Epidural Anesthesia

Epidural anesthesia involves the use of local anesthetics injected into the epidural space to produce a reversible loss of sensation and motor function. Epidural anesthesia requires larger amounts of local anesthetic than a spinal anesthetic. Close attention to the total dose is required to avoid toxicity. Epidural anesthesia is versatile and can be administered by a single injection or through a catheter. The use of a catheter allows the anesthesia provider to add local anesthetics as surgery progresses, extending duration beyond the original dose. Epidural anesthesia can be combined with a general anesthetic or used as the sole anesthetic. In addition, the epidural catheter can be used for postoperative analgesia.

Epidural anesthesia provides excellent operating conditions for surgical procedures below the umbilicus. Procedures include:

- ✓ cesarean section
- ✓ procedures of the uterus, perineum*
- ✓ hernia repairs
- ✓ genitourinary procedures
- ✓ lower extremity orthopedic procedures

In addition, it is an excellent option for the elderly patient who may not tolerate a general anesthetic. It is important not to use an epidural anesthetic in patients who are hypovolemic or severely dehydrated. Patients receiving an epidural anesthetic should be preloaded with .5-1 liter of crystalloid solution, such as ringers lactate, immediately prior to the block.

Epidural anesthesia has a higher rate of failure for surgical procedures in the perineal area. Lower lumbar and sacral nerve roots are large and there is an increase in the amount of epidural fat which can affect local anesthetic penetration and subsequent blockade. This phenomenon is known sacral nerve sparing.

Advantages of Epidural Anesthesia

Several advantages of neuraxial blockade were listed in the Introduction to Neuraxial Blockade section of this manual. Additional advantages specific to epidural anesthesia include:

- Easy to perform (though it takes a bit more practice than spinal anesthesia)
- Reliable form of anesthesia
- Provides excellent operating conditions
- The ability to administer additional local anesthetics increasing duration
- The ability to use the epidural catheter for postoperative analgesia
- Return of gastrointestinal function generally occurs faster than with general anesthesia
- Patent airway
- Fewer pulmonary complications compared to general anesthesia
- Decreased incidence of deep vein thrombosis and pulmonary emboli formation compared to general anesthesia

Disadvantages of Epidural Anesthesia

There are several disadvantages to epidural anesthesia including:

- Risk of block failure. The rate of failure is slightly higher than with a spinal anesthetic. Always be prepared to induce general anesthesia if block failure occurs.
- Onset is slower than with spinal anesthesia. May not be a good technique if the surgeon is impatient or there is little time to properly perform the procedure.
- Normal alteration in the patient's blood pressure and potentially heart rate (generally slower onset with less alteration in blood pressure and heart rate than with a spinal anesthetic). It is essential to place the epidural block in the operating room/preoperative area with monitoring of an ECG, blood pressure, and pulse oximetry. Resuscitation medications/equipment should be available.
- Risk of complications as outlined in Introduction to Neuraxial Blockade chapter. There is an increase in the complication rate compared to spinal anesthesia.
- Continuous epidural catheters should not be used on the ward if the patient's vital signs are NOT closely monitored.
- Risk for infection, resulting in serious complications.

Contraindications

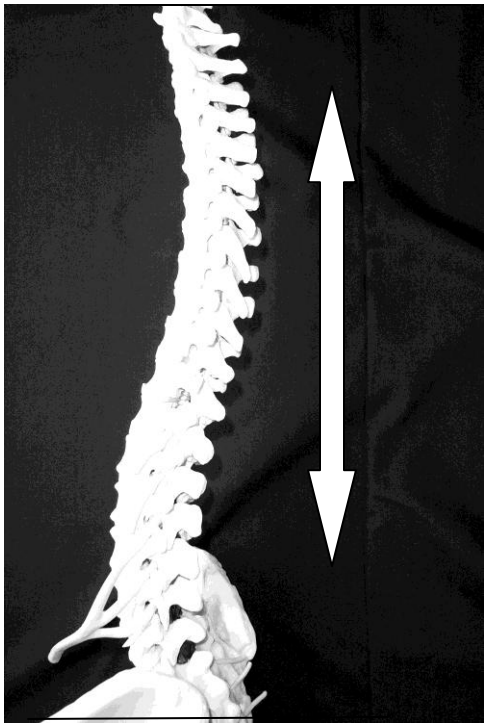
Please review chapter 2 for contraindications.

