrathecally administered local anaesthetic in the rat. Anesthesiology. 1996;85:A770*).

100. F T T T F

Headache has low incidence of 15–20%. (*Santanen U, et al. Comparison of 27 gauge (0.41 mm) Whitacre and Quincke needles with respect to post dural pressure headache and non dural puncture headache. Acta Anesthesiol Scand. 2004;48:474–9*). Risk factors for headache include immobilisation, dehydration, fasting, hypoglycaemia, deprivation of caffeine and anxiety. Post dural headache is seen in frontal and occipital regions and is aggravated by upright posture and straining. Auditory dysfunction is due to 8th nerve dysfunction and may present as unilateral or bilateral deafness. Most common visual disturbance seen is diplopia and is due to involvement of abducens nerve.

101. T T T F T

Headache is due to traction of cerebral structures and also due to loss of CSF causing compensatory cerebral vasodilatation dural fibers are oriented longitudinally so parallel insertion of the needle is less traumatic. (*Lybecker H, et al. Incidence and prediction of post dural puncture headache. A prospective study of 1021 spinal anaesthetics. Anesth Analg. 1990;70:383–94*). Horizontal position for more than 24 h has no added benefit on the incidence or duration of the headache. (*Kaukinen S, et al. The prevention of headache following spinal anaesthesia. Ann Chir Gynaecol. 1981;70:107–11*). Caffeine can be given intravenously with a bolus dose of 30–60 mg every 6 hourly for four doses.

102. F F F T T

Epidural blood patch should be done at least 24 h after dural puncture. (*Loeser EA, et al. Time vs success rate for epidural blood patch. Anesthesiology. 1978;49:147–8*). Epidural blood patch causes the volume effect and compresses the dural canal and increases CSF pressure and relieves the headache. Clotting and sealing of the hole occurs later. (*Vakharia SB, et al. Magnetic resonance imaging of cerebrospinal fluid leak and tamponade effect of blood patch in postdural puncture headache. Anesth Analg. 1997;84:585–90*). Epidural blood patch has a success rate of 70–90%. Epidural blood injection should be done in the same space or a space below as the blood spreads more in cephalad than caudad direction. (*Szeinfeld M, et al. Epidural blood patch:*

evaluation of the volume and spread of blood injected into epidural space. Anesthesiology. 1986;64:820–2).

103. T T T T T
Pruritus due to use of opioids normally do not cause severe Pruritus and does not need treatment. 5-HT antagonists can treat Pruritus. Catheter placement near the nerve root is the most common cause of cauda equine syndrome. Spinal cutaneous fistula may develop as a result of continuous spinal anaesthesia. (*Hullander M, et al. Spinal cutaneous fistula following spinal anaesthesia. Anesthesiology. 1992;76:139–40*). Aseptic meningitis can be caused by preservatives. (*Kasai T, et al. Aseptic meningitis during combined continuous spinal and epidural analgesia. Acta Anaesthesiol Scand. 2003;47: 775–6*).

104. T T T T F
Low amplitude electrical current via electrical conducting catheters can be used to localise the placement. Correct placement is indicated by a motor response elicited with a current between 1 and 10 mA. (*Tsui BC, et al. Determining epidural catheter location using nerve stimulation with radiological confirmation. Reg Anesth Pain Med. 2000;25:306–9*). Motor response <1 mA suggests catheter in subarachnoid or subdural space. (*Tsui BC, et al. Detection of subdural placement of epidural catheter using nerve stimulation. Can J Anaesth. 2000;47: 471–3*). Electromyography can pick up degree of axonal loss within 3 weeks.

105. T F F F T
Epidural abscess is a rare phenomenon. (*Moen V, et al. Severe neurological complications after central neuraxial blockades in Sweden 1990–1999. Anesthesiology. 2004;101:950–9*). Most common organism in infection is Staphylococcus epidermidis. (*Darchy B, et al. Clinical and bacteriological survey of epidural analgesia in patients in the intensive care unit. Anesthesiology. 1996;85:988–98*). Neuraxial anaesthesia may cause benefit in HIV patients as it eliminates delayed metabolism of systemic opioids caused by protease inhibitors. (*Hughes SC. HIV and anaesthesia. Anaesthesiol Clin N Am. 2004;22:379–404*).

106. T T T T T
Tunnelling the catheter along with the occlusive dressing prevents infection (*Bubeck J, et al. Subcutaneous tunnelling of caudal catheters reduces the rate of bacterial colonisation to that of lumbar epidural catheters. Anesth Analg. 2004;99:689–93*). Obstetric patients are more susceptible to high spinal or total spinal because of engorged epidural venous plexus. Total spinal is rarely seen in non obstetric patients. Potency of sedative agents is increased in high spinal. (*Tversky M, et al. Effect of epidural bupivicaine block on midazolam hypnotic requirements. Reg Anesth. 1996;21:209–13*). Subdural space is seen both intracranially and extracranially and extends from second sacral vertebrae to floor of third ventricle. Epidural space is only extracranially and injection into this space is seen in 0.1–0.8% of patients. (*Lubenow T, et al. Inadvertent subdural injection: a complication of an epidural block. Anesth*

Analg. 1988;67:175–9). Subdural injection may cause cardio-respiratory arrest especially in obstetric patients. (*Wills JH. Rapid onset of massive subdural anesthesia. Reg Anesth Pain Med. 2005;30:299–302*).

107. T F F F T

Cardiovascular toxicity due to local anaesthetics manifests as tachycardia and hypertension followed by bradycardia and hypotension. Change in heart rate is not a reliable indicator of intravascular administration in sedated patients. (*Tanaka M, et al. The efficacy of simulated intravascular test dose in sedated patients. Anesth Analg. 2001;93:1612–7*). Acidosis along with hypoxia and hypercapnia are the risk factors for local anaesthetic toxicity. (*Heavner JE, et al. Resuscitation from bupivicaine induced asystole in rats: comparison of different cardioactive drugs. Anesth Analg. 1995;80:1134–9*). Incidence of post dural puncture headache is 0–2.6% which increases to 70% with 16G needle. (*Turnbull DK, et al. Post dural puncture headache: pathogenesis, prevention and treatment. Br J Anaesth. 2003;91:718–29*). Frontal pain seen with post dural puncture headache is because of trigeminal involvement while traction on infratentorial structures causes occipital pain and neck pain which is relayed through glossopharyngeal, vagus and cervical nerves. (*Horlocker TT. Complications of spinal and epidural anesthesia. Anesthesiol Clin N Am. 2000;18:461–85*).

108. T T F F F

Incidence of visual disturbance is 0.4% in postdural puncture headache. Most common disturbance seen is diplopia. (*Vandam LD, et al. Long term follow up of patients who received 10,098 spinal anaesthetics: syndrome of decreased intracranial pressure (headache and ocular and auditory difficulties). JAMA. 1956;161:586–91*). Auditory symptoms are due to change in CSF pressures which is transmitted to circulating endocochlear lymph in the semicircular canals. (*Lybecker H, et al. The effect of epidural blood patch on hearing loss in patients with severe post dural puncture headache. J Clin Anesth. 1995;7:457–64*). Dura is made of mixture of elastic collagen and elastin fibers contained in a viscous intracellular ground substance. (*Patin DJ, et al. Anatomic and biomechanical properties of human lumbar dura mater. Anesth Analg. 1993;76:535–40*). Younger patients are at more risk for post dural puncture headache. As they have more dural elasticity which maintains a patent defect on puncture. (*Fink BR. Post spinal headache. Anesth Analg. 1990;71:208–9*). Vasoconstrictor effects of caffeine are transient and headache may return after 48 h. It should be avoided in patients with pregnancy induced hypertension as it may lower seizure threshold. (*Bollen VE, et al. Post partum seizure after epidural blood patch and intravenous caffeine sodium benzoate. Anesthesiology. 1989;70:146–9*).

109. F T T T T

Success rate with first blood patch is 85% and this increases to 98% on repeated injection. Epidural blood patch compresses thecal sac and conus. The mass effect seen persists beyond 3 h and clot resolution occurs in 7 h. (*Beards SC, et al. Magnetic resonance imaging of extradural blood patches:*

appearances from 30 minutes to 18 hours. Br J Anaesth. 1993;71:182–8). The average amount of blood required for patch in thoracic region is 5–10 mL and about 15 mL for lumbar region. (*Szeinfeld M, et al. Epidural blood patch: evaluation of the volume and spread of blood injected into the epidural space. Anesthesiology. 1986; 64:820–2*). Facial palsy can be seen because of epidural blood patch along with transient bradycardia and lumbo-vertebral syndrome. (*Perez M, et al. Facial nerve paralysis after epidural blood patch. Reg Anaesth. 1993;18:196–8*). Dextran-40 has been used for PDPH because of high viscosity and weight. (*Reynvoet ME, et al. Epidural dextran 40 patch for post dural puncture headache. Anaesthesia. 1997;52:886–8*).

110. F T T T T
Epidural anaesthesia is beneficial in coronary artery bypass grafting as it causes dilation of coronary vessels, decreases heart rate and decreased myocardial oxygen demand. (*Meissner A, et al. Thoracic epidural anaesthesia and the patient with heart disease: benefits, risks and controversies. Anesth Analg. 1997;85:517–28*). High thoracic and lumbar epidurals do not interfere with ventilator response. (*Sakura S, et al. Effect of extradural anesthesia on the ventilatory response to hypoxaemia. Anaesthesia. 1993;48:205–9*). False loss of resistance is common in elderly population because of incidence of cyst formation within the interspinous ligaments. (*Sharrock NE. Recordings of and anatomical explanation for false positive loss of resistance during extradural analgesia. Br J Anaesth. 1979;51:253–8*). Higher failure rate of epidural anaesthesia is seen in obstetric population (15%). (*Portnoy D, et al. Mechanisms and management of an incomplete epidural block for caesarean section. Anesth Clin North Am. 2003;21:39–57*). Pruritus is seen with 80% of patients with opioids via epidural route.

111. F T T T T
Pruritus seen as a result of epidural opioid administration is due to involvement of CNS, medullary dorsal horn activation and antagonism of inhibitory transmitters. (*Szarras S, et al. Neuraxial opioid induced Pruritus: a review. J Clin Anesth. 2003;15:234–9*). Pruritus is a dose dependent phenomenon and mediators include c fibers in skin, 5-HT3 receptors and prostaglandins. Dexamethasone has shown the best evidence for post operative nausea and vomiting. (*Tzeng JI, et al. Low dose dexamethasone reduces nausea and vomiting after epidural morphine: a comparison of metoclopramide with saline. J Clin Anesth. 2002;14:19–23*). Nalbuphine is an opioid mixed agonist/antagonist and restores detrusor function with reversing analgesic effects. (*Malinovsky JM, et al. Nalbuphine reverses urinary effects of epidural morphine: a case report. J Clin Anaesth. 2002;14:535–8*). Back pain after epidural anaesthesia is seen more with younger age, prior history of back pain and greater weight.

112. F T T T F
Brachial plexus has a high failure rate of up to 30% while failure rates with ophthalmic blocks are less than 5%. (*Baranowsky AP, et al. A comparison of three methods of axillary plexus anaesthesia. Anaesthesia. 1990;45:362–5*).

Ultrasound frequencies are between 10 and 14 MHz (*Marhofer P, et al. Ultrasound guidance in regional anaesthesia. Br J Anaesth. 2005 94(1):7–17*). High concentration of local anaesthetic can cause permanent muscle damage along with neural oedema, lipid inclusion, fiber injury and Schwann cell injury. (*Kalichman MW, et al. Quantitative histologic analysis of local anaesthetic induced injury to rat sciatic nerve. J Pharmacol Exp Ther. 1989; 20:406–13*). Local anaesthetics can cause focal myonecrosis with regeneration seen over several weeks. (*Komorowski TE, et al. An electron microscopic study of local anesthetic induced skeletal muscle fiber degeneration and regeneration in the monkey. J Orthop Res. 1990;8:495–503*).

113. F F T T T

Anticoagulation does not contribute to an increase risk of hematomas. (*Weller RS, et al. Extensive retroperitoneal hematoma without neurologic deficit in two patients who underwent lumbar plexus block and later ant coagulated. Anesthesiology. 2003;98:581–5*). Hand washing is the single most important barrier to the infection and gloves is not a replacement. (*Saloojee H, et al. The health professional's role in preventing nosocomial infections. Post Graduate Med. 2001;77:16–9*). Lithotomy position causes injury to the obturator, lateral femoral cutaneous and sciatic nerve. (*Warner MA, et al. Lower extremity neuropathies associated with lithotomy positions. Anesthesiology. 2000;93:938–42*). To prevent injury to the nerves, the pressure of the tourniquet should be kept less than 150 mmHg and deflation should be done every 90–120 min. (*Finsen V, et al. Tourniquets in forefoot surgery: less pain when placed at ankle. J Bone Joint Surg. 1997;79:99–101*). Risk factors for arthroscopy include extensive joint distension, excessive traction and extravasation of fluid during surgery. (*Ferkel RD, et al. Neurological complications of ankle arthroscopy. Arthroscopy. 1996;12:200–8*).

114. T T T T F

Myocardial toxicity is related to the potency of local anaesthetics. (*Reiz S, et al. Cardiotoxicity of local anaesthetic agents. Br J Anaesth. 1986;58:736–46*). Increased concentration of plasma Lidocaine cause peripheral dilation and reduced contractility which manifests as hypotension. Lidocaine is more neurotoxic than Ropivicaine. (*Atanassoff PG, et al. Central nervous system side effects are less important after regional anaesthesia with ropivicaine 0.2% compared to lidocaine 0.5% in volunteers. Can J Anaesth. 2002;49(2):169–72*). Prilocaine may cause methemoglobinemia but is perfectly safe to use in clinical practice. (*Bartholomew K, et al. Prilocaine for Bier's block: how safe is safe? Arch Emerg Med. 1990;7:189–95*).

115. T T F F T

Chlorprocaine is formulated with a preservative which is damaging to vascular endothelium and can cause pain. (*Suzuki N, et al. The effect of plain 0.5% 2-chlorprocaine on venous endothelium after intravenous regional anaesthesia in the rabbit. Acta Anesthesiol Scand. 1994;38:653–6*). Intravenous block with guanethedine can cause apnoea along with hypotension and angina. (*Woo R, et al. Apnoea and syncope following intravenous guanethedine bier*

block in the same patient on two different occasions. Anesthesiology. 1987;67:281–2). Almost 100% of lower limb intravenous regional anaesthesia blocks are associated with leakage of local anaesthetic while only 25% of upper limb blocks leak. (*Davies JA, et al. Intravenous regional anaesthesia for foot surgery. Acta Anaesthesiol Scand. 1986;30:145–7*). Toxicity seen on deflation is due to local anaesthetic levels in the arterial system. (*Thorn-Alqvist AM. Blood concentration of local anaesthetics after intravenous regional anaesthesia. Acta Anesthesiol Scand. 1969;13:229–40*).

116. T T T T T

Tourniquet pain can be reduced by Lidocaine priming with 1 mg/kg intravenous 5 min before the administration. (*Estebe J-P, et al. Lidocaine priming reduces tourniquet pain during intravenous regional anaesthesia. A preliminary study. Reg Anesth Pain Med. 2003;28(2):120–3*). Neuromuscular dysfunction is seen with an incidence of 1:8000. This is decreased by restricting tourniquet time to less than 2 h to avoid capillary and muscle damage. (*Love BR. The tourniquet. ANZ J Surg. 1978;48(1):66–70*). Prilocaine 0.5% in the dosage of 3–4 mg/kg and Lidocaine in the dosage of 1.5–3 mg/kg is used for intravenous regional anaesthesia. Protective factors for tourniquet induced injury include use of safe dosage of local anaesthetic, injection over 90 s and injection as far as distal as possible. (*Plourde G, et al. Decreasing the toxic potential of intravenous regional anaesthesia. Can J Anaesth. 1989;36(5):498–502*).

117. F T T T T

Loss of resistance technique with air should be avoided as it can develop life threatening venous air embolism. (*Guinard J-P, et al. Probable venous air embolism during caudal anaesthesia in a child. Anesth Analg. 1993;76:1134–5*). Risk of dural puncture is more in infants because of lower extension of dural sac. Infection is mostly caused by corynebacterium (82%) or staphylococci. (*Holt HM, et al. Infections following epidural catheterisations. J Hosp Infect. 1995;30:253–60*). Obstruction to passage of epidural catheter is more in infants as lumbar lordosis is not developed thus obstructing passage. (*Blanco D, et al. Thoracic epidural anaesthesia via the lumbar approach in infants and children. Anesthesiology. 1996;84:1312–6*). Incidence of post dural puncture headache is rarely seen in less than 10 years due to lower CSF pressures. (*Wee LH, et al. The incidence of post dural puncture headache in children. Anaesthesia. 1996;51:1164–6*).

118. F T T T T

Blood patch can be done in paediatric population with the recommended volume of 0.5–0.75 mL/kg and should be injected slowly (*Kumar V, et al. Epidural blood patch for treatment of subarachnoid fistula in children. Anaesthesia. 1991;46:117–8*). Plasma levels of 4.0 μg/mL is toxic in adults where as <2.0 μg/mL is safe in paediatric population. (*Tucker GT. Pharmacokinetics of local anaesthetics. Br J Anaesth. 1986;58:717–31*). Warning signals are usually missing during toxicity in paediatric population. (*Aggarwal R, et al. Seizures occurring in paediatric patients receiving con-*

tinuous infusion of bupivicaine. Anaesth Analg. 1992;75:284–6). Clonidine causes analgesia without much side effects. (*Jamail S, et al. Clonidine in paediatric caudal anaesthesia. Anesth Analg. 1994;78:663–6*).

119. F T T T T

Headache develops in 70–80% of patients with dural puncture and most commonly has postural dependence. (*Paech M, et al. An audit of accidental dural puncture during epidural insertion of a Tuohy needle in obstetric patients. Int J Obst Anesth. 2001;10:162–7*). Post dural puncture headache is accompanied by nausea, vomiting, headache (frontal/occipital), neck/shoulder stiffness and photophobia. (*Chan TM, et al. Post partum headaches: summary report of the national obstetric anaesthetic database (NOAD) 1999. Int J Obstet Anaesth. 2003;12:107–12*). Caffeine and sumatriptan both can relieve dural puncture headache. (*Berger CW, et al. North American survey of the management of dural puncture occurring during labour epidural analgesia. Can J Anaesth. 1998;45:110–4*). Most common complication seen with epidural blood patch is low back pain which is self limiting. (*Abouleish E, et al. Long term follow up of epidural blood patch. Anesth Analg. 1975;54:459–63*). Hypotension seen after neuraxial block is because of decreased cardiac output and decreases systemic vascular resistance.

120. T F T F T

Though colloids are better than crystalloids in preventing hypotension, the side effects seen are more. The most effective intervention other than medications is wrapping legs with elastic bandages. (*Morgan PJ, et al. The effects of an increase of central blood volume before spinal anaesthesia for cesarean section: a qualitative systemic review. Anesth Analg. 2001;92:997–1005*). Combined spinal epidural has shown to have less incidence of instrumental delivery due to a reduction in the dosage of local anaesthetic agent used. (*Comparative Obstetric Mobile Epidural Trial (COMET) Study Group. Effect of low dose mobile versus traditional epidural technique son mode of delivery: a randomised controlled trial. Lancet. 2001;358:19–23*). The incidence of post dural puncture headache does not increase with combined spinal epidural. (*Hughes D, et al. Combined spinal-epidural versus epidural analgesia in labour. Cochrane Database Syst Rev. 2003;(4):CD003401*). Intrathecal opioids increase the risk of foetal bradycardia. (*Mardirosoff C, et al. Fetal bradycardia due to intrathecal opioids for labour analgesia: a systemic review. BJOG. 2002;109:274–81*).

121. T T T T F

Neuraxial blocks may cause reactivation of herpes simplex labialis. (*Davies PW, et al. Oral herpes simplex reactivation after intrathecal morphine: a prospective randomised trial in an obstetric population. Anesth Analg. 2005;100:1472–6*). Respiratory depression is seen more in obese population and those with high doses of systemic opioids. (*Ferouz F, et al. Risk of respiratory arrest after intrathecal sufentanil. Anesth Analg. 1997;85:1088–90*). The onset of subdural block is slow spread over 20–35 min. (*Collier CB. Accidental subdural injection during attempted lumbar epidural block*

may present as failed or inadequate block: radiographic evidence. Reg Anesth Pain Med. 2004;29:45–51). Subdural block has variable motor block, less severe hypotension and sacral dermatomes are preserved. (*Jenkins JG. Some immediate serious complications of obstetric analgesia and anaesthesia: a prospective study of 145,550 epidurals. Int J Obstet Anesth. 2005;14:37–42*).

122. T F T T T

Most nerve injuries associated with neuraxial blocks are radiculopathies involving single nerve root and are usually reversible. Lignocaine causes more incidences of transient neurologic symptoms than bupivicaine (*Zaric D, et al. Transient neurologic symptoms after spinal anaesthesia with lidocaine versus other local anaesthetics: a systemic review of randomised controlled trials. Anesth Analg. 2005;100:1811–6*). Pregnancy is a protective factor for transient neurologic symptoms while the risk is increased in ambulatory patients and surgery in lithotomy position. (*Pollock JE. Transient neurologic symptoms: aetiology, risk factors and management. Reg Anesth Pain Med. 2002;27:581–6*). Cauda equina syndrome is not normally seen with neuraxial block in obstetrics. (*Moen V, et al. Severe neurological complications after central neuraxial blockade in Sweden 1990–1999. Anesthesiology. 2004;101:950–9*). Increased risk factors for cauda equina syndrome include use of microcatheters, local anaesthetic toxicity, and hematoma formation. (*Rigler ML, et al. Cauda equina syndrome after continuous spinal anaesthesia. Anesth Analg. 1991;72:275–81*).

123. T T T T T

Large volumes of local anaesthetic can cause anterior spinal syndrome which is due to interruption of blood supply to anterior two-thirds of spinal cord via artery of Adamkiewicz. Other risk factors include hypotension and addition of vasoconstrictors. (*Loo CC, et al. Neurological complications in obstetric regional anaesthesia. Int J Obstet Anaesth. 2000;9:99–124*). Combined spinal epidural is associated with increased risk of meningitis which is mostly bacterial but may present as aseptic meningitis. Epidural abscess may present 4–10 days after the block and present most commonly as backache followed by radicular pain, loss of sensory and motor function and bladder dysfunction. Risk of permanent neurologic damage is high in epidural hematoma and surgical intervention should be done within 8 h to prevent permanent damage (*Vandermeulen EP, et al. Anticoagulants and spinal epidural anesthesia. Anesth Analg. 1994;79:1165–77*). Epidural puncture may cause loss of CSF and traction and eventual rupture of intracranial subdural veins.

124. T T T F T

Most consistent feature with intracranial hematoma is persistent headache and diagnosis is made between 8 and 42 days post partum. Risk factors for nerve injury include primiparity and instrumental delivery. (*Ong BY, et al. Paraesthesias and motor dysfunction after labour and delivery. Anesth Analg. 1987;66:108–22*). The obstetric risk factors for nerve palsy include compression by foetal head, mid forceps delivery, improper positioning during deliv-

ery. Most injuries are unilateral. Most cases of nerve injury involve lateral femoral cutaneous nerve. This is also seen with maternal pushing in the lithotomy position. Femoral nerve injury is caused by exaggerated hip flexion and manifests as limited thigh flexion, quadriceps weakness, absent or reduced knee jerks. (*Dar AQ, et al. Post partum neurological symptoms following regional blockade: a prospective study with case controls. Int J Obstet Anesth. 2002;11:85–90*).

125. F T F F T

Obturator nerve palsy is uncommon during labour and presents as decreased sensation over medial thigh and weakness of hip adduction and internal rotation. Para cervical block can provide good analgesia during first stage and involves transvaginal injection of local anaesthetic into the paracervical tissues. (*Rosen MA, et al. Paracervical block for labour analgesia: a brief historic review. Am J Obstet Gynaecol. 2002;186:S127–30*). Most common symptom of paracervical block in fetus is bradycardia. It is transient and is due to vasoconstriction of the uterine arteries, uterine hypertonicity, and direct local anaesthetic toxicity. The incidence is 15%. Para cervical block may cause complications in females which include systemic local anaesthetic toxicity, paracervical abscess, sacral plexus neuropathy. (*Chestnut DH. Alternative regional anesthetic techniques: paracervical block, lumbar sympathetic, pudendal nerve block and perineal infiltration. In: Chestnut DH, editor. Obstetric anesthesia. Philadelphia: Mosby; 2004. p. 387–96*). General anaesthesia is an independent risk factor for intraoperative blood loss more than 1000 mL. (*Rodgers A, et al. Reduction of post operative mortality and morbidity with epidural or spinal anaesthesia: results from overview of randomised trials. BMJ. 2000;321:1493*.)

126. T T T T F

Canulation of epidural vein has an incidence of 1.3–5.7%. it is seen more often during insertion in sitting position. (*Harney D, et al. Influence of posture ion the incidence of vein canulation during epidural catheter placement. Eur J Anaesthesiol. 2005;22:103–6*). Venous cannulation can be avoided by injecting fluid during insertion and also by using flexible tip. (*Mannion D, et al. Extradural vein puncture—an avoidable complication. Anaesthesia. 1991;46:585–7*). Tsui test comprises of stimulating the catheter the neuraxial placement. (*Tsui BC, et al. Detection of subarachnoid and intraventricular epidural catheter placement. Can J Anaesth. 1999;46:675–8*). Catheter may move up to 1–2 cm even after tunnelling or fixation (*Chadwick VL, et al. Epidural catheter migration: a comparison of tunnelling against a new technique of catheter fixation. Anesth Intens Care. 2003;31:474–7*).

127. F F F T T

Knotted catheter should be removed by applying a firm steady pull but should be removed only after the anaesthetic effect has *worn* off so as to detect nerve root involvement. (*Gozal D, et al. Removal of knotted epidural catheters. Case reports. Reg Anesth. 1996;2171–3*). Most retained catheters are surrounded by fibrous tissue and thus are less prone to infections. Retained cath-

eters require 2.5 times more force to remove in sitting position than the lateral position. (*Boey SK, et al. Withdrawal forces during removal of lumbar extradural catheters. Br J Anaesth. 1994;73:833–5*). Bloody taps have an incidence of 1–10% during insertion of catheters and the incidence is about 18% in pregnant patients. (*Moir DD, et al. Obstetric anaesthesia and analgesia, 3rd ed. London: Bailliere Tindall; 1986*).

128. F T T T T
Epidural abscess can cause permanent neurologic deficit. (*Kee WD, et al. Extradural abscess complicating extradural anaesthesia for cesarean section. Br J Anaesth. 1992;69:647–52*). Bupivicaine has better antimicrobial effect. (*Pere P, et al. Poor antimicrobial effect of ropivicaine: comparison with bupivicaine. Anesthesiology. 1999;91:884–6*).

129. T F F T T
Incidence of post dural puncture headache is less than 1%. (*Pitkanen M. Continuous spinal anaesthesia. Curr Opin Anaesthesiol. 1992;5:676–80*). Prophylactic blood patch has no role in the prevention of epidural puncture pain. (*Scavone BM, et al. Efficacy of a prophylactic epidural patch in preventing post dural puncture headache in parturients after inadvertent dural puncture. Anesthesiology. 2004;101:1422–7*). Potassium chloride if injected intrathecally can cause pain and thiopental has been injected causing irritation. (*Liu K, et al. Inadvertent epidural injection of potassium chloride. Report of two cases. Acta Anesthesiol Scand. 1995;39:1134–7*). Paraesthesias are seen up to 10% in needle through needle technique while only 6.5% in side by side technique. (*Cook TM, et al. 201 combined spinal epidurals for anaesthesia using a separate needle technique. Eur J Anaesthesiol. 2004;21:679–83*).

130. T T T F F
Preoperative Antiplatelet therapy does not increase the risk of spinal hematoma. (*Horlocker TT, et al. Preoperative antiplatelet therapy does not increase the risk of spinal hematoma associated with regional anaesthesia. Anesth Analg. 1995;80:303–9*). A bacterial filter (diameter: 0.22) must be used in catheters. The incidence of post dural puncture headache in elderly is minimal. (*Silvanto M, et al. Technical problems associated with the use of 32 gauge and 22 gauge spinal catheters. Acta Anesthesiol Scand. 1992;36:295–9*). Pleural puncture is seen more with supraclavicular block. Interscalene infusion causes phrenic nerve palsy in 100% of patients while other palsies seen are: stellate ganglion (17%) and recurrent laryngeal nerve (35%). (*Tuominien M, et al. Continuous interscalene brachial plexus block: clinical efficacy, technical problems and plasma bupivicaine concentrations. Acta Anesthesiol Scand. 1989;33:84–8*).

131. T T F T T
Reversible hearing loss may be seen with continuous infusion due to sympathetic block. (*Rosenberg PH, et al. Auditory disturbances associated with interscalene brachial plexus block. Br J Anaesth. 1995;74:89–91*). Long term plexus anaesthesia can be used for the treatment of chronic pain. (*Aguilar JL,*

et al. Long term brachial plexus anaesthesia using a subcutaneous implantable injection system. Reg Anesth. 1995;20:242–5). Intercostals injection may cause damage to nerves (*Crossley AWA, et al. Radiographic study of intercostals nerve block in healthy volunteers. Br J Anaesth. 1987;59:149–54*). Paravertebral blocks can cause Pneumothorax. (*Naja Z, et al. Somatic paravertebral nerve blockade. Incidence of failed block and complications. Anaesthesia. 2001;56:1184–8*). Femoral nerve injury in psoas compartment block is due to direct trauma to nerve roots. (*Al-Nasser B, et al. Femoral nerve injury complicating psoas compartment block. Reg Anaesth Pain Med. 2004;29:361–3*).

132. T F F T F

Patient controlled epidural analgesia may cause hypotension with an incidence of 6–8%. (*Wheatley RG, et al. Safety and efficacy of post operative analgesia. Br J Anaesth. 2001;87:47–61*). Ropivicaine causes less motor blockade than bupivicaine. (*Liu SS, et al. Comparison of three solutions of ropivicaine/fentanyl for post operative patient controlled epidural analgesia. Anesthesiology. 1999;90:727–33*). Thoracic epidural increases coronary flow to ischemic areas and attenuate sympathetic associated vasoconstriction. Lumbar epidural increase myocardial oxygen consumption. (*Veering BT, et al. Cardiovascular and pulmonary effects of epidural anaesthesia. Anaesth Intens Care. 2000;28:620–35*).

133. T T F F T

Incidence of convulsions is between 0.01 and 0.12%. Short acting opioids like Fentanyl and sufentanil are suitable for continuous administration whereas long acting opioids like morphine are given intermittently. Late onset respiratory depression is seen more with hydrophilic opioids like morphine where as lipophillic opioids like Fentanyl and Sufentanil are localised segmentally and are safe. (*Wigfull J, et al. Survey of 1057 patients receiving post operative patient controlled epidural analgesia. Anaesthesia. 2001;56:47–81*). Lipid soluble opioids can spread more rapidly in CSF and can cause harm. (*Eisenach JC, et al. Lipid soluble opioids do move in cerebrospinal fluid. Reg Anesth Pain Med. 2001;26:296–7*). Spinally administered opioids act via brainstem. (*Bernards CM, et al. Recent insights into the pharmacokinetics of spinal opioids and the relevance to opioid selection. Curr Opin Anaesthesiol. 2004;17:441–7*).

134. T T T F T

Epidural Fentanyl infusion produces analgesia by uptake into plasma and redistribution to brain and peripheral opioid receptors, whereas Fentanyl bolus produces analgesia by a spinal mechanism. (*Ginosar Y, et al. The site of action of epidural Fentanyl in humans: the difference between infusion and bolus administration. Anesth Analg. 2003;97:1428–38*). Local anaesthetic administration at lumbar level causes more motor weakness than at thoracic administration. (*Torda TA, et al. Comparison of extradural fentanyl, bupivicaine and two fentanyl-bupivicaine mixtures for pain relief after abdominal surgery. Br J Anaesth. 1995;74:35–40*). Patient controlled epidural analgesia

provides increased satisfaction because of a sense of control and flexibility to increase analgesic demand. The dosage for epidural morphine is 10–20 fold more than intrathecal injection because of systemic uptake and fat sequestration. (*Stoelting RK. Intrathecal morphine: an underused combination for post operative pain management. Anesth Analg. 1989;68:707–9*).

135. T F T T T

Pruritus with opioids is seen due to interaction of oestrogen with opioid receptors. (*Waxter B, et al. Primer of post operative pruritus for anaesthesiologists. Anesthesiology. 2005;103:168–78*). Urinary retention is seen due to interaction with opioid receptors located in the sacral plexus. It causes inhibition of sacral parasympathetic nervous system flow causing detrusor muscle relaxation and increased bladder capacity leading to urinary retention. (*Rawal N, et al. An experimental study of urodynamic effects of epidural morphine and of naloxone reversal. Anesth Analg. 1983;62:641–7*). Type of surgery affects complications like patients having knee surgery do not present normally with increased urinary retention. (*Ben-David B, et al. Intrathecal fentanyl with small dose dilute bupivicaine: better anaesthesia without prolonging recovery. Anesth Analg. 1997;85:560–5*). Single catheterisation is required in patients who are unable to void after 6 h of surgery and naloxone not causing any effect. This helps prevent myogenic bladder damage because of overdistension. Incidence of nausea and vomiting after intrathecal is about 30% but it may increase in certain surgeries like caesarean section when uterus is exteriorised and peritoneal closure. (*Manullang TR, et al. Intrathecal fentanyl is superior to intravascular ondansetron for the prevention of post operative nausea during cesarean delivery with spinal anaesthesia. Anesth Analg. 2000;90:1162–6*).

136. F T T T T

Incidence of respiratory depression is less than 1% regardless of the route of administration. (*Etchis RC. Respiratory depression associated with patient controlled analgesia: a review of eight cases. Can J Anaesth. 1994;41:125–32*). Ropivicaine is ideal for perineural infusion as it is long acting with motor sensory differential blockade. (*Nielson KC, et al. Ambulatory evaluation and safety considerations. Tech Reg Anesth Pain Manag. 2004;8:99–103*). Catheter dislodgement may be dependent on the site at which it is secured as some sites are easy to secure like infraclavicular. Increased colonisation is seen with femoral catheters while infection risk is low. Most common organism seen is Staphylococcus epidermidis. (*Cuvillon P, et al. The continuous femoral nerve block catheter for post operative analgesia: bacterial colonisation, infections rate and adverse effects. Anesth Analg. 2001;93:1045–9*).

137. T F T T F

Highest rate of complications are seen with urologic surgery, orthopaedic, general and vascular surgery. This is seen because of important risk factors in this cohort of disordered coagulation, osteoporosis, spinal stenosis, and immunosupression (*Renck H. Neurologic complications of central nerve blocks. Acta Anaesthesiol Scand. 1995;39(7):859–68*). The risk of neurologic

complications in spinal is 1:10,000 and epidural is 1:30,000. (*Aurey Y, et al. Major complications of regional anaesthesia hotline service. Anesthesiology. 2002;97(5):1274–80*). Most common injury is a damage to nerve root which usually resolves within a year. Most common symptom is a sensory deficit followed by painful paraesthesias and paresis. Obstetric population is at a lower risk for nerve injuries (*Scott DB, et al. Serious non fatal complications associated with extradural block in obstetric practice. Br J Anaesth. 1990;64:537*).

138. T T F T T
Epidural space fluid may cause transient paraplegia. (*Jacob AK, et al. Transient profound neurologic deficit associated with thoracic epidural analgesia in an elderly patient. Anesthesiology. 2004;101(6):1470–1*). Risk factors for neurologic injury includes female gender, diabetes, spinal disorders (osteoporosis, spondylitis, spinal stenosis, osteoarthritis), neuropathy and hypotension.

139. T F F F T
Lithotomy position is especially associated with cauda equina syndrome. Fibers of cauda equina are affected more by compression, ischaemia and neurotoxicity. (*Loo CC, et al. Cauda equina syndrome after spinal anaesthesia with hyperbaric 5% lignocaine: a review of six cases of cauda equina syndrome reported to the Swedish pharmaceutical insurance 1993–1997. Acta Anaesthesiol Scand. 1999;43(4): 371–9*). Damage to S2-S4 nerve roots are required to produce a lower motor neuron disease and saddle shaped anaesthesia. Numbness is seen in the thighs extending up to the feet if L5/S1 is involved.

140. F F T T F
Most common cause for spinal hematoma is idiopathic which is about 39%. (*Kreppel D, et al. Spinal hematoma: a literature survey with meta-analysis of 613 patients. Neurosurg Rev. 2003;26(1):1–49*). It usually presents with in 24 h of injury. It may develop in absence of risk factors. (*Horlocker TT. What's a nice patient like you doing with a complication like this? Diagnosis, prevention of spinal hematoma. Can J Anaesth. 2004;5(6):527–34*). The incidence of spinal hematoma after obstetric epidural is 1:100,000. (*Palot M, et al. Epidemiology of complications of obstetric epidural analgesia. Can J Anesthesiol. 1994;42(2):229–33*). Spinal hematoma presents as lower limb weakness causing flaccid paralysis, numbness and loss of bladder and bowel continence.

141. F T F F T
Spinal hematoma mostly presents as paraplegia within hours with no acute pain. Complete neurologic recovery is seen in up to 40% of patients. Recovery is better for lumbosacral hematomas (L2-S1). (*Vandermeulen EP, et al. Anticoagulants and spinal-epidural anesthesia. Anesth Analg. 1994;79:1165*). Treatment with steroids increase the vessel wall fragility and increase the risk of spinal hematomas.

142. F T T F T
Epidural lipomatosis (excessive hypertrophy and abnormal accumulation of epidural fat) is seen with epidural injection. Normally fat is absent in extradural space in cervical region and is highest in lumbosacral region. (*Reina MA, et al. Clinical implication of epidural fat in the spinal canal. A scanning electron microscope study. Acta Anesthesiol Belg. 2009;60:7–17*). The posterior epidural space is 0.4 mm in C7-T1, 7.5 mm in upper thoracic region and 4–7 mm in the lumbar region. (*Nickalls RW, et al. The width of the posterior epidural space in obstetric patients. Anaesthesia. 1986;41:432–3*). Epidural veins are seen in the anterolateral aspect of the spine (*Meijenhorst GC. Computed tomography of the lumbar epidural veins. Radiology. 1982;145:687–91*). Epidural injection may cause connective tissue proliferation and adhesions develop between the dura mater and the ligamentum flavum. (*Igavashi T, et al. Inflammatory changes after extradural anesthesia may affect the spread of local anesthetic within the extradural space. Br J Anaesth. 1996;77:347–51*). Previous surgery is a risk factor for spinal hematomas due to reduced ability to absorb blood and blood products. (*Uribe J, et al. Delayed post operative spinal epidural hematomas. Spine J. 2003;3:125–9*).

143. T F T F F
Stress may cause hypercoaguable state by increasing procoagulant molecules (fibrinogen or coagulation factor VII), decreased fibrinolytic capacity and increased platelet activity. (*Von Kamel R. Changes in blood coagulation in stress and depression-from evolution to gene regulation. Ther Umsch. 2003;60:682–8*). NSAIDs inhibit COX-2 which prevents formation of prostaglandin H2 which is required for formation of thromboxane A2 having vasoconstriction effect. (*Patrono C, et al. Clinical pharmacology of platelet cyclooxygenase inhibition. Circulation. 1985;72:1177–84*). Aspirin irreversibly inactivates COX-1 through deacetylation of amino acid serine (*Merritt JC, et al. The efficacy and safety of perioperative antiplatelet therapy. J Thromb Thrombolysis. 2004;17:21–7*). Aspirin also affects megakaryocytes which are responsible for platelet production. Aspirin causes dose dependent inhibition of platelet function, Suppression of platelet coagulation and increase in fibrinolysis (*Patrono C, et al. Platelet active drugs: the relationships among dose, effectiveness and side effects: the seventh ACCP conference on antithrombotic and thrombolytic therapy. Chest. 2004;126:234S–64S*).

144. F F F F T
Aspirin is a known risk factor for post operative bleeding and develop of hematomas. (*Kou J, et al. Risk factors for spinal epidural hematoma after spinal surgery. Spine. 2002;27:1670–3*). Prasugrel is a prodrug similar to Clopidogrel and works by irreversible inhibition of P2Y12 receptors. (*Farid NA, et al. The disposition of Prasugrel, a novel thienopyridine in humans. Drugs Metab Dispos. 2007;35:1096–104*). Prasugrel causes 90% inhibition of platelet function compared with 60% by Clopidogrel. It should be stopped for 7–10 days before neuraxial injection. (*Brand JT, et al. A comparison of*

prasugrel and clopidogrel loading doses on platelet function: magnitude of platelet inhibition is related to active metabolite formation. Am Heart J. 2007;153:C9–16). Warfarin inhibits factors II, VII, IX, and X. Half life of factor VII is shorter than the other factors. This is antagonised by decrease in anticoagulant protein C, making INR unreliable during early phase of treatment (*Benzon HT, et al. Factor VII levels and international normalised ratios in the early phase of warfarin therapy. Anesthesiology. 2010;112:298–304*). The levels of factor VII are greater than 40% within 12–16 h of warfarin. INR should be checked if neuraxial anaesthesia is done after 24 h of warfarin administration. (*Parvizi J, et al. Can epidural anaesthesia and warfarin be coadministered? Clin Orthop Relat Res. 2007;456:133–7*).

Equipment for Regional Anaesthesia

5

1. Equipment for regional anaesthesia:
   (a) Pencil point needles can cause more myelin damage.
   (b) Resistance to injection is less in smaller gauge needles.
   (c) Echogenic needles increase visibility by trapping air bubbles.
   (d) Catheter over needle technique is associated with less leakage and migration.
   (e) Catheter over needle has no advantages versus a catheter through the needle.
2. Peripheral nerve stimulation:
   (a) Current output should be constant.
   (b) Long pulse width is an indicator of nerve proximity.
   (c) Anode is used as stimulating electrode.
   (d) Lower frequencies should be used for nerve localisation.
   (e) Impedance measurement is necessary.
3. Monitoring devices:
   (a) Toxicity from local anaesthetics is mostly delayed.
   (b) Nerve stimulation threshold of less than 0.2 mA suggests intraneural needle location.
   (c) Nerve stimulation alone is sensitive.
   (d) Impedance change may indicate intraneural needle placement.
   (e) Electrical impedance changes with intravascular or perineural injection.
4. Monitoring devices:
   (a) Intraneural injection may be associated with high injection pressures.
   (b) Breach in perineurium during intraneural injection is protective for injury.
   (c) Pressure greater then 20 psi can cause permanent neurological damage.
   (d) High injection pressures may cause undesirable neuraxial spread.
   (e) Infrared thermal imaging can be used to monitor block regression.
5. Continuous peripheral nerve blockade:
   (a) May have hemostatic valve.
   (b) Styletted catheters can result in greater tissue or vessel trauma.

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(c) Multiorifice catheters have no advantage over single orifice catheters for analgesia.
(d) Stimulating catheters conduct current at their distal end.
(e) Stimulating catheters is associated with increased local anaesthetic consumption.

6. Nerve fixation systems:
   (a) A twitch is a reliable indicator of proximal placement of needle to nerve.
   (b) Sensors in needle help in predicting needle trajectory.
   (c) Paraesthesia technique for nerve localisation is associated with fewer complications.
   (d) Elastomeric pumps can be used on outpatient basis.
   (e) Purulent discharge at catheter site can be treated with antibodies with catheter in situ.
7. Electrical nerve stimulation:
   (a) High intensity stimulation is for nerves.
   (b) Peripheral nerve stimulation is not reliable when muscle relaxation is used.
   (c) Lowest current threshold is called rheobase.
   (d) Constant current source and sufficient power can compensate for wide variation of impedance.
   (e) Transcutaneous nerve mapping should be done by ball tip less than 3 mm.
8. Electrical nerve stimulation:
   (a) Same amplitude is required for superficial and deep nerves.
   (b) High current density can be misleading.
   (c) Short pulse duration better estimates the distance between the nerve and the needle.
   (d) High stimulating current should be given when initiating needle movement.
   (e) Impedance decreases when needle move from extraneural to intraneural position.
9. Electrical nerve stimulation:
   (a) 5%d increases the impedance in perineural tissues.
   (b) Sequential electrical stimulation nerve stimulator catheters create a 3 Hz stimulation frequency.
   (c) Spatial discrimination near the nerve is more precise in needles with pin pint electrode.
   (d) Threshold current with stimulating catheters may be lower.
   (e) Catheters are unlikely to cause trauma.
10. Electrical nerve stimulation:
    (a) Action potential is created by anode.
    (b) Insulated needles increase the current density.
    (c) Use of 5%D may augment the motor response at a low current.
    (d) Maximum injury occurs when solution is injected outside the fascicle.
    (e) Ultrasound guidance is superior to nerve stimulation for avoiding nerve injuries.

Answers

1. T F T T F
   Pencil point and tuohy needles cause more post traumatic inflammation, myelin damage and intraneural hematoma. (*Ganesh A, Rose JB, Well L, et al. Continuous peripheral nerve blockade for inpatient and outpatient postoperative analgesia in children. Anesth Analg. 2007;105:1234–42*). Resistance to injection increases with smaller gauge needles. Echogenic needles reflect ultrasound beams with a special coating that traps micro air bubbles, grooves near the needle tip, echogenic dots made by cornerstone reflectors. (*Abbal B, Choquet O, Gourari A, et al. Enhanced visual acuity with echogenic needles in ultrasound guided axillary brachial plexus block: a randomised comparative observer blinded study. Minerva Anesthesiol. 2015;81:369–79*). Perineural catheters are associated with leakage and migration. (*Tsui BC, Tsui J. Less leakage and dislodgement with a catheter over needle versus a catheter through needle approach for peripheral nerve block: an ex vivo study. Can J Anaesth. 2012;59:655–61*). Advantages of catheter over needle includes:
   - Simple to insert.
   - Less leakage.
   - Less risk of depressing disruption.
   - Less risk of dislodgement.
   - Easy visualisation of catheter tip

   (*Tsui BC, Ip VH. Catheter over needle method reduces risk of perineural catheter dislocation. Br J Anaesth. 2014;112:759–60*).
2. T F F F T
   Peripheral nerve stimulators have the ability to produce constant current output in the presence of varied resistance. Short pulse width (0.04 ms) is better indicator of the distance between the nerve and the needle. It also has a role in electrical epidural stimulation test.

   Pulse width used for different spaces:

0.1 ms	Motor nerve
0.2 ms	Intrathecal space
1 ms	Epidural space

   Cathode is selected as stimulating electrode as it is 3–4 times more effective than anode at depolarising the nerve membrane. Mostly a frequency of 2 Hz should be used for nerve localisation. Less than 1 Hz may miss the nerve.
3. F T F T T
   Toxicity from local; anaesthetics usually occurs within the first 30 min. (*Becker DE, ReedKL. Essentials of local anaesthetic pharmacology. Anesth Prog. 2006;53:98–108*). Less than 0.2 mA is suggestive of intraneural placement. (*Robards C, Hadzic A, Somasundaram L, et al. Intraneural injection with low current stimulation during popliteal sciatic nerve block. Anesth Analg. 2009;109:673–7*). Nerve stimulation alone lacks sensitivity. (*Chan VW, Brull*

R, McCartney CJ, et al. An ultrasonographic and histological study of intraneural injection and electrical stimulation in pigs. Anesth Analg. 2007;104:1281–4). Impedance is electrical resistance of the nerve stimulation circuit. It is highly sensitive to tissue composition and dependent on water content of tissues. Increase in impedance by more than 4% may indicate intraneural needle placement. (*Bardou P, Merle JC, Woilord JB, et al. Electrical impedance to detect accidental nerve puncture during ultrasound guided peripheral nerve blocks. Can J Anesth. 2013;60:253–8*). Electrical impedance changes with 5% dextrose. (*Chin J, Tsui BC. No change in impedance upon intravascular injection of D5W. Can J Anaesth. 2010;57:559–64*).

4. T F T T T

Even small volumes of local anaesthetic can contribute to nerve injury. (*Kapur E, Vuckovic I, Dilberonic F, et al. Neurologic and histologic outcome after intraneural injections of Lidocaine in canine sciatic nerves. Acta Anaesthesiol Scand. 2007;51:101–7*). Injury to nerves is a combination of breach in perineurium, interference with endoneural microcirculation and injury from chemicals. (*Myers RR, Kalichman MW, Reisner LS, et al. Neuroptoxicity of local anaesthetics: altered perineural permeability edema, nerve fiber injury. Anesthesiology. 1986;64:29–35*). Pressures more than 20 psi indicates intrafascicular injection. (*Gadsden J, Latmore M, Levine DM, et al. High opening injection pressure is associated with needle nerve and needle fascia contact during femoral nerve block. Reg Anesth Pain Med. 2016;41(1):50–5*). High injection pressures may cause neuraxial spread especially during lumbar plexus block or brachial plexus block. (*Orebaugh SL, Mukalel JJ, Krediet AC, et al. Brachial plexus root injection in a human cadaver model: injectate distribution and effects on the neuraxis. Reg Anesth Pain Med. 2012;37:525–9*). Skin temperature increases after a regional block which can be picked up by infrared thermal imaging. (*Asghar S, Lundstorm LH, Bjerregaard LS, et al. Ultrasound guided lateral infraclavicular block evaluated by infrared thermography and distal skin temperature. Acta Anesthesiol Scand. 2014;58:867–74*).

5. T T F T F

Continuous peripheral nerve blockade may have a haemostatic valve. This minimises the likelihood of needle movement, catheter misplacement and secondary block failure. (*Steele SM, Klein SM, D'Ercole FJ, et al. A new continuous catheter delivery system. Anesth Analg. 1998;87(1):228*). Multiorifice catheters provide better spread of local anaesthetic solution and increase analgesia. (*Fredrickson MJ, Ball CM, Dalgleish AJ. Catheter orifice configuration influences the effectiveness of continuous peripheral nerve blockade. Reg Anesth Pain Med. 2011;36(5):470–5*). Stimulating catheters helps in assessing proximity of the tip to the neural structures. (*Kick O, Blanche E, Pham-Dang C, et al. Continuous peripheral nerve blocks with stimulating catheters. Reg Anesth Pain Med. 2003;28(2):83–8*). Stimulating catheters is associated with decreased local anaesthetic consumption and decreased opioid requirements. (*Casati A, Fanelli G, Koscelniak-Nielson Z, et al. Using stimulating catheters for continuous sciatic nerve block shortens onset time of surgical block and minimises post opera-*

tive consumption of pain medicine after halux valgus repair as compared with conventional non stimulating catheters. Anesth Analg. 2005;101(4):1192–7).

6. F T F T F

Needle tip can come in contact with the nerve without a twitch and the needle can be in the nerve without a twitch at low current. Purulent discharge at catheter site warrants removal of the catheter.

7. F T T T T

Nerve stimulation requires low intensity (upto 5 mA) and short duration (0.05–1 ms) stimulus. Certain minimum current is necessary at a given pulse duration to reach threshold (Rheobase). Pulse duration at double the rheobase is called chronaxie. Electrical impulses with the duration of the chronaxy are most useful to elicit action potentials.

Chronaxy figures:

50–100 mics- Aα

170 mics Aδ

More than 400 mics is required for c fibers.

Transcutaneous nerve mapping provides sufficient current density and spatial discrimination which is not seen with large tips.

8. F T T F F

1 mA is mostly chosen for superficial nerves and 1.5–3 mA for deeper nerves. High current density can lead to direct muscle stimulation. High stimulating current can cause patient discomfort. Electrical impedance doubles (12.0–31 kΩ) from advancement from extraneural to intraneural position. (*Tsui BC. Electrical impedance to distinguish intraneural from extraneural needle placement in porcine nerves during direct exposure and ultrasound guidance. Anesthesiology. 2008;109:479–83*).

Desired properties of electrical nerve stimulation:

- Short pulse width: shorter pulse width stimulates only motor fibres thus sensory stimulation and resultant painful paraesthesia is not seen.
- Square wave current: avoids difficulty in nerve stimulation.
- Cathode stimulation: this leads to depolarisation while anode stimulation will cause hyperpolarisation.
- Constant current generator: same current is generated despite the resistance
- Frequency: Hz is preferred for easy manoeuvring of the needle.

9. T T T F T

5%d increases the impedance in perineural tissues. (*Tsui BC, Chin JH. Electrical impedance to intravascular needle placement. Abstract ASRA 2007. Reg Anesth Pain Med. 2007;32:A–51*). Normal stimulation is 1–2 Hz repetition whereas SENS uses 3 Hz stimulation. This allows the motor response to be observed even when moving the needle. (*Urmey WF, Grossi P. Use of sequential electrical nerve stimuli for location of the sciatic nerve and lumbar plexus. Reg Anesth Pain Med. 2006;31:463–9*). Injection of local anaesthetic or saline may increase threshold current significantly. 5%D should be used to avoid losing motor response. (*Tsui BC, Kropelin B. The electrpphysiological effect of dextrose 5% in water on single shot peripheral nerve stimulation.*

Anesth Analg. 2005;100:1837–9). Catheters are pliable and are unlikely to be inserted into a fascicle. (*Gadsden J, Latmore M, Levine DM, et al. High opening injection pressure is associated with needle nerve and needle fascia contact during femoral nerve block. Reg Anesth Pain Med. 2016;41:50–5*).

10. F T T F F

Negative current from cathode alters the resting membrane potential of the neuronal cell causing depolarisation causing action potential. Needles are covered with non conducting material which localises the current density to a sphere on the needle tip. Fascicle contains individual axons surrounded by endoneurium. Maximum damage is done when the solution is injected inside the fascicle. Perineurium surrounds fascicles. (*Moayeri N, Biegeleison PE, Groen GJ. Quantitative architecture of the brachial plexus and surrounding compartments and their possible significance for plexus blocks. Anesthesiology. 2008;108(2):299–304*).

Coulomb's law: describes the relation between distance and current intensity.

$I = \kappa (i/r^2)$

I = current required

K = constant

i = minimal current

r = distance from nerve.

Pulse Width: duration of the pulse enables selective stimulation of sensory or motor nerves. Motor nerves are better localised with shorter pulse width (50–150 μs).

Facts:

- Application of cathode depolarises the nerve while the anode hyperpolarises it.
- The total charge (Q) required to depolarise a nerve is the product of current intensity (I) and the duration (t) for which it is applied.
  $Q = I \times t$
- The current required to produce depolarisation:
  $I = Ir \times (1 + C/t)$
  Ir = rheobase (minimum current of indefinite duration required to depolarise a nerve)
  C = Chronaxie (minimum duration of current twice the rheobase). It is inversely proportional to fibre size.
- Nerve stimulation:
  - Negative (cathode) pole to needle.
  - Positive (anode) to patient.
  - Square wave impulse.
  - Frequency of 2 Hz.
  - Initial
  - Acceptable current is between 0.2 and 0.5 mA.
- Optimal range for peripherals nerve stimulation is 0–5 mA as high values may be required for diabetics, elderly and neurologic disease. Higher value (0–10 mA) is required for epidural stimulation.

Basics of Ultrasound

6

1. Ultrasound physics:
   (a) Most ultrasound machines are based on B-mode display.
   (b) The beam is generated by piezoelectric crystals.
   (c) Ultrasound beams have frequency less than 20 KHz.
   (d) High frequency waves are more useful for deep structures.
   (e) Speed of sound is low in fat as compared to soft tissues.
2. Ultrasound tissue interactions:
   (a) Transmission is 100% through the tissues.
   (b) Ultrasound image is caused due to reflection.
   (c) The maximum scatter seen in tissues is due to red blood cells.
   (d) Attenuation is due to the absorption by the tissues.
   (e) Refraction can be used to enhance image quality.
3. Ultrasound- basic functions:
   (a) Higher frequencies provide superior axial resolution.
   (b) Increasing the depth improves temporal resolution.
   (c) Increasing the gain increases the lateral resolution.
   (d) Time gain compensation allows brightness at different depths.
   (e) Focal zone is normally fixed for all depths.
4. Colour Doppler:
   (a) Facilitates identification of blood flow.
   (b) It is based on the principle of static frequency.
   (c) Can be used to detect direction of flow.
   (d) Increased Doppler sensitivity decreases motion artefacts.
   (e) Temporal resolution is reduced in Doppler mode.
5. Ultrasound imaging:
   (a) Phantoms can be used as simulator for training.
   (b) Time taken for beam to return back is independent of depth.
   (c) Impedance differences may enhance needle visualisation.
   (d) Gauge of the needle has no bearing on image enhancement.
   (e) Steep angle results in decreased needle visibility.

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6. Ultrasound imaging:
   (a) Pressure on one end of transducer can decrease image quality.
   (b) Echogenic needles can be picked with angles up to 30°.
   (c) Needle visibility can be improved by indentation or notches in the needle.
   (d) Polymer encasing increases needle echogenecity.
   (e) Low frequency generator at needle end improves needle visibility.
7. Ultrasound imaging:
   (a) Compound spatial imaging should be avoided to increase the image quality.
   (b) Frequency compound sonography improves needle quality image.
   (c) Higher frequency probes are used for spatial structures.
   (d) Harmonic imaging increases the ultrasound image.
   (e) Oblique plane treatment avoids side effects of in plane and out of plane techniques.
8. Ultrasound imaging:
   (a) Mechanical needle guides improve needle placement.
   (b) Needle visibility improves by 30%.
   (c) Poor ergonomics have a high error rate.
   (d) Enhancement decreases the visualisation of needle during procedure.
   (e) Priming the needle with water before insertion can decrease the enhancement.
9. Ultrasound:
   (a) Is associated with piezoelectric effect.
   (b) Increased acoustic pressure decreases the amplification.
   (c) Low frequency provides better axial and lateral resolution.
   (d) Temporal resolution is important for moving agents.
   (e) High frequency ultrasound can detect smaller objects.
10. Ultrasound image modes:
   (a) A-mode is mainly used for regional anaesthesia.
   (b) B-mode involves 100–300 elements of piezoelectric crystal.
   (c) Doppler shift is not seen with angle of 180°.
   (d) Power doppler is used to identify smaller blood vessels.
   (e) M-mode has negligible role in regional anaesthesia.
11. Ultrasound imaging:
   (a) Spatial resolution of 3D imaging is about 0.34–0.5 mm.
   (b) Time gain compensation is amplification independent of time.
   (c) Focus improves the spatial resolution on the plane of interest.
   (d) Ultrasound causes more heat production in bones than soft tissues.
   (e) Ultrasound usage is safe in pregnancy.
12. Ultrasound image:
   (a) Lower frequency transducer with doppler settings is used in major plexus.
   (b) Excess gain can increase image optimisation.
   (c) Doppler velocity is set at higher rate to reduce aliasing.
   (d) Gate size should be as small as possible to overlay area of interest.
   (e) Injection of air can increase the visualisation of catheter tip.

13. Ultrasound and artefacts:
    (a) Shadowing is seen because of reflection of ultrasound waves.
    (b) Enhancement is seen in solid structures.
    (c) Reverberation is eliminated with the change in scanning direction.
    (d) Duplicated image in mirror artefact is always less bright.
    (e) Velocity error is the result of difference in velocity of human soft tissue.
14. Ultrasound;
    (a) Speed of sound is inversely related to the frequency.
    (b) Speed of ultrasound in tissues is 1540 m/s.
    (c) Coarse speckle is because of tissue parenchyma.
    (d) Compression wave of pure sinusoidal shape has one frequency component.
    (e) Resonance is used as diagnostic tool.
15. Ultrasound imaging:
    (a) Linear array is most commonly employed in musculoskeletal tissue.
    (b) B-mode imaging uses long length waves.
    (c) M-mode imaging is helpful in establishing fine temporal detail.
    (d) Maximum reflection is seen at soft tissue air interface.
    (e) Scattering and beam divergence are frequency dependent.
16. Ultrasound imaging:
    (a) Bone causes maximum attenuation of the pulses.
    (b) Harmonic imaging improves image detail.
    (c) Elastography property has been used to investigate deep structures.
    (d) Size of doppler shift is inversely related to the size of the velocity of the motion.
    (e) Double doppler effect is seen when the object moves towards the transducer.
17. Doppler techniques:
    (a) Doppler effect relates to a change in observed frequency.
    (b) Basic pulsed wave doppler uses array of crystals.
    (c) Echo signals takes less time in doppler imaging than in B-mode imaging.
    (d) Doppler tissue imaging can only be used for cardiac muscle.
    (e) Axial resolution depends on the length of the transmitted ultrasound pulse.
18. Ultrasound resolution:
    (a) Axial resolution is better produced at higher frequency.
    (b) Contrast resolution is poor.
    (c) Temporal resolution is improved by high frame rates.
    (d) M- Mode imaging has better temporal resolution than B mode.
    (e) Velocity resolution is 105 in colour image.
19. Ultrasound transducers:
    (a) Temperature can turn material into piezoelectric properties.
    (b) Waves produced are a result of interference of a single wavelet.
    (c) Reflection gets stronger with more impedance notch.
    (d) Damping material serves to shorten the length of pulse.
    (e) Curved sequenced array is used in vascular imaging.

20. Ultrasound resolution:
    (a) Axial resolution relates to difference between two dots horizontally.
    (b) Lateral resolution relates to the length of the beam.
    (c) Contrast resolution differentiates between colours.
    (d) Temporal resolution displays structures in real time.
    (e) Higher line density worsens temporal resolution.
21. Ultrasound display modes:
    (a) A-mode generates high resolution image.
    (b) B-mode can differentiate tissues on basis of their reflection.
    (c) M-mode is related to time.
    (d) M-mode is dependent on range equation.
    (e) Frequency and amplitude are inter-related.
22. Ultrasound physics:
    (a) Increased output power is detrimental to ultrasound image.
    (b) Harmonic signals may increase reverberation artefact.
    (c) Gain increases the strength of all the returning echoes.
    (d) Time gain compensation works by increasing the brightness of proximal echoes.
    (e) Comet tail is a reverberation artefact.
23. Ultrasound image:
    (a) Echo amplitude and target spatial position are essential for image formation.
    (b) Anisotropy is due to hyperechogenicity.
    (c) Dynamic range adjustment is inversely proportional to contrast resolution.
    (d) Angle of insonation is critical in estimating correct velocity of the vessel.
    (e) Flow parameters determine flow resistance in the vascular system.
24. Doppler ultrasound:
    (a) Continuous wave doppler gives information about velocity of blood flow.
    (b) Pulsed wave doppler can detect depth.
    (c) Duplex scanner is a variation of pulsed wave doppler.
    (d) Aliasing is related to repeated pulsing frequency.
    (e) Colour doppler is optimised at an angle more than 60° with respect to the vessel.
25. Sonoelastography:
    (a) Fluids exhibit volume elasticity.
    (b) Viscoelastic fluids do not exhibit elasticity.
    (c) Higher modulus means material is easy to deform.
    (d) Young's modulus describes the response to linear stress.
    (e) Elastography assesses tissue stiffness.

Answers

1. T T F F T
   B-mode is brightness mode that involves transmitting small pulses of ultrasound echo from a transducer into the body. The crystals in transducer are

interconnected electrically and vibrate in response to applied electric current. Ultrasound works on a frequency more than 20 KHz which exceeds audible human hearing. (*Lawrence JP. Physics and instrumentation of ultrasound. Crit Care Med. 2007;35:S314–22*). High frequency waves generate images of high axial resolution. They are attenuated more than lower frequency for a given distance, hence suitable for superficial structures. Speed of sound in fat is 1450 m/s while in soft tissues, it is 1540 m/s (Table 6.1).

2. F T T T T
   The energy transmission through the tissues is partial. Some of the energy continues in the body while some waves are reflected. Scattering is due to the reflected signal which reaches the transmitter is weaker than the transmitted one (40–60 db less). Attenuation is the decreasing intensity of a sound wave as it passes through a medium. It is seen due to absorption, reflection and scattering. Refraction is the change in the direction of sound transmission after hitting an interface of two tissues with different velocity coefficients. Tyhis can give rise to duplication artefacts. (*Middleton W, Kurtz A, Hertzberg B. Practical physics. In: Ultrasound, the requisities. 2nd ed. St Louis, MO: Mosby;2004. p. 3027*).
3. T F F T F
   Higher frequencies enable differentiation between structures lying closer to each other at different depths. They are best for depths up to 3–4 cm. Temporal resolution improves in decreasing the depth. Ultrasound machines preserve temporal resolution by reducing the width of the sector beam. Gain dictates how bright or dark the image appears. Lateral resolution is the ability to distinguish objects side by side. The gain is divided into near and far gains and helps in brightness of structures. The ultrasound beam converges to focal zone and then diverges to fraunhofer zone as it diverges.
4. T F T F T
   Colour Doppler identifies velocity and direction of blood flow. If a sound wave is emitted from a stationary transducer and reflected by a moving object, the frequency of the reflected sound will change. Doppler equation:
   Frequency shift = (2vfi)(cosine)/c
   V = velocity of moving object.
   Fi = transmitted frequency
   α = angle of incidence
   c = speed of ultrasound in blood
   Motion artefacts are increased created by patient movement. Temporal resolution is reduced in doppler mode as more time is required to process returning echoes compared to single B-mode imaging.

Table 6.1 Ultrasound frequencies

Frequency range (Hz)	Designation	Examples
16 Hz–20 KHz	Audible sound	Speed
20 KHz–10 GHz	Ultrasound	Dolphins
1 MHz–20 MHz	Medical ultrasound	Ultrasound imaging

5. T F T F T
   High fidelity phantoms can act as a cadaver specimen and low fidelity phantom can represent a water bath. (*Tsui B, Dillane D, Pillay J, et al. Ultrasound imaging in cadavers: training in imaging for regional blockade at the trunk. Can J Anesth. 2008;55(2):105–11*). The time taken for an ultrasound acoustic beam to return back to the ultrasound probe is proportional to depth. This is termed pulse-echo principle. Large gauge needles have a greater surface area that produces more significant change in acoustic impedance and result in brighter image. (*Schafhatter-Zoppoth I, McCulloch CE, Gray AT. Ultrasound visibility of needles used for regional nerve block: an in vitro study. Reg Anesth Pain Med. 2004; 29(5):480–8*). Acute angle in relation to ultrasound probe leads to small portion of uoltrasound beam reflected back thus decreasing visibility.
6. F T T T T
   Pressure or tilting the opposite end of transducer probe decreases the distance between needle and probe and increase the image quality. (Heel in manoeuvre). (*Chin KJ, Perlas A, Chan VW, et al. Needle visualisation in ultrasound guided regional anesthesia: challenges and solutions. Reg Anesth Pain Med. 2008;33(6):532–44*). Optimum needle angle requirement is up to 45°. Echogenic needles can be picked up at an angle of 30°. (*Nichols K, Wright LB, Spencer T, et al. Changes in ultrasonographic echogenicity and visibility of needles with changes in angles of insonation. J Vasc Interv Radiol. 2003;14(12):1553–7*). Needle visibility can be improved by indentation or notches but is at the cost of decreased needle movements because of more friction at needle tissue interface. (*Deam RK, Kluger R, Barrington MJ, et al. Investigation of a new echogenic needle for use with ultrasound peripheral nerve blocks. Anesth Intensive Care. 2007;35(4):582–6*). Polymeric needle coating is treated with bubbling agent creating micro bubbles on the needle shaft surface causing an increase in acoustic impedances. (*Culp WC, McCowan TC, Guertzen TC, et al. Relative ultrasonographic echogenecity of standard, dimpled and polymeric coated needles. J Vasc Interv Radiol. 2000;11(3):351–8*). Large amplitude vibrations are created along the needle shaft increasing visibility. (*Simonetti F. A guided wave technique for needle biopsy under ultrasound guidance. Proc SPIE. 2009;7261:726118*).
7. F F T T T
   Compound spatial imaging combines more than three different steering angles into a single frame. It allows greater clarity, resolution and better needle definition. (*Cheung S, Rohling R. Enhancement of needle visibility in ultrasound guided percutaneous procedures. Ultrasound Med Biol. 2004;30(5):617–24*). Frequency compound sonography obtains scans from several different frequencies which are averaged to reduce speckle and graining appearance. This improves anatomical but not needle image. (*Mesurolle B, Bining HJ, El Khoury M, et al. Contribution of tissue harmonic imaging and frequency compound imaging in interventional breast sonography. J Ultrasound Med. 2006;25(7):845–55*). Most commonly used probe frequencies include 5–10 MHz and provides good imaging at depths 1–5 cm. 2–5 MHz is used for deeper structures while up

to 18 MHz is used for superficial structures. (*Ricci S, Moro L, Antonel Li Incalzi R. Ultrasound imaging of the sural nerve: ultrasound anatomy and rationale for investigation. Eur J Vasc Endovasc Surg. 2010;39(5):636–41*). Harmonic imaging involves low frequency high amplitude noise to improve ultrasound image. (*Yen CL, Jeng CM, Tang SS. The benefits of comparing conventional sonography, tissue harmonic sonography, and tissue harmonic compound sonography of hepatic lesions. Clin Imaging. 2008;32(1):11–15*).

