Solved Papers
Anesthesia
for PG Students

A must for MD and DNB Students

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Contents

CHAPTER

11 Central Neuraxial Block

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Q1. Spinal-induced hypotension. *(DNB June 2022) (5)*

Ans.

Mechanism of hypotension:

Blockade of the sympathetic chain which leads to the cardiovascular changes.

The height of the block determines the level of sympathetic block which leads to the cardiovascular changes. Higher levels of blockade can result in loss of compensatory mechanisms and collapse of the cardiorespiratory system.

The sympathetic system block is sudden and does not give ample time for the cardiovascular system to compensate hence the hypotension is rapid in onset.

Reduction in cardiac output: The sympathetic block causes hypotension by affecting the pre-load, afterload, contractility and heart rate and by decreasing systemic vascular resistance.

Pooling of blood and decreased venous return due to venous dilation. Loss of sympathetic arterial vascular tone leads to arterial vasodilation.

Activation of cardio-inhibitory receptors

Patient positioning, aortocaval compression influences the venous return during spinal anesthesia.

Methods to reduce/treat spinal induced hypotension:

1. Lateralizing the spinal block to one side if possible (orthopedic cases)
2. Titrating the spinal anesthesia dose by using a catheter
3. Patient positioning to limit aortocaval compression
4. Assess patient's volume status and preload with fluid—colloid preloading has shown to be more effective than crystalloid preloading. Concurrent administration of fluids along with SA can also be used if patient is euvolemic
5. Vasopressors (phenylephrine, ephedrine and norepinephrine) are used to treat spinal-induced hypotension.

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2. Hadzic A. Part 3: Clinical practice of regional anaesthesia, Chapter 23 Spinal Anaesthesia. In: Chin A, Zundart AV (Eds). Hadzic's Textbook of regional Anaesthesia and acute pain management, 2nd edition. New York: McGraw Hill; 2022. pp. 344-7.

Q2. Adjuvants for regional anesthesia for pediatric patients. *(DNB June 2018) (5)*

Ans.

Various adjuvants have been used in regional anesthesia for pediatric patients:

1. **Opioids**
   - Enhance the effects of local anesthetics and prolong analgesia.
   - Can be used in caudal analgesia, spinal anesthesia and regional blocks
   - *Mechanism of action:* Centrally mediated antinociception and peripheral attenuation of substance P release.
   - Fentanyl, Morphine, and Buprenorphine (perineural) have been used.

- *Caudal dose:* Fentanyl (2 mcg/kg), Morphine (30–90 mcg/kg)
- *Side effects:* Potential risk for respiratory depression.

2. **Clonidine**
   - It enhances the analgesic effect and prolongs the duration of action of local anesthetics.
   - *Mechanism of action:* Alpha-2 receptor agonist inhibits the action potential in A-delta and C-fibers that carry pain sensation in the spinal cord and inhibits the release of Substance P and Glutamate.
   - *Caudal dose:* 1–5 mcg/kg
   - *Side effects:* Higher doses have been associated with sedation and hemodynamic instability
3. **Dexmedetomidine**
   - A more recent added drug which produces not only profound analgesia but causes sedation as well with very few adverse effects
   - *Mechanism of action:* Same as Clonidine
   - *Dose:* 0.6–0.9 mcg/kg/block
   - *Side effects:* Higher doses can cause bradycardia and hypotension
4. **Ketamine**
   - S-ketamine to single injection caudal block prolongs the analgesic effect of local anesthetics.
   - Ketamine and clonidine have shown to provide postoperative analgesia for up to 20 hours on caudal administration
   - *Mechanism of action:* NMDA receptor antagonist attenuates pain and reduces the glutamate action on the peripheral nerve fibers which are nociceptive in nature.
   - *Caudal dose:* 0.25–1 mg/kg
   - *Side effects:* Psychomimetic effects.
5. **Dexamethasone**
   - Improves the quality of the block administered as well as increases the duration of peripheral nerve block.
   - *Mechanism of action:* Inhibits the release of inflammatory mediators and reduces the neuronal discharge of nociceptive C fibers.
   - *Dose:* 1–2 mg/block

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2. Hadzic A. Chapter 9: Analgesic Adjuvants in the peripheral nervous system. In: McCartney CJL, Choi S (Eds). Hadzic's Textbook of regional Anaesthesia and acute pain management, 2nd edition. New York: McGraw Hill; 2022. pp. 149- 54.
3. Hadzic A. Chapter 43: Paediatric Epidural and Spinal Anaesthesia & Analgesia. Hadzic's Textbook of regional Anaesthesia and acute pain management, 2nd edition. New York: McGraw Hill; 2022. pp. 809-10.
4. Tafoya SP, Tumber SS. The use of multimodal perineural adjuvants in paediatric peripheral nerve blocks: Technique and experiences. Cureus. 2022;14(3):e23186.

Q3. Inadvertent total spinal block. *(WBUHS June 2021) (5)*

Or

Q. What is total spinal? What is the management? *(WBUHS DA 2018) (2 + 8)*

Or

Q. How do you diagnose a case of total spinal? Describe its management. *(WBUHS May 2023) (2 + 3)*

Ans.

Total spinal is the spread of local anesthetic agent far into the subarachnoid space affecting the brainstem and involving the cranial nerves.

Occurrence: Total spinal block can be caused during/after administration of spinal anesthesia, epidural anesthesia, caudal anesthesia, cervical plexus block, and interscalene brachial plexus block.

It is one of the major complications of a central neuraxial block or brachial plexus block.

Mechanism: The mechanism is unclear of the occurrence of total spinal anesthesia but is usually the local anesthetic agents entering into higher centers via the subarachnoid space.

Etiological factors

- *Dose of local anesthetic:* Estimation of the dose of local anesthetic is based on the type and extent of surgery, patient anatomy, technique of injection, etc. Also, the physiological status of the patient influences the dose requirement like height of the patient, obesity, pregnancy. Required dose of drug is much less in obesity, pregnancy comparing to others due to reduced central neuraxial compartment size, owing to increased intra-abdominal pressure and engorgement of epidural veins. Administration of higher dose of drug may result in high spinal anesthesia.
- Positioning of the patient—for hyperbaric drugs position can influence spread of the drug according to gravity, like making the patient head down following administration of neuraxial block results in cephalad spread of the drug.
- Preexisting epidural block—after recent epidural top up resulting in expansion of epidural space with compression of subarachnoid space, administration of spinal anesthesia can result in unexpected high block.
- Unrecognized dural puncture and intrathecal injection of local anesthetic following epidural top up.
- Accidental subdural block

Preventive measures

Stringent monitoring following administration of neuraxial anaesthesia as well as awareness regarding signs and symptoms of high spinal anesthesia is the most important preventive measure. The anesthesiologist must remain vigilant throughout with continual assessment of progression of the block.