Site of Action for Local Anesthetics in the Epidural Space

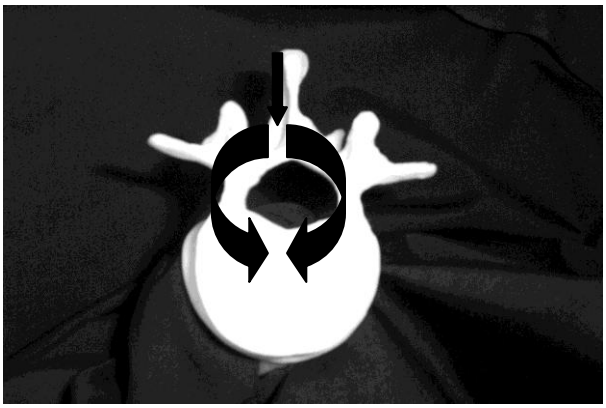
The majority of the local anesthetic administered is absorbed systemically by the rich venous plexus found within the epidural space. Dura surrounding spinal nerve/nerve roots are a modest barrier to the spread of local anesthetics. A small amount of local anesthetic will be absorbed into epidural fat. What remains will eventually reach its intended site of action, the spinal nerve and nerve roots.

Spread of Local Anesthetics within the Epidural Space

Local anesthetics administered in the epidural space move in a horizontal and longitudinal direction. Theoretically, if enough local anesthetic is injected, it could spread up to the foramen magnum and down to the sacral foramina. Clinically, the extent of longitudinal spread is volume dependent and cephalad spread is limited. It has been found that an epidural will spread only 4 additional dermatomes when increasing the volume of local anesthetics from 10ml to 30 ml. Horizontal spread occurs through intervertebral foramina, entering the dural cuff. A small amount of local anesthetic may travel to the anterior epidural space. Diffusion into the CSF occurs at the dural cuff through arachnoid granules.



Longitudinal Movement



Horizontal Movement

Distribution, Uptake & Elimination

It takes approximately 6-8 times the amount of local anesthetic in the epidural space to produce the same degree of blockade with a spinal anesthetic. This is due to the following factors:

- Larger mixed nerves are found in the epidural space.
- Local anesthetics must penetrate the arachnoid and dura mater.
- Local anesthetics are lipid soluble and will be absorbed into tissue and epidural fat.
- Epidural veins absorb a significant amount of local anesthetics. Peak blood concentrations occur 10-30 minutes after a bolus.

Local anesthetics are initially absorbed into epidural veins and diluted in the blood. The pulmonary system acts as a temporary buffer and protects other organs from the toxic effects of local anesthetics. The local anesthetic is redistributed to vessel rich organs, muscles, and fat. Long acting amide local anesthetics are bound to α-1 globulins, which have a high affinity for local anesthetics but become saturated quickly. Amide local anesthetics are metabolized in the liver and excreted by the kidneys. Ester local anesthetics are metabolized by plasma pseudocholinesterase. Rarely are there significant plasma levels.

Factors Affecting Height

Factors that affect the height of epidural anesthesia are fewer and less predictable than spinal anesthesia and include the following:

- Volume of local anesthetic
- Age
- Height
- Gravity

Volume

Dosing an epidural can be variable. Placement of the epidural at an appropriate level is essential. An epidural should be placed at an appropriate level that corresponds to the dermatome level of the intended surgical procedure since epidurals produce a segmental block. The rule of thumb for dosing an epidural is 1-2 ml of local anesthetic per dermatome segment. For example, if an epidural catheter is placed at L4-L5, and for surgical purposes a T4 sensory block is required, dose the patient with 12-24 ml of local anesthetic. There are 4 lumbar dermatomes (L1-L4) to block, as well as 8 thoracic dermatomes (T4-T12) to block, for a total of 12 dermatomes. Twelve (12) dermatomes times 1-2 ml = 12-24 ml of local anesthetic. This is quite a range of local anesthetic. Since the dose may be variable from patient to patient, it is important to dose the epidural in increments while continually assessing block progression. A segmental block for epidural analgesia would require a smaller dose. The volume of local anesthetic plays a crucial role in the block height.

The dose of local anesthetics administered in the thoracic region should be decreased by 30-50% due to a decrease in compliance and volume. Epidurals placed in this anatomical location are used for surgical procedures of the upper abdomen and thorax.

Age

As patients age, less local anesthetic is required to achieve the same level of blockade as their younger counterpart. This is largely due to changes in the size and compliance of the epidural space.

Height

Height plays a role in epidural block height. The shorter the patient, the less anesthetic required to achieve the same level of anesthesia as a tall patient. For example, a patient who is 5'3 may require 1 ml per dermatome, whereas a patient who is 6'3" may require 2 ml per dermatome.

Gravity

Positioning the patient after injection of local anesthetic into the epidural space impacts its spread and height, but not to the degree that it does with spinal anesthesia. For example, positioning the patient in a lateral decubitus position will concentrate local anesthetic and extend block height in the dependent area compared to the non-dependent area. A sitting patient will have more local anesthetic delivered to the lower lumbar and sacral dermatomes. A Trendelenburg or reverse Trendelenburg position may help spread local anesthetic, or limit its spread.