8. T T T F F
   Mechanical needle along with the laser guide device improves needle placement. Needle guides improves visibility by 30%. (*Wang AZ, Zhang WX, Jiang W. A needle can facilitate visualisation of needle passage in ultrasound guided nerve blocks. J Clin Anesth. 2009;21(3):230–2*). Poor ergonomics have a high error rate op to 10%. Enhancement increases the visualisation of needle procedure. Priming the needle with water can increase enhancement. (*Chapman GA, Johnson D, Bodenham AR. Visualisation of needle position during ultrasonography. Anaesthesia. 2006;61(2):148–58*).
9. T F F T T
   Piezoelectric effect is the phenomenon exhibited by the generation of electric charge in response to a mechanical force applied on certain materials. Ultrasound waves have a self focussing effect, which refers to natural narrowing of the ultrasound beam at a certain level distance. It is the transition between near and far field. Self focussing effect amplifies ultrasound signal by increased acoustic pressure. Axial resolution is the minimum separation of above below planes along the beam axis. Lateral resolution is the sharpness to describe the minimum side by side distance between two subjects. Both resolutions are dependent on higher frequencies to get better resolution. Imaging resolution is compromised by increasing the frame rate optimising the ratio of resolution to the frame rate, which is essential for best possible image.
10. F T F T T
    A mode provides little information on the spatial relations ship of imaged structures, so is not applicable in regional anaesthesia. One element of crystal is seen in A-mode. B-mode can provide an image of a cross section. Largest doppler shift is detected at an angle of 18–0° but no shift is seen at 90°. M-mode is used extensively in cardiac and foetal cardiac imaging.
11. T F T T T
    Gain is the ratio of output to input electric power; it controls the brightness of the image. Time gain compensation is time dependent. It can be used to increase the amplitude of incoming signals from various tissue depths. There are two types of focussing—annular and linear. Spatial resolution is improved as beam width is converged. Generation of heat is increased in tissues with the usage of ultrasound and is seen more with the increase in frequencies. Ultrasound is safe for usage in pregnancy in humans though undesirable side effects like foetal height reduction, foetal abnormalities, blood flow stasis, abnormality in B-cell development are seen. (*Kerny BG, Robertson VJ, Duck FA. A review of therapeutic ultrasound: biophysical effects. Phys Ther. 2001;81:1351–8*).

12. T F F T T
Lower frequency transducer is used for identification of vasculature close to lumbar plexus in obese patients. Excess gain can cause blurring of tissue boundaries. Doppler velocity is set at 15 and 35 cm/s to reduce aliasing. Small gate size excludes distractive signals from adjacent tissues but can also improve temporal resolution by increased frame rate. Injection of air can increase the visualisation of catheter tip at the expense of degrading the image.
13. T F T T T
Shadowing may interfere with nerve visualisation in regional anaesthesia. Enhancement manifests as overly intense echogenicity behind an object (fluid filled structure such as vessel or cyst). Scanning from different angles may help decrease shadowing. Mirror image artefact results from an object located on one side of highly reflective linear boundary that acts like a mirror.
14. F T F T T
Speed of sound is directly related to frequency.
$C = f - \lambda$
C = speed of sound
f = frequency
λ = wave length

Speed of ultrasound in tissues (m/s)	
Blood	1457
Water	1480
Fat	1450
Liver	1550
Muscle	1580
Skin	1600
Cartilage	1660
Tendon	1750
Bone	3600
Soft tissue	1540

Speckled pattern is due to fluctuant signal at transducer. True speckle is due to small parenchyma tissue structures and coarse speckle is due to small blood vessels or muscle fibers. Compression wave of pure sinusoidal shape has one frequency component and is called Fourier component. Resonance happens when wave bounces within a structure which can cause build up of wave amplitude due to interference. It can be used to improve detection of contrast agent in blood.
15. T F T T T
B mode imaging uses short length of 0.5 mm and frequency used is 10 MHz.
The reflection coefficients seen are:

Fat/muscle	1.1
Muscle/blood	0.1
Bone/fat	48.9

Bone/muscle	41.2
Soft tissue/water	0.2
Soft tissue/air	99.9

16. T T F F T
Thickness of tissues required to decrease intensity by half:

Blood	20
Water	140
Fat	5
Tendon	1.5
Muscle	1.5
Bone	0.2
Soft tissue	4

Elastography is used to investigate superficial structures. Elastic measure is called the shear modulus and measured in pascals. Size of doppler shift is directly related to the velocity of the motion.

17. T F F F T
Doppler effect is the change in the observed frequency of a wave due to motion of the source of the wave or the observer. Size of doppler shift is directly related to the size of the velocity of motion. Basic pulsed wave doppler uses one crystal and used for transcranial examinations. Frame rates are slower in colour doppler (15) as compared to B-mode (100). With tissues, the echo signals are stronger and the speeds lower and thus visualisation is enhanced. Doppler tissue is used for imaging myocardial muscles and other muscle and tissues. Axial resolution is the smallest separation of two targets lying along the beam axis for which individual echoes can be seen.

18. T T F T T
Higher frequencies produce better axial and lateral resolution. Contrast resolution is the smallest change in echo signal level that can be detected between regions in an image. Contrast resolution is normally poor (up to 20%). Temporal resolution is the smallest separation in time for which two events can be identified separately.

19. T F F T F
Curie point is around 328–365° and is the temperature at which material will obtain piezoelectric properties. Huygen's principle-waves are created as a result of interference of many wavelets produced at the face of the transducer. Reflection gets stronger with more impedance mismatch. Backing material or damping material provides damping of the piezoelectric material. It shortens the length of the pulse by decreasing the number of cycles in the pulse. Linear sequenced array is used in vascular imaging.

20. T F F T T
Lateral resolution relates to the width of the beam. Contrast resolution differentiates one shade of grey from another. Line density is the space between the scan lines. It affects frame rate.

21. F T T F F
A-mode only generates a set of spikes representing the amplitude of reflectory and their depth. It is used in ophthalmology. Brightness mode picks up the dots and gives bright dots. The reflectors may be hyperechoic (white), dark shade of grey (hypoechoic) and anechoic (black). M-mode image is B-mode scan line represented over time. Range equation determines the time it takes for the sound to reach reflector and its return. Frequency and amplitude are unrelated.
22. F F T F T
Increased output power has many advantages: higher amplitude return echoes for a better signal to noise ratio and improved depth penetration. Harmonic signals are multiples of the fundamental frequency. Narrow harmonic signal improves lateral resolution. Signal strength decreases because of attenuation, therefore the echoes farther away are weaker. TGC increases the brightness of distant echoes.
23. T F T T T
Echo amplitude is coded into stages of grey. Anisotropy is due to loss of echogenicity in structure. If angle is correctly adjusted under 60°, the spectrum is better delineated. When the angle is greater than 60°, there is spectral broadening. Flow parameters include resistive index (RI) and pulsatility index (PI).
RI = maxV−minV/maxV = S−D/S
PI = maxV−minV/Mean V = S−D/mean
MaxV—maximum velocity
minV—minimum velocity
S—systole
D—Diastole
24. F T T T F
Continuous wave doppler helps in detection of blood flow but does not give any information about direction, depth and velocity of flow. Pulsed wave doppler detects depth by measuring transit time. Duplex scan is obtained when pulsed wave doppler is combined with 2D, real time, B mode scanner. Repeated pulsing frequency (PRF) is the number of pulses per unit of time that is transmitted to the blood vessel. PRF scale is too long relative to the velocity of blood flow, aliasing is seen. Colour Doppler is seen when ultrasound beam is set at an angle less than 60° with respect to the vessel.
25. T F F T T
Elasticity is the property to resume its original shape and size after a deforming force. Viscoelastic fluids exhibit elasticity under certain conditions. Higher modulus means material is harder to deform.
Young, modulus:
E = S/e
S—Stress
e—Strain

Terminology
Sound: form of energy. Period: time for sound wave to complete one cycle. Wavelength: length of space over which one cycle occurs. Frequency: number of cycles repeated per second. Acoustic velocity: speed at which sound waves travel through the media. Acoustic variables: changes that occur within a medium as a result of sound travelling through that medium. Period: time it takes for one cycle to occur. Frequency; number of cycles/second. Propagation speed: speed at which a sound wave travels through a medium. Wavelength: length of a single cycle is called the wavelength. If frequency increases, wavelength decreases and vice versa. Amplitude: defined as the maximum or minimum deviation of an acoustic variable from the average value of that variable. Power: rate at which work is performed or energy is transmitted. Intensity: power of the wave divided by the area over which it is spread or the energy/unit area. Impedance: resistance to the propagation of sound through the medium. It depends on density and propagation speed of the medium. Piezoelectric materials: consists of some form of lead zirconate titanate. It operates on the principal of piezoelectricity. Pressure is created when voltage is applied to the material and electricity is created when pressure is applied to the material. Pulse repetition frequency (PRF): the number of pulses of sound produced in 1 s with units of KHz. As the image depth increases, PRF decreases and as the depth decreases, the PRF increases. Pulse repetition period: time taken for a pulse to occur. It is inversely related to the frequency of the pulse. Spatial pulse length: length of a pulse which depends on the wavelength of each cycle and the number of cycles in each pulse. Attenuation: decrease in the amplitude and intensity of the sound beam as sound travels through tissues. The mechanisms involved are absorption, reflection and scattering. Absorption is the greatest contributor. Specular reflection: size of reflection is larger than the wave length of the incident beam. The reflection is to the angle of 90°. Non specular reflectors are the ones in which their size is smaller than the wave length of the incident beam. Extremely small reflectors like rbcs are Rayleigh scatters.

Upper Extremity

7

1. Cervical plexus:
   (a) Is formed from ventral rami of upper four cervical nerves.
   (b) Superficial branches are motor.
   (c) There is no input from sympathetic ganglion.
   (d) Ansa cervicalis branches supply muscles.
   (e) Ansa cervicalis supply all infrahyoid muscles.
2. Cervical plexus:
   (a) Transverse nerve of the neck is purely sensory.
   (b) Greater occipital nerve is a part of cervical plexus.
   (c) Supraclavicular nerves are purely sensory.
   (d) Supra-acromial branch block causes complete anaesthesia of the shoulder.
   (e) Phrenic nerve arises from C4 only.
3. Cervical plexus block:
   (a) Superficial cervical plexus block is not required for shoulder surgery.
   (b) Anatomical landmarks for nerve injection are 2–3 cm above clavicle.
   (c) Can be used for carotid endarterectomy.
   (d) Deep cervical plexus involves four injections 1.5 cm apart.
   (e) Horner syndrome is a known complication.
4. Ultrasound guided cervical plexus block:
   (a) Sternocleidomastoid forms the roof over superficial cervical plexus.
   (b) Nerves are visualised as hypo echoic structures.
   (c) Local anaesthetic infiltration may involve trigeminal nerve.
   (d) The plane for injection visualised on ultrasound is below the prevertebral fascia.
   (e) Large volume is required for effective block.
5. Brachial plexus:
   (a) Is derived from C5-C8 dorsal rami.
   (b) Dorsal scapular nerve arises from the upper trunk.
   (c) C5 and T1 rami are the target.

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(d) Blood supply is from subclavian and vertebral artery.
(e) Upper trunk is formed by C5 and C6.

6. Brachial plexus:
   (a) Trunk divides into anterior and posterior divisions.
   (b) Axillary artery lies anterior to the three cords.
   (c) Axillary nerve is purely sensory.
   (d) Radial nerve is the largest nerve in the upper limb.
   (e) Radial nerve is the most commonly damaged.
7. Brachial plexus:
   (a) Anatomical snuff box is supplied by six radial nerve.
   (b) Median nerve is formed by union of lateral and medial root.
   (c) Ulnar nerve is continuation of the medial cord.
   (d) Musculocutaneous nerve is purely sensory.
   (e) Suprascapular nerve arises from the upper trunk.
8. Brachial plexus:
   (a) Posterior interosseous nerve is not associated with any cutaneous sensory loss.
   (b) Injury in axilla can cause paralysis of all the three heads of triceps.
   (c) Musculocutaneous nerve injury causes loss of elbow flexion.
   (d) Deep branch of ulnar nerve does not have cutaneous sensation.
   (e) Tinel's sign is specific to ulnar nerve.
9. Brachial plexus injuries:
   (a) Lower segment of plexus is mostly involved in trauma.
   (b) C7 paresis is restricted for finger flexion only.
   (c) Klumpke's paresis is due to lower plexus involvement.
   (d) Root avulsions are painless.
   (e) Demyelinating injuries have more favourable prognosis.
10. Brachial plexus injuries:
    (a) Upper segment is susceptible to inflammation injuries.
    (b) Adson test is diagnostic of compression syndromes.
    (c) Pancoasts tumour presents in radial aspect of hand and forearm.
    (d) Diabetes increases the severity.
    (e) Radiation induced damage develops within days.
11. Brachial plexus:
    (a) Long thoracic nerve involvement causes winging of scapula.
    (b) Dorsal scapular nerve is purely sensory.
    (c) Nerve to subclavius gets contribution from phrenic nerve.
    (d) Suprascapular nerve injury can mimic as rupture of the rotator cuff.
    (e) Phrenic nerve gets contribution from brachial plexus.
12. Brachial plexus:
    (a) Axillary nerve supplies skin over the shoulder.
    (b) Musculocutaneous nerve has no sensory innervation.
    (c) Radial nerve supplies hand extensors.
    (d) Triceps muscle is paralysed with fracture of humeral shaft.
    (e) Supinator syndrome causes pure motor deficit.

13. Brachial plexus:
    (a) Ulnar nerve supplies ulnar flexors.
    (b) Isolated hand paresis indicates lesion in the upper arm.
    (c) Ulnar groove is the most common site of injury.
    (d) Median nerve supplies the wrist joint.
    (e) Carpal tunnel syndrome is due to involvement of median nerve.
14. Brachial plexus:
    (a) Spinal nerve roots lie anterior to vertebral artery.
    (b) Dorsal rami are not a part of the brachial plexus.
    (c) Supplies all the muscles of upper extremity.
    (d) There is no sympathetic contribution.
    (e) Roots for the plexus descend over the first rib.
15. Brachial plexus:
    (a) Is formed in the posterior cervical triangle.
    (b) Erb's point is at the junction of C8T1.
    (c) Cords are based on their anatomic relationship to the axillary artery.
    (d) Major contribution to phrenic nerve is from C4.
    (e) Clavipectoral fascia is pierced by medial pectoral nerve.
16. Cords of brachial plexus:
    (a) Musculocutaneous nerve innervates coraco-brachialis and biceps brachii.
    (b) Medial pectoral nerve innervates pectoralis major muscle.
    (c) Teres major muscle is supplied by both upper and lower subscapular nerve.
    (d) Thoracodorsal nerve supplies latissimus dorsi.
    (e) Axillary nerve has no sensory supply.
17. Cords of brachial plexus:
    (a) Lateral cord does not give rise to any of the peripheral nerves.
    (b) Radial nerve may be compressed between muscles.
    (c) Ulnar nerve does not supply any forearm muscles.
    (d) Ulnar nerve may get compressed at the elbow.
    (e) Median nerve is mostly sensory at wrist.
18. Brachial plexus:
    (a) Median nerve is medial to the brachial artery at the level of supracondylar process.
    (b) Median nerve lies underneath the deep head of pronater teres.
    (c) Flexor pollicis longus can cause median nerve compression.
    (d) Anterior interosseous nerve compression can cause sensory neuropathy.
    (e) Injury of median or ulnar nerve in forearm is never complete.
19. Brachial plexus, Tomographic anatomy:
    (a) Superficial cervical fascia splits to enclose sternocleidomastoid.
    (b) Sternocleidomastoid is supplied by the accessory nerve only.
    (c) Omohyoid contraction increases neck blood flow.
    (d) Deltoid muscle twitch is important during brachial plexus block for shoulder surgery.
    (e) Rotator cuff includes three muscles.

20. Interscalene plexus block:
    (a) Can be used for clavicle surgery.
    (b) Involves all the trunks.
    (c) Vascular structures lie superficial to prevertebral fascia.
    (d) Scalene muscles are visualised more caudal than the landmark.
    (e) Targets for interscalene blockade are relatively hypoechoic.
21. Interscalene brachial plexus block:
    (a) Phrenic nerve is hyperechoic.
    (b) Phrenic nerve palsy is often seen.
    (c) Ultrasound guidance does not prevent phrenic nerve palsy.
    (d) Sympathetic block is not seen.
    (e) Permanent Phrenic nerve paralysis is a recognised complication.
22. Supraclavicular brachial plexus block:
    (a) Labat technique causes total shoulder block.
    (b) Kulenkampeff technique uses subclavian artery as the landmark.
    (c) Pneumothorax is not a complication with Bonica and Moore's technique.
    (d) Intercostobrachial plexus block is necessary for usage of tourniquet.
    (e) Moorthy's technique avoids Pneumothorax.
23. Parascalene brachial plexus block technique:
    (a) Kappis technique uses transverse process technique.
    (b) Pippa's technique involves space between C6-C7.
    (c) Plumb-bob technique has a low incidence of Pneumothorax.
    (d) Horner's syndrome is a complication of Winnie's technique.
    (e) Meier technique is helpful in compression of brachial plexus.
24. Brachial plexus block:
    (a) Dalens technique may miss ulnar nerve.
    (b) Middle interscalene block is the same as winnie's technique.
    (c) Dysphonia is one of the complications.
    (d) Pneumothorax is rare in middle interscalene approach.
    (e) Foraminal injury of nerves can occur in middle interscalene approach.
25. Ultrasound guided brachial plexus block:
    (a) Pure nerve tissue is anechoic.
    (b) Ultrasound helps in easily identifying roots from trunks.
    (c) C6 loops below the vertebral artery at its origin.
    (d) Nerve stimulator needle contact with needle always gives neuromuscular response.
    (e) Hydrolocalisation should be done with conductive solution.
26. Ultrasound guided brachial plexus block:
    (a) Air should be injected for adequate localisation of the nerve.
    (b) Out of plane approach is better for interscalene block than the in plane approach.
    (c) Catheter insertion is better in posterior approach.
    (d) Supraclavicular block is inadequate for hand surgery.
    (e) In plane approach is the preferred technique for supraclavicular block.

27. Ultrasound guided brachial plexus block:
    (a) Septa may delay the onset of the block.
    (b) Female patients are more prone to Pneumothorax.
    (c) Ultrasound can adequately localise the depth of pleura in supraclavicular block.
    (d) Short bevel needles are less damaging than long bevel needles.
    (e) Even trivial nerve injuries during nerve blocks need antibiotic management.
28. Complication with brachial plexus block:
    (a) Phrenic nerve is blocked almost always with high interscalene block.
    (b) Vascular injury is rare.
    (c) High spinal block is a complication.
    (d) Dextro rotatory form causes more cardiac disorders on injection.
    (e) Bezold-Jarisch syndrome responds to atropine.
29. Complications with brachial plexus block:
    (a) Horner's syndrome regresses within 6 h.
    (b) Ptosis is seen.
    (c) Enopthalmos is due to sympathetic block.
    (d) Dysphonia is due to sympathetic block.
    (e) Bronchospasm may be seen.
30. Infraclavicular brachial plexus block:
    (a) Bazy's technique involves needle insertion lateral to the coracoids process.
    (b) Raj's technique is needle insertion above the clavicle.
    (c) Borgeat's technique is a modification of Raj's technique.
    (d) Kilka's approach is perpendicular insertion of the needle.
    (e) Lower stimulation current has a higher success rate of successful blockade.
31. Infraclavicular brachial plexus block:
    (a) Distal contraction with stimulation of radial nerve achieves greater success rate.
    (b) Single stimulation is better than double stimulation for the success of the block.
    (c) Position of the upper limb is not important with ultrasound guidance.
    (d) Local anaesthetic deposition below subclavian artery/axillary artery ensures good blockade.
    (e) Lateral approach is preferred in patients unable to abduct the arm.
32. Ultrasound guided infraclavicular brachial plexus block:
    (a) Ropivicaine causes more motor blockade than L-bupivicaine.
    (b) Injecting small volumes around cords is better than injecting a large volume in total.
    (c) Ultrasound guidance totally eliminates the Pneumothorax.
    (d) Respiratory changes are not seen.
    (e) Median nerve is the most commonly involved in neurological damage.

33. Axillary brachial plexus block:
    (a) Is adequate for surgery below elbow.
    (b) Is adequate for tolerance of tourniquet induced pain.
    (c) Axillary block has better efficacy than mid humeral block.
    (d) Eliciting more paraesthesias improves the success rate.
    (e) Speed of local anaesthetic injection does not affect the final result.
34. Axillary brachial plexus block:
    (a) Loss of resistance technique aids in success.
    (b) Temperature of saline does not improve the success rate.
    (c) Single twitch stimulation has better success with radial than median nerve.
    (d) Single stimulation has similar efficacy as double stimulation.
    (e) Distal radial stimulation permits a better sensory block than proximal radial stimulation.
35. Axillary brachial plexus block:
    (a) Radial nerve is the most easy to visualise on ultrasound.
    (b) Musculocutaneous nerve is seen with in the coracobrachialis muscle.
    (c) Ultrasound guidance reduces block performance time.
    (d) Patient comfort is most during in plane block.
    (e) Nerve injuries are not seen.
36. Upper limb blocks distal to the axilla:
    (a) Mid humeral block is a plane infiltration block.
    (b) Median nerve block is done at the lateral border of biceps brachii muscle.
    (c) Radial nerve is located with extensor muscle contractions.
    (d) Ulnar nerve block at medial epicondyle can cause nerve damage.
    (e) Wrist block is done between flexor muscle tendons.
37. Intravenous regional anaesthesia:
    (a) Has a higher failure rate.
    (b) Works by direct effect on muscles.
    (c) Obesity is a contraindication.
    (d) Adjuvants can prolong the effect of blockade.
    (e) Major complications are not seen.
38. Intravenous regional anaesthesia:
    (a) Two phases are seen in anaesthesia.
    (b) Contraindicated in paediatric population.
    (c) Alkalinisation increases the sensory block.
    (d) Temperature sensation is lost before the touch sensation.
    (e) Complete recovery is fast with Prilocaine.
39. Pharmacology of intravenous regional anaesthesia:
    (a) Muscle relaxants are contraindicated.
    (b) Dexmedetomidine is better than clonidine.
    (c) Midazolam enhances analgesia through systemic effect.
    (d) Ketamine blocks sodium and potassium channels.
    (e) Tourniquet pain is more with double tourniquet.

40. Ultrasound guided interscalene brachial plexus block:
    (a) Brachial plexus is a deep block.
    (b) Supraclavicular branches are also blocked.
    (c) Head elevation improves the visualisation of brachial plexus.
    (d) High opening pressure (>15 psi) indicates needle root contact.
    (e) Needle insertion lateral to medial insertion of sternocleidomastoid prevents nerve injuries.
41. Ultrasound guided supraclavicular block:
    (a) Is adequate for surgery of upper limb distal to the shoulder.
    (b) Proximal part of the medial side of the arm is adequately blocked.
    (c) Lower volumes may be required in elderly population.
    (d) Pneumothorax is a delayed complication.
    (e) More risk of phrenic nerve palsy is seen.
42. Ultrasound guided infraclavicular brachial plexus block:
    (a) Is not ideal for catheter technique.
    (b) Cords are seen superficial to pectoralis minor.
    (c) Flexion of elbow enhances visualisation of pectoralis muscles.
    (d) Medial cord flexion is initially seen if nerve stimulation is used.
    (e) Injecting in 2–3 aliquots ensures better success rate of the block.
43. Ultrasound guided axillary nerve block:
    (a) Skin over deltoid muscle is not anaesthetised.
    (b) Ultrasound is the best way to block Musculocutaneous nerve.
    (c) Over abduction of the arm helps in visualising the plexus.
    (d) Musculocutaneous nerve is seen deep to artery.
    (e) Separate injection to Musculocutaneous nerve is always required.
44. Ultrasound guided blocks distal to elbow:
    (a) In association with proximal blocks improves consistency.
    (b) Radial nerve can be visualised superficial to triceps muscle in spiral groove.
    (c) Medial cutaneous nerve of the forearm requires additional block.
    (d) Complete local anaesthetic engulfing of nerve is required for adequate block under ultrasound.
    (e) Radial nerve is the easiest to block under ultrasound.
45. Ultrasound guided wrist block:
    (a) Median nerve is superficial in the wrist.
    (b) Median nerve is least anisotropic.
    (c) Ulnar nerve can be visualised medial to ulnar artery up to wrist.
    (d) Ultrasound is not useful for visualising radial nerve at the level of the wrist.
    (e) Wrist block gives complete anaesthesia of the entire hand.
46. Ultrasound guided interscalene block:
    (a) Distal roots are spared.
    (b) High frequency probe is used.
    (c) Traffic light sign is seen on ultrasound.
    (d) Out of plane approach is ideal.
    (e) Ultrasound is effective in decreasing the failure rate due to variation.

47. Ultrasound guided supraclavicular block:
    (a) Is done in prone position.
    (b) High frequency probe is required.
    (c) The plexus appears hyperechoic.
    (d) Out of plane approach is used.
    (e) Multiple injections between the plexus nerves increase the rapid onset of block.
48. Ultrasound guided infraclavicular block:
    (a) The infraclavicular plexus is visualised around the second part of axillary artery.
    (b) Is ideal for brachial plexus catheter insertion.
    (c) The ideal position for the block is adduction of the arm.
    (d) Low frequency probe is used.
    (e) Pneumothorax is a major complication.
49. Ultrasound guided axillary block:
    (a) Complete block is seen.
    (b) Low frequency probe is used.
    (c) Axillary artery is the main landmark visualised.
    (d) Musculocutaneous nerve is visualised in coracobrachialis muscle.
    (e) Axillary artery perforation is the main complication.
50. Ultrasound guided median nerve block:
    (a) Nerve can be visualised proximal to elbow crease.
    (b) Arm is abducted along with elbow extension for visualisation.
    (c) High frequency probe is used.
    (d) Nerve lies lateral to brachial artery.
    (e) In plane approach is used.
51. Ultrasound guided ulnar nerve block:
    (a) Block is done proximal to the ulnar groove.
    (b) Low frequency transducer is used.
    (c) In plane approach is used.
    (d) Nerve is deep to the muscles in the arm.
    (e) Nerve entrapment is a known complication.
52. Ultrasound guided radial nerve block:
    (a) Nerve is visualised lateral to the artery.
    (b) Proximal block requires arm abduction.
    (c) Nerve is visualised deep to the muscles in the arm.
    (d) In plane approach is used.
    (e) Arterial puncture is a complication.
53. Ultrasound guided supraclavicular nerve block:
    (a) The nerve is a branch of cervical plexus.
    (b) Has no sensory supply to the chest.
    (c) Is not required for shoulder surgery.
    (d) Interscalene block can cause blockade of the nerve.
    (e) Is located under paravertebral fascia under ultrasound.

54. Ultrasound guided interscalene block:
    (a) Ultrasound helps in detecting anomalies of the plexus thereby increasing success rate.
    (b) Best visualisation of the nerve is seen near the first rib.
    (c) Compact transducer is usually required.
    (d) Multiple injection technique improves the success rate.
    (e) Lateral approach as compared to medial approach increases the success rate.
55. Ultrasound guided infraclavicular nerve block:
    (a) Is ideally performed at the level of pectoralis minor muscle.
    (b) Infraclavicular block does not produce tourniquet tolerance.
    (c) Adduction of the arm helps in the blockade.
    (d) Dark stripe under the artery on long axis view is indication of successful block.
    (e) Proximal approach to second part of axillary artery is more successful for block.
56. Ultrasound guided axillary plexus block:
    (a) Radial nerve is the easiest branch to locate in axillary ultrasound approach.
    (b) Hyper abduction of the arm assists in the success of the block.
    (c) Local anaesthetic injection is done on front and back of axillary artery.
    (d) Intercostobrachial nerve originates from lower part of plexus.
    (e) Classic approach covers radial and Musculocutaneous nerve.
57. Ultrasound guided Musculocutaneous nerve blockade:
    (a) Has only sensory innervation.
    (b) The nerve exits by piercing the biceps muscle.
    (c) The location of the nerve within the muscle is ideal plane for the block.
    (d) Ultrasound helps in effective blockade in anatomical anomalies.
    (e) Lateral cutaneous nerve branch supplies palmer aspect of the thumb.
58. Ultrasound guided radial nerve block:
    (a) The nerve has “snake eyes” appearance on ultrasound.
    (b) It is the biggest nerve among median and Ulnar nerve.
    (c) Pronation of the arm helps in facilitation of the needle.
    (d) Nerve can be blocked with adequate volume infiltration in the fascial plane.
    (e) Superficial radial nerve joins the radial artery in the distal third of forearm.
59. Ultrasound guided median nerve block:
    (a) Palmer cutaneous branch is the largest branch.
    (b) Block should be performed with wrist hyperextension.
    (c) Brachial artery injury is a possibility in proximal blocks.
    (d) Persistent median artery cannot be visualised on ultrasound.
    (e) Nerve can be seen between flexor muscles.
60. Ultrasound guided ulnar nerve block:
    (a) The nerve lies on lateral side of the ulnar artery.
    (b) Terminal branches of ulnar nerve are not visualised on ultrasound.

(c) The ulnar nerve is a fascial plane block.
(d) Ulnar nerve lies deep to flexor muscles.
(e) High frequency linear probe is used.

Answers

1. T F F T F
Cervical plexus supplies neck muscles, diaphragm, areas of skin on the head, neck and chest. Superficial branches perforate cervical fascia to supply skin whereas deep branches supply muscles. The first four cervical ventral rami receive a grey ramus communication from superficial cervical sympathetic ganglion. Superficial root of ansa cervicalis leaves hypoglossal nerve, curves around the occipital artery and then descends in the carotid sheath. It joins inferior root from C2 and C3 and supplies sternohyoid, sternothyroid and inferior belly of omohyoid. Ansa cervicalis supply all infrahyoid muscles except thyrohyoid which is supplied by nerve to thyrohyoid muscle (Table 7.1).
2. F F T T F
Transverse nerve of neck arises from cervical plexus and supplies suprahyoid and infrahyoid muscles. Arnold's nerve (Greater Occipital nerve) is formed by posterior branch of C2 which does not contribute to cervical plexus. Supraclavicular nerves innervated sklin over supra and infraclavicular region as far as pectoralis major muscle. Supra-acromial branch arises from C4. Phrenic nerve gets contribution from C3, C4 and C5.

Superficial cervical plexus block relies on anaesthetic volume. Mostly the block is done at the posterior border of sternocleidomastoid muscle. Infiltration deep to posterior border will produce a block.

Deep Cervical Plexus Block: patient is positioned with neck extended and head turned away. A line is drawn between tip of the mastoid process and chassaignac's tubercle (transverse process of C6). Second line is drawn parallel and 1 cm posterior to the first line. 10-12mls of local anaesthetic is injected. Ultrasound can identify C4 transverse process. Local anaesthetic spread can be identified in paravertebral space.

Table 7.1 Components of cervical plexus

Cervical plexus		
Nerves	Spinal segments	Distribution
Ansa cervicalis	C1-C4	Sternothyroid, sternohyoid, omohyoid, geniohyoid, thyrohyoid
Lesser occipital, transverse cervical	C2-C3	Upper chest, shoulder
Phrenic nerve	C3-C5	Diaphragm
Cervical nerves	C1-C5	Levator scapulae, scalene, sternomastoid, trapezius

3. F T T T T
   Isolated nerve (supraclavicular nerve) is required for shoulder surgery. Anatomical landmarks are 2–3 cm above clavicle, posterior to sternocleidomastoid and superficial to deep cervical investing fascia. Superficial and deep cervical plexus block can provide analgesia for carotid endarterectomy. Deep cervical plexus block involves C2-C5, 105 cm apart in the groove of each transverse process. Local anaesthetic may spread superior in the direction of superior cervical ganglion and may cause Horner syndrome.
4. T T F F F
   Cervical plexus roots emerge from posterior border of sternocleidomastoid. The roots combine to form terminal branches lesser occipital, greater auricular, transverse cervical and supraclavicular nerves. Nerves are seen mostly deep to sternocleidomastoid but greater auricular nerve is visualised on the superficial surface of sternocleidomastoid. Cervical plexus block results in anaesthesia of skin of anterolateral neck, anteauricular and retroauricular areas. Mental, infraorbital and supraorbital nerves are from trigeminal nerve and not blocked. Cervical plexus may not be easily visualised. On ultrasound, infiltration is seen of local anaesthetic deep to sternocleidomastoid and superficial investing layer of deep cervical fascia and superficial to the prevertebral fascia. (*Dhonneur G, Saidi NE, Merle JC, et al. Demonstration of the spread of injectate with deep cervical plexus block: a case series. Reg Anesth Pain Med. 2007;32:116–19).* 5–10 mL of local anaesthetic is required for effective block. (*Saudeman DJ, Griffiths MJ, Lennox Af. Ultrasound guided deep cervical plexus block. Anesth Intensive Care. 2006;34:240–4).*
5. F F F T T
   The brachial plexus is derived from ventral rami of C5-T1. A branch from C4-C5 may innervate glenohumeral and elbow flexor muscles. Dorsal scapular nerve, long thoracic nerve and contribution to Phrenic nerves come from roots. Dorsal scapular nerve arises from C5 root and provides motor innervation to rhomboid muscles and levator scapula muscle. Long thoracic nerve arises from C5-C7 roots. It supplies serratus anterior muscle. Rami from C7 and C8 are largest (30,000 myelinated axons) while C5 and T1 are the smallest (15000–20000 myelinated axons). Upper trunk is formed by C5 and C6, middle trunk from C7 and lower trunk from C8-T1.
6. T T F T T
   Posterior division of the lower trunk may be absent in 10% of patients. Axillary nerve innervates teres minor and deltoid. It supplies skin on the lateral aspect of shoulder. Radial nerve arises from C5-T1 and is the terminal branch of the posterior cord. Radial nerve originates at the base of the skull and till it enters the spiral groove, its blood supply is precarious. The first 8–10 cm may not have a nutrient artery and is prone to injury.
7. T T T F T
   Anatomical snuff box is formed by tendons of external pollicis longus (medially), extensor pollicis brevis and abductor pollicis longus (laterally). It is most prominent during thumb extension. Floor is formed by trapezium and scaphoid.

The area is supplied by diorsal cutaneous branch of radial nerve. Median nerve is formed by union of lateral root (C6,7) and the medial root (C8,T1) when they meet anterior to the third part of axillary artery. Lateral root conveys most of the sympathetic fibres. Ulnar nerve passes through a canal (arcade of Struthers) formed by fascial sheath covering the medial head of triceps. It is derived from C7,8 T1. Musculocutaneous is derived from C567 and supplies coracobrachialis, biceps brachii and brachialis. Suprascpaular nerve arises from C56.

8. T T F T F
   Active medial and long heads and paralysis of lateral head is due to lesion in spiral groove. Musculocutaneous nerve injury does not involve brachioradialis which acts as a powerful flexor. Tinel's sign is not specific to Ulnar nerve but any motor nerve which is superficial. A tinel's sign that remains static at lesion suggests rupture of the nerve or spontaneous regeneration.
9. F F T F T
   Upper segment is affected from C5-C7. Motor deficit seen is more than sensory deficit. C7 paresis is associated with weakness of triceps, paresis of pectoral muscles and finger flexors. Klumpke's paresis is due to involvement of C8 and T1. Small muscles are involved and claw shaped deformity is seen. Sensory involvement is seen of the ulnar forearm. Root avulsions do not heal and may cause deafferentation pain.
10. T F F T F
    Inflammation injuries presents as plexus neuritis or Parsonage Turner syndrome. It involves shoulder and arm. Adson test is a provocative test associated with extension of arm with 30° abduction. The patient turns the head towards the affected side and takes a deep breath. The test is positive if there is marked decrease or disappearance of radial pulse. It is positive in 80%b of healthy subjects. Pancoasts tumour presents as severe pain in forearm including two ulnar fingers. Pancoasts tumour is seen when brachial carcinoma is located at the tip of the lung. Diabetes is associated with progressive and painless amyotrophy. Dosage of more than 6000 rads within a year causes tissue damage and can appear after a latency of weeks or years.
11. T F T T T
    Long thoracic nerve comprises of C567 and supplies serratus anterior. Normally serratus anterior pulls the scapula forward and its involvement can cause winging scapula. Dorsal scapular nerve arises from C5 and provides motor innervation to the rhomboid muscles and levator scapulae muscles. Nerve to subclavius arises from C56 (erb's point) and gets contribution from Phrenic nerve. It supplies subclavius which depresses shoulders. Suprascpaular nerve originates from C56 and supplies supraspinatus and infraspinatus muscles and shoulder joint. Phrenic nerve originates from C4 but gets contribution from C3 and C5.
12. T F T T T
    Axillary nerve arises from C56 and innervates deltoid muscle, teres minor muscle and skin over the shoulder. Musculocutaneous nerve arises from C5-C7. The motor supply is to brachial biceps and brachialis muscle. The sensory supply is to the skin of radial forearm up to the wrist (lateral antebrachial cutaneous

nerve). Radial nerve originates from C5-T1. It supplies long and short brachioradialis muscle and extensor carpi radialis muscle. Lesions above supinator canal causes foot drop. Supinator syndrome primarily affects finger extensors and drop hand is not seen.

13. T F T T T
Ulnar nerve originates from C8T1 and supplies ulnar flexors. It supplies the small muscles of the hand. Isolated hand paresis is due to lesion in the distal forearm with no sensory involvement. The hand takes the shape of a claw. Median nerve originates from C6-T1. It supplies pronator, flexor digitorium superficialis, flexor policis longus. It gives anterior interosseous nerve which supplies joint capsule, periosteum at the wrist and motor to flexor digitorium profundus, flexor policis longus and pronator quadrates. Anterior interosseus nerve can be irritated by strands of connective tissue below the pronator teres muscle (Kiloh-Nevin syndrome).
14. F T F F T
Spinal nerve roots lie posterior to vertebral artery. Dorsal rami supply motor function and sensation to posterior neck. Brachial plexus supplies all muscles except levator scapulae and trapezius which are supplied by CNXI and C34. Sympathetic contribution is from gray rami communicantes, middle cervical ganglion (C56), cervicothoracic ganglion (C78T1). Roots for the plexus descend over the first rib except T1 which ascends over the first rib.
15. T F T T F
Brachial plexus is bordered by trapezius muscle (posterior), sternocleidomastoid (anterior) and clavicle (inferior). Structures overlying the posterior triangle include skin, platysma muscle and deep fascia. Erb's point is at the level where C5 and C6 unite at the anterolateral surface of scaleneus medius muscle. Injury at this point is mostly seen during shoulder dystocia during a difficult birth. The injury presents as lower motor neurone involving suprascapular nerve, Musculocutaneous nerve and axillary nerve. The arm hangs by the side and is rotated medially with extension and pronation of the forearm (waiter's tip deformity). Phrenic nerve is formed from C345. It innervates the diaphragm after entering thorax. Clavipectoral fascia is pierced by cephalic vein, thoracolumbar artery and lateral pectoral nerve.
16. T T F T F
Musculocutaneous nerve arises from C4567 with contributions from C8 and T1 in 7% only. Medial pectoral nerve arises from medial cord in 70% of cases and contains fibres from C8T1 and rarely C7. Upper and lower subscapularis are derived from C56. Upper and lower subscapularis supplies subscapularis muscle. Teres major is supplied by lower subscapular nerve. Thoracodorsal nerve originates from C5678. Axillary nerve arises from C567. It passes to the posterior aspect of arm through quadrangular space. Its boundaries are: subscapularis and teres minor (superior), teres major (inferior), surgical neck of humerus (laterally) and long head of triceps brachii (medially). The sensory component is via its posterior terminal branch and supplies skin over the inferior portion of the deltoid.

17. F T F T T
Axillary and radial nerves arise from posterior cord. Musculocutaneous nerve arises from lateral cord. Cheiralgia Paraesthetica (Wartenberg syndrome involves symptomatic compression of superficial nerve of radial nerve between brachioradialis and extensor carpi radialis longus. Radial nerve arises from C5-C8 and supplies anconeus and triceps. Ulnar nerve arises from medial cord of brachial plexus (C78T1). It innervates flexor carpi ulnaris and flexor digitorium profundus. Ulnar nerve can get compressed at the following points:
- First rib
- Arcade of Struthers (fibrous canal near medial intramuscular septum).
- Internal brachial ligament (medial head of triceps).
- Anconeous epitrochlearis muscle (1–30%).
- Osborne's ligament (cubital tunnel).
- Flexor carpi ulnaris.

Median nerve is 95% sensory and 5% motor.

18. T F T F T
Median nerve is present in 1% of population and ligament of struthers joins supracondylar process to form a fibroosseous tunnel. The median nerve passes through it and is medial to brachial artery. Median nerve lies between deep and superficial head of the pronater teres. The nerve may be compressed at this point causing pain syndrome without motor/sensory findings (pronater syndrome). An anamolous muscle arises from medial humeral condyle and insert into flexor pollicus longus which is dorsal to anterior interosseous nerve and can cause compression. Motor compression syndrome with absent/weak motor function of flexor pollicis longus and flexor digitorium profundus. Injury is never complete due to communicating nerve between median and ulnar nerve (Martin-Gruber anastomosis). It is seen in 23% of patients and carries motor nerve fibers.

19. T F T T F
Superficial cervical fascia also includes superficial nerves which are mostly sensory except the nerve to platysma. Sternocleidomastoid is supplied by the accessory nerve and third cervical somatic nerve. Omohyoid is present partially behind the clavicle. Its contraction increases the radius of curvature of arch of clavicle. This increases the tension in middle cervical fascia, keeping the large veins open. Deltoid is supplied by axillary nerve (C56). Twitch is essential in addition to biceps and triceps muscle. Rotator cuff includes supraspinatus, infraspinatus, subscapularis and teres minor muscle.

20. T F T T T
Interscalene muscles can be used for clavicle surgery along with shoulder surgery. The block mainly involves upper (C56) and middle trunk (C7). Superficial cervical artery and vein and external jugular vein lie anterior to prevertebral fascia. (*Muhly WT, Orebaugh SL. Sonoanatomy of the vasculature at the supraclavicular and interscalene regions relevant for brachial plexus block. Acta Aanesthesiol Scand. 2011;55(10):1247–53).* Needle entry point is more cephaled and medial to landmark technique. There is decreased connective tissue at the level of interscalene level, thus structures appear at hypoechoic on ultrasound.

21. F T F F T
Phrenic nerve is a small hypoechoic structure anterior to interscalene muscle. (*Kessler J, et al. An ultrasound study of the phrenic nerve in the posterior cervical triangle: implications for the interscalene brachial plexus block. Reg Anesth Pain Med. 2008;33(6):545–50).* Phrenic nerve palsy may be seen due to local anaesthetic spread across the anterior surface of anterior scalene muscle and variation of phrenic nerve anatomy. (*Bigeleison PE. Anatomical variations of the phrenic nerve and its clinical implication for supraclavicular block. Br J Anaesth. 2003;91(6):916–7).* Ultrasound block prevents the phrenic nerve palsy as compared to landmark technique. (*Renes SH, Rettig HC, Gielen MJ, et al. Ultrasound guided low dose interscalene brachial plexus block reduces the incidence of hemi diaphragmatic paresis. Reg Anesth Pain Med. 2009;34(6):595–9).* Cervicothoracic sympathetic trunk lies postero lateral to prevertebral fascia anterior to longus colli muscle and can cause horner's syndrome. Permanent Phrenic nerve paralysis may be seen. (*Kaufman MR, et al. Surgical treatment of permanent diaphragm paralysis after interscalene nerve block for shoulder surgery. Anesthesiology. 2013;119(2):484–7).*

22. F T F T T
Labat's technique involves patient in supine position with the arm extended downside the body and shoulder lowered to bring brachial plexus closer to surface. Additional infiltration of subcutaneous clavicular border acromion and thoracic wall of axilla is required. In Kulenkampff's technique, patient is seated with head slightly towards the opposite side. Entry point is lateral to the pulse of subclavian artery, posterior to midpoint of the clavicle. The technique used by Bonica and Moore is similar to Kulenkampff's technique with the addition of two supplementary needles. Complications include Pneumothorax (0.5–4%), Phrenic nerve block (40–60%), horner's syndrome (70–90%). Usage of tourniquet requires the blockade of intercostobrachial nerve and medial cutaneous nerve of arm. In Moorthy's technique needle is directed laterally to the artery and does not come into contact with the first rib. The needle traverses a posterior path and avoids Pneumothorax. (*Moorthy SS, et al. A supraclavicular lateral paravascular approach for brachial plexus regional anesthesia. Anesth Analg. 1991;72:241–4).*

23. T T F F T
In Kappis technique, entry point is 3 cm lateral to the spinous process of C6. Articular process is reached and needle is slightly altered laterally to touch the transverse process and local anaesthetic is deposited. The landmarks for Pippa's technique include midpoint between C6-C7, 3 cm distal to mid point. The needle traverses trapezius muscle which is painful. (*Pippa P, et al. Brachial plexus using the posterior approach. Eur J Anaesth. 1990;7:411–20).* Boezaart's technique avoids this complication by inserting the needle anterior to trapezius. (*Boezaart AP, et al. Paravertebral approach to the brachial plexus: an anatomic improvement in technique. Reg Anesth Pain Med. 2003;28:241–4).* The plumb bob technique was described by David Brown (1993). Needle is inserted at the lateral edge of clavicular head of sternocleidomastoid muscle above the

clavicle. Complications include Pneumothorax (0.5–5%), Phrenic nerve blockade (50%), puncture of subclavian artery. (*Brown DL, et al. Supraclavicular nerve block: anatomic analysis of a method to prevent pneumothorax. Anesth Analg. 1993;76:530–34).* Winnie's technique involves needle insertion at C6 transverse process (Chassaignac's tubercle). Complications include Pneumothorax (rare), subarachnoid injection, Phrenic nerve, hematoma. Horner's syndrome is a side effect and not a complication. (*Winniw AP. Interscalene brachial plexus block. Anesth Analg. 1970;49:455–66).* Meier's technique involves insertion of the needle 2 cm above the intercricothyroid line and is directed caudal towards the midpoint of the clavicle. More useful in infection of the supraclavicular fossa, pancoasts tumour and fibrosis of scalene muscles.

24. T F T T T

Dalens parascalene technique is mostly used in children. The patient is supine and head turned to the other side. Landmarks include midpoint of clavicle, Chassaignac's tubercle. Ulnar nerve may be missed. (*Dalens B, et al. A new parascalene approach to the brachial plexus in children: comparison with supraclavicular approach. Anesth Analg. 1987;66:1264–71).* Winnie's technique is high interscalene block. The scalene angle is entered at its apex. Landmarks include pulse of subclavian artery, midpoint of clavicle, and spinous process of C7. Dysphonia is due to block of lower laryngeal nerve. Needle is directed towards the intervertebral foramen of C7 and may cause nerve injury.

25. T F F F F

Connective tissue surrounding the nerve (epineurium and Perineurium) appears hyperechoic. In the periphery, the nerve changes its structure to assume honey comb appearance. Ultrasound does not helps in differentiating roots from trunks. C6 is above the artery and the artery moves down and medial in relation to C7-C8. One third of neuromuscular stimulations are negative (*Perlas A, Niazi A, McCartney C, et al. The sensitivity of motor response to nerve stimulation and paraesthesia for nerve localisation as evaluated by ultrasound. Reg Anesth Pain Med. 2006;31(5):440–5).* Non conductive solution (5% glucose) should be used without interfering with the nerve stimulation.

26. F T T T T

Air injection may cause impaired visual access. Out of plane approach provides better anatomical approach to the interscalene groove with a shorter needle path. Catheter insertion in posterior approach courses through substantial layer of muscles (posterior scalene, middle scalene). Entry point for catheter is far from surgical field. Supraclavicular block is adequate for performing anaesthesia for distal part of humerus, elbow, forearm and hand. Subclavian artery is the landmark and is near to plexus. In plane approach avoids vascular injury or Pneumothorax.

27. T T F F T

Septa may be present with relative lack of communication between one compartment and the other. (*Thompson GE, Rovie DK. Functional anatomy of the*

brachial plexus sheaths. Anesthesiology. 1983;59:117–22). In females with asthenic habitus (drooping shoulders and winged scapulae), lateral apophysis of clavicle rotates downwards thus making brachial plexus superficial. The reverberation of first rib makes it impossible to ascertain distance between the needle and the pleural dome. Long bevelled needles have oval exit hole and therefore during partial insertion in nerves, the local anaesthetic will be administered out. (*Rice ASC, Mc Mahon SB. Peripheral nerve injury caused by injection needles used in regional anaesthesia: influence of bevel configuration studies in a rat model. Br J Anaesth. 1992;69:433).* Antibiotic prophylaxis and cortisone is justified even after trivial injury to prevent any fibroblast proliferation.

Sunderland Classification of nerve injury:

- *First degree*: It is seen due to moderate pressure to nerve for a brief period. There is compression of axonal fluid, compression of vasa nervorum followed by anoxia. Recovery is seen within a fortnight.
- *Second degree*: The distal parts of the axons donot receive the axoplasm from the respective neurons with wallerian degeneration. Endoneural tubules are salvaged and they regenerate at the rate of 2–3 mm/day.
- *Third degree*: Nerve fibre interruption is seen. Lesion of endoneurium is seen while epineurium and Perineurium remains intact. Lesions of endoneural tubules but fascicles are intact. Lesion is caused by needle and not by injection.
- *Fourth degree*: Axons and myelin sheath degenerate.

28. T F T T F

Phrenic nerve is blocked with high interscalene block (100%) while the incidence is less with middle interscalene block (60%). Vascular injury may be seen due to proximity of vertebral artery, ascending cervical artery and lateral spinal arteries. Dextrorotatory form occupies potassium channels and causes more cardiac toxicity. Bezold-jarisch syndrome has severe vagal component causing bradycardia, hypotension and apnoea. It responds poorly to atropine and better to ephedrine and ethylephrine.

29. F F T T T

Horner's syndrome was described by Claude Bernard (1862) and John Friedrich Horner (1869). The block is seen more than 6 h as unmyelinated plexus remains anaesthetised for longer than myelinated fibres. Real Ptosis is not real as third cranial nerve is intact after the block. The eyelid is relaxed due to sympathetic block of superior tarsal nerve (Muller's tarsal muscles). Tenon's capsule envelops the eyeball and is made up of smooth muscle fibres innervated by sympathetic neuronal system. Sympathetic blockade causes enopthalmos. Dysphonia is due to recurrant nerve block but also due to block of sympathetic system. This causes secondary vasodilatation causing oedema of vocal cords. Brachial plexus block may cause sympathetic blockade of bronchial system with increase in vagal activity. (*Sgah MB, et al. Sympathetic blockade cannot explain bronchospasm following interscalene brachial plexus block. Anesthesiology. 1985;62:847–48).*

30. F F T T T
Bazy's technique involves inserting the needle below the clavicle immediately medial to the coracoid process. In Raj's technique, patient is supine with arm abducted to 90°. Needle entry is 2.4 cm below the clavicle. In Borgeat's technique, arm is abducted 90° and raised 30°. Entry point is 1 cm caudad to lower edge of clavicle at its mid point. *(Borgeat A, et al. An evaluation of the infraclavicular block via a modified approach of the Raj's technique. Anesth Analg. 2001;93(2):436–41).* Needle stays to the lateral border of the pectoralis major. The landmarks for Kilka' approach includes jugulum and ventral part of acromion. Entry point is the midpoint of the landmarks below the clavicle. *(Kilka HG, Geiger P, et al. Infraclavicular vertical brachial plexus blockade. A new method for anaesthesia of the upper extremity. An anatomical and clinical study. Anesthetist. 1995;44(5):339–44).* Stimulation current if reduced to 0.1–0.3 mA presents a higher success rate. (*Gu HH, Che XH, Li PY, et al. Low minimal stimulating current improves infraclavicular brachial plexus block efficacy. Zhongua Yi Xue Za Zhi. 2007;87(21):1470–3).*

31. T F F T T
Distal contraction with radial nerve has higher success rate. (*Bloc S, Garnier T, Komly B, et al. Single stimulation low volume infraclavicular plexus block: influence of the evoked distal motor response on success rate. Reg Anesth Pain Med. 2006;31(5):433–37).* In single stimulation, only the posterior cord is sought where as in double stimulation, other nerves are stimulated and success rate is increased. (*Rodriguez J, Borcena M, Laguinilla J, et al. Increased success rate with infraclavicular brachial plexus block using a dual injection rate. J Clin Anesth. 2004;16(4):251–6).* Position of the limb makes a difference in the success rate. Ninety degrees abduction with external rotation of the shoulder causes the brachial plexus to come closer to the skin and move pleura away. (*Wang FY, Wu SH, Lu IC, et al. Ultrasonographic examination to search out the optimal upper arm position for coracoids approach to infraclavicular brachial plexus block—a volunteer study. Acta Anesthesiol Taiwan. 2007;45(1):15–20).* Local anaesthetic deposition below the artery causes adequate blockade (Double Bubble Effect). (*de Tran QH, Charghi R, Finlayson RJ. The "double bubble sign" for successful infraclavicular brachial plexus blockade. Anesth Analg. 2006;103(4):1048–9).* Lateral approach involves the patient being supine with the arm adducted close to the side and coracoids process is used as a landmark. (*Bigeleisen P, Wilson M. A comparison of two techniques for ultrasound guided infraclavicuklar block. Br J Anaesth. 2006;96(4):502–7).*

32. T T F F T
Ropivicaine causes more motor blockade than L-Bupivicaine which causes more sensory block. (*Piangatelli C, De Angelis C, Pecora L, et al. L-bupivicaine and ropivicaine in the infraclavicular brachial plexus block. Minerva Anestesiol. 2006;72(4):217–21).* Injecting small volumes is better. (*Jiang XB, Zhu SZ, Jiang Y, et al. Optimal dose of local anaesthetic mixture in ultrasound guided infraclavicular brachial plexus block via coracoids approach: analysis of 160 patients. Zhang-Hua Yi Xue Za Zhi. 2009;89(7):449–2).* Ultrasound

guidance does not completely eliminate the risk of Pneumothorax. (*Koscielniak-Nielson ZJ, Rasmussen H, Hesselbjorg L. Pneumothorax after an ultrasound guided lateral sagittal infraclavicular block. Acta Anaesthesiol Scand 2008;52(8):1176–7).* Decrease in total forced expiratory volume and FEV1 is seen with the block. (*Rettig HC, Gielen MJ, Boersona E, et al. Vertical infraclavicular block of the brachial plexus: effects on hemidiapgramtic movement and ventilator function. Reg Anesth Pain Med. 2005;30(6):529–5*). Median nerve runs through medial brachial fascial compartment and is characterised by neurological deficit and pain. (*Isao BE, Wilbourne AJ. Infraclavicular brachial plexus injury following axillary regional block. Muscle Nerve. 2004;30(1):44–8).*

33. T F T T F

Infraclavicular block adequately provides the block and covers tourniquet induced pain. (*Chin KJ, Singh M, Velyautham V, et al. Infraclavicular brachial plexus block for regional anaesthesia of the lower arm. Cochrane Database Syst Rev. 2010;2:CD005487).* Axillary block provides shorter execution and onset of anaesthesia times. (*Bouoziz H, Narchi P, Mercier J. Comparison between conventional axillary block and a new approach at the mid-humeral level. Anesth Analg. 1997;84(5):1058–62).* Contact of the needle with the peripheral nerve produces a sensation of sudden, intense tingling, tickling, burning in the area they innervate and is called paraesthesia. Eliciting one, two or three paraesthesias increase the success rate by 60, 82 or 100%. (*Baranowski AP, Pither CE. A comparison of three methods of axillary brachial plexus anesthesia. Anaesthesia. 1990;45(5):362–5).* Slow injection of local anaesthetic yields better results. (*Rucci FS, Pippa P, Boccacini A, et al. Effect of injection speed on anesthetic spread during axillary block using the orthogonal two needle technique. Eur J Anesthesiol. 1995;12(5):505–11).*

34. T F T F T

Loss of resistance technique results in better success rates. It is seen when the needle penetrates the fascia investing the neurovascular bundle in that region. (*Hill DA, Campbell WI. Two approaches to the axillary brachial plexus. Loss of resistance to saline or paraesthesia? Anaesthesia. 1992;47(3):207–9).* Cold saline (8–11°) combined with fascial click improves paraesthesias and success rate. (*Rodriguez J, Carcellar J, Barcena M, et al. Cold saline is more effective than room temperature saline in inducing paraesthesia during axillary block. Anesth Analg. 1995;81(2):329–31).* Single twitch stimulation has better success with radial nerve than median nerve. *(Rodriguez J, Taboada M, Valino C, et al. A comparison of stimulation patterns in axillary block: part 2. Reg Anaesth Pain Med. 2006;31(3):202–5).* Combination of radial and musculocutaneous nerve contraction is better than ulnar nerve and musculocutaneous nerve. (*Sia S, Bartoli M, Lepri A, et al. Multiple injection axillary brachial plexus block: a comparison of two methods of nerve localisation nerve stimulation versus paraesthesia. Anesth Analg. 2000;91(3):647–51).* Distal radial stimulation permits a better sensory block than proximal radial stimulation and also decreases the onset time of the block. (*Sia S, Lepri A, Magherini M, et al.*

A comparison of proximal and distal radial motor nerve responses in axillary block using triple stimulation. Reg Anesth Pain Med. 2005;30(5):458–83).

35. F T T F F
Radial nerve has complex sonoanatomy and poor visualisation is seen because of post acoustic reinforcement artefact due to brachial artery. Ultrasound guidance improves block performance time. (*Sites BD, Beach ML, Spence BC, et al. Ultrasound guidance improves the success rate of a perivascular axillary plexus block. Acta Anaesthesiol Scand. 2006;50(6):678–4).* Maximum comfort is seen in out of plane technique (25–55%) as compared to in plane technique (20–32%). (*Bloc S, Mercadel L, Gournier T, et al. Comfort of the patient during axillary block placement: a randomised comparison of the neurostimulation and the ultrasound guidance techniques. Eur J Anaesthesia. 2010;27(7):628–3).* Administration of local anaesthetic at high pressure can cause nerve injuries.

36. F F T T T
Musculocutaneous nerve stimulation is sought for and then further radial nerve stimulation and the nerves are blocked in sequential manner. Needle is inserted along the medial border of biceps brachii muscle for median nerve block and contractions of flexor muscles are looked for. Ulnar nerve block is done between medial epicondyle and olecranon and may cause compression of nerve if large volumes are injected. Wrist block is done between flexor muscles. Median nerve is blocked between tendons of flexor muscles of fingers and flexor pollicis longus muscles. Ulnar nerve is blocked between tendons of flexor Carpi ulnaris and flexor digitorium superficialis.

37. F F T T F
The failure rate is less than 1%. It is mostly used in surgical operations on the forearm, hand, legs and feet. It is for surgeries not lasting more than 90 min. Local anaesthetics penetrates vasa vasorum and capillaries into the nerve trunks and causes effect. Adjuvants can shorten the latency of the block. Body mass index more than 35 is a contraindication. Other contraindications include hypertension, arterial calcification, allergy tolocal anaesthetics, ischaemia of limb, cellulitis, arteritis and liver failure. Opioids, NSAIDs or clonidine increases analgesia and bicarbonate is used for alkalinisation. Major complications include permanent nerve lesions, braducardia, arrythemia, convulsions, respiratory failure and heart failure. (*Guay J. Adverse events associated with intravenous regional anaesthesia (Bier's block): a systemic review of complications. J Clin Anesth. 2009;21(8):585–4).*

38. T F F T T
Intravenous regional anaesthesia shows two phases. A phase of immediate onset of direct anaesthesia between the two tourniquets and an indirect anaesthesia distal to distal tourniquet (5–7 min delay). (*Biev A. A new method of local anaesthesia. Muench Med Wschir. 1909;56:589).* It is perfectly safe in paediatric population and is safe, efficient and cost effective. (*Aarons CE, Fernandez MD, Willsey M, et al. Bier's block regional anaesthesia and casting for forearm fractures: safety in the paediatric emergency department setting. J Pediatr Orthop. 2014;34:45–9).* Alkalinisation has no effect on sensory block, motor

block or post operative pain. (*Benlabed M, Julien P, Guelmi K, et al. Alkalinisation of 0.5% lidocaine for intravenous regional anaesthesia. Reg Anesth. 1990;15:59–60).* Temperature is lost before the touch sensation. (*Horn JL, Cordo P, Kunster D, et al. Progression of forearm intravenous regional anaesthesia with ropivicaine. Reg Anesth Pain Med. 2011;36(2):177–80).*

39. F T T T T
Muscle relaxants improved post operative motor block and is beneficial in fracture reduction. (*Choycea A, Peng P. A systematic review of adjuncts for intravenous regional anaesthesia for surgical structures. Can J Anaesth. 2002;49:32–45).* Dexmedetomidine is eight times more selective for alpha receptors. It shows rapid onset of sensory and motor block, increased sensory motor block, prolonged tolerance for tourniquet, improved quality of analgesia. (*Memis D, Turan A, Kavamanlioglu B, et al. Adding dexmedetomidine to lidocaine for intravenous regional anaesthesia. Anesth Analg. 2004;98:835–40).* Midazolam enhances analgesia through systemic effect in addition to peripheral analgesic effect. (*Farouk S, Aly AJ. Quality of lidocaine analgesia with or without midazolam for intravenous regional anaesthesia. J Anesth. 2010;24(6):864–8).* Ketamine blocks both sodium and potassium channels (*Brau ME, Sander F, Vogel W, et al. Blocking mechanisms of ketamine and its enantiomers in enzymatically demyelinated peripheral nerves as revealed by single channel experiments. Anesthesiology. 1997;86:394–404).*

40. F T T T T
Brachial plexus is a superficial block visualised at the depth of 1–3 cm. Supraclavicular branches supply skin over acromion and clavicle. Inferior trunk (C8-T1) is spared. Head elevation allows for drainage and less prominence of neck veins. High opening pressure indicates needle root contact. (*Orebaugh SL, Mukalel JJ, Krediet AC, et al. Brachial plexus root injection in a human cadaver model: injectate distribution and effects on the neuraxis. Reg Anesth Pain Med. 2012;37:525–9).* Lateral insertion prevents injury to phrenic nerve which is located to anterior scalene. Dorsal scapular nerve and long thoracic nerve may be injured as they pass through middle scalene muscle. (*Hanson NA, Auyong DB. Systematic ultrasound identification of the dorsal scapular and long thoracic nerves during interscalene block. Reg Anesth Pain Med. 2013;38:54–7).*

41. T F T T F
Proximal part of medial side of the arm is supplied by intercostobrachial nerve (T2) and is not blocked by any approach. Additional subcutaneous injection distal to axilla is required. Normally the volume required to produce analgesia is 20–25 mL and lower volume is required in elderly. (*Pavicic Saric J, Vidjak V, Tomulik K, et al. Effects of age on minimum effective volume of local anaesthetic for ultrasound guided supraclavicular brachial plexus block. Acta Anesthesiol Scand. 2013;57:761–6).* Pneumothorax is a delayed complication. (*Abell DJ, Barrington MJ. Pneumothorax after ultrasound guided supraclavicular block: presenting features, risk and related training. Reg Anesth Pain Med. 2014;39:164–7).* Risk of Phrenic nerve palsy is more with interscalene block. (*Guirguis M, Kauroum R, Abd-Elsayed AA, et al. Acute*

respiratory distress following ultrasound guided supraclavicular block. Oschner J. 2012;12:159–2).

42. F F T F T
The block is ideally suited for catheter technique because of the musculature of the chest wall that helps stabilise the catheter. The plexus cords are seen underneath the fascia of pectoralis minor. The arm is abducted to 90° and elbow is flexed. This raises clavicle and reduces depth from skin to plexus and facilitates visualisation of pectoralis muscle and plexus. (*Auyong DB, Gonzales J, Benonis JG. The Houdini clavicle: arm abduction and needle insertion site adjustment improves needle visibility for the infraclavicular nerve block. Reg Anesth Pain Med. 2010;35:403–4).* The initial motor response is seen that from lateral cord (elbow flexion or finger flexion). Injecting in small volumes at different places helps succeed the block as fascia may prevent spread of local anaesthetic. (*Dolan J. Fascial planes inhibiting the speed of local anaesthetic during ultrasound guided infraclavicular brachial plexus block are not limited to the posterior aspect of the axillary artery. Reg Anesth Pain Med. 2009;34:612–3)* (Table 7.2).

43. T T F F F
Axillary block does not block axillary nerve as it departs from the posterior cord more proximally in the axilla. Nerve stimulator and landmark techniques are unreliable for blocking musculocutaneous nerve. (*Orebaugh SL, Pennington S. Variant location of the musculocutaneous nerve during axillary nerve block. J Clin Anesth. 2006;18:541–4).* Over-abduction of the arm does not help in visualising the plexus but may make the plexus more vulnerable to injury by the needle. Acoustic enhancement artefact is seen deep to the artery and is misinterpreted as musculocutaneous nerve. The nerve is seen between the plane of corachobrachialis and biceps muscle. (*Remerand F, Laulan J, Courret C, et al. Is the musculocutaneous nerve really in the coracobrachialis muscle when performing an axillary block? An ultrasound study. Anesth Analg. 2010;110:1729–34).* In 16% of cases, the musculocutaneous nerve splits off the median nerve distal to axilla. A separate injection is not required as it will be blocked by local anaesthetic injection around the median nerve.

44. T F T F F
Block both distal and proximal to elbow improves the success. (*Fredricksson MJ, Ting FS, Chinchanwala S, et al. Concomitant infraclavicular plus distal*

Table 7.2 Stimulation of brachial plexus cords

Cord	Nerves	Motor response	Little finger orientation
Medial	Ulnar	Medial fingers flexion and ulnar deviation of wrist	Medial
Posterior	Radial and axillary	Finger, wrist extension, abduction of thumb	Posterior
Lateral	Median	Pronation, elbow flexion, finger flexion and thumb opposition	Lateral

median, radial and ulnar nerve blockade accelerates upper extremity anaesthesia and improves block consistentcy compared with infraclavicular block alone. Br J Anaesth. 2011;107:236–2). Radial nerve can be visualised deep to the triceps muscle. The superficial branch of the radial nerve is easy to block as it can be easily visualised at the proximal forearm covered by brachioradialis. Deep branch is difficult to visualise between exstensor carpi radialis muscle and brachioradialis. The deep branch passes under the two heads of supinator and is difficult to visualise. (*Anagnostopoulu S, Sarantes T, Chantzi C, et al. Ultrasound identification of the radial nerve and its divisions. Is rescue nerve block at or below the elbow possible. Anesth Intens Care. 2008;36:457–9).*

45. T F T T F
Median nerve exhibits pronounced anisotropy. The superficial branch divides into terminal branches at the level of the wrist and hence ultrasound is not much useful in visualisation. It is more useful at the level of the elbow or mid forearm. Wrist block spares area innervated by deep branch of radial nerve.
46. T T T F T
Interscalene blocks C4-C7 while C8-T1 are spared. 10–15 MHz linear probe is normally used. Three trunks form the traffic light sign and are seen between anterior and middle scalene muscles. (*Franco CD, Williams JM. Ultrasound guided interscalene block: re-evaluation of the "spotlight" sign and clinical implications. Reg Anesth Pain Med. 2016;41(4):452–9).* The in-plane approach is ideal. C5 root can pass through or above anterior scalene muscle thus causing failure in blind approach.
47. F T F F T
The block is done in supine position with pillow under the shoulder. 10–15 MHz linear probe is used. Plexus appears as several hypoechoic structures underneath as hyperechoic superior cervical fascia. In plane approach is preferred. Multiple injections are used known as targeted intra cluster injection. (*Nwaka OK, Miller TT, Jawetz ST, et al. Ultrasound guided perineural injection for nerve blockade: does a single sided injection produce circumferential nerve coverage? J Clin Ultrasound. 2016;44(8):465–9).*
48. T T F F T
Ideal position of the arm is aide abduction to 90°. The artery becomes more superficial and moves away from the pleura. High frequency linear probe (6–13 MHz) is used.
49. F F T T T
Complete block is rarely seen. This is due to the musculocutaneous nerve which departs from lateral cord and is spared in axillary approach. High frequency (6–13 MHz) linear probe is used. Median nerve is antero-medial to the axillary artery while ulnar nerve is medial to the artery and radial nerve on posteromedial angle to the artery. The musculocutaneous nerve is mostly visualised in coracobrachialis muscle but can be seen between coracobrachialis and triceps muscles.