During epidural analgesia/anesthesia:

- For labor analgesia, use of low concentration of local anesthetic.
- Prior to top-up assessment of block to guide the dose.
- Aspiration of epidural catheter with syringe to rule out intrathecal/intravenous placement.
- Large volume of local anesthetic to be given in divided doses.

During spinal anesthesia:

- Local anesthetic dose to be selected judiciously according to level of block to be achieved.
- For hyperbaric drugs block height can be manipulated by alternation of position. Position of the patient following administration of spinal anaesthesia to be taken care of.
- Dose reduction to be considered in patients of short height, having morbid obesity, etc.
- For spinal following an epidural, a dose reduction may be required depending on the existing level of block.

During combined epidural and spinal anesthesia:

To avoid drug injection during a contraction/cough/Valsalva maneuver as this can increase the cephalad spread of the drug.

Diagnosis: The diagnosis is a rapid clinical diagnosis based on clinical signs and symptoms of the patient along with hemodynamic instability.

Signs and Symptoms:

- Maybe preceded by numbness, tingling, paresthesia/weakness of upper limbs followed by dilation of pupils, anxiety and shortness of breath along with hemodynamic instability.
- Results in respiratory depression, cardiovascular collapse and loss of consciousness.

Management: Management is symptomatic and supportive measures comprising of the following:

1. Anxiolysis (Midazolam/Thiopental) and paralysis (Atracurium/Rocuronium)
2. *Cardiovascular support:* IV fluids, vasopressor and atropine
3. *Respiratory support:* Establishment of a definitive airway (ETT/LMA) and controlled positive pressure mechanical ventilation.
4. *Cardiovascular collapse:* According to cardiac life support algorithm

TABLE 11.1: Symptoms according to extension of level of blockade and management.

Spinal level	*Sites affected*	*Clinical features*	*Line of therapy*
T1–T4	Cardiac sympathetic fibers	Hypotension, bradycardia	• Left lateral tilt/wedge • Intravenous fluids, vagolytics (inj. atropine 0.6 mg IV), sympathomimetics (Inj. ephedrine 6 mg bolus, inj. mephentermine 3–5 mg bolus) or vasopressor (inj. phenylephrine 50–100 mcg bolus)
C6–C8	• Hands and arms • Accessory muscles of respiration	Tingling of hand with progressive weakness and grip	• Reassurance • Reverse Trendelenburg position in spinal block • Stopping local anesthetic injection in epidural top up
C3–C5	Diaphragm and shoulders	Shoulder weakness, respiratory compromise, hypoventilation, desaturation	• To assess airway • Oxygen supplementation • May require intubation and ventilation
Intracranial spread	Brainstem	Slurring of speech, sedation, loss of consciousness	Call for help, ABC approach, intubation and ventilation, circulatory support, epinephrine bolus, as required, foetal monitoring

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Q4. Discuss the prevention and treatment of postdural puncture headache (PDPH). *(DNB June 2022) (5)*

Q. Preventive measures and management of postdural puncture headache (PDPH) in an adult patient. June 18(5+5) + pathophysiology. *(DNB December 2016) (5)*

Or

Q. List the various methods for prevention of postdural puncture headache. *(DNB June 2017)*

Or

Q. Factors affecting PDPH. *(DNB December 2022) (5)*

Or

Q. Define postdural puncture headache. Describe its clinical features and management. *(WBUHS DA 2021) (2 + 4 + 4)*

Or

Q. Describe the causes of PDPH and management of the same. *(WBUHS DA 2018) (5 + 5)*

Or

Q. Postdural puncture headache. *(WBUHS DA 2019 (10); WBUHS DA 2014) (6)*

Or

Q. Write a note on post-dural puncture headache. *(Dr NTRUHS November 2021) (10)*

Ans.

Postural headaches following interventions that disrupt meningeal integrity are most commonly labeled postdural puncture headaches.

Pathophysiology:

Pathophysiology is incompletely understood. Research and data suggest:

1. Disruption of normal CSF homeostasis.
2. Loss of ~10% of circulating CSF volume leads to PDPH.

3. Bimodal mechanism is proposed for the pathophysiology:
   A. Loss of intracranial support leading to diminished buoyant support which allows brain sagging in upright position. This traction and pressure results in pain.
   B. Cerebral vasodilation secondary to loss of CSF (Monro-Kellie hypothesis) leads to taction on intracranial vessels.

Nerves involved in PDPH: Ophthalmic nerve V1 (frontal headache), IX, X (occipital headache), C1-C3 (neck and shoulder pain). Transient palsy of CN-III, IV and VI lead to visual disturbances.

Risk factors for PDPH:

1. *Patient characteristics:*
   - Age—Peak incidence in teens and early 20s.
   - Gender—(F > M) Non pregnant females have twice the risk compared to age matched men.
   - Pregnancy
   - Low BMI is an independent risk factor.
   - Previous history of chronic bilateral tension type headache
2. *Procedure:*
   - Needle size and tip—Cutting and large caliber needles have more risk of PDPH
   - Bevel end—Bevel parallel to long axis of spine reduces incidence of PDPH
   - Multiple dural punctures lead to more risk of PDPH.
   - Skill/Experience of performer.

Clinical Features:

- Onset—Usually after 12–48 hours following puncture, rarely more than 5 days
- Postural nature of headache (worse in upright position and lesser in recumbency)
- Dull aching/throbbing/pressure type of headache, bilateral (occipital, frontal mostly)
- Other associated symptoms:
  - Neck/shoulder pain and/or stiffness
  - Tinnitus and hypoacusia
  - Photophobia
  - Nausea and vomiting

Prevention:

General Measures:

Patient selection:

- Weigh risk-vs-benefit of neuraxial block in patients under 40 years of age
- Past history of PDPH.