Local Anesthetics used for Epidural Anesthesia

When choosing a local anesthetic for epidural anesthesia, consider the following:

- local anesthetic potency and duration
- surgical requirements and duration
- postoperative analgesia requirements

Seven local anesthetics can be used to produce epidural anesthesia. Only preservative free solutions should be used. Check the label to ensure the solution is "preservative free" and prepared specifically for epidural/caudal anesthesia/analgesia.

Short Acting:

- 2- chloroprocaine

Intermediate Acting:

- lidocaine
- mepivacaine

Long Acting:

- bupivacaine
- etidocaine
- ropivacaine
- levobupivacaine

Short Acting Local Anesthetics

2-Chloroprocaine

2-chloroprocaine is an ester local anesthetic. 2-chloroprocaine initially was associated with neurotoxicity (adhesive arachnoiditis) when large volumes were inadvertently administered in the subarachnoid space. This was attributed to bisulfate. In 1985, a reduced bisulfate solution was introduced. In 1987, a bisulfate free solution was produced. In 1996, a preservative free solution was introduced into clinical practice. Since the formulation of 2-chloroprocaine has been changed, there have been no reports of neurotoxicity. It is important to always check the contents of 2-chloroprocaine to ensure there is no bisulfite or preservative. Some formulations may still have bisulfate, or other preservatives which could cause problems if an inadvertent subarachnoid injection occurs. In addition, large doses of local anesthetics injected in the subarachnoid space may cause neurotoxicity. Back pain can occur after doses > 25 ml have been used. EDTA containing solutions are thought to "leach" calcium out of muscles. The preservative free formulations do not appear to cause back pain.

2-chloroprocaine is best suited for short surgical procedures. There are two concentrations available: 2% and 3%. The 2% concentration can be used for procedures that do not require muscle relaxation (it provides mild muscle relaxation); the 3% concentration provides for dense muscle relaxation. Do not mix epidural opioids with 2-chloroprocaine. 2-chloroprocaine interferes with the analgesic effects of epidural opioids.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
2-chloroprocaine	2%	Fast 10-15 minutes	Analgesic	Mild to moderate	45-60 minutes	60-90 minutes
2-chloroprocaine	3%	Same	Dense	Dense		

Intermediate Acting Local Anesthetics

Lidocaine
Lidocaine is the prototypical amide local anesthetic. For epidural anesthesia, concentrations of 1.5 – 2% are commonly used. Epinephrine will prolong the duration of lidocaine by 50%. The addition of preservative free fentanyl (50-100 mcg) will accelerate the onset of analgesia and create a more potent/complete block.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
Lidocaine	1.5%	Intermediate 15 minutes	Dense	Mild to moderate	80-120 minutes	120-180 minutes
Lidocaine	2%	Same	Dense	Dense		

Mepivacaine
Mepivacaine is similar to lidocaine. It is an amide local anesthetic that lasts about 15-30 minutes longer than lidocaine. Epinephrine will prolong duration by 50%.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
Mepivacaine	1%	Intermediate 15 minutes	Analgesic	Minimal		
Mepivacaine	2%	Same	Dense	Dense	90-140 minutes	140-200 minutes

Long Acting Local Anesthetics

Bupivacaine
Bupivacaine is a long acting amide local anesthetic. For epidural anesthesia, the most common concentrations are 0.5-0.75%. Concentrations for analgesia range from 0.125-0.25%. Epinephrine (1:200:000) will prolong the duration of action of bupivacaine, but is not as reliable as with lidocaine and mepivacaine. Bupivacaine in concentrations of 0.75% should not be used for obstetric anesthesia. The FDA's recommendation in 1983 occurred after several cardiac arrests were reported related to inadvertent intravenous injection. Bupivacaine (in addition to etidocaine) is more likely to impair the myocardium and conduction than other local anesthetics during inadvertent intravenous injection. Patients are difficult to successfully resuscitate due to bupivacaine's high protein binding and lipid solubility, which allow it to accumulate in the cardiac conduction system, resulting in refractory reentrant arrhythmias.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
Bupivacaine	<0.25%	Slow	Dense	Minimal to moderate		
Bupivacaine	0.5-.75%	Same	Dense	Mild to dense	165-225 minutes	180-240 minutes

Levobupivacaine

Levobupivacaine is the S enantiomer of bupivacaine. Clinically it is used in the same concentrations and is indistinguishable from bupivacaine, except for one important fact; it is less cardiotoxic.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
Levobupivacaine	<0.25%	Slow	Dense	Minimal to moderate		
Levobupivacaine	0.5-.75%	Same	Dense	Mild to dense	150-225 minutes	150-240 minutes