50. T T T F T
Nerve is visualised proximal to elbow crease medial to brachial artery. 6–13 MHz linear probe is used. Transducer is placed perpendicular to the long axis of arm and needle inserted in plane.
51. T F T F T
High frequency 6–13 MHz linear probe is used. Nerve is superficial to brachialis and biceps muscles. Nerve entrapment is commonly seen especially if injection is done at the ulnar groove.
52. T F F T T
The arm is adducted and elbow if flexed to 90°. Nerve is visualised between brachialis and brachioradialis.
53. T F F T F
Supraclavicular nerve arises from third and fourth cervical ventral rami. The nerve provides sensory supply to clavicle and shoulder, chest wall to the second rib and acromioclavicular and sternoclavicular joints. The block can augment interscalene and supraclavicular blocks. Local anaesthetic tracks to C4 within the interscalene groove and can cause blockade of supraclavicular block. The nerve is seen over the paravertebral fascia. (*Lanz E, Theiss D, Jankovic D. The extent of blopckade following various techniques of brachial plexus block. Anesth Analg. 1983;62:55–8).*
54. T T T T F
C5 and C6 may pass over or through the muscle and can be picked up by the ultrasound. (*Kessler J, Gray AT. Sonography of scalene muscle anamolies for brachial plexus block. Reg Anesth Pain Med. 2007;32:172–3).* Brachial plexus is compact and seen lateral to the subclavian artery. The space above the clavicle is compact and a small curved or linear (20–25 mm footprint) is preferred. Injections less than 10 mL are effective if given at multiple locations. Lateral approach does not increase the success rate. (*Subramanyam R, Varshnav V, Chan VW, et al. Lateral versus medial needle approach for ultrasound guided supraclavicular block: a randomised controlled trial. Reg Anesth Pain Med. 2011;36(4):387–92).*
55. T F F T T
The cords of the brachial plexus hug the walls of second part of axillary artery in a compact way. (*Sauter AR, Smith HJ. Use of magnetic resonance imaging to define the anatomic location closest to all three cords of the infraclavicular brachial plexus. Anesth Analg. 2006;103:1574–6).* The block gives good analgesia for tourniquet tolerance. (*Chin KJ, Singh M, et al. Infraclavicular brachial plexus block for regional anaesthesia of the lower arm. Anesth Analg. 2010;111(4):1072).* Abduction of the arm leads to straightening of neurovascular bundle and retraction of clavicle. Signs of successful blacked include:
    - U shaped distribution under the artery.
    - Separation of the cords and the artery.
    - “White walls” appearance of the artery.
    - “Dark stripe” under the artery.

Proximal approach is more successful for the block. (*Sala-Blanch X, Reina MA, et al. Anatomic basis for brachial plexus block at the costoclavicular space: a cadaver anatomic study. Reg Anesth Pain Med. 2016;41(3):787–91).*

56. F T T F F

Radial nerve is the most difficult terminal branch to block. (*Frkovic V, Word C, Preckel B, et al. Influence of arm position on ultrasound visibility of the axillary brachial plexus. Eur J Anaesthesiol. 2015;32(11):771–80).* Hyper abduction retracts the pectoralis major and improves needle visibility. Injection along the back side of the artery is done first which brings the neurovascular bundle closer to the skin. Musculocutaneous will need to be blocked separately. Intercostobrachial originates from T1 and T2 and is not a part of brachial plexus and innervates medial arm. Subcutaneous infiltration is done at axillary crease. Classic approach spares radial and musculocutaneous nerves. (*Lanz E, Theiss D, Jankovic D. The extent of blockade following various techniques of brachial plexus block. Anesth Analg. 1983;62:55–8).*

57. F F T T F

Musculocutaneous nerve is a branch of lateral cord of brachial plexus. It innervates all the flexors of arm at the elbow. It also gives rise to lateral cutaneous nerve of forearm. The nerve passes through the coracobrachialis muscle and exits between its two parts and short head of biceps. (*Tagliafico AS, Michaud J, et al. Ultrasound imaging of the musculocutaneous nerve. Skeletal Radiol 2011;40(5):609–16).* The nerve is typically flat in the muscle and relatively high surface area to volume ratio increases the onset kinetics of the block. (*Schafhalter-Zoppoth I, Graty AT. The musculocutaneous nerve block: a description of a novel technique. Teg Anesth Pain Med. 2005;30:198–201).* Anatomical variation is seen in 8–30% of patients where the nerve passes over coracobrachialis. (*Remerand F, Laulan J, et al. Is the musculocutaneous nerve really in the coracobrachialis muscle when perforoming an axillary block. An ultrasound study. Anesth Analg. 2010;110:1729–4).* Another anomaly seen is fusion of median nerve and musculocutaneous nerve which can be identified on ultrasound (*Orebaugh SL, Pennington S. Variant location of the musculocutaneous nerve during axillary nerve block. J Clin Anesth. 2006;18:541–4).* Lateral cutaneous nerve supplies dorsal aspect of thumb. It can be blocked lateral to biceps tendon at the antecubital fossa. (*Hasenkam CS, Hoy GA, et al. Sensory distribution of the lateral cutaneous nerve of forearm after ultrasound guided block: potential implications for thumb based surgery. Reg Anesth Pain Med. 2017;42:478–2).*

58. T F T T F

The snake eyes appearance is seen typically before the nerve divides into superficial and deep branch. Radial nerve is the smallest nerve with average cross sectional area of 2.7 mm^2. (*Meng S, Tinhofer I, et al. Anatomical and ultrasound correlation of the superficial branch of the radial nerve. Muscle Nerve. 2014;50(6):939–2).* Pronation of the arm helps in the block especially at the proximal third of forearm where the nerve travels over the supinator muscle. (*Henshaw DS, Kittner SL, Jaffe JD. Ultrasound guided continuous*

superficial radial nerve block for CRPS. J Pain Palliat Care Pharmacother. 2016;30:118–23). Nerve can be blocked in the fascia between brachialis and brachioradialis muscle. The nerve joins the radial artery in proximal third of forearm, travels with the artery in mid forearm and leaves in distal third of the forearm.

59. T F T F T

Median nerve has two main terminal branches: anterior interosseous nerve and palmer cutaneous nerve. Both arise 5 cm proximal to the wrist crease. (*Tagliafico A, Lugliese F, Bianchi S, et al. High resolution sonography of the palmer cutaneous branch of the median nerve. AJR Am J Roentgen. 2008;191:107–14).* Hyperextension stretches the median nerve and can lead to nerve impairment. Block should be done in neutral position. Brachial artery injury can cause median epineural hematoma. (*Chuang YM, Luo CB, Chou YH, et al. Sonographic diagnosis and treatment of a median nerve epineural hematoma caused by brachial artery catheterisation. J Ultrasound Med. 2002;21:705–8).* Ultrasound can visualise high division or bifid median nerve. (*Klauser AS, Halpern EJ, Faschingbauer R, et al. Bifid median nerve in a carpal tunnel syndrome: assessment with ultrasound cross sectional area measurement. Radiology. 2011;259(3):808–15).* Nerve is visualised in the fascia separating flexor digitorium superficialis and flexor digitorium profundus.

60. F F T T T

Ulnar nerve lies on medial side of artery. Dorsal cutaneous nerve leaves proximal to the wrist. (*Grossman JA, Yen L, Rapaport D. The dorsal cutaneous branch of the ulnar nerve: an anatomic classification with six case reports. Chir Main 1998;17:154–8).* Dorsal and palmer cutaneous nerves are visualised on ultrasound. (*Kim KH, Lee SJ, Park BK. Sonoanatomy of sensory branches of the ulnar nerve below the elbow in healthy subjects. Muscle Nerve. 2018;57(4):569–3).* Local anaesthetic is injected within the fascial plane that connects ulnar nerve to ulnar artery. In 3–10% cases, ulnar nerve lies superficial to flexor muscles.

Lower Extremity

8

1. Lumbosacral plexus:
   (a) Lumbar and sacral plexus are not connected.
   (b) Obturator nerve block is not required for anaesthesia of the leg.
   (c) Lumbar plexus has contribution by thoracic segment.
   (d) Lateral cutaneous nerve is purely sensory.
   (e) Saphenous nerve is purely sensory.
2. Lumbar plexus:
   (a) Is covered by psoas muscle.
   (b) Obturator nerve provides innervation to capsule of hip joint.
   (c) Femoral nerve supplies thigh flexors.
   (d) Is formed from posterior rami of L1-L4.
   (e) Femoral nerve passes over the inguinal ligament.
3. Sacral plexus:
   (a) Is the biggest plexus in the body.
   (b) Is formed from anterior rami of sacral nerves.
   (c) Is motor to hip muscles.
   (d) Supplies buttock area.
   (e) Receives innervation from L4.
4. Sciatic plexus:
   (a) Has no contribution from lumbar muscles.
   (b) First sacral nerve has a small contribution.
   (c) The plexus lies on the piriformis muscle.
   (d) Superior and inferior gluteal arteries are related to the plexus.
   (e) Both trochanters are supplied by the same nerve.
5. Innervation of the leg:
   (a) Sciatic nerve block alone is adequate for complete anaesthesia of the leg.
   (b) Innervation of leg bones is different.
   (c) Femur is innervated by one nerve.
   (d) Tibia and fibula are supplied by tibial nerve.
   (e) Tarsal nerves are supplied by sural nerve.

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6. Psoas block (lumbar plexus):
   (a) Is formed from first four lumbar nerves.
   (b) Ramus of L4 forms lumbosacral trunk.
   (c) Femoral nerve is the biggest branch.
   (d) Lateral cutaneous nerve is purely sensory.
   (e) Transverse process of L4 is a useful landmark.
7. Lumbar plexus block technique of Chayen:
   (a) Involves L4 vertebrae.
   (b) Patient may lie sitting or lateral position.
   (c) Transverse process of L4 is a useful landmark.
   (d) Loss of resistance technique is used.
   (e) Anterior thigh contractions require withdrawal of the needle.
8. Ultrasound guided lumbar plexus block:
   (a) The nerves can be easily visualised.
   (b) Visualisation of articular process is the first structure to be visualised on ultrasound.
   (c) Lumbar process is a superficial block.
   (d) Lateral to medial approach is recommended.
   (e) Technique should be conducted with simultaneous use of nerve stimulator.
9. Lumbar plexus block:
   (a) A full leg block is not possible.
   (b) Total spinal anaesthesia can occur.
   (c) L3 approach increases the risk of renal injury.
   (d) High volume of local anaesthetic is required.
   (e) Bilateral spread is rarely seen.
10. Femoral nerve block:
    (a) Nerve arises in a muscle.
    (b) Femoral nerve is superficial to fascia lata.
    (c) Femoral nerve innervates knee flexors and hip extensors.
    (d) The nerve is approached above the inguinal ligament.
    (e) Two clicks are essential for successful needle placement with landmark technique.
11. Femoral nerve block:
    (a) Successful block is indicated by contractions of quadriceps muscle.
    (b) Femoral nerve is least anisotropic on ultrasound.
    (c) Local anaesthetic spreads under iliac fascia.
    (d) Circumferential spread ensures more success in the block than depositing local anaesthetic above the nerve.
    (e) Paraesthesia may be obtained with nerve stimulator.
12. Femoral nerve block:
    (a) Trans arterial technique has a good success rate.
    (b) Contractions of patella means successful block.
    (c) Needle insertion is recommended distal to the inguinal crease.
    (d) Complete Obturator block is indicated by motor block of hip flexors and knee extensors.
    (e) Obturator nerve is most consistently blocked with winnie technique.

13. Femoral nerve block:
    (a) Intraneural injection may go unnoticed.
    (b) Complete analgesia of hip is achieved.
    (c) Combined femoral and sciatic nerve block can be used for operations on leg.
    (d) Catheter insertion can be used for post operative pain management.
    (e) Efficacy of continuous femoral nerve block with sciatic nerve is as effective as epidural infusion for post operative pain control.
14. Sciatic nerve block:
    (a) Sciatic plexus lies on the piriformis muscle.
    (b) Sciatic nerve has the highest resistance among all nerve cords.
    (c) Sciatic nerve supplies all the flexor muscles of thigh.
    (d) Sciatic nerve injury can cause foot drop.
    (e) Posterior aspect of thigh is supplied by posterior cutaneous nerve of thigh.
15. Anterior sciatic nerve block:
    (a) Sartorius muscle is one of the landmarks.
    (b) Needle insertion is above the inguinal crease.
    (c) Linear transducer is helpful in localising the space.
    (d) Plantar flexion on nerve stimulation is accepted as end point.
    (e) Ischio-crural muscle contractions are accepted for injection.
16. Anterior sciatic nerve block:
    (a) Can be used to treat complex regional pain syndrome.
    (b) Dysesthesia is a known complication.
    (c) Posterior cutaneous nerve of thigh can be blocked by meier's technique.
    (d) Successful block causes an increase in plantar temperature.
    (e) A contraction of gluteus maximus is an adequate response.
17. Ultrasound guided anterior sciatic nerve block:
    (a) Curvilinear probe is ideal.
    (b) Femur is seen as convex hyperechoic line.
    (c) Catheter is best placed in in plane technique.
    (d) Anterior technique has no advantages over the posterior technique.
    (e) Nerve should be visualised in the long axis.
18. Blocks at the knee:
    (a) Dorsum of the feet is innervated by superficial peroneal nerve.
    (b) Tibial nerve is innervated by deep fibular nerve.
    (c) Popliteal block is performed at the level of popliteal crease.
    (d) Single injection is sufficient for the block.
    (e) Double injection technique increases the risk of intraneural injection.
19. Blocks at the knee:
    (a) Out of plane approach technique is more reliable than in plane technique.
    (b) Meier's technique involves needle insertion at medial boundary of popliteal fossa.
    (c) Popliteal fossa is medially bounded by biceps femoris.
    (d) Pronation of foot with dosriflexion indicates adequate placement of needle.
    (e) Long onset time of block is seen.

20. Blocks at the knee:
    (a) Lateral approach involves needle insertion between biceps femoris and vastus lateralis.
    (b) Needle should be inserted as near as possible to the knee joint.
    (c) Vascular complication is a known complication with the lateral technique.
    (d) Saphenous nerve block is necessary for tourniquet use.
    (e) Fascial sheath around nerve increases the success of catheter technique.
21. Blocks at the knee:
    (a) Tibial nerve is more difficult to block as compared to common fibular nerve.
    (b) Popliteal fossa block has a shorter onset.
    (c) Perpendicular angle of needle increases the ease of insertion of the catheter.
    (d) Sciatic nerve has a triangular shape on ultrasound.
    (e) Sciatic nerve is posterior to popliteal artery in the popliteal crease.
22. Peripheral nerve blocks:
    (a) Lateral cutaneous nerve of thigh innervates up to the middle of thigh.
    (b) Lateral cutaneous nerve blockade can provide analgesia of knee.
    (c) Transdermal technique for lateral cutaneous nerve block involves lower volume of anaesthetic.
    (d) Lateral cutaneous nerve can be visualised on Sartorius under ultrasound.
    (e) Fascia lata visualisation helps in blocking the lateral cutaneous nerve on ultrasound.
23. Obturator nerve block:
    (a) Is only a sensory block.
    (b) Pubic tubercle is one of the landmarks.
    (c) Obturator nerve injury is a complication.
    (d) Contraction of adductors at 0.3 mA/0.1 ms indicate anterior branch of Obturator nerve stimulation.
    (e) Is mostly a plane block.
24. Obturator nerve block:
    (a) Is required for bladder resection under spinal.
    (b) Abduction of thigh aids in blockade.
    (c) Adductor spasm may persist after Obturator nerve block.
    (d) Medial side of thigh is appropriate for testing sensation after blockade of Obturator nerve.
    (e) Block may be effective even with absence of cutaneous anesthesia.
25. Saphenous nerve block:
    (a) Forms sub-sartorial plexus.
    (b) Saphenous nerve supplies up to great toe.
    (c) Nerve is blocked just under the skin.
    (d) Trans-arterial technique is based on the needle passage through artery.
    (e) Trans-arterial technique is suitable for catheter insertion.

26. Saphenous nerve block:
    (a) Is seen immediately close to femoral artery on ultrasound.
    (b) Motor impairment is seen involving other nerves.
    (c) Can be used on its own for operations.
    (d) Trans-arterial technique has the lowest failure rate.
    (e) Continuous saphenous block may decrease complications seen with femoral nerve block.
27. Fibular nerve block:
    (a) The nerve is purely sensory.
    (b) Nerve supplies sensory innervation to the heel of the feet.
    (c) Dorsiflexion of feet is accepted as adequate response.
    (d) Foot drop is a complication.
    (e) Fibular paresis may be a complication.
28. Nerve blocks at the ankle:
    (a) Feet is supplied by sciatic nerve only.
    (b) Tibial nerve does not supply sole.
    (c) Sural nerve innervates lateral border of the feet.
    (d) Deep fibular nerve innervates extensors.
    (e) Plantar flexion of toes indicates stimulation of posterior tibial nerve.
29. Ankle block:
    (a) All nerves can be blocked by subcutaneous infiltration.
    (b) Epinephrine free solutions should be used.
    (c) Complication rate is low.
    (d) High levels of local anaesthetic in blood are seen after ankle block.
    (e) Long term paraesthesia may be seen as a complication.
30. Lumbar plexus block:
    (a) Is a fascial plane block.
    (b) Higher frequency ultrasound probe is required.
    (c) Trident sign is seen on ultrasound.
    (d) Psoas muscle appears hyperechoic on ultrasound.
    (e) Prone position is better than lateral position to perform the block.
31. Sciatic block:
    (a) Posterior superior iliac spine is one of the landmarks.
    (b) Anterior approach is above the inguinal ligament.
    (c) Dysesthesia is rarely seen.
    (d) The best approach under ultrasound is at subgluteal region.
    (e) In plane approach is preferred as compared to out of plane in sub gluteal region.
32. Femoral nerve block:
    (a) Elicitation of paraesthesia is required for the block.
    (b) Femoral nerve divides inferior to inguinal ligament.
    (c) Medio-lateral injection increases the success of the block.
    (d) Nerve is difficult to visualise under ultrasound.
    (e) The nerve can be confused with lymph nodes on ultrasound.

33. Lateral femoral cutaneous nerve block:
    (a) Requires higher volume for effective volume.
    (b) Nerve supplies the antero-lateral thigh.
    (c) Nerve lies lateral to psoas muscle.
    (d) Anterior superior iliac spine is a landmark.
    (e) Can be used for skin graft.
34. Obturator nerve block:
    (a) Is must for hip and knee operations.
    (b) Elicitation of paraesthesia is a must for effective block.
    (c) Needle is inserted medial to pubic tubercle.
    (d) It is a large volume injection.
    (e) Single injection is required for both the branches.
35. Popliteal block:
    (a) Is primarily a motor block.
    (b) Tibial nerve is superior to popliteal block.
    (c) Saphenous nerve blockade adds to the block.
    (d) Is used for block of distal leg and feet.
    (e) Plantar flexion aids in visualising nerves under ultrasound.
36. Adductor canal block:
    (a) Adductor canal contains both femoral and Obturator nerve branches.
    (b) Needle is placed medial to the artery for effective block.
    (c) Low frequency transducer is ideal for visualisation.
    (d) Quadriceps weakness is a known complication.
    (e) Fascial expansion with normal saline aids in positioning of the catheter.
37. Ultrasound guided lumbar plexus block:
    (a) Plexus is visualised within psoas muscle.
    (b) High frequency probe is used.
    (c) Transverse process is used as a landmark.
    (d) Karmaker's approach involves visualisation at L3-L4.
    (e) Shamrock method involves needle placement caudal to iliac crest.
38. Ultrasound guided lateral femoral cutaneous nerve block:
    (a) Leg should be externally rotated for optimum position.
    (b) Low frequency probe is required.
    (c) Nerve gives an "eye "appearance on ultrasound.
    (d) Injection is done deep to fascia lata.
    (e) Intraneural complications may be seen.
39. Ultrasound guided femoral nerve block:
    (a) Nerve is visualised medial to femoral artery.
    (b) High frequency transducer is used.
    (c) Nerve is visualised after injection.
    (d) Nerve lies below fascia iliaca.
    (e) In plane approach is used parallel to inguinal ligament.
40. Ultrasound guided saphenous nerve block:
    (a) Visualised anterior to femoral artery.
    (b) High frequency probe is required.
    (c) Saphenous nerve is clearly visualised.

(d) Local anaesthetic deposition is superior to Sartorius.
(e) Nerve can be blocked at the level of tibial tuberosity.

41. Ultrasound guided Obturator nerve block:
(a) Is seen coursing between pectineus and Obturator externus.
(b) Neutral position of leg helps in placement.
(c) High frequency probe is used.
(d) Both branches are hyperechoic.
(e) Adductor muscle contractions are required for localisation.

42. Ultrasound guided sciatic nerve block:
(a) Is better visualised in sub-gluteal than gluteal region.
(b) Lateral decubitus position is ideal for visualisation.
(c) High frequency probe is used.
(d) Nerve is visualised deep to quadratus femoris muscle.
(e) Intraneural injection is a complication.

43. Ultrasound guided popliteus nerve block:
(a) Ideally blocked at the lower edge of popliteal fossa.
(b) High frequency probe is required.
(c) Nerve is identified lateral to pulsatile popliteal artery.
(d) In plane approach is used.
(e) Feet movements may aid visualisation of nerves.

44. Ultrasound guided ankle block:
(a) Five nerve need to be individually blocked.
(b) Dorsiflexion of feet is required for visualisation.
(c) High frequency probe is required.
(d) Tibial nerve is visualised at the level of extensor retinaculum.
(e) Sural nerve cannot be visualised.

45. Ultrasound guided lateral femoral cutaneous nerve block:
(a) The nerve can be seen crossing Sartorius muscle from lateral to medial side.
(b) Short axis view is the ideal to visualise the nerve.
(c) Visualisation of the nerve is easy as it has a large cross sectional area.
(d) The nerve runs between two muscles.
(e) High frequency linear probe is used.

46. Ultrasound guided fascia iliaca block:
(a) Blocks only femoral nerve.
(b) Iliacus muscle is visualised medial to femoral nerve.
(c) In plane approach is used.
(d) Deep circumflex artery is a valuable landmark.
(e) Local anaesthetic can be tracked on ultrasound.

47. Ultrasound guided femoral nerve block:
(a) Nerve appears triangular on ultrasound.
(b) The nerve is least anisotropic.
(c) Needle should be placed between fascia iliaca and iliopsoas muscle.
(d) Vessel puncture can cause retroperitoneal bleed.
(e) Transducer should be placed distal to the inguinal ligament for visualisation of nerve.

48. Ultrasound guided adductor canal block:
    (a) The canal is covered by the muscle.
    (b) Only femoral vessels and saphenous nerve is visualised in the adductor canal.
    (c) Sub-sartorial plexus is easily identified with ultrasound.
    (d) The block preserves motor strength as compared to femoral block.
    (e) All the nerves in the canal are sensory.
49. Ultrasound guided obturator nerve block:
    (a) The nerve supplies adductor muscles.
    (b) Anterior and posterior divisions can be seen separating.
    (c) Out of plane approach is used.
    (d) Transadductor brevis injection can cause life threatenting bleed.
    (e) Accessory Obturator nerve may cause failure of the block.
50. Ultrasound guided sciatic nerve block:
    (a) Sciatic nerve has the largest diameter of all the nerves.
    (b) Multiple injections increase the success rate.
    (c) "tram track sign" is a sonographic sign of ultrasound guided successful block.
    (d) Bony landmarks are not visualised under ultrasound in gluteal region.
    (e) Blood supply to sciatic nerve may aid in the nerve block.
51. Ultrasound guided popliteal nerve block:
    (a) Tibial nerve is difficult to identify than common peroneal nerve.
    (b) Nerve is best visualised in neutral position of the leg.
    (c) Nerve block is done proximal to sciatic nerve bifurcation.
    (d) Onset of blockade is faster for tibial nerve than for common peroneal nerve.
    (e) Movement of feet aids in nerve localisation.
52. Ultrasound guided posterior cutaneous femoral nerve block:
    (a) The nerve is derived from sacral plexus.
    (b) Ischial tuberosity is one of the landmarks.
    (c) The nerve lies between the muscles.
    (d) Associated sciatic nerve block is always seen.
    (e) The nerve can be confused with tendon on ultrasound.
53. Ultrasound guided saphenous nerve block:
    (a) The nerve can provide sensory supply to the great toe.
    (b) Saphenous nerve moves away from vein around the middle of the leg.
    (c) Can be blocked in the middle third of the leg.
    (d) Saphenous nerve cannot be visualised on ultrasound.
    (e) Can be blocked by injecting under the fascia lata.
54. Ultrasound guided peroneal nerve block:
    (a) Ultrasound improves the quality of deep peroneal block at ankle.
    (b) In plane approach is preferred to out of plane approach for deep peroneal nerve.
    (c) Distal scanning from head of fibula can identify superficial peroneal nerve.
    (d) Foot surgery can be done without superficial peroneal nerve block.
    (e) Superficial peroneal nerve is best blocked under fascia lata.

55. Ultrasound guided sural nerve block:
    (a) Sural nerve gets contribution from both peroneal and tibial nerve.
    (b) Innervates lateral aspect of the feet.
    (c) Sural nerve emerges between heads of gastrocnemius muscle.
    (d) The nerve is not visualised on ultrasound.
    (e) Small toe can be operated with peroneal nerve block only.

Answers

1. F F T T F
   Lumbar and sacral plexus are connected by fourth lumbar nerve. This nerve is bifurcated and belongs to both lumbar and the sacral plexus. The nerves required for the anaesthesia of the leg include:
   - Posterior cutaneous nerve of thigh (Sciatic nerve)
   - Lateral cutaneous nerve of thigh, obturator nerve, femoral nerve (lumbar plexus).

   Lumbar plexus is formed from T12 and L1-L4. Lateral cutaneous nerve arises from L23 and supplies the skin on the lateral side of the thigh. Saphenous nerve is purely sensory and innervates inside of lower leg as far as the ankle.
2. T T T F F
   Obturator nerve is derived from L2-L4. It provides motor innervation to the adductors. Accessory obturator nerve is seen in 9% which supplies capsule of the hip joint. Femoral nerve is formed from L1 to L4 and is motor to quadriceps, Sartorius and pectineus muscle. Lumbar plexus is formed from anterior rami of L1-L4. Femoral nerve passes under the inguinal ligament.
3. T T T T T
   Sacral plexus is from anterior rami of five sacral nerves and the coccygeal nerve. Sacral plexus supplies hip muscles, flexor muscles of thigh, muscles of lower leg and feet. It also supplies posterior side of the thigh and anterior side of lower leg and feet.
4. F F T T T
   Sacral plexus is derived from anterior rami of L4 and L5. It also gets contribution from S123. Anterior rami of first sacral nerve is the biggest branch of the lumbosacral plexus. The plexus lies on the piriformis muscle and is covered by parietal peritoneum. Superior gluteal artery passes between lumbosacral trunk and S1 while inferior artery passes between S1 and s2. Both trochanters are supplied by articular rami of the sciatic plexus.
5. F T F F T
   Femoral nerve is required in addition to the sciatic nerve. Obturator nerve is not consistent but a block may be required for total knee replacement. Head of tibia is innervated by sciatic nerve whereas hip is innervated by femoral nerve. The perosteum of femur is innervated posteriorly and anteriorly by sciatic nerve in upper third, Obturator nerve in middle third, distal third by

Table 8.1 Components of lumbar plexus

Lumbar plexus		
Nerves	Spinal segments	Innervation
Iliohypogastric nerve	T12–L1	Abdominal muscles, skin over lower abdomen
Ilioinguinal nerve	L1	Abdominal muscles, skin over lower abdomen
Genitofemoral nerve	L1-2	Skin over anteromedial surface of thigh and genitalia
Lateral femoral cutaneous nerve	L23	Skin over anterior lateral and posterior surface of thigh
Femoral nerve	L234	Anterior muscles of thigh, skin over anteromedial thigh, medial surface of leg and feet
Obturator nerve	L234	Adductors of thigh, skin over medial surface of thigh
Saphenous nerve	L234	Skin over medial surface of leg

sciatic, femoral and Obturator nerves. Tibia and fibula are supplied by tibial nerve except lateral head of tibia and head of fibula which is supplied by tibial nerve. Tarsal bones are supplied by sural nerve (*Gligorijevic S. Lower extremity blocks for day surgery. Tech Reg Anesth Pain Manag. 2000;4:30–7*).

6. T T T T T
   Lumbar plexus is formed from anterior rami of first four lumbar nerves. They lie between the deep and superficial origins of psoas major muscle. L4 nerve divides into cranial, medial and caudal branches. Cranial part supplies femoral nerve, medial part supplies the Obturator nerve. Caudal branch combines with anterior rami of L5 to form lumbosacral trunk (Table 8.1).

7. T T F T F
   A 3 cm interspinal line is drawn caudally from spinous process of L4. 5 cm lateral, a line is drawn which is the needle insertion site. Transverse process of L5 is usually hit at a depth of 5–8 cm. The needle is withdrawn and advanced cranially. Loss of resistance indicates needle passing through the quadrates lumborum muscle and transversalis and psoas fascia. Anterior thigh contractions indicate needle proximity to femoral nerve which is adequate for block.

8. F T F F T
   The nerves are not easily visualised due to large skin to nerve distance. The nerves run in the posterior third of psoas major muscle. Articular process appears as a continuous wavy hyperechoic line. Lumbar plexus is a deep block usually found at the depth of 7.5 cm. (*Ilfeld BM, Loland VJ, Mariano ER. Prepuncture ultrasound imaging to predict transverse process and lumbar plexus depth for psoas compartment block and perineural catheter insertion: a prospective, observational study. Anesth Analg. 2010;110:1725–8*).

9. F T T T F
   The lateral cutaneous nerve of thigh, Obturator nerve, femoral nerve is adequately blocked and a full block is seen. Iliohypogastric, ilioinguinal and genitofemoral nerves are not necessary for leg block. Complications include

peritoneal injection, retroperitoneal hematoma, infection, systematic toxicity and nerve damage. (*Pousman M, et al. Total spinal anaesthetic after continuous posterior lumbar plexus block. Anesthesiology. 2003;98(5):1281–2*). About 30 mL is required for adequate relief. Lateral cutaneous nerve may be spared because of high origin from the plexus. Bilateral spread is seen in up to 90% due to diffusion of local anaesthetic into the epidural space. (*Hahn MB, et al. Tegional anesthetic: an atlas of anatomy and techniques. St Louis: Mosby; 1996*).

10. T T F F T
    Nerve arises within the psoas muscle from anterior divisions of L1-L4. It is the largest nerve of lumbar plexus. Femoral nerve lies under fascia lata and iliac fascia. (*Platzer W. Colour atlas of human anatomy, vol 1. Locomotor system. 7th ed. Stuttgart: Thieme; 2014*). Femoral nerve supplies sensory innervation to anterior thigh and provides motor supply to the knee extensors and hip flexors. Nerve is approached 3 cm below the inguinal ligament (winnie approach). Two clicks indicate entry points at fascia lata and iliac fascia.
11. T F T F F
    Femoral nerve has a stronger anisotropic behaviour than other nerves. (*Soong J, et al. The importance of transducer angle to ultrasound visibility of the femoral nerve. Reg Anesth Pain Med. 2005;30:505*). Circumferential spread ensures better blockade. (*Szucs S, et al. A comparison of three techniques (local anaesthetic deposited circumferential vs above vs below the nerve) for ultrasound guided femoral nerve block. BMC Anesthesiol. 2014;14:6*). Femoral nerve is a motor nerve and paraesthesia is not seen. (*Urmey WF. Femoral nerve block for the management of post operative pain. Tech Reg Anesth Pain Manag. 1997;1:88–92*).
12. F F T T F
    Femoral nerve is separated from artery by iliopectineal arc so transarterial approach is not possible. (*Rosenquist RW, et al. Femoral and lateral cutaneous nerve block. Tech Reg Anesth Pain Manag. 1999;3:33–8*). Contractions are due to Sartorius and has no effect on the quality of block. (*Anns JP, et al. A comparison of Sartorius versus quadriceps stimulation for femoral nerve block: a prospective randomised double blind controlled trial. Anesth Analg. 2011;112:725–31*). At inguinal crease, the insertion site is wider and lies closer to fascia lata. (*Vloka JD, et al. Anatomical landmarks for femoral nerve block: a comparison of four needle insertion sites. Anesth Analg. 1999;89:1467–70*). The most consistent nerve to be blocked with winnie's technique is femoral (81%) followed by lateral cutaneous nerve (96%) and Obturator (4%). (*Lang SA, et al. The femoral 3 in 1 block revisited. J Clin Anesth. 1993;5:292–6*).
13. T F T T T
    The nerve has pure motor neurons and a significant proportion of intraneural injections may go unnoticed. (*Graf BM, et al. Peripheral nerve block. An overview of new developments in an old technique. Anesthetist. 2001;50:312–22*). Hip is supplied by sacral plexus. (*Fournier R, et al. Post operative analgesia with "3 in 1" femoral block after prosthetic hip surgery. Can J Anesth.*

1998;45:34–8). Catheter insertion can be done for pain management (*Morin AM. Regional anaesthesia and analgesia for total knee replacement. Anesthesiol Intensivmed Notfallmed Schmerther. 2006;41:498–505).* Co0ntinuous femoral nerve block is as good as epidural infusion. (*AL-Zahrani T, et al. Randomised clinical trial of continuous femoral nerve block combined with sciatic nerve block versus epidural analgesia for unilateral total knee arthroplasty. J Orthoplasty 2014).*

14. T T F T T
The plexus lies on piriformis muscle and covered by parietal peritoneum. Sciatic nerve has a tear strength of 91.5 kg. Roots unite at lower end of piriformis to form sciatic nerve. Tibial branch supplies all flexor muscles except short head of biceps femoris. Sciatic nerve injury affects external rotation of thigh and knee flexion. Unopposed quadriceps muscle leads to instability of ankle and foot drop. Posterior aspect of thigh is supplied by posterior cutaneous nerve of thigh (S1-S3). It leaves with sciatic nerve and lies medial to the sciatic nerve.
15. T F F T F
The block was originally described by Beck in 1963 and modified by Meier in 1998. Landmarks include inguinal crease, gap between rectus femoris and Sartorius muscle. (*Beck GP. Anterior approach to sciatic nerve block. Anesthesiology. 1963;24:222–4*). Needle insertion is 10 cm below the inguinal crease. Curvilinear transducer is preferred due to the depth involved. Motor response in any of the divisions of sciatic nerve is acceptable (fibula: dosriflexion, tibial nerve: plantar flexion). Ischio-crural contractions mean that the needle is deeper and should be withdrawn and inserted laterally.
16. T T T T F
Sciatic nerve block can be used with femoral nerve block to treat complex regional pain syndrome. Dysesthesia can be seen and lasts for 1–3 days.
17. T T F F T
Curvilinear probe is ideal because of the depth (10–20 cm). The catheter can be advanced easily in out of plane technique. The success rate is same for anterior or posterior technique but anterior technique requires less time. (*Ota J, et al. Ultrasound guided anterior approach to sciatic nerve block: a comparison with the posterior approach. Anesth Analg. 2009;108:660–5*). Nerve is better visualised in long axis. (*Tsui BCH, et al. Ultrasound guided anterior sciatic nerve block using a longitudinal approach: "expanding the view". Reg Anesth Pain med. 2008;33:275–6*).
18. T F T T T
The area between great toe and the second toe is innervated by deep fibular nerve. Tibial nerve supplies flexor muscles. Popliteal block is performed at the popliteal crease or slightly cranial to it. Fibular and tibial nerve can be blocked with one puncture or separately. Double injection increases the risk of intraneural injection because of the time required to perform the block. (*Gligorijevic P. Lower extremity blocks for day surgery. Tech Reg Anesth Pain Manag. 2000;4:30–7).*

19. T F F T T
Out of plane technique distal to bifurcation is fast and reliable. (*Perlas A, et al. Ultrasound guided popliteal block through a common perineural sheath versus conventional injection: a prospective, randomised double blind study. Reg Anesth Pain Med. 2013;38:218–225*). The insertion site in Meier's technique is lateral boundary 8–12 cm above the popliteal crease. Popliteal fossa is laterally bound by tendon of biceps femoris and medially by semimembranous and semitendinosus. Position is optimal with pronation of feet with dorsiflexion (fibular division) or a motor response of the tibial nerve (supination of feet with plantar flexion). Onset time is prolonged because of the presence of fat tissue in the popliteal fossa.
20. T F F T T
A minimum distance of 8 cm is required as distal to the common fibular nerve and tibial nerve. (*Neuberger M, et al. Lateral approach to blockade of sciatic nerve. Biometric data using magnetic resonance imaging. Anaesthetist. 2005;54:877–83*). Vascular complications are not seen normally with the lateral technique and a distal sciatic nerve block. Saphenous nerve is the sensory terminal branch of the femoral nerve and is necessary for the tourniquet usage. Fascial sheath ensures even spread in the space. (*Bauereis CH, et al. The continuous distal sciatic nerve block for anaesthesia and post operative pain management. Intern Monitor Reg Anesth. 1997;9:96*).
21. T F F T T
The diameter of tibial nerve is twice that of common fibular nerve and takes longer to block. (*Mach D. Is the type of motor response an important factor in determining the quality of the sciatic nerve block with a relatively small volume of local anaesthetic. Int Monitor Reg Abnesth. 2000;12:203*). Popliteal fossa block has a longer onset time because of increase fat tissue in the popliteal fossa. Acute angle of the needle facilitates the insertion of catheter. (*Meier G. Peripheral nerve blocks in lower extremity. Anesthetist. 2001;50:536–57*). Sciatic nerve has a triangular shape on ultrasound and is seen anterior to long head of biceps. (*Moayeri N, et al. Correlation among ultrasound, cross sectional anatomy and histology of the sciatic nerve: a review. Reg Anesth Pain Med. 2010;35:442–9*). Sciatic nerve is posterior to popliteal artery. (*Tsui BC, Finucaine BT. The importance of ultrasound landmarks: a "trackback" approach using the popliteal blood vessels for identification of the sciatic nerve. Reg Anesth Pain Med. 2006;31:481–2*).
22. T T T F T
Lateral cutaneous nerve of thigh originates from L2 to L3. After leaving the lumbar plexus, it divides into anterior and posterior branches. Anterior branch supplies the skin of the lateral thigh down to the knee whereas posterior branch innervates skin of lateral hip below the greater trochanter. Anterior branch terminates in prepatellar area, so can be used for operations on the knee. The nerve is seen under the Sartorius muscle but distally it lies between Sartorius and tensor fascia lata. Fascia lata appears as strong hyperechoic band in front of the Sartorius.

23. F T T F T
Obturator nerve arises from L2 to L4 and has both sensory and motor fibres. It divides into anterior and posterior branch. Anterior branch innervates anterior adductors and hip joint while posterior branch supplies posterior adductors and posterior knee joint. The needle insertion site is 1.5 cm lateral and distal to pubic tubercle. Contraction of adductors indicates adequate needle placement. Both branches of Obturator nerve can be blocked by injecting between fascial layers between pectineus/adductor liongus and adductor brevis and adductor magnus. (*Soong J, et al. Sonographic imaging of the Obturator nerve for regional block. Reg Anesth Pain Med. 2007;32:146–51*).
24. T T T F T
Obturator nerve block is required for bladder resection to eliminate Obturator reflex. (*Auhsperger RR, et al. Prevention of Obturator nerve stimulation during transurethral surgery. J Urol. 1980;123:170–2*). Abduction increases the muscle gap between adductor longus and Sartorius. (*Platzer W. Colour atlas of human anatomy. Locomotor system, vol. 1. Sttuttgart: Thieme; 2014*). Accessory Obturator nerve arises in 30% of cases which does not pass through Obturator foramen and is thus missed in the block. (*Vloka JD. Obturator and genitofemoral nerve blocks. Tech Reg Anesth Pain Manag. 1999;3:28–32*). Nerve supply is variable and therefore medial side may not be approprioate for testing. (*Geiger M, et al. 3 in 1 block: reality or fantasy? Int Monitor Reg Anesth. 2000;A(12):74*).
25. T T F F T
Saphenous nerve arises from L2-L4, that along with infrapatellar nerve and nerve to vastus medialis forms sub-sartorial plexus. The nerve innervates the skin of the inside of the lower leg from knee to the dorsum of foot and reaches upto toe in 20%. (*Morris GF, Lang LA. Innovations in lower extremity blockade. Tech Reg Anesth Pain Manag. 1999;3:9–18*). Nerve can be blocked around the great saphenous vein which runs between gastrocnemius and tibia. Needle passes through Sartorius until appropriate loss of resistance is felt at around 2–4 cm. The advantage is that it is pain free with more success rate.
26. T T T T T
Motor involvement is not of much importance. (*Manickam B, et al. Feasibility and efficacy of ultrasound guided block of the saphenous nerve in the adductor canal. Reg Anesth Pain Med. 2009;34:578–80*). The nerve block can be used for muscle biopsy, skin grafts. Transarterial approach has lower failure rate. (*Benzon HT, et al. Comparison of the different approaches to saphenous nerve block. Anesthesiology. 2005;102:633–8*). Continuous block in the adductor canal for knee surgery decreases the failure rate associated with femoral nerve block. (*Anderson HL, et al. Continuous saphenous nerve block as supplement to single dose local infiltration analgesia for post operative pain management after total knee arthroplasty. Reg Anesth Pain Med. 2013;38:106–111*).
27. F T T F T
Fibular nerve arises from L4-5 and S1-S2 and has both motor and sensory fibres. It is motor to the muscles of antero-lateral leg and responsible for dorsi-

flexion and pronation of feet. The nerve supplies sensory supply to the knee, lateral lower leg, ankle and heel. Persistent paraesthesia may be seen. Successful block leads to paresis of dorsiflexors causing foot drop. Fibular paresis along with fibular neuritis may be seen.

28. F F T T T
Feet are supplied by five nerves. Four are from sciatic nerve (tibial nerve, superficial fibular nerve, deep fibular nerve, sural nerve). Saphenous is sensory terminal branch from lumbar plexus. Tibial nerve is motor for plantar flexion and supplies anterior and medial regions of the sole. Sural nerve arises from tibial nerve and innervates lateral heel, lateral malleolus, lateral border of feet up to the small toe. Deep fibular nerve innervates toe extensors and first digital space.

29. F T T F F
Saphenous, superficial fibular and sural nerves can be blocked by subcutaneous infiltration. Tibial and deep fibular nerves are blocked separately. Success rate is high with the block. (*Malloy RE. Ankle block. In: Benson B, Malloy RE, editors. Essentials of pain medicine and regional anaesthesia. Philadelphia: Churchill livingstone; 1999. p. 437*). Low levels are seen in blood after the ankle block (*Sharrock NE, Minco R. Venous Lidocaine and bupivicaine levels following mid tarsal ankle block. Reg Anesth. 1988;13(3):75*). Paraesthesia if seen subsides by 4-6 weeks. (*Sharrock NE, et al. Midtarsal block for surgery of the forefoot. Br J Anaesth. 1986;58:37–40*).

30. T F T F T
The injection for lumbar plexus tracks between iliacus and psoas muscles to infiltrate the nerve roots. Lumbar plexus is a deep block that requires a lower frequency (2–5 MHz) probe. Interspace between L5 and S1 is identified on ultrasound. Probe is moved laterally to identify the process of L5. Acoustic shadow of transverse process is known as trident sign. Psoas muscle appears as hypoechoic with multiple hyperechoic striations deeper to the transverse process which is the plexus. Prone position provides a more resting hand position while doing under ultrasound guidance.

31. T F F F T
A line is drawn from posterior superior iliac spine to midpioint of greater trochanter. Another line is drawn perpendicular to this line and needle is inserted 5 cm distal. Leg is positioned in neutral position and a line is drawn from anterior superior iliac spine to pubic tubercle. Another line is drawn parallel to this line from midpoint of greater trochanter inferomedial. Dysesthesia is a painful, itchy, burning/restrictive sensation which is seen most commonly with this block than any other peripheral block. The nerve is difficult to visualise in the sub gluteal region and can be identified in mid thigh by tracking upwards from the popliteal region. Short axis view with in plane approach is preferred.

32. T F T F T
Femoral nerve emerges beneath the inguinal ligament, posterolateral to vessels. It is the largest branch of the lumbar plexus (L2-4). It is visualised as a biconvex or oval hyperechoic structure. Both femoral nerve and lymph nodes appear hyperechoic.

33. F T T T T
Lateral femoral nerve does not have motor component, so large volumes are not required. The nerve divides into anterior and posterior branch. Anterior branch supplies skin over antero-lateral thigh whereas posterior branch supplies skin over lateral thigh up to mid thigh. The nerve lies lateral to psoas muscle immediately caudal to ilioinguinal nerve. Needle is inserted 2 cm medial and caudad to anterior superior iliac spine.
34. T F F T F
The nerve has an articular branch to the joints and therefore is necessary for joint operations. Needles is inserted 1.5 cm caudad and lateral to the tubercle. It is a large volume injection and solution upto 15 mL may be required.. Separate injections are required as branches are separated by Obturator externus muscle.
35. F T T T F
Popliteal is primarily a sensory block, thus lower concentration of local anaesthetic can be used. Popliteal fossa is formed by semimembranous and semitendinosus superomedially and biceps femoris laterally. Inferiorly it is bound by gastrocnemius muscle. Tibial nerve lies just underneath the popliteal fascia. The block is used for any surgery involving S2–S4. Dorsiflexion of the feet aids in visualising the nerve under ultrasound.
36. T F F T T
Hunter's canal is an aponeurotic tunnel in the middle third of the thigh. It contains superficial femoral artery, vein, saphenous nerve, nerve to vastus medialis and terminal branch of Obturator nerve. Needle is placed lateral to the artery. Saphenous nerve appears as hyperechoic structure lateral to artery. High frequency transducer is ideal. Quadriceps weakness is a known complication especially if large volume is infiltrated in the canal.
37. T F T T F
Low frequency probe (6–8 MHz) convex probe is ideally used. Lumbar plexus root is seen just below the lamina and above vertebral body. Needle is visualised between the transverse process of L2-L3 or L3-4 and contractions obtained with nerve stimulator. Shamrock technique involves needle placement cranial to iliac crest.
38. F F T T T
The leg should be positioned in neutral position. High frequency probe (10–15 MHz) is used. Nerve is identified as hypoechoic structure above the Sartorius muscle. Intraneural complications may be seen. (*Shteynberg A, et al. Ultrasound guided lateral femoral cutaneous nerve block: safe and simple anaesthesia for harvesting skin grafts. Burns. 2013;39:146–9*).
39. F T T T T
Nerve is visualised lateral and deep to femoral artery. 10–15 MHz transducer is used. Nerve lies above ilioinguinal muscle.
40. T T F F T
Saphenous nerve lies beneath Sartorius muscle. High frequency probe (10–15 MHz) is required. Saphenous nerve is infrequently visualised as a small

round hyperechoic structure medial to the artery. Local anaesthetic is deposited deep to Sartorius, medial to artery in adductor canal. Nerve pierces fascia lata between the Sartorius and gracilis.

41. T F T F T
The position of thigh slightly abducted and laterally rotated. 10–15 MHz probe is used. Anterior branch lies in a fascial plane between pectineus, adductor longus and adductor brevis. Posterior branch lies between adductor brevis and adductor magnus. Both the branches are not visible and only fascial planes are visualised. Adductor muscle contraction is required for localisation. (*Yoshida T, et al. Ultrasound guided Obturator nerve block: a focussed review on anatomy and updated techniques. Biomed Res Int. 2017;70:7023750*).

42. T T T F T
The nerve is superficial in sub gluteal region and better visualised. The ideal position is between lateral decubitus and prone (Sim's position). Low frequency (4–6 MHz) convex probe is required. Nerve is deep to gluteal muscle and superficial to quadratus femoris.

43. F T T T T
The nerve is ideally blocked at the proximal crease of popliteal fossa. 10–15 MHz linear probe is required. In plane approach is used under the deep border of sciatic nerve. Plantarflexion and dorsoflexion will cause the tibial and peroneal components to move and aid in visualisation.

44. F F T T F
The nerves can be blocked by subcutaneous infiltration. Supine position with a foot rest under the calf facilitates access to ankle. High frequency (10–15 MHz) probe is used. Tibial nerve is visualised immediately lateral to the artery. Sural nerve can be visualised as small hyperechoic structure near to lateral malleolus. (*Redborg KE. Ultrasound improves the success rate of a tibial nerve block at the ankle. Reg Anesth Pain Med. 2009;34(3): 256–60*).

45. F T F T T
The nerve is seen crossing from medial to lateral side. The nerve arises from L23 and supplies cutaneous sensation from the lateral aspect of the thigh and sometimes up to the knee. (*Corujo A, Franco CD, Williams JM. The sensory territory of the lateral cutaneous nerve of thigh as determined by anatomic dissection and ultrasound guided blocks. Reg Anesth Pain Med. 2012;37(5):561–4*). Short axis view is most useful for visualisation in the proximal thigh superior to Sartorius muscle. (*Thain LM, Dawney DB. Sonography of peripheral nerves: technique, anatomy and pathology. Ultrasound Q. 2002:18:225–45*). The nerve is small (cross sectional area of 0.8 sqmm) and visualisation is difficult due to echo bright subcutaneous tissue of anterior thigh. The nerve runs between fat filled fascial tunnel between the Sartorius and tensor fascial lata. (*Zhu J, Zhao Y, Liu F, et al. Ultrasound of the lateral demoral cutaneous nerve in asymptomatic adults. BMC Musculoskelet Disord. 2012;13:227*).

46. F F T T T
The fascia iliaca block is anterior approach to lumbar plexus block. It reliably blocks femoral nerve and lateral femoral cutaneous nerve. Transducer is

oriented longitudinally to image iliacus muscle lateral to nerve. Tilting transducer laterally enhances imaging. (*Hebbard P, Ivanosic J, Sha S. Ultrasound guided supra inguinal fascia iliaca block: a cadaveric evaluation of a novel approach. Anesthesia. 2011;66(4):300–5*). In plane is used and a needle is positioned between fascia iliaca and iliacus muscle. (*Dalens B, Vanneuville G, Tanguay A. Comparison of the fascia iliaca compartment block with the 3 in 1 block in children. Anesth Analg. 1989;69(6):705–13*). Deep circumflex artery arises from recurrant branch from the external iliac artery. The nerve lies deep to the artery. Local anaesthetic can be seen to track over the retroperitoneal surface of the iliacus muscle. (*Eastburn E, Hernandez MA, Boretsky K. Technical success of the ultrasound guided supra inguinal fascia iliaca compartment block in older children and adolescents for hip arthroscopy. Paediatr Anesth. 2017;27:1120–4*).

47. T F T T F

The femoral nerve appears oval or triangular with antero-posterior diameter of 3 mm and 10 mm of medio-lateral diameter. (*Grber H, Peer S, Kovacs P, et al. The ultrasonographic appearance of the femoral nerve and cases of iatrogenic impairment. J Ultrasound Med. 2003;22:163–72*). Femoral nerve is very anisotropic and the tilt of transducer influences visibility. (*Soong J, Schafhalter-Zoppoth I, Gray AT. The importance of transducer angle to ultrasound visibility of the femoral nerve. Reg Anesth Pain Med. 2005;30:505*). The needle may puncture inguinal vessels causing retroperitoneal bleed. (*Spies JB, Berlin L. Complications of femoral artery puncture. AJR AM J Roentgenol. 1998;170:9–11*). The nerve divides away from artery distal to the inguinal ligament causing compromise of the nerve visibility. (*Lonchona TK, McFadden K, Orebaugh SL. Correlation of ultrasound appearance, gross anatomy and histology of the femoral nerve at the femoral traiangle. Surg Radiol Anat. 2016;38(1):115–22*).

48. F F F T F

The adductor canal is bounded anteriorly by the Sartorius, anterolateral by vastus medialis and posteropmedially by adductor longus/magnus. The canal is covered by thickened fascia known as vasoadductor membrane. (*Bendsten TF, Moriggl B, Chan V, et al. Defining adductor canal block. Reg Anesth Pain Med. 2014;39(3):253–4*). The contents of the canal include femoral vessels, saphenous nerve, nerve to vastus medialis, medial femoral cutaneous nerve, anterior and medial genicular nerves. (*Davis JJ, BondTS, Swenson JD. Adductor canal block: more than just the saphenous nerve?Reg Anesth Pain Med. 2009;34(6):618–9*). Sub-sartorial plexus is formed with infrapatellar branch, cutaneous branches of Obturator nerve and deep genicular nerves. Only saphenous nerve and infrapatellar nerve can be visualised. Quadriceps weakness is not seen as seen with femoral block. (*Mariano ER, Kim TE, Wagner MJ, et al. A randomised comparison of proximal and distal ultrasound guided adductor canal catheter insertion sites for knee arthroplasty. J Ultrasound Med. 2014;33:1653–62*). 92% of baseline quadriceps strength is retained. (*Jaeger P, Nielson ZJ, Henningsen MH, et al. Adductor canal block versus femoral block*

and quadriceps strength. a randomised , double blind placebo controlled, cross over study in healthy volunteers. Anesthesiology. 2013;118:409–15). All the nerves in the canal are sensory except nerve to vastus medialis which is motor.

49. T T T T T

Obturator nerve supplies most adductors of medial compartment. Other adductors include pectineus (femoral nerve) and adductor magnus (sciatic nerve). Anterior and posterior divisions are separated by the Obturator externus muscle. (*Choquet O, Capdevilla X, Bennourine K, et al. A new inguinal approach for the Obturator nerve block: anatomical and randomised clinical studies. Anesthesiology. 2005;103:1238–45*). Out of plane is usually preferred because of proximity of femoral vessels to the needle path. The nerve block can cause puncture of Obturator artery and bleed. (*Akata T, Murakami J, Yoshinaga A. Life threatening haemorrhage following obstetric artery injury during transuretheral bladder surgery: a sequel of unsuccessful Obturator nerve block. Acta Anaesthesiol Scand. 1999;43:784–8*). Accessory Obturator nerve is present in 8% of subjects and supplies pectineus. (*Woodburne RT. The accessory Obturator nerve and the innervation of the pectineus muscle. Anat Rec. 1960;136:367–9*).

50. T T T F T

Sciatic nerve has the largest diameter and transverse diameter of more than 17 mm is seen on ultrasound. (*Heinemeyer O, Reimers CD. Ultrasound of radial, ulnar, median and sciatic nerves in healthy subjects and patients with hereditary motor and sensory neuropathies. Ultrasound Med Biol. 1999;25:481–5*). Multiple injections increase the success rate. (*Yamamaoto H, Sakura S, Wada M. A prospective, randomised comparison between single and multiple injection techniques for ultrasound guided subgluteal sciatic nerve block. Anesth Analg. 2014;119(6):1442–8*). Ultrasound signs of successful block include:

- Local anaesthetic distribution along the course of the nerve.
- Tram track sign(due to local anaesthetic peeling edges on both sides of the nerve).
- Orange peel sign: echogenic fascia lifting.
- Heart sign: clarity of common peroneal and tibial nerve on injection.

Landmarks for gluteal technique include:

- Greater trochanter (lateral)
- Ischial tuberosity (medial)

Landmarks for infragluteal technique:

- Conjoint tendon of biceps and semitendinosus

(*Bruhn J, Moayeri N, Groen GJ, et al. Soft tissue landmark for ultrasound identification of the sciatic nerve in the infragluteal region: the tendon of the long head of the biceps femoris muscle. Acta Anesthesiol Scand. 2009;53(7):921–5*). Blood supply of proximal sciatic nerve (arteria comitans) can be imaged and nerve localised. (*Elsharkawy H, Kashy BK, Baonzade R, et al. Ultrasound detection of arteria comitans: a novel techniques to locate the sciatic nerve. Reg Anesth Pain Med. 2017;PMID 29035937*).

51. F F F F T
Common peroneal nerve is smaller and has fewer fascicles so is difficult to identify. (*Peters EY, Nieboer KH, et al. Sonography of the normal ulnar nerve at guyon's canal and of the common peroneal nerve dorsal to the fibular head. J Clin Ultrasound. 2004;32:375–80*). Nerve is best visualised with elevation of leg and internal rotation. (*Gray AT, Huczko EL, et al. Lateral popliteal nerve block with ultrasound guidance. Reg Anesth Pain Med, 2004;29:507–9*). Block is done usually distal to sciatic nerve bifurcation. This is due to nerves close to posterior skin surface. (*Germain G, Levesque S, Dion N, et al. Brief reports: a comparison of an injected cephelad or caudad to the division of the sciatic nerve for ultrasound guided popliteal block: a prospective randomised study. Anesth Analg. 2012;114(1):233–5*). Onset of block is faster for tibial nerve (*Paqueron X, Bouaziz H, Macalou D, et al. The lateral approach to the sciatic nerve at the popliteal fossa: one or two injections? Anesth Analg. 1999;89:1221–5*). Movement of the feet leads to characteristic nerve motion on ultrasound (the seesaw sign).

52. T T T F T
The nerve is derived from S1-3 and is parallel to the scitic nerve. (*Meng S, Lieba-samal D, Reissig LF, et al. High resolution ultrasound of the posterior cutaneous nerve visualisation and initial experience with patients. Skeletal Radiol. 2015;44(10):1421–6*). The nerves that innervate medial thigh and lateral perineum arise 2–4 cm distal to the ischial tuberosity. (*Fritz J, Bizzell C, Kathuria S, et al. High resolution magnetic resonance guided posterior femoral cutaneous nerve blocks. Skeletal Radiol. 2013;42(4):579–86*). The nerve lies underneath the gluteus maximus muscle and over the biceps femoris muscle. (*Hughes PJ, Brown TC. An Approach to posterior femoral cutaneous nerve block. Anaesth Intensive Care. 1986;14(4):350–1*). Ultrasound guidance helps in preventing concomitant sciatic nerve block. (*Johnson C, Johnson R, Niesen A, et al. Ultrasound guided posterior femoral cutaneous nerve block. J Ultrasound Med. 2017*). The nerve can be confused with the tendon of semitendinosus in popliteal fossa. The tendon has a fibrillar echotexture as compared to the nerve (Table 8.2).

Table 8.2 Components of sacral plexus

Sacral plexus		
Nerve	Segment	Distribution
Posterior femoral cutaneous nerve	S123	Abductors of thigh, extensors of thigh
Sciatic nerve	L45S123	Hamstring muscles, adductor magnus
Tibial nerve		Flexors of knee, ankle and toes. Skin over lateral portion of feet
Common peroneal nerve		Biceps femoris, tibialis anterior, skin over anterior surface of leg and dorsal surface of feet
Pudendal nerve	S″£$	Muscles of perineum, skin of external genitalia

53. T F T F T
Saphenous nerve is a terminal branch of femoral nerve that provides sensation to medial leg, malleolus, feet and up to the toe. (*Benzon HT, Sharma S, Calimaran A. Comparison of the different approaches to saphenous nerve block. Anesthesiology. 2005;102:633–8*). The nerve adheres to the saphenous vein and branches away approximately 6 cm proximal to medial malleolus (*Dayan V, Cura L, Clobas S, et al. Surgical anatomy of the saphenous nerve. Ann Thorac Surg. 2008;85(3):896–900*). The nerve can be visualised at tibial tuberosity (*Gray AT, Collino AB. Ultrasound guided saphenous nerve block. Reg Anesth Pain Med. 2003;28:148*). It has an "Egyptian eye" appearance on ultrasound. Fascia lata is thicker and can be identified on ultrasound.

54. F T F F F
Ultrasound improves onset but does not affect the quality of the block. (*Antonakis JG, Sealzo DC, Jorgenson AS, et al. Ultrasound does not improve the success rate of a deep peroneal block at the ankle. Reg Anesth Pain Med. 2010;35(2):217–21*). In plane lateral to medial approach avoids the tendons (tibialis anterior and extensor hallucis). Also the nerve lies on the lateral side. Scanning proximally from the lateral malleolus can identify the nerve. (*Canella C, Demondion X, Guilin R, et al. Anatomic study of the superficial peroneal nerve using sonography. AJR AM J Roentgen. 2009;193(1):174–9*). Superficial peroneal nerve supplies dorsum which is involved with most foot surgeries. Block under the fascia lata may spare peroneus longus and peroneus brevis.

55. T T T F F
Anatomic variation of sural nerve is quite variable. (*Zhu J, Li D, Shao J, et al. An ultrasound study of anatomic variants of the sural nerve. Muscle Nerve. 2011;43(4):560–2*). The nerve innervates the lateral foot along with the toes. (*Soloman LB, Ferris L, Tedman R, et al. Surgical anatomy of the sural and superficial fibular nerves with an emphasis on the approach to the lateral malleolus. J Anat. 2001;199:717–23*). Sural nerve emerges between the medial and lateral heads of the gastrcnemius muscle where it can be seen with ultrasound lying with saphenous vein. (*Caggiat A. Fascial relationships of the short saphenous vein. J Vasc Surg. 2001;34(2):241–6*). The nerve can be visualised just proximal to malleolus and blocked with an in plane approach. (*Redborg KE, Sites BD, Chinn CD, et al. Ultrasound improves the success rate of a sural nerve block at the ankle. Reg Anesth Pain Med. 2009;34(1):24–8*) (Table 8.3).

Table 8.3 Dermatomal levels required for surgery

Dermatomal levels required	
Procedure	Level
Hip arthroplasty	T10
ORIF femur	T12
Knee amputation	T12 (T8 with tourniquet)
Knee arthroplasty	T12 (T8 with tourniquet)

Truncal Blocks

9

1. Anterior abdominal wall:
   (a) Rectus abdominal muscle is the thickest muscle of the abdominal wall.
   (b) Abdominal block is done between external oblique and transversus abdominis muscles.
   (c) Blood supply to anterior abdominal wall is via inferior epigastric artery only.
   (d) Anterior abdominal wall is supplied by posterior primary root of T6-L1.
   (e) There is no overlap between the nerves.
2. Anterior abdominal wall:
   (a) A single plexus innervates all the layers of abdominal wall.
   (b) Lumbar plexus does not innervate the abdominal wall.
   (c) Referred pain from kidney is through ilioinguinal nerve.
   (d) Spermatic cord contains both ilioinguinal and genitor-femoral nerve.
   (e) Inguinal canal is formed by transversalis fascia.
3. Genitofemoral nerve:
   (a) Emerges from L1 to L2 roots.
   (b) Runs above the transversalis fascia.
   (c) Genital branch supplies genito-perineal area.
   (d) Femoral branch supplies proximal medial area of thigh.
   (e) Is involved with the cremastric reflex.
4. Rectus sheath:
   (a) Is formed by the aponeurotic layers.
   (b) The sheath has no connection in the midline.
   (c) There are no vessels in the sheath.
   (d) There is no communication between different planes in anterior abdominal wall.
   (e) Local anaesthetic administration may track into paravertebral space.
5. Transversus abdominal plane block:
   (a) Is a compartmental block.
   (b) Block only involves anterior abdominal wall.

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(c) Residual block may last for more than 24 h.
(d) Blind technique can be done percutaneously.
(e) Two pops are required for successful needle placement.

6. Transversus abdominis plane block:
   (a) Only cephalad spread of local anaesthetic is seen when injected at the level of Petit's triangle.
   (b) Triangle is easy to locate.
   (c) Triangle may not be found in small amount of patients.
   (d) Muscles appear hyperechoic.
   (e) Quadratus lumborum muscle is spared in the block.
7. Transversus abdominis plane block:
   (a) Reliably provides analgesia for procedures above the level of umbilicus.
   (b) Extension of local anaesthetic is from L1 to T10.
   (c) Is contraindicated in children.
   (d) Subcostal approach provides adequate analgesia for upper quadrants of the abdomen.
   (e) The efficacy is the same as epidural analgesia for upper abdominal surgery.
8. Iliohypogastric and ilioinguinal nerve block:
   (a) Anterior superior iliac spine is one of the landmarks.
   (b) Multiple injections provide more success than single injection.
   (c) First click felt on landmark technique is due to external oblique muscle.
   (d) Ultrasound clearly defines three separate muscle layers.
   (e) Visceral puncture may be seen.
9. Iliohypogastric and ilioinguinal nerve block:
   (a) Failure rate is low even with blind technique.
   (b) Blind technique may cause administration of local anaesthetic in the adjacent structures.
   (c) Fascial click is not required in blind technique for confirmation of needle position.
   (d) Volume can be controlled with the use of ultrasound.
   (e) Neuronal fascicles are hyper echoic.
10. Iliohypogastric and ilioinguinal nerve block:
    (a) Ultrasound provides 100% visualisation in children.
    (b) Ilioinguinal nerve is lateral as compared to iliohypogastric nerve.
    (c) Transversus abdominis plane near anterior superior iliac spine is ideal for block.
    (d) Is a plane block
    (e) In plane approach with ultrasound is safe.
11. Genitofemoral nerve block:
    (a) Nerve innervates the cremaster muscle.
    (b) Is not possible with blind technique.
    (c) Nerve lies above external iliac artery.
    (d) Nerve stimulator does not help in nerve block.
    (e) Injection into the spermatic cord increases the chances of success.

12. Rectus sheath block:
    (a) Local anaesthetic spread is seen along the anterior rectus sheath.
    (b) Surgical anaesthesia can be achieved.
    (c) The block cannot be used for incision below the umbilicus.
    (d) Ultrasound usage increases the success rate.
    (e) Classical transversus abdominis plane block extends to T12.
13. Inguinal hernia repair:
    (a) Pain seen after herniorrhaphy is more in young patients.
    (b) Anaesthetic technique does not contribute to post operative pain.
    (c) Early post operative discharge is seen with field block.
    (d) An improvement of pulmonary function tests is seen.
    (e) More intra and post operative pain is seen in obese patients.
14. Inguinal hernia repair:
    (a) Premptive block is better than intra operative block.
    (b) Premptive ilioinguinal block may increase the time to first rescue analgesia.
    (c) Beneficial effect may last for up to 10 days.
    (d) Blocks help reduce complications with spinal anaesthesia.
    (e) Discharge time is prolonged if block is given with spinal anaesthetic.
15. Inguinal surgery in children:
    (a) Ilioinguinal block is most commonly used.
    (b) Blind technique has high success rate.
    (c) Ilioinguinal block is better than wound infiltration for post operative pain relief.
    (d) Long duration of analgesia is seen with blocks as compared to caudal epidural.
    (e) Orchidopexy has similar analgesic requirements as herniorrhaphy.
16. Complications with abdominal blocks:
    (a) Transient femoral nerve block is seen immediately.
    (b) Spontaneous recovery is seen.
    (c) Transient nerve block has equal incidence between males and females.
    (d) Local anaesthetic diffusion is the only mechanism.
    (e) Location of nerves for the block is age dependent.
17. Complication with abdominal block:
    (a) Pelvic hematoma is a known complication.
    (b) Visceral puncture may go unnoticed.
    (c) Liver injury may occur after transverse abdominal block.
    (d) Retroperitoneal hematoma may be seen with rectus sheath block.
    (e) Genitofemoral nerve block may cause testicular artery injury.
18. Breast block:
    (a) Provides motor blockade.
    (b) Block of second to seventh intercostals nerves is required.
    (c) Lateral cutaneous branch of intercostals nerves may be missed.
    (d) Pneumothorax is a frequent complication.
    (e) Thoracic paravertebral block is a suitable alternative.

19. Intercostal block:
    (a) Extends from ventral rami of T1-T11.
    (b) The nerve has three branches.
    (c) Nerve is superior to artery and vein.
    (d) Most commonly blocked at posterior angle of rib.
    (e) Pneumothorax is a frequent complication.
20. Interpleural anesthesia:
    a. Can be used for surgery.
    b. Pleural space extends to L1.
    c. Needle insertion is done at fifth rib.
    d. Pneumothorax is a common complication.
    e. Local anaesthetic acts at mediastinal level.
21. Lumbar somatic block:
    a. Is done at the level of paravertebral level.
    b. Is a small volume block.
    c. Nerves blocked are mainly lumbar.
    d. Prone position is ideal for block.
    e. Lumbar sympathetic blockade is a complication.
22. Inguinal block:
    a. All the nerves originate from L1.
    b. All these nerves can be blocked at the same point.
    c. Injection is done medial and inferior to anterior superior iliac spine.
    d. Hematoma formation is one of the complications.
    e. High concentration of local anaesthetic is required.
23. Paravertebral block:
    a. Parietal pleura is one of the landmarks.
    b. Paravertebral space is an enclosed space.
    c. Anterior displacement of pleura is a sign of successful block.
    d. Costo-tranverse ligament may cause failure of the block.
    e. Transverse approach is ideal for catheter insertion.
24. Transversus abdominis block:
    a. High frequency probe is used.
    b. Scanning should be done medially and posterior for the ideal view.
    c. Fascial layers appear as hyperechoic structures under ultrasound.
    d. Is a plane block.
    e. Preperitoneal fatty layer can cause complications.
25. Transversus abdominis plane clock (subcostal approach):
    (a) Muscle appears as hypoechoic.
    (b) In plane approach is preferred.
    (c) Is a low volume block.
    (d) Mainly used for supraumbilical procedures.
    (e) Spread can be seen up to T1.
26. Quadratus lumborum block:
    (a) The muscle lies between the fascia.
    (b) Muscle is visualised at anterior axillary line.