Pharmacology:

- Use of Caffeine used prophylactically to reduce the incidence of PDPH.
- Other drugs have been used in trials such as aminophylline, dexamethasone, opioids, per-rectal indomethacin and cosyntropin, but none have been of conclusive benefit

Spinal/Epidural Technique:

1. *Needle selection:* Small gauge and non-cutting needle should be used.
2. Replacing stylet before withdrawal of the needle after drug administration.
3. Using CSE technique over only epidural technique.
4. Some studies suggest use of intrathecal catheters.

Other methods have been researched and studied but no definite conclusion

Management/Treatment:

1. *Time:* PDPH is a spontaneously resolving condition that improves with the passage of time
2. *Supportive measures:* Reassurance, recumbent position, hydration
3. *Pharmacology:* Analgesics, antiemetics, acupuncture and B/L greater occipital nerve block
4. *Epidural therapy:* Epidural saline and epidural blood patch (gold standard) for PDPH using 20 mL autologous blood. Epidural blood patch leads to a tamponade effect leading to the cephalad displacement of CSF. Post-EBP, Patients are advised to avoid heavy lifting, straining/Valsalva and air travel for 24 hours.

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2. Plewa CM, McAllister RK, Hall WA. Postdural puncture headache. Treasure Island (FL): StatPearls Publishing; 2024.

Q5. Discuss the anatomy of epidural space. Describe various techniques to identify the space. *(DNB June 2021) (4 + 6)*

Or

Q. Discuss the anatomy of epidural space. Discuss the various techniques for confirmation of placement of needle in epidural space *(WBUHS 2019) (5 + 5)*

Or

Q. Methods for identification of epidural space. *(DNB June 2018) (5)*

Or

Q. Various methods, techniques to identify epidural space. *(DNB December 2022) (5)*

Or

Q. Walking epidural. *(DNB December 2022) (5)*

Or

Q. What is walking epidural. What are its indications? *(WBUHS DA 2018) (3 + 7)*

Or

Q. Describe steps of epidural anesthesia. *(WBUHS DA 2020) (10)*

Or

Q. Mention the boundaries of epidural space. *(WBUHS May 2023) (3)*

Ans.

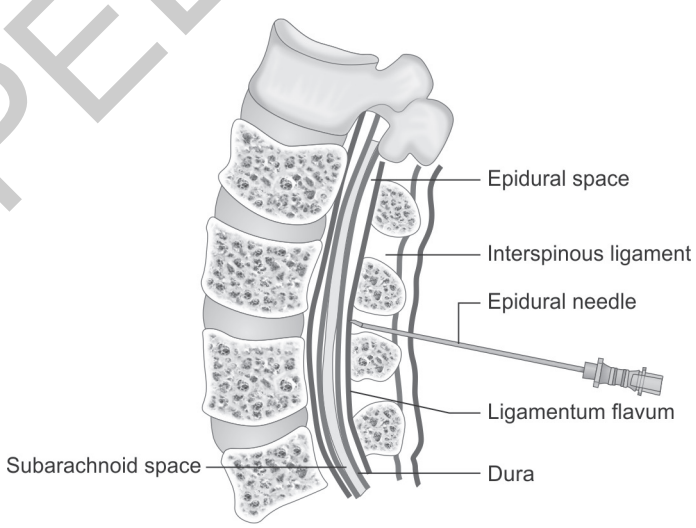

Fig. 11.1: Boundaries of epidural space.

Contents of epidural space:

Epidural space contains blood vessels, nerve roots, adipose tissue, and loose connective tissue in a non-uniform manner. Veins in the epidural space are continuous with the iliac vessels of pelvis and the azygos system of

abdominal and thoracic walls. As the plexus is valveless, blood from any of the concerned systems can flow into the epidural vessels.

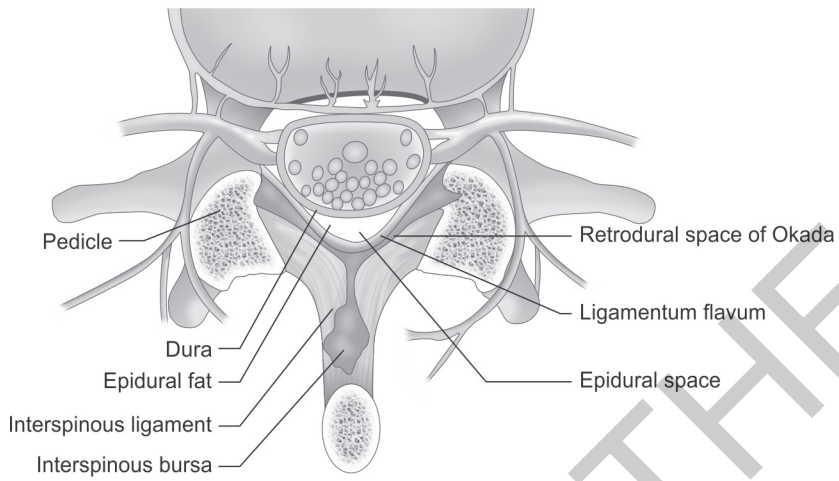

Fig. 11.2: Epidural space and contents.

Blood vessels are primarily located in anterior epidural space, where they are confined mainly by the membranous extension of the posterior longitudinal ligament. This is a frequent site of blood vessel puncture by epidural catheter.

The amount of adipose tissue in epidural space affect the spread of local anesthetics. Reduction of adipose tissue with age is related with higher level and faster onset of epidural anesthesia in elderly people. Similarly, increased adipose tissue in lower lumbar area where the dural sac tapers is related to variable effects of LA injections below L4–L5.

Septae, (or, sparse strands) is a continuous membrane that attaches the dura to the ligamentum flavum and may obstruct catheter advancement, can affect the spread, onset and distribution of LA.

Anatomy of Epidural Space:

- Epidural space surrounds the dura mater circumferentially.
- *Extent:* It extends from foramen magnum to the sacrococcygeal ligament.
- The epidural space is bound
  - *Anteriorly by:* Posterior longitudinal ligament
  - *Posteriorly by:* Ligamentum flavum
  - *Laterally by:* Pedicles and intervertebral foramina.
- The posterior space is most clinically relevant.
- The epidural space contains adipose tissue, blood vessels, nerve roots and loose connective tissue.

