Epidural Anesthesia

Spinal, epidural, and caudal neuraxial blocks result in sympathetic blockade, sensory analgesia, or anesthesia and motor blockade, depending on the dose, concentration, or volume of local anesthetic, after insertion of a needle in the plane of the neuraxis. Epidural anesthesia necessitates the use of a large mass of local anesthetic that produces pharmacologically active systemic blood levels, which may be associated with side effects and complications unknown with spinal anesthesia. The introduction of combined spinal and epidural techniques blurs some of these differences but also adds flexibility to clinical care.

INDICATIONS

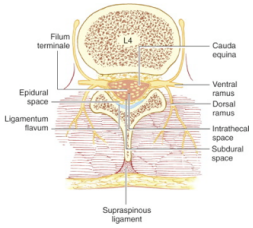
- any surgical procedure that can be accomplished with a sensory level of anesthesia that does not produce adverse patient outcomes

CONTRAINDICATIONS

- **ABSOLUTE**
  - patient refusal
  - inability of patient to cooperate and remain still during procedure
- **RELATIVE**
  - coagulopathy
  - infection at site of insertion
  - systemic bacteremia/sepsis
  - increased ICP (inadvertant dural puncture)
  - hypovolemia or inability to tolerate vasodilation (HOCM)

ANATOMY

- spinal cord: foramen magnum to L1 (L3 in infants)
- spinal cord surrounded by membranes:
  - (in to out) Pia mater, arachnoid mater, dura mater



- CSF sits within the subarachnoid space (contains CSF, spinal nerves, a trabecular network between the two membranes, and blood vessels that supply the spinal cord and lateral extensions of the pia mater and dentate ligaments, which provide lateral support from the spinal cord to the dura mater)
- Subarachnoid space extends to S2
- Subdural space is a potential space
- Epidural space surrounds the dura
  - Borders:
    - Anterior: posterior longitudinal ligaments
    - Lateral: pedicles and intervertebral foramina
    - Posterior: ligamentum flavum
      - two ligamenta flava, the right and the left, which join in the middle and form an acute angle with a ventral opening.
      - not uniform from skull to sacrum, nor even within an intervertebral space.
      - Ligament thickness, distance to the dura, and skin-to-dura distance vary with the area of the vertebral canal.
      - The two ligamenta flava are variably joined (fused) in the midline, and this fusion or lack of fusion of the ligamenta flava even occurs at different vertebral levels in individual patients.
      - Immediately posterior to the ligamentum flavum are the lamina and spinous processes of vertebral bodies or the interspinous ligaments.

Table 51-1 -- Characteristics of the Ligamentum Flavum at Different Vertebral Levels

Site	Distance from Skin to Ligament (cm)	Thickness of Ligament (mm)
Cervical	—	1.5-3.0
Thoracic	—	3.0-5.0
Lumbar	3.0-8.0*	5.0-6.0[†]
Caudal	Variable	2.0-6.0

Data from Cousins MJ, Bromage PR: Epidural neural blockade. In Cousins MJ, Bridenbaugh PO (eds): Neural Blockade in Clinical Anesthesia and Management of Pain. Philadelphia, JB Lippincott, 1988, p 255, and other sources.

* The distance is 4 cm for 50% of patients and 4 to 6 cm for 80% of patients.

† Within each interlaminar space, the ligamentum flavum varies in thickness from cephalad to caudad: near the rostral lamina, it is 1.3 to 1.6 mm, and near the caudad lamina, it is 6.9 to 9.1 mm.

  - Contents:
    - nerve roots
    - fat, areolar tissue
    - lymphatics
    - blood vessels, including the well-organized Batson venous plexus.