(c) Can be done through different approaches.
(d) Catheter insertion is done out of plane.
(e) The block covers T4-L2.

27. Thoracic paravertebral block:
(a) Does not provide surgical anaesthesia.
(b) Is not indicated in paediatric population.
(c) Thoracic paravertebral space has only one compartment.
(d) The space contains intercostals nerves.
(e) The space communicates with cervical space.

28. Thoracic paravertebral block:
(a) Can spread to epidural region.
(b) Single dermatome is blocked with injection at the site.
(c) Walking off in cephalad direction increases the success rate.
(d) Catheter insertion usually encounters no resistance.
(e) Kyphoscoliosis increases the risk of thecal puncture.

29. Thoracic paravertebral block:
(a) High concentration continuous block provides better analgesia than low concentration.
(b) Continuous paravertebral block has same efficacy as epidural injection.
(c) Continuous paravertebral block has similar efficacy as intra venous PCA alone.
(d) Paravertebral block is contraindicated in lumbar trauma.
(e) Complication risk is low.

30. Lumbar paravertebral block:
(a) Psoas major forms one of the boundaries.
(b) Injection is done between the muscles.
(c) Ipsilateral sympathetic block may be seen.
(d) Epinephrine may not be used.
(e) Complications are rare.

31. Intercostal nerve block:
(a) Can be used for upper abdominal surgery.
(b) Is effective for visceral abdominal pain.
(c) Intercostals nerves are purely sensory.
(d) Lateral cutaneous branch supplies muscles and skin of the lateral torso.
(e) Anterior branch innervates midline of torso.

32. Intercostals nerve block:
(a) Spinal anaesthesia is a known complication.
(b) Most commonly blocked at the angle of the rib.
(c) Posterior aspect approach increases the risk of Pneumothorax.
(d) High incidence of Pneumothorax is seen.
(e) Is contraindicated in muscular dystrophies.

33. Ultrasound guided transversus abdominis plane block:
(a) L1 segmental nerve is spared.
(b) The spread of local anaesthetic is caudal between the muscles.
(c) High frequency transducer is used.

(d) Quadratus lumborum block is similar to fascial transverse plane block.
(e) Large volume may increase the risk of toxicity.

34. Pectoralis and Serratus anterior plane block:
(a) PECS block anaesthetise pectoral nerves.
(b) PECS II block involves intercostals nerves.
(c) Rib fracture is one of the indications.
(d) Only pectoral nerves are blocked.
(e) Intercostobrachial nerve arises from intercostals nerve.
35. Pectoralis and Serratus anterior branch:
(a) PECS I can be done under ultrasound guidance.
(b) Both PEC I and PEC II are high volume blocks.
(c) Serratus anterior block is done medial to PECS block.
(d) Block can provide surgical anaesthesia for breast surgery.
(e) PECS block is better than paravertebral block in breast surgery.
36. Thoracic paravertebral block:
(a) Paravertebral space is continuous with retroperitoneal space.
(b) The local anaesthetic spreads evenly in cranial or caudal direction.
(c) Loss of resistance superior to transverse process indicates epidural space insertion.
(d) Pleural puncture is usually missed.
(e) Movement of parietal pleura during injection indicates pleural perforation.
37. Intercostal nerve block:
(a) All the intercostal nerves reach anterior to midline.
(b) Low frequency probe is used.
(c) Targeted paraesthesias are elicited.
(d) Higher levels of local anaesthetic are seen.
(e) Supine position is ideal under ultrasound guidance.
38. Transversus abdominis nerve block;
(a) Lateral border of rectus sheath is an important landmark.
(b) The TAP plane only contains nerves.
(c) Injection close to xiphisternum increases the success rate.
(d) Quadratus lumborum block aims to deposit local anaesthetic solution in paravertebral space.
(e) Transversalis fascia block covers large area.
39. Paediatric truncal blocks:
(a) Relative skin to plexus distance remains same as in adults.
(b) In paravertebral block, distance from skin to the space can be accurately calculated.
(c) In plane approach is required for rectus sheath block in children.
(d) Paediatric TAP block is done near the iliac crest.
(e) Linear probe is used for TAP block.
40. Ultrasound guided abdominal nerve blocks:
(a) Only three muscles are seen under ultrasound.
(b) Rectus sheath is formed by external oblique only.

(c) Curvilinear transducer aids in muscle plane visualisation in TAP block.
(d) Peritoneum can be easily distinguished from fascia transversalis.
(e) Single injection is less successful than multiple blocks in subcostal TAP block.

41. Ultrasound guided abdominal wall nerve blocks:
(a) Rectus abdominis muscle is hypoechoic on ultrasound.
(b) Both ilioinguinal nerve and iliohypogastric nerves are best visualised close to anterior iliac spine.
(c) Quadratus lumborum block works by diffusing into the epidural space.
(d) Quadratus lumborum block may cause extended anaesthesia and spread can be seen on ultrasound.
(e) Ultrasound decreases the complication rate in quadratus lumborum block.

42. Ultrasound guided thoracic wall nerve blocks:
(a) PECS I is a high volume block.
(b) Serratus plane block is performed at the level of second rib.
(c) Intercostobrachial nerve gets contribution from first intercostal only.
(d) The target for ultrasound guided serratus plane block is superolateral margin of teres major muscle.
(e) Single injection can block pectoral nerves for breast surgery.

43. Ultrasound guided thoracic paravertebral block:
(a) The space is continuous with intercostal space.
(b) Horner's syndrome is a known complication.
(c) High frequency transducer is ideal.
(d) "lung sliding sign" is indicative of Pneumothorax.
(e) Block can be done through intercostal approach.

44. Ultrasound guided lumbar plexus block:
(a) Nerves are blocked near the paravertebral space.
(b) The psoas muscle differs in size based on the gender.
(c) High frequency transducer is used.
(d) Lamina and transverse process are visualised on ultrasound for blockade.
(e) Delayed retroperitoneal hematoma is a complication.

45. Ultrasound guided intercostal nerve block:
(a) Intercostal nerves are easy to visualise under ultrasound.
(b) Doppler ultrasound can visualise nerves.
(c) All the intercostal muscle layers are visualised on ultrasound.
(d) Blocks are ideally done at mid axillary line.
(e) Transverse approach of transducer allows better spread of local anaesthetic than longitudinal approach.

46. Ultrasound guided rectus sheath block:
(a) Nerves of rectus sheath are easy to identify.
(b) Nerve visualisation is required for effective blockade.
(c) Transversalis fascia is not visualised on ultrasound.
(d) Rectus sheath blocks are of short duration as compared to transversus abdominis block.
(e) Ultrasound guided injection have same adverse effects as loss of resistance technique.

47. Ultrasound guided ilioinguinal and iliohypogastric nerve block:
    (a) Is better than caudal epidural for inguinal surgeries.
    (b) Selective blockade is advised with the help of ultrasound.
    (c) Internal oblique is the thickest muscle.
    (d) External oblique is best visualised at anterior superior iliac spine.
    (e) Deep circumflex artery on ultrasound is indicative of nerve position.
48. Ultrasound guided transversus abdominis plane block:
    (a) Iliac crest forms one of the landmarks for the block.
    (b) Low volume is required for the block.
    (c) A single injection blocks more than 10 dermatomes.
    (d) The block is effective in gynaecological cancer surgery.
    (e) TAP blocks can help in laparoscopic surgery.
49. Ultrasound guided quadratus lumborum block:
    (a) Can be approached by two techniques.
    (b) Low frequency transducer is used.
    (c) Lateral decubitus position is ideal.
    (d) Lower pole of kidney helps in the blockade.
    (e) Local anaesthetic spread can be visualised.
50. Ultrasound guided thoracic paravertebral block;
    (a) Bilateral blocks are contraindicated.
    (b) Spinal nerves in the thoracic paravertebral space are enclosed in the sheath.
    (c) Thoraco lumbar spread may be seen up to the retroperitoneal space.
    (d) Single injection covers 8–9 spaces.
    (e) Previous thoracotomy affects the sensory distribution of the block.
51. Ultrasound guided thoracic paravertebral block:
    (a) Anaesthetic block is gravity dependent.
    (b) Significant epidural block may be seen as a complication.
    (c) Loss of resistance is seen in all cases.
    (d) Pleura can be visualised at all levels.
    (e) Correct position of needle in space can be confirmed by ultrasound.
52. Ultrasound guided thoracic paravertebral block:
    (a) Anterior displacement of pleura is visualised.
    (b) High frequency transducer is ideal.
    (c) Thoracic paravertebral block can be approached through intercostal space.
    (d) Oblique axis of transducer increases the visibility of the pleura.
    (e) Intercostal approach increases the risk of central neuraxial complications.

Answers

1. T F F F F
   The muscles of abdominal wall include rectus abdominis, external oblique, internal oblique and transversus abdominis. Rectus abdominis is the thickest followed by internal oblique, external oblique and transversus abdominis muscle. The block is done between internal oblique and transversus abdominis

muscle. (*Rankin G, Stokes M, Newham DJ. Abdominal muscle size and symmetry in normal subjects. Muscle Nerve. 2006;34:320–6*). Blood supply to anterior abdominal wall is through the deep epigastric artery, deep circumflex iliac artery and superficial epigastric artery. (*Mirilas P, Skanadalakis JE. Surgical anatomy of the retroperitoneal spaces, Part IV: retroperitoneal nerves. Am Surg. 2010;76:253–62*). Anterior abdominal wall is supplied by anterior abdominal wall. The nerves along with intercostals nerves, subcostal nerves and L1 lies in plane between internal oblique and transversus abdominis. (*Rozen WM, Tram TM, Ashton MW, et al. Reprising the course of the thoracolumbar nerves: a new understanding of the innervation of the anterior abdominal wall. Clin Anat. 2008;21:325–33*). Each segmental origin contributes at least two nerves that branches extensively and communicates freely. (*Barrington MJ, Ivanusic JJ, Rozen WM, et al. Spread of injectate after ultrasound guided subcostal transversus abdominis plane block: a cadaveric study. Anaesthesia. 2009;64:745–50*).

2. F F T T T

   Two nerve plexuses are seen. T9-L1 forms longitudinal nerve plexus while T6-L1 forms rectus sheath plexus. Lumbar plexus innervates the lower part of abdominal wall through iliohypogastric, ilioinguinal and genitofemoral nerve. The referred pain from kidney passes through iliohypogastric and ilioinguinal nerves. (*Anloague PA, Muijbregts P. Anatomical variation of the lumbar plexus: a descriptive anatomy study with clinical implications. J Man Manip Ther. 2009;17:e107–14*). Spermatic cord contains both ilioinguinal and genitofemoral nerves. (*Rab M, Eboner And J, Dellon AL. Anatomic variability of the ilioinguinal and genitofemoral nerve: implications for the treatment of groin pain. Plast Reconst Surg. 2001;108:1618–23*). Inguinal canal is an oblique passage about 4 cm that extend from internal inguinal ring (defect in transversalis fascia) to external ring (defect in external oblique aponeurosis).

3. T F T T T

   The nerve pierces the psoas major muscle and runs between transversalis fascia and peritoneum. (*Liu WC, Chen TH, Shyu JF, et al. Applied anatomy of the genital branch of the genitofemoral nerve in open inguinal herniorraphy. Eur J Surg. 2002;168:145–9*). The genital branch supplies cremaster muscle and skin of scrotum and thigh in males and round ligament of uterus in females. Femoral branch supplies proximal medial area of thigh and skin over the triangle of scarpa. The triangle of scarpa is a subfascial space bounded by inguinal ligament (superiorly), adductor longus (medially) and Sartorius laterally. The nerve is involved with both sensory and motor aspects of cremastric reflex. It involves contraction of cremaster muscle on stroking the superior and medial inner part of thigh.

4. T F F F T

   Rectus sheath is a bilaminar fibrous extension of the aponeurotic layer of external oblique, internal oblique and transversus abdominis muscle. The muscles fuse in midline as linea alba. The sheath consists of superior and inferior epigastric vessels and run longitudinally through the medial portion of rectus

abdominis muscle. There is communication between different planes at the level of inguinal level. (*Rosario DJ, Jacob S, Luntley J, et al. Mechanism of femoral nerve palsy complicating percutaneous ilioinguinal field block. Br J Aanesth. 1997;78:314–6*). Local anaesthetic may track into paravertebral space as there may be a communication between the thoracolumbar fascia, paravertebral space, fascia transversalis and iliac fascia. (*Saito T, Tanuma K, Yamada K, et al. Anatomical consideration of anaesthetic dispersion into abdominal cavity causing broad unilateral anaesthesia after inadvertent local anaesthetic infusion into endothoracic fascia. Masui. 1994;43:1467–71*).

5. T F T T T
   Local anaesthetic is deposited between internal oblique and transversus abdominis muscle (TAM plane). (*McDonell JG, O'Donnell BD, Farrell T, et al. Transversus abdominis plane block: a cadaveric and radiologic evaluation. Reg Anesth Pain Med. 2007;32:399–404*). Block involves antero-lateral abdominal wall. Blind technique can be done through lumbar triangle of petit and its margins include iliac crest (inferior), latissmus dorsi (posterior), external oblique (anterior) and internal abdominis muscle (floor). (*Rafi AN. Abdominal field block: a new approach via the lumbar triangle. Anaesthesia. 2001;56:1024–6*). Two clicks are required for successful block. First click pierces the fascia between external oblique and internal oblique while the second click pierces the fascia between internal oblique and transversus abdominis muscle.
6. F F T T F
   Only the fascia between the internal oblique and transversus abdominis muscle can be felt and both caudad and cephalic spread is seen. Petits triangle is difficult to locate especially in obese patients. (*Jancovic ZB, Du Feu FM, McDonnell P. An anatomical study of the transverse abdominal plane block: location of the lumbar triangle of petit and adjacent nerves. Anesth Analg. 2009;109:981–5*). In about 17.5% of the patients, the triangle cannot be found as latissmus dorsi may be covered with external oblique muscle. (*Loukas M, Tubbs RS, El-Sedfy A, et al. The clinical anatomy of the triangle of petit. Hernia. 2007;11:441–4*). The three muscles (external oblique, internal oblique, transversus abdominis) are visualised as hypoechoic longitudinal bands. Internal oblique is thickest and transversus abdominis is the deepest. The fascia between the muscles is hyperechoic. (*Hebbard P. Subcostal transversus abdominis block under ultrasound guidance. Anesth Analg. 2008;106:674–5*). Local anaesthetic may track down the quadratus muscle. (*Carney J, Lane J, Quondamattaeo F, et al. Defining the limits and the spread beyond the transversus abdominis plane block: radiological and anatomical study. Reg Anesth Pain Med. 2008;33(S1):e7*).
7. F T F T T
   Transversus abdominis plane block is not reliable above T10. (*Barrington MJ, Ivanusic JJ, Rosen WM, et al. Spread of injectate after ultrasound guided subcostal transversus abdominis plane block: a cadaveric study. Anaesthesia. 2009;64:745–50*). The spread of local anaesthetic is seen from L1 to T10. (*McDonnell JG, O'Donnell B, Corley G, et al. The analgesic efficacy of transversus abdominis plane block after abdominal surgery: a prospective ran-*

domised controlled trial. Anesth Analg. 2007;104:193–7). The block can be used in children at the dosage of 0.2 mL/kg. (*Palmer GM, Luk VH, Smith KR, et al. Audit of initial use of the ultrasound guided transversus abdominis plane block in children. Anesth Intensiv Care. 2011;39:279–86*). Subcostal approach provides analgesia for upper quadrants. (*Niraj G, Searle A, Mathews M, et al. Analgesic efficacy of ultrasound guided transversus abdominis plane block in patients undergoing open appendecectomy. Br J Anaesth. 2009;103:601–5*). The efficacy of the block is the same as epidural analgesia. (*Niraj G, Kelkar A, Jeyapalan I, et al. Comparison of analgesic efficacy of subcostal transversus abdominis plane block with epidural analgesia following upper abdominal surgery. Anesthesia. 2011;66:465–71*).

8. T F T F T

   Needle insertion for the block is medial and inferior to anterior superior iliac spine. Multiple injections has the same efficacy as a single injection. (*Lim SL, Ng SB, Tan GM. Ilioinguinal and iliohypogastric nerve block revisited: single shot versus double shot technique for hernia repair in children. Paediatr-Anaesth. 2002;12:255–60*). Ultrasound does not always defines three separate muscle layers. Fifty percent has only two muscle layers as external oblique is limited to an aponeurosis in the medial area adjacent to anterior superior iliac spine. (*Willschke H, Marhofer P, Boseberg A, et al. Ultrasonography for ilioinguinal/iliohypogastric nerve blocks in children. Br J Anaesth. 2005;95:226–30*). Visceral puncture may be seen. (*Van Schoor AN, Boon JM, Bosenberg AT, et al. Anatomical consideration of the paediatric ilioinguinal/iliohypogastric nerve block. Paediatr Anaesth. 2005;15:371–7*).

9. F T F T F

   The failure rate is of the incidence of 6–43% due to high anatomical and landmark variability. (*Randhawa K, Soumian S, Kyi M, et al. Sonographic assessment of the conventional "blind" ilioinguinal block. Can J Anesth. 2010;57:94–5*). Blind technique can cause administration of local anaesthetic into iliac muscle (18%), Transverse Abdominal Muscle (26%), internal oblique muscle (29%), external oblique muscle (9%), subcutaneous tissue (2%) and peritoneum (2%). (*Weintraud M, Marhaufer P, Bosenberg A, et al. Ilioinguinal/iliohypogastric blocks in children: where do we administer the local anaesthetic without direct visualisation? Anesth Analg. 2008;106: 89–93*). If the clicks are not ascertained during the needle insertion, the rate of complications increases. (*Hong JY, Kim WO, Koo BN, et al. The relative popostion of ilioinguinal and iliohypogastric nerves in different age groups of paediatric patients. Acta Anaesthesiol Scand. 2010;54:566–70*). The volume can be controlled with the use of ultrasound. (*Willschke H, Bosenberg A, Marhofer P, et al. Ultrasonography guided ilioinguinal/iliohypogastric nerve block in paediatric anesthetic: what is the optimal volume? Anesth Analg. 2006;102:1680–4*). Neuronal fascicles are hypoechoic that run longitudinally with in the nerve. Intrafascicular epineurium appears as hyperechoic. (*Martinoli C, Biannchi S, Dahmane M, et al. Ultrasound of tendons and nerves. Eur Radiol. 2002;12:44–55*).

10. T T T F T
Ultrasound provides 100% visualisation of the nerves in children and up to 95% in adults. (*Eichenberger U, Greher M, Kirchmair L, et al. Ultrasound guided blocks of the ilioinguinal and iliogypogastric nerve: accuracy of a selective new technique compared by anatomical technique. Br J Anaesth. 2006;97:238–43*). TAM plane is the plane between transversus abdominis and internal oblique muscle where nerves are present. (*Ford S, Dosani M, Robinson AJ, et al. Defining the reliability of sonoanatomy identification by novices in ultrasound guided pediatric ilioinguinal and iliohypogastric nerve bolockade. Anesth Analg. 2009;109:1793–8*). The nerves can be visualised and selectively blocked. In plane approach prevents peritoneal puncture.
11. T F T F F
The nerve can be blocked by landmark technique. The landmarks include one finger breadh above the midpoint between the anterior superior iliac spine and mid fold at the symphysis pubis. (*Hsu GL, Ling Py, Hseich CH, et al. Outpatient varicocelectomy performed under local anaesthesia. Asian J Androl. 2005;7:439–44*). Typical site for injection is supero-lateral to the pubic tubercle. (*Peng PW, Tumber PS. Ultrasound guided interventional procedures for patients with chronic pelvic pain: a description of techniques and review of literature. Pain Physician. 2008;11(2):215–24*). Pain radiates upwards towards inguinal ligament where femoral artery becomes iliac artery. Nerve can be seen lying superficial to the artery. Visible testicle retraction may be seen with stimulation of nerve. Injection into the spermatic cord increases the risk of spermatic artery injury and deferens duct puncture.
12. F T F T F
The nerves lie between muscle and posterior sheath. Myofascial intersections present on anterior rectus muscle and not posterior sheath, thus extending the spread cephalo-caudal. The block can be used for surgical anaesthesia and post operative analgesia for laparotomy or kaparoscopic structures. (*Finnerty O, Carney J, McDonnell JG. Trauma blocks for abdominal surgery. Anesthesia. 2010;126:1723–32*). Rectus sheath block along with other blocks like ilioinguinal block can be used for incisions below umbilicus. Ultrasound guidance increases the success rate. (*Dolan J, Lucic P, Geary T, et al. The rectus sheath block: accuracy of local anaesthetic placement by trainee anesthetiologists using loss of resistance or ultrasound guidance. Reg Anesth Pain Med. 2009;34:247–50*). The spread of the block is seen from L1 to T10.
13. T F T T T
Post operative pain is seen more in young patients. (*Lau H, Lee F. Determinant factors of pain after ambulatory inguinal herniorrhaphy: a multivariate analysis. Hernia. 2001;5:17–20*). Anaesthetic technique also contributes to the post operative pain after hernia repair. (*Song D, Greilich NB, White PF, et al. Recovery profiles and costs of anaesthesia for out patient unilateral inguinal herniorrhaphy. Anesth Analg 2000;91:876–81*). Early post operative discharge is seen with field block for inguinal surgery. (*Aaasto V, Thuen A, Raeder J. Improved long lasting post operative analgesia, recovery function and patient satisfaction after inguinal hernia repair with inguinal field block compared*

with general anaesthesia. Acta Anaesth Scand. 2002;46:674–8). An improvement in pulmonary function tests is seen. (*Gonullu NN, Cubukcu A, Alponat A. Comparison of local and general anaesthesia in tension free (Lichenstein) hernioplasty: a prospective randomised trial. Hernia. 2002;6:29–32*). Obese patients have more incidence of post operative pain. (*Reid TD, Sanjay P, Woodword A. Local anaesthetic hernia repair in overweight and obese patients. World J Surg 2009;33:138–41*).

14. F T T T F

There is no difference in pain scores between pre emptive and intra operative block. (*Trotter C, Martin P, Youngson G, et al. A comparison between ilioinguinal-iliohypogastric nerve block performed by anaesthetist or surgeon for post operative analgesia following groin surgery in children. Paediatr Anaesth. 1995;5:363–7*). Time to first rescue analgesia is increased. (*Ong CKF, Lirk P, Seymour RA, et al. The efficacy of pre emptive analgesia for acute post operative management: a meta analysis. Anesth Analg. 2005;100:757–73*). Extended beneficial effect for pain relief is seen upto few days. (*Toivonen J, Permi J, Rosenberg PH. Effect of preincisional ilioinguinal and iliohypogastric nerve block on post operative analgesic requirement in day surgery patients undergoing herniorrhaphy under spinal anaesthesia. Acta Anaesthesiol Scand. 2001;45:603–7*). The complications seen with spinal anaesthesia specially hypotension, motor blockade and inability to void may be decreased with the block. (*Toironen J, Permi J, Rosenberg PH. Analgesia and discharge following preincisional, ilioinguinal and iliohypogastric neural blockade combined with general or spinal anaesthesia for inguinal herniorrhaphy. Acta Anaesthesiol Scand. 2004;48:480–5*). The discharge time remains the same if the block is given. (*Gupta A, Axelsson K, Thorn SE, et al. Low dose bupivicaine plus Fentanyl for spinal anaesthesia during ambulatory inguinal herniorrhaphy: a comparison between 6 mg and 75 mg of bupivicaine. Acta Anaesthesiol Scand. 2003;47:13–9*).

15. T F T T F

Ilioinguinal block is used in 70% of children between 4 and 7 years. Blind technique has a success rate of up to 70–80%. (*Lim SL, Ng Sb A, Tan GM. Ilioinguinal and iliohypogastric nerve block revisited: single shot versus double shot technique for hernia repair in children. Paediatr Anaesth. 2002;12:255–60*). Ilioinguinal block is better than wound infiltration for post operative analgesia. (*Caetano AM, Falbo GH, Lima LC. Comparison among three techniques of post operative regional anaesthesia with ropivicaine in children. Rev Bras Anestesiol 2006;56:561–70*). The nerve block leads to longer duration of analgesia with no difference in post operative pain relief. (*Hanallah RS, Broadman LM, Belman AB, et al. Comparison of caudal and ilioinguinal/iliohypogastric nerve blocks for control of post orchipexy pain in paediatric ambulatory surgery. Anesthesiology. 1987;66:832–4*). Orchidopexy involves more testicular and spermatic cord traction and gets innervation from T10 and aortic and renal sympathetic plexus. (*Jagannathan N, Sohn L, Sawarlekar A, et al. Unilateral groin surgery in children: will the addition of an ultrasound guided ilioinguinal nerve block enhcance the duration of analgesia of a single shot caudal block? Paediatr Anaesth. 2009;19:892–8*).

16. F T F F T
Transient femoral nerve block is seen with ilioinguinal of trans abdominal plane block and there may be 2.5–6 h delay. Incidence is 0.27–28%. (*Kluger MT. Delayed onset femoral nerve block following an inguinal field block for hernia repair. Anesth Intensive Care. 1998;26:592–3*). Recovery from block is seen within 12 h but can take 36 h. The transient femoral block is seen less likely to occur in females because of increased distance between femoral nerve and point of injection. The mechanisms of transient femoral palsy include local anaesthetic diffusion, femoral nerve trauma, suture involvement, staple entrapment, compression and hematoma. (*Garcia-Urena MA, Vega V, Rubio G, et al. The femoral nerve in the repair of inguinal hernia: well worth remembering. Hernia. 2005;9:384–7*). In children, the abdominal wall is thinner and body size and operative area smaller and the nerves are close to peritoneum. (*Hong JY, Kim WO, Koo BN, et al. The relative position of ilioinguinal and iliohypogastric nerves in different age groups of paediatric patients. Acta Anaesthesiol Scand. 2010;54:566–70*).
17. T T T T T
The complication includes pelvic hematoma (*Amory C, Mariscal A, Guyot E, et al. Is ilioinguinal/iliohypogastric nerve block always totally safe in children? Paediatr Anaesth. 2003;13:164–66*). Liver injury is also seen. (*Lancaster P, Chadwick M. Liver trauma secondary to ultrasound guided transverse abdominal plane block. Br J Anaesth. 2010;104:509–10*). Retroperitoneal hematoma is a known complication. (*Yuen PM, Ng PS. Retroperitoneal hematoma after a rectus sheath block. J Am Assoc Gynecol Laparsoc. 2004;11:448*). Genitofemoral nerve block may cause testicular artery injury. (*Goldstein M, Young GPH, Einer-Jenson N. Testicular artery damage due to infiltration with a fine gauge needle: experimental evidence suggesting that blind spermatic cord blockade should be abandoned. Surg Forum. 1983;24:653–6*).
18. F T T F T
The breast block is aimed at sensory block and lower concentration of local anaesthetic is used (0.25% bupivicaine. 0.2% ropivicaine). Intercostals nerve block is required along with superficial cervical nerve plexus. Lateral cutaneous nerve may be missed and usually blocked by subcutaneous infiltration. Pneumothorax is seen in less than 1%.
19. T F F T F
The intercostals nerves extend from ventral rami of T1 to T11. Twelfth thoracic nerve is subcostal and is not an intercostal nerve. Intercostals nerve has five branches:
    - Preganglionic sympathetic fibres to sympathetic chain.
    - Receives postganglionic neurons from sympathetic chain ganglion.
    - Dorsal rami carrying posterior cutaneous and motor fibers to paravertebral region.
    - Lateral cutaneous branch.
    - Anterior cutaneous branch.

Table 9.1 Nerves for pectoral and serratus blocks

Nerves for pectoral and serratus blocks		
Nerve	Origin	Innervation
Long thoracic	C567	Serratus anterior muscle
Lateral pectoral	C567	Pectoralis major and minor
Medial pectoral	C8T1	Pectoralis major and minor
Intercostal	Anterior rami of thoracic rami	Sensory innervation to skin
Thoracodorsal nerve	C678	Latissimus dorsi

The nerve lies inferior to intercostals artery and vein throughout the intercostals space. Most commonly the nerve is blocked at the posterior angle of the rib as lateral approach may miss lateral cutaneous branch. The incidence of Pneumothorax is less than 0.5% (Table 9.1).

20. T T F F T
The anesthesia can be used for analgesia for fracture of ribs. Pleural space extends from apex of lung to L1. Skin wheal is raised superior to eighth rib in seventh intercostals space, 10 cm to midline. Pneumothorax is infrequent. Local anaesthetic diffuses from pleural space to reach intercostals nerves. Local anaesthetic also diffuses to mediastinum and blocks greater, lesser and least splanchnic nerves.
21. T F T T T
Block requires 5–7 mL/lumbar root while for analgesia only 1–2 mL is required. Lumbar nerves give off posterior branch to paravertebral muscles, receives white rami communicantes. After these branches, lumbar plexus is formed between psoas and quadratus lumborum muscles. Prone position is ideal for the block and is done 2.5–3 cm lateral to midline. The needle is made to contact with transverse process at a depth of 3–5 cm, needle is withdrawn and directed caudad to block the nerve root at the same level.
22. F F T T F
Iliohypogastric and ilioinguinal nerves originate from L1 while genitofemoral nerve arises from L1 to L2. Genitofemoral nerve follows a different course and needs to be blocked at a different level. Hematoma formation is seen especially if done in the spermatic cord. It is a sensory block and only low concentration is required.
23. T F T T F
The boundaries of paravertebral space include: parietal pleura (anterior), superior costotransverse ligament (posterior), vertebral body (medial), intervertebral disc and intervertebral foramen. Paravertebral space is connected to level above and below. The injection may be done superficial to the ligament as it can be taken for parietal pleura. Paramedian approach is preferred for catheter insertion because of decreases angle of placement.
24. T F T T T
8–12 MHz probe is used. Scanning too medially shows only two layers with only the aponeurosis of external oblique. Scanning posteriorly will scan latissmus

dorsi which can cause confusion. It is a plane block and minimum volume of at least 20 mL is required. Transversus abdominis muscle appears as hypoechoic band and can get confused with peritoneal fatty layer. Peristaltic movements of the bowel in preperitoneal fatty layer can help identify.

25. T T F T F
The muscle is hypoechoic and passes beneath rectus abdominis muscle. Needle is inserted from postero-lateral position and advanced until tip is between rectus abdominis and transversus abdominis muscle. Usually a volume of 20 mL is injected. The spread of local anaesthetic can be seen upto T8.
26. T T T F T
The block is done between the superficial medial and deep layers of the thoraco-lumbar fascia. Linear probe is placed at anterior axillary line above the iliac crest. There are two approaches to the block:
QL1: injection in the aponeurosis of quadratus lumborum muscle.
QL2: injection is done between quadratus lumborum fascia and deep thoraco lumbar fascia.
Catheter insertion is done in in plane technique. A dosage of 0.3 mL/kg can cover an area of T4-L2 and a higher dosage of 0.6 mL/kg can cover more dermatomes.
27. F F F T T
Paravertebral block provides surgical anaesthesia. (*Klein SM, Bergh, Steck AM, et al. Thoracic paravertebral block for breast surgery. Anesth Analg. 2000;90:1402–5*). The block is done in paediatric population. (*Lonnqvist PA, Continuous paravertebral block in children. Initial experience. Anaesthesia. 1992;47:607–9*). Thoraci paravertebral space has two compartments: Anterior extrapleural paravertebral compartment containing sympathetic chain, and the posterior subendothoracic paravertebral compartment containing intercostals nerves and vessels. (*Nunn JF, Slavin G. Posterior intercostals nerve block for pain relief after cholecystectomy. Anatomical basis and efficacy. Br J Anaesth. 1980;52:253–60*). Thoracic paravertebral space communicates with cervical space. (*Purcell-Jones G, Pither CE, Justins DM. Paravertebral somatic nerve block: a clinical, radiographic and computed tomographic study in chronic pain patients. Anesth Analg. 1989;68:32–9*).
28. T F F F T
Thoracic paravertebral block can spread to epidural region that result in greater distribution of anaesthesia. (*Saito T, Gallagher ET, Cutler S, et al. Extended unilateral anaesthesia. New technique or paravertebral anaesthesia? Reg Anesth. 1996;21:304–7*). A single injection extends caudad and cephalad involving many dermatomes. (*Saito T, Den S, Tanuma K, et al. Anatomical basis for paravertebral anesthetic block: fluid communication between the thoracic and lumbar paravertebral regions. Surg Radiol Anat. 1999;21:359–363*). Needle is inserted and a contact is made at the transverse process and needle walked off caudad. Cephalad progression may lead to Pneumothorax. (*Gilbert J, Multman J. Thoracic paravertebral block: a method of pain control. Acta Anesthesiol Scand. 1989;33:142–5*). Certain resistance is expected qwhile

inserting the catheter. No resistance should raise the suspicion of interpleural placement. (*Sabanathan S, Smith PJ, Pradhan GN, et al. Continuous intyercostal block for pain relief after thoracotomy. Ann Thorac Surg. 1988;46:425–6*).

29. F T F F T

The efficacy of high concentration is the same as low concentration, though complication rate increases with the high concentration. Continuous thoraci paravertebral block has same efficacy as epidural but with less side effects (hypotension, urinary retention). (*Matheus PJ, Govenden V. Comparison of continuous paravertebral and extradural infusions of bupivicaine for pain relief after thoracotomy. Br J Anaesth. 1989;62:204–5*). Continuous paravertebral thoracic block has better efficacy than PCA. (*Carabine UA,Gilliland H, Johnston JR, et al. Pain relief for thoracotomy: comparison of morphine requirements using an extrapleural infusion of bupivicaine. Reg Anesth. 1995;20:412–7*). The block is not contraindicated in lumbar trauma as it does not cause urinary retention or lower limb motor function. It is useful in patients with multiple rib fractures with lumbar trauma. It also allows continuous neurologic assessment. (*Karmaker MK, Chui PT, Joynt GM, et al. Thoracic paravertebral block for management of pain associated with multiple rib fractures in patients with concomitant lumbar spinal trauma. Reg Anesth Pain Med. 2001;26:169–73*). Complication rate is up to the rate of 2.6–5%. These include vascular puncture (3.8%), hypertension (4.6%), pleural puncture (1.1%), Pneumothorax (0.5%). (*Lonnqvist PA, Mackenzic J, Soni AK, et al. Paravertebral blockade: failure rate and complications. Anaesthesia. 1995;50:813–5*).

30. T T T F T

The boundaries include: psoas major (anterolateral), vertebral body, intervertebral disc and intervertebral foramen (medially), transverse ligament and transverse process (posterior). Local anaesthetic is injected anterior to the transverse process between the two parts of psoas major muscle. Ipsilateral sympathetic block may be seen due to the epidural spread and anterior spread via tendinous arches to lumbar sympathetic chain. Addition of epinephrine (2.5–5.0 mcg/mL) reduces systemic absorption and decreases toxicity. Complications include intravascular spread, epidural spread, migration into intrathecal space, visceral injury and motor weakness. (*Wassef MR, Randazzo T, Ward W. The paravertebral nerve root block for inguinal herniorrhaphy- a comparison with the field block approach. Reg Anesth Pain Med. 1998;23:451–6*).

31. T F F T T

The indications for intercostals block include: rib fracture, thoracotomy, thoracosotomy, mastectomy, gastrostomy and cholecystectomy. Celiac plexus block is required for somatic blocks, 2 dermatomes above and two below the level of surgical incision. (*Kopors DJ, Thompson GE. Intercostals blocks for thoracic and abdominal surgery. Tech reg Anesth Pain Manag. 1998;2:25–9*).

32. T T T F F

The complications of intercostals nerve blockade include spinal anaesthesia, Pneumothorax, local anaesthetic toxicity and hematoma. The block is most commonly done 6–8 cm from the spinous processes. The rib is superficial at the

angle and easy to palpate. The average distance from posterior aspect of rib to pleura averages 8 mm and may increase the risk of Pneumothorax. (*Nunn JF, Slavin G. Posterior intercostals nerve block for pain relief after cholecystectomy. Anatomical basis and efficacy. Br J Anaesth. 1980;52:253–60*). The incidence of Pneumothorax is less than 1% and other complications include perforation of peritoneum and abdominal viscera. The block is not contraindicated in muscular dystrophies. *(Vandepitte C, Gautier P, Bellen P, et al. Use of ultrasound guided intercostals nerve block as a sole anaesthetic technique in a high risk patient with duchenne muscular dystrophy. Acta Anaesthesiol Belg. 2013;64(2):91–94*).

33. T F F T T

L1 segmental nerve is spared as it is not covered by lateral TAP block and requires an anterior TAP block medial to anterior superior iliac spine. The spread is seen cranially to thoracic paravertebral space. (*Carney J, Finnerty O, Rauf J, et al. Studies on the spread of local anaesthetic solution in transversus abdominis plane block. Anaesthesia. 2011;66:1023–30*). Low frequency transducer (5–2 MHz) curved transducer is placed in transverse axis to visualise three muscles and quadratus lumborum muscle. Linear transducer is placed in axial plane in midaxillary line and moved posteriorly. (*Willard FH, Vleeming A, Schuenke MD, et al. The thoracolumbar fascia: anatom, function and clinical considerations. J Anat. 2012;221:507–36*). Quadratus lumborum muscle is well vascularised and large volume injected may lead to increase in absorption. (*Moruchi T, Iwaraski S, Yamakage M. Quadratus lumborum block: analgesic effects and chronological ropivicaine concentration after laparoscopic surgery. Reg Anesth Pain Med. 2016;41:146–50*) (Table 9.2).

34. T T T F T

PECS 1 blocks medial and lateral pectoral nerves. Local anaesthetic is injected between pectoralis major and minor muscles. (*Blanco R. The "PECS block": a novel technique for providing analgesia after breast surgery. Anaesthesia. 2011;66:847–8*). PECS II involves second injection lateral to PECS I block in the plane between pectoralis minor and serratus anterior muscles. This involves upper intercostals nerves. (*Blanco R, Fajardo M, Parras Maldonado T. Ultrasound*

Table 9.2 Quadratus lumborum blocks

	QLB1	QLB2	TQLB
Clinical indications	Abdominal surgery below the umbilicus	Above or below the umbilicus	Above or below the umbilicus
Dermatomes covered	L1	T4-L1	T4-L1
Lower extremity weakness	Nil	Nil	possible
Spread to lumbar plexus	Nil	Nil	possible
Injection site	Lateral to quadratus lumborum muscle	Posterior to quadratus lumborum muscle	Anterior to quadratus lumborum muscle

description of PECS II (modified PECS I): a novel approach to breast surgery. Rev Esp Anestesiol Reanim. 2012;59:470–5). The indications include rib fracture, breast surgery and thoracotomy. Lateral and medial pectoral nerves are blocked along with supraclavicular nerves and intercostal nerves. Intercostobrachial nerve is the lateral branch of second and third intercostal nerve. It innervates axilla.

35. T F F F T

Landmarks for PECS I block include pectoralis major, pectoralis minor and pectoral branch of thoracoacromial artery. A total volume of 0.2 mL/kg long acting local anaesthetic is sufficient. Serratus anterior block is done lateral and more posterior then PECS I and PECS II. (*Womack J, Varma MK. Serratus anterior block for shoulder surgery. Anaesthesia. 2014;69:395–6*). At this level, the intercostobrachial nerve, lateral cutaneous branch of intercostal nerves (T3-T9), long thoracic nerve and thoracodorsal nerve are in one place between serratus anterior and latissmus dorsi. The block does not provide surgical anaesthesia but significantly decrease post operative analgesic requirements. (*Bashandy GM, Abbas DN. Pectoral nerves I and II blocks in multimodal analgesia for breast cancer surgery: a randomised clinical trial. Reg Anesth Pain Med. 2015;40:68–74*). PECS block has shown more efficacy than paravertebral block in mastectomy. (*Watiba SS, Kamel SM. Thoracic paravertebral block versus pectoral nerve block for analgesia after breast surgery. Egyptian J Anaesth. 2014;30:129–35*).

36. T F F F F

The paravertebral space is continuous with retroperitoneal space via medial and lateral arcuate ligaments of the diaphragm. (*Karmaker MK. Thoracic paravertebral block. Anesthesiology. 2001;95:771–80*). The spread of local anaesthetic is seen both cranially and caudally. Four dermatomes caudal and one dermatome cranial spread is seen. Loss of resistance indicates entry through superior costo-transverse ligament. Inadequate caution regarding depth may lead to pleural puncture. Pleural irritation makes the patient cough. Anterior movement of parietal pleura indicates correct needle placement. (*Hara K, Sakura S, Nomura T, et al. Ultrasound guided thoracic paravertebral block in heart surgery. Anaesthesia. 2009;64:223–5*).

37. F F F T F

The six upper intercostal nerves reach as far as edge of sternum while lower six reach linea alba. (*Brown DL. Intercostal block. In: Brown DL, editor. Atlas of regional anaesthesia. Philadelphia: WB Saunders Company; 1992. p. 211–7*). High frequency probe is placed at perpendicular angle to the ribs. (*Shankar H, Eastwood D. Retrospective comparison of ultrasound and fluoroscopic guidance for intercostal steroid injections. Pain Pract. 2010;10:312–7*). Highest blood levels of local anaesthetic/ml injected are achieved. The block is done in prone position as it is easier to count the levels of the ribs. Prone position also helps in diagnosis of Pneumothorax as air tends to stay in non dependent position. (*Curatolo M. Intercostal nerve block. In: Peng PW, editor. Ultrasound for pain medicine: a practical guide, peripherals tructures. Philip Peng educational series. Vol 1. 1st ed. Cupertino: ibook apple inc; 2013. p. 65–8*).

38. T F T T F

The three muscles are replaced by an aponeurosis (linea semilunaris) at the lateral border of rectus sheath. (*Snell R. Clinical anatomy by seizures. 8th ed. Baltimore: Lippincott Wiliams and Wilkins; 2008*). TAP plane contains intercostal, subcostal, L1 nerves and vessels (deep circumflex iliac, inferior epigastric, superuior epigastric artery). Injection of local anaesthetic between rectus abdominis and transversus abdominis muscle close to xiphisternum increase the success rate. (*Carney J, Finnerty O, Rauf J, et al. Studies on the spread of local anaesthetic solution in transversus abdominis block. Anaesthesia. 2011;66(11):1023–30*). Quadratus lumborum block is deposited in paravertebral space. (*Boerglum J, Morriggl B, Jensen K, et al. Ultrasound guided transmuscular quadratus lumborum blockade. 2013*). Transversalis fascia block is limited to T12/L1 dermatome. (*Chin KJ, Chan V, Hebbard P, et al. Ultrasound guided transversus fascia plane block provides analgesia for anterior iliac creast bone graft harvesting. Can J Anesth. 2012;59(1):122–3*).

39. T T T T T

Skin to plexus distance correlates with weight for 3–12 years and ranges from 1.24 to 1.74 mm/kg. (*Kirchmair L, Enna B, Moriggl B et al. Lumbar plexus in children. A sonographic study and its relevance to paediatric regional anaesthesia. Anesthesiology 2004;101:445-50).* The distance can be calculated accurately.

Depth of epidural space: 0.48X body weight (kg) + 18.7

Distance from midline (spinous process) in mms: 0.12 X body weight (kg) + 10.2

(*Lonnqvist PA. Continuous paravertebral block in children. Initial experience. Anesthesia 1992;47:607-9).* An in plane approach is ideal avoiding rectus sheath approaching from lateral to medial side. (*Willschke H, Bosenberg A, Marhofer P, et al. Ultrsonographic guided rectus sheath block in paediatric anaesthesia – a new approach to an old technique. Br J Anaesth. 2006;97:244–9*). Point of needle insertion is at the point anterior to attachment of latissmus dorsi to the external lip of iliac crest. (*Rafi AN. Abdominal field block: a new approach via the lumbar triangle. Anaesthesia. 2011;56:1024–6*).

40. F F F F T

The muscles visualised are external oblique, internal oblique, transverse abdominis muscle, pyramidalis and cremaster. Rectus sheath is formed by three muscles. High frequency (13–8 MHz) linear array transducer is used. Muscles are usually hypoechoic while fascia transversalis and peritoneum appear hyperechoic. (*Hebbard PD, Barrington MJ, Vasey C. Ultrasound guided continuous subcostal transversus abdominis plane blockade: description of anatomy and clinical detail. Reg Anesth Pain Med. 2010;35:436–41*). It is not easy to differentiate but peritoneum appears as hyperechoic layer by observing peristaltic movements of the bowels ort loops. (*Abrahams M, Derby R, Horn JL. Update on ultrasound for truncal blocks: a review of the evidence. Reg Anesth Pain Med. 2016;41:275–88*). Single injection is less successful than multiple injections. (*Barrington MJ, Ivanusic JJ, Rozen WM, et al. Spread of injectate after ultrasound guided subcostal transversus abdominis plane block: a cadaveric study. Anesthesia. 2011;66:1023–30*).

41. T T T T T
Rectus abdominis muscle appears as hypoechoic oval to elliptical structure that is surrounded by hyperechoic epimysium. The mechanisms of quadratus lumborum block include:
- Ipsilateral paravertebral spread.
- Fascial plane anterior to quadratus lumborum.
- Ipsilateral epidural spread.

(*Carney J, Finnerty O, Rauf J, et al. Studies on the spread of local anaesthetic solution in transverse abdominis blocks. Anaesthesia. 2011;66:1020–30*). Quadratus lumborum block may cause extended anaesthesia. (*Saito T, Den S, Tanuma K, et al. Anatomical bases for paravertebral anesthetic block: fluid communication between the thoracic and lumbar paravertebral regions. Surg Radiol Anat. 1999;21:359–63*). Ultrasound usage decreases the incidence of peritoneal puncture and visceral injury.

42. T F F F F
PECS I is a high volume block as even though the plane is visualised on ultrasound, still 0.4 mL/kg or 20–30 mL is required. Serratus plane block is done at the level of fifth rib and 0.4 mL/kg of local anaesthetic is injected between latissmus dorsi and the serratus anterior. (*Blanco R, Parras T, McDonnell JG, et al. Serratus plane block: a novel ultrasound guided thoracic wall nerve block. Anaesthesia. 2013;68:1107–13*). Intercostobrachial nerve gets contribution from first, third and fourth intercostal nerve. (*Loukas M, Hullett J, Louis RG Jr, et al. The gross anatomy of the extrathoracic cause of the intercostobrachial nerve. Clin Anat. 2006;19:106–11*). The transducer is moved cranially until the inferolateral margins of Teres major muscle and serratus plane (between latissmus dorsi and serratus anterio) is visualised which is the window for needle insertion. (*Blanco R. Thoracic interfascial nerve blocks: PECS (I&II) and serratus plane block, musculoskeletal ultrasound for regional anaesthesia and pain medicine. In: Karmaker MK, editor. 2nd ed. Hong Kong: Department of Anaesthesia and Intensive care, the Chinese university of Hong Kong; 2016:377–82*). Pectoral nerves form subpectoral plexus which needs injection at 3 sites for effective block:
- Deep and lateral aspect of pectoralis minor.
- Between pectoralis minor and major.
- Superior to posterior fascia of pectoralis major muscle.

(*Desroches J, Grabs U, Grabs D. Selective ultrasound guided pectoral nerve targeting in breast augmentation. How to spare the brachial plexus cords? Clin Anat. 2013;26(1):49–55*).

43. T T T F T
The apex of space is continuous with posterior intercostal space lateral to the tips of transverse process. (*Eason MJ, Wyatt R. Paravertebral thoracic block-a reappraisal. Anaesthesia. 1979;34:638–42*). The mechanism of Horner's syndrome is not known (*Prusch F, Freiberg H, Weinstabl C, et al. Single injection paravertebral block compared to general anaesthesia in breast surgery. Acta Anaesthesiol Scand. 1999;43:770–4*). Ideal transducer is 13–6 MHz. (*Shibata Y, Nishiwaki K. Ultrasound guided intercostal approach to thoracic paravertebral block. Anesth Analg 2009;109:996-997).* Lung sliding sign is

the sonographic appearance of the pleural surfaces moving relative to each other within the thorax and is synchronous with respiration. (*Lichenstein DA, Menu Y. A bedside ultrasound sign ruling out Pneumothorax in the critically ill. Lung sliding. Chest. 1995;108:1345–8*). Block can be done through intercostal approach. (*Ben–Ari A, Moreno M, Chelly JE, et al. Ultrasound guided paravertebral block using an intercostal approach. Anesth Analg. 2009;109:1691–4*).

44. T T F T T

Nerves for lumbar plexus are blocked near the paravertebral space. (*Karmaker MK, Li JW, Kwok WH, et al. Sonoanatomy relevant for lumbar plexus block in volunteers correlated with cross sectional anatomic and magnetic resonance images. Reg Anesth Pain Med. 2013;38:391–7*). The psoas muscle differs in males and females. (*Ikezoe T, Mori N, Nakamura M, et al. Atrophy of the lower limbs in elderly women. Is it related to walking ability? Eur J Appl Physiol. 2011;111:989–95*). Lumbar plexus and psoas muscle is located at a depth. So low frequency transducer (5–2 MHz) and curved transducer array is used. (*Karmaker MK, Li JW, Kwok WH. Ultrasound guided lumbar plexus block using a transverse scan through the lumvbar interscalene space: a prospective case series. Reg Anesth Pain Med. 2015;40:75–81*). Lumbosacral junction is visualised on a saggittal sonogram and then moved cranially to locate lamina and transverse processes of L345 where block is done. (*Karmaker MK, Li X, Kwok WH et al. Sonoanatomy relevant for ultrasound guided central neuraxial blocks via the paramedian approach in the lumbar region. Br J Radiol. 2012;85:e262–9*). Complications of block include psoas hematoma, lumbar plexopathy, delayed retroperitoneal hematoma. (*Areline C, Bonnett F. Delayed retroperitoneal hematoma after failed lumbar plexus block. Br J Anaes. 2004;93:589–91*). Echo intensity is increased in elderly. It is due to age related changes in the muscles. There is reduction in skeletal muscle mass, increase in extracellular water content in the muscle. (*Tsubanera A, Chino N, Akaboshi K, et al. Age related changes of water and fat content in muscles estimated by magnetic resonance imaging. Disabil Rehabil. 1995;17:298–304*).

45. F T F T F

Intercostal nerves are difficult to visualise under ultrasound as they are often small and covered by the ribs. (*Bhatia A, Gofeld M, Ganapthy S, et al. Comparison of anatomic landmarks and ultrasound guidance for intercostal nerve injection in cadavers. Reg Anaesth Pain Med. 2013;38(6):503–7*). Doppler can visualise intercostal arteries which are next to intercostal nerves. (*Koyanagi T, Kawaharada N, Kurimoto Y, et al. Examination of intercostal arteries with transthoracic doppler sonography. Echocardiography. 2010;27(1):17–20*). The intercostal muscles are difficult to distinguish on ultrasound. (*Sakai F, Sone S, Kiyomo K, et al. High resolution ultrasound of the chest wall. Rofo. 1990;153:390–4*). The block is done at mid axillary line as lateral cutaneous branch of intercostal nerve emerge at this level, so blockade at this level is more complete. Both the approaches have similar spread of local anaesthetic. (*Paraskeupoulos T, Saranteas T, Kouladouras K, et al. Thoracic paravertebral spread using two different ultrasound guided intercostal injection techniques in human cadavers. Clin Anat. 2010;23(7):840–7*).

46. F F F T F

Nerves of rectus sheath are too small to be seen on ultrasound. (*Rozen WM, Tran TM, Ashton MW, et al. Refining the course of the thoracolumbar nerves: a new understanding of the innervation of the anterior abdominal wall. Clin Anat. 2008;21:325–33*). The goal of block is to inject local anaesthetic under the rectus abdominis muscle. (*Sandeman DJ, Dilley AV. Ultrasound guided rectus sheath block and catheter placvement. ANZ J Surg. 2008;78:621–3*). The transversalis fascia and aponeurosis of the transversalis fascia form a double layer appearance on ultrasound scan. (*Muradali D, Wilson S, Burns PN, et al. A specific sign of pneumoperitoneum on sonography: enhancement of the peritoneal stripe. AJR Am J Roentgenol. 1999;173(5):1257–62*). Rectus sheath block is of short duration. (*Murouchi T, Iwasaki S, Yamakage M. Chronological changes in ropivicaine concentration and analgesic effects between transversus abdominis plane block and rectus sheath block. Reg Anesth Pain Med 2015;40(5):568-571).* 21% of rectus sheath injections done with landmark loss of resistance technique have been found to be intraperitoneal. (*Dolan J, Lucic P, Geary T, et al. The rectus sheath block: accuracy of local anaesthetic placement by trainee anaesthesiologist using loss of resistance or ultrasound guidance. Reg Anesth Pain Med. 2009;34:247–50*).

47. F F T F T

Caudal is better than nerve blocks with higher risk of motor block and urinary retention. (*Shanthamna H, Singh B, Guyatt G. A systematic review and meta analysis of caudal block as compared to non caudal regional techniques for inguinal seizures in children. Biomed Res Int. 2014;2014:890626*). The nerves cannot be selectively blocked by ultrasound guidance. (*Schmutz M, Schumacher PM, Luyet C, et al. Ilioinguinal and iliohypogastric nerves cannot be selectively blocked by ultrasound guidance: a volunteer study. Br J Anaesth. 2013;111(2):264–70*). Internal oblique is the thickest muscle visualised on ultrasound. (*Rankin G, Stokes M, Newham DJ. Abdominal muscle size and symmetry in normal subjects. Muscle Nerve. 2006; 34:320–6*). External oblique is often aponeurotic and difficult to visualise. Deep circumflex artery is indicative of nerve position. (*Schlenz I, Burggasser G, Kuzbai R, et al. External oblique abdominal muscle: a new look on its blood supply and innervation. Anat Rec. 1999;255:388–95*).

48. T F F F T

A continuous line from xiphoid process to the iliac crest, just posterior to anterior superior iliac spine (oblique subcostal line) is the optimal site for block. (*Hebbard PD, Barrington MJ, Vasey C. Ultrasound guided continuous oblique subcostal transverse abdominis plane blockade: description of anatomy and clinical technique. Reg Anesth Pain Med. 2010;35(5):436–41*). The volume required is more than 20 mL and multiple needle positions are needed for the block. A single injection blocks 3–4 dermatomes. (*Storing K, Rotha C, Rosenstock CV et al. Cutaneous sensory block area, muscle relaxing effect, and block duration of the transversus abdominis muscle plane block: a randomised blinded and placebo controlled study in healthy volunteers. Reg Anesth Pain Med 2015;40(4):355-362).* A TAP block gives better relaxation of the abdominal wall for surgery and less pain due to abdominal stretching.

(*Arora S, Chhabra A, Subramaniam R, et al. Transversus abdominis plane block for laparoscopic inguinal hernia repair: a randomised trial. J Clin Anesth. 2016;33:357–364*).

49. T T T T T

The block can be approached by two techniques:

- Lateral: at the junction of tapered transversus abdominis muscle and the quadratus lumborum muscle.
- Posterior: local anaesthetic is deposited posterior to the lateral edge of the quadratus lumborum muscle.

(*Willard FH, Vleeming A, Scheunke MD, et al. The thoracolumbar fascia: anatomy, function and clinical correlations. J Anat. 2012;221:507–36*).

Low frequency (5–2 MHz) curved array transducer is used. Lateral decubitus position gives more exposure of neuraxial structures and more stability in handling the probe. Ultrasound helps in visualising the lower pole of kidney, lower lobe of liver or spleen and can aid in the block. Local anaesthetic can be seen to spread cephalad from the iliac crest to the twelfth rib. (*Elsharkawy H. Ultrasound guided quadratus lumborum block: how to do it? ASRA News. 2015;36–42*).

50. F F T F F

Bilateral blocks can be given and not contraindicated. (*Karmaker MK. Thoracic paravertebral block. Anesthesiology. 2001;95:771–780*). Nerves are segmented into small bundles and are devoid of fascial sheath making than susceptible to local anaesthetic block. (*Nunn JF, Slavin G. Posterior intercostal nerve block for pain relief after cholecystectomy.anatomical basis and efficacy. Br J Anaesth. 1980;52:253–60*). Thoracolumbar spread may be seen up to the retroperitoneal space via subendothoracic fascial compartment. (*Karmaker MK, Gin T, Ho AM. Ipsilateral thoraco lumbar anesthesia and paravertebral spread after low thoracic paravertebral injection. Br J Anaesth. 2001;87:312–6*). A single injection of 15 mL covers at least 4 spaces. (*Eason MJ, Wyatt R. Paravertebral thoracic block- a reappraisal. Anesthesia. 1979;34:638–42*). Previous thoracotomy has not effect on subsequent paravertebral block. (*Cheema S, Riachardson J, McGurgan P. Factors affecting the spread of bupivicaine in the adult thoracic paravertebral space. Anaesthesia. 2003;58:684–7*).

51. F F F F T

The anaesthetic block is not gravity dependent but there is preferential caudal spread of somatic blockade. (*Naja ZM, El-Rajab M, Al-Tannir MA, et al. Thoracic paravertebral block: influence of the number of injections. Reg Anesth Pain Med. 2006;31:196–201*). The volume injected is too small to produce epidural block. (*Lonnqvist PA, Mackenzie J, Soni AK, et al. Paravertebral blockade: failure rate and complications. Anesthesia. 2005;60:930–1*). Loss of resistance is seen due to entry into superior costo transverse ligament. There may be a gap between the medial and lateral portion of the ligament and loss of resistance may not be seen. (*Luyet C, Herrmann G, Ross S, et al. Ultrasound guided thoracic paravertebral puncture and placement of catheters in human cadavers. Where do catheters go? Br J Anaesth. 2011;106:246–54*). Pleura is

visualised better at T4 than at T1 because of greater depth to paravertebral space in upper thoracic region compared to mid thoracic region. (*Hara K, Sakura S, Nomora T, et al. Ultrasound guided thoracic paravertebral block in breast surgery. Anaesthesia. 2009;64:223–5*). Injection of the saline causes distension of the space under ultrasound.

52. T T T T T

Once the needle is positioned between internal intercostal membrane and pleura, local anaesthetic injection results in anterior displacement of the pleura. (*Marhofer P, Kettner SC, Hajbok L, et al. Lateral ultrasound guided paravertebral blockade: an anatomical based description of a new technique. Br J Anaesth. 2010;105:526–32*). High frequency transducer is ideal because the transverse process, costotransverse ligament and pleura are located at a shallow depth. (*Ben-Ari A, Moreno M, Chelly JE, et al. Ultrasound guided paravertebral blockade using an intercostal approach. Anesth Analg. 2009;109:1691–4*). Local anaesthetic injected into posterior intercostal space can spread medially into the paravertebral space. (*Shibata Y, NIshiwaki K. Ultrasound guided intercostal approach to thoracic paravertebral block. Anesth Analg. 2009;109:996–7*). Oblique axis gives better view of the pleura due to ultrasound beam at right angles to the pleura, which reduces anisotropy. (*O'riain SC, Donnell BO, Cuffe T, et al. Thoracic paravertebral block using real time ultrasound guidance. Anesth Analg. 2010;110:248–51*). Intercostal approach especially from the lateral to medial side increases the risk of central neuraxial complications.

Head and Neck

10

1. Retrobulbar block:
   (a) In itself is sufficient for intraocular surgery.
   (b) Large volume is required as compared to peribulbar approach.
   (c) Sensation to the eye is through the ophthalmic nerve.
   (d) The gaze should be fixed "up and in" for optimum block.
   (e) Retrobulbar hematoma is an immediate complication.
2. Ophthalmic surgery:
   (a) Most common cause of injury during surgery is patient movement.
   (b) Mortality is high.
   (c) Sub-tenons technique is most widely used.
   (d) Topical anaesthesia is seldom used.
   (e) Volume of globe is about 15 mL.
3. Functional anatomy of eye:
   (a) Sclera is thinnest at the equator.
   (b) Four muscles form retrobulbar cone.
   (c) Intrathecal compartment does not communicate with extraconal compartment.
   (d) Orbit is supplied by CN III and IV only.
   (e) Superonasal quadrant is ideal for sub tenon's block.
4. Subtenons block:
   (a) Local anaesthetic is placed between Tenons capsule and the sclera.
   (b) Administration of local anaesthetic deep into space ensures high quality of analgesia.
   (c) Large volumes if injected have no side effects.
   (d) Ultrasound increases the success rate of the block.
   (e) Higher complication rate is seen.
5. Subtenons block:
   (a) Conjuctival cutting is not associated with any long term side effects.
   (b) Can be done without conjuctival incision.
   (c) Medial canthus technique has high rate of complications.

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(d) Have no contraindications.
(e) Iodine should be used as disinfectant.

6. Retrobulbar ophthalmic block:
   (a) Involves extraconal injection of local anaesthetic.
   (b) There is a risk of injury to globe.
   (c) Additional facial nerve blockade is required.
   (d) Classical "up and in" gaze is preferred.
   (e) Ultrasound guidance can be used.
7. Peribulbar anaesthesia:
   (a) Needle is placed in extraconal space.
   (b) Large volumes increase the success rate.
   (c) Multiple injections increase the success rate.
   (d) Inferonasal approach is ideal.
   (e) Needle insertion depth should be restricted to 25 mm.
8. Ophthalmic anaesthesia:
   (a) Short bevelled needles are safer for blocks.
   (b) Prolonged compression increases the quality of the block.
   (c) Retrobulbar block is more effective than peribulbar block.
   (d) Seizures are one of the complications.
   (e) Brainstem anaesthesia may be seen.
9. Ophthalmic block:
   (a) Globe perforation has poor prognosis.
   (b) Staphyloma is seen in hypermetropic eyes.
   (c) Extraocular muscle injury is not seen.
   (d) Usage of bupivicaine is protective against myotoxicity.
   (e) Retrobulbar anaesthesia can cause optic nerve trauma.
10. Ophthalmic regional anaesthesia:
    (a) Topical anaesthesia is not suitable for most procedures.
    (b) Intracameral injections are not safe.
    (c) Topical agents may cause corneal toxicity.
    (d) Perilimbar anaesthesia provides akinesia.
    (e) Injection at supero-temporal conjunctiva is less painful than infero-temporal.
11. Ophthalmic regional anaesthesia:
    (a) Anterior segment surgery requires sub tenon's block.
    (b) Hyaluronidase decreases incidence of post operative strabismus.
    (c) Alpha-2 adrenergic agonists decrease intraocular pressure.
    (d) Opioids are more effective via regional route than systemic route for ophthalmic anaesthesia.
    (e) Muscle relaxants enhance akinesia.
12. Perioperative management of eye blocks:
    (a) Deep sedation is associated with more side effects.
    (b) Propofol anaesthesia is safe during needle insertion for block.
    (c) Sedation requires full fasting.
    (d) Viteroretinal procedures can be done in patients on full anticoagulation.
    (e) Sub tenon's block can be done on patients with Clopidogrel.

13. Retrobulbar block:
    (a) Can be used for chronic orbital pain.
    (b) Blunt and dull needles are preferred.
    (c) Needle is inserted tangential to globe.
    (d) Akinesia and anaesthesia are dose dependent.
    (e) Chemosis is the most common complication.
14. Peribulbar block:
    (a) Is done in the inferotemporal quadrant.
    (b) A supplementary injection may be required.
    (c) Is contraindicated in staphyloma.
    (d) Medial canthus region should be avoided.
    (e) Extra ocular muscle damage may be seen.
15. Sub tenon's block:
    (a) Aim is to block long ciliary nerves.
    (b) Is restricted to viteroretinal surgery only.
    (c) Performed in neutral gaze.
    (d) Large volumes are required.
    (e) Retrobulbar haemorrhage is a known complication.
16. Ophthalmic regional anaesthesia:
    (a) INR less than 3.5 is accepted for regional blocks in eye.
    (b) Epinephrine is safe as an adjuvant.
    (c) Hyaluronidase use can avoid myotoxicity.
    (d) Sudden rise in intraocular pressure is observed after sub tenon's block.
    (e) Verbal and tactile contact during surgery is important.
17. Airway blocks:
    (a) Trigeminal, glossopharyngeal and vagus nerves are involved.
    (b) Glossopharyngeal blockade provides motor block.
    (c) Glossopharyngeal nerve can be blocked by two approaches.
    (d) Head is placed in neutral position for peristyloid approach.
    (e) Glossopharyngeal block abolishes gag reflex.
18. Superior laryngeal block:
    (a) Provides anaesthesia below the vocal cords.
    (b) Mainly blocked where it enters the thyrohyoid membrane.
    (c) Neck extension is required for the block.
    (d) Laryngeal puncture is a known complication.
    (e) Is a high volume block.
19. Translaryngeal block:
    (a) Can be done in patients whom valsalva like straining is required.
    (b) Is a small volume block.
    (c) Extension of neck is required.
    (d) Midline needle insertion is avoided.
    (e) Usually done after forceful exhalation.
20. Anaesthesia for fiberoptic intubation:
    (a) Lidocaine may be used in different concentrations.
    (b) Cocaine is contraindicated.

(c) Anticholinergics should be used.
(d) Local anaesthetic gargling is not effective.
(e) Phenylephrine can be used.

21. Vagus nerve block for the airway:
(a) Mainly 2 nerves are involved.
(b) Second degree AV block is a contraindication for superior laryngeal nerve block.
(c) Loss of resistance can be used for superior laryngeal nerve block.
(d) Motor blockade may be seen with superior laryngeal nerve block.
(e) Laryngeal perforation is a known complication.
22. Ultrasound guided superior laryngeal nerve block;
(a) Low frequency probe is used.
(b) Bilateral blocks are contraindicated.
(c) Space visualisation is seen.
(d) Thyrohyoid muscle is hyperechoic.
(e) The nerve is well visualised in in plane technique.
23. Ultrasound guided recurrent laryngeal nerve block:
(a) Can be used for prophylaxis against laryngospasm.
(b) Goitre is a contraindication.
(c) Cricothyroid membrane can be visualised.
(d) High concentration of local anaesthetic is helpful.
(e) Oesophageal perforation is a complication.
24. Glossopharyngeal nerve block:
(a) Contains only visceromotor fibres.
(b) Bilateral blockade is indicated in glossopharyngeal neuralgia.
(c) Done in supine position.
(d) Lateral cervical technique is done at mastoid tip.
(e) Vagus nerve paresis may be seen.

Answers

1. F F T F T
Retrobulbar block is sufficient for corneal, anterior chamber and lens procedures. Small volume (4–6 mL) is required in peribulbar approach. Sensation to the eye is through long and short posterior ciliary nerves. Autonomic innervation is through same nerves and sympathetic fibers travelling with the arteries. Primary gaze should be directed straight ahead to minimise intra neural placement. A pop is appreciated as the needle traverses the bulbar fascia and enters orbital muscle cone. Retrobulbar hematoma is seen 5–10 min after the injection. (*McGrath LA, Bradshaw CP. Transconjuctival approach to peribulbar block. Clin Ophthalmol. 2013;1073–6*).
2. T F T F F
Patient movement causes maximum amount of injuries during surgery. (*Gild WM, Posner KL, Caplan RA, et al. Eye injuries associated with anesthesia. A closed claims analysis. Anesthesiology. 1992;76:204–8*). Patients are older

with significant co morbidities but the mortality remains low. (*Quigley HA. Mortality associated with ophthalmic surgery. A 20 year experience at the Wilmer institute. Am J Ophthalmol. 1974;477:517–24*). Sixty-four percent of anaesthetic blocks are subtenon injections. (*Thampy R, Hariprasad M, Saha B. Local anaesthesia for ophthalmic surgery: a multicenter survey of current practice amongst anaesthetists in the north west. Anaesthesia. 2007;62:101–3*). Up to 76% of surgical procedures are done under topical anaesthesia. (*Learning DV. Surveys of American society of cataract and refracting surgery members 1999–2012*). The volume of globe is about 7 mL. Anteroposterior length is 24 mm. The diameter for myopic eye is more than 26 mm. The diameter for hypermetropic eye is more than 20 mm.