Methods and Techniques to identify epidural space:

Identification methods of epidural space

Methods of epidural space localization		
Guiding the needle	***How to identify the entry of needle into the space***	***Confirming the catheter location in the space***
• 2D ultrasonography (USG) – Preprocedural scanning – Real time ultrasound guidance – Real time 3D/4D USG – Preacquired 3D images of spine – Ultrasound through needle – Needle through ultrasound • Acoustic radiation force impulse imaging • Fluoroscopy	• Modification of 'Loss of resistance' technique – Membrane in syringe technique – Epidural balloon – Epidrum – Episure autodetect – Auditory and visual display of pressure wave • Bio-impedance technique • Optical coherence tomography	• Epidural stimulation test • Electrocardiography guided system • Epidurography • Epidural pressure waveform analysis • Near infrared tracking system • Ultrasonography

1. *Loss of Resistance to Air:*
   - Epidural space is identified with the help of loss of resistance technique using air in the LOR syringe.
   - Continuous or intermittent pressure is applied to the syringe plunger, when the needle encounters the ligamentum flavum a resistance is felt and once pierced a "give" is felt when pressure is applied to the plunger.
   - *Avoid injecting the air fully to avoid pneumocephalus, PDPH, patchy block.*
2. *Loss of resistance to saline with or without an air bubble:*
   - 2–3 mL of saline is filled in the syringe and same technique of LOR is used and smooth passage of saline into the epidural space is appreciated once in epidural space on applying pressure to the plunger of syringe.
   - Air bubble can be used with saline which will disappear once needle is in the epidural space.
3. *Hanging drop method:*
   - This technique is based on the sub-atmospheric pressure present in the epidural space (more pronounced in cervical and thoracic region).
   - "Dural tenting" occurs when the needle advances, it contributes to the pressure that appears to suck in the drop of fluid.
   - A drop of saline is placed *at* the hub of the needle and when the needle enters the epidural space, the drop of saline is sucked *into* the hub.
   - This technique may not be reliable in COPD patients. It is better suited for thoracic region. It carries the risk of meningeal tear.
4. *Ultrasonography:* US visualization of the epidural space results in lesser attempts and minimize complications. It helps to locate the epidural space, midline location and skin to epidural space depth.

Steps of Epidural Anesthesia

There are 4 main techniques—Midline, paramedian, Taylor and caudal.

Midline Approach (Most Common):

1. Parts are painted and draped with sterile sheet.
2. Space is identified by finger palpation or ultrasound.
3. The skin and subcutaneous tissue is infiltrated with generous amount of local anesthetic.
4. The epidural needle is held by the anesthesiologist by resting the middle fingers on the patient's back while the index finger and thumb hold the needle wings. Stylet needle is inserted along the track with bevel end cephalad up to the interspinous ligament (gritty sensation).
5. Once the ligamentum flavum is touched (resistance) the LOR syringe is attached either with air/saline after removing the stylet.
6. The epidural needle is advanced with continuous/intermittent pressure on the plunger. Once the "Give" is felt, a small amount of saline can be injected to dilate the space and reduce chance of vessel cannulation.
7. Note the depth of the needle from the skin (subtract the total number of markings from the markings present outside the skin). This will allow to calculate the length from the skin to epidural space.
8. Insert the hub catheter mount and insert the catheter through the needle till the 15 cm mark is visible in the hub. Add 3–5 cm to the skin-epidural space distance and fix the catheter with a clear occlusive dressing.
   Example, if length is 6cms from skin to epidural space, then fix at 6 cm + 3 cm = 9 cm to 6 cm + 5 cm = 11cm. So, 9–11cm.
9. A test dose is administered before the main anesthetic agent. 3 mL of Lignocaine (1.5%) + 15 mcg of epinephrine is administered and looked for intravascular administration.

   A change of heart rate of 20% or 10–25 beats per 1 minute signifies intravascular placement
10. Local anesthetic is administered 1–2 mL per segment in Lumar region and 0.75 mL per segment in thoracic segment.

Accidental Dural Puncture:

Whatever the choice is to be taken, it has to be taken as quickly as possible to limit the loss of CSF.

Management Options of Accidental Dural Puncture include:

1. *Placing a continuous spinal catheter*
   Advantage:
   - Reduces the incident of PDPH and need of epidural blood patch.
   - Dural puncture during epidural for labor analgesia can benefit when converted to CS section by using continuous spinal anesthesia (rapid onset).
   - Avoids the risk of a second dural puncture.
   - Rapid onset of surgical anesthesia and postoperative analgesia.

   Disadvantage:
   - Accidental injection of large dose of LA can lead to total spinal anesthesia. [Label the catheter as spinal catheter].
   - Possible risk of infection into subarachnoid space.
2. *Withdrawing the epidural needle and repeating epidural procedure in a different space.*
   Disadvantage:
   - Second risk of accidental dural puncture.
   - Caution while administrating bolus dose—Passage of LA from epidural to subarachnoid space via the dural breach, can result in a higher than anticipated block.
3. *Converting into spinal anesthesia*
   - Administrating a spinal dose through the epidural needle.
   - *Disadvantage:* No postoperative analgesia.
4. *Abandon the procedure and opt for other regional/general anesthesia.*

Walking Epidural

Walking epidural is a technique of neuraxial analgesia that allows ambulation safely.

Initially, walking epidural term was coined to describe a low dose opioid CSE analgesia that allowed ambulation without motor block.

Proprioception is blunted if local anesthetic agents are used in very low doses (sensory block), hence, patient should be accompanied while walking.

Walking epidural is an excellent option for labor analgesia. Low dose anesthetic agents (Inj. Ropivacaine 0.1–0.2%, Bupivacaine 0.0625%) with low dose opioids provide satisfactory labor analgesia without compromising motor function.

The goal of labor analgesia should be:

1. Relief from labor pain
2. No compromise on safety of mother or fetus
3. No compromise to the progress of labor.

Walking epidural offers numerous advantages:

- Safe and effective pain relief.
- Maternal and fetal safety
- No risk of maternal respiratory depression/sedation
- Stable maternal and fetal vitals
- Reduces the operative delivery rate.
- Increased rate of vaginal delivery.
- No/minimal motor weakness
- High degree of patient satisfaction.
- Can be converted into operative anesthesia if need of CS delivery

Indications of walking epidural:

- Labor analgesia
- Anticipated instrument delivery
- Prolonged labor
- Hypertensive disease of pregnancy

- Breech presentation for vaginal delivery
- Postoperative analgesia after abdominal surgery
- Post operative analgesia after lower limb surgery

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Q6. Describe the anatomy of the caudal space. Mention the indications, techniques and complications of caudal block in pediatrics. *(WBUHS MD 2023) (5 + 5)*

Q. Discuss the indications, technique and complications of caudal epidural block in children. *(WBUHS MD 2016 (10); DNB June 2016) (2 + 4 + 4)*

Or

Q. Caudal block. *(DNB December 2018) (5)*

Or

Q. Indications of caudal epidural anesthesia in pediatric patients. Describe the technique and its complications. *(DNB December 2015) (3 + 4 + 3)*

Ans.