PHYSIOLOGIC EFFECTS

- CVS:
  - decreased SVR, arterial dilation, venodilation
  - sympathectomy AT level of sensory level (vs 2-6 dermatomes above sensory level with spinal)
- RESP:
  - Minimal decrease in tidal volume
  - Decrease FVC secondary to decreased ERV (paralysis of abdominal muscles – primary muscles of expiration)

- May have difficulty with effective cough and clearing of secretions in respiratory cripples
- Inspiratory muscle function preserved
- Respiratory arrest during total spinal is secondary to brain stem hypoperfusion

- GI:
  - Nausea and vomiting with high neuraxial block >T5 (likely secondary to unopposed parasympathetic tone) – treatment: atropine
  - Increased peristalsis
  - Increased intestinal intramucosal pH with postoperative epidural analgesia vs opioid (systemic)
- GU:
  - Urinary retention
- OTHER:
  - Epidural more likely to have systemic manifestations of local anesthetic because of large doses used

TECHNIQUE

- **PREPARATION**
  - epidural kit
    - tuohy needle for catheter technique
    - crawford needle if single shot
    - LOR syringe **(AIR/SALINE)**
    - Sterile prep solution and draping
    - Sterile gloves, mask, hat
  - local anesthetic for skin/subcutaneous infiltration
  - catheter if continuous technique
  - local anesthetic solution for epidural injection
- **POSITION**
  - sitting
    - maintain vertical plane while flexing neck/back to open up intervertebral spaces
  - lateral decubitus
    - thighs and neck flexed ('forehead to knees')
- **PROJECTION AND PUNCTURE**
  - Epidural technique requires placement of the needle tip into the ligamentum flavum for the loss-of-resistance and hanging-drop methods.
  - Placing the needle (with stylet) into the ligamentum flavum before attaching the syringe or placing solution into the needle hub allows an improved appreciation of epidural anatomy for the operator. If the needle is merely inserted into the supraspinous ligament and then loss-of-resistance or hanging-drop insertion is begun, an increased chance of false release seems likely.
  - Lumbar approach: depth from skin to the ligamentum flavum ~ 4 cm, most (80%) patients between 3.5 and 6 cm.
  - Ligamentum flavum 5 to 6 mm thick (midline)
  - for thoracic epidural: control is of equal or greater importance because injury to the spinal cord is possible if the needle is advanced too far. Thoracic epidural anesthetics do not appear to be associated with an increased incidence of neurologic injury because those choosing to use the technique are most often anesthesiologists with considerable experience in lumbar epidural anesthesia.
  - caution performing thoracic epidural techniques in adult patients receiving general anesthesia because these patients are unable to provide feedback to the operator about neural stimulation during needle insertion.
  - **LOSS-OF-RESISTANCE TECHNIQUE:**
    - insert the needle to the ligamentum flavum and attach a 3- to 5-mL glass syringe filled with 2 mL of saline and a small (0.25-mL) air bubble.
    - Grasp needle with the nondominant hand and pull toward the epidural space while the dominant hand (thumb) applies constant steady pressure on the syringe plunger to compress the air bubble.
    - When the epidural space is entered, the pressure applied to the syringe plunger allows the solution to flow without resistance into the epidural space.
    - The incidence of unintentional intravenous cannulation with an epidural catheter may be lessened by injecting air or solution before threading the catheter.
    - epidural catheters should be inserted only 2 to 3 cm (Barash 3-5cm) into the epidural space for surgical or obstetric patients needing rapid onset of analgesia. (more catheter increases the likelihood of catheter malposition)
    - In obstetric patients, it appears that the catheter should be inserted between 4 and 6 cm to optimize efficacy and prevent unintentional movement of the catheter during prolonged labor analgesia
    - Despite an adequately positioned catheter during first use of a local anesthetic, each subsequent injection should be preceded by aspiration and an epidural test dose because catheter migration into vessels and the subarachnoid or subdural space does occur. entered, the pressure applied to the syringe plunger allows the solution to flow without resistance into the epidural space.

LOCAL ANESTHETIC OPTIONS

Table 51-5 -- Comparative Onset Times and Analgesic Durations of Local Anesthetics Administered Epidurally in 20- to 30-mL Volumes

Drug	Conc. (%)	Onset (min)	Duration (min)	
			Plain	1 : 200,000 Epinephrine
2-Chloroprocaine	3	10-15	45-60	60-90
Lidocaine	2	15	80-120	120-180
Mepivacaine	2	15	90-140	140-200
Bupivacaine	0.5-0.75	20	165-225	180-240
Etidocaine	1	15	120-200	150-225
Ropivacaine	0.75-1.0	15-20	140-180	150-200
Levobupivacaine	0.5-0.75	15-20	150-225	150-240

Data from Cousins MJ, Bromage PR: Epidural neural blockade. In Cousins MJ, Bridenbaugh PO (eds): Neural Blockade in Clinical Anesthesia and Management of Pain. Philadelphia, JB Lippincott, 1988, p 255, and other sources.