3. T T F F F

Sclera is thinnest at the equator as it is the insertion site of extraocular muscles. Four rectus muscles running posterior from equator to annulus of Zinn forms the cone. There is free communication between the two compartments. (*Ripart J, Lepant J, de la Coussage J, et al. Peribulbar versus retrobulbar anaesthesia for ophthalmic surgery. An anatomical comparison of extraconal amnd intraconal injections. Anesthesiology. 2001;94:56–62*). Sensory innervation of the orbit and globe is provided by frontal and nasociliary branch of ophthalmic nerve, floor of orbit by infraorbital branch of the maxillary nerves (second branch of trigeminal nerve), extraocular muscles supplied by optic nerve (CN III), while superior oblique is supplied by trochlear nerve (IV), lateral rectus by abducens nerve (VI). Superonasal quadrant is quite vascular, so inferonasal quadrant is used. (*Edward DP, Kaufmann LM. Anatomy, development and pathology of the visual system. Paedtr Clin North Am. 2003;50:1–23*).

4. T F F T F

Tenon's capsule: fibro elastic layer stretching from the corneal limbus anterior to optic nerve posterior. Superficial or anterior injections allow the local anaesthetic to spread circularly around the scleral portion of the globe with low volumes. (*Ripart J, Prat-Pradal D. Medial canthus single injection episcelral (subtenon) anaesthesia computed tomographic imaging. Anesth Analg. 1998;87:43–5*). 8–11 mL can produce akinesia. Chemosis may be seen. (*Li H, Abovleish A, Grady J, et al. Sub tenons injection for local anaesthesia in posterior segment surgery. Ophthalmology. 2000;107:41–7*). The spread of the local anaesthetic can be seen under the ultrasound. (*Kumar CM, Mac Neela BJ. Ultrasonic localisation of anaesthetic fluids using sub tenons cannulae of three different lengths. Eye. 2003;17:1–5*). Serious complications are rarely seen. Subconjuctival hematoma (7%), subconjuctival edema (6%). (*Guise P. Subtenons anaesthesia: a prospective study of 6000 blocks. Anesthesiology. 2003;98:964–8*).

5. F T F F T

Long term scarring may be seen along with infection with conjunctival cutting. (*Heatley CJ, Marshall J, Toma M. "A trip to eye casualty". An unusual complication of subtenons anaesthesia. Eye. 2006;20:738–9*). The conjuctival incision can be avoided as it causes less trauma, decreased bleeding. (*Allman KG, Theron AD, Bayles DB. A new technique of incisionless minimally invasive sub*

tenons anaesthesia. Anaesthesia. 2008;63:782–3). Medial canthus technique has lower rate iof complications. (*Nouvellon E, L'Hermite J, Chaumenon A, et al. Medial canthus injection subtenons anaesthesia: a 2000 case experience. Anesthesiology. 2004;100:370–4*). The contraindications include obliterated conjuctival fornices (pemphigus), thin or frail sclera (staphyloma). Iodine should be used as it decreases bacterial endopthalmitis. (*Giulla TA, Starr MB, Masket S. Bacterial endopthalmitis prophylaxis for cataract surgery: an evidence based update. Ophthalmology. 2002;109:13–24*).

6. F T T F T

   Intraconal injection is required for retrobulbar technique. Superior oblique is spared as it is extraconal. Additional facial nerve block is required to involve orbicularis oculi muscle to prevent blinking. Neutral position is required as the classical approach increasdes the risk of optic nerve damage. (*Liu C, Youl B, Moseley I. Magnetic resonance imaging of the optic nerve in the extremes of gaze. Implications for the positioning of globe for retrobulbar anaesthesia, Br J Ophthalmol. 1992;76:728–33*). Ultrasound usage does not increase the efficacy, though sterility may be compromised. (*Guyer S, Shaw ES. Ocular ultrasound guided anaesthesia. In: Singh AD, editor. Ophthalmic ultrasonography. Amsterdam Netherlands: Elsevier; 2012*).

7. T T F T T

   Needle is placed in extraconal space. (*Davis D, Mandel M. Efficiency and complication rate of 16,224 consecutive peribulbar blocks. A prospective multicenter study. J Cataract Refract Surg. 1994;20:327–37*). A volume of 6–12 mL allows spread into the whole corpus adiposum of orbit, including intraconal space. This allows anterior spread to block orbicularis muscle. Increasing the volume is sufficient for successful blockade. Additional injections are not required. (*Demivok A, Sinsek S, Cinal A, et al. Peribulbar anaesthesia: one versus two injections. Ophthalmic Surg Losses. 1997;28:998–1001*). The complication rate may also increase. (*Ball JL, Woon WH, Smith S. Globe perforation by the second peribulbar injection. Eye. 2002;16:663–5*). Superonasal approach should be avoided as there is decreased distance between the orbital roof and the globe. There is also a risk of injury to superior oblique muscle. Incidence of injury increases with the increase in depth of insertion. (*Katsev D, Draws RC, Rose BT. Anatomic study of retrobulbar needle path length. Ophthalmology. 1989;96:1221–4*).

8. T F F T T

   Short bevelled needles are safer for the blocks. There is enhancement of tactile perception of resistance during needle insertion. (*Waller S, Taboada J, O'Connor P. Retrobulbar anaesthesia risk: do sharp needles really perforate the eye more easily than the blunt needles? Ophthalmology. 1993;100:506–10*). Prolonged compression is not required. A pressure of 30 mmHg for 5–10 min is sufficient. If sufficient volumes are injected, both the blocks have the same efficiency. (*Demediuk O, Dhaliwal R, Papworth D, et al. A comparison of peribulbar and retrobulbar anaesthesia for vitero retinal surgical procedures. Arch Ophthalmol. 1995;113:908–13*). Intrarterial injection may cause seizures and

volume as small as 4 mL can cause it. (*Aldrete J, Romo-Salas F, Arora S, et al. Reverse arterial blood flow as a pathway for central nervous system toxic responses following injection of local anaesthetics. Anesth Analg. 1978;57:428–33*). Brainstem anaesthesia may be seen due to puncture of dura mater sheath of the optic nerve or direct injection into the optic foramen. (*Loken R, Mervyn Kirker GE, Hamilton RC. Respiratory arrest following peribulbar anaesthesia for cataract surgery: a case report and review of the literature. Can J Ophthalmol. 1997;32:450–4*).

9. T F F F T

Globe perforation has poor prognosis especially when the diagnosis is delayed. Rish factors include inadequate experience and myopic eyes. (*Vohra S, Good P. Altered globe dimensions of axial myopia as risk factors for penetrating ocular injury during peribulbar anaesthesia. Br J Anaesth. 2000;85:242–5*). Staphylomas are seen in highly myopic eyes causing more perforations. Injury to extraocular muscles may cause diplopia and Ptosis. The mechanisms include needle injury, increased pressure and direct local anaesthetic myotoxicity. (*Carlsum B, Rainin E. Rat extraocular muscle regeneration. Repair of local anaesthetic induced damage. Arch Ophthalmol. 1985;103:1373–7*). Bupivicaine causes myotoxicity. The injury is seen in three steps. First the muscle is paralysed. Second the muscle seems to repair and thirdly retractile hyperplasia develops. (*Zhang C, Phamonvaechavan P, et al. Concentration dependent bupivicaine toxicity in resistant extraocular muscle. J AAPOS. 2010;14:323–7*). Bupivicaine toxicity is deliberately induced to treat strabismus. (*Scott AB, Alexander DE, Miller JM. Bupivicaine injection of eye muscles to treat strabismus. Br J Ophthalmol. 2007;91:146–8*). Retrobulbar anaesthesia can cause blindness and is due to intraneural hematoma. (*Hersch M, Baer G, Diecker JP, et al. Optic nerve enlargement and central retinal artery occlusion secondary to retrobulbar anaesthesia. Ann Ophthalmol. 1989;21:195–7*).

10. F F T F T

Most surgeons prefer topical anaesthesia in uncomplicated cases. (*Rebolleda G, Munoz-Negrete FJ, Gulierrez-ortiz C. Topical plus intracameral Lidocaine versus retrobulbar anesthesia in phacotrabeculectomy: prospective randomised study. J Cataract Refract Surg. 2001;27:1214–20*). Intracameral injections are safe but there were early concerns about the toxicity effects of local anaesthetic on corneal endothelium. (*Heurman T, Hartman C, Andes N. Long term endothelial cell loss after phacoemulsification: peribulbar anaesthesia versus intercameral Lidocaine 1%. Prospective randomised study. J Catarct Refract Surg. 2002;28:638–43*). Repeated exposure of local anaesthetic causes reversible corneal thickening and opacification. (*Guzeg M, Satiei A, Dogan Z, et al. The effects of bupivicaine and Lidocaine on the corneal endothelium when applied into the anterior chamber of concentrations supplied commercially. Ophthalmologica. 2002;216:113–7*). Subconjuctival injection of local anaesthetic provides anaesthesia of anterior segment without akinesia. It is useful for cataract, pterygium and superficial glaucoma surgery. (*Wood CC, Menon G, Ayliffe W. Subconjuctival block fro cataract extraction and keratoplasty. Br J*

Anaesth. 1999;83:969). Injection at superotemporal conjunctiva is less painful. (*Yuen JS, Prineas S, Pham T, et al. Effectiveness of superior versus inferior conjuctival anaesthesia for cataract surgery. Anaesth Intensive Care. 2007;35:945–8*).

11. F T T F T

Anterior segment surgery results in minimal or no discomfort. The block can be used for post operative pain. (*Duker J, Nielsen J, Vander JF, et al. Retrobulbar bupivicaine irrigation for post operative pain after sclera buckling surgery. Ophthalmology. 1991;98:514–8*). *H*yaluronidase is an enzyme that is widely used to facilitate the spread of local anaesthetic through connective tissue. (*Strouthis NG, Sobha S, Lanigen L, et al. Vertical diplopia following peribulbar anaesthesia: the role of hyaluronidase. J Pediatr Ophthalmol Strabismus. 2004;41:25–30*). Alpha-2 agonists decrease intraocular pressure and is also used to enhance intraoperative anaesthesia and post operative analgesia. (*Cabral SA, Carraretto AR, Brocco MC, et al. Effect of clonidine added to Lidocaine for sub tenon's anaesthesia in cataract surgery. J Anesth. 2014;28:70–5*). Opioids have equal efficacy whether given through regional route or systemic route. (*Hemmerling TM, Budde WM, Koppert W, et al. Retrobulbar versus systemic application of morphine during tuitrable regional anaesthesia via retrobulbar catheter in intraocular surgery. Anesth Analg. 2000;91:585–8*). Muscle relaxants have been used to enhance akinesia. (*Kucukyavuz Z, Arici MK. Effects of atracurium added to local anaesthetics on akinesia in peribulbar block. Anesth Intens Care. 2002;30:438–41*).

12. T F F T T

Deep sedation is associated with side effects. (*Katz J, Feldmann MA, Bass EB, et al. Adverse intraoperative medical events and their association with anaesthesia management strategies in cataract surgery. Ophthalmology. 2001;108:1721–6*). Involuntary sneezing is seen with propofol which increases the risk of globe perforation. The risk is increased in males and concomitant use of midazolam. (*Ann ES, Mills DM, Meyer DR, et al. Sneezing reflex associated with intravenous sedation and periocular anaesthetic injection. Am J Ophthalmol. 2008;146:31–5*). Sedation usage does not requires full fasting but may depend upon associated factors. (*Cranshaw JT, Winslaw EH. Preop fasting: old habits die hard. Am J Nurs. 2002;102:36–44*). Viteroretinal procedures have a low bleeding risk as compared to oculoplastic and glaucoma procedures and therefore can be done on full anticoagulation. Subtenon's block can be done with patients on Clopidogrel as compared to retrobulbar and peribulbar blocks.

13. T T T T F

The block can be used for delivery of neurolytic agents. Blunt needles push the blood vessels away and avoid traumatisation. (*Kumar CM, Dodds C, Faaning GL, et al. Ophthalmic anaesthesia. Lisse: Swets and Zeitlinger; 2002*). Needle is inserted tangential to globe and then passed below the globe and directed along the floor of the orbit. Small amount of local anaesthetic will cause anaesthesia without analgesia while a higher volume causes both analgesia and

anaesthesia. Most common complication seen is conjuctival haemorrhage (20–100%), Chemosis (25–40%), haemorrhage (0.7–1.7%). (*Kumar CM, Dowd TC. Complications of ophthalmic regional blocks: their treatment and prevention. Ophthalmologica. 2006;220:73–82*).

14. T T F F T
The block is done in the inferotemporal quadrant with needle directed along the orbital floor. The block is not contraindicated in staphyloma and medial Peribulbar approach is used. (*Vohra SB, Good PA. Altered globe dimensions of axial myopia as risk factors for peneterating ocular injury during Peribulbar anaesthesia. Br J Anaesth. 2000;85:242–5*). Aponeurosis are not present in the medial canthus causing better diffusion of local anaesthetic with requirements of lesser volumes. The extraconal space is large and avascular reducing the risk of hematoma. Complications include failure of block, corneal abrasion, Chemosis, conjuctival haemorrhage, vessel damage, optic nerve damage and extra ocular muscle damage.

15. F F F F T
Injection is done under tenon capsule and the local anaesthetic diffuses into the intraconal space. The aim is to block short ciliary nerves. The block can be done for cataract, viteroretinal, pararetinal surgery and also for trabeculectomy, strabismus, optic nerve sheath fenestration. (*Kumar CM, Dodds C. Sub Tenon's anaesthesia. Ophthalmol Clin North Am. 2006;19:209–19*). Patient is asked to look upwards and outwards and only 3–5 mL is required. Complications include orbital and retrobulbar haemorrhage, rectus muscle paralysis and trauma, globe perforation and orbital cellulitis.

16. T F T F T
Smaller needles, small volumes and sub tenon technique is safer. Epinephrine may cause vasoconstriction of the ophthalmic artery causing a compromise of the retinal circulation. It should also be avoided in elderly with cardiovascular disease. (*McLure HA, Rubin AP. Review of local anaesthesia agents. Minerwa Anestesiol. 2005;71:59–74*). Hyaluronidase is an enzyme that liquefies the interstitial barrier between cells by depolymerisation of hyaluronic acid to a tetrasacharide. The concentration should be limited to 15 IU/mL. If it is not used, local anaesthetic stays in contact with thin muscles for a longer period causing myotoxicity. (*British National Formulary. A joint publication of the British medical association and the royal pharmaceutical society of great Britain, London; 2002*). Sudden rise in intraocular pressure is seen after retrobulabr and Peribulbar injections but not after sub tenon's block. Oculocompression device may be used but pressure should not exceed 25 mmHg.

17. T F T T T
The main nerves involved are glossopharyngeal and vagus. Glossopharyngeal innervates through pharyngeal nerve (pharyngeal mucosa), tonsillar nerve (palatine tonsil, soft palate), sensory branch (posterior one third of tongue). Vagus innervates through superior and recurrant laryngeal nerves, superior laryngeal nerve (epiglottis upto vocal cords, motor to cricothyroid), recurrant laryngeal

nerve (distal to vocal cords). Glossopharyngeral nerve can be blocked intraorally at the base of posterior tonsillar pillar and peristyloid. The head is placed in neutral position. Marks are drawn on mastoid process and angle of mandible. Line is drawn and at midpoint, a needle is inserted to contact styloid process.

18. F T T T F
Superior laryngeal block covers from epiglottis to vocal cords. The block is done inferior to caudal aspect of the hyoid bone. The block is done with patient supine and neck extended. Complications include laryngeal puncture and superior laryngeal artery puncture. The block only involves administration of 2–3 mL.

19. T T T F T
Translaryngeal block is a small volume block and usually 3–4 mL is sufficient. Needle insertion is done in the midline as there are no vascular structures in the midline. Forceful exhalation makes distal airway anaesthesia more predictable.

20. T F T F T
Lidocaine may be used in different concentrations. Four percent (mucosal anaesthesia), 10% spray (orophrayngeal nasopharynx), 2% viscous (oropharyngeal anaesthesia), 2% gel (anaesthesia of the nose). Bleeding is one of the complications in nasopharynx. Cocaine is a vasoconstrictor and is advantageous. It is used as 4–10% nose drops with a maximum dosage of 100–200 mg. Anticholinergics are used to dry mucosal surfaces. 2–4 mL of 2% Lidocaine for 30–40 s is effective. A mix of Lidocaine (4%) and phenylephrine (1%) in a ratio of 3:1 is used. (*Ovassapian A. Fiberoptic airway endoscopy in anaesthesia and clinical care. New York: Raven; 1990*).

21. T T T T T
The nerves involved are superior laryngeal and recurrent laryngeal nerves. Loss of resistance on superior laryngeal nerve block indicates entry into thyrohyoid ligament. Superior laryngeal nerve blocks epiglottis, larynx and glottis. Higher concentration may produce motor blockade on cricothyroid.

(*Kiray A, Naderi S, Ergur I, et al. Surgical anatomy of the internal branch of the superior laryngeal nerve. Eur J Spine. 2006;15:1320–5*).

22. F F T F F
High frequency ultrasound probe (6–15 MHz)is used. Bilateral blocks can be done at greater cornu of hyoid bone and the thyroid cartilage. Superior laryngeal space is visualised which contains superior laryngeal nerve, hyoid bone superior, thyroid cartilage inferior, thyrohyoid muscle inferior, thyrohyoid muscle anterior, external carotid artery posterior, and thyrohyoid membrane as the floor. Thyrohyoid muscle appears as hypoechoic band while thryohyoid membrane appears as hyperechoic layer. In plane technique is used but nerve is not well visualised. Local anaesthetic is injected into the surface of the thyrohyoid membrane, anterior to external carotid artery and posterior to thyrohyoid muscle. (*Lidda T, Suzuki A, Kunisanoa T, et al. Ultrasound guided superior laryngeal nerve block and translaryngeal block for awake tracheal intubation in a patient with laryngeal abscess. J Anesth. 2013;27(4):83–6*).

23. T T T T T
The contraindications include goitre, short neck and cervical immobility. Two to four percent solution accelerates the onset of effect.
24. F F T T T
The glossopharyngeal nerve contains motor, visceromotor (parasympathetic), viscerosensory and gustatory fibres. Bilateral blockade is contraindicated in second degree AV block and anticoagulant treatment. The block is done with head rotated to the contralateral side by approximately 30°. The lateral cervical technique involves introducing needle at the midpoint between the mastoid tip and angle of mandible until styloid process is contacted. Vagus nerve paresis may be seen (collection of saliva in the piriform fossa accompanied by hoarseness and nasal vocalisation). This is associated with weakness of hypoglossal nerve and accessory nerve. (*Murphy TM. Somatic blockade of head and neck. In: Cousins MJ, Bridenbaugh PO, editors. Neural blockade. Murphy TM. Somatic blockade of head and neck. In: Cousins MJ, Bridenbaugh PO, editors. Neural blockade. 4th ed. Philadelphia/New York: Lippincott-Raven; 1998*).

Neuraxial Blocks

11

1. Spinal anaesthesia:
   (a) Can be used solely for mid abdominal surgeries.
   (b) Diaphragm is blocked with spinal anaesthesia.
   (c) Spinal headache is seen less in young patients.
   (d) Usage of small needles decreases the incidence.
   (e) Incidence of neurologic injury with spinal anaesthesia is less than general anaesthesia.
2. Spinal anaesthesia:
   (a) Backache is seen more with spinal anaesthesia than the general anaesthesia.
   (b) Spinal anaesthesia may cause dyspnoea.
   (c) Electromyography studies done in early stage are helpful in diagnosing neurologic injury.
   (d) Adding Fentanyl enhances motor effect.
   (e) Combined spinal epidural increases the duration of surgical anaesthesia.
3. Epidural block:
   (a) Pharmacological toxicity is seen.
   (b) Segmental anaesthesia is seen.
   (c) Ligamentum flavum is thickest in thoracic region.
   (d) Catheter should be inserted only 2–3 cm into the epidural space.
4. Epidural block:
   (a) Hanging drop method can be used thoracic epidural space.
   (b) Epinephrine is used as test dosage.
   (c) Subdural block develops immediately.
   (d) Catheter can be withdrawn after 12 h of low molecular weight heparin administration.
   (e) Frequent epidural dosages increase the block height.

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5. Caudal blockade:
   (a) Can be used for lower extremity operations.
   (b) Sacral hiatus is easy to palpate in all patients.
   (c) Is a high volume block.
   (d) Ligamentum flavum is absent.
   (e) Anatomy is the same in males and females.
6. Caudal block:
   (a) Legs should be abducted to locate sacral hiatus.
   (b) Has a risk of toxicity equivalent to lumbar block.
   (c) Increased risk of subarachnoid puncture is seen.
   (d) Rectal perforation is a possibility.
   (e) Small pressure waves during local anaesthetic injection means subcutaneous placement.
7. Caudal block in paediatrics:
   (a) Ultrasound guidance is not useful in paediatric patients.
   (b) Transversus view is ideal.
   (c) Sacral hiatus is between two hyperechoic lines.
   (d) Loss of resistance is no seen.
   (e) Sacrum cannot be penetrated with ultrasound beam.
8. Neuraxial anatomy:
   (a) C1 is an atypical vertebra.
   (b) Sacral vertebra fuse to form sacrum.
   (c) Sacral hiatus is due to 5th sacral vertebra.
   (d) Ligament flavum consists of collagen fibres.
   (e) Ligament flavum has gaps.
9. Neuraxial anatomy:
   (a) Ligament flavum is thickest in the lumbar region.
   (b) Subarachnoid space ends at S2 level.
   (c) Plexus of upper and lower limbs are larger than other plexus of the body.
   (d) Scoliosis has no effect on neuraxial anaesthesia.
   (e) Ultrasound cannot be used to assess the orientation of the spine.
10. Spinal anaesthesia:
    (a) Coagulopathy is an absolute contraindication.
    (b) Aortic stenosis is an absolute contraindication.
    (c) Multiple sclerosis is a contraindication.
    (d) Previous spinal surgery is a known contraindication.
    (e) Use of introducers help prevent contamination of cerebrospinal fluid.
11. Complications of spinal anaesthesia:
    (a) Post operative nausea and vomiting is seen more in obstetric population.
    (b) Glycopyrrolate can reduce nausea.
    (c) Shivering is seen more with spinal anaesthesia than epidural anaesthesia.
    (d) Pruritus is seen more with spinal route.
    (e) Hearing loss may be seen with neuraxial block.

12. Complications of spinal anaesthesia:
    (a) Post operative urinary retention is seen more with bupivicaine.
    (b) Female gender is a risk factor for post dural puncture headache.
    (c) Meningitis seen is mostly aseptic.
    (d) Spinal hematoma has poor prognosis then infective complications.
    (e) Catheters may increase the risk of cauda equina syndrome.
13. Complications with regional anaesthesia:
    (a) Arachnoiditis can be seen with traumatic dural puncture.
    (b) Total spinal anaesthesia can be used for therapeutic purposes.
    (c) Cardiovascular collapse is rare.
    (d) Neurological complications have a high incidence.
    (e) Risk of paraplegia is low.
14. Spinal anaesthesia:
    (a) Has been shown to reduce intraoperative blood loss.
    (b) Maternal blood loss is more with spinal anaesthesia.
    (c) Intrathecal opioids decreases stress response more than intrathecal bupivicaine.
    (d) Early extubation is seen with intrathecal opioids.
    (e) Sparing of motor and sympathetic fibers is seen during subdural block.
15. Spinal anaesthesia:
    (a) Spinal cord may extend to sacral region.
    (b) Blood flow to nerve tissue affects uptake of local anaesthetic from sub-arachnoid space.
    (c) Local anaesthetic uptake is via diffusion.
    (d) Nerve damage is seen more in Unmyelinated nerves.
    (e) Elimination of local anaesthetic depends on vascular perfusion.
16. Spinal anaesthesia:
    (a) Cerebrospinal volume remains constant at all times.
    (b) Transient neurologic symptoms are seen with Lidocaine.
    (c) Epinephrine should not be added to 2-chlorprocaine.
    (d) High rate of block failure is seen with procaine.
    (e) The incidence of transient neurologic symptoms is same with bupivicaine and Lidocaine.
17. Spinal anaesthesia:
    (a) Phenylephrine is protective against transient neurologic symptoms.
    (b) High rate of transient neurologic symptoms is seen with Mepivicaine.
    (c) Vasoconstrictors given intrathecally increase the risk of cauda equina syndrome.
    (d) Epinephrine does not increase the duration of hyperbaric spinal bupivicaine.
    (e) Side effects with intrathecal opioids are partial.
18. Spinal anaesthesia:
    (a) Clonidine does not causes motor blockade if added to local anaesthetic.
    (b) Hypotension seen is due to sympathetic blockade.
    (c) Cardiac output falls due to decreased preload.
    (d) ST segment changes may be seen on the ECG.
    (e) Heart rate always increases with spinal blockade.

19. Spinal anaesthesia:
    (a) Obesity is a risk factor for hypotension.
    (b) Trendelenberg position should be a minimum of 30°.
    (c) Left lateral tilt in obstetric population after neuraxial block should be more than 20°.
    (d) Coloading of fluids is better than preloading at preventing hypotension.
    (e) Ephedrine is similar in efficacy to Phenylephrine in treating hypotension.
20. Spinal anaesthesia:
    (a) The effect on respiratory system is minimal.
    (b) High spinal anaesthetic affects phrenic nerve.
    (c) Incidence of nausea and vomiting is high.
    (d) Hepatic blood flow is not affected.
    (e) Spinal anaesthesia does not affect renal perfusion.
21. Spinal anaesthesia:
    (a) Isobaric bupivicaine causes more variation in block height as compared to hyperbaric bupivicaine.
    (b) Age has no effect on block height.
    (c) Positioning of patient can affect block height.
    (d) Speed of injection can affect spinal block height.
    (e) Higher doses of local anaesthetic do not affect block duration.
22. Spinal anaesthesia:
    (a) Chlorhexidine is superior to provide iodine in asepsis.
    (b) Full asepsis should be practised for performing blocks.
    (c) Ultrasound guided approach has been described for taylor's approach.
    (d) Catheters smaller than 24G should be used for continuous spinal anaesthesia
    (e) Spinal anaesthesia has a high failure rate.
23. Spinal anaesthesia:
    (a) Ability to palpate landmark is an independent predictor of success.
    (b) Positive aspiration of cerebrospinal fluid is a predictor of successful block.
    (c) Lumbar cerebrospinal fluid volume is an important determinant of spread.
    (d) Subdural block is faster than subarachnoid block.
    (e) Cannot be used for outpatient surgery.
24. Spinal anaesthesia:
    (a) Unilateral spinal block has better hemodynamic profile in elderly.
    (b) Slow injection rate should be used for unilateral blockade.
    (c) Ultrasound usage helps in localising space better then palpation of lumbar spine.
    (d) Learning curve is long for ultrasound guidance for neuraxial block.
    (e) Spinal anaesthesia can be used for laparoscopic surgery.
25. Failed spinal anaesthesia:
    (a) High incidence of inadequate anesthesia is seen.
    (b) An error of judgement is the main cause of failure.
    (c) Lumbar plexus block may extend to epidural space.
    (d) Large doses are required for adequate block.
    (e) Aspiration of cerebrospinal fluid reduces failure rate.

26. Failed spinal anaesthesia:
    (a) Subdural block is seen only with epidural block.
    (b) Intrathecal chemotherapy increases incidence of failed spinal.
    (c) Marfan's syndrome may cause failure of spinal anaesthesia.
    (d) Block failure may be seen due to local anaesthetic activity.
    (e) Local anaesthetic resistance is a cause of the failure.
27. Epidural anaesthesia:
    (a) Decreased post operative confusion is seen in elderly.
    (b) Preservative free morphine may delay onset on tourniquet pain.
    (c) Quadriplegic patients are safe for neuraxial anaesthesia.
    (d) Epidural anaesthesia has more risk for hysteroscopy.
    (e) Epidural in addition to general anaesthesia decreases the incidence of complications in off pump coronary artery bypass.
28. Epidural anaesthesia:
    (a) Can be used for breast surgery.
    (b) Dennervation of viscera can be seen.
    (c) Neuraxial techniques are associated with decreased intra operative blood loss.
    (d) Epidural can be used for controlled hypotension.
    (e) Abdominal hysterectomy can be done under epidural.
29. Epidural anaesthesia:
    (a) Decreased incidence of post operative ileus is seen.
    (b) Epidural leads to delayed hospital discharge.
    (c) Neuraxial block is ideal for myasthenia gravis.
    (d) Neuraxial is better than general anaesthesia in malignant hyperthermia.
    (e) Epidural infusions prevent intrauterine growth restriction.
30. Epidural anaesthesia:
    (a) Regional anaesthesia prevents cancer recurrence.
    (b) Epidural blockade is contraindicated in sepsis.
    (c) Epidural injection decreases intracranial pressure.
    (d) INR <1.5 is sufficient for catheter removal.
    (e) Platelet count more than 70,000 is accepted for epidural placement.
31. Epidural anaesthesia:
    (a) Increased relapse is seen with local anaesthetic in multiple sclerosis.
    (b) Improvement in symptoms in Guillain Barry syndrome.
    (c) Genital herpes increases the neurologic complication with neurologic anaesthesia.
    (d) Varicella infection contraindicates epidural anaesthesia.
    (e) Is contraindicated in anesthetised patients.
32. Anatomy of the epidural space:
    (a) Spinal cord curves fully develop by adult age.
    (b) C1 and C2 are atypical vertebrae.
    (c) All cervical vertebrae have bifid vertebrae.
    (d) C6 and C7 are easily distinguished.
    (e) Epidural space may be altered in degenerative spine disease.

33. Anatomy of the epidural space:
    (a) Most easily palpable space is at L5–S1.
    (b) Tuffier line always crosses at L4–L5.
    (c) Posterior longitudinal ligament may hinder the spread of epidural injection.
    (d) Ligamentum nuchae is most prominent in thoracic region.
    (e) Ossification may be seen in ligamentum flavum.
34. Anatomy of epidural space:
    (a) Ligamentum flavum is thickest in the lumbar region.
    (b) Pregnancy may increase the thickness of ligamentum flavum.
    (c) Arachnoid mater is responsible for puncture headaches.
    (d) Subdural space doesnot exist.
    (e) Arachnoid dura interface can be opened easily.
35. Anatomy of the epidural space:
    (a) Artery of Adamkiewicz is present on one side only.
    (b) Vertebral venous plexus is composed of single anterior and two posterior vessels.
    (c) Puncture of vessels usually occur in the anterior epidural space.
    (d) Adipose tissue is increased in the epidural space in the elderly.
    (e) Distribution of solution is uniform.
36. Epidural space:
    (a) Distance from skin to space is shallowest at cervical spine.
    (b) Greatest depth of cervical space is seen at C6–T1.
    (c) Mostly is 4–6 cm in most patients.
    (d) Antero-posterior distance is largest in cervical area.
    (e) Imaging should be used in cervical space where possible.
37. Epidural block:
    (a) Maximum spread is seen with motor block.
    (b) Lumbar blockade has more sedative effect than thoracic blockade.
    (c) Temperature is the first sensation to be blocked.
    (d) Morphine added to epidural solution reduces volatile agent requirement.
    (e) Epidural local anaesthetic decreases inhalational and opioid requirements.
38. Epidural blockade:
    (a) Hypotension is a result of vasodilatation.
    (b) Incidence of hypotension is similar with spinal and epidural.
    (c) Ventricular function is affected in lumbar epidural.
    (d) Thoracic epidural has cardiac beneficiary effects.
    (e) Pulmonary function is not affected.
39. Epidural blockade:
    (a) Lumbar epidural protects against post operative ileus.
    (b) Bladder function may be impaired.
    (c) Thoracic epidural with general anaesthesia decreases surgical stress response.
    (d) Incidence of hypothermia is less as compared to general anaesthesia.
    (e) Forced air warming occurs more rapidly with neuraxial anaesthesia than general anaesthesia.

40. Epidural block:
    (a) Motor fibres require more local anaesthetic solutions.
    (b) Drug administration affects only ventral nerve roots.
    (c) Chlorprocaine is contraindicated for epidural anaesthesia.
    (d) Adding sodium bicarbonate enhances blockade.
    (e) Clonidine increase the duration of neuraxial anaesthesia.
41. Epidural block:
    (a) Clonidine exerts its action by acting on alpha receptors.
    (b) Lung function is preserved with clonidine in thoracotomy.
    (c) Midazolam is safe to use via neuraxial route.
    (d) Catheter should be inserted to the target dermatome.
    (e) For an equivalent dosage, onset of anaesthesia is delayed in thoracic than lumbar region.
42. Epidural blockade:
    (a) Blockade does not dependent on drug concentration.
    (b) Time to two segment regression has shortest time with Lignocaine.
    (c) Block done in lateral position increases the density of the block.
    (d) More dosage is required in obese patients for the same amount of block.
    (e) Fluid loading prior to block is not helpful.
43. Epidural block:
    (a) Concomitant sedation increases pain perception.
    (b) Sedation should be avoided in maternal patients during neuraxial placements.
    (c) Chlorprocaine is less painful than Lidocaine for skin infiltration.
    (d) Sitting position is associated with the shorter distance from skin to space.
    (e) Lateral position during block decreases the incidence of dural puncture.
44. Epidural block;
    (a) Two applications of chlorhexidine is better than one.
    (b) Chlorhexidine is not neurotoxic.
    (c) Air technique for loss of resistance is free of complications.
    (d) Loss of resistance to air can result in patchy block.
    (e) Catheter insertion is easy with loss of resistance to air.
45. Epidural block:
    (a) Paramedian technique causes a large opening into the epidural space than the midline approach.
    (b) Taylors approach is a midline approach.
    (c) Loss of resistance is ideal for access to cervical epidural.
    (d) Test dose is the only way to confirm epidural catheter placement.
    (e) Higher concentration of local anaesthetic improves spread and analgesia.
46. Epidural block:
    (a) Flexible catheters decrease the incidence of paraesthesia.
    (b) Prophylactic blood patches prevents headache after dural puncture.
    (c) Number of top ups is a reliable indicator of conversion of epidural used in labour for surgical anaesthesia.
    (d) Epidural placement in lateral position avoids epidural vein complication.
    (e) Ischaemic heart disease may predispose to local anaesthetic toxicity.

47. Epidural block:
    (a) High incidence of local anaesthetic allergy is seen.
    (b) Adhesive arachnoiditis is rare.
    (c) Backache is uncommon after epidural block.
    (d) Lithotomy position increases the risk of backache.
    (e) Epidural dexamethasone prevents backache.
48. Epidural block—post dural puncture headache:
    (a) Cranial nerve palsy is seen uncommonly with post dural puncture headache.
    (b) Post dural puncture headache may last for many years.
    (c) Intrathecal catheter insertion after dural puncture decreases the incidence of headache.
    (d) Conservative management of post dural puncture headache decreases hospital stay.
    (e) Injection of more than 20 mL of blood is of little benefit in extra dural blood patch.
49. Complications of epidural block:
    (a) Subdural injection is rare.
    (b) Total spinal anaesthesia has a small incidence.
    (c) Alcohol excess may predispose to epidural abscess.
    (d) Epidural abscess is seen more in cervical region.
    (e) High morbidity is seen with epidural abscess.
50. Complications of epidural block;
    (a) Dural puncture increases the risk of meningitis.
    (b) Serious neurologic injury is rare.
    (c) Spondylolisthesis predisposes to cauda equina syndrome.
    (d) Avoidance of 5% Lidocaine decreases the incidence of cauda equina syndrome.
    (e) MRI can rule out hematomas accurately.
51. Complications of epidural block:
    (a) Proprioception is affected in anterior spinal artery syndrome.
    (b) Cardiac arrest is a rare complication.
    (c) Patient position may contribute to cardiac arrest.
    (d) Increased temperature seen with epidural in maternal patients may adversely affect foetal outcome.
    (e) Lipophillic opioids provide protection against post operative nausea and vomiting.
52. Caudal anaesthesia:
    (a) There is wide variation in termination of spinal cord.
    (b) Caudal anaesthesia is more predictable in children than adults.
    (c) Mean volume of caudal space is 25 mL.
    (d) Sacral hiatus is closed in some patients.
    (e) Curvature of sacrum is more in females than males.

53. Caudal anaesthesia:
    (a) Blood patch can be done through the caudal approach.
    (b) Landmark technique is accurate.
    (c) Accurate placement of needle can be done with auscultation.
    (d) Ultrasound can help visualise the spread of injectate.
    (e) Electrical stimulation can confirm needle placement in caudal space.
54. Caudal epidural:
    (a) Can be used in all stages of labour.
    (b) Lumbar approach to caudal injection has high success rate.
    (c) Speed of injection determines the spread in caudal blockade.
    (d) Minimum local anaesthetic concentration is gender dependent.
    (e) Catheter tip can be placed with the help of ECG leads.
55. Caudal epidural:
    (a) Segmental spread is predictable.
    (b) Caudal block helps reduce opioid requirements.
    (c) Ropivicaine shows the highest incidence of motor blockade.
    (d) Anal sphincter tone can predict opioid requirement.
    (e) Caudal in children alters cardiac parameters.
56. Caudal epidural:
    (a) Can be used for pain relief.
    (b) Parotid swelling may be seen with caudal injection.
    (c) failure is most commonly seen after caudal epidural.
    (d) Epidural catheter can migrate to cervical level in paediatric population.
    (e) Most common cause of infection is pseudomonas aeruginosa.
57. Combined spinal epidural:
    (a) Has delayed onset.
    (b) Duration of spinal anaesthesia is dependent on stage of labour in maternal patients.
    (c) Small opioid doses are sufficient.
    (d) Motor power is maintained better with combined spinal epidural than the epidural.
    (e) Combined spinal epidural prolongs the first stage of labour.
58. Combined spinal epidural:
    (a) Local dose of local anaesthetic decreases complications.
    (b) Failed epidural after combined spinal epidural is one of the complications.
    (c) CSE provides more intense motor block than epidural in orthopaedic surgery.
    (d) CSE increases the adverse effects associated with neuraxial anaesthesia.
    (e) Epidural volume extension increases the sensory block in CSE.
59. Combined spinal epidural:
    (a) Is contraindicated in heart disease.
    (b) Posterior epidural space is important in CSE.
    (c) Ligament flavum gaps are most frequent in lumbar spine.
    (d) Separate needle technique has less side effects than needle through needle technique.
    (e) Use of saline for loss of resistance decreases the incidence of paraesthesia during thecal perforation.

60. Combined spinal epidural:
    (a) Meperidine exerts local anaesthetic effect.
    (b) Pencil point needles are more prone to failed spinal.
    (c) Penetration of dura requires substantial force.
    (d) Delay in inserting catheter after administration of spinal may alter block characteristics.
    (e) Subarachnoid placement of epidural catheter always is due to dural puncture.
61. Combined spinal epidural:
    (a) Increases the level of subsequent epidural top ups.
    (b) Difference in local anaesthetic levels are seen if epidural is not preceded by spinal.
    (c) Leakage of spinal anaesthesia into subarachnoid space from epidural space increases the sensory block.
    (d) Test dosage is more reliable in intrathecal placement of catheter than aspiration.
    (e) Subarachnoid block induced by combined spinal epidural causes more sensorimotor anaesthesia.
62. Combined spinal epidural:
    (a) Loss of resistance produces greater sensorirmotor block.
    (b) Hypotension seen is due to vasodilatation.
    (c) Paraesthesias during needle insertion increases the risk of long term paraesthesias.
    (d) Intraneural injection leads to nerve injury.
    (e) Needle through needle technique increases the risk of neurological complications.
63. Combined spinal epidural:
    (a) Pencil point needles causes more neurological injuries.
    (b) Metallic fragments may be retained in neuraxial space with needle through needle technique.
    (c) Epidermoid tumour formation is a complication of lumbar puncture.
    (d) CSE causes more proximity for infection as compared to epidural alone.
    (e) Face masks does not prevent infection in neuraxial procedures.
64. Combined spinal epidural:
    (a) Incidence of post dural puncture headache is decreased.
    (b) Administration of intrathecal opioids decreases the incidence of post dural puncture headache.
    (c) Persistent cerebrospinal leak may be seen after combined spinal epidural.
    (d) Foetal complications are increased with combined spinal epidural.
    (e) Intrathecal opioids increase the risk of subsequent caesarean section.
65. Combined spinal epidural:
    (a) Foetal bradycardia seen is short lived.
    (b) Rotation of epidural needle increases the incidence of dural puncture.
    (c) Incidence of failed spinal tap dependent on the type of needle used.
    (d) Test dose can cause total spinal anaesthesia.
    (e) Hypotension is seen when combined spinal epidural is done in sitting position.

66. Post dural puncture headache:
    (a) Total cerebrospinal volume is intracranial.
    (b) A large volume of cerebrospinal fluid needs to be lost to develop post dural puncture headache.
    (c) Arachnoid mater plays an important role in developing post puncture headache.
    (d) Headache is due to trigeminal nerve only.
    (e) Nerve palsies can be seen after combined spinal epidural.
67. Post dural puncture headache:
    (a) Headache resolves within 24 h.
    (b) Onset of headache can occur within 1 h.
    (c) Headache is mostly unilateral.
    (d) Headache may be associated with tinnitus.
    (e) Symptoms may depend on needle size.
68. Post dural puncture headache- risk factors:
    (a) Age is the biggest risk factor.
    (b) Males are more prone to develop PDPH.
    (c) PDPH is not dependent on the stage of the labour.
    (d) Increased BMI is a risk factor.
    (e) Cigarette smoking is protective for post dural puncture headache.
69. Post dural puncture headache:
    (a) Chronic headaches increase the risk.
    (b) History of dural puncture increases the risk of subsequent punctures.
    (c) Non cutting needles are associated with less post dural puncture headache.
    (d) Bevel orientation perpendicular to the long axis of spine decreases the incidence of PDPH.
    (e) Incidence is more with procedures done at night.
70. Post dural puncture headache:
    (a) Dexamethasone decreases the risk of headache.
    (b) Early mobilisation increases the risk of PDPH.
    (c) Increased oral hydration decreases the risk of PDPH.
    (d) Continuous spinal anaesthesia increases the risk of PDPH.
    (e) Decreasing the size of epidural needle increases the risk of PDPH.
71. Post dural puncture headache:
    (a) Needle orientation affects the incidence.
    (b) Combined spinal epidural increases the risk of post dural puncture headache.
    (c) Replacing stylet as soon as possible decreases the incidence of post dural puncture headache.
    (d) Injection of saline into the CSF decreases the incidence of PDPH.
    (e) Inserting intrathecal catheter decreases the risk of PDPH.
72. Post dural puncture headache:
    (a) Prophylactic blood patch prevents headache from developing.
    (b) Prophylactic blood patch has no complications.
    (c) Early blood patch may inhibit coagulation.
    (d) Increase in intra-abdominal pressure can help diagnose PDPH.
    (e) Pneumoencephalus can produce headache similar to PDPH.

73. Post dural puncture headache:
    (a) Early treatment of PDPH helps prevent subdural hematoma.
    (b) Aggressive hydration decreases the signs symptoms of PDPH.
    (c) Acupuncture has efficacy in PDPH.
    (d) Caffeine has shown efficacy.
    (e) Ergot alkaloids have no benefit.
74. Post dural puncture headache:
    (a) Steroids do not show any efficacy.
    (b) Gabapentin has shown some efficacy.
    (c) Epidural saline injection leads to long term relief of symptoms.
    (d) Epidural blood patch causes effect by tamponade effect.
    (e) Blood patch efficacy depends upon the duration of dural puncture.
75. Post dural puncture headache:
    (a) The maximum amount of blood injected is 20 mL.
    (b) The blood patch can be used for intracranial hypotension.
    (c) Large volume blood patch does not have any complications.
    (d) Patients should be encouraged to mobilise immediately after EBP.
    (e) Blood patch is contraindicated in Jehovah's Witness.
76. Post dural puncture headache:
    (a) Blood patch should be avoided in paediatric population.
    (b) Blood patch is contraindicated in cervical taps.
    (c) Blood patch should be avoided in multiple sclerosis.
    (d) Chronic backache is a complication of blood patch.
    (e) Decreasing the size of the needle decreases the incidence of PDPH.
77. Ultrasound guided neuraxial block:
    (a) Usage of ultrasound decreases the number of attempts.
    (b) Conus medullaris may extend up to L3.
    (c) Dural sac may end up as low as S4.
    (d) Low frequency transducer can give high quality image.
    (e) Paramedian scan should be avoided.
78. Ultrasound guided neuraxial block;
    (a) Laminas are difficult to visualise under the ultrasound.
    (b) Epidural space is hyperechoic.
    (c) Ultrasound can diagnose scoliosis.
    (d) Upper thoracic levels are poorly visualised.
    (e) High frequency probe should be used for caudal epidural.
79. Ultrasound for neuraxial block:
    (a) Two sacr vb al cornu appear as frog's eyes.
    (b) Gel used for ultrasound application is safe.
    (c) Changes can be visualised under ultrasound during lumbar epidural injection.
    (d) Epidural catheters are easily visualised.
    (e) Colour doppler aids in the caudal injection.

80. Ultrasound for neuraxial blocks:
    (a) Ultrasound decreases the failure rate for caudle needle placement.
    (b) Ultrasound helps identify possibility of failure rate.
    (c) Ultrasound can pick previous dural puncture scans.
    (d) Lumbar space can be accurately identified with ultrasound.
    (e) Ultrasound underestimates needle depth.
81. Ultrasound for neuraxial blocks:
    (a) Ultrasound helps in decreasing the number of attempts in difficult spinal anatomy.
    (b) Epidural has decreased failure rate.
    (c) Preprocedural ultrasound decreases the complication.
    (d) Size of the interlaminar space helps in predicting difficult neuraxial block.
    (e) Thoracic epidural space is difficult to visualise.
82. Neuraxial anatomy:
    (a) Mean length of spinal column is shorter in males than females.
    (b) Ligamentum flavum is continuous.
    (c) Cauda equina roots are of the same thickness.
    (d) Dura mater consists of only elastin fibers.
    (e) CSF moves with cardiac cycle.
83. Neuraxial anatomy:
    (a) Pia mater stabilises spinal cord.
    (b) Cauda equina is supplied by one artery.
    (c) Majority of the CSF volume is extracranial.
    (d) CSF in the spinal canal has little circulation.
    (e) Ultrasound visualisation of the structures may improve in elderly.
84. Neuraxial anaesthesia:
    (a) Paramedian insertion of needle is useful in elderly.
    (b) Ligamentum flavum and interspinous ligaments are continuous.
    (c) Epidural space is a continuous space.
    (d) Lipophillic drugs in epidural space may have delayed onset and a longer duration of action.
    (e) Ultrasound accurately measures epidural depth.
85. Physiologic effects of neuraxial block:
    (a) Autonomic fibres are last to recover.
    (b) Bradycardia seen is due to decreased preload.
    (c) Epidural blockade may cause laryngospasm.
    (d) Respiratory arrest following a total spinal is due to effect of local anaesthetic.
    (e) Neuraxial block delays gastrointestinal function.
86. Neuraxial block:
    (a) Decrease in blood pressure is more in lateral decubitus position.
    (b) Prone jack knife position can be used for spinal anaesthesia.
    (c) Slower injection of local anaesthetic involves fewer spinal segments.
    (d) Cardiac arrest may be seen in young patients.
    (e) First subjective sign of successful block is feeling of warmth in the feet.

87. Neuraxial block:
    (a) Midline approach should be avoided.
    (b) Loss of resistance to air may cause patchy block.
    (c) Hanging drop method is due to negative pressure generated.
    (d) Epidural test dose is safe.
    (e) Thiopentone can identify CSF from saline.
88. Neuraxial block:
    (a) Paramedian approach avoids all ligaments.
    (b) Addition of opioids may extend the number of segments blocked.
    (c) Sensory loss seen is differential.
    (d) Bromage scale can be used for both lumbar and thoracic epidural.
    (e) Ligamentum flavum depth is increased in obese patients.
89. Neuraxial block:
    (a) Neuraxial approach does not matter in scoliosis patients.
    (b) Previous laminectomy increases the chances of successful dural puncture.
    (c) Previous spinal surgery makes epidural insertion difficult.
    (d) Ultrasound can help visualise ligamentumn flavum alterations due to previous surgery.
    (e) Hypertonic solutions produce greater spread than isobaric or hypobaric solutions.
90. Neuraxial anaesthesia:
    (a) Effect of drug mass injected is always more important than volume or concentration.
    (b) Needle direction has no effect on the neuraxial block.
    (c) Barbotage increases the time to onset of the block.
    (d) Extent of spinal anaesthesia influences the duration of action.
    (e) Ropivicaine is short acting than bupivicaine.
91. Neuraxial block:
    (a) Dermatomal spread is dependent upon the level of spine at which local anaesthetic is injected.
    (b) Addition of epinephrine produces vasodilatation.
    (c) Young age is a risk factor for bradycardia on neuraxial block.
    (d) Spinal anaesthesia is a risk factor for subdural anaesthesia.
    (e) Facial palsies may be seen after neuraxial block.
92. Neuraxial anaesthesia:
    (a) Direct needle trauma is associated with severe paraesthesia.
    (b) Epidural blood patch causes immediate relief of signs and symptoms in PDPH.
    (c) Anticoagulation techniques do not affect peripheral nerve blocks.
    (d) Hypoacusis is a known complication.
    (e) Old age is protective for PDPH.
93. Ultrasound guided neuraxial blockade:
    (a) Cervical curvature is present since birth.
    (b) Spinal sonography required low frequency ultrasound.
    (c) Neuraxial structures are better visualised with paramedian saggittal plane.
    (d) Patient comfort is increased with the usage of ultrasound.
    (e) Both layers of dura mater are hyperechoic.

94. Ultrasound guided neuraxial block:
    (a) Sacrococcygeal ligament is an extension of ligamentum flavum.
    (b) Epidural space is hypoechoic.
    (c) L5-S1 space is different from other epidural spaces.
    (d) Cauda equina nerves cannot be seen on ultrasound.
    (e) Thecal sac is not visualised on ultrasound.

Answers

1. F F F T T
   Spinal anaesthesia can be used for mid abdominal surgeries though mild general anaesthesia may be required for mid abdominal to upper abdominal surgeries. Diaphragm involvement requires phrenic nerve involvement which is not blocked with spinal anaesthesia. The incidence of spinal headache increases with decreased age and female sex.
2. F T F F T
   The incidence of backache is the same between spinal and general anaesthesia. Spinal anaesthesia causes a sensation of dyspnoea due top loss of chest wall sensation rather than decreased inspiratory capacity. Electromyographic alterations take time to develop in the lower extremities and are useful after 14–21 days. Addition of Fentanyl to local anaesthetic enhances the sensory effect.
3. T T F T
   Full pharmacologic doses are required in epidural block as compared to spinal block and thus make it more prone to toxicity. Ligamentum flavum is thickest in lumbar region (5–6 mm), followed by cervical (4–6 mm) and thoracic (3–5 mm). Catheter should normally be inserted only 2–3 cm into the epidural space while obstetric patients require 3–5 cm to minimise dislodgement.
4. T T F T F
   Hanging drop method is used for cervical and thoracic spaces. Epinephrine is used in a dosage of 3 mL of local anaesthetic containing 1:200,000 epinephrine (15 μg). Subtotal blockade presents as higher than expected block after a delay of 15–30 min. More frequent dosages only improve block quality.
5. T T F T F
   Caudal blockade can be used for anorectal, perineal and lower extremity procedures. In 5% of patients the anatomy is not clear. Caudal block is a high volume block and 25–35 mL is needed to provide a sensory level of T12 to T10. An equivalent of ligamentum flavum is seen in the form of fibroelastic membrane. The anatomy is different based on the gender. In men, the cavity of the sacrum has a smooth curve from S1 to S5. In females, sacrum is flat from S1 to S3 with a pronounced curve in S4–5 region.
6. T T F T F
   Sacral hiatus is localised ideally with legs abducted to 20° with toes rotated inwards. This relaxes gluteal muscles making it easier to identify the sacral hiatus. Risk of toxicity is higher than lumbar epidural blockade. Dural sac ends

at S2 and carries risk of puncture if needle is inserted deep. Rectal perforation is a possibility if needle is passed anterior to the ventral plate of the sacrum. Accurate caudal placement of the needle and rapid injection of the local anaesthetic feels like pressure waves over sacral foramina.

7. F T T T F
   Transversus view is ideal as sacral cornua are visualised as humps. Sacral hiatus is seen between two hyperechoic lines. Upper hyperechoic line (sacrococcygeal membrane) and inferior hyperechoic line (dorsum of the pelvic surface of the sacrum). Loss of resistance is not seen because the sacrococcygeal ligament is softer in paediatric patients. Sacrum in paediatric patients is not ossified, so the beam can be penetrated.
8. T T FT F T
   C1 is an atypical vertebra. It has no body or spinous process. Also C2 and C7 are atypical vertebra. C2 has dens and is called axis. C7 transverse process is large and has only posterior tubercle. Sacrum connects the spine with the iliac wings of the pelvis. (*Aggarwal A, Kaur H, Batra YK, et al. Anatomic considerations of caudal epidural space: a cadaver study. Clin Anat. 2009;22:730*). Sacral hiatus is due to incomplete posterior fusion of the 5th sacral vertebra. Ligamentum flavum is a dense, homogenous structure, mainly composed of elastin which connects lamina of adjacent vertebra. (*Zarzur E. Anatomic studies of the human lumbar ligamentum flavum. Anesth Analg. 1984;63:499*). The ligament flavum has left and right halves, that join at an angle less than 90°. Fusion gaps may be seen that allows for veins to connect to vertebral venous plexus. Fusion gaps are more at cervical and thoracic level. (*Yoon SP, Kim HJ, Choi YS. Anatomic variations of cervical and high thoracic liamentum flavum. Korean J Pain. 2014;27:321*).
   Supraspinopus ligament extends from C7 to sacrum connecting the tips of the spinous processes. The same ligament is ligamentum nuchae above the C7. The lamina are connected by ligamentum flavum. The vertebral bodies are connected by the anterior and posterior ligaments.
   Structures encountered during the spinal anaesthetic includes skin, subcutaneous tissue, supraspinous ligaments, interspinous ligaments, ligamentum flavum, dura mater, subdural space, arachnoid mater and subarachnoid space.
9. T T T F T
   Ligamentum flavum is thinnest in cervical and upper thoracic region and thickest in lower thoracic and lumbar regions. (*Lirk P, Calvin J, Steger B, et al. Incidence of lower thoracic ligamentum flavum midline gaps. Br J Anaesth. 2005;94:852*). Subarachnoid space contains spinal cord, dorsal and ventral nerve roots and cerebrospinal fluid. Limb nerve plexuses are larger than the other plexuses of the body. (*Kostelic JK, Haughton VM, Sether LA. Lumbar spinal nerves in the neural foramen. MR Appear Radiol. 1991;178:837*). In scoliosis, the vertebral body rotates towards the convex side of the curve. Spinous processes point towards the midline leading to a large interlaminar space on convex side of spine. Paramedian approach from

convex side is more successful. (*Ko JY, Leffert LR. Clinical implications of neuraxial anaesthesia in the parturient with scoliosis. Anesth Analg. 2009;09:1930*). Ultrasound has been used to assess the orientation of the spine. (*Chin KJ, Karmaker MK, Peng P. Ultrasonography of the adult thoracic and lumbar spine for central neuraxial blockade. Anesthesiology. 2011;114:1459*).

10. F F F F T

Spinal anaesthesia depends upon the level of derangement. Absolute contraindications include patient refusal, increased intrtracranial pressure, allergy, hypovolemia and infection. Relative contraindications include sepsis, neurological disease, fixed cardiac output and Coagulopathy. Aortic stenosis is not an absolute contraindication. (*McDonald SB. Is neuraxial blockade contraindicated in the patient with aortic stenosis?Reg Anesth Pain Med. 2004;29(5):496502*). Multiple sclerosis is not a contraindication. Pain, stress, fever and fatigue exacerbate the symptoms and should be avoided. (*Vadalouca A, Moka E, Sykiotis C. Combined spinal epidural technique for total hysterectomy in a patient with advanced, progressive, multiple scoliosis. Reg Anesth Pain Med. 2002;27(5):540–1*).

11. T T F T T

Post operative nausea and vomiting is seen in 80% of obstetric population. (*Balki M, Carvalho JC. Intraoperative nausea and vomiting during ceserean section under regional anaesthesia. Int J Obstet Anesth. 2005;14(3):230–41).* Risk factors include patient factors (anxiety, decreased lower oesophageal sphincter pressure, increased gastric pressure, vagal hyperactivity and hormonal changes), surgical factors (exteriorisation of uterus, peritoneal traction). Glycopyrrolate is associated with hypotension but has been found to reduce nausea. (*Ure D, James KS, McNeil M, et al. Glycopyrrolate reduces nausea during spinal anaesthesia for ceserean section with out affecting neonatal outcome. Br J Anaesth. 1999;82(2):277–9).* The incidence of shivering is equal with both spinal and epidural though intensity of shivering if increased with epidurals. The mechanism include decreased shivering threshold with involvement of more dermatomes (*Crowley LJ, Buggy DJ. Shivering and neuraxial anaesthesia. Reg Anesth Pain Med. 2008;33(3):241–52*) (Table 11.1).

Table 11.1 Post operative nausea and vomitting

Post operative nausea and vomitting	
Prevention	Treatment
• Prewarming with forced air warming for 15 min • Avoiding cold solutions • Intrathecal Fentanyl 20mcg • Intravenous ondansetron • Intrathecal Meperidine • Epidural fentanyl	• Intravenous Meperidine • Intravenous Tramadol • Intravenous clonidine

Pruritus is seen more with spinal route (46%) than the epidural route (8.5%). (*Ballantyne JC, Loach AB, Carr DB. Itching after epidural and spinal opiates. Pain. 1988;33(2);149–60).* Hearing loss is seen in 3–92% of the patients. Full recovery is seen in 15 days. This is seen due to dysfunction of outer hair cells. (*Karatas E, Goksu S, Durucu C, et al. Evaluation of hearing loss after spinal anaesthesia with otoacoustic emissions. Eur Arch Otorhinolarngol. 2006;263(8):705–10*).

12. T T F T T

Post operative urinary retention is due to parasympathetic blockade and retention gets resolved with the return of S2–S4 segments. (*Choi S, Mahon P, Awad IT. Neuraxial anaesthesia and bladder dysfunction in the perioperative period: a systematic review. Can J Anaesth. 2012;59(7):681–703).* The risk factors for post dural puncture headache include needle size, female gender, high BMI, recurrent headaches, previous post dural puncture headache. (*Chol PT, Galinski SE, Takuchi L, et al. Post dural puncture headache is a common complication of neuraxial blockade in parturients: a meta analysis of obstetric studies. Can J Anaesth. 2003;50(5):460–9*). Meningitis can be aseptic or bacterial. (*Marinac JS. Drug and chemical induced aseptic meningitis: a review of the literature. Ann Pharmacother. 1992;26(6):813–22*). Risk factors for cauda equina syndrome include spinal microcatheters, lithotomy position, repeated dosing. Aspiration of cerebrospinal fluid before and after local anaesthetic injection prevents the syndrome. (*Lopez-Soriono F, Verdu JM, et al. Cauda equina hemi syndrome after intradermal anaesthesia with bupivicaine for hip surgery. Rev Esp Anestesiol Reanim. 2002;49(9):494–6.*)

13. T T T T T

Causes of arachnoiditis include use of oil based dyes, blood in inthrathecal space, intrathecal steroids. (*Aldrete JA. Neurologic deficits and arachnoiditis following neuraxial anaesthesia. Acta Anaesthesiol Scand. 2003;47(1):3–12*). Total spinal anaesthesia has been used for intractable pain. (*Yokoyama M, Itano Y, Kusume Y, et al. Total spinal anaesthesia provides transient relief of intractable pain. Can J Anaesth. 2002;49(8):810–3).* There is a high incidence of neurological complications. (*Brull R, McCartney CJ, Chan VW, et al. Neurological complications after regional anaesthesia: contemporary estimates of risk. Anesth Analg. 2007;104(4):965–74*). *Risk of paraplegia is 1:141,500.*

14. T F F T T

Spinal anaesthesia decreases intraoperative blood loss. (*Guay J. The effect of meuraxial blocks on surgical blood loss and blood transfusion requirements. A meta analysis. J clin Anesth. 2006;18(2):124–8).* Maternal blood loss is less as compared to general anaesthesia (*Afolabi BB, Lesi FE, Merah NA. Regional versus general anaesthesia for caesarean section. Cochrane Database Syst Rev. 2006(4):CD004350*). Stress response is attenuated by bupivicaine more than the opioids. (*Hall R, Adderley N, Maclaren C, et al. Does intrathecal morphine alter the stress response following coronary artery bypass grafting sur-*

gery? Can J Anaesth, 2000;47(5):463–6). Early extubation has been seen with usage of intrathecal opioids. (*Liu SS, Block BM, Wu CL. Effects of perioperative central neuraxial analgesia on outcome after coronary artery bypass surgery: a meta analysis. Anesthesiology. 2004;101(1):153–61*). Subdural space is an acquired space that becomes real after tearing of mesotheliel cells within the space. (*Agarwal D, Mohta M, Tyagi A, et al. Subdural block and the anaesthetist. Anesth Intensive Care. 2010;38(1):20–6*).

15. T T T T T

Spinal cord may extend to sacral region. (*Reiman A, Ansun B. Vertebral termination of the spinal cord with report of a case of sacral cord. Anat Rec. 1944;88:127*). The factors affecting the uptake include concentration of local anaesthetic in cerebrospinal fluid, surface area of nervous tissue exposed to cerebrospinal fluid, lipoid content of nerve tissue and blood flow to nervous tissue. (*Steinstra R, Greene NM. Factors affecting the subarachnoid spread of local anaesthetic solutions. Reg Anesth. 1991;16(1):1–6*). Diffusion occurs from cerebrospinal fluid to the pia mater and into the spinal cord. Another mechanism is by extension of local anaesthetic into spaces of Virchow- Robin. The spaces of Virchow-Robin connect with the perineural clefts. Nerve damage is seen more in unmyelinated nerves. (*Takenami T, Yagishita S, Asato F, et al. Neurotoxicity of intrathecally administered tetracaine commences at the posterior roots near entry into the spinal cord. Reg Anesth Pain Med. 2000;25(4):372–9*). Elimination of local anaesthetic depends on vascular perfusion. (*Greene NM. Uptake and elimination during spinal anesthesia. Anesth Analg. 1983;62(11):1013–24*).

Determinants of local anaesthetic spread in subarachnoid space:

Baricity, position during surgery, dose, height, volume, spinal anatomy, specific gravity and decreased cerebrospinal fluid.

Dermatomal levels required with spinal anaesthesia:

- Upper abdominal surgery: T4
- Intestinal/gynaecol/ urological: T6
- TURP: T10
- Vaginal delivery: T10
- Thigh surgery: L1
- Perineal: S2–S4
- Genitourinary: T10

16. F T T T T

The cerebrospinal fluid is produced at 0.35 mL/min. The adult volume seen is 150 mL. Decreased volume is seen in obesity, pregnancy and increased abdominal pressure. (*Hogan QH, Prost R, Kulier A, et al. Magnetic resonance imaging of cerebrospinal fluid volume and the influence of body habitus and abdominal pressure. Anesthesiology. 1996;84(6):1341–9*). The incidence of transient neurologic symptoms is about 14%. (*Zaric D, Christiansen C, Pace NL, et al. Transient neurologic symptoms after spinal anesthesia with Lidocaine versus other local anaesthesia: a systematic review of randomised controlled trials. Anesth Analg. 2005;100(6): 1811–6*). Epinephrine added to

2-chlorprocaine increases flu like symptoms and back pain.(*Smith KN, Kopacz DJ, McDonald SB. Spinal 2-Chlorprocaine: a dose ranging study and the effect of added epinephrine. Anesth Analg. 2004;98(1):81–8*). High rate of failure block is seen with procaine (14%). (*Le Truong HH, Girard M, Drolet P, et al. Spinal anaesthesia: a comparison of Prilocaine and Lidocaine. Can J Anesth. 2001;48(5):470–3*). The incidence of transient neurologic symptoms with bupivicaine is low. (*Keld DB, Hein L, Dalgaard M, et al. The incidence of transient neurologic symptoms (TNS) after spinal anaesthesia in patients undergoing surgery in the supine position. Hyperbaric Lidocaine 5% vs hyperbaric bupivicaine 0.5%. Acta Anestesiol Scand. 2000;44(3):285-90*).

17. F T T F F

Phenyephrine if used increases the incidence of transient neurologic symptoms especially with tetracaine. (*Sakura S, Sumi M, Sakaguchi Y, et al. The addition of phenylephrine contributes to the development transient neurologic symptoms after spinal anaesthesia with 0.5% tetracaine. Anesthesiology. 1997;87(4):771–8*). High incidence of transient neurologic symptoms is seen with Mepivicaine (30%). *(Salazaar F, Bogdanonch A, Adalia R, et al. Transient neurologic symptoms after spinal surgery using isobaric 2% Mepivicaine and isobaric 2% Lidocaine. Acta Anaesthesiol Scand. 2001;45(2):240-5*). Phenyephrine increases the incidence of cauda equina syndrome and decreases the block height. *(Machara Y, Kusunoki S, Kawamoto S, et al. A prospective multicenter trial to determine the incidence of transient neurologic symptoms after spinal anaesthesia with phenylephrine added to 0.5% tetracaine. Hiroshima J Med Sci. 2001;50(2):47–51).* Epinephrine increases the duration of hyperbaric spinal bupivicaine. (*Moore JM, Liu SS, Pollock JE, et al. The effect of epinephrine on small dose hyperbaric bupivicaine spinal anaesthesia: clinical implications for ambulatory surgery. Anesth Analg. 1998;86(5):973–7*). Full side effects are seen as all opioid receptors are present. (*Nordberg G, Hedner T, Mellstrand Y, et al. Pharmacokinetic aspects of intrathecal morphine analgesia. Anesthesiology. 1984;60(5):448–54*).

18. F T T T F

Clonidine induces hyperpolarisation at the ventral horn of the spinal cord and facilitates action of local anaesthetic causing both motor and sensory blockade. If used alone, it does not cause motor blockade (*Filos KS, Goudas LC, Patroni O, et al. Hemodynamic and analgesic profile after intrathecal clonidine in humans. A dose response study. Anesthesiology. 1994;81(3):591–601*). Hypotension is seen due to preganglionic sympathetic block. Other factors include: local anaesthetic direct effect, adrenal insufficiency, skeletal muscle paralysis, medullary vasomotor block. (*Mark JB, Steele SM. Cardiovascular effects of spinal; anesthesia. Int Anesthesiol Clin. 1989;27(1):31–9*). Cardiac output falls due to decrease in preload. (*Salinas FV, Sueda LA, Liu SS. Physiology of spinal anesthesia and practical suggestions for successful spinal anaesthesia. Best Pract Clin Anaesthesiol. 2003;17(3):289–303*). Biphasic change is seen in elderly. Cardiac output increases in initial first 7 min followed by a fall.

This is due to a fall in afterload preceeding a fall in preload. (*Meyhoff CS, Hesselbjorg L, Kosielniak-Nielson Z, et al. Biphasic cardiac output changes during onset of spinal anaesthesia in elderly patients. Eur J Anesthesiol. 2007;24(9):770–5*). Hyperkinetic contractile state is seen leading to ST segment depression. (*Roy L, Ramanathan S. ST segment depression and myocardial contractility during caesarean section under spinal anaesthesia. Can J Anaesth. 1999;46(1):52–5*). Heart rate may increase with with spinal block (secondary to hypotension via the baroreceptor reflex)) or decrease (blockade of sympathetic cardiac accelerator fibres or via reverse Bainbridge reflex). Reverse Bainbridge reflex refers to decrease in heart rate due to decreased venous return detected by stretch receptors in right atrium.(*Cooper DW. Ceserean delivery vasopressor management. Curr Opin Anaesthesiol. 2012;25(3):300–8*). Heart rate also decreases due to Bezold-jarisch reflex. It is a cardioinhibitory reflex and causes bradycardia after spinal anaesthesia. (*Campagna JA, Carter C. Clinical relevance of the bezold-jarisch reflex. Anesthesiology. 2003;98(5):1250–60*).