Caudal block: Caudal epidural block is a technique of providing analgesia and/or anesthesia of the lumbar-sacral nerve roots. It reduces the surgical stress response.

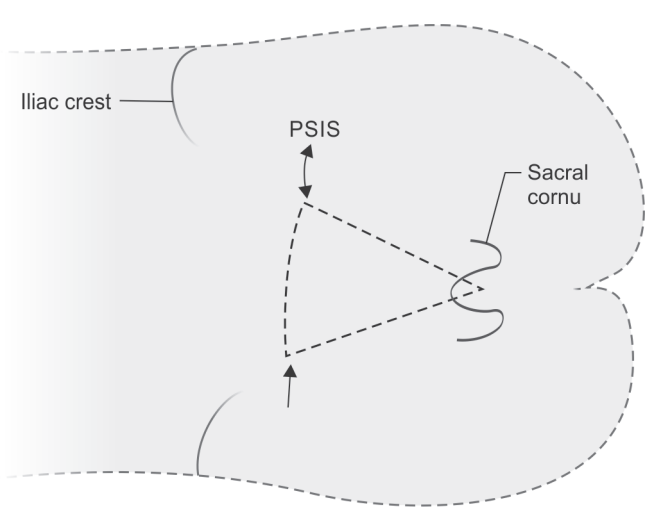
It is the most common regional anesthetic technique used in pediatric age group.

Also used in adult patients as an alternative route to lumbar epidural space when access is difficult or for acute/chronic pain relief.

Caudal Anatomy:

The sacral hiatus is U/V shaped, due to lack of fusion of 4th and 5th sacral vertebrae. The hiatus is covered by sacro-coccygeal ligament which is a continuation of ligamentum flavum.

The hiatus is present between the sacral cornu of either side and forms the apex of an inverted triangle formed by PSIS of either side as the base.



Indications in Pediatrics:

1. *Requirement of sacral block:* Circumcision, anal surgery, etc.
2. *Requirement of lumbar and lower thoracic block:* Lower limb surgeries, herniotomy, inguinal and lower abdominal surgeries, etc.
3. *Analgesia of thoracic dermatomes:* Upper abdominal/thoracic surgeries
4. Postoperative analgesia

Technique of Caudal in Pediatric Population:

1. *Anatomical landmark*
   Position: Lateral position is chosen for pediatric population with knee flexed to chest. In some older children, prone frog position with towel under pelvis.
   Locating the space: The sacral cornu is traced by using the thumb while the index finger is placed at the coccyx tip in the inter-gluteal cleft. In between the cornu, the thumb sinks into a gap which is the entry point for the needle.
   Procedure: The needle is inserted perpendicular to the skin then cephalic re-directed after piercing the sacrococcygeal ligament (pop sensation). The syringe is attached and air is pushed under auscultation for confirmation.
   Aspiration is done to confirm no CSF/blood is present before administration of the drug.
2. *Ultrasound guided*
   USG is used to identify the sacral hiatus and visualize the needle entry into the caudal canal.
   The curvilinear probe is placed in between the two sacral cornu (Frog eye appearance on USG). Two hyperechoic structures are seen; one being the sacrococcygeal ligament and the other bony surface of sacrum.
   The ligament is pierced under vision and drug is administered after aspiration.
3. *Electric stimulation*
   In pediatric population, electric stimulation has been used to ascertain correct needle placement by noting the anal sphincter contraction (S2-S4)

Technique of caudal anaesthesia

After attaching standard ASA monitors and keeping all emergency drugs and equipment ready, the patient is placed in lateral position with one or both hips flexed. Sacral hiatus is palpated, which is like a groove or notch above the coccyx and between two bony prominences, the *sacral cornua*.

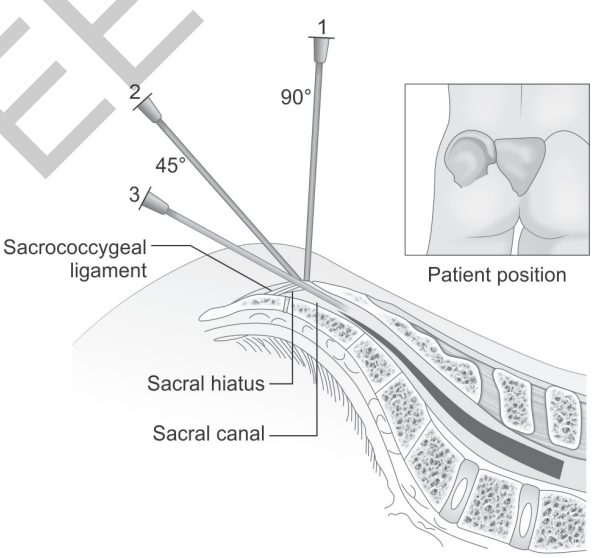


Fig. 11.3: Direction of insertion of needle in caudal block.

After sterile skin preparation, a needle or IV cannula (18–23G) is advanced at a 45° angle cephalad till a *pop* is felt as the needle pierces the *sacrococcygeal* ligament. The angle of the needle is then flattened and then advanced 1–2 cm, the space can be identified by auscultation after administration of a small amount of air through a syringe.

Amount of drug administered: 'Armitage' formula:

- 0.5 mL/kg—all sacral dermatomes are blocked (sacral-lumbar block)
- 1 mL/kg—all sacral and lumbar dermatomes are blocked (upper abdominal block)
- 1.25 mL/kg—upper limit of anesthesia is at least mid-thoracic (Mid thoracic block)

Ultrasound guided technique:

- High frequency linear probe is placed in transverse plane to identify the sacral hiatus. It is located between an upper hyperechoic line (i.e., sacrococcygeal membrane) and an inferior hyperechoic line (i.e., dorsum of pelvic surface of sacrum).
- Probe is rotated in longitudinal plane to trace sacrococcygeal membrane.