Ropivacaine

Ropivacaine is a long acting amide local anesthetic. It is a mepivacaine analogue. Ropivacaine is used in concentrations of 0.5-1% for anesthesia, and 0.1-0.3% for analgesia. Ropivacaine is similar to bupivacaine in onset, duration, and quality of blockade. When used for analgesia it provides excellent sensory blockade with minor motor blockade. It is less cardiotoxic than bupivacaine. Ropivacaine is unique among local anesthetics, since it exhibits a vasoconstrictive effect at clinically relevant doses.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
Ropivacaine	0.1-0.2%	Slow	Analgesic	Minimal		
Ropivacaine	0.5%	Same	Dense	Mild to moderate		
Ropivacaine	0.75-1%	Same	Dense	Dense	140-180 minutes	150-200 minutes

Etidocaine

Etidocaine is a long acting amide local anesthetic. Its use clinically is infrequent due to intense motor blockade. Motor blockade is more intense than sensory. A 1% concentration is used for surgical anesthesia.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
Etidocaine	1%	Slow	Dense	Dense	120-200 minutes	150-225 minutes

Epidural Additives

Epinephrine will increase the duration of action for all epidurally administered local anesthetics. Differences exist in the extent of increase among individual local anesthetics. The greatest increases are found with lidocaine, mepivacaine, and 2-chloroprocaine. It is less effective for bupivacaine, levobupivacaine, and etidocaine. Epinephrine is not added to ropivacaine due to its inherent vasoconstrictive effects. When epinephrine is compared to phenylephrine, it has been found that epinephrine is more effective in reducing peak blood levels of local anesthetics.

It is well known that epinephrine has an antinociceptive effect when injected into the subarachnoid space. Epinephrine exerts its analgesic effect through an α2 adrenergic effect in the substantia gelatinosa of the dorsal horn. The small doses of epinephrine added to epidural local anesthetics are not entirely responsible for analgesia. Reducing absorption of local anesthetics and opioids allows for a prolonged exposure to their site of action resulting in a prolonged and intense effect. Combining local anesthetics (NA+ channels), opioids (mu receptors), and epinephrine (α2 adrenergic receptors) allows for a multi modal approach to treating pain through synergism.

Sodium bicarbonate added to local anesthetics such as lidocaine, mepivacaine, and 2-chloroprocaine, appears to have several positive effects, including an increase in the concentration of free base, which enhances the rate of diffusion, speeding onset. Studies have found that the addition of sodium bicarbonate to 1.5% lidocaine produces a significantly faster onset of sensory blockade/anesthesia, and a more complete block. One (1) meq of bicarbonate is added to every 10 ml of local anesthetic (i.e. lidocaine, mepivacaine, 2-chloroprocaine). The addition of bicarbonate to bupivacaine is less popular since precipitation occurs above a pH of 6.8. If bicarbonate is added, it should be in a ratio of 0.1 ml of bicarbonate to every 10 ml of bupivacaine.

Agent	Concentration	Onset	Sensory Block	Motor Block	Plain Solution	1:200,000 Epinephrine
Short Acting Local Anesthetics						
2-chloroprocaine	2%	Fast 10-15 minutes	Analgesic	Mild to moderate	45-60 minutes	60-90 minutes
2- chloroprocaine	3%	Same	Dense	Dense		
Intermediate Acting Local Anesthetics						
Lidocaine	1.5%	Intermediate 15 minutes	Dense	Mild to moderate	80-120 minutes	120-180 minutes
Lidocaine	2%	Same	Dense	Dense		
Mepivacaine	1%	Intermediate 15 minutes	Analgesic	Minimal		
Mepivacaine	2%	Same	Dense	Dense	90-140 minutes	140-200 minutes
Long Acting Local Anesthetics						
Bupivacaine	<0.25%	Slow	Dense	Minimal to moderate		
Bupivacaine	0.5-.75%	Same	Dense	Mild to dense	165-225 minutes	180-240 minutes
Levobupivacaine	<0.25%	Slow	Dense	Minimal to moderate		
Levobupivacaine	0.5-.75%	Same	Dense	Mild to dense	150-225 minutes	150-240 minutes
Ropivacaine	0.1-0.2%	Slow	Analgesic	Minimal		
Ropivacaine	0.5%	Same	Dense	Mild to moderate		
Ropivacaine	0.75-1%	Same	Dense	Dense	140-180 minutes	150-200 minutes
Etidocaine	1%	Slow	Dense	Dense	120-200 minutes	150-225 minutes

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