19. T F F T T

Risk factors for hypotension include hypovolemia, preoperative hypotension, high sensory block height, age more than 40 years, obesity, combined spinal epidural, chronic alcohol consumption, increased BMI. (*Hrtmann B, Junger A, Klasen J, et al. The incidence and risk factors for hypotension after spinal anesthesia induction: an analysis with automated data collection. Anesth Analg. 2002;94(6):1521–9*). Trendelenberg position should not exceed 20 degrees as extreme position decreases central perfusion and blood flow due to increase in jugular venous pressure. (*Sinclair CJ, Scott DB, Edstrom HH. Effect of the trendelenberg position on spinal anaesthesia with hyperbaric bupivicaine. Br J Anaesth. 1982;54(5):497–500*). Optimal angle of left lateral tilt is unknown. (*Khaw KS, Ngan Kee WD, Lee SW. Hypotension during spinal anaesthesia for ceserean section: implications, detection, prevention and treatment. Fetal Matern Med Rev. 2006;17(2):157–83*). Coloading of fluids is rapid administration of fluids immediately after spinal anaesthesia. (*Dyer RA, Farina Z, Joubert IA, et al. Crystalloid preload versus rapid crystalloid administration after induction of spinal anaesthesia (coload) for elective ceserean section. Anesth Intensive Care. 2004;32(3):351–7*). Ephedrine is a direct and indirect alpha and beta receptor agonist. It has slow onset of action and is subject to tachyphylaxis. Phenylephrine is an indirect alpha-1 receptor agonist. It reduces incidence of nausea in addition. (*Habib AS. A review of the impact of Phenylephrine administration on maternal hemodynamics and maternal and neonatal outcomes in women undergoing ceserean section under spinal anaesthesia. Anesth Analg. 2012;114(2):377–90*).

20. T F T F T

High spinal patients may complain of dyspnoea. It is due to the inability to feel the chest wall move during respiration. The main effect of high spinal is on expiration, as the muscles of expiration are impaired. Sparing of phrenic nerve is seen along with normal diaphragmatic function. Increased ventilator response

is seen to CO_2. (*Steinbrook RA, Concepcion M, Topulo GP. Ventilatory responses to hypercapnia during bupivaine spinal anaesthesia. Anesth Analg. 1988;67(3):247–52*). Incidence of nausea and vomiting is high up to 42% in non obstetric surgery and up to 80% in parturients. Arterial blood flow decreases causing a decrease in hepatic blood flow. (*Zinn SE, Fairley HB, Glenn JD. Liver function in patients with mild alcoholic hepatitis, after enflurane, nitrious oxide-narcotic and spinal anaesthesia. Anesth analg. 1985;64(5);487–90*).

21. T F T T F

Isobaric bupivicaine produces sensory blockade that is reduced by two dermatomes per interspace. (*Tuominen M, Tairainen T, Rosenberg PH. Spread of spinal anaesthesia with plain 0.5% bupivicaine: influence of the vertebral interspace used for injection. Br J Anaesth. 1989;62(4):358–61*). Isobaric bupivicaine increases block height while hyperbaric bupivicaine does not change block height. (*Pargger H, Hampl KF, Aeschbach A, et al. Combined effect of patient variables on sensory level after spinal 0.5% plain bupivicaine. Acta Anaesthesiol Scand. 1998;42(4):430–4*). Positioning of patients is important for hyperbaric and hypobaric solutions and not for isobaric solutions. (*Alston RP. Spinal anaesthesia with 0.5% bupivicaine 3ml: comparison of plain and hyperbaric and hyperbaric solutions administered to seated patients. Br J Anaesth. 1988;61(4);385–9*). Speed of injection affects spinal block height. (*Van Gessel EF, Praplan J, Fuctis T. Influence of injection speed on the sduibarachnoid distribution of isobaric bupivicaine 0.5%. Anesth Analg. 1993;77(3);483–7*). Higher doses causes longer block.

22. T T T T F

An ideal aseptic agent should be bactericidal and have a quick onset and long duration. (*Cook TM, Fischer B, Bogod D, et al. Antiseptic solutions for central neuraxial blockade: which concentration of chlorhexidine in alcohol should we use? Br J Anaesth. 2009;103:456–7*). 0.5% in 70%b alcohol is recommended. Full asepsis is mandatory for performing a neuraxial block (face mask, surgical hat, sterile draping). (*Hebl JR. The importance and implications of aseptic techniques during regional anaesthesia. Reg Anesth Pain Med. 2006;31(4):311–23*). Taylor's approach is paramedian approach to spinal anaesthesia at L5–S1 interspace. Needle is inserted at a point 1cm medial and inferior to posterior superior iliac spine and angled 45–55° and medially. Ultrasound guidance improves patient comfort and compliance. (*Lee PJ, Tang R, Suruka A, et al. Brief report: real time ultrasound guided spinal anaesthesia using Taylor's approach. Anesth Analg. 2011; 112(5):1236–8*). Catheters smaller then 24G avoid the complication of cauda equina syndrome. (*Palmer CM. Continuous spinal anaesthesia and analgesia in obstetrics. Anesth Analg. 2010;111(6);1476–9*). Spinal anaesthesia has failure rate less than 1%. (*Sng BL, Lim Y, Sia AT. An observational prospective cohort study of incidence and characteristics of failed spinal anaesthesia for ceserean section. Int J Obstet Anesth. 2009;18(3);237–41*).

Feltes PD, Jansson JR, Wildsmith JA. Failed spinal anaesthesia: mechanisms, management and prevention. Br J Anaesth. 2009;102(6):739–48.

23. T F T F F

Predictors of success include adequate positioning, anaesthesiologist experience and ability to palpate anatomical landmarks. (*de Filho GR, Gomes HP, da Fonscea MH, et al. Predictors of successful neuraxial blockL a prospective study. Eur J Anaesthesiol. 2002;19(6);447–51*). Failure of solution spread into cerebrospinal fluid may be seen due to kyphosis, previous surgery, longitudinal spinal septae, spinal stenosis and extradural cysts. Tarlow cysts are a type of extradural cysts with an incidence up to 9% and contains cerebrospinal fluid and may account for pontine aspiration and subsequent failure (*Hoppe J, Popham P. Complete failure of spinal anaesthesia in obstetrics. Int J Obstet Anaesth. 2007;16(3);250–5*). Lumbar cerebrospinal fluid is an important determinant of spread. (*Carpenter RL, Hogan QH, Liu SS, et al. Lumbosacral cerebrospinal fluid volume is the primary determinant of sensory block extent and duration during spinal anaesthesia. Anesthesiology. 1998;89(1):24–9*). Subdural block presents as high sensory level block with motor and sympathetic sparing. Subdural block may present as failed block, unilateral block, Horner syndrome, trigeminal nerve palsy, respiratory insufficiency. Onset of block is slower than subarachnoid block but faster than epidural block. It resolves within 2 h. (*Agarwal D, Mohta M, Tyagi A, et al. Subdural block and the anaesthetist. Anaesth Intensive Care. 2010;38(1):20–6*). Spinal anaesthesia can be used for outpatient surgery. (*Cappelleri G, Aldeghari G, Danielli G, et al. Spinal anaesthesia with hyperbaric levobupivicaine and ropivicaine for out patient knee arthroscopy: a prospective, Randomised, double blind study. Anesth Analg. 2005;101(7):77–82*).

24. T T T F T

Unilateral spinal is done using a hypobaric solution and operative side up which provides excellent analgesia. It results in decreased changes in systolic, mean and diastolic pressures and oxygen saturation. (*Khatouf M, Loughnane F, Boini S, et al. Unilateral spinakl anaesthesia in elderly patients for hip trauma: a pilot study. Ann Fr Anesth. Reanim 2005;24(3):249–54*). Slow injection rate in unilateral block produces laminar flow that assists in unilateral block. (*Casati A, Fanelli G. Unilateral spinal anaesthesia: state of the art. Minerva Anestesiol. 2001;67(12);855–62*). Ultrasound usage is better for space localisation as palpation is likely to generate a higher space. (*Broadbent CR, Maxwell WB, Ferrie R, et al. Ability of anaesthetists to identify a marked lumbar interspace. Anesthesia. 2000;55(11):1122–6*). (*Chin KJ, Perlas A. Ultrasonography of the lumbar spine for neuraxial and lumbar plexus blocks. Curr Opin Anesthesiol. 2011;24(5):567–72*). The learning curve with ultrasound involved up to 22–30 patients. (*Halpern SH, Banerjee A, Stocche R, et al. The use of ultrasound for lumbar spinous process identification:a pilot study. Can J Anaesth. 2010;57(9):817–22*). Main complication seen with laparoscopic surgery under spinal anaesthesia is shoulder tip pain. (*Chilvers CR, Vaghalia H, Mitchell GW, et al. Small dose hypobaric Lidocaine Fentanyl spinal anaesthesia for short duration outpatient la[aroscopy. Anesth Analg. 1997;84(1):65–70*).

25. F T T F F
The incidence of inadequate anesthesia is less than 2%. (*Horlocker TT, McGregor DG, Matsushinge DK, et al. A retrospective review of 4767 consecutive spinal anaesthetics: central nervous system complications. Anesth Analg. 1997;84:578–84).* An error of judgement is the main cause for failure. (*Munhall RJ, Sukhani R, Winnie AP. Incidence and etiology of failed spinal anaesthetics in a university hospital. Anesth Analg. 1988;67:843–8*). Lumbar plexus block may extend to epidural space. (*Lang SA, Prusinkiwicz C, Tsui BCH. Failed spinal anesthesia after a psoas compartment block. Can J Anaesth. 2005;52:74–8*). A dosage of 5–10 mg is sufficient. (*Atallah MM, Shorrab AA, Abdel Mageed YM, et al. Low dose bupivicaine spinal anaesthesia for percutyaneous nephrolithotomy: the solubility and impact of adding intrathecal Fentanyl. Acta Anaesthesiol Scand. 2006;50:798–805*). Aspiration of cerebrospinal fluid does not reduce failure rate. (*Tarkkila PJ. Incidence and causes of failed spinal anaesthetics in a university hospital: a prospective study. Reg Anesth. 1991;16:48–51*).
26. F T T T T
Subdural block is seen with both epidural and spinal anaesthesia. (*Singh B, Sharma P. Subdural block complicating spinal anaesthesia. Anesth Analg. 2002;94:1007–9*). Intrathecal chemotherapy increases the incidence of failed spinal anaesthesia. (*Westphal M, Gotz T, Booke M. Failed spinal anesthesia after intrathecal chemotherapy. Eur J Anesthesiol. 2005;22:235–6*). Marfan syndrome patients have dural ectasia (pathological enlargement of the dura). (*Lacassie HJ, Millar S, Leithe LG, et al. Dural ectasia: a likely cause of inadequate spinal anaesthesia in two parturients with Marfan's syndrome. Br J Anaesth. 2005;94:500–4*). Block failure may be seen due to local anaesthetic inactivity especially with ester type local anaesthetics. (*Harris RW, Mcdonald P. Inadequate spinal anaesthesia with 0.5% marcaine heavy (batch DK-1961). Int J Obstet Anaesth. 2004;13:130–1*). Local anaesthetic resistance may contribute to failure of the block. (*Kaulock R, Ting PH. Local anaesthetic resistance in a pregnant patient with lumbosacral plexopathy. BMC Anesthesiol. 2004;4(1):1*).
27. T T T T T
Epidural anaesthesia decreases post operative confusion provided intraoperative hypotension is avoided. (*Schindler I. Regional anaesthesia in the elderly: indications and contraindications. Acta Anaestesiol Scand Suppl. 1997;111:209–11*). Preservative free morphine if injected intrathecally may delay the onset of tourniquet pain. (*Cherng CH, Wong CS, Chang FL, et al. Epidural morphine delays the onset of tourniquet pain during epidural Lidocaine anaesthesia. Anesth Analg. 2002;94:1614–6*). Neuaraxial anaesthesia is preferred for quadriplegic patients because of risk of autonomic hypereflexia. Hysteroscopy with distension media may need general anaesthesia or epidural. Epidural administration has been known to increase glycine administration. (*Goldenberg M, Cohen SB, Etchin A, et al. A randomised prospective comparative study of general versus epidural*

anesthesia for transcervical hysteroscopic endometrial resection. Am J Obstet Gynecol. 2001;184:273–6) epidural along with general anaesthesia decreases the incidence of post operative arrhythmias in off pump coronary artery bypass along with increased pain control and increased quality of recovery. (*Caputo M, Alwair H, Rogers CA, et al. Thoracic epidural anesthesia improves early outcomes in patients undergoing off pump coronary artery bypass surgery*: *a prospective randomised controlled trial. Anesthesiology. 2011;14:380–90*).

28. T T T T T

Epidural anaesthesia is done at mid-upper thoracic region for breast procedures. It is beneficial in high risk patients. The block required for breast augmentation should involve T1–T7 while for modified radical mastectomy, C5–T7 is required. Mastectomy with TRAM flap requires C5–T1. Denervation of viscera needs block extending from T4 to T12. Neuraxial techniques are associated with decreased intra operative blood loss. (*Shir Y, Raja SN, Frank SM, et al. Intraoperative blood loss during radical retropubic prostatectomy. Epidural versus general anaesthesia. Urology. 1995;45:993–9*). Epidural anaesthesia can be used for controlled hypotension. (*Ozyuvaci E, Alton A, Karadeniz T, et al. General anaesthesia versus epidural and general anaesthesia in radical prostatectomy. Urol Int. 2005;74:62–7*). Visceral pain associated with bowel and peritoneal manipulation decrease as the level of the blockade increases. T3-T4 level blockade may be required for abdominal hysterectomy.(*Mihic DN, Abram SE. Optimal regional anaesthesia for abdominal hysterectomy: combined subarachnoid and epidural block compared with other regional techniques. Eur J Anesthesiol. 1993;10:297–301*).

29. T F T T T

Incidence of post operative ileus is decreased without affecting healing and leakage. (*Holte K, Kehlet H. Epidural analgesia and risk of anastomotic leakage. Reg Anesth Pain Med. 2001;26:111).*epidural leads to early discharge along with early oral nutrition and mobilisation. (*Bardram L, Funch-Jensen P, Kehlet H. Rapid rehabilitation in elderly patients after laparoscopic colonic resection. Br J Surg. 2000;87:1540–5*). Epidural eliminates the need for intraoperative relaxants in myasthenia gravis. It also minimises opioid respiratory depression and pulmonary dysfunction. (*Kirsch JR, Diringer MN, Borel CO, et al. Preoperative lumbar epidural morphine improves post operative analgesia and ventilator function after transsternal thymectomy in patients with myasthenia gravis. Crit Care Med. 1991;19:1474–9*). Neuraxial anaesthesia is better than general anaesthesia in malignant hyperthermia. (*Ording H. Incidence of malignant hyperthermia in Denmark. Anesth Analg. 1985;64:700–4*). Epidural infusions increase placental blood flow in chronically compromised uterine perfusion and intrauterine growth restriction. (*Strumper D, Lauwen F, Duriewx ME, et al. Epidural local anaesthetics: a novel treatment for fetal growth retardation? Fetal Diagn Ther. 2005;20:208–13*).

Table 11.2 Antithrombotics and neuraxial blockade

Neuraxial blockade and antithrombotics	
NSAIDs	No caution required
5000 units subcutaneously	No caution required
Heparin	Donot administer for up to 1 h after blockade and give 2–4 h before catheter removal
Clopidogrel	Stop for 7 days
LMWH prophylaxis	Wait for 12 h
LMWH therapeutic dose	Wait for 24 h
Warfarin	INR should be less than 1.5

30. T F F T T
Regional anaesthesia prevents cancer recurrence (*Biki B, Mascha E, Moriarty DC, et al. Anesthesia technique for radical prostatectomy surgery affects cancer recurrence. A retrospective analysis. Anesthesiology. 2008;109:180–7*). There is no consensus about epidural blockade in sepsis. (*Mutz C, Vagts DA. Thoracic epidural anesthesia in sepsis—is it harmful or protective? Crit Care. 2009;13:182*). Epidural injection is associated with increased ICP pressure. (*Grocott HP, Mutch WA. Epidural anesthesia and acutely increased intracranial pressure: lumbar epidural space hydrodynamics in a porcine model. Anesthesiology. 1996;85:1086–1091*). Platelet count more than 70,000 is accepted for epidural block in absence of clinical bleeding. (*O'Rourke N, Khan K, Hepner DL. Contraindications to neuraxial anaesthesia. In: Wong CA, editor. Spinal and epidural anaesthesia. New York: McGraw-Hill; 2007. p. 127–49*) (Table 11.2).

31. T F F F T
Higher concentration of local anaesthetics in epidural anaesthesia may cause an increase in relapse of multiple sclerosis. (*Bader AM, Hunt CO, Dalta S, et al. Anesthesia for the obstetric patient with multiple sclerosis. J Clin Anesth. 1988;1:21–4*). Epidural anaesthesia may cause worsening of symptoms in Guillain Barry syndrome. (*Wiertlewski S, Magot A, Drapier S, et al. Worsening of neurologic symptoms after epidural anaesthesia for later in a Guillain Barre syndrome. Anesth Analg. 2004;98:825–7*). Genital herpes does not increase the neurologic complications with epidural. (*Crosby ET, Halpern SH, Rolbin SH. Epidural anaesthesia for ceserean section in patients with active recurrent genital herpes simplex infection. A retrospective review. Can J Anaesth. 1989;36:701–4*). Epidural anaesthesia is preferred in varicella infection. (*Brown NW, Parsons APR, Kam PCA. Anesthetic considerations in a parturient with varicella presenting for caesarean section. Anesthesia. 2003;58:1092–5*). Epidural anaesthesia can be done in patients who are anesthetised. (*Rosenquist RW, Birnbach DJ. Epidural insertion in anesthetised adults: will your patients thank you? Anesth Analg. 2003;96:1545–6*).

32. F T F F T
Spinal curves are fully developed by 10 years of age and become more pronounced in pregnancy and old age. All cervical vertebrae have bifid vertebrae except C7. C6 is difficult to distinguish from C7 in 50% of patients especially females. (*Stonelake PS, Burwell RG, Webb JK. Variation in vertebral levels of the vertebrae prominens and sacral dimples in subjects with scoliosis. J Anat. 1988;159:165–72*).

33. T F T T T
Tuffier's line of intercristal line joins the superior aspect of iliac crests and may be up to two levels higher than L4–L5 especially in elderly, pregnant and obese. (*Lee AJ, Ranasinghe JS, Chehade JM, et al. Ultrasound assessment of the vertebral level of the intercristal line in pregnancy. Anesth Analg. 2011;113:559–64*). A membrane lateral extension of the posterior ligament may serve as a barrier to the spread of epidural solution. (*Hogan QH. Lumbar epidural anatomy. A new look by cryomicrotome section. Anesthesiology. 1991;75:767–75*). Ligamentum nuchae extends from C7 to L5. It is more prominent in cervical region and becomes less prominent in lumbar region. (*Heylings DJ. Supraspinatus and interspinous ligaments of the human lumbar spine. J Anat. 1978;125:127–31*). Bony spurs may be seen in ligamentum flavum and can prevent needle insertion. The spurs are most commonly seen in lower thoracic region between T9 and T11. (*Williams DH, Gabrielson TO, Latack JT, et al. Ossification in the cephalic attachment of the ligamentum flavum. An anatomical and CT study. Radiology. 1984;150:423–26*).

34. T T T F F
Ligamentum flavum is thickest in the lumbar region (Table 11.3).
Pregnancy may increase the thickness of ligamentum flavum. It can increase up to 10 mm due to oedema. (*Westbrook JL, Renowden SA, Carrie LE. Study of the anatomy of the xtradural region using magnetic resonance imaging. Br J Anaesth. 1993;71:495–8*). Architecture of arachnoid mater accounts for difference in headache rates between perpendicular and parallel insertion of bevelled spinal needles. (*Bernards CM. Sophistry in medicine. Lessons from the epidural space. Reg Anesth Pain Med. 2005;30:56–66*). Subdural is an actual space and serous fluid may be seen in 66% of patients. The space accounts for patchy or failed epidurals. (*Blomberg RG. The lumbar subdural extraarachnoid space of humans: an anatomical study using spinaloscopy in autopsy cases. Anesth Analg. 1987;66:177–80*). Arachnoid dura interface space cannot be easily opened. The interface is prone to mechanical stress that opens after direct trauma such as air or fluid injection. (*Haines DE. On the question of a subdural space. Anat Rec. 1991;230:3–21*).

Table 11.3 Ligamentum flavum thickness

Region	Thickness (mm)
Cervical	1.5–3.0
Thoracic	3.0–5.0
Lumbar	5.0–6.0
Caudal	2.0–6.0

35. T F T F F
Artery of Adamkiewicz is the largest segmental artery, is unilateral and arises from left side of aorta between T8 and L1. Vertebral venous plexus is comprised of two anterior and two posterior vessels. The plexus is involved in bloody or traumatic needle or catheter placements. (*Boon JM, Abrahams PH, Meiring JH, et al. Lumbar puncture: anatomical reviewof a clinical skill. Clin Anat. 2004;17:544–53*). Veins are present in anterior epidural space confined by the membranous extension of the posterior longitudinal ligament. (*Hogon QH. Epidural anatomy: new observations. Can J Anesth. 1998;45:R40–8*). Adipose tissue decreases with age and accounts for higher levels and faster onset of epidural anaesthesia in the elderly. (*Igarashi T, Hirabayashi Y, Shimizu R. et al. The lumbar extradural structure changes with increased age. Br J Anaesth. 1997;78:149–52*). Adipose tissue in the midline gap, where ligamentum flava fuse, may alter the tactile sensation that is normally seen during loss of resistance technique. Distribution of solution in the epidural space is non uniform and directed according to differential pressures. (*Hogan QH. Distribution of solution in epidural space: examination by cryomicrotome section. Reg Anesth Pain Med. 2002;27:150–6*).

36. T T T F T
Distance from skin to space is shallowest at the level of C5–C6. (*Han KR, Park SK, et al. Distance to the adult cervical epidural space. Reg Anesth Pain Med. 2003;28:95–7*). Greatest depth of cervical space is seen at C6–T1 which is due to hump pad due to presence of fatty tissue. (*Fujinaka MK, Lawson EF, Schukteis G, et al. Cervical epidural depth:correlation between needle angle, cervical anatomy and body surface area. Pain Med. 2012;13:665–9*). The space is 4–6 cm in 76% of patients. 16% have shallow depth. (*Sutton DN, Linter SP. Depth of extradural space and dural puncture. Anaesthesia. 1991;46:97–8*). Anteroposterior distance is largest in lumbar area (L3–L4). The distance is decreased in thoracic area and is absent in cervical region. (*Hogan QH. Epidural anatomy examined by cryomicroteme section. Influence of age, vertebral level and disease. Reg Anesth. 1996;21:395–406*). Imaging should always be used for cervical spine because of risk of spinal cord injury, total spinal anaesthesia and intra arterial injection.

37. F F T F T
Sympathetic blockade extends 2–6 dermatomes higher than sensory blockade which is more than motor blockade. (differential blockade). Middle thoracic dermatome blockade causes more sedation than lower lumbar segments. (*Toprak HI, Ozpolat Z, Ozturk E, et al. Hypertonic bupivicaine affects the doses of midazolam requirement for sedation after spinal anaesthesia. Eur J Anaesthesiol. 2005;22:904–6*). Temperature is the first sensation to be blocked followed by pinprick and then touch. Morphine added to epidural solution does not reduce volatile agent requirement. (*Koo M, Sabate A, Dalmau A, et al. Sevoflurane requirement during colpopractic surgery: difference between two different epidural regimens. J Clin Anesth. 2003;15:97–102*). Epidural local anaesthetic decrease inhalational and opioid requirements. (*Reinoso-Barbero F, Martinez-Garcia E, Hernandez-Gancedo MC, et al. The effect of epidural bupivicaine on maintenance requirements of sevoflurane evaluated by bispectral index in children. Eur J Anaesthesiol. 2006;23:460–4*).

38. T F F T F

Hypotension is due to vasodilation due to vascular and capacitance vessels. (*Holte K, Foss NB, Svenson C, et al. Epidural anesthesia, hypotension and changes in intravascular volume. Anesthesiology. 2004;100:281–6*). Risk factors for hypotension include level of blockade more than T5, low baseline pressure, increased age, combined general and neuraxial anesthesia. Hypotension is more common with spinal as compared to epidural despite equivalent sympathetic blockade. Epidural anaesthesia decreases systemic vascular resistance without affecting left or right ventricular function. (*Missant C, Claus P, Rex S, et al. Differential effects of lumbar and thoracic epidural anaesthesia on the hemodynamic response to acute right ventricular pressure overload. Br J Anaesth. 2010;104:143–9*). Thoracic epidural increases tissue oxygenation, increased myocardial blood flow, antianginal effects and increased coronary perfusion. (*Richter A, Cederholm I, Fredrikson M, et al. Effect of long term thoracic epidural analgesia on refractory angina pectoris: a 10 year experience. J Cardiothoracic Vasc Anesth. 2012;26:822–8*). Thoracic epidural anaesthesia is also protective against post operative arrhythmias and atrial fibrillation. (*Freise H, Van Aken HK. Risks and benefits of thoracic epidural anaesthesia. Br J Anaesth. 2011;107:859–68*). Epidural block higher than T4 results in pulmonary derangement. (*Groeben H. Epidural anaesthesia and pulmonary function. J Anesth. 2006;20:290–9*).

39. F T T F T

Thoracic epidural protects against splanchnic hypotension and decreased post operative ileus. (*Sielenthamper AW, Van Aken H. Thoracic epidural anaesthesia: more than just anaesthesia/analgesia. Anesthesiology. 2003;99:523–5*). Bladder function may be impaired secondary to block of S2–S4 nerve roots. Thoracic epidural decreases stress response. (*Brodner G, Van Aken H, Hertle L, et al. Multimodal perioperative management-combining thoracic epidural analgesia, forced mobilisation, and oral nutrition-reduces hormonal and metabolic stress and improves convalescence after major urologic surgery. Anesth Analg. 2001;92:1594–600*). The incidence of hypothermia is equal with epidural as compared to general anaesthesia. It is due to peripheral vasodilatation impairment of thermoregulatory control. (*Matsukawa T, Sessler DI, Christensen R, et al. Heat flow and distribution during epidural anesthesia. Anesthesiology. 1995;83:961–7*). Forced air warming occurs more with neuraxial anaesthesia due to peripheral vasodilatation. (*Szmuk P, Ezri T, SEssler D, et al. Spinal anaesthesia speeds active post operative rewarming. Anesthesiology. 1997;87:1050–4*).

40. T F F T T

Motor fibres require more local anaesthetic solutions because of thick myelin sheath. Drug administration affects both ventral and dorsal nerve roots. (*Bromage PR, Joyal AC, Binney JC. Local anaesthetic drugs: penetration from the spinal extradural space into the neuraxis. Science. 1963;140:392–4*). Chlorprocaine can cause adhesive arachnoiditis if injected spinally. It is mainly due to EDTA. (*Moore D, Spierdijk J, Vankleef J, et al. Chlorprocaine neurotoxicity. Four additional cases. Anesth Analg. 1982;61:155–9*). Sodium bicabomnate addition causes faster onset of anaesthesia and dense block. (*Curatolo M, Peterson-Felix*

S, Arendt-Nielson L, et al. Adding sodium bicarbonate to Lidocaine enhances the depth of epidural blockade. Anesth Analg. 1998;86:341–7). Clonidine decreases the regional spinal cord blood and decrease the rate of drug elimination. (*Bouguet D. Caudal clonidine added to local anaesthetics enhances post operative analgesia ater anal surgery in adults. Anesthesiology. 1994;81:A942*).

41. F T F T F

Clonidine exerts its effect by hyperpolarisation activated cation current. (*Kroin JS, Buvanendran A, Beck DR, et al. Clonidine prolongation of Lidocaine analgesia after sciatic nerve blockade in rats is mediated via the hyperpolarisation activated cation current, not by alpha adrenoceptors. Anesthesiology. 2004;101:488–94*). Lung function is preserved with the addition of clonidine. (*Matot I, Drenger B, Weissman C, et al. Epidural clonidine, bupivicaine, & methadone as the sole anaesthetic agent for thoracotomy for lung resection. Anaesthesia. 2004;59:861–6*). Midazolam is safe to use via intrathecal route. (*Ugur B, Basaloglu K, Yurtseren T, et al. Neurotoxicity with single dose intrathecal midazolam administration. Eur J Anaesth. 2005;22:907–12*). Catheter should be inserted to the target dermatome as it decreases the total dosage of local anaesthetic required. Local anaesthetic solutions spreads to a greater degree cranially than caudally thus block onset in lumbar region is delayed. It is also due to larger size of the nerve roots. (*Galindo A, Hernandez J, Benavides O, et al. Quality of spinal extradural anesthesia: the influence of spinal nerve root diameter. Br J Anaesth. 1975;47:41–7*).

42. F F T F T

Blockade is dependent on the drug concentration. The higher the concentration, the more profound is the motor and sensory effect. (*Duggan J, Bowler GM, McClure JH, et al. Extradural block with bupivicaine: influence of dose, volume, concentration and patient characteristics. Br J Anaesth. 1998;61:324–31*).

Time to two segment regression: time it takes for the sensory block to regress by two dermatome levels (Table 11.4).

Neuraxial block done in lateral position leads to faster onset time, long duration and density of motor block on the dependent side. (*Seow LT, Lips FJ, Cousins MJ. Effect of lateral position on epidural blockade for surgery. Anesth Intensiv Care. 1983;11:97–102*). There is compression of epidural space in obese patients. A high block is attained with the same dose of local anaesthetic. Fluid loading prior to block is not required and may be harmful in patients with decreased serum colloid oncotinc pressure (burns, preeclampsia). (*Henke VG, Bateman BT, Leffert LR. Spinal anaesthesia in severe preeclampsia. Anesth Analg. 2013;117:686–93*).

Table 11.4 Time to two segment regression

Drug	Concentration	Time to two segment regression (min)	Recommended time to "topup"
2-chlorprocaine	3	45–75	45
Lidocaine	2	60–140	60
Bupivicaine	0.10	180–260	120
Ropivicaine	0.10	180–260	120

43. T F T T T
Concomitant sedation increases pain perception in an agent type specific manner. (*Frolich MA, Zhang K, Ness TJ. Effect of sedation on pain perception. Anesthesiology. 2013;118:611–21*). Fentanyl and midazolam neuraxially has not been shown to adversely affect neonatal outcome. (*Frolich MA, Burschfield DJ, Euliano TY, et al. A single dose of Fentanyl and midazolam prior to ceserean section have no adverse neonatal effects. Can J Anesth. 2006;53:79–85*). Chlorprocaine is less painful than Lidocaine for skin infiltration. (*Marica LS, O'day T, Janosky J, et al. Chlorprocaine is less painful than Lidocaine for skin infiltration anesthesia. Anesth Analg. 2002;94:351–4*). Sitting position is associated with shorter distance from skin to space (*Hamilton CL, Riley ET, Cohen SE. Changes in the position of epidural catheters associated with patient movement. Anesthesiology. 1997;86:778–84*). Lateral position for the neuraxial block decreases the incidence of dural puncture. (*Tsen LC. Neuraxial techniques for labor analgesia should be placed in the lateral position. Int J Obstet Anesth. 2008;17:146–9*).

44. F F F T F
Single application is as efficacious as double application. (*Malhotra S, Dharmadasa A, Yentis SM. One versus two applications of chlorhexidine/ethanol for disinfecting the skin: implications for regional anaesthesia. Anaesthesia. 2011;66:574–8*). All antiseptic solutions are neurotoxic if they come into direct contact with meninges. (*Bogod DS. The sting in the tail. Antisepsis and the neuraxis revisitied. Anesthesia. 2012;67:1305–9*). Loss of resistance with air is associated with pneumoencephalus. It may cause hemiparesis and convulsions and may present as headache that develops immediately on injection of air. (*Laviola S, Kirrela M, Spoto M. Pneumoencephalus with intense headache and unilateral dilatation after accidental dural puncture during epidural anaesthesia for cesarean section. Anesth Analg. 1999;88:582–3*). Loss of resistance to air can result in patchy block due to compression of nerve roots or spinal cord by air bubbles. (*Dalens B, Bazin JE, Haberer JP. Epidural bubbles as a cause of incomplete analgesia during epidural anesthesia. Anesth Analg. 1987;66:679–83*). Loss of resistance increases the incidence of epidural venous cannulation and difficult catheter insertion. (*Euron S, Sessler D, Sadan O, et al. Identification of the epidural space: loss of resistance with air, Lidocaine or the combination of air and Lidocaine. Anesth Analg. 2004;99:245–50*) (Table 11.5).

Table 11.5 Complications with loss of resistance technique

Complications with loss of resistance technique
• Pneumoencephalus
• Increased risk of dural puncture
• Faster onset of signs and symptoms of post dural puncture headache
• Increased incidence of post dural puncture headache
• Incomplete/patchy block
• Spinal cord or nerve root compression by air
• Venous air circulation
• Subcutaneous emphysema
• Increased incidence of epidural venous canulation
• Difficult catheter insertion

45. T F F F F
Paramedian approach is a useful technique for those who cannot get into position easily or who cannot flex the spine, Patients with calcified ligaments or spinal deformities. Needle entry is directed caudal and lateral to the inferior aspect of the superior spinous process of the desired interspace and walked off the lamina in a cephalad direction. Taylor approach is the paramedian approach utilising the large L5-S1 interspace. Entry is 1cm medial and 1 cm caudad to the posterior superior iliac spine. Ligamentum flavum is discontinuous at cervical region in large percentage of population contributing to false loss of resistance. ECG changes can be used for epidural catheter placement. (*Tsui B, Gupta S, Finucaine B. Confirmation of epidural catheter placement using nerve stimulation. Can J Anaesth. 1998;45:640–4*). Higher volume of low concentration of local anaesthetics provide better spread and improved analgesia. (*Lyons GR, Kocarev MG, Wilson RC, et al. A comparison of minimum local anaesthetic volumes and dose of epidural bupivicaine (0.125%w/v and 0.25% w/v) for analgesia in labor. Anesth Analg. 2007;104:412–5*).

46. T F T T T
Flexible catheters especially the wire reinforced catheters decrease the incidence of paraesthesias. Prophylactic blood patch has not been shown to prevent headache after dural puncture. (*Agerson AN, Scavone BM. Prophylactic epidural blood patch after unintentional dural puncture for the prevention of postdural puncture headache in patients. Anesth Analg. 2012;115:133–6*). Several top ups with same level of analgesia warrants replacement of catheters. (*Bauer ME, Kountanis JA, Tsen LC, et al. Risk factors for failed conversion of labour epidural analgesia to caesarean section delivery anesthesia: a systematic review and meta analysis of observational trials. Int J Obstet Anesth. 2012;21:294–309*). Strategies to avoid epidural vein cannulation:
- Placement in lateral position.
- Use of flexible wire reinforced catheter.
- Use of single orifice catheters.
- Fluid pre distension of epidural space prior to catheter insertion.
- Limits depth of insertion to less than 6 cm.

(Mhyre *JM, Greenfield ML, Tsen LC, et al. A systematic review of randomised controlled trials that evaluate strategies to avoid vein cannulation during obstetric epidural catheter placement. Anesth Analg. 2009;108:1232–42*). The risk factors for local anaesthetic toxicity include increased age, liver failure, decreased protein concentration, severe cardiac dysfunction, ischaemic heart disease, cardiac conduction abnormalities, metabolic and respiratory acidosis. (*Neal JM, Mulroy WF, Weinberg GL. American Society of Regional Anaesthesia and Pain Medicine checklist for managing local; anaesthetic systemic toxicity: 2012 version. Reg Anesth Pain Med. 2012;37:16–8*).

47. F T F T T
The prevalence of true IgE mediated allergy is less than 1%. *(Bhole MV, Manson AL, Senveratne SL, et al. IgE mediated allergy to local anaesthetics: separating fact from perception. A UK perspective. Br J Anaesth. 2012;108:903–11*).

Table 11.6 ARACHNOIDITIS: clinical features

• Back pain
• Muscle spasms
• Pain in buttocks
• Paralysis
• Dysfunction of urinary sphincter

Adhesive arachnoiditis is due to collagen deposits that encapsulate the nerve roots, creating nerve root atrophy as a result of interruption to the blood supply. (*Rice I, Wee MY, Thomson K. Obstetric epidurals and chronic adhesive arachnoiditis. Br J Anaesth. 2004;92:109–20).* Backache is up the extent of 3–31%. (*Wang YL, Hsieh JR, Chung HS, et al. The local addition of tenoxicam reduces the incidence of low back pain after lumbar epidural anaesthesia. Anesthesiology. 1998;89:1414–7*). Risk factors for backache after neuraxial anaesthesia include multiple attempts, increased BMI, lithotomy position and surgical time more than 2.5 h. (*Hakim SH, Narouze S, Shaker NN, et al. Risk factors for new onset persistent low back pain following non obstetric surgery performed with epidural anaesthesia. Reg Anesth Pain Med. 2012;37:175–82*). Epidural dexamethasone prevents back pain. Other prophylactic measures include concomitant recurrent spinal nerve anaesthesia, adding NSAIDs to local anaesthetic used for local anaesthetic infiltration. (*Wang YL, Tan PP, Yang CH, et al. Epidural dexamethasone decreases the incidence of backache after lumbar epidural anesthesia. Anesth Analg. 1997;84:376–8*) (Table 11.6).

48. T T T F T

Cranial nerve palsy is seen uncommonly. (*Brownbridge P. The management of headache following accidental dural puncture in obstetric patients. Anesth Intensiv Care. 1983;11:4–15*). Post dural puncture headache may lead to chronic headaches. (*Webb CA, Wzyker PD, Zhang L, et al. Unintentional dural puncture with a tuohy needle increases the risk of chronic headache. Anesth Analg. 2012;115:124–32*). Intrathecal catheter insertion after epidural puncture decreases the incidence of headache. (*Apfel CC, Saxena A, Cakmakkaya OS, et al. Prevention of postdural puncture headache after accidental dural puncture. A quantitative systematic review. Br J Anaesth. 2010;105:255–63*). Risk factors for post dural puncture headache include younger age, female gender, low BMI, loss of resistance to air, pushing during second stage of labour, use of cutting needle, use of larger gauge needle. Early treatment decreases the length of hospital stay and early return to daily activities of life. (*Angle P, Tang SL, Thompson D, et al. Expectant management of post dural headache increases hospital length of stay and emergency room visits. Can J Anaesth. 2005;52:397–402*). Injection of more than 20 mL has no benefit. (*Paech MJ, Doherty DA, Christmas T, et al. The volume of blood for epidural blood patch in obstetrics. A randomised blinded clinical trial. Anesth Analg. 2011;113:126–33*).

49. T T T F F

Subdural injection has an incidence of 0.1–0.82% (*Lubenow T, Keh Wong E, Krislof K, et al. Inadvertent subdural injection: a complication of epidural block. Anesth Analg. 1988;67:175–9*). Presentation of subdural block manifests

as higher block, sacral sparing, variability of the block, horner's syndrome, hypotension and breathlessness. Total spinal has an incidence of 1 in 1400. The incidence is seen more with combined spinal epidural techniques and spinal technique after failed epidural. (*Cappiello E, Tsen LC. Complications and side effects of central neuraxial techniques. In: Wong CA, editor. Spinal and epidural anesthesia. New York: McGraw Hill; 2007. p. 152–82*). Risk factors for epidural abscess include increased intensive care stay, intravenous drug user, diabetes mellitus, alcohol dependence, cancer, HIV, end stage renal disease. (*Duroviche R. Spinal epidural abscess. N Engl J Med. 2006;355:2012–20*). Epidural abscess is seen more with thoracic and lumbar catheters than cervical region. Predisposing factors for spinal epidural abscess include increased age, diabete mellitus, prolonged steroid usage, HIV, urinary catheterisation, adrenal insufficiency, spinal instrumentation, heavy alcohol usage, liver/renal disease, rheumatoid arthritis, osteomyelitis.

50. T T T T F

Dural puncture increases the risk of meningitis due to transfer of blood borne pathogens across the blood brain barrier. (*Reynolds F. Neurologic infection after neuraxial anaesthesia. Anesthesiol Clin. 2008;26:23–52*). Serious neurologic injury is seen in 0.03-0.1% of patients. Risk factors for cauda equina syndrome include trauma, infection, lithotomy position, hematoma, abscess, tumour, prolap[sed disc and spondylolisthesis. Avoidance of 5% Lidocaine decreases the incidence of cauda wequina syndrome (*Gaiser RR. Should intrathecal Lidocaine be used in the 21st century? J Clin Anesth. 2000;12:476–81).* MRI scan cannot rule out a developing hematopma. (*Walters MA, Van De Velde M, Wilms G. Acute intrathecal hematoma following neuraxial anesthesia: diagnostic delay after apparently normal radiological imaging. Int J Obstet Anesth. 2012;21:181–5*).

51. F T T F T

Anterior spinal artery syndrome presents as immediate painless paraplegia and loss of lower extremity sensory function. Proprioception and vibration sense is spared. Cardiac arrest is rare. (*Auroy Y, Narchi P, Messiah A, et al. Serious complications related to regional anaesthesia: result of prospective survey in France. Anesthesiology. 1997;87:479–86*). Patient position may contribute to cardiac arrest. (*Pollard JB. Cardiac arrest during spinal anaesthesia: common mechanisms and strategies for prevention. Anesth Analg. 2001;92:252–6*). Increased temperature does not affect foetal outcome. (*Camann WR, Harlet LA, Hughes N, et al. Maternal temperature regulation during extra dural analgesia for labour. Br J Anaesth. 1991;67:565–8*). Lipophillic opioids like Fentanyl and sufentanil protect against post operative nausea and vomiting. (*Borgeat A, Ekatodramis G, Schenker LA. Post operative nausea and vomiting in regional anaesthesia: a review. Anesthesiology. 2003;98:530–47*).

52. T T F T F

Termination of spinal cord has wide variation. (*Macdonald A, Chatrath P, Specter T, et al. Level of termination of the spinal cord and the dural sac: a magnetic resonance study. Clin Anat. 1999;12:149–52*). Caudal epidural is

more predictable in children than adults. (*Igarashi T, Hirabagashi Y, Shimizu R, et al. The lumbar extradural structure changes with increasing age. Br J Anaesth. 1997;78:149–52*). Mean volume of caudal space is 15 mL with a range of 9.5–26.6 mL. (*Crighton I, Barry B, Hobbs G. A study of the anatomy of the caudal space using magnetic resonance imaging. Br J Anaesth. 1997;78:391–5*). Sacral hiatus is closed in 3% of population. (*Sekiguchi M, Yabuki S, Saloh K, et al. An anatomic study of sacral hiatus. A basis for successful epidural block. Clin J Pain. 2004;20:51–4*). Curvature of sacrum is more in males than females especially at S3. (*Aggarwal A, Kaur H, Batra YK, et al. Anatomic consideration of epidural space: a cadaver study. Clin Anat. 2009;22(6):730–7*).

53. T F T T T

Blood patch can be done through the epidural space. (*Cook RA, Driver RP Jr. Epidural blood patch. Med J. 2009;105(5):28–9*). Landmark technique has high failure rate. (*Kim MS, Han KH, Kim EM, et al. The myth of the epidural triangle for identification of sacral hiatus in children disproved by ultrasonography. Reg Anesth Pain Med. 2013;38(3);243–7*). Auscultation of thoracolumbar region during injection of 2–3 mL of air into the caudal region can be picked up (whoosh test). (*Orme R, Berg S. The "swoosh test" an evaluation of a modified "whoosh test" in children. Br J Anaesth. 2003;90:62–5*). Ultrasound can help visualise the spread of injectate during caudal injection. (*Yoon YS, Sim KH, Kim SJ, et al. The feasibility of colour doppler ultrasonography for caudal epidural steroid injection. Pain. 2005;118:210–4*). Anal sphincter contraction with 1–10 mA current confirms needle pklacement in the caudal space. (*Tsui B, Tarkkila P, Gupta S, et al. Confirmation of caudal needle placement using nerve stimulation. Anesthesiology. 1999;91:374–8*).

54. F F F T T

Caudal epidural injection is not safe when the presenting part has descended into the perineum. (*Dawkins C. An analysis of the complications of extradural and caudal block. Anaesthesia. 1969;24:554–63*). Lateral approach to caudal has 20% failure rate witgh the catheter moving to paravertebral or retrorectal space. (*Chung Y, Lin C, Pang W, et al. An alternative continuous caudal block with caudad catherisation via lumbar interspace in adult patients. Acta Anaesthesiol Scand. 1998;36:221–7*). Speed of injection has no effect on the spread of injectate in the caudal space. (*Triffterer L, Machata AM, Latzke D, et al. Ultrasound assessment of cranial spread during caudal blockade in children: effect of the spread of injection of local anaesthetics. Br J Anaesth. 2012;108(4):670–4*). Minimum local anaesthetic concentration for caudal in females is 31% higher than male patients. (*Li Y, Zhou Y, Chan H, et al. The effect of sex on the minimum local analgesic concentration of Ropivicaine for caudal anaesthesia in anorectal surgery. Anesth Analg. 2010;110:1490–3*). Catheter tip can be placed with the ehlp of ECG leads. (*Tsui B, Seal R, Koller J. Thoracic epidural catheter placement via the caudal approach in infants by using electrocardiographic guidance. Anesth Analg. 2002;95:326–33*).

55. T T F T T
Segmental spread with caudal epidural is predictable up to 12 years of age. (*Lundblad M, Lonnquist PA, Eksborg S, et al. Segmental distribution of high volume caudal anaesthesia in neonates, infants and toddlers as assessed by ultrasonography. Paediatr Anaesth. 2011;21(2):121–7*). Caudal blockade helps reduce opioid requirements. (*Rojaz-Perez E, Castillo-Zamora C, Nava-Ocampo A. A randomised trial of caudal block with bupivicaine 4 mg/kg vs general anaesthesia with Fentanyl for cardiac surgery. Paediatr Anaesth. 2003;13:311–7*). Bupivicaine has highest incidence of motor blockade while ropivicaine has the lowest incidence. (*Dobererner EF, Cox RG, Ewen A, et al. Evidence based clinical update: which local anaesthetic drug for paediatric caudla block provides optimal efficacy with the fewest side effects? Can J Anaesth. 2010;57(12):1102–10*). Lax anal sphincter at termination of surgery correlates with decreased need for post operative opioids. (*Vergheses S, Mortello L, Patel R. Testing anal sphincter tone predicts the effectiveness of caudal analgesia in children. Anesth Analg. 2002;94:1161–4*). Caudal blockade in children is associated with decreased aortic ejection volume and aortic vascular resistance by about 40%. Blood pressure and heart rate is not affected. (*Larousse E, Asehnoune K, Dartajet B, et al. The hemodynamic effects of pediatric caudal anesthesia assessed by esophageal doppler. Anesth Analg. 2002;94:1165–8*).

56. T T T T T
Caudal epidural has been used for treating chronic pain especially hypertonic saline. (*Manchikanti L, Singh V, Cash KA, et al. A randomised controlled double blind trial of fluoroscopic caudal epidural injection in the treatment of lumbar disch herniation and radiculitis. Spine. 2011;36(23);1897–1905*). Parotid swelling has been seen with caudal epidural. (*Lin J, Zuo YX. Unilateral parotid swelling, following caudal block without airway device placement. Pediatr Anesth. 2011;21:169–78*). Other complications of epidural blockade include epidural abscess, meningitis, hematoma, dural puncture, post dural opuncture headache, air embolism, persistent hiccoughs, intracranial hypotension. (*Bagdure DN, Reiter PD, Bhoite GR, et al. Persistent hiccoughs associated with epidural ropivicaine in a newborn. Ann Pharmacother. 2011;45(6):e35*). Catheter can easily pass to the cervical level in infants. (*Tsui B, Malherbe S. Inadvertent cervical epidural catheter placement via the caudal route using electrical stimulation. Anesth Analg. 2004;99:259–61*).

57. F T T T F
Rapid onset is seen with combined spinal epidural with minimal risk of toxicity or motor block. Onset of spinal anaesthesia is immediate and the duration is between 2 and 3 h. (*hermanides J, Hollmann MW, Stevens MF, et al. Failed epidural: causes and management. Br J Anaesth. 2012;109:144–54*). Duration of spinal anaesthesia is dependent on stage of labour in maternal patients. (*Viscomi CM, Rathmell JP, Pacc NL. Duration of intrathecal labour analgesia. Early versus advanced labour. Anesth Analg. 1997;84:1108–12*). Small doses are required for the spinal anaesthesia to exert its effect. (*Sia AT, Chong*

JL, Chiu JW. Combination of intrathecal sufentanil 10 micrograms plus bupivicaine 2.5 mg for labour analgesia. Is half the dose enough? Anesth Analg. 1999;88:362–6). Females maintain superior leg power for a larger period with combined spinal epidural anaesthesia. (*Wilson MJ, MacArthur C, Cooper GM, et al. COMET study group use: ambulation in labour and delivery mode: a randomised controlled trial of high dose versus mobile epidural analgesia. Anaesthesia. 2009;64:266–72*). Combined spinal epidural decreases the duration of first stage of labour in primi parturients. (*Wong CA, Scavon BM, Penceman AM, et al. The risk of caesarean delivery with neuraxial analgesia given early versus late in labour. N Engl J Med. 2005;352(7);655–65*).

58. T T T F T

Low dose of local anaesthetics in CSE decreases the incidence of high spinal block or prolonged hypotension. (*Crowhurst J, Birnbach DJ. Low dose neuraxial block:heading towards the new millennium. Anesth Analg. 2000;90:241–2*). Complications of CSE include failed epidural catheter, inability to test the catheter, enhanced spread. (*Blumgort CH, Ryall D, Dennison B, et al. Mechanism of extension of spinal anaesthesia by extradural injection of local anaesthetic. Br J Anaesth. 1992;169:457*). CSE provides more intense block. (*Holmstrom B, Lowgaland K, Rawal N, et al. Combined spinal epidural versus spinal and epidural block for orthopaedic surgery. Can J Anaesth. 1993;40:601–6*). CSE decreases the adverse effects associated with CSE. (*Pan PH, Bogard TD, Owen MD. Incidence and characteristics of failures in obstetric neuraxial analgesia and anesthesia: a retrospective analysis of 19,259 deliveries. Int J Obstet Anesth. 2004;13(4):227–33*). Supplementation of epidural space with saline has a compressive effect on the subarachnoid space promoting Cephalad spread of local anaesthetic. (*Taliguchi T. Okamo T, Egawa H, et al. The effect of epidural saline injection on analgesic level during combined spinal epidural anaesthesia assessed clinically and myelographically. Anesth Analg. 1997;85:1097–100*). Epidural volume expansion is seen more if epidural injection is done in supine position. Also the epidural expansion is more effective than hyperbaric bupivicaine. (*Tyagi A, Kumar A, Sethi AK, et al. Epidural volume extension and intrathecal dose requirement: Plain versus hyperbaric bupivicaine. Anesth Analg. 2008;107:333–8*).

59. F T T T T

Combined spinal epidural has advantages in high risk patients. (*Agarwal A, Gorg R, Joshi R, et al. Combined spinal epidural anesthesia with epidural volume extension technique for hysterectomy in patients with unpalliated cyanotic heart disease—a case report. Acta Anaesthesiol Belg. 2010;61:159–61*). The measurement of posterior epidural space improves the success rate and underestimation leads to spinal block failure. (*Hoffman VL, Yercauteren MP, Buczkowski PW, et al. A new combined spinal epidural apparatus. Measurement of the distance to the epidural and subarachnoid spaces. Anaesthesia. 1997;52:350–5*). Gaps are seen in ligamentum flavum, most frequently between L1 and L2 (22%). (*Lirk P, Moriggl B, Calvin J, et al. The incidence of lumbar*

ligamentum flavum midline gaps. Anesth Analg. 2004;98:1178–80). Separate needle technique has less risk of nerve injury, unilateral, sacral or low lumbar block. (*Cook TM. 201 combined spinal epidurals for anaesthesia using a separate needle technique. Eur J Anesthesiol. 2004;21:679–83*). Saline if injected during epidural placement modulates dural sensitivity and decreases the incidence of paraesthesias. (*Vanden Berg AA, Ghatge S, Wang S. Loss of resistance to saline reduces responses accompanying spinal needle insertion during institution of "needle through needle" combined spinal epidural analgesia. Anesth Intensive Care. 2010;38:1013–17*).

60. T T T T T

Meperidine is the only opioid to exert local anaesthetic effect. It blocks conduction at proximal end of the dorsal root and is not reversible with naloxone. (*Jaffe RA, Rowe MA. Comparison of local anaesthetic effects of Meperidine, Fentanyl and sufentanil on dorsal root axons. Anesth Analg. 1996;83:776–81*). Pencil point needles are more prone to failed spinal as they lacks the rigidity to puncture the dura. (*Brighthouse D, Wilkins A. Failure of pencil point needles to enter the subarachnoid space. Anaesthesia. 1994;55:176).* Penetration of dura required considerable force. (*Meiklejohn BH. The effect of rotation of an epidural needle. An in vitro study. Anaesthesia. 1987;42:1180–2*). Subarachnoid placement of epidural catheter always needs dural puncture. (*Angle P, Kronberg JE, Thompson DE, et al. Epidural catheter penetration of human dura tissue: in vitro investigation. Anesthesiology. 2004;100(6):141–6*).

61. T F F T T

CSE produces a higher dermatomal level than expected because of subarachnoid movement of the drug. (*Leighton BL, Arkoosh VA, Huffnagle S, et al. The dermatomal spread of epidural bupivicaine with and without prior intrathecal sufentanil. Anesth Analg. 1996;83:526–9*). There is no difference in Lignocaine concentration in CSF with or without meningeal hole. Lidocaine readily passes through meningeal tissue. (*Kamiya Y, Kikuchi T, Inagawa G, et al. Lidocaine concentration in cerebrospinal fluid after epidural administration. A comparison between epidural and combined spinal epidural anesthesia. Anesthesiology. 2009;110:1127–32*). Leakage of local anaesthetic into subarachnoid space does not increase sensory block. (*Gaiser RR, Lewin RR, Cheek TG, et al. Effects of immediately initiating an epidural infusion in the combined spinal and epidural technique in multiparous parturients. Reg Anesth Pain Med. 2000;25:223–7*). Test dose is more reliable than aspiration. (*Kuakowski KM, Birnbauch DJ, O'Gormen DA, et al. Does a test dose increase the likelihood of identifying intrathecal placement of epidural catheters during labour analgesia? Abstract of scientific papers SOAP. Anesthesiology. 2000;A26*). Subarachnoid block induced by CSE leads to greater senosrimotor anaesthesia and proonged recovery. There is also more incidence of hypotension and vasopressor use. (*Goy RW, Sia AT. Senosrimotor anesthesia and hypotension after subarachnoid block: combined spinal epidural versus single shot spinal technique. Anesth Analg. 2004;98(2):491–6*).

62. T F T F T

Use of air creates air pockets which can extend up to three lumbar vertebral segments, compressing lumbar thecal sac dorsally and laterally. (*Gaur V, Gupta RK, Agarwal A, et al. Air or nitrous oxide for loss of resistance techniques for epidural. Can J Anaesth. 2000;47:503–5*). This compression can decerease the lumbosacral CSF volume and enhance the extent of sensory anaesthesia. (*Carpenter RL, Hogan QH, Liu SS, et al. Lumbosacral cerebrosp[inal fluid volume is the primary determinant of sensory block extent and duration during spinal anaesthesia. Anesthesiology. 1998;89:24–9*). Vasodilatation due to sympathectomy cause a decrease in preload, end diastolic index, stroke index and increase in heart rate. In CSE, the end diastolic index and stroke index remains stable, therefore hypotension seen is not due to vasodilatation. (*Mandell GL, Jamaback L, Ramanathan S. Hemodynamic effects of subarachnoid Fentanyl in labouring patients. Reg Anesth. 1995;21(2);103–11*). Paraesthesia during needle insertion increases the risk of long term paraesthesias. (*Horlocker TT, McGregor DG, Matsushige DK, et al. A retrospective review of 4757 consecutive spinal anaesthetics: central nervous system complications. Anesth Analg. 1997;55:578–84*). Nerve puncture and intraneural injection does not cause significant neurological injury. (*Biegeleisen PE. Nerve puncture and apparent intraneural injections during ultrasound guided axillary block does not invariably result in neurological injury. Anesthesiology. 2006;105:779–83*). Needle through needle technique increases the risk of neurological complications due to deeper penetration of the subarachnoid space with the CSE technique. (*McAndrew CR, Harms P. Paraesthesia during needle through needle combined spinal epidural versus single shot spinal for elective caesarean section. Anaesth Intensive Care. 2003;31(5):514–7*).

63. T T T T F

Pencil point needles cause nerve root damage and may cause spinal cord injury. (*Turner MA, Shaw M. Atraumatic spinal needles. Anaesthesia. 1993;48:452*). Tiny metal particles abraded by the spinal needle fro m the inner edge of the tuohy needle may be seen in needle through needle technique. (*Eldor J. Metallic fragments and the combined spinal extradural technique. Br J Anaesth 1992;69:663*). Tissue coring is seen in which pieces of tissues are removed by the needle as it passes through the tissue and deposited in the subarachnoid space. Use of introducer increases the risk. The technique of using separate needles for CSE introduced fewer epithelial cells. (*Sharma B, Gupta S, Jain N, et al. Cerebrospinal fluid cytology in patients undergoing combined spinal epidural versus spinal anaesthesia without an introducer. Anesth Intensive Care. 2011;39:914–8*). There is deliberate puncture of dura in CSE and a foreign body (catheter) is kept which increases the risk of infection. (*Pinder AJ, Dresner M. Meningococcal meningitis after combined spinal epidural analgesia. Int J Obstetr Anesth. 2003;12:183–7*). Face masks prevent forward dispersal of organisms from the upper airway and downward dispersal during talking and head turning. (*Mclure HA, Talboys CA, Yentis SM, et al. Surgical facemasks and downward dispersal of bacteria. Anaesthesia. 1998;53: 624–6*).

64. F T T T F
There is no consensus about the incidence of PDPH with combined spinal epidural. (*Dunn SM, Connelly NR, Parker RK. Postdural puncture headache and combined spinal anaesthesia. Int J Obst Anaesth. 2003;12(4);305–6*). Administration of opioids decreases the incidence of post dural puncture headache. (*Brownbridge P. Spinal anaesthesia in obstetrics. Br J Anaesth. 1991;67:663–7*). Persistent cerebrospinal fluid leak may be seen after combined spinal epidural. (*Chan PO, Paach MJ. Persistent cerebrospinal fluid leak: a complication of the combined spinal epidural technique. Anesth Analg. 2004;98(3);828–30*). Combined spinal epidural is associated with increased frequency of non reassuring foetal heart rate tracings and foetal bradycardia. This is due to acute reduction in circulating maternal catecholamines. Unopposed alpha adrenoceptor effects on uterine tone with increased uterine vascular resistance leading to decreased uterine blood flow. (*Kuczkowski KM. Severe persistent foetal bradycardia following subarachnoid administration of Fentanyl and bupivicaine for induction of a combined spinal epidural analgesia for labor pain. J Clin Anesth. 2004;16(1);78–9*). Intrathecal opioids do not increase the risk of subsequent caesarean section. (*Mardirosoff C, Dumont L, Boulvain M, et al. Foetal bradycardia due to intrathecal opioids for labor analgesia. A systematic review. BJOG. 2002;109:274–81*).

65. T T T T T
Foetal bradycardia seen is short lived and resolves within 5–8 min. (*Clarke VT, Smiley RM, Finster M. Uterine hyperactivity after intrathecal injection of Fentanyl for analgesia during labour: a cause of foetal bradycardia? Anesthesiology. 1994;81:1083*). Rotation of the needle decreases the force required to puncture the dura causing a wet tap. (*Meikeljohn BH. The effect of rotation of an epidural needle: an invitro study. Anaesthesia. 1987;42:1180–2*). Failure rate is more with whitacre needle (17%) than gertie max (0%). (*Riley ET, Hamilton CL, Ratner EF, et al. A comparison of the 24G sprotte and gertie max needles for combined spinal epidural analgesia during labour. Anesthesiology. 2002;97:574–7*). Test dose can cause total spinal anaesthesia. (*Steffeck M, Owczuk R, Szlyk-Augustyn M, et al. Total spinal anaesthesia as a complication of local anaesthetic test dose administration through an epidural catheter. Acta Anaesthesiol Scand. 2004;48(9):1211–3*). More hypotension is seen in the sitting position. (*Yun EM, Marx GF, Santos AC. The effects of maternal position during induction of combined spinal epidural anesthesia for caesarean section delivery. Anesth Analg. 1998;87:614–8*).

66. F T T F T
Cerebrospinal fluid is produced in choroidal plexus at the rate of 0.35 mL/min. Total volume is 150 mL of which half of the volume is extracranial. Headache develops if there is loss of 10% of the total cerebrospinal fluid volume. (*Kunkle EC, Ray BS, Wolff HG. Experimental studies on headache. Analysis of the headache associated with changes in intracranial pressure. Arch Neurol. Psychiatry 1943;49:323–58*). (*Levine DN, Rapalino O. The pathophysiology of lumbar puncture headache. J Neurol Sci. 2001;192:1–8*). Arachnoid mater has

tight junctions and occluding junctions. This is more important then duramater which is more permeable and acellular. (*Reina MA, Lopez A, Badorrey V, et al. Dura arachnoid lesions produced by 22 gauge quincke spinal needles during a lumbar puncture. J Neurol Neurosurg Psychiatry, 2004;75893–7*). Headache is due to involvement of different innervations. The nerves involved are ophthalmic branch of the trigeminal nerve (frontal pain), cranial nerves IX and X in occipital pain, and cervical nerves C1–C3 in neck and shoulder pain. (*Klarrier D, Lee A. Anatomy of headache and facial pain. Otolaryngol Clin N Am. 2003;36:1041–53*). Nerve palsies seen after the combined spinal epidural are abducens nerve (CN VI), trigeminal nerve (CN V), facial (CN VII), and auditory (CN VIII) nerve. (*Fang JY, Lin Jw, Li Q, et al. Trigeminal nerve and facial nerve palsy after combined spinal epidural anaesthesia for caesarean section. J Clin Anesth. 2010;22:56–8).*

67. F F F T T

Post dural puncture headache begins within 12–48 h and resolves within 5 days. (*Lybecker H, Djernes M, Schmidt JF. Postdural puncture headache: onset, duration, severity, and associated symptoms: an analysis of 75 consecutive patients with PDPH. Acta Anesthesiol Scand. 1995;39:605–12*). Onset of headache within an hour of doing the neuraxial block is more indicative of pneumoencephalus (*Aida S, Taga K, Yamakura T, et al. Headache after attempted epidural block: the role of intrathecal air. Anesthesiology. 1998;88:76–80*; *Reamy BV. Post epidural headache. How late can it occur? J Am Board Fam Med. 2009;22:202–5*). Headache is always bilateral. May present as frontal (25%), occipital (27%) or both (45%). Headache is dull aching or pressure type. Headache may be associated with neck stiffness, tinnitus, hyopoacusia, photophobia and nausea. (*Amorin JA, Gomes de Barros MV, Valena MM. Post dural puncture headache: risk factors and clinical features. Cephalalgia. 2012;32:916–23*). Symptoms especially auditory or visual symptoms may depend on the needle size. (*Sprung J, Bourke BA, Contreras MG, et al. Perioperative hearing impairment. Anesthesiology. 2003;98:241–57*).

IHS criteria for PDPH:

- Neck stiffness
- Tinnitus
- Hypoacusia
- Photphobia
- Nausea

68. T F F F T

Age may affect the post dural puncture headache. It is uncommon in children less than 10 years. It peaks in teens and early 20s and is less frequent after 50 years. (*Lybecker H, Moller JT, May O, et al. Incidence and prediction of postdural puncture headache: a prospective study of 1021 spinal anaesthesia. Anesth Analg. 1990;70:389–94*). Non pregnant females have twice the risk of PDPH. (*Wu CL, Rowlindson AJ, Cohen SR, et al. Gender and post dural puncture headache. Anesthesiology. 2006;105:613–8*). Excessive pushing through the second stage of labour increases the risk of PDPH. (*Angle P, Thompson D,*

Halpern S, et al. Second stage pushing correlates with headache after unintentional dural puncture in parturients. Can J Anesth. 1999;46:861–6). The requirement for blood patch also varies between those who pushed and who did not. High BMI is protectuive against the PDPh because of increased intraabdominal pressure. (*Faure E, Moreno R, Thisted R. Incidence of post dural puncture headache in morbidly obese parturients. Reg Anesth. 1994;19:361–3*). Cigarette smoking has been found to be protective for PDPH. (*Dodge HS, Ekhater NN, Jefferson-Wielson L, et al. Cigarette smokers have reduced risk for post dural puncture headache. Pain Physician. 2013;16:e25–30*).

69. T T T F T

Bilateral tension type headache increases the risk of post dural puncture headache. (*Hannerz J. Post lumbar puncture headache and its relation to chronic tension type. Headache. 1997;37:659–62*). Unilateral headache is not a risk factor. (*Van Oosterhout WPJ, Van der plas AA, Van Zwet EW, et al. Post dural puncture headache in migranous and non headache subjects. A prospective study. Neurology. 2013;80:941–8*). History of dural punctures increases the risk of subsequent punctures. (*Blanche R, Eisenach JC, Tuttle R, et al. Previous wet tap does not reduce success rate of labour epidural analgesia. Anesth Analg. 10994;79:291–4*). Non cutting needles cause more trauma and results in better inflammatory healing response and thus decreases the incidence of PDPH. (*Lambert DH, Hurley RJ, Hertwig L, et al. Role of needle gauge and tip configuration in the production of lumbar puncture headache. Reg Anesth. 1997;22:66–72*). Needle bevel parallel to the long axis of spine decreases the incidence of PDPH. (*Richman J, Joe E, Cohen S, et al. Bevel direction and post dural puncture headache. A meta analysis. Neurologist. 2006;12:224–8*). Incidence of puncture is more at night due to operator fatigue. (*Aya AGM, Manguin R, Robert C, et al. Increased risk of unintentional dural puncture in night time obstetric epidural anaesthesia. Can J Anaesth. 1999;46:665–9*).

70. T F F F F

Dexamethasone is known to decrease the risk of headache. (*Yousefishahi F, Dahmardeh AR, Khajavi M, et al. Effect of dexamethasone on the frequency of postural puncture headache after spinal anaesthesia for caesarean section. A double blind randomised controlled trial. Acta Neurol Belg. 2012;112:345–50*). Early mobilisation decreases the risk of PDPH. (*Jacobs CH. Does bed rest prevent post lumbar puncture headache? Ann Emerg Med. 2012;59:139–40*). Increased oral hydration does not decrease the incidence or duration of PDPH. (*Sudlow C, Warlow C. Posture and fluids for preventing postdural puncture headache. Cochrane Database Syst Rev. 2002;(2):CD001790*). Continuous spinal anaesthesia decreases the risk of PDPH compared with single dose spinal techniques. (*Moore JM. Continuous spinal anaesthesia. Am J Ther. 2009;16:289–94*). Decreasing the size of the needle from 16 to 18 gauge decreases the incidence of PDPH from 88 to 64%. (*Sadashivaiah J, McClure H. 18G tuohy needle can reduce the incidence of severe dural puncture headache. Anaesthesia. 2009;64:1379–80*).

71. T F T T T
When bevel is inserted parallel to long axis of spine, incidence is 24% while perpendicular insertion has an incidence of 70%. (*Norris MC, Leighton BL, Desimone CA. Needle bevel direction and headache after inadvertent dural puncture. Anesthesiology. 1989;70:729–31).* Combined spinal epidural has low risk of PDPH as compared to conventional epidural anaesthesia. (*Simmons SW, Cyna AM, Dennis AT, et al. Combined spinal epidural versus epidural analgesia in labour. Cochrane Database Syst Rev. 2009;(1):CD003401*). Replacing stylet back in the needle before the needle removal decreases the incidence of PDPH. (*Strupp M, Brandt T, Muller A. Incidence of post lumbar puncture syndrome reduced by reinserting the stylet: a randomised prospective study of 600 patients. J Neurol. 1998;245:589–92*). Injection of saline into CSF decreases the incidence of PDPH due to volume maintenance. (*Charsley MM, Abram SE. The injection of intrathecal normal saline redfuces the severity of postdural puncture headache. Reg Anesth Pain Med. 2001;26:301–5*). Inserting intrathecal catheter decreases the risk of PDPH. (*Ayad S, Bernian Y, Narouze S, et al. Subarachnoid catheter placement after wet tap for analgesia in labour: influence on the risk of headache in obstetric patients. Reg Anesth Pain Med. 2003;28:512–*5).