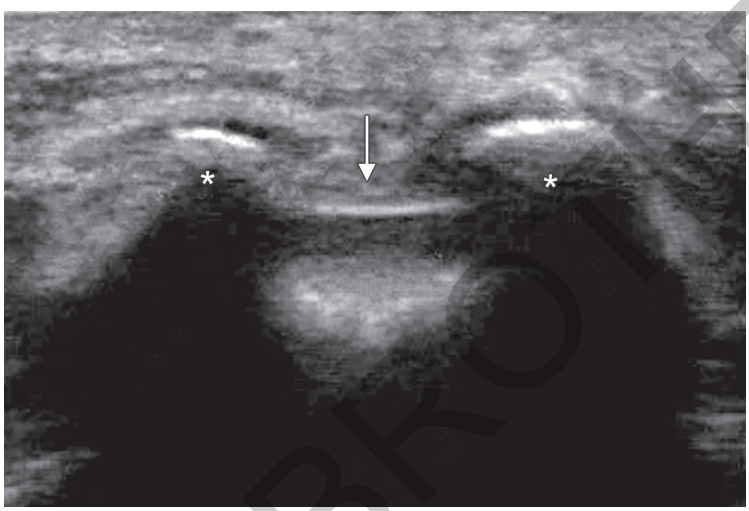


Fig. 11.4: USG scanning of caudal space. Asterisk—sacral cornua; Arrow—sacrococcygeal ligament covering sacral hiatus.

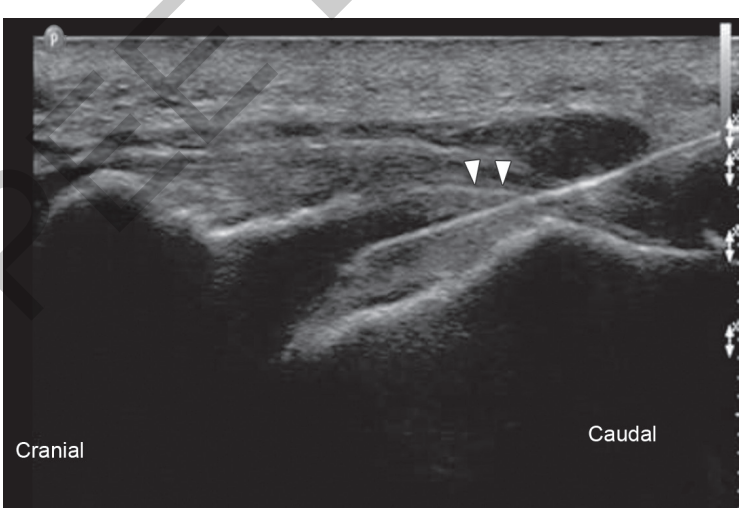


Fig. 11.5: Needle inside caudal epidural space.

Needle can be inserted in either of the views. Longitudinal view allows optimal viewing along the needle. Transverse view can be used after placement of the needle in the epidural space which enables to view the spread of local anesthetic.

Contraindications:

Major malformations of sacrum (myelomeningocele, spina bifida), intracranial hypertension.

Complications:

1. Dural puncture and subarachnoid drug administration
2. Intravascular drug administration
3. Total spinal anesthesia and LAST leading to cardiorespiratory arrest
4. Local site infection, epidural abscess, epidural hematoma, meningitis
5. Pneumocephalus, air embolism.
6. *Rare complication:* U/L parotid swelling.

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Q7. Cauda equina syndrome. *(DNB December 2022) (5)*

Ans.

Cauda equina syndrome is a condition of neurological compromise occurring due to compression of the lumbosacral nerve roots. It is rare complication of neuraxial block.

Sign and Symptoms:

- Low back pain
- Perineal loss of sensation
- Bowel and bladder function
- Other patchy sensory deficits
- Unilateral or bilateral sciatica and
- Lower extremity motor weakness.

Causes:

- Trauma
- Infection
- Lithotomy position
- Ischemic compression by hematoma, abscess, tumor, prolapsed intervertebral disc or spondylolisthesis
- *Neurotoxicity of LA's:* Lignocaine and Mepivacaine administration.
  Large volume or high concentration of LA in the sacral CSF.

Pathophysiology:

- The nerve roots of cauda equina have a poorly developed epineurium
- Limited blood supply
- More susceptible to the pooling of LAs (continuous spinal infusions with microbore catheters, accidental intrathecal injections of large doses of LA and repeated intrathecal injections after failed spinal).

Management:

- CES is a permanent disability and symptoms related to CES should prompt neurological consultation and imaging.
- High dose corticosteroid; surgical decompression and treatment of underlying disorder with chemotherapeutic agents (for tumors) or antibiotics (for abscess) have been sued but limited data are available on optimal therapies.

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2. Shields LBE, Iyer VG, Zhang YP, Shields CB. Acute cauda equina syndrome following orthopaedic procedures as a result of epidural anaesthesia. Surg Neurol Int. 2018;9:81.

Q8. What is saddle block? Describe regional anesthesia for hemorrhoidectomy? *(WBUHS DA 2020) (4 + 6)*

Ans.

Saddle block is the sensory loss in the perineal regions and inner aspects of thighs and legs after administration of central neuraxial block.

The saddle region (area of the rider sitting on a horseback across a saddle) or the perineum and inner thigh area corresponds to the area that is supplied by mainly S1-S2 segments of the spinal cord. A block of this nerve root results in a saddle block.

Regional Anesthesia for hemorrhoidectomy: Saddle block is used for this surgery

Technique: The technique is same as administration of spinal anesthesia

Drug: Hyperbaric Bupivacaine/Ropivacaine

Position: Performed in sitting position

Insertion of needle: It is performed in the subarachnoid space of the low lumbar or sacral region.

The patient should continue in sitting position even after the administration of the hyperbaric local anesthetic drug for at least 5 minutes to allow the drug to settle in that region.

The approach to the subarachnoid space can be via. midline, paramedian or the Taylor's approach.

Block: The block is used for various surgical procedures like obstetrics, urological, anorectal surgeries, etc.

Advantages of saddle block:

- Rapid onset
- Dense block
- No or minimal hemodynamic changes.
- Early mobilization
- Low dose of drug requirement
- Early discharge after procedure
- Post operative analgesia

Contraindications: Same as spinal anesthesia.