ADDITIVES

- Epinephrine
  - increases the duration
  - effect is greatest with lidocaine, mepivacaine, and 2-chloroprocaine
  - lesser effect with bupivacaine, levobupivacaine, and etidocaine
  - limited effect with ropivacaine
- Phenylephrine
  - Phenylephrine has been used in epidural anesthesia less widely than in spinal anesthesia, perhaps because it does not reduce peak blood levels of local anesthetic as effectively as epinephrine does during epidural use.
- Bicarbonate
  - means of increasing the speed of onset and quality of the block
    - producing more rapid intraneural diffusion and more rapid penetration of connective tissue surrounding the nerve trunk.
    - Some data suggest that there are no clinical advantages for carbonated solutions
    - disadvantages may occur more rapidly because peak blood levels of the drug are higher after carbonation of the local anesthetic and blood pressure decreases
  - increases speed of onset by: increasing pH of the local anesthetic solution and increasing the concentration of nonionized free base, which theoretically increases the rate of diffusion of the
  - ? more complete block
- Clonidine/ Neostigmine

DETERMINANTS OF :

1. ONSET
- Onset with all epidural blocks with all local anesthetics can be detetcted within 5 minutes in dermatomes immediately surrounding injection site.
- Time to peak effect differs among local anesthetics
  - Short: 15-20 min
  - Longer acting: 20-25min
  - Increasing DOSE of local anesthetic speeds onset of both motor and sensory block

2. BLOCK HEIGHT AND SPREAD
- Injection site
  - Most important determinant of the spread of epidural block
- Dose, volume and concentration
  - Within range typically used for surgical anesthesia, drug concentration is relatively unimportant in determining block spread
  - Dose and volume are important variables determining spread and quality of epidural block (increasing dose and volume will increase spread and densitiy in a nonlinear fashion)
- Position
  - Effect of posture on spread is generally not clinically important
- Age
  - Greater spread in older patients secondary to less compliant epidural space and diminished ability for epidural solutions to leak out of intervertebral foramina
- Height and weight
  - Weak correlation and of little clinical significance except if very tall/short/obese
- Pregnancy
  - ?controversial
    - greater spread at term AND in early pregnancy?

3. DURATION
- choice of local anesthetic is the MOST important determinant of duration of epidural block
- addition of adrenergic agonists may prolong block
- increasing dose results in increased duration and density of block
- age does not correlate with duration of block

COMPLICATIONS
- **Intravascular injection**
  - Test dose: 3cc 2% lidocaine + 1:200000 Epi
  - 30 for 30 – increase in HR by 30 bpm in 30s
  - in beta blocked patients increase in SBP >20mmHg may be more reliable indicator of intravascular injection
  - sensitivity is diminished by preexisting high thoracic epidural anesthesia, or concurrent GA
  - very low sensitivity in laboring women
- **Intrathecal injection**
- **Nerve damage**
- **Inadvertent dural puncture**
- **Epidural hematoma**
- **Epidural abscess**

COMBINED SPINAL EPIDURAL ANESTHESIA
- popular technique due to rapid onset of dense spinal anesthesia combined with flexibility afforded by epidural catheter
- epidural needle placed into epidural space and long spinal needle threaded through epidural needle into subarachnoid space
- desired local anesthetic injected into subarachnoid space
- catheter threaded epidurally through epidural needle (promptly to allow for adequate patient positioning)
- after peak spinal height is established, epidural saline/LA injection can push block height higher (volume effect)
- theoretical concern of total spinal secondary to epidural local anesthetic migration into intrathecal space

REFERENCES

Miller Anesthesia Chapter 51
Barash Chapter 37