72. F F T T T
Prophylactic doesnot prevent headache but decreases the duration of sumptoms (5 days to 2 days). (*Scavone BM, Wong CA, Sullivabn JT, et al. Efficacy of a prophylactic epidural blood patch in preventing post dural headache in parturients after inadvertent dural puncture. Anesthesiology. 2004;101:1422–7*). Prophylactic blood patch causes excessive cephalad displacement of local anaesthetic and may cause total spinal. (*Leivers D. Total spinal anesthesia following early prophylactic epidural blood patch. Anesthesiology. 1990;73:1287–9*). Early blood patch inhibits coagulation and thuis decreases the efficacy of blood patch. (*Tobias MD, Pilla MA, Rogers C, et al. Lidocaine inhibits blood coagulation: implications for epidural blood patch. Anesth Analg. 1996;82:766–9*). "Sitting epigastric pressure test" uis done to diagnose. Patient is placed in sitting position until headache appears. One hand is placed on back and other on abdomen while pressing on abdomen. Improvement is seen in 15–30 s. (*Gutsche BB. Lumbar epidural analgesia in obstetrics: taps and patches. In: Reynolds F, editor. Epidural and spinal blockade in obstetrics. Bailliere Tindall 1990; p. 75–160*). Pneumoencephalus causes Ipsilateral headache but does not respond to blood patch and easily diagnosed with CT scan. Ondansetron is known to mimic post dural puncure headache. (*Somri M, Teszler CB, Vaida, et al. Post dural puncture headache. An imaging guided management protocol. Anesth Analg. 2003;96:1809–12*).

73. T F T T F
Subdural hematoma is a complication of dural puncture seen due to intracranial hypotension resulting in excessive traction on cerebral vessels causing disruption. (*Machurot PY, Vergnium M, Fraipont V, et al. Intracranial subdural hematoma following spinal anaesthesia: case report and review of literature. Acta*

Anesthesiol Belg. 2010;61:63–6). Dehydration should be avoided but aggressive hydration has not shown any benefit. (*Sudlow C, Warlow C. Posture and fluids for preventing postdural puncture headache. Cochrane Database Syst Rev. 2002;(2);CD001790*). Acupuncture has shown some efficacy. (*Sharma A, Cheam E. Acupuncture in the management of post partum headache following neuraxial analgesia. Int J Obstet Anesth. 2009;18:417–9*). Bilateral occipital nerve blocks have also shown some efficacy. (*Takmaz SA, Kantekin CU, Kaymak C, et al. Treatment of post dural puncture headache with bilateral greater occipital nerve block. Headache. 2010;50:869–72*). Caffeine causes improvement in headache at 1–4 h in over 70% of patients. Both oral and intravenous preparation are used though positive studies are lacking. (*Halker RB, Demaershcalk BM, Wellik KE, et al. Caffeine for the prevention and management of postdural puncture headache: debulking the myth. Neurologist. 2007;13:323–7*). Methylergonovine (0.25 mg orally three times for 48 h) hasten resolution of PDPH. (*Hakim S, Khan RM, Maroof M, et al. Methylergonovine maleate relieves post dural puncture headache in obstetric patients. Acta Obstet Gynecol Scand. 2005;84:100*).

74. F T F T T

Steroids help decrease the intensity of headaches. (*Rabiul A, Aminar R, Reza E. Role of very short term intravenous hydrocortisone in reducing post dural puncture headache. J Anesthesiol Clin Pharmacol. 2012;28:190–3*). Gabapentin has shown early resumption of neuronal activity. (*Wagner Y, Storr F, Cope S. Gabapentin in the treatment of post dural puncture headache: a case series. Anaesth Intensive Care. 2012;40:714–8*). Epidural saline injection leads to relief of symptoms but the symptoms come back with in 10 min. (*Kroin JS, Nagalla SKS, Buvanderen, et al. The mechanisms of intracranial pressure modulation by epidural blood and other injectates in a pist dural puncture. Rat model. Anesth Analg. 2002;95:423–9*). Epidural blood patch stops further blood loss by forming a clot over the defect along with a tamponade effect with cephalad displacement of CSF. (epidural pressure patch). *(Vakharia SB, Thomas PS, Rosenbaum AE, et al. Magnetic resonance imaging of cerebrospinal fluid leak and tamponade effect of blood patch in post dural puncture headache. Anesth Analg. 1997;84:585–90*). Doing the patch within 4 days increases the risk of failure. (*Safa-Tisseront V, Thorman F, Malassine P, et al. Effectiveness of epidural blood patch in the management of post dural puncture headache. Anesthesiology. 2011;95:334–9*).

75. F T F F F

The ideal volume for the blood patch is not known. The volume should be sufficient to form an organised clot and also to produce tamponade. 20 mL is optimum and is based on the fact that headache develops with 10% of CSF volume loss which is about 15–20 mL. (*Paech MJ, Doherty DA, Christmas T, et al. The volume of blood for epidural blood patch in obstetrics: a randomised blinded clinical trial. Anesth Analg. 2011;113(1);126–33*). Blood patch can be used for intracranial hypotension and up to 100 mL may be required. (*Schievink WI. Spontaneous spinal cerebrospinal fluid leaks and intracranial hypotension.*

JAMA. 2008;295:2286–96). Severe radiculopathy may be seen with injection of large volumes of blood. (*Riley CA, Spiegel JE. Complications following large volume epidural blood patches for post dural puncture headaches. Lumbar subdural hematoma and arahnoiditis: initial cause or final effect? J Clin Anesth. 2009;21:355–9*). Patients should be encouraged to take bed rest for at least 1–2 h. Patients should avoid lifting, valsalva manoeuvres and avoid air travel. (*Martin R, Jourdin S, Clairoux M, et al. Duration of decubitus position after epidural blood patch. Can J Anaesth. 1994;41:23–5*). Blood patch can be done in Jehova's witness for as long as the autologous blood is kept with in a closed circuit. (*Jagannathan N, Tetzlaff JE. Epidural blood patch in a jehova's witness patient with post dural puncture cephalgia. Can J Anaesth. 2005;52:113*).

76. F F F T T

Blood patch can be used in paediatric population and blood volume of 0.2–0.3 mL/kg is appropriate. (*Kokki M, Sjovall S, Kokki H. Epidural blood patches are effective for post dural puncture headache in paediatrics. A 10 years experience. Paeditr Anesth. 2012;22:1205–10*). Blood patch is effective in cervical taps. (*Waldman SD, Feldstein GS, Allen ML. Cervical epidural blood patch: a safe effective treatment for cervical post dural puncture headache. Anaesth Rev. 1987;14:23–4*). Blood patch can be done though slow injection is recommended as increased epidural pressures may worsen clinical condition. (*Koeva V, Bar-or A, Gendron D, et al. Epidural blood patch in a patient with multiple sclerosis: is it safe? Can J Anaesth. 2013;60:479–83*). Backache seen after blood patch is short lived but in 16%, the backache may last for up to 100 days. Other complications include transient backache, bradycardia and increased temperature. (*Abouleish E, de la Vega S, Blendinger I, et al. Long term follow up of epidural blood patch. Anesth Analg. 1975;54:459–63*). Decreasing the size of the needle decreases the incidence of PDPH. (*Sadashivaiah J. 18G tuohy needle can reduce the incidence of severe post dural puncture headache. Anaesthesia. 2009;64:1379–80*).

77. T T T T F

Ultrasound usage decreases the number of attem,pts, decrease the need to puncture multiple levels and increased patient comfort. (*Perlas A, Chaparo LE, Chin KJ. Lumbar neuraxial ultrasound for spinal and epidural anaesthesia: a systematic review and meta analysis. Reg Anesth Pain Med. 2016;41:251–60*). Conus medullaris may extend up to L3. (*Saifuddin A, Burnett SJ, White J. The variation of position of the conus medullaris in an adult population. A magnetic resonance imaging study. Spine. 1998;23:1452–6*). Dural sac may end as low as S4. (*Macdonald A, Chatrath P, Spector T, et al. Level of termination of the spinal cord and the dural sac: a magnetic resonance study. Clin Anat. 1999; 12:149–52*). Low frequency transducer gives high quality images. (*Kamaker MK, Li X, Kwok WH, et al. Sonoanatomy relevant for ultrasound guided central neuraxial blocks via the paramedian approach in the lumbar region. Br J Radiol. 2012;85:e262–9*). Paramedian saggittal oblique plane is ideal. Transducer is positioned 2–3 cm lateral to midline and over them lamina in the

saggittal axis. Purpose of tilt is to make sure signal enters through interlaminar space which is the widest portion. (*Grau T, Leipold RW, Delorme S, et al. Paramedian access to the spidural space: the optimum window for ultrasound imaging. J Clin Anesth. 2001;13:213–7*).

78. F F T T T
Sonographic appearance of lamina prioduces a pattern that resembles head and neck of a horse (horse head sign). Lamina appears hyperechoic. Ligamentum flavum appears as hyperechoic band while epidural space is hypoechoic. Posterior dura is more hyperechoic than ligamentum flavum. (*Avvamescu S, Arzola C, Tharmaratnam U, et al. Sonoanatomy of the thoracic spine in adult volunteers. Reg Anesth Pain Med. 2012;37:349–53*). Ultrasound should show both the laminae and articular processes in a symmetrical position. If they are not symmetrical, rotational deformity should be suspected. (*Suzuki S, Yamamuro T, Shikata J, et al. Ultrasound measurement of vertebral rotation in idiopathic scoliosis. J Bone Joint Surg Br. 1989;71:252–5*). Thoracic epidural space is best visualised in paramedian saggittal scan. (*Grau T, Leipold RW, Delorme S, et al. Ultrasound imaging of the thoracic epidural space. Reg Anesth Pain Med. 2002;27:200–6*). High frequency probes should be used for caudal epidural as the sacrum is a superficial structure. (*Chen CP, Tang SF, Hsu TC, et al. Ultrasound guidance in caudal epidural needle placement. Anesthesiology. 2004;101:181–4*).

79. T F T F T
Two sacral cornu and posterior surface of sacrum produce a pattern that is known as "frog eye sign". Sacrococcygeal ligament is also clearly visualised. Only the lower part of caudal epidural space is visualised. The gel used for ultrasound procedures may result in inflammatory response if injected in the neuraxial space. (*Pinatric TS, Hadzic A, Strbenc M, et al. Inflammatory response after injection of aqueous gel into subarachnoid space in piglets. Reg Anesth Pain Med. 2013;38:100–5*). While injecting in the lumbar epidural space, anterior displacement of the posterior dura and widening of the posterior epidural space are seen. (*Rapp HJ, Folger A, Graw T. Ultrasound guided epidural catheter insertion in children. Anesth Analg. 2005;101;333–9*). Catheters are not easy to visualise due to small diameter and poor echogenicity of catheters. (*Grau T. The evaluation of ultrasound imaging for neuraxial anaesthesia. Can J Anesth. 2003;50:R1–8*). Colour doppler can aid in identification as injection deep to sacrococcygeal ligament with unidirectional flow can be visualised a one colour. (*Yoon JS, Sim KH, Kim SJ, et al. The feasibility of colour doppler ultrasonography for caudal epidural steroid injection. Pain. 2005;118:210–4*).

80. T T T F T
The failure rate is high if ultrasound is not used (up to 25%). *(Tsui BC, Tarkkila P, Gupta S, et al. Confirmation of caudal needle placement using nerve stimulation. Anesthesiology. 1999;91:374–8).* Ultrasound can help identify a closed sacral hiatus and a sacral canal diameter less than 1.5 mm is associated with increased failure and can be picked by ultrasound. (*Chen CP,*

Wong AM, Hsu CC, et al. Ultrasound as a screening tool for proceeding with caudal epidural injections. Arch Phys Med Rehabil. 2010;91:358–63). Ultrasound can identify ligamentum flavum defects in thin patients which may give indication of previous dural puncture. (*Lee Y, Tanaka M, Carvalho JC. Sonoanatomy of the lumbar spine in patients with previous unintentional dural punctures during lumbar epidurals. Reg Anesth Pain Med. 2008;33:266–70*). Accurate lumbar space may be difficult to distinguish and there is 93% chance of disagreement. (*Locks GF, Almeida MC, Pereira AA. Use of the ultrasound to determine the level of lumbar puncture in pregnant women. Rev Bras Anestesiol. 2010;60:13–9*). Ultrasound may underestimate needle depth due to soft tissue compression by transducer. (*Gnaho A, Nguyen V, Villevielle T, et al. Assessing the depth of the subarachnoid space by ultrasound. Rev Bras Anestesiol. 2012;62:520–30*).

81. T T T T T

Ultrasound helps in halving the median number of needle insertions from two to one and decreases the need for additional needle passes. (*Chin KJ, Perlas A, Cham, et al. Ultrasound imaging facilitates spinal anaesthesia in adults with difficult surface anatomic landmarks. Anesthesiology. 2011;115:94–101*). Ultrasound decreases the failure rate in epidural. (*Vallejo MC, Phelps AL, Singh S, et al. Ultrasound decreases the failed labour epidural rate in resident trainees. Int J Obstet Anesth. 2010;19:373–8*). Preprocedural ultrasound can decrease the complication rates like spinal hematoma and persistent neurologic deficit. (*Chin KJ, Chan V. Ultrasound as preoperative assess ent tool: predicting the feasibility of central neuraxial blockade. Anesth Analg. 2010;110:252–3*). Size of the interlaminar space helps in predicting difficult neuraxial blocks. (*Weed JT, Taenzer AH, Finkel KJ, et al. Evaluation of preprocedure ultrasound examination as a screening tool for difficult spinal anaesthesia. Anaesthesia. 2011;66:925–30*). Thoracic epidural space is difficult to visualise. (*Rasoulina A, Lohser J, Najafi M, et al. Utility of prepuncture ultrasound for localisation of th thoracic epidural space. Can J Anaesth. 2011;58:815–23*).

82. F F F F T

Mean length of spinal column from foramen magnum to coccyx is 73.6 cm while in females it is 7–10 cm shorter. Ligamentum flavum si deficient between atlas and occiput. It is mostly composed of 50–80% elastin and 20–50% collagen. Cauda equina roots are of different thickness and increase in diameter is seen between L1 and L3 segments. Duramater consists of collagenous fibres and few elastic fibres. Dural sac is enlarged in the area between T12 and L1 (Spischarny's terminal cystoma). CSF moves from basal cisterns into the subarachnoid space with cardiac systole. (*Schroth G, Lose U. Cerebrospinal fl;uid flow. Physiology of cardiac related pulsations. Neuroradiology. 1992;35:1–9*).

83. T F F F F

Pia mater sends off 22 denticulate ligaments on each side to attach dura mater. Cauda equina is supplied by branches of lumbar, iliolumbar, lateral or median sacral arteries. The toal volume of CSF is 120–150 mL. 20–35 mL is below the formane ovale and 15 mL below T5. CSF is circulated werll except that is in

Table 11.7 Cerebrospinal fluid: characteristics

Cerebrospinal fluid	
Pressure (supine)	6–10 cmH_2O
Pressure (seated)	20–25 cmH_2O
Specific gravity	1.007
Osmolarity	300 mosm/L

CSF sheath of cranial nerves and root pockets of spinal nerves. The liquid from these can enter the extradural lymphatic vessels directly (Table 11.7).
Ultrasound visualisation becomes challenging due to narrowing of the interspinous and interlaminar spaces.

84. T F F T T
Paramedian insertion of needle bypasses the supraspinous and interspinous ligaments and usefl in older patients with degenerative spine disease and narrowed interspinous spaces. Interspinous ligaments extends from spinous processes above to the spinous process below. Lgamentum flavum extends from laminae superior to the lamina inferior. Epidural space is segmented along the length where the dura is directly fused with the bone. This may impede the movement of injectate and may explain unpredictable epidural spread. (*Hogan Q. Distribution of solution in the epidural space:examination by cryomicrotome section. Reg Anesth Pain Med. 2002;27(2):150–6*). Lipophillic drugs in epidural space may have a delayed onset because of the epidural fat. (*Bernards CM, Shen DD, Sterling ES, et al. Epidural cerebrospinal fluid and plasma pharmacokinetics of epidural opioids (part 1): differences among opioids. Anesthesiolgoy 2003;99(2):455–65*). Ultrasound can accurately measure epidural depth. (*Balki M, Lee Y, Halpern S, et al. Ultrasound imaging of the lumbar spine in the transverse plane: the correlation between estimated and actual depth to the epidural space in obese parturients. Anesth Analg. 2009;108(6):1876–81*).

85. T T T F F
The neuraxial blockade first affects smaller diameter fibres before the larger myelinated sensory motor fibres. (*Jaffe R, Rowe MA. Differential nerve block. Direct measurements on individual myelinated and Unmyelinated dorsal root axons. Anesthesiology. 1996;84(6):1455–64*). Braducardia is seen due to decrease preload. The block activates cardiac reflexes involving intracardiac stretch receptors. (*Crystal GJ, Salem MR. The Bainbridge and the "reverse" Bainbridge reflex: history, physiology and clinical relevance. Anesth Analg. 2012;114(3):520–32*). Thoracic epiodural blcks T1-T4 and unopposed vagal tone has been thought to cause laryngospasm. (*Subramani K, Paul A. Laryngospasm during subarachnoid block. Br J Anaesth. 2005;94(5):668–70*). Respiratory arrest is due to the effect of local anaesthetic causing medullary hypoperfusion. (*Steinbrook RA, Concepcion M. Respiratory effects of spinal anaesthesia: resting ventilation and single breath CO2 response. Anesth Analg. 1991;71(2):182–6*). Neuraxial block helps gastrointestinal function. Improved visceral perfusion due to vasodilatation may improve healing and contribute to early recovery. (*Shi W-Z, Miao*

Y-L, Yakoob MY, et al. Recovery of gastrointestinal function with thoracic epidural versus systemic analgesia following gastrointestinal surgery. Acta Anesthesiol Scand. 2014;58(8):923–32).

86. F T T T T
Decrease in blood pressure is seen less in lateral position as compared to sitting position. (*Obasayi BI, Fyneface-Ogan S, Mato CN. A comparison of the hemodynamic effects of lateral and sitting positions during induction of spinal anaesthesia for caesarean section. Int J Obstet Anesth. 2013;22(2);124–8*). Prone jack knife position can be used for procedures in the rectum, perineum, sacrum and lower spine. (*Edgcombe H, Carter K, Yarrow S. Anaesthesia in the prone position. Br J Anaesth. 2008;100(2):165–83*). Slower injection of local anaesthetic involves fewer spinal segments. (*Casati A, Fanelli G. Unilateral spinal anaesthesia. State of the art. Minerva Anestesiol. 2001;67(12):855–62*). Bradycardia and hypotension may be seen. (*Dyamanna DN, Bs SK, Zacharia BT. Unexpected bradycardia and cardiac arrest under spinal anaesthesia: case reports and review of literature. Middle East J Anesthesiol. 2013;22(1):121–5*).

87. F T T T T
Midline approach is preferred. In the midline, ligamentum flavum is thickest but the epidural space is widest and blood vessels are at their smallest. (*Zarzur E. Anatomic studies of the human ligamentum flavum. Anesth Analg. 1984;63(5);499–502*). Loss of resistance to air may cause the block to be patchy. (*Saberski LR, Konadnuri S, Osinubi OY. Identification of the epidural space: is loss of resistance to air a safe technique? A review of the complications related to the use of air. Reg Anesth. 1997;22(1);3–15*). After the needle passes the ligamentum flavum, negative pressure sucks the drop in which is taken as a confirmation of entry into the epidural space. (*Todorov L, VadeBoncover T. Aertiology and use of the "hanging drop" technique: a review. Pain Res Treat. 2014:Article ID146750,10 p*). Caution should be exercised with the test dose in pregnant patients, elderly with coronary heart disease and hypertension. (*Guay J. The epidural test dose: a review. Anesth Analg. 2006;102(3):921–9*). A higher viscosity, higher temperature near neutral pH, higher glucose content and turbidity with thiopentone helps in identification of CSF. (*Walker DS, Brock-Utne JG. A comparison of simple tests to distinguish CSF from saline. Can J Anaesth. 1997;44(5):494–7*).

88. F T T F T
The only ligament that is peneterated in paramedian approach is ligamentum flavum. It has a rubbery resistance. Addition of opioids increase the number of segments blocked. (*Hermanides J, Hollman MW, Stevens MF, et al. Failed epidural: causes and management. Br J Anaesth. 2012;109(2):144–54*). Differential block is seen between the complete loss of cold sensation and complete loss of both pinprick and light touch sensation. (*Cainorcia M, Capogna G. Sensory assessment of epidural block for caesarean section: a systematic comparison of pin prick, cold and touch sensation. Eur J Anesthesiol. 2006;23(7):611–7*). Bromage scale is used for lumbar epidural while a RAM

(rectus abdominis muscle) test can be used for thoracic epidural. (*Graham AC, McClure JH. Quantitative assessment of motor block in labouring women receiving epidural analgesia. Anaesthesia. 2001;56(5):470–6*).

Bromage scale		
Grade	Criteria	Degree of block
I	Free movement of legs and feet	Nil (0%)
II	Able to flex knees with free movement of feet	Partial (33%)
III	Unable to flex knees with free movement of the feet	Almost complete (66%)
IV	Unable to move legs and feet	Complete (100%)

RAM test of abdominal muscles	
Power (100%)	Criteria
100	Able to raise from supine to sitting position with hands behind the head
80	Can sit only with arms extended
60	Can lift only head and scapula off the bed
40	Can only lift shoulders
20	No other response

Ligamentum flavum thickness is increased in obese patients. (*Ellinas EH, Eastwood DC, Paki SN, et al. The effect of obesity on neuraxial technique difficulty in pregnant patients: a prospective observational study. Anesth Analg. 2009;109(4);1225–31*).

89. F T T T T

Paramedian approach is preferred in scoliosis as the convex side provides direct access to neuraxis. (*Huang J. Paramedian approach for neuraxial anaesthesia in parturients with scoliosis. Anesth Analg. 2010;111(3);821–2*). Previous laminecomy increases the size of the interlaminar gap thus increasing the risk for dural puncture. (*Kim SH, Jeon DH, Chang CH, et al. Spinal anaesthesia with isobaric tetracaine in patients with previous lumbar surgery. Yonsei Med J. 2009;50(2):252–6*). Previous spinal surgery causes spinal stenosis immediately above the fusion or decompression and tethering of the dura to the ligamentum flavum. (*Brodsky AE. Post laminectomy and post fusion stenosis of the lumbar spine.Clin Orthop Relat Res. 1976;115:130–9*). Ultrasound can visualise ligamentum flavum alterations from previous surgery. (*Yamuchi M, Honma E, Mimura M, et al. Identification of the lumbar intervertebral level using ultrasound imaging in a post laminectomy patient. J Anesth. 2006;20(3):231–3*). Baricity is defined as the ratio of the density of the local anaesthetic solution relative to patient CSF at 37°.

90. F F F T T

Effect of drug mass ia important only for plain solutions but the effect is not seen with hypertonic solutions. (*VanZundert AA, Grouls RJ, Korsten HH, et al. Spinal anaesthesia. Volume or concentration—what matters? Reg Anesth.*

Table 11.8 Pharmacology of local anaesthetics

Local anaesthetic	Dosage (mL)	Duration (min)
Prilocaine 2%	3–4	60–120
Mepivicaine 2%	3–5	30–90
Lidocaine 2%	3–5	30–90
Bupiviaine 0.5%	3–4	160
Ropivicaine 0.5%	3–5	60–120

1996;21(2):112–8). Cephalad angle of needle results in greater cephalad spread of the block. (*Urmey WF, Stanten J, Bassin P, et al. The direction of the whitacre needle aperture affects the extent and duration of isobaric spinal anaesthesia. Anesth Analg. 1997;84(2):337–41*). Barbotage is administration of local anaesthetic after repeated aspiration of CSF. It decreases the time to onset of block with hyperbaric solutions. (*Janik R, Dick W, Stanton-Hicks MD. Influence of barbotage on block characteristics during spinal anaesthesia with hyperbaric tetracaine and bupivicaine. Reg Anesth. 1989;14(1);26–30*). A block with greater spread will regress faster, thus shortening the duration of action. (*Kooger Infante NE, Van Gessel E, Forster A, et al. The effect of epinephrine on small dose hyperbaric bupivicaine spinal anaesthesia: clinical implications for ambulatory surgery. Anesth Analg. 1998;86(5):973–7*) (Table 11.8).

91. T T T T T

The spread depends upon the location. The same volume of local anaesthetic in caudal space covers less dermatomes when compared to thoracic levels. (*Visser WA, Lee RA, Gielen MJM. Factors affecting the distribution of neural blockade by local anaesthetics in epidural anaesthesia and a comparison of lumbar versus thoracic epidural anaesthesia. Anesth Analg. 2008;107(2):708–21*). Epinephrine produces vasodilatation secondary to β2 adrenergic effects in the periphery. There is decrease in mean arterial pressure and increase in cardiac output. (*Bonica JJ, Kennedy WF, Ward RJ, et al. A comparison of the effects of high subarachnoid and epidural anaesthesia. Acta Anesthesiol Scand Suppl. 1966;23:429–37*). The risk factors for bradycardia during neuraxial block includes high block, young age, ASA I status, preoperative use of β blockers, and male gender. (*Lesser JB, Sanborn KV, Valskys R, et al. Severe bradycardia during spinal and epidural anaesthesia recorded by an anaesthetic management system. Anesthesiology. 2003;99(4):859–66*). Spinal anaesthesia cause more subdural anaesthesia than epidural anaesthesia. (*Singh B, Sharma P. Subdural block complicating spinal anaesthesia? Anesth Analg. 2002;94(4):1007–9*). Facial palsies have been reported after neuraxial anaesthesia, especially the trigeminal anaesthesia and Horner syndrome. (*Day CJ, Shutt LE. Auditory, ocular and facial complications of central neural block. A review of possible mechanisms. Reg Anesth. 1996;21(3):197–201*).

92. T T F T T

Direct needle trauma is associated with severe paraesthesias. (*Reynolds F. Damage to the conus medullaris following spinal anaesthesia. Anaesthesia. 2001;56(3):238–47*). The blood patch causes immeduiate relief of symptoms. (*Gielen M. Post dural puncture headache (PDPH): a review. Reg Anesth. 1989;*

14(3):101–6). The guidelines for anticoagulation usage have been documented. (*Horlocker TT, Wedel DJ, Rowlingson JC, et al. Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy. American Society of Regional Anaesthesia and Pain Medicine evidence based guidelines. Reg Anesth Pain Med. 2010;35(1):64–101*). Hypoacusis is a known complication with and incidence of 0.4–40%.

93. F T T T T
Cervical curvature develops between 4 and 9 months of age and lumbar curvature between 12 and 18 months. Spinal sonography required low frequency probe (5–2 MHz) and a curved array transducer. Patient comfort is increased with the help of ultrasound. (*Grau T, Leipold RW, Conradi R, et al. Efficacy of ultrasound imaging in obstetric epidural anaesthesia. J Clin Anesth. 2002;14:169–75*). Both layers of dura mater are hyperechoic.

94. T T T F F
Sacrococcygeal ligament is an extension of ligamentum flavum and covers sacral hiatus. The space at L5–S1 is wider, has thinner ligamntum flavum and lack of posterior epidural fat. (*Hameed F, Hunter DJ, Rainville J, et al. Prevalence of anatomic impediments to interlaminar lumbar epidural steroid injection. Arch Phys Med Rehabil. 2012;93:339–43*). Cauda equina nerves can be seen as hyperechoic streaks within the anechoic cerebrospinal fluid filled thecal sac. Thecal sac is visualised as a round to oval anechoic structure with in the spinal cord.

Anaesthesia in Patients with Special Considerations

12

1. Paediatric regional anaesthesia:
   (a) Nerve myelination is complete at birth.
   (b) Pain localisation is poor in neonates.
   (c) Risk of local anaesthetic toxicity is low in neonates.
   (d) Cytochrome enzymes mature at birth.
   (e) Clearance of drugs is decreased in neonates.
2. Paediatric regional anaesthesia:
   (a) Children can tolerate high doses of bupivicaine.
   (b) Ropivicaine lasts longer in caudal route than bupivicaine in children.
   (c) L-bupivicaine causes less myocardial depression than bupivicaine.
   (d) Spinal anaesthesia in infants may require more local anaesthetic as compared to adults.
   (e) Ultrasound guided injection may cause higher plasma concentration as compared to landmark based techniques.
3. Paediatric regional anaesthesia:
   (a) EMLA is contraindicated in children.
   (b) LMX-4 is vasodilatory.
   (c) Conus medullaris is at the level of adults at birth.
   (d) Onset of neuraxial block is quicker than adults.
   (e) Amount of CSF is higher in neonates than adults.
4. Paediatric regional anaesthesia:
   (a) Lignocaine should be avoided.
   (b) Cumulative toxicity is not seen in neonates.
   (c) Opioids should be avoided in infusions.
   (d) Clonidine should be avoided in infusions.
   (e) Psychomimetic effects of Ketamine can be avoided by using small doses.
5. Paediatric regional anaesthesia:
   (a) Regional anaesthesia done under general anaesthesia is safe.
   (b) Epidural space depth can be calculated.

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(c) Staph epidermidis is the predominant microorganism in epidural infections.
(d) Subcutaneous tunnelling increases the risk of bacterial infection.
(e) Epidural blood patch should be avoided in children.

6. Paediatric regional anaesthesia:
   (a) Hypotension is uncommonly seen with neuraxial block.
   (b) Total spinal is not life threatening in children.
   (c) Urinary retention is the most common side effect with epidural anaesthesia.
   (d) ECG monitoring can help intravascular injection.
   (e) Low current electrical stimulation test can help position epidural catheter.
7. Paediatric regional anaesthesia:
   (a) Ultrasound can detect catheter placement.
   (b) Ultrasound is not helpful during caudal injection.
   (c) Volume of local anaesthetic correlates with cranial spread during caudal blockade.
   (d) Spread of local anaesthetic is seen in two phases after caudal blockade.
   (e) Tuffier's line is higher in infants.
8. Paediatric regional anaesthesia;
   (a) Adjuvants have no role in spinal anaesthesia.
   (b) Adjuvants may increase the risk of post anaesthetic apnoea.
   (c) Fluid loading is contraindicated in children.
   (d) The incidence of post dural puncture headache is the same in adults.
   (e) Neck flexion is not required for spinal tap.
9. Peripheral nerve block in children:
   (a) Motor response is a reliable indicator of needle nerve distance.
   (b) Low frequency prober are used.
   (c) Supraclavicular approach in paediatrics is safe.
   (d) Lateral femoral cutaneous nerve block should be done for surgery above greater trochanter.
   (e) Penile block in children is as efficacious as subcutaneous ring infiltration.
10. Regional anaesthesia in elderly:
    (a) Nerve conduction velocity is affected.
    (b) Pain sensation is not altered.
    (c) Sympathetic tone is increased in elderly.
    (d) Small myelinated fibres are particularly affected.
    (e) Remyelination is decreased in elderly.
11. Regional anaesthesia in elderly:
    (a) Thoracic epidural decreases ventricular function.
    (b) Work of breathing increases.
    (c) Decrease in functional residual capacity in the post operative period lasts for 24 h.
    (d) Increased sensitivity to opioids is seen.
    (e) Epinephrine is safe to use.
12. Regional anaesthesia in elderly:
    (a) Ketamine sensitivity is not altered.
    (b) Local anaesthetic clearance is increased in elderly.

(c) Local anaesthetic sensitivity is increased.
(d) Pain sensitivity is decreased with ageing.
(e) Old patients may feel less post operative pain as compared to young.

13. Regional anaesthesia in elderly:
(a) Recovery is prolonged after hyperalgesia.
(b) Pain perception is diminished in elderly with dementia.
(c) VRS scale is most widely used in elderly.
(d) Epidural anaesthesia may cause increased motor blockade.
(e) Post operative cognitive dysfunction is not seen with neuraxial anaesthesia.

14. Regional anaesthesia and elderly:
(a) Age determines spread of local anaesthetic in the neuraxial space.
(b) Increased concentration of local anaesthetic is required for epidural to achieve motor block as age increases.
(c) Intrathecal morphine provides better analgesia than intravenous morphine.
(d) Post operative cognitive deficit is less with regional anaesthesia.
(e) Regional anaesthesia may decrease the incidence of cancer recurrence.

15. Regional anaesthesia and cardiac disease:
(a) Epidural technique can decrease cardiac pain.
(b) Thoracic epidural decreases left ventricular contractility.
(c) Thoracic epidural causes deterioration of coronary arterioles.
(d) Thoracic epidural causes detrimental decrease in coronary perfusion pressure.
(e) Thoracic epidural does not affect ventricular hemodynamics.

16. Regional anaesthesia and cardiac disease:
(a) Thoracic epidural is beneficial in gastric bypass surgery.
(b) Lumbar epidural anaesthesia should be avoided in patients with angina.
(c) Lumbar epidural anaesthesia improves outcome in revascularisation procedures.
(d) Regional anaesthesia decreases stress response during CABG.
(e) Paravertebral block is contraindicated in ischaemic heart disease.

17. Regional anaesthesia and cardiac disease:
(a) Carotid endarterectomy has low complication rate with cervical plexus block than general anaesthesia.
(b) Thoracic epidural is contraindicated in off pump coronary artery bypass.
(c) Risk of thoracic epidural in cardiac surgery is high.
(d) Regional anaesthesia decreases complications in cardiac surgery.
(e) Poor left ventricular systolic function is a contraindication for central neuraxial anaesthesia.

18. Regional anaesthesia and systemic disease:
(a) Cervical epidural can be done to achieve selective sensory block.
(b) High neuraxial anaesthesia has no effect on chest wall compliance.
(c) Epidural blockade may increase the tidal volume.
(d) Lumbar epidural does not affect respiratory function.
(e) Cervical epidural decreases lung function capacity.

19. Regional anaesthesia and systemic disease:
    (a) Ventilatory response to hyperaemia and hypoxia is affected in neuraxial anaesthesia.
    (b) Interscalene block causes phrenic nerve blockade in 100% of patients.
    (c) Interscalene block does not affect lung parameters.
    (d) Both supraclavicular and infraclavicular approach to brachial plexus can affect Phrenic nerve.
    (e) Combination of axillary and supraclavicular block is an alternative to interscalene block.
20. Regional anaesthesia and systemic disease:
    (a) Prolonged Phrenic nerve paresis may be seen with interscalene catheters.
    (b) Phrenic nerve palsy duration can be decreased with saline lavage.
    (c) Intercostal block increases peal expiratory flow rate.
    (d) Pulmonary function is better preserved with intercostal block than paravertebral block.
    (e) Supraclavicular block has high incidence on Pneumothorax.
21. Regional anaesthesia and systemic disease:
    (a) Procaine is nephrotoxic.
    (b) Renal blood flow is affected in neuraxial anesthesia.
    (c) Thoracic epidural has no effect on rennin angiotensin system.
    (d) Choice of anaesthesia may affect recipient graft outcome.
    (e) Acidosis in renal failure is protective against local anaesthetic toxicity.
22. Regional anaesthesia and systemic disease:
    (a) Increased levels of local anaesthetic are seen normally in patients with chronic renal failure.
    (b) Increased levels of α-acid glycoprotein in renal failure lend a protective effect.
    (c) Lidocaine toxicity can be treated with haemodialysis.
    (d) Spinal anaesthetic is safe in uremic Coagulopathy.
    (e) Uremic patients are prone for thrombotic effects.
23. Regional anaesthesia and systemic disease:
    (a) Regional anaesthesia should be avoided for arteriovenous fistula in end stage renal failure.
    (b) Hepatic disease has no effect on LA toxicity.
    (c) Continuous infusions of local anaesthetic may cause toxicity in liver disease.
    (d) Liver disease has no effect on ester local anaesthetics.
    (e) PT/INR has a high predictive value for bedside.
24. Regional anaesthesia and systemic disease:
    (a) A safe value of INR <1.5 only is related to warfarin induced anticoagulation.
    (b) Increase in paraesthesias may be seen in nerve blocks in diabetic patients.
    (c) Motor response elicited in diabetic patients requires increase intensity on nerve stimulator.
    (d) Regional anaesthesia decrease the stress response to surgery.
    (e) Obesity may increase the failure rate of regional blocks.

25. Regional anaesthesia in pre-existing neurologic disease:
    (a) Second insult to the nerve should occur at peripheral nerve trunk to cause "double crush phenomenon".
    (b) Increased duration of regional anaesthesia is seen in charcot marie tooth disease.
    (c) Acute glycemic control in diabetic patients can help reduce side effects with regional anaesthesia.
    (d) Success rate of regional anaesthesia is higher in diabetic patients.
    (e) Epinephrine should be avoided as adjuvant in nerve blocks for diabetic patients.
26. Regional anaesthesia and pre-existing neurologic disease:
    (a) Local anaesthetic should be avoided in chemotherapy induced peripheral neuropathy.
    (b) Regional anaesthesia is contraindicated in Guillain Barre Syndrome in obstetric patients.
    (c) Epidural anaesthesia mat precipitate Guillain Barre Syndrome.
    (d) Regional anaesthesia can cause post surgical inflammatory neuropathy.
    (e) Regional anaesthesia is safe in multiple sclerosis.
27. Regional anaesthesia and pre-existing neurologic disease:
    (a) Spinal anaesthesia may worsen sign and symptoms of multiple sclerosis.
    (b) Neuraxial anaesthesia is contraindicated in pregnant patients with multiple sclerosis.
    (c) Epidural anaesthesia is better than spinal anaesthesia in multiple sclerosis.
    (d) Neuraxial anaesthesia is safe in amyotrophic lateral sclerosis.
    (e) Spinal anaesthesia is safe in post polio syndrome.
28. Acute compartment syndrome:
    (a) Most commonly seen in lower limbs.
    (b) Lower leg muscles are at lower risk than upper leg muscles.
    (c) Permanent myoneural damage is rarely seen.
    (d) Compartment pressures more than 50 mmHg require urgent intervention.
    (e) Irreversible changes in the muscles occur within 2 h.
29. Compartment syndrome:
    (a) Palpable tense extremity compared with the uninjured limb is diagnostic.
    (b) Measurement of compartment pressures can lead to diagnosis.
    (c) Absolute value of interstitial pressure less than 30 rules out compartment syndrome.
    (d) Intramuscular pH can accurately diagnose the compartment syndrome.
    (e) Regional anaesthesia masks ischemic pain.
30. Anticoagulants and regional anaesthesia:
    (a) Elderly are more prone to spinal hematomas.
    (b) Obstetric patients have a high risk of spinal hematomas.
    (c) Preoperative Antiplatelet therapy is not a risk factor for needle or catheter placement.
    (d) Pain medications can increase bleeding tendencies.
    (e) COX-2 inhibitors do not increase the risk of bleeding.

31. Anticoagulants and regional anaesthesia:
    (a) Clopidogrel inhibition of platelets cannot be assessed.
    (b) Ticagrelor is a direct acting P2Y12 receptor inhibitor.
    (c) Clopidogrel causes 100% inhibition of platelet function.
    (d) An interval of 7 days is adequate for performing regional anaesthesia.
    (e) P2Y12 receptor activity cannot be monitored.
32. Anticoagulants and regional anaesthesia;
    (a) Warfarin takes about 5 days to exert its full effect.
    (b) Heparin acts by activity against factor Xa.
    (c) Heparin has a long half life.
    (d) Heparin is an ideal anticoagulant.
    (e) Precaution for needle insertion and catheter insertion is not necessary with heparin therapy.
33. Anticoagulants and regional anaesthesia:
    (a) Low molecular weight heparin has a greater bioavailability.
    (b) All low molecular weight heparins have the same efficacy.
    (c) Low molecular weight heparin does not affect administration of regional anaesthesia.
    (d) Regional anaesthesia catheters can be removed with thrombolytic administration.
    (e) Herbal treatment may affect coagulation.
34. Anticoagulation and regional anaesthesia:
    (a) Fondaparinaux has 100% bioavailability.
    (b) Fondaparinaux should not be used in presence of indwelling regional anaesthesia catheter.
    (c) Two half life interval is sufficient between anticoagulant administration and neuraxial technique.
    (d) Clot lysis with thrombolytic agents should be done as early as possible.
    (e) Enoxaparin increases the size of hematoma after intracerebral haemorrhage.
35. Anticoagulants and regional anaesthesia:
    (a) Catheter placement can be done in patients receiving dabigatran.
    (b) Thrombin time is more sensitive to dabigatran than aPTT.
    (c) Protamine can antagonise dabigatran.
    (d) Rivaroxaban half life is dependent on renal function.
    (e) rivaroxaban may be removed by dialysis.
36. Regional anaesthesia and critically ill:
    (a) A direct measure of pain scale is available.
    (b) Critical illness is a contraindication for regional anaesthesia.
    (c) Tunnelling of the catheters decreases the infection rate.
    (d) Epidural confirmation can be done with electrical stimulation.
    (e) Serum markers can help guide insertion of epidural.
37. Regional anaesthesia in critically ill:
    (a) Complication rate is increased in those with catheter in situ.
    (b) Brachial plexus blocks are safe in critically ill patients.

(c) Interscalene block may impair weaning from mechanical ventilation.
(d) Local anaesthetics have positive effects in critically ill.
(e) Regional anaesthesia catheters can be cut and reinserted if dislodged.

38. Pain and opioid dependent patient:
(a) Withdrawal symptoms begin m ore rapidly for short acting opioids.
(b) Methadone maintenance program shows decreased pain prevalence.
(c) Hypersensitivity to pain stimuli is a part of withdrawal syndrome.
(d) Tolerance is the mechanism for opioid induced hyperalgesia.
(e) Central glutaminergic system is involved in opioid induced hyperalgesia.

39. Pain and opioid dependent patients:
(a) Ketamine prevents development of opioid induced hyperalgesia.
(b) Opioids used for treating opioid abuse have no analgesic effect.
(c) Maintenance of opioid withdrawal requires twice daily dosing.
(d) Respiratory depression can occur with methadone.

40. Pain and opioid dependent patient:
(a) Patients on high dose opioids are at risk of toxicity on maintenance with methadone.
(b) Buprenorphine needs multiple dosing schedules.
(c) Buprenorphine can induce withdrawal symptoms.
(d) Additional analgesia is not required for patients on buprenorphine in the post operative period.
(e) Patients abusing illicit opioids need baseline opioid replacement for surgery.

41. Regional anaesthesia and trauma:
(a) Regional anaesthesia has shown to prevent transition of acute trauma pain to chronic pain.
(b) Trauma patients are more likely to get peripheral nerve block catheters than elective patients.
(c) Use of prophylactic antibiotics increases the risk of catheter infection.
(d) Wire reinforced catheters are less prone to infection.
(e) Femoral nerve block does not help in hip fracture.

42. Regional anaesthesia and trauma:
(a) Fascia iliaca block is superior in efficacy then femoral nerve block in hip fracture analgesia.
(b) Delirium is an independent risk factor for death in hip fracture.
(c) Neuraxial anaesthesia in hip fracture decreases mortality.
(d) Epidural anesthesia has no superiority over intravenous opioids in rib fracture injury.
(e) Continuous paravertebral catheter infusion is superior to thoracic epidural infusion in rib fracture.

43. Regional anaesthesia and thoracic/cardiac surgery:
(a) Neuraxial techniques are contraindicated.
(b) High thoracic epidural anaesthesia is beneficial in CABG.
(c) High thoracic epidural worsens myocardial ischaemia.
(d) High thoracic epidural analgesia increases pulmonary complications.

(e) High thoracic epidural in cardiac surgery decreases time spent in ICU.

44. Regional anaesthesia in thoracic/cardiac surgery:
    (a) High thoracic epidural in cardiac surgery improves depression.
    (b) High thoracic epidural anaesthesia is used for 48 h after cardiac surgery.
    (c) High rate of epidural abscess is seen after high thoracic epidural anaesthesia.
    (d) Awake cardiac surgery has benefits with regional anaesthesia.
    (e) Paralysis of diaphragm may be seen with high thoracic epidural.
45. Regional anaesthesia and cardio/thoracic surgery:
    (a) Spinal anaesthesia has been used for cardiac surgery.
    (b) Intrathecal opioids decrease stress response.
    (c) Most catheter associated hematomas occur during insertion.
    (d) Paravertebral block for cardiac surgery has minimal complications.
    (e) Bronchial tone is increased with thoracic epidural.
46. Regional anaesthesia and cardiac/thoracic surgery:
    (a) High thoracic epidural has no effect on lung mechanics.
    (b) Thoracic epidural in combination with general anaesthesia increases shunt fraction in one lung anaesthesia.
    (c) Thoracic epidural has low failure rate.
    (d) Adjuvants increase the efficacy of thoracic paravertebral block.
    (e) Increased incidence of urinary retention is seen with intrathecal opioids.
47. Regional anaesthesia in emergency department:
    (a) Pain in emergency department is mostly undertreated.
    (b) Extremes of ages are prone to oligo-analgesia.
    (c) Gender difference may account for pain management in emergency department.
    (d) Numerical rating scale can be used in emergency department.
    (e) Sequential measurement of pain scores increase analgesia efficacy.
48. Pain management in emergency department:
    (a) Ketamine has advantage of not causing sedation.
    (b) Ketamine should be avoided in traumatic brain injury.
    (c) N2O can be used for pain management in emergency department.
    (d) Ketamine can be better titrated then nitrous oxide.
    (e) Vapocoolant spray can act as topical anaesthesia.
49. Local anaesthetic systemic toxicity:
    (a) Bupivicaine is more cardiotoxic.
    (b) Toxicity is a manifestation of increased plasma levels.
    (c) Toxicity manifest within 15 min.
    (d) Paravertebral block has highest incidence of LAST.
    (e) Increased levels of albumin increases toxicity.
50. Local anaesthetic systemic toxicity (LAST):
    (a) Incidence of LAST is more with epidural anaesthesia.
    (b) LAST can follow ophthalmic blocks.
    (c) Lipid emulsion reverses local anaesthetic toxicity.
    (d) Lipid emulsion acts by scavenging effect.
    (e) Lipid emulsion is contraindicated in paediatric local anaesthetic toxicity.

51. Obstetric regional anaesthesia:
    (a) Cardiac output increases in pregnancy.
    (b) Left lateral position of the mother is more effective after the neuraxial block.
    (c) Pregnancy has no effect on ECG.
    (d) Minute ventilation increases during pregnancy.
    (e) pH remains unchanged during pregnancy.
52. Obstetric anaesthesia:
    (a) Gastric emptying does not change during pregnancy.
    (b) Increased red cell blood volume leads to decrease in haemoglobin.
    (c) Pregnancy is a hypercoaguable state.
    (d) Local anaesthetic sensitivity of inhalational anaesthetics is seen.
    (e) Increased requirement of inhalational anaesthetics is seen.
53. Obstetric regional anaesthesia:
    (a) Foetal acidosis can cause local anaesthetic toxicity.
    (b) Elimination half life of bupivicaine after epidural injection changes in pregnant patients.
    (c) Newborn neurologic and adaptive function is changed with regional anaesthesia.
    (d) Sacral nerves are involved in the discomfort in the first stage of labour.
    (e) Fentanyl is contraindicated in pregnancy.
54. Obstetric regional anaesthesia:
    (a) Remifentanil PCA is most commonly used in labour.
    (b) Remifentanil provides better pain relief than nitrous oxide in labour.
    (c) Epidural may increase first stage of labour.
    (d) Prolonged second stage of labour can be avoided by using dilute solutions of local anaesthetic.
    (e) Patient controlled epidural anaesthesia has shown better pain management.
55. Obstetrical regional anaesthesia:
    (a) Combined spinal epidural has an early onset than epidural in labour.
    (b) Pruritus is seen more with epidural opioids than spinal opioids.
    (c) Early administration of combined spinal epidural analgesia increases caesarean section delivery rate.
    (d) Spinal anaesthesia may cause uterine hyper stimulation.
    (e) Foetal heart rate abnormalities are seen more in nulliparous women.
56. Obstetrical regional anaesthesia:
    (a) Combined spinal epidural increases the emergency caesarean section.
    (b) Increased incidence of headache is seen with combined spinal epidural.
    (c) Epidural drug requirement increases with combined spinal epidural.
    (d) Paracervical block is safe for analgesia in first stage of labour.
    (e) Racemic bupivicaine causes lesser foetal bradycardia then levobupivicaine.
57. Obstetrical regional anaesthesia:
    (a) Lumbar sympathetic block can be used for first stage of labour analgesia.
    (b) Lumbar sympathetic block increases cervical dilatation during active phase of labour.

(c) Pudendal nerve block can be used for vaginal repair.
(d) Prehydrating before intrathecal injection is better than coloading to prevent hypotension.
(e) Intrathecal clonidine decreases shivering.

58. Obstetrical regional anaesthesia:
(a) Ropivicaine is ideal for test dose in epidural.
(b) 2-chlorprocaine may cause back pain.
(c) Fentanyl has different sites of action depending upon the path of administration.
(d) Hypotension seen with regional anaesthesia is seen with labouring females.
(e) Intrathecal catheter after accidental dural puncture decreases the incidence of headache.

59. Obstetrical regional anaesthesia:
(a) Presence of oedema is a diagnostic criteria for preeclampsia.
(b) Bleeding time is accurate test of clotting.
(c) Antihypertensive agents decrease the progression of preeclampsia.
(d) Epidural anaesthesia improves foetal outcome in pre eclampisa.
(e) General anaesthesia cause adverse effects in neonates born with caesarean section as compared to regional anaesthesia.

Answers

1. F T F F T

Myelination is incomplete at birth and takes 12 years to complete. The receptive field of neurons is big leading to poor pain localisation. (*Fitzgerald M, Walker SM. Infant pain management: a developmental neurobiological approach. Nat Clin Pract Neurol. 2009;5:35–50*). Risk of local anaesthetic toxicity is high in neonates due to immaturity of neonatal liver and high cardiac output. (*Mazoit JX, Dalens BJ. Pharmacokinetics of local anaesthetics in infants and children. Clin Pharamcokinet. 2004;43:17–32*). CYP3A4 matures within first nine months of life as against to CYP1A2 which can take up to 8 years to mature. (*Besunder JB, Reed MD, Blomer JL. Principles of drug disposition in the neonate. A critical evaluation of the pharmacokinetic pharmacodynamics interface (part-1). Clin Pharmacokinet. 1988;14:189–216*). Clearance of drugs is decreased in infants less than 3 months and reaches the adult levels by 8 months of age. As a result, elimination half lives are large in neonates as compared to adults. (*Mazoit JX, Denson DD, Samii K. Pharmacokinetics of bupivicaine following caudal anaesthesia in infants. Anesthesiology. 1988;68:387–91*).

2. T T T T T

Children can tolerate higher dosages of local anaesthetics as compared to neonates and infants. The dosage for older children is 0.4 mg/kg/h while for neonates, it is 0.2 mg/kg/h. The dosage for single injection bupivicaine is 2–4 mg/kg while the dosage for continuous infusion is 0.2–0.4 mg/kg. (*Berde CB. Toxicity*

of local anaesthetics in infants and children. J Paediatr. 1993;122(part-2):S14–20). Ropivicaine has vasoconstrictive effect and has longer Tmax when administered caudally. (*Ala-Kokko TI, Partanen A, Karinen J, et al. Pharmacokinetics of 0.2% ropivicaine and 0.2% bupivicaine following caudal blocks in children. Acta Anesthesiol Scand, 2000;44:1099–102*). L-bupivicaine causes less myocardial depression and decreased incidence of fatal dysrhythemias. (*Mather LE, Huang YF, Veering B, et al. Systematic and regional pharamcokinetics of bupivicaine and bupivicaine enantiomers in sheep. Anesth Analg, 1998;86:805–11*). Spinal anaesthesia in infants require more local anaesthetic as compared to adults especially with bupivicaine or tetracaine. (*Frumiento C, Abajian JC, Vane DW. Spinal anesthesia for preterm infants undergoing inguinal hernia repair. Arch Surg. 2000;135:445–51*). Ultrasound guided injections may cause higher plasma concentrations due to greater surface area of absorption when injected into plane under ultrasound as compared to multiple deposits in muscle as is seen in landmark technique. (*Weintraud M, Lundblad M, Kettner SC, et al. Ultrasound versus landmark based technique for ilioinguinal iliohypogastric nerve blockade in children: the implications on plasma levels of ropivicaine. Anesth Analg. 2009;108:1488–92*).

3. F F F T T

EMLA (eutectic mixtures of local anaesthetics) contains Lidocaine and Prilocaine. It is a 5% emulsion containing 2.5% of each drug. It is applied at least 1 h before cannulation and lasts for 30–60 min. (*Guorier E, Karoubi P, El hamache A, et al. Use of EMLA cream in a department of neonatology. Pain. 1996;68:431–4*). LMX-4 (4% liposomal Lidocaine solution) takes 30 min to cause effect. (*Eichenfield LF, Funik A, Fallen-Friedlander S, et al. A clinical study to evaluate the efficacy of ELA-Max (4% liposomal Lidocaine) as compared with eutectic mixture of local anaesthetics cream for pain reduction of venipuncture in children. Pediatrics. 2002;109:1093–9*). Ametop (4% amethocaine gel) requires 45 min to take effect and must be removed within an hour of application. The duration of action is 3 h as it binds to the proteins in stratum corneum. It is vasodilatory but causes erythema and edema (*Jain A, Rutter N. Topical amethocaine gel in the newborn infant: how soon does it work and how long does it last? Arch Dis Child fetal neonatal Ed. 2003;83:F211–214*). Conus medullaris is at L3 as compared to L1. It reaches the level of L1 by 1 year of age. Dural sac ends at about S4 in infants less than 1 year of age while it is at the level of S2 in children. Onset of epidural block is quicker in paediatric population as epidural fat is less densely packed and facilitates spread resulting in quicker block. (*Peutrell JM, Lonqvist PA. Neuraxial blocks for anaesthesia and analgesia in children. Curr Opin Anesthesiol. 2003;16:461–70*). Amount of CSF is higher in neonates than adults as per body weight. It is 4ml/kg in neonates and infants as compared to 2 mL/kg in adults.

4. T F T F T

Lignocaine should be avoided in paediatric population because of intense motor block. Ropivicaine and bupivicaine are better in profile. Cumulative toxicity is

a concern even at low rates of infusion and therefore the infusion duration should be less than 48 h. (*Lonnqvist PA. Review article. Toxicity of local anaesthetics: a paediatric perspective. Paediatr Anaesth. 2012;22:39–43*). Clonidine can be used in infusions. 0.1 μg/kg/h have been used in children. (*De Nigri P, Ivani G, Visconti C, et al. The dose response relationship for clonidine added to a post operative continuous epidural infusion of ropivicaine in children,. Anesth Analg. 2001;93:73–6*). Psychomimetic effects of Ketamine can be avoided by using small doses (0.25–0.5 mg/kg). (*Passariello M, Almenradar N, Cannetti A, et al. Caudal analgesia in children: S(+) Ketamine versus S(+) Ketamine plus clonidine. Paediatr Anesth. 2004;14:851–5*).

5. T T T F F

Regional anaesthesia is done mostly under general anaesthesia in paediatric population. Keeping the patient breathing spontaneously may decrease the incidence of complications. (*Fischer HB. Performing epidural insertion under general anesthesia. Anaesthesia. 2000;55:288–9*). Epidural space can be calculated in paediatrics.

Weight more than 10 kgs: 1 mm/kg of body weight

Depth (cm): 1+ (0.15 X age in years)

Depth (cm): 0.8 + (0.05 X weight in kgs)

Staphylococcus epidermidis is the predominant organism in epidural infections. (*Kost-Byery S, Tobin JR, Greenberg RS, et al. Bacterial colonisation and infection rate of continuous catheters in children. Anesth Analg. 1998;86:712–6*). Subcutaneous tunnelling and occlusive dressing decreases the risk of bacterial colonisation. (*Bubeck J, Boos K, Krausse H. Subcutaneous tunnelling of caudal catheters reduces the rate of bacterial colonisation to that of lumbar epidural catheters. Anesth Analg. 2004;99:689–93*). Epidural patch can be used in paediatric population and a dosage of 0.3 mL/kg of autologous blood is used. (*Janssens E, Aerssens P, Alliet P, et al. Post dural puncture headaches in children. A literature review. Eur J Pedaitr. 2003;162:117–21*).

6. T F F T T

High sympathetic block to T6 does not cause hypotension. Hypotension in paediatric population is indicative of total spinal anaesthesia. (*Tsuji MH, Horigome H, Yamashita M. Left ventricular functions are not impaired after lumbar epidural anaesthesia in young children. Paediatr Anesthesia. 1996;6:405–9*). Total spinal can be life threatening. Cerebrospinal lavage has been suggested where 20–30 mL of CSF can be withdrawn and replaced with 30–40 mL of normal saline, ringers lactate or plasmalyte. (*Tsui BC, Malherbe S, Koller J, et al. Reversal of an unintentional spinal anaesthetic by cerebrospinal lavage. Anesth Analg. 2004;98:434–6*). The most common side effect with epidural anaesthesia is Pruritus (26.1%), nausea and vomiting (16.9%), urinary retention (20.8%). (*Flandin-Blety C, Barrier G. Accidents following extradural analgesia in children. The results of a retrospective study. Paediatr Anaesth. 1995;5:41–6*). ECG changes in the form of more than 25% increase in the T wave after the injection of epinephrine test dose (0.5 μg/kg) can help diagnose intravenous placement. (*Tsui BC. Thoracic epidural catheter placement in*

Table 12.1 Electrical stimulation test

Electrical stimulation test		
Catheter location	Motor response	Current
Subcutaneous	None	>10 mA
Subdural	Bilateral	<1 mA
Subarachnoid	Unilateral or bilateral	<1 mA
Epidural space		
Against nerve root	Unilateral	<1 mA
Nonintravasular	Uni or bilateral	1–10 mA
Intravascular	Uni or bilateral	1–10 mA

infants via the caudal approach under ECG guidance. Simplification of original technique. Anesth Analg. 2004;98:273). Low current electrical stimulation test can helpposition epidural catheter. (*Tsui BC, Gupta S, Finucaine B. Complications of epidural catheter placement using nerve stimulation. Can J Anesth. 1998;45:640–4*) (Table 12.1).

7. T F F T T
   In infants, catheter advancement can be seen under ultrasound visualisation by observing visualisation of fluid. (*Chawathe MS, Jones RM, Gildersleve CD, et al. Detection of epidural catheters with ultrasound in children. Paediatr Anesth. 2003;13:681–4*). Ultrasound can visualise the fluid injected during the caudal injection. It can also visualise dura displaced ventrally. (*Triffterer L, Machata AM, Latzke D, et al. Ultrasound assessment of cranial spread during caudal blockade in children: effect of speed of the injection of local anaesthetic. Br J Anaesth. 2012;108:670–4*). Volume of local anaesthetic does not correlates with cranial spread during caudal blockade. (*Brenner L, Marhofer I, Ketnner SC, et al. Ultrasound assessment of cranial spread during caudal blockade in children: the effect of different volumes of local anaesthetics. Br J Anaesth. 2011;107:229–35*). An initial horizontal intersegmental distribution from the dorsal to ventral epidural space is seen after caudal epidural. A delayed longitudinal cranial spread is seen after the dura returns to its original position. This causes the local anaesthetic to displace in the caudal direction (CSF rebound mechanism). *(Lundbland M, Etesborg S, Lonnqvist PA. Secondary spread of caudal block as assessed by ultrasonography. Br J Anaesthesia. 2012;108:675–81*). Tuffier line is higher in infants. This is due to neonates having a smaller pelvis than adults and sacrum is located more cephaled relative to iliac crests. Tuffier's line crosses at L4–L5.
8. F T F F T
   Clonidine (1 μg/kg) added to bupivicaine increases the block duration to twice. (*Rochette A, Raux O, Truncin R, et al. Clonidine prolongs spinal anaesthesia in newborns. A prospective dose ranging study. Anesth Analg. 2004;98(1):56–9*).Clonidine usage may lead to apnoea. Caffeine in a dosage of 10mg/kg intravenously has been used to prevent the complications. (*Welborn LG, De Soto H, Hanallah RS, et al. The use of caffeine in the control of post*

anesthetic apnea in former premature infants. Anesthesiology. 1988;68:796–8). Fluid loading is not contraindicated in children as hypotension and bradycardia is uncommonly seen. Fluid loading is rarely required but can be done at 10ml/kg. (*Oberlander TF, Berde CB, Lann KH, et al. Infants tolerate spinal anesthesia with minimal overall autonomic changes. Analysis of heart rate variability in former premature infants undergoing hernia repair. Anesth Analg. 1995;80:20–7*). The incidence of post dural puncture headache is lower in children (8%) as compared to adults. (*Ramamoorthy C, Geiduschek JM, Bratton SL, et al. Post dural puncture headache in paediatric incology patients. Clin Paediatr 1998;37:247–51*). Different needles make no difference to incidence of headache. (15% with quincke, 9% with pencil point whitacre). Incidence of headaches was also not related to age group. (*Kokki H, Salonvaara M, Herrgord E, et al. Post dural puncture headache is not an age related symptom in children: a prospective open randomised parallel group study comparing a 22 gauge quincke with a 22 gauge whitacre needle. Paediatr Anesth. 1999;9:429–34*). Neck flexion does not facilitate the performance of the block in paediatric population. (*Gleason CA, Martin RJ, Anderson JV, et al. Optimal position for a spinal tap in preterm infants. Pediatrics. 1983;71:31–5*).

9. F F T F F

   Motor response is not a reliable indicator as the needle may be intraneurally but may have no motor response. (*Chan VW, Brull R, McCartney CJL, et al. An ultrasonographic and histologic study of intraneural injection and electrical stimulation in pigs. Anesth Analg. 2007;104:1281–4*). The neural structures are superficial in children, therefore high frequency probes (>13 MHz) is mostly required. (*Tsui B, Suresh S. Ultrasound imaging for regional anaesthesia in infants, children and adolescents. Anesthesiology. 2010;112:473–92*). Supraclavicular approach is mostly safe though first rib may not be ossified in young children and predispose to injury. (*De Jose Maria B, Banus E, Navarroegea M, et al. Ultrasound guided supraclavicular versus infraclavicular brachial plexus blocks in children. Paediatr Anesth. 2008;18:838–44*). Surgery above greater trochanter is supplied by T12 and L1 and lateral femoral cutaneous nerve block may not be sufficient. Penile block is indicated for circumcision and distal hypospadias repair. The supply is by dorsal nerves of pudendal nerve. Block is done just under the symphysis pubis *and 0.1mL/kg of plain local anaesthetic is injected.* (*Holder KJ, Peutrell JM, Weir PM. Regional anaesthesia for circumcision. Subcutaneous ring block of the penis and subpubic penile block compared. Eur J Anaesthesiol. 1997; 14:495–8*).

10. T F T F T

    Degenerative changes in myelin sheath of nerve fibres in central nervous system and peripheral nervous system can lead to decrease in nerve conduction velocity. (*Turnheim K. When drug therapy gets old: pharmacokinetics and pharmacodynamics in the elderly. Exp Gerontol. 2003;38:843–53*). Changes seen in the nervous system with ageing include:
    - Peripheral nerve deterioration.
    - Dysfunction of genes responsible for myelin sheath protein components.

- Decreased myelinated nerve fibre conduction velocity.
- Changes in sensation (pain, touch).

(*Morrison JH, Hof PR. Life and death of neurons in the ageing brain. Science. 1997;278:412–9*). Sympathetic tone is increased and sympathetomimetics should be avoided as it may be poorly tolerated. (*Collins KJ, Exton-Smith AN, James MH, et al. Functional changes in autonomic nervous responses with ageing. Age Ageing. 1980;9:17–24*). Large myelinated fibres are affected as compared to small fibres and degenerative changes are seen. (*Meier-Ruge W, Ulrich J, Brohlmann M, et al. Age related white matter atrophy in the human brain. Ann NY Acad Sci. 1992;673:260–9*). Remyelination is decreased in elderly as oligodendrocyte progenitor recruitment and differentiation are impaired. (*Salat DH. The declining infrastructure of the ageing brain. Brain Connect. 2011;1:279–93*).

11. F T F T T

Thoracic epidural improves left ventricular function and increases myocardial oxygen availability. (*Jacobson CJ, Nygaard E, Norrild K, et al. High thoracic epidural epidural analgesia improves left ventricular function in patients with ischaemic heart. Acta anesthesiol Scand. 2009;53:559–64*). Compliance of chest wall decreases causing increased work of breathing and increased risk for respiratory failure in post operative period. (*Sprung J, Gajic O, Warner DO. Review article: age related alterations in respiratory function–anesthertic considerations. Can J Anaesth. 2006;53:1244–57*). The decrease in functional residual capacity persists for 7–10 days after the surgery. (*Don HF, Wahba M, Cuadrado L. et al. The effects of anaesthesia and 100% O2 on the functional residual capacity of the legs. Anesthesiology. 1970;32:521–29*). Epinephrine is mostly safe to use but caution should be exercised because of the sympathetic tone and pre-existing neuropathy. (*Hebl JR, Kopp SL, Schroeder DR, et al. Neurologic complications after neuraxial anaesthesia or analgesia in patients with pre existing peripheral sensori motor neuropathy or diabetic Polyneuropathy. Anesth Analg. 2006;103:1294–99*).

12. F F T T T

NMDA receptor composition is altered causing increased sensitivity. (*Clayton DA, Grosshans DR, Browning MD. Ageing and surface expression of hippocampal NMDA receptors. J Biol Chem. 2002;277:14367–9*). The clearance of bupivicaine and ropivicaine is decreased in elderly. (*Olofsen E, Burm AG, Simon MJ, et al. Population pharmacokinetic pharmacodynamic modelling of epidural anaesthesia. Anesthesiology. 2008;109:664–74*). Local anaesthetic sensitivity is increased in elderly due to slowing of conduction velocity and decrease in the number of neurons in the spinal cord. (*Simon MJ, Veering BT, Vletter AA, et al. The effect of age on the systemic absorption and systemic disposition of ropivicaine after epidural administration. Anesth Analg. 2006;102:276–82*). A 10–20% decrease in pain intensity is seen for each decade after 60 years of age. (*Gibson SJ, editor. Pain and ageing: the pain experience over the adult life span. Seattle: IASP; 2003;Dostrovsky JO, Corr DB, Koltzenberg M, editors. In: Proceedings of the 10th world congress on pain.*

Progress in pain research and management. p. 24). Elderly patients may feel less post operative pain because of decrease of density of opioid receptors in brain and decreased circulating endogenous opioids. (*Onur OA, Piefne M, Lie CH, et al. Modulatory effects of leva dopa on cognitive control in young but not in older subjects: a pharmacological fMRI study. J Cog Neurosci. 2011;23:2797–810*).

13. T F T T F

Elderly patients show small increase in pain thresholds following noxious stimuli with evidence of prolonged recovery from hyperalgesia. (*Fjell AM, Walhoud KB. Structural brain changes in ageing: courses, causes and cognitive consequences. Rev Neurosci. 2010;21:187–221*). Pain perception is not diminished dementia. (*Benedetti F, Arduino C, Costa S, et al. Loss of expectation related mechanisms in Alzheimer's disease makes analgesic therapies less effective. Pain. 2006;121:133–4*). VRS or behavioural scale (doloplus-2 or algoplus) are better tools. (*Zwakhalen SM, Hamers JP, Abu-saad HH, et al. Pain in elderly people with severe dementia: a systematic review of behavioural pain assessment tools. BMC Geriatr. 2006;6:3*). Epidural anaesthesia may decrease the incidence of nausea and vomiting while the incidence of Pruritus and motor blockade is increased. (*Foss NB, Kristensen MT, Kristensen BB, et al. Effect of post operative epidural analgesia on rehabilitation and pain after hip fracture surgery. A randomised double blind placebo controlled trial. Anesthesiology. 2005;102:1197–204*). Post operative cognitive dysfunction is seen with neuraxial anaesthesia but the incidence is less with intrathecal Fentanyl as compared to intrathecal morphine. (*Herrick IA, Ganapthy S, Komar W, et al. Post operative cognitive impairment in the elderly. Choice of patient controlled analgesia opioid. Anesthesia. 1996;51:356–60*).

14. T F T T T

Age determines spread of local anaesthetics in the neuraxial space. (*Simm MJ, Veering BT, Stienstra R, et al. The effects of age on neural blockade and hemodynamic changes after epidural anaesthesia with ropivicaine. Anesth Analg. 2002;94:1325–30*). Decreased concentration of local anaesthetic is required for motor block. Intrathecal morphine provides better analgesia than intravenous morphine with fewer side effects. (*Murphy PM, Stack D, Kinitrons B, et al. Optimising the dose of intrathecal morphine in older patients undergoing arthroplasty. Anesth Analg. 2003;97:1709–15*). Post operative cognitive deficit is decreased with regional anaesthesia. (*Rasmussen LS, Johnson T, Kuipers HM. Does anaesthesia cause post operative cognitive deficit?a randomised study of regional versus general anaesthesia in 438 elderly patients. Acta Anaesthesiol Scand. 2003;47:260–6*). Regional anaesthesia has been shown to decrease cancer recurrence. (*Heaney A, Buggy DJ. Cam anaesthetic and analgesic techniques affect cancer recurrence or metastasis? Br J Anaesth. 2012;109:i17–2*8).