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1. Hadzic A. Chapter 23: Spinal Anaesthesia. In: Chin A, Zundart AV (Eds). Hadzic's Textbook of regional Anaesthesia and acute pain management, 2nd edition. New York: McGraw Hill; 2022. p. 351.
2. Mariam A, Sajjad H. Saddle anaesthetic block. Treasure Island (FL): StatPearls Publishing; 2024.

Q9. What are the contraindication of spinal anesthesia? *(WBUHS May 2023) (2)*

Or

Q. Enumerate the complication of spinal anesthesia and management? *(WBUHS DA 2015) (6)*

Or

Q. What are the complications of spinal anesthesia? Describe the management of post-dural puncture headache. *(Tripura University 2014) (10)*

Ans.

Contraindications of spinal anesthesia:

Absolute:	***Relative:***
• Patient refusal	• Coagulopathy/thrombocytopenia
• Infection at site of injection	• Sepsis
• Drug allergy	• Fixed cardiac output states
• Raised intracranial pressure	• Uncorrected hypovolemia
	• Indeterminate neurological state

Complications and Management of Spinal Anesthesia:

Complications	*Management*
Minor:	
• Nausea and vomiting	• Manage hypotension first • Metoclopramide, 5HT3 antagonists, use of Fentanyl as adjuvant, acupuncture
• Mild hypotension	• Fluid administration and vasopressors
• Shivering	• Warm iv fluids, warm air blankets, tramadol 0.25–1 mg/kg iv. Meperidine 50 mg. Clonidine 30–150 mcg
• Transient mild hearing loss	• Reassurance, recovers spontaneously
• Postoperative urinary retention (POUR)	• Catheterization, ending of parasympathetic block
• Pruritus	• Naloxone/Naltrexone, Ondansetron and Propofol can be used
Moderate:	
• Failed spinal	• Alternative mode of anesthesia
• Post dural puncture headache	• Discussed earlier under PDPH
Major:	
• Needle trauma	• Neurological consult, corticosteroids, some cases resolve within 24 months
• Meningitis/arachnoiditis	• Antibiotics and management according to protocol
• Vertebral canal hematoma	• MRI and Neurosurgical consultation
• Cauda equina syndrome	• Discussed earlier under cauda equina syn
• Peripheral nerve injury	• Appropriate positioning of limbs and neurological consult
• Total spinal anesthesia	• Anxiolysis and cardiorespiratory support
• Cardiovascular collapse	• Resuscitation according to standard protocol

SUGGESTED READING

1. Hadzic A. Chapter 23: Spinal Anaesthesia. In: Chin A, Zundart AV (Eds). Hadzic's Textbook of regional Anaesthesia and acute pain management, 2nd edition. New York: McGraw Hill; 2022. pp. 330-3.
2. Miller RD, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Cohen NH, Young WL. Chapter: 56: Spinal, Epidural and Caudal Anaesthesia. Miller's Textbook of Anaesthesia, 8th International Edition. Volume 1. Philadelphia: Elsevier; 2015. pp. 1711-5.

Q10. Principles of co-loading during subarachnoid block. *(DNB June 2021) (5)*

Ans.

Neuraxial blocks can lead to severe hypotension by blocking sympathetic system and peripheral pooling of blood.

To prevent this hypotension co-loading and pre-loading with iv fluids are of the few methods to have shown good results. No technique is effective alone however and has to be coupled with vasopressors.

Principles of Co-loading:

1. Intravascular volume expansion counteracts the peripheral pooling of blood.
2. *Kinetics:* Increase in intravascular volume by co-loading coincides with the maximum vasodilation after spinal anesthesia, thus reducing hypotension
3. Sustained increase of cardiac output with co-loading of iv fluids.
4. Safer in some patients as it avoids volume overload
5. *Use of colloids for co-loading:* More effective due to longer half-life in the intravascular compartment.

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1. Bhajwa SJS, Kulshrestha A, Jindal R. Co-loading or pre-loading for prevention of hypotension after spinal anaesthesia! A therapeutic dilemma. Anesth Essays Res. 2013;7(2):155-9.
2. Oh AY, Hwang JW, Song IA, Kim MH, Ryu JH, Park HP, et al. Influence of the timing of administration of crystalloid on maternal hypotension during spinal anaesthesia for caesarean delivery: preload versus co-load. BMC Anaesthesiology. 2014;14:36.

Q11. Intravenous sedation with neuraxial block as an anesthetic technique for pelvic laparoscopic surgery.
(WBUHS MD 2016) (5)

Ans.

Neuraxial block alone for a laparoscopic surgery is often uncomfortable and painful for the patient due to:

a. Effects of pneumoperitoneum.
b. Higher migration of the drug can cause anxiety and unpleasant sense of respiratory distress for the patient.

Therefore, to counter-act the effects of pneumoperitoneum and alleviate anxiety, anesthesiologists give sedation (Dexmedetomidine infusion, Ketamine, Midazolam, Propofol infusion, etc.) along with CNB to the patient which makes the procedure tolerable and surgery can be performed without any discomfort to the patient.

Neuraxial block for laparoscopic pelvic surgery holds the following advantages:

1. Avoids GA complications like sore throat, airway complications, reversal complications, pulmonary complications etc.
2. During COVID pandemic where general anesthesia was a risk, neuraxial blocks was a good alternative method.
3. Reduced length of hospital stay and better pain control.

Disadvantages:

1. Trendelenburg position under spinal anesthesia increases the risk of high/total spinal.
2. Insufflation for pneumoperitoneum is painful and uncomfortable for the patient.
3. Raised $EtCO_2$ due to inadequate ventilation and respiratory depression from sedation.
4. Hemodynamic instability
5. Many surgeons find difficulty in operating with less gas insufflation.
6. Requires experienced surgeon and anesthetist.
7. Increased chances of PDPH.

Sedations carries the risk of further respiratory depression and raised $EtCO_2$ and further hemodynamic suppression additive to CNB.

Experienced and vigilance is key to performing laparoscopic pelvic surgeries under CNB with sedation.

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1. Fayyad A, Said M, Hasan M, Saleh M. Total laparoscopic hysterectomy and bilateral salpingo-oophrectomy for stage 1 endometrial carcinoma under regional anaesthesia. Gynaecol Oncol Rep. 2023;48:101222.
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Q12. What is the mechanism of action of neuraxial opioids? Which is the ideal opioid for epidural use and why? What are the advantages and side effects of use of neuraxial opioids? *(DNB June 2017) (4 + 2 + 4)*

Ans.