15. T T F F F

High thoracic anaesthesia (T1–T5) blocks cardiac afferent and efferent sympathetic fibres with loss of ionotropic drive to the myocardium. (*Veering BT,*

Cousins MJ. Cardiovascular and pulmonary effects of epidural anaesthesia. Anesth Intensive Care. 2000;28:620–35). Thoracic epidural decreases left ventricular contractility only in high thoracic epidural. (*Niimi Y, et al. Echocardiographic evaluation of global left ventricular function during high thoracic epidural anaesthesia. J Clin Anesth. 1997;9:118–24*). Thoracic epidural increases the diameter of stenotic epicardial coronary arteries in coronary artery disease without affecting coronary arterioles. (*Blomberg S, et al. Effects of thoracic epidural anaesthesia on coronary arteries and arterioles with coronary artery disease. Anesthesiology. 1990;73:840–7*). Thoracic epidural does not cause decrease in coronary perfusion but causes decrease in mean arterial pressure and coronary perfusion pressure without causing cardiovascular effects. (*Stenseth R, et al. The influence of thoracic epidural analgesia alone and in combination with general anaesthesia on cardiovascular function and myocardial metabolism in patients receiving β-adrenergic blockers. Anesth Analg. 1993;77:463–8*). Thoracic epidural improves left ventricular diastolic function where as systolic function does not change. (*Schmidt C, et al. The effect of high thoracic epidural anaesthesia on systolic and diastolic left ventricular function in patients with coronary artery disease. Anesth Analg. 2005;100:1561–9*).

16. T F T T F

Thoracic epidural anaesthesia is associated with better pain relief in the post operative period with decrease in systemic vascular resistance and intrapulmonary shunt as compared to general anaesthesia. (*Gelman S, et al. Thoracic epidural versus balanced anaesthesia in morbid obesity: an intraoperative and post operative hemodynamic study. Anesth Analg. 1980;59:902–8*). Lumbar epidural anaesthesia may improve global and regional ventricular function in patients with angina provided volume loading is limited. (*Baron JF, et al. Left ventricular global and regional function during lumbar epidural anaesthesia in patients with or without angina pectoris. Influence of volume loading. Anesthesiology. 1987;66:621–27*). Lumbar epidural anaesthesia decreases the risk of arterial thrombotic complications due to the prevention of post operative inhibition of fibrinolysis. (*Rosenfeld BA, et al. The effects of different anaesthetic regimens on fibrinolysis and the development of post operative arterial thrombosis. Perioperative ischaemia randomised anaesthesia trial study group. Anesthesiology. 1993;79:435–43*). The stress response is decreased with regional anaesthesia and general anaesthesia than general anaesthesia and intravenous opioids. (*Hall R, et al. Does intrathecal morphine alter the stress response following coronary artery bypass grafting surgery? Can J Anaesth. 2000;47:463–6*). Paravertebral block causes resolution of ST segment depression. (*Ho AM, et al. The resolution of ST segment depression after high thoracic paravertebral block during general anaesthesia. Anesth Analg. 2002;95:227–8*).

17. F F F T F

There is no difference in stroke rate, myocardial infarction and death between general anaesthesia and cervical plexus block in the first 30 days (GALA trial).

(*Group GTC, et al. General anaesthesia versus local anaesthesia for carotid disease (GALA): a multicentre randomised controlled trial. Lancet. 2008;372:2132–42*). Thoracic epidural can be inserted up to 60–90 min before heparinisation or a day before surgery. (*Mehta Y, Arora D. Benefits and risks of epidural analgesia in cardiac surgery. J Cardiothorac Vasc Anesth. 2014;28:1057–63*). Risk of transient neurologic symptoms with thoracic epidural in cardiac surgery is 1:1700. (*Ruppen W, et al. Incidence of epidural hematoma and neurological injury in CVS patients with epidural analgesia/anesthesia: systemic review and meta analysis. BMC Anesthesiol. 2006;6:10*). Regional anaesthesia decreases the incidence of myocardial incidence and atrial fibrillation. (*Djaini G, Fedorko L, Beattie WS. Regional anesthesia in cardiac surgery: a friend or foe? Semin Cardiothoracic Vasc Anesth. 2005;9:87–104*). Patients with coronary artery disease and poor left ventricular systolic function (ejection fraction <30%), require careful titration of central neuraxial anaesthesia.

18. T F T F T

Cervical epidural can be done to achieve selective sensory block. (*Michalek P, David I, Adamec I, et al. Cervical epidural anesthesia for combined neck and upper extremity procedure: a pilot study. Anesth Analg. 2004;99:1833–6*). High neuraxial anaesthesia makes the chest wall more compliant. The chest wall is retracted during inspiration and may display paradoxical rib cage motion. (*Kochi T, Sako S, Nishimo T, et al. Effect of high thoracic extradural anaesthesia on ventilator response to hypercapnia in normal volunteers. Br J Anaesth. 1989;62:362-7*). Epidural blockade up to the level of T6 or T1 may increase chest wall expansion causing an increase in tidal volume. (*Warner DO, Warner MA, Ritman EL. Human chest wall function during epidural anesthesia. Anesthesiology. 1996;85:761–73*). Lumbar epidural exhibits decrease in FEV1, FVC and peak expiratory flow. (*Reber A, Bein T, Hogman M, et al. Lung aeration and pulmonary gas exchange during lumbar epidural anaesthesia and in the lithotomy position in elderly patients. Anaesthesia. 1998;53:854–61*) (Table 12.2).

FRC is increased with thoracic epidural along with decrease in vital capacity and total lung capacity. Cervical epidural causes a 15–30% decrease in vital capacity and FEV1. (*Capdevilla X, Bihoulet P, Rubenovitch J, et al. The effects of cervical epidural anaesthesia with bupivicaine on pulmonary function in conscious patients. Anesth Analg. 1998;86:1033-1038*).

19. F T F T T

Ventilator response is preserved in neuraxial anaesthesia (*Sakura S, Saito Y, Kosaka Y. The effects of epidural anaesthesia on ventilatory response to*

Table 12.2 Effect of neuraxial blockade on lung mechanics

	FEV1	FVC	PEF
Lumbar epidural	Decreased	Decreased	Decreased
Thoracic epidural	Decreased	Decreased	decreased

hypercapnia and hypoxia in elderly patients. Anesth Analg. 1996;82:306–11). Interscalene block causes phrenic nerve blockade in 100% of patients. (*Urmey WF, Talts KH, Sharrock NE. One hundred percent incidence of hemi diaphragmatic paresis associated with interscalene brachial plexus analgesia as diagnosed by ultrasonography. Anesth Analg. 1991;72:498–503*). Interscalene block causes a 27% decrease in FVC and FEV1. (*Urmey WF, McDonald M. Hemi diaphragmatic paresis during interscalene brachial plexus block: effects on pulmonary function and chest wall mechanics. Anesth Analg. 1992;74:352–7*). Volume is a major determinant of Phrenic nerve blockade. Decreasing the volume to just 5 mL under ultrasound guidance decreases the incidence by 45–50%. (*Lee JH, Cho SH, Kim SH, et al. Ropivicaine for ultrasound guided interscalene block: 5mls provides similar analgesia but less Phrenic nerve paralysis than 10 mls. Can J Anaesth. 2011;58:1001–6*). Both supra and infraclavicular approaches affect Phrenic nerve. (*Yang CW, Jung SM, Kwon HU, et al. Transient hemi diaphragmatic paresis after ultrasound guided lateral saggittal infraclavicular block. J Clin Anesth. 2013;25:496–8*). Axillary and Suprascapular nerve blocks are an alternative to intertscalene block. (*Verelst P, Zundert A van. Respiratory impact of analgesic strategies for shoulder surgery. Reg Anesth Pain Med. 2013;38:50–53*).

20. T T T F T

Interscalene catheters may affect phrenic nerve causing chest pain, atelectasis, pleural effusion and dyspnoea. (*Souron V, Reiland Y, Delaunay L. Pleural effusion and chest pain after continuous interscalene brachial plexus block. Reg Anesth Pain Med. 2003;28:535–8*). Phrenic nerve palsy can be decreased if there is a catheter in situ. 0.9% saline lavage has been used. Intercostal blocks increase arterial oxygen saturation and peak expiratory flow rate in rib fracture. (*Osinowo OA, Zahrami M, Softah A. Effect of intercostal nerve block with 0.5% bupivicaine on peak expiratory flow rate and arterial oxygen saturation in rib fractures. J Trauma. 2004;56:345–7*). Paravertebral block is better than intercostal blockade or epidural analgesia in preserving pulmonary function. (*Davies RG, Myles PS, Graham JM. A comparison of the analgesic efficacy and side effects of paravertebral versus epidural blockade for thoracotomy—a systemic review and meta-analysis of randomised trial. Br J Anaesth. 2006;96:418–26*). Supraclavicular block has high incidence of Pneumothorax, though most are small and undergo spontaneous resolution. (*Bhatia A, Lai J, Chan VWS, et al. Case report: Pneumothorax as a complication of the ultrasound guided supraclavicular approach for brachuial plexus block. Anesth Analg. 2010;111:817–9*).

21. F F F F F

Procaine mitigates the nephrotoxic effect of cisplatin. (*Fenoglio C, Boicelli CA, Offone M, et al. Protective effect of procaine hydrochloride on cisplatin induced alterations in rat kidney. Anticancer Drugs. 2002;13:1043–54*). Neuraxial anaesthesia and concurrent sympathectomy can reduce mean arterial pressure but mostly renal blood flow is preserved. This is due to increase in left ventricular stroke volume in response to decrease in systemic vascular resistance.

(*Suleiman MY, Passannante AN, Onder RL, et al. Alteration of renal blood flow during epidural anaesthesia in normal subjects. Anesth Analg. 1997;84:1076–80*). Thoracic epidural suppresses the rennin response to induced hypotension. (*Hopf HB, Schlaghecke R, Peters J. Sympathetic neural blockade by thoracic epidural anaesthesia suppresses rennin release in response to arterial hypotension. Anesthesiology. 1994;80:992–9*). Choice of anaesthetic agent has not outcome on graft outcome. (*Sener M, Torgay A, Akpek E, et al. Regional versus general anaesthesia for donor nephrectomy: effect on graft function. Transplant Proc. 2004;36:2954–8*). Acidemia decreases the protein binding of bupivicaine and increased risk of toxicity. (*Coyle DE, Denson DD, Thompson GA, et al. The influence of lactic acid on the serum protein binding of bupivicaine: species differences. Anesthesiology. 1984;61:127–33*).

22. T T F F T

Increased levels of local anaesthetic is seen in renal failure due to increased blood flow . this is due to the hyper dynamic circulation in uremic patients. (*Pere P, Salonen M, Jokinen M, et al. Pharmacokinetics of ropivicaine in uremic and non uremic patients after axillary brachial plexus block. Anesth Analg. 2003;96:563–9*). Increased levels of alpha acid glycoprotein has a protective effect by binding more local anaesthetic in the blood stream.(*Vasson MP, Baguet JC, Arveillar MR, et al. Serum and urinary alpha-1 acid glycoprotein in chronic renal failure. Nephron. 1993;65:299–303*). Lidocaine toxicity cannot be treated with hemodialysis as it is ineffective in removing Lignocaine from plasma. (*Vaziri ND, Saiki JK, Hughes W. Clearance of Lidocaine by hemodialysis. South Med J. 1979;72:1567–8*). Uremic Coagulopathy is associated with defect of platelet aggregation. This is due to binding of fibrinogen to platelet glycoprotein. It manifests as clinical bleeding and any neuraxial bklock may cause spinal hematoma. (*Gawaz MP, Dobos G, Spath M, et al. Impaired function of platelet membrane glycoprotein IIb-IIIa in end stage renal disease. J Am Soc Nephrol. 1994;5:36–46*). Uremic patients are prone for thrombotic effects. (*Boccardo P, Remozzi G, Galbusera M. Platelet dysfunction in renal failure. Semin Thromb Hemost. 2004;30:579–89*).

23. F F T F F

Regional anaesthesia has been found to be better than general or local anaesthesia as it increases vein diameter, increases rate of native fistula formation, increased fistula blood flow and shorter maturation time. (*Schenk WG. Improving dialysis access: regional anaesthesia improves arteriovenous fistula prevalence. Am Surg. 2010;76:938–42*). Amide local anaesthetics are metabolised in liver microsomes by cytochrome P450 system. A decrease in function is seen in liver disease and local anaesthetic toxicity may be seen. (*Jikinen MJ, Neuvenen PJ, Lindgren L, et al. Pharmacokinetics of ropivicaine in patients with chronic end stage liver disease. Anesthesiology. 2007;106:43–55*). Continuous infusion of local anaesthetic may cause toxicity ion liver disease (*Barry M, Keeling PW, Weir D, et al. Severity of cirrhosis and the relationship of alpha-1-acid glycoprotein concentration to plasma protein binding of lidocaine. Clin Pharmacol Ther. 1990;47:366–70*). Ester local

anaesthetics are cleared by plasma cholinesterases. Liver disease can causes decreased levels of cholinesterase and may increase half life of ester local anaesthetics. (*Reidenberg MM, James M, Dring LG. The rate of procaine hydrolysis in serum of normal subjects and diseased patients. Clin Pharmacol Ther. 1972;13:279–84*). The predictive value of PT/INR has poor value for bedside procedures. (*Dzik WH. Predicting haemorrhage using preoperative coagulation screening assays. Curr Hematol Rep. 2004;3:324–30*).

24. T T T T T

INR alteration is also seen in liver failure. In diabetic patients, an increase in endoneural pressure may cause constriction of small transperineural vessels increasing the ischaemia. (*Al-Nasser B. Toxic effects of epidural analgesia with ropivicaine 0.2% in a diabetic patient. J Clin Anesth. 2004;16:220–3*). Motor response in diabetic patients requires increase in intensity on nerve stimulator. (*Keyl C, Held T, Albeiz G, et al. Increased electrical nerve stimulation threshold of the sciatic nerve in patients with diabetic foot gangrene: a prospective parallel cohort study. Eur J Anaesthesiol. 2013;30:435–40*). Regional anaesthesia decreases the stress response to surgery. (*Milosavljevic SB, Pavlovic AP, Trpkovic SV, et al. Influence of spinal and general anaesthesia on the metabolic, hormonal and hemodynamic response in elective surgical patients. Med Sci Monit. 2014;20:1833–40*). Patients with BMI >30 kg/sqm were 1.62 times more likely to experience a failed regional block than those with a BMI <25 kg/sqm. (*Nielson KC, Gueller U, Steele SM, et al. Influence of obesity on surgical regional anaesthesia in the ambulatory setting: an analysis of 9038 blocks. Anesthesiology. 2005;102:181–7*).

25. F T F T T

" Double crush phenomenon" suggests that patients who have prior neural injuries are more susceptible to injury at other site. These insults include surgical or anaesthetic factors. Second insult can be at any point along the neural transmission pathway. (*Osterman AL. The doubkle crush syndrome. Orthop Clin North Am. 1988;19:147–55*). Charcot marie tooth disease affects 1:2500 people and starts in the childhood. It is due to mutation inn genes responsible for manufacturing neurons or myelin sheaths. (*Bui AH, Marco AP. Peripheral nerve blockade in a patient with charcot marie tooth disease. Can J Anesth. 2008;55:718–9*). Diabetic neuropathy is not reversed immediately. (*Williams BA, Murinson BB. Diabetes mellitus and subclinical neuropathy: a call for new paths in peripheral nerve block research. Anesthesiology. 2008;109:361–2*).

Alterations in diabetes mellitus:

- Distal symmetric sensorimotor Polyneuropathy is the most common.
- All neuropathies will have evidence of abnormal nerve conduction.
- Damage to small nerve fibres (numbness, pain, autonomic dysfunction) is seen before large fibres.
- Axonal degeneration is the most common pathology.

Proposed mechanism of neuropathy:

- Sorbital deposition.
- Local tissue ischaemia

- Abnormal tissue repair mechanism.
- Mitochondrial dysfunction in dorsal root ganglion.

(*Sinnreich M, Taylor BV, Dyck PJ. Diabetic neuropathies. Classification, clinical features and pathophysiological basis. Neurologist. 2005;11:63–79*). Success rate of regional anaesthesia is higher in diabetic patients. The reasons are:

- Increased sensitivity of diabetic nerve fibres to local anaesthetics.
- Possible intraneural penetration before injection.
- Pre-existing diabetic neuropathy.

(*GebhardRE, Nielson KC, Pietrobon R, et al. Diabetes mellitus, independent of body mass index, is associated with a "higher success" rate for supraclavicular brachial plexus block. Reg Anesth Pain Med. 2009;34:404–7*). Epinephrine increases the risk of neural ischaemia and infarction. (*Williams BA, Murinson BB, Grable BR, et al. Future considerations for pharmacologic adjuvants in single injection peripheral nerve blocks for patients with diabetes mellitus. Reg Anesth Pain Med. 2009;34:445–57*).

26. T F T F F

Chemotherapy induced neuropathy may be subclinical and may develop into full fledged neuropathy with administration of local anaesthetics. (*Gupta R, Bhaskar A. Chemotherapy induced peripheral neuropathic pain. BJA Education. 2011;16(4):115–9*). Regional anaesthesia has been used in Guillain Barre Syndrome in obstetric patients. (*Vassiliev DV, Nystron EU, Leight CH. Combined spinal and epidural anaesthesia for labour and caesarean delivery in a patient with guillain barre syndrome. Reg Anesth Pain Med. 2001;26:174–6*). Neuraxial anaesthesia may precipitate or reactivate Guillain Barre Syndrome, hours to weeks following surgery. (*Bamberger PD, Thys DM. Guillain barre syndrome in a patient with pancreatic cancer after an epidural general anaesthesia. Anesth Analg. 2005;100:1197–9*). Post surgical inflammatory neuropathy is an autoimmune or inflammatory processes that causes severe neurologic deficits. Risk factors include malignancy, diabetes mellitus, tobacco, systemic infection, volatile anaesthesia use, recent blood transfusion. (*Ahn KS, Kopp SL, Watson JC, et al. Postsurgical inflammatory neuropathy. Reg Anesth Pain Med. 2011;36:403–5*). Multiple sclerosis is an inflammatory autoimmune disorder of CNS. There is focal Demyelination within the spinal cord and the brain. Signs and symptoms include sensory or motor deficits, vision loss, bowel or bladder dysfunction, ataxia. Patients may have subclinical neuropathy. Peripheral Demyelination is seen in 47% of patients and peripheral nerve conduction deficits in 14.7% of patients. (*Misawa S, Kuwabara S, Mori M, et al. Peripheral nerve demyelination in multiple sclerosis. Clin Neurophysiol. 2008;119:1829–33*).

27. T F T T T

Pregnancy is associated with decrease in disease relapse. While post partum period is associated with an increase in relapse. There is change from cellular immunity to humoral immunity in mother's immune system to tolerate the foetus which is protective against multiple sclerosis. Cell mediated immunity

rebounds during the post partum period. (*Confaureux C, Hutchinson M, Hours MM, et al. Rate of pregnancy related relapse in multiple sclerosis. Pregnancy in multiple sclerosis Group. N Engl J Med. 1998;339:285–91*). Concentration of local anaesthetic in white matter of spinal cord is one fourth the level of epidural injection compared to intrathecal injection. (*Warren TM, Datta S, Ostheimer GW. Lumbar epidural anaesthesia in patient with multiple sclerosis. Anesth Analg. 1982;61:1022–3*). Amytrophic lateral sclerosis is a progressive degenerative disease of upper and lower motor neurons. It presents as atrophy, weakness and fasciculation in the intrinsic hand muscles. Autonomic dysfunction may be seen in the form of hypotension and increased resting heart rate. Neuraxial anaesthesia has been found to be safe. (*Hobaika AB, Neves BS. Combined spinal epidural block in a patient with amyotrophic lateral sclerosis: case report. Rev Bras Anestesiol. 2009;59:206–9*). Post polio syndrome develops years after acute poliomyelitis infection. It affects anterior horn cells and is classified as lower motor neurone disease. Sensory deficits are not seen. Neuraxial anaesthesia is given on individual basis. (*Bordes J, Gaillard PE, Laeroix G, et al. Spinal anaesthesia guided by computed tomography scan in a patient with severe post polio sequalea. Br J Anaesth. 2010;105:702–3*).

28. T F F F F

Compartment syndrome is an acute condition of limbs in which pressure of isolated or groups of poorly compliant muscle compartments increase and causes motor and sensory impairment. (*Matsen F, Winquist R, Krugmire R. Diagnosis and management of compartment syndromes. J Bone Joint Surg. 1980;62A:286*). Upper leg muscles are at lower risk than lower leg muscles as the the muscles of thigh can dissipate the large forces of direct trauma causing less muscle injury and resultant oedema. (*Schwartz J, Brumback R, Lakotas R. Acute compartment syndrome of the thigh: a spectrum of injury. J Bone Joint Surg. 1989;71:392–400*). Increase in pressure causes tissue hypoperfusion leading to tissue hypoxia and may cause permanent damage. (*Bottle M, Santi M, Prestianni C, et al. Ischaemic contracture of foot and ankle: principles of management and prevention. Orthopaedics. 1996;19:235–44*). Compartment pressures more than 30 mmHg requires urgent intervention. The first manifestations after the muscle injury is sensory change within 30 min of Ischaemia. Irreversible nerve damage begins after 12–24 h of total ischemia. Irreversible changes in muscles begin after 4–8 h causing muscle death. (*Whitesides T, Harada H, Morimoto K. The response of skeletal muscle to temporary ischemia. An experimental study. J Bone Joint Surg. 1971;53A:1027–8*).

29. F T F T F

Warning signs for compartment syndrome include pain out or proportion to injury, palpable tense extremity with uninjured limbs but none of the symptoms is diagnostic (*McQueen M, Gaston P, Court-Brown C. Acute compartment syndrome. Who is at risk? J Bone Joint Surg. 2000;8LB:200–3*). Clinical signs are supportive but diagnosis needs measurement of compartmental pressures. (*Shuler FD, Dietz MJ. Physician's ability to manually detect isolated elevations in leg intracompartmental pressure. J Bone Joint Surg Am. 2010;92:361–*

7). The absolute value of interstitial pressure is decreased in hypertensive patients as hypotension makes the limb more prone to ischemic injury. Intramuscular pH can accurately diagnose the compartment syndrome. (*Elliott KG. Intramuscular pH as a novel diagnostic tool for acute compartment syndrome. A prospective clinical study. Aberdeen: University of Aberdeen; 2007*). Regional anaesthesia may not mask timely diagnosis. (*Walker BJ, Noonan KJ, Bosenberg AT. Evolving compartment syndrome not masked by a continuous nerve block. Reg Anaesth Pain Med. 2012;393–7*).

30. T F T T T

The incidence of spinal hematomas is 1:3800. The increased risk is due to degenerative spinal abnormalities, osteoporosis, and peripheral vascular disease. (*Horlocker T. Neuraxial blockade in patients with spinal stenosis: between a rock and a hard place. Anesth Analg. 2010;110:1305*). Obstetric patients have a lower risk of spinal hematomas (1:200,000). It is due to hypercoaguable state of pregnancy, wider capacity of epidural space and high intraepidural pressure. Preoperative Antiplatelet therapy is not a risk factor for needle or catheter placement (*Horlocker TT, Wedel DJ, Schroeder DR, et al. Preoperative Antiplatelet therapy does not increase the risk of spinal hematoma associated with regional anaesthesia. Anesth Analg. 1995;80:303–9*). Risk factors include female gender, increased age, history of excessive bruising, large needle size, multiple attempts, and difficult needle placements. Oxcarbazepine and serotonergic reuptake inhibitors increase the bleeding tendencies. (*Meijer WEE, Heerdink ER, Nolen WA, et al. Association of risk of abnormal bleeding with degree of serotonin reuptake inhibition by antidepressants. Arch Intern Med. 2004;164:2367–70*). Cox-2 inhibitors does not increase the risk of bleeding (*Van Heeken H, Schwartz JI, Depre M, et al. Comparative inhibitory activity of rofecoxib, meloxicam, diclofenac, ibuprofen and naproxen on COX-2 versus COX-1 in healthy volunteers. J Clin Pharmacol. 2000;40:1109–20*) (Table 12.3).

31. T T F T F

P2Y12 assay can be done to assess platelet activity during Clopidogrel administration. (*Benzon HT, McCarthy R, Benzon HA, et al. determination of the residual antiplatalet activity of Clopidogrel. Br J Anaesth. 2011;107:966–71*). Ticagrelor is a direct acting P2Y12 receptor inhibitor. (*Wallentin L. P2Y12 inhibitors. Differences in properties and mechanisms of action and potential consequences for clinical use. Eur Heart J. 2009;30:1964–77*). Prasugrel and ticagrelor causes platelet inhibition of upto 90% while Clopidogrel causes 60–70% inhibition. (*Brandt JT, Payne CD, Winiott SD, et al. A comparison of prasugrel and Clopidogrel loading doses on platelet function: magnitude of platelet inhibition is related to active metabolite formation. Am Heart J. 2007;153:66:e9–16*). 10–15% of circulating platelet pool is formed every day. Ticagrelor should be stopped for 5–7 days and 7–10 days for prasugrel. (*George JN. Platelets. Lancet. 2000;355:1531–9*). P2Y12 receptor activity can be monitored with vasodilator stimulated phosphorylation (VASP) assay and multiple platelet aggregometry test. (*Benzon HT, Avram J, Green D, et al. New oral anticoagulants and regional anaesthesia. Br J Anaesth. 2013;111(suppl 1):i96–113*).

Table 12.3 Anticoagulants and characteristics

AGENT	PT	APTT	Time to maximum effect	Time to normal coagulation after stopping the medicine
Intravenous heparin	Slight increase	Very much increased	Minutes	4–6 h
Subcutaneous heparin	No effect	Slight increase	40–50 min	4–6 h
Low molecular weight heparin	No effect	No effect	3–5 h	12–24 h
Warfarin	Very much increased	Slight increase	4–6 days	4–6 days
Aspirin	No effect	No effect	Hours	5–8 days
Other NSIADs	No effect	No effect	Hours	1–3 days
Ticlodipine/ Clopidogrel	No effect	No effect	Hours	1–2 weeks
Glycoprotein IIb/ IIIa inhibitors	No effect	No effect	Minutes	8–48 h
Fibrinolytics	Slight increase	Increased	Minutes	24–36 h

32. T T F F F

Warfarin requires suppression of factor VII,II and V to exert its full effect whioch takes about 5 days. (*Schulman S, Lockner D, Bergstrom K, et al. Intensive initial oral anticoagulation and shorter heparin treatment in deep vein thrombosis. Thromb Haemost. 10984;52:276–80*). Heparin acts by activity against factor Xa. (*Abilgaard V, Lindahl AK, Sandset PM. Heparin requires both antirhrombin and extrinsic pathway inhibitor for its anticoagulant effect in human blood. Hemostasis. 1991;21:254–7*). Heparin has a half life of 1.5 to 2 h. Maximum duration is 4–6 h. aPTT is used to monitor the effect of heparin. aPTT more than 1.5 times correlates with a heparin level of 0.2–0.4 units/mL. (*Murray DJ, Brod snahan WJ, Pennell B, et al. Heparin detection by the activated coagulation time: a comparison of the sensitivity of coagulation tests and heparin assays. J Cardiothorac Vasc Anesth. 1997;11:24–8*). Heparin is a mixture of molecules and a fraction has anticoagulant activity. Heparin-antithrombin complex is not very effective in neutralising clot. It is associated with thrombocytopenic and thrombosis. (*Shapiro SS. Treating thrombosis in the 21st century. N Engl J Med. 2003;349:1762–4*). Catheter should be removed 2–4 h after the last heparin dose and 1 h before heparin administration. (*Liu SS, Mulroy MF. Neuraxial anaesthesia and analgesia in the presence of standard heparin. Reg Anesth Pain Med. 1998;23:157–63*).

33. T T F F T

Low molecular weight heparin has a greater activity against factor Xa. Plasma half life ranges from 2 to 4 h after intravenous injection and 3–6 h after subcutaneous injection. It has low affinity for plasma proteins, resulting in greater bioavailability. Laboratory monitoring is not required. (*Horlocker TT, Heit*

JA. Low molecular weight heparin: biochemistry, pharmacology, perioperative prophylaxis regimens, and guidelines for regional anaesthetic management. Anesth Analg. 1997;85:874–85). The low molecular weight heparins available are Enoxaparin, Dalteparin and Tinzaparin. Enoxaparin is given as twice a day preparation while other two have once daily dosing. All three have comparative efficacy in venous thromboembolism , prevention of myocardial infarction in unstable angina. (*White RH. Low molecular weight heparins. Are they all the same? Br J Haematol. 2003;121:12–20*). Neuraxial anaesthesia should be delayed for a minimum of 12 h after the low molecular weight heparin. The catheter should be removed at least 12 h after low molecular weight heparin administration and 4 h before the next dosage. Thrombolytics dissolve fibrin clots. Streptokinase and Urokinase dissolve thrombus and affects circulating plasminogen. Recombinant tissue type plasminogen activator (r-TPA) is fibrin selective with less effect on circulating plasminogen. (*Rosenqvist RW, Brown DL. Neuraxial bleeding: fibrinolytics/thrombolytics. Reg Anesth Pain Med. 1998;235:152–6*). Garlic inhibits platelet aggregation and effect lasts for upto 7 days. Gingko inhibits platelet activating factor and effect lasts for 36 h. Ginseng inhibits platelet aggregation and prolongs thrombin time and aPTT and effect lasts for 24 h (Table 12.4).

34. T T T T F

Fondaparinaux is a synthetic anticoagulant that inhibits factor Xa. Half life is 17–21 h. It is used for antithrombosis and pulmonary embolism (*Bauer KA. Fondaparinaux: basic properties and efficacy and safety in venous thromboembolism prophylaxis. Am J Orthop. 2002;31:4–10*). It should not be used in presence of indwelling catheters. (*Singelyn FJ, Verheyen CC, Piovella F, et al. EXPERT study investigations: the safety and efficacy of extended thromboprophylaxis with Fondaparinaux after major orthopaedic surgery of the lower limb with or without neuraxial or deep peripheral nerve catheter: the EXPERT study. Anesth Analg. 2007;105:1540–7*). 2–3 half life intervals are more than appropriate for those who are at high risk of venous thromboembolism. (*Connolly G, Spyropoulos AC: oractical issues, limitations and peripheral*

Table 12.4 Herbs and effect on coagulation

Herb	Effects	Concerns	Time to normal coaulation
GARLIC	• Inhibition of platelet aggregation • Increased fibrinolysis • Antihypertensive activity	Increased bleeding	7 days
GINKO	Inhibition of platelet activating factor	Increase bleeding	36 h
GINSENG	• Decreases blood glucose. • Increased PT and aPTT	• Hypoglycaemia • Increased bleeding • Decreases anticoagulant effect of warfarin	24 h

management of the NOACs. J Thromb Thrombolysis. 2013;36:212-22) (Table 12.5).

Clot stabilisation occurs within 8 h, so clot lysis should be done within 6 h. (*IST-3 Collaborative Group. The benefits and hours of intravenous thrombolysis with recombinant tissue plasminogen activator with in 6 hours of acute ischaemic stroke: a randomised trial. Lancet. 2012;379:2352–63*). Enoxaparin if given within 24–48 h of intracerebral haemorrhage does not increase hematoma size. (*Tertri S, Hakal J, Juvela S, et al. Safety of low dose subcutaneous Enoxaparin for the prevention of venous thromboembolism after primary intracerebral haemorrhage. Thromb Res. 2008;123:206–12*).

35. F T F T F

Dabigatran etexilate is a prodrug that is hydrolysed in stomach. It has bioavailability of 72%. It is direct thrombin inhibitor. The half life is 14–17 h. (*Stangier J, Clemens A. Pharmacology, pharmacokinetics and pharamciodynamics of dabigatran etexilate, an oral direct thrombin inhibitor. Clin Appl Thromb Hemost. 2009;15(S1):9S–16S*). Thrombin time is used for assessing the anticoagulant effect. Ecarin clotting time is the most sensitive assay. (*Miyares MA, Davies K. Newer oral anticoagulants: a review of laboratory monitoring options and reversal agents in the haemorrhagic patient. Am J Health Syst Pharm. 2012;69:1473–84*). There is no effective antidote for dabigatran. Activated charcoal can be used with in 2 h of ingestion. Dialysis may help in removal. Idarucizumab is a monoclonal antibody that bionds to the drug. (*Levy S. Newer available antithrombotics and their antidotes. J Intern Card Electrophysiol. 2014;40:269–75*). Rivaroxaban is a direct factor Xa inhibitor. The effect is maintained for 12 h. Terminal half life is 5.7–9.2 h. This can increase to 11–13 h in elderly due to decrease in renal function. (*Jiang J, Hu Y, Zhang J, et al. Safety, pharmacokinetics and pharmacodynamics of single dose of rivaroxaban- an oral, direct factor Xa inhibitor- in elderly Chinese subjects. Thromb Haemost. 2010;103:234–41*). Rivaroxaban is highly bound to protein and not dialyzable (Table 12.6).

Table 12.5 Time interval before or after neuraxial procedure and epidural catheter

Drug	Half life	European guidelines	Five half-lives
DABIGATRAN	12–17 h 28 h (renal disease)	Contraindicated	85 h
RIVAROXABAN	9–13 h	22–26 h	65 h
APIXABAN	15–23 h	26–30 h	75 h

Table 12.6 Time interval for resumption of drug after neuraxial procedure

Drug	European guidelines
DABIGATRAN	6 h
RIVAROXABAN	4–6 h
APIXABAN	4–6 h

36. F F T T T
Changes in heart rate and blood pressure in response to dressing changes and nursing activity serve as indirect measures of pain. (*Blenkhorn A, Faughnan S, Morgan A. Developing as pain assessment tool for use by nurses in an adult intensive care unit. Intensive Crit Care Nurs. 2002;18:332–41*). Critical illness is not a contraindication for regional anaesthesia. (*Stundner O, Memtsoudis SG. Regional anaesthesia in critically ill patients. Reg Anesth Pain Med. 2012;37:537–44*). Tunnelling of catheters decrease the incidence of infection and epidural placement of catheters can be done with the help of electrical stimulation. (*Tsui BC, Guenther C, Emey D, et al. Determining epidural catheter location using nerve stimulation with radiologic confirmation. Reg Anesth Pain Med. 2000;25:306–9*). Increased serum markers like CRP, procalcitonin and IL-6 indicates bacterial sepsis and can help in decision making for an epidural. (*Luzzoni A, Polati E, Dorizzi R, et al. Comparison of procalcitonin and CRP as markers of sepsis. Crit Care Med. 2003;31:1737–41*).

37. F F T FT F
Complication rate is not increased with the catheter in situ though the catheter placement is increased. (Mean of 5 days). (*Schulz-Stubner S, Czaplik M. Quality management in regional anaesthesia using the example of the regional anaesthesia surveillance system (RASS). Schmerz. 2013;27:56–66*). Spinal cord injury has been reported with interscalene approach in critically ill patients. (*Benumof JL. Permanent loss of cervical cord function associated with interscalene block performed under general anaesthesia. Anesthesiology. 2000;93:1541–4*). Interscalene block may cause blockage of Phrenic nerve and loss of hemidiapgramatic function. Local anaesthetic exerts positive effects in critically ill with regards to analgesia, bronchodilation, neuroproetection, anti inflasmmatory effect, anti arrythemic and antithrombotic effects. Negative effects include neurotoxicity, myotoxicity, inhib ition of wound healing, cardiotoxicity, CNS excitation or depression. (*Zink W, Graf BM, et al. The acute myotoxic effects of bupivicaine and ropivicaine after continuous peripheral nerve blockade. Anesth Analg. 2003;97:1173–9*). The dislodged catheter may be immersed in disinfectant, cut and reconnected if fluid column is static in catheter. Stimulating catheters should never be cut. (*Langerin PB, Gravenstein N, Langerin SO, et al. Epidural catheter reconnection. Safe and unsafe practice. Anesthesiology. 1996;85:883–8*).

38. T F T T T
Withdrawal symptoms begin more rapidly with short acting opioids like heroin and morphine. Some symptoms may last for weeks. (*Farrell M. Opiate withdrawal. Addiction. 1994;89:1471–3*). Methado0ne maintenance program does not show decreased pain prevalence. It is 61% in chronic pain and 37% in severe chronic pain. (*Rosenblum A, Joseph H, Fang C, et al. Prevalence and characteristics of chronic pain among chemically dependent patients in methadone maintenance and residential treatment facilities. JAMA. 2003, 289:2370–8*). Opioid induced hyperalgesia may present as hypersensitivity to painful stimuli. (*Angst MS, Clark JD. Opioid induced hyperalgesia: a qualita-*

tive systematic review. Anesthesiology. 2006;104:570–87). The mechanisms of opioid induced hyperalgesia include tolerance and down regulation of opioid receptors. (*Bailey CP, Connor M. Opioids: cellular mechanisms of tolerance and physical dependence. Curr Opin Pharmacol. 2005;5:60–8*). There is activation of NMDA receptors (glutamate receptors), inhibition of glutamate reuptake and activation of protein kinase c. (*Silverman S. Opioid induced hyperalgesia: clinical implications for the pain practitioner. Pain. Physician 2009;12:679–84*).

39. T T F T

Ketamine decreases the analgesic tolerance and development of opioid induced hyperalgesia. (*Joly V, Richebe P, Guignord B, et al. Remifentanil induced post operative hyperalgesia and its prevention with small dose Ketamine. Anesthesiology. 2005;103:147–55*). Mostly methadone or burpenorphine is used for treating opioid abuse and have no analgesic effect because of tolerance. The half life of methadone is 12–28 h. It has a biphasic elimination curve with rapid alpha elimination phase followed by longer beta elimination phase. For withdrawal prevention, once daily dosing is sufficient. Analgesic effects may need more frequent dosages. (*Bart G. Maintenance medication for opiate addiction: the foundation of recovery. J Addict Dis. 2012;31:207–25*). Inhibition of methadone metabolism causes side effects like respiratory depression and sedation. It also prolongs QT interval. (*Ferrari A, Coccia CP, Bertolini A, et al. Methadone metabolism, pharmacokinetics and interactions. Pharmacol Res. 2004;50:551–9*).

40. T F T F T

High dose opioids are risk factors for toxicity with methadone. (*Traftan JA, Ramani A. Methadone: a new old drug with promises and pitfalls. Curr Pain Headache Rep. 2009;13:24–30*). Buprenorphine has a half life of 37 h, so can be used as once daily dosage. Buprenorphine has 1000 times the affinity for μ receptors and may precipitate withdrawal as it displaces opioids from receptors. (*Bryson EO, Lipson A, Gerirtz C. Anaesthesia for patients on buprenorphine. Anesthesiol Clin. 2010;28:611–7*). Burpenorphine has long half life and high affinity making the opioid receptor binding high and interfering with analgesia. The options available are:

- Continue buprenorphine and add short acting opioid.
- Divide buprenorphine dosage and administer every 6–8 h with an additional opioid.
- Discontinue buprenorphine and restart after surgery with intra-operative analgesia.
- Convert buprenorphine to methadone and short acting opioid.

(*Alford DP, Compton P, Samet JH. Acute pain management for patients receiving maintenance methadone and buprenorphine treatment. Ann Intern Med. 2006;144:127–34*). Patients abusing illicit opioids should be given intravenous or oral doses of methadone or morphine as baseline. (*Rubenskin RB, Spira I, Wolff WI. Management of surgical patients on methadone maintenance. Am J Surg. 1976;131:566–9*).

41. F T T F F

77% of patients with acute pain in trauma will have pain at the end of 3 months (chronic post traumatic pain). Risk factors include age, co morbidity, depression, anxiety, alcohol and tobacco consumption. Most associated is intensity of acute pain at the time of the surgery. Regional anaesthesia has poor preventive role. (*Radressa O, Chaung JM, Lavigne G, et al. Current views on acute to chronic pain transition in post traumatic patients: risk factors and potential for pre emptive treatments. J Trauma Acute Care Surg. 2014;76:1142–50.*) Trauma patients are more likely to get peripheral nerve block catheters then elective patients. (*Capdevilla X, Bringuier S, Borgeat A. Infectious risk of continuous peripheral nerve blocks. Anesthesiology. 2009;110:182–8*). Risk factors for catheter infection include prophylactic antibiotics, catheter duration more than 48 h, insertion at femoral or axillary location and frequent dressing changes. (*Morin AM, Kerwat KM, Klatz M, et al. Risk factors for bacterial catheter colonisation in regional anaesthesia. BMC Anesthesiol. 2005;5:1*). Repetitive movement of a catheter with an internal metal coil results in microhematoma formation providing culture media for bacteria. Femoral nerve block decreases intensity of pain in hip fracture. (*Temelkovska-skranovska M, Durner V, et al. Continuous femoral nerve block versus fascia iliaca compartment block as post operative analgesia in patients with hip fracture. Prilozi. 2014;35:85–94*).

42. FT T F F

Fascia iliaca block does not provide same degree of pain relief as femoral nerve block. (*Newman B, McCarthy L, Thomas PW, et al. A comparison of preoperative nerve stimulator guided femoral nerve block and fascia iliaca compartment block in patients with a femoral neck fracture. Anaesthesia. 2013;68:899–903*). Delirium is an independent risk factor for death and the risk factors for delirium include severe pain and use of opioids. (*Mareantonio ER, Flacker JM, Michaels M, et al. Delirium is associated independently with poor functional recovery after hip fracture. J Am Geriatr Soc. 2000;48:618–24*). Neuraxial anaesthesia in hip fracture decreases mortality, decrease the incidence of deep venous thrombosis, confusion post operatively, post operative hypoxia, pneumonia and fatal pulmonary embolism. (*Luger TJ, Kammerlander C, Gosch M, et al. Neuraxial versus general anaesthesia in geriatric patients for hip fracture surgery: does it matter? Osteoporos Int. 2010;21(suppl4):S555–72*). Thoracic epidural decreases the risk of pneumonia and number of days spent on ventilator. (*Pierre E, Martin P, Frohock J, et al. Lumbar epidural morphine versus patient controlled analgesia morphine in patients with multiple rib fractures. Anesthesiology. 2005;103:A289*). Continuous paravertebral catheter infusion has same efficacy as thoracic epidural infusion in rib fracture with regards to increased respiratory function, decrease in pulmonary complications. The advantage of paravertebral catheter is long duration analgesia. (*Mohta M, Verma P, Saxena AK, et al. Prospective randomised comparison of continuous thoracic epidural and thoracic paravertebral infusion in patients with unilateral multiple fractured ribs- a pilot study. J Trauma. 2009;66:1096–101*).

43. F T F F F
Neuraxial techniques are not common in cardiac surgery because of potential risks of epidural hematoma and subsequent adverse neurological sequalae. (*Chancy MA. Intrathecal and epidural anaesthesia and analgesia for cardiac surgery. Anaesthesia. 2003;58:365–70*). High thoracic epidural allows faster recovery and extubation after surgery and improves respiratory muscle strength. (*Tenling A, Joachimsson P-O, Tyden H, et al. Thoracic epidural analgesia as an adjunct to general anaesthesia for cardiac surgery. Effects on pulmonary mechanics. Acta Anaesthesiol Scand. 2000;44:1071–6*). High thoracic epidural between T1 and T5 causes sympatholysis and dilates the coronary arteries and the internal mammary arteries and thus improves perfusion. (*Nygard E, Kofoed KF, Freiberg J, et al. Effects of high thoracic epidural analgesia on myocardial blood flow in patients with ischaemic heart disease. Circulation. 2005;111:2165–70*). High thoracic epidural anaesthesia improves pulmonary function without affecting ventilation perfusion ratio and thus assists in early weaning and extubation. There is also decrease in post operative pulmonary dysfunction. (*Djaiani G, et al. Thoracic epidural anaesthesia as an adjunct to general anaesthesia for cardiac surgery: effects on ventilation perfusion relationships. J Cardiothorc Vasc Anaesth. 2000;14:359–60*). High thoracic epidural does not affect the time spent in ICU. (*Nielson DV, Bhavsar R, Nielson DN, et al. High thoracic epidural analgesia in cardiac surgery: part 2 high thoracic epidural analgesia does not reduce time in or improve quality of recovery in the intensive care unit. J Cardiothorac Vasc Anesth. 2012;26:1048–54*).

44. T F F T T
High thoracic epidural has been shown to improve depression in cardiac surgery. (*Royse C, Remedios C, Royse A, et al. High thoracic epidural analgesia reduces the long term depression in patients undergoing coronary artery bypass surgery. Ann Thorac Cardiovasc Surg. 2007;13:32–5*). Maximum pain is seen within 48 h after the cardiac surgery, so epidural analgesia is used for 3 days. (*Roediger L, Larbuisson R, Lamy M, et al. New approaches and old controversies to post operative pain control following cardiac surgery. Eur J Anaesthesiol. 2006;23:539–50*). The incidence of epidural abscess after thoracic epidural is 0.04–0.6%. (*Grewal S, Hocking G, Wildsmith JA, et al. Epidural abscesses. Br J Anaesth. 2006;96:292–302*). Benefits of awake cardiac surgery include:
- Better post operative pain relief.
- Shorter ICU stay.
- Avoidance of general anaesthesia.
- Faster mobilisation.
- Increased patient acceptance.

(*Bottio T, Bisleri G, Piccoli P, et al. Heart valve surgery in a very high risk population: a preliminary experience in awake patients. J Heart Valve Dis. 2007;16:187–94*). Paralysis of diaphragm may be seen with high thoracic epidural with spread to C5/6. (*Kessler P, Aybek T, Neidhart G, et al. Comparison of three anaesthetic techniques for off pump coronary artery bypass grafting:*

general anaesthesia, combined general and high thoracic epidural anaesthesia or high thoracic epidural anaesthesia alone. J Cardiothorac Vasc Anaesth. 2005;19:32–9). Side effects of awake cardiac surgery:

- Insufficient analgesia.
- Increased motor block
- Haemodynamic changes.
- Phrenic nerve palsy.

45. T F F F T

Spinal anaesthesia has been used for cardiac surgery especially the patients undergoing CABG. It provides prolonged profound analgesia. It also attenuates sympathetic autonomic activity. (*Lena P, Balarac N, Arnulf JJ, et al. Intrathecal morphine and clonidine for coronary artery bypass grafting. Br J Anaesth. 2003;90:300–3*). Intrathecal opioids does not alter the sympathetic response to cardiac surgery. This effect is seen only with intravenous opioids. (*Lee TW, Grocott HP, Schwinn D, et al. High spinal anaesthesia for cardiac surgery: effects on beta adrenergic receptor function, stress response and hemodynamics. Anesthesiology. 2003;98:499–510*). Most catheter associated hematoms are associated with catheter removal (50%). (*Vandermeulen EP, Van Aken H, Vermylen J, et al. Anticoagulants and spinal epidural anaesthesia. Anesth Analg. 1994;79:1165–77*). Paravertebral block has been used for thoracoscopic access. Side effects include hypotension, blood vessel puncture (5%), Failure rate (10%), Pneumothorax (0.4–4%). *(Naja Z, Lonnqvist PH, et al. Somatic paravertebral nerve blockade. Incidence of failed block and complications. Anaesthesia. 2001;56:1184–8*). Increased bronchial tome and reactivity is seen with thoracic epidural because of unopposed vagal tone. (*Groeben H, Schwalen A, Irsfeld S, et al. High thoracic epidural anaesthesia does not alter airway resistance and attenuates the response to an inhalational provocation test in patients with bronchial hyperactivity. Anesthesiology. 1994;81:868–74*).

46. F F F F T

High thoracic epidural decreases the vital capacity and decrease in FEV1. (*Sundberg A, Wattwil M, Arvill A, et al. Respiratory effects of high thoracic epidural anaesthesia. Acta Anaesthesiol Scand. 1986;30:215–7*). Thoracic epidural does not increase the shunt fraction in one lung anaesthesia. (*Garutti I, Cruz P, Olmedilla L, et al. Effects of thoracic epidural Meperidine on arterial oxygenation during one lung ventilation in thoracic surgery. J Cardiothorac Vasc Anaesth. 2003;17:302–5*). Thoracic epidural has a failure rate to the extent of 10%. (*Mcleod G, Danes H, Munnoch N, et al. Post operative pain relief using thoracic epidural analgesia: outstanding success and disappointing factors. Anaesthesia. 2001;56:75–81*). Adjuvants do not increase the efficacy when added to paravertebral block. (*Kotze A, Seally A, Howett S, et al. Efficacy and safety of different techniques of paravertebral block for analgesia after thortacotomy: a systemic review and metaregression. Br J Anaesth. 2009;103:626–36*).

47. T T F T T

Pain in emergency department is undertreated and may lead to anxiety, depression, sleep disturbance, increased oxygen demand and increased deep venous thrombosis. (*Rupp T, Delaney KA. Inadequate analgesia in emergency medicine. Ann Emerg Med. 2004;43:494–503*). Young children and elderly patients are more prone to oligoanalgesia. (*Jones JS, Johnson K, McNinch M. Age as a risk factor for inadequate emergency department analgesia.Am J Emerg Med. 1996;14:157–60*). Gender does not influence the quality of analgesia. (*Raftery KA, Smith-Coggins R, Chen AH. Gender associated differences in emergency department pain management. Ann Emerg Med. 1995;26:313–21*). 11 point numerical rating scale (NRS) have been shown to be reliable. Other scale used is visual analogue scale. (*Bijur PE, Latimer CT, Gallaghar EJ. Validation of a verbally administered rating scale of acute pain for use in the emergency department. Acad Emerg Med. 2003;10:390–2*). Measurement of pain increases the efficacy of pain management. (*Nelson BP, Cohen D, Lander O, et al. Mandated pain scales improve frequency of emergency department analgesic administration. Am J Emerg Med. 2004;22:582–5*).

48. T F T F T

Ketamine does not cause sedation at a dose of less than 0.3 mL/kg. (*Herring AA, Ahern T, Frazee B. Emerging application of low dose Ketamine for pain management in the emergency department. Am J Emerg Med. 2013;31:416–9*). The dosage of Ketamine should be reduced in traumatic brain injury as its effect is still not certain. (*Cohen L, Athaide V, Wickham ME, et al. The effect of Ketamine on intracranial and cerebral perfusion pressure and health outcomes: a systemic review. Ann Emerg Med. 2015;65:43–51*). Nitrous oxide can be used in emergency department especially in paediatric population. (*Tobias JD. Application of nitrous oxide for procedural sedation in the paediatric population. Paediatr Emerg Cave. 2013;29:243–65*). Nitrous oxide allows controlled depth of sedation with faster recovery times. (*Lee JH, Kim K, Kim TY, et al. A randomnised comparison of nitrous oxide versus intravenous Ketamine for laceration repair in children. Pediatr Emerg Care. 2012;28:1297–301*). Mostly ethyl chloride is used as vapocoolant. It is sprayed until skin blanches for upto 10seconds. It lasts for upto 1 min after spray. (*Yun Z, Xue P, Shuang W, et al. Vapocoolant spray versus placebo spray/ no treatment for reducing pain from intravenous cannulation: a metanalysis of randomnised controlled trials. Am J Emerg Med. 2018;36(11):2085–92*).

49. T F F T F

Bupivicaine is more lipophillic and has greater affinity for voltage gated sodium channels. (*Heavner JE. Cardiac toxicity of local anaesthetics in there intact isolated heart model: a review. Reg Anesth Pain Med. 2002;27:545–55*). Toxicity with local anaesthetics can occur at low serum levels as local anaesthetics accumulate in mitochondria and cardiac tissue. (*Hiller N, Mirtschnik P, Merkel C, et al. Myocardial accumulation of bupivicaine and ropivicaine is associated with reversible effects on mitochondria and decreased myocardial function. Anesth Analg. 2013;116:83–92*). Toxicity may be delayed for 1 h.

(*DiGregrio, Neal JM, Rosenqvist RW, et al. Clinical presentation of local anaesthetic systemic toxicity: a review of published cases. 1979–2009. Reg Anesth Pain Med. 2010;35:181–7*). LAST is seen mostly with paravertebral block followed by trunk and block of lower extremity. (*Borrington MJ, Kluger R. Ultrasound guidance reduces the risk of local anaesthetic systermic toxicity following peripheral nerve blockade. Reg Anesth Pain Med. 2013;38:289–99*). Decreased levels of albumin increase levels of free drug and increases toxicity. (*Calenda E, Baste JM, Hajjci R, et al. Toxic plasma concentration of ropivicaine after a paravertebral block in a patient suffering from severe hypoalbuminemia. J Clin Anesth. 2014;26:149–51*).

50. T T T T F

Incidence of LAST is more with epidural anaesthesia because of the volume injected. Then incidence is 0.1/1000 while the incidence with the peripheral nerve blocks is 0.08–0.98/1000. (*Brown, Ransom DM, Hall JA, et al. Regional anaesthesia and local anaesthetic induced systemic toxicity. Seizure frequency and accompanying cardiovascular changes. Anesth Analg. 1995;81:321–8*). High incidence of LAST is seen with retrobulbar blocks causing mental status alteration, apnea and seizures. (*Dahle JM, Iserson KV. ED treatment of brainstem anaesthesia after retrobulbar. Am J Emerg Med. 2007;25:105–6*). Overloading cells with exogenous fatty acids by infusing a lipid emulsion decreases lipid toxicity. (*Ozcan MS, Weinberg G. Update on the use of lipid emulsions in local anaesthetic systemic toxicity: a focus on differential efficacy and lipid emulsion as part of advanced cardiac life support. Int Anesthesiol Clin. 2011;49:91–103*). Lipid emulsion takes up lipophilic moieties and transfers them for detoxification (scavenging effect). (*Kuo IK, Akpa BS. Validity of the lipid sink as a mechanism for the reversal of local anaesthetic systemic toxicity. Anesthesiology. 2013;118:1350–61*). Lipid emulsion also exerts its effect by increased cardiac output and direct cardiotoxic effect. (*Fettiplace MR, Akpa BS, Ripper R, et al. Resuscitation with lipid emulsion: dose dependent recovery from cardiac pharmacotoxicity requirement. A cardiotoxic effect. Anesthesiology. 2014;120:915–25*). Lipid emulsion has a risk of causing death in children due to fat accumulation in lungs. (*Brull SJ. Lipid emulsion for the treatment of local anaesthetic toxicity: patient safety implications. Anesth Analg. 2008;106:1337–9*). Lipid emulsion can be safely given via interosseous route. *(Fettiplace MR, Ripper R, Lis K, et al. Intraosseous lipid emulsion: an effective alternative to intravenous delivery in emergency situation. Crit Care Med. 2014;42:157–60*) (Table 12.7).

51. T T F T T

The cardiac output increase by 15–25%. The increase in heart rate is seen which further leads to increase in cardiac output. It is due to the effect of oestrogen, progesterone and prostyacyclin. (*Goodman RP, Killom AP, Brash AR, et al. Prostacyclin production during pregnancy: comparison of production during normal pregnancy and pregnancy complicated by hypertension. Am J Obstet Gynecol. 1982;142:817*) (Table 12.8).

Table 12.7 Local anaesthetic systemic toxicity

Local anaesthetic systemic toxicity	
CNS toxicity	CVS toxicity
Perioral tingling	Hypotension
Dizziness	Peripheral vasodilation
Tinnitus	Bradycardia, dysrhythmias
Agitation	
Slurred speech	
Shivering	
Respiratory arrest	

Table 12.8 Physiologic changes in pregnancy

Physiologic changes in pregnancy		
Parameter	Change	Amount
Total blood volume	Increase	25–30%
Plasma volume	Increase	40–50%
Cardiac output	Increase	30–50%
Minute ventilation	Increase	50%
Alveolar ventilation	Increase	70%
Functional residual capacity	Decrease	20%
Oxygen consumption	Increase	20%
Minimum alveolar concentration	Decrease	30–40%

Uterine tilt after neuraxial anaesthesia is more effective when the mother is placed in full lateral position and then is turned onto the pelvic wedge. (*Kundra P, Velraj J, Amirthalingam U, et al. Effect of positioning from supine and kleft lateral position to left lateral tilt on maternal blood flow velocities and waveforms in full term parturients. Anaesthesia. 2012;67:889–93*). Pregnancy causes the QRS axis to shift to right in the first trimester and rotating to left axis by the end of third trimester. This is due to the expanding uterus. There is also decrease in PR and QT intervals. (*Carruth JE, Mivis SB, Brogan DR, et al. The electrocardiogram in normal pregnancy. Am Heart J. 1981:102:1075–8*). The minute ventilation increases by 50% above normal by term. The tidal volume is increased by 40% and alveolar ventilation by 70%. These changes are due to progesterone and return to normal after delivery. There is decrease in expiratory residual volume, functional residual capacity and decrease in residual volume. Total lung capacity remains unchanged. The oxygen consumption increases by 20% whereas the $PaCO_2$ decreases and PaO_2 increases. There is thus no alteration in pH.

52. T T T T F

An increase in progesterone causes a decrease in gastrointestinal mobility and slows absorption of food. Decreased lower oesophageal sphincter tone is seen. (*Wong CA, Loffredi M, Ganchiff JN, et al. Gastric emptying of water in term pregnancy. Anesthesiology. 2002;96:1395–1400*). Plasma volume (40–50%)

and total blood volume (25–40%) increase during pregnancy. This is due to increase in mineralocorticoid activity causing sodium retention and increased body water content. The result is a decrease in haemoglobin along with a decrease in haematocrit. Platelet count stays unchanged. Pregnancy causes an increase of plasma fibrionogen by 50%. There is also increase in Factor I, VII, VIII, IX, X, XII. (*Gerbasi FR, Buttoms S, Farag A, et al. Increased intravascular coagulation associated with pregnancy. Obstet Gynecol. 1990;75:385–9*). Local anaesthetic sensitivity is increased in pregnancy. This is due to progesterone mediated increase in neural sensitivity. (*Dalta S, Lambert DH, Gregus J, et al. Differential sensitivities of mammalian nerve fibres during pregnancy. Anesth Analg. 1983;62:1070*). Minimum alveolar concentration of inhalational agents is decreased by 8–12 weeks of gestation and is due to an increase in progesterone. (*Gin T, Chan MTV. Decreased minimum alveolar concentration of isoflurane in pregnant humans. Anesthesiology. 1994;81:829*).

53. T F T F F

Foetal acidosis causes the drug to be in ionised form which cannot diffuse back across the placenta. Large amount of local anaesthetic gets trapped in foetal plasma and tissues (ion trapping). (*Brown WU, Bell GC, Alper MH. Acidosis, local anaesthetic and the newborn. Obstet Gynecol. 1976;48:27*). Elimination half life of bupivicaine remains the same in pregnant and non pregnant females. (*Pihlajamaki K, Kanto J, Lindberg R, et al. Extract: oral administration of bupivicaine: pharmacokinetics and metabolism in pregnant and non pregnant women. Br J Anaesth. 1990;64:556*). The changes seen in newborn neurologic and adaptive function are minor and transient lasting for up to 48 h. (*Brockhurst NJ, Littleford JA, Halpern SH. The neurological and adaptive capacity score: a systematic review of its use in obstetric anesthesia research. Anesthesiology. 2000;92:237*). The first stage of labour involves dilatation of cervix and distension of lower uterine segment. Early labour involves T11–T12 and with progressive cervical dilatation T10–L1 is involved. The second stage involves distension of vaginal vault and perineum involving S2–S4. Single dose and patient controlled analgesia Fentanyl is safe to use in pregnancy. (*Morley-Foster PK, Reid DW, Vandeberghe H. A comparison of patient controlled analgesia Fentanyl and Alfentanil for labour analgesia. Can J Anaesth. 2000;47:113–9*) (Table 12.9).

54. T T F T T

Remifentanil is rapidly metabolised by serum and tissue cholinesterases and has a short context sensitive half time. It has minimal effect on neonate. *(Evron*

Table 12.9 Nueraxial opioid administration

Neuraxial opioid administration		
Opioid	Spinal dose	Epidural dose
Morphine	0.1–0.2 mg	2–5 mg
Diamorphine	0.25–1 mg	2–5 mg
Fentanyl	10 μg	50 μg
Meperidine	10 mg	50 mg

S, Glezerman M, Sadan O, et al. Remifentanil: a novel systemic analgesic for labour pain. Anesth Analg. 2005;100:233–8). Remifentanil can cause hypoventilation and hypotension. (*Volmanen P, Akurel E, Raudaskoski T, et al. Comparison of remifentanil and nitrous oxide in labour analgesia. Acta Anaesthesiol Scand. 2005;49:453–8*). Early initiation of epidural during latent phase of labour (2–4 cm) may cause prolongation of second stage of labour and increased incidence of dystocia. (*Halpern SH, Leighton BL, Ohlsson A, et al. Effect of epidural versus parenteral opioid analgesia in the progress of labour. A meta analysis. JAMA. 1998;280:2105*). An ultradilute local anaesthetic solution with opioid can be used to avoid prolonged second stage of labour. (*Chestnut DH, Laszeski LJ, Pollock RL, et al. Continuous epidural infusion of 0.0625% bupivicaine- 0.0002% Fentanyl during the second stage of labour. Anesthesiology 1990;72:613*). Patient controlled epidural anaesthesia requires few anaesthetic interventions. (*Halpern S. Recent advances in patient controlled epidural analgesia for labour. Curr Opin Anaesthesiol. 2005;18:247–51*) (Table 12.10).

55. T F F T F

Combined spinal epidural has an early onset than epidural in labour. (*Simons SW, Cyna AM, Dennis AT, et al. Combined spinal epidural versus epidural analgesia in labour. Cochrane fatabase Syst Rev. 2007;3:CD003401*). Intrathecal opioids cause more Pruritus. (*Labenne I, Gharsallah H, Abderrahaman A, et al. Effects of 15micrograms intrathecal clonidine added to bupivicaine and Sufentanil for labour analgesia. Tunis Med. 2011;89:853–9*). Early administration of combined spinal epidural does not increase the caesarean section rate. (*Wong CA, Scavone BM, Peaccinan AM, et al. The risk of caesarean section delivery with neuraxial analgesia given early versus late labour. N Engl J Med. 2005;352:655*). Spinal anaesthesia may cause decrease in maternal catecholamines. This causes uterine hyper stimulation and causes transient non reassuring foetal heart rate patterns. (*Clarke VT, Smiley RM, Finster M. Uterine hyperactivity after intrathecal injection of Fentanyl for analgesia during labour. A cause of foetal bradycardia? Anesthesiology. 1994;81:1083*). Foetal heart rate abnormalities are seen more in multiparous females with a rapidly progressing labour. (*Riley ET, Vogel TM, El-Sayed YY, et al. Patient selection bias contributes to an increased incidence of foetal bradycardia after combined spinal epidural analgesia for labour. Anesthesiology. 1999;91:A1054*) (Table 12.11).

Table 12.10 Opioids for PCA

PCA opioids			
Drug	Bolus (mg)	Interval (min)	Background infusion (mg/h)
Fentanyl	0.01–0.5	3–5	0.02
Morphine	1–1.5	5	1–2
Meperidine	5–10	6	5–10

Table 12.11 Side effects of neuraxial opioids

Neuraxial opioids-side effects		
Side effect	Treatment	Dose
Pruritus	Naloxone Propofol	0.04–0.8 mg iv 10 mg iv
Nausea and vomiting	Cyclizine Ondansetron Metoclopramide dexamethasone	50 mg iv 4 mg iv 10 mg iv 5–10 mg iv
Respiratory depression	Naloxone	0.2–0.4 mg iv

56. F F F F F

Combined spinal epidural anaesthesia does not increase the emergency caesarean section. (*Albright GA, Forester RM. Does combined epidural analgesia with subarachnoid Sufentanil increase the incidence of emergency caesarean section. Reg Anesth. 1997;22:400*). Incidence of headache is the same with combined spinal epidural as compared to standard epidural. (*Norris MC, Gricco WM, Barkowski M, et al. Complication of labour analgesia: epidural versus combined spinal epidural techniques. Anesth Analg. 1995;79:529*). Epidural drug requirements decrease up to 30% with combined spinal epidural than standard lumbar epidural. (*Leighton BL, Arkoush VA, Huffnagle S, et al. The dermatomal spread of epidural bupivicaine with and without prior intrathecal Sufentanil. Anesth Analg. 1996;83:526*). Paracervical block may cause foetal bradycardia due to uterine bradycardia due to uterine artery constriction or uterine tone. (*Baxi LV, Petrie RH, James LS. Human foetal oxygenation following paracervical block. Am J Obstet Gynecol. 1979;135:1109*). L-Bupivicaine causes less foetal bradycardia. (*Palomaki O, Huhtala H, Kirkinen P. A comparative study of the safety of 0.25% levobupivicaine and 0.25% racemic bupivicaine for paracervical block in the firts stage of labour. Acta Obstet Gynecol Scand. 2005;84:956–61*).

57. T F T F F

Lumbar sympathetic block has been found to be effective for the first stage of labour analgesia. The block has a more rapid rate of cervical dilatation and shortens second stage of labour. (*Leighton BL, Halpern SH, Wilson DB. Lumbar sympathetic block speeds early and second stage induced labour in nulliparous women. Anesthesiology. 1999;90:1039–46*). Pudendal nerve block can be used for episiotomy and repair. (*Pace MC, Aurilio C, Bulletti C, et al. Subarachnoid analgesia in advanced labour: a comparison of subarachnoid analgesia and pudendal nerve block in advanced labour. Amalgesic quality and obstetric outcome. Ann NY Acad Sci. 2004;1034:356–63*). Prehydrating before intrathecal injection is equally effective as compared to coloading. (*Dyer RA, Farina Z, Joubert IA, et al. Crystalloid preload versus rapid crystalloid administration after induction of spinal anaesthesia for elective caesarean section. Anesth Intensive Care. 2004;32:35–7*). Intrathecal clonidine improves intraoperative

analgesia and shivering. (*Roelants F. The use of neuraxial adjuvant drugs (Neostigmine,Clonidine) in obstetrics. Curr Opin Anaesthesiol. 2006;19:233–7*).

58. F T T F F

Ropivicaine has slow onset of motor block, so even if placed intrathecally, immediate confirmation is not possible. (*Ngankee WD, Khaw KS, Lee BB, et al. The limitation of ropivicaine with epinephrine as an epidural test in parturients. Anesth Analg. 2001;92:1529–31*). EDTA is present in 2chlorprocaine. This induces leaching of calcium from paravertebral muscles causing pain. (*Hynson JM, Sessler DI, Glosten B. Back pain in volunteers after epidural anaesthesia with chlorprocaine. Anesth Analg. 1991;72:253*). Epidural Fentanyl has activity at both spinal and supraspinal sites of action. (*Ginsar Y, Riley ET, Anst MS. The site of action of epidural Fentanyl in humans: the difference between infusion and bolus administration. Anesth Analg. 2003;97:1428–38*). Intrathecal catheter does not decrease the incidence of headache or the need for blood patch. (*Russell IF. A prospective controlled study of continuous spinal analgesia versus repeat epidural analgesia after accidental dural puncture in labour. Int J Obstet Anesth. 2012;21:7–16*).

59. F F F T F

Preeclampsia is proteinacious increase in blood pressure. Presence of oedema is not a required criteria. Blood pressure more than 15% of the baseline is diagnostic. (*Bodurka D. Whats new in gynecology and obstetrics. J Am Coll Surg. 2005;201:265–74*). Bleeding time is prolonged in 25% of normal patients. (*Rodgers R, Levin J. A critical reappraisal of the bleeding time. Semin Thromb Hemost. 1990;16:1–20*). Antihypertensives are used to lessen the risk of cerebral haemorrhage and there is no evidence of delay in disease progression or improved perinatal outcome. (*Abatos E, Duley L, Steyn DW, et al. Antihypertensive drug therapy for mild to moderate hypertension during pregnancy. Cochrane Database Syst Rev. 207;1:CD002252*). Epidural anaesthesia improves intervillous blood flow by 75%. (*Jouppila P, Jouppila R, Hollmen A, et al. Lumbar epidural analgesia to improve intervillous blood flow during labour in severe pre eclampsia. Obstet Gynecol. 1982;52:158*). Mild impairment of cognition is seen with those born under general anaesthesia as compared to regional anaesthesia. (*Sprung J, Fleich RP, Wilder RT, et al. Anaesthesia for caesarean delivery and learning disability in a population based birth cohort. Anesthesiology. 2009;111:302–10*).