All four types of opioid receptors are found in dorsal horn of the spinal cord and serve as target for intrathecal injection. These are present in the spinal cord neurons and in the dorsal root ganglion.

Mechanism of action:

- The action is mediated mainly by Mu-opioid receptors, these involve local effects in the spinal cord (Substantia gelatinosa and dorsal horn), supraspinal effects and systemic effects after absorption of the opioid from vasculature.
- Activation of Delta and Kappa receptors are also associated with spinal analgesia.
- Opioids inhibit release of excitatory neurotransmitters (substance P and glutamate) pre-synaptic terminals, and release spinal adenosine post-synaptic terminals.
- The effects are variable and depends on the respective opioid that is used.
- Administration of hydrophilic opioids provide long lasting analgesia which is enhanced when given with a local anesthetic agent.

Ideal Opioid for epidural

Morphine can be considered an ideal opioid for neuraxial anesthesia adjuvant as:

1. It has best bioavailability amongst the other opioid drugs (Hydrophilic nature)
2. Good spinal cord selectivity.
3. Morphine can be administered alone or with local anesthetic agent.
4. Good quality of postoperative analgesia (~48 hours)

Advantages of Neuraxial Opioids:

1. Provides a dense block with profound analgesia when administered with local anesthetic agents. Enhances intraoperative analgesia.
2. Prolongs the duration of postoperative analgesia.
3. Better maintained hemodynamic stability.
4. Excellent efficacy and safety profile.
5. Decreased requirement of other anesthetic agents in patient undergoing GA + neuraxial block (Decreased MAC of volatile agents)
6. Blunted surgical stress response.
7. Early extubating (if co-administered with GA)
8. Early ambulation.

Side effects of Neuraxial Opioids:

Most side effects are dose dependent. Side effects decrease on chronic exposure of the opioids when administered intrathecal, epidural or systemic.

Most common complications are:

1. Pruritus
2. Nausea
3. Vomiting
4. Urinary retention
5. Respiratory depression is a serious complication of neuraxial opioids.

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1. Bujedo BM. Current evidence for spinal opioid selection in postoperative pain. Korean J Pain. 2014;27(3):200-9.
2. Chaney MA. Side effects of intrathecal and epidural opioids. Can J Anaesth. 1995;42(10):891-903.
3. Hermanns H, Bos EME, van Zuylen ML, Hollmann MW, Stevens MF. The options for neuraxial drug administration. CNS Drugs. 2022;36(8):877-96.

Q13. Compare clinical features of epidural block with subdural block and total spinal.

(DNB June 2015) (3 + 4 + 3)

Ans.

Characteristics and clinical features	*Epidural block*	*Subdural block*	*Total spinal*
Block	• Differential block occurs when sensory motor and sympathetic nerves are obtunded at different rates and degrees • Sympathetic block is higher than sensory block and sensory higher than motor block	• Higher than expected sensory block • Poor caudal spread sacral spreading • Higher than expected motor blockade of variable density • Blockade usually bilateral, but maybe unilateral or asymmetric	• LA spreads high enough to block the entire spinal cord and even brainstem • Sensory and motor changes develop rapidly • Entire spinal cord is blocked bilaterally
Clinical features	• Hypotension and bradycardia according to the dose and concentration of drug • Adequate ventilation is maintained • Higher blocks can impair cough • Hypothermia occurs with epidural	• Horner syndrome • Facial and corneal anesthesia • Dyspnea • Hypotension	• Profound hypotension, bradycardia, dyspnea. • Difficulty in phonation and swallowing • Unconsciousness, respiratory paralysis and cerebral hypoperfusion can occur

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3. Mullick P, Gupta N, Deuri A. Subdural block-a complication of epidural anaesthesia. Anaesthesia, pain and intensive care. 2015;19(2):211-12.

Q14. Describe anatomy of the spinal cord and its anesthetic significance (extent, layers, routes main divisions, sympathetic chains) *(DNB June 2022) (1 + 1 + 1 + 1 + 1 + 3)*

Ans.

Anatomy of the spinal cord and its significance:

1. *Extent:*
   Anatomy: The spinal cord is a continuation or an extension of medulla oblongata. It tapers and ends as conus medullaris at the level of L1/L2 intervertebral disk. Filum terminale is a slender extension all the way to the coccyx. Cauda equina is a bunch of nerve roots distal to conus medullaris.
   Significance: So as to avoid injury, spinal anesthesia is usually administered in the L3-L4/L4-L5 space in adult patients.
2. *Layers:*
   Anatomy: It has 3 layers—the dura, arachnoid and pia mater. These layers divide into 3 compartments: Epidural, subdural and subarachnoid space. The subarachnoid space ends at S2.
   Significance: The compartments hold a significance in the administration of the drug in each layer and the effects of the blocks in the patient.
3. *Routes:*
   Anatomy: Spinal Cord is divided into cervical (8), thoracic (12), lumbar (5) sacral (5) coccyx (1) segments. Each segment corresponds to a dermatome and a myotome.
   Significance:
   - The route and level of administration along with the drug volume decide the segment of the spinal cord that will be blocked.

- Each spinal segment and the neuraxial block of the dermatome and myotome are dependent on the spinal segment blocked.
- Median and paramedian for both spinal and epidural, Taylor's method for spinal/saddle anesthesia and Caudal epidural are various routes to achieve central neuraxial block.

4. *Nerve plexus and divisions:*
   Anatomy:
   Total of 31 pairs of nerve roots emerge from the spinal cord and forms cervical, brachial, lumbar and sacral plexus.
   Significance:
   - The various nerve plexus and nerve roots originating from the spinal cord are often targets for nerve plexus blocks (Lumbo-sacral block, intercostal nerve block) for surgeries/postoperative analgesia.
   - Cervical nerves (C3-C5) supply nerves to diaphragm and can also be affected by a higher spinal block or during brachial plexus block.
5. *Sympathetic chains:*
   Anatomy: Major sympathetic chains around the spinal cord are the Thoraco-lumbar trunk.
   Significance:
   - Most neuraxial blocks are administered in these regions.
   - Pharmacological lysis of the sympathetic trunk leads to vasomotor tone loss, hypotension and bradycardia with peripheral pooling of blood occurring after Neuraxial blocks. Parasympathetic dominance occurs after lysis of sympathetic system.
   - Awareness of this helps the anesthesiologist to be prepared and take necessary measures to counter the reaction.

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