Introduction

Anatomy

– Epidural space – base of skull (foramen magnum) to the coccyx (sacroccocygeal membrane)

_The epidural space surrounds the dura mater posteriorly, laterally, and anteriorly. Nerve roots travel in this space as they exit laterally through the foramen and course outward to become peripheral nerves

– Distance from skin to epidural space – 4-5 cm

– Epidural space contains loose areolar tissue, fat, arterial and venous networks, lymphatics, spinal nerve roots
Introduction

Epidural (extradural) anesthesia involves the use of local anesthetics injected into the epidural space (space outside dura) to produce a reversible loss of sensation and motor function. This space extends from the craniocervical junction at C1 to the sacrococcygeal membrane, and anesthesia can theoretically be safely instituted at any level in between. Continuous epidural anesthesia is a neuraxial technique offering a range of applications wider than single-dose spinal anesthesia.
Introduction

In practice, an epidural is sited adjacent to the nerve roots that supply the surgical site; that is, the lumbar region is used for pelvic and lower limb surgery and the thoracic region for abdominal surgery. A single injection of local anesthetic can be given but more commonly, a catheter is inserted into the epidural space and either repeated injections or a constant infusion of a local anesthetic drug is used.

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.
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.
Factors Affecting Level of Block

Factors affecting the level of epidural anesthesia may not be as predictable as with spinal anesthesia. In adults, 1 to 2 mL of local anesthetic per segment to be blocked is a generally accepted guideline. For example, to achieve a T4 sensory level from an L4–L5 injection would require about 12 to 24 mL. For segmental or analgesic blocks, less volume is needed.
Factors Affecting Level of Block

**Age**: The dose required to achieve the same level of anesthesia decreases with age.

**Height**: Patient height affects the extent of cephalad spread. Thus, shorter patients may require only 1 mL of local anesthetic per segment to be blocked, whereas taller patients generally require 2 mL per segment.

**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.

**Volume**: The volume of local anesthetic plays a crucial role in the block height. For example, to achieve a T4 sensory level from an L4–L5 injection would require about 12 to 24 mL. For segmental or analgesic blocks, less volume is needed.
Factors Affecting Level of Block

**Drug Used**: Additives to the local anesthetic, particularly opioids, tend to have a greater effect on the quality of epidural anesthesia than on the duration of the block. Epinephrine in concentrations of 5 mcg/mL prolongs the effect of epidural lidocaine, mepivacaine, and chloroprocaine more than that of bupivacaine, levobupivacaine, or ropivacaine. In addition to prolonging the duration and improving the quality of block, epinephrine delays vascular absorption and reduces peak systemic blood levels of all epidurally administered local anesthetics.
Failed Epidural Blocks

Unlike spinal anesthesia, in which the procedural endpoint is usually very clear (free-flowing CSF), the onset is very fast, and the technique has a very high success rate, epidural anesthesia is dependent on detection of a more subjective loss of resistance (or hanging drop). Also, the onset of epidural anesthesia is slower, and the more variable anatomy of the epidural space and less predictable spread of local anesthetic make epidural anesthesia inherently less predictable than spinal anesthesia.

Misplaced injections of local anesthetic can occur in a number of situations. In some patients, the spinal ligaments are soft, and either good resistance is never appreciated or a false loss of resistance is encountered. Similarly, entry into the paraspinal muscles during an off-center midline approach may cause a false loss of resistance. Other causes of failed epidural anesthesia (such as intrathecal, subdural, and intravenous injection) are discussed in the late section of this chapter on complications.
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:
- chloroprocaine

Intermediate Acting:
- lidocaine
- mepivacaine

Long Acting:
- Bupivacaine
- etidocaine
- ropivacaine
- levobupivacaine
<table>
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<tr>
<th>Agent</th>
<th>Concentration</th>
<th>Onset</th>
<th>Sensory Block</th>
<th>Motor Block</th>
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<tr>
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<td>2%</td>
<td>Fast</td>
<td>Analgesic</td>
<td>Mild to moderate</td>
</tr>
<tr>
<td></td>
<td>3%</td>
<td>Fast</td>
<td>Dense</td>
<td>Dense</td>
</tr>
<tr>
<td>Lidoctiane</td>
<td>≤1%</td>
<td>Intermediate</td>
<td>Analgesic</td>
<td>Minimal</td>
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<tr>
<td></td>
<td>1.5%</td>
<td>Intermediate</td>
<td>Dense</td>
<td>Mild to moderate</td>
</tr>
<tr>
<td></td>
<td>2%</td>
<td>Intermediate</td>
<td>Dense</td>
<td>Dense</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>1%</td>
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<td>Analgesic</td>
<td>Minimal</td>
</tr>
<tr>
<td></td>
<td>2–3%</td>
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<td>Dense</td>
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<tr>
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<td>≤0.25%</td>
<td>Slow</td>
<td>Analgesic</td>
<td>Minimal</td>
</tr>
<tr>
<td></td>
<td>0.5%</td>
<td>Slow</td>
<td>Dense</td>
<td>Mild to moderate</td>
</tr>
<tr>
<td></td>
<td>0.75%</td>
<td>Slow</td>
<td>Dense</td>
<td>Moderate to dense</td>
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<tr>
<td>Ropivacaine</td>
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<td>Slow</td>
<td>Analgesic</td>
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<td>0.5%</td>
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<tr>
<td></td>
<td>0.75–1.0%</td>
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Types – selective blockade possible because it can be performed at any level of spine
- Cervical epidural
- Thoracic epidural
- Lumbar epidural
- Caudal epidural
Epidural Technique

Preparation

Prepare the patient. Discuss options, risks and benefits. Explain what to expect during an epidural anesthetic.

Positioning

Proper positioning is essential for a successful block.

There are three positions used for the administration of epidural anesthesia: lateral decubitus, sitting, and prone (Used for caudal approach in adults).
Patient Positioning
A. Sitting Position
The anatomic midline is often easier to identify when the patient is sitting than when the patient is in the lateral decubitus position (Figure 45–12). This is particularly true with obese patients. Patients sit with their elbows resting on their thighs or a bedside table, or they can hug a pillow.
FIGURE 45-12 Sitting position for neuraxial blockade. Note an assistant helps in obtaining maximal spinal flexion.
B. Lateral Decubitus

Many clinicians prefer the lateral position for neuraxial blocks (Figure 45–14). Patients lie on their side with their knees flexed and pulled high against the abdomen or chest, assuming a “fetal position.” An assistant can help the patient assume and hold this position.
FIGURE 45-14 Lateral decubitus position for neuraxial blockade. Note again the assistant helping to provide maximal spine flexion.
Anatomic Approach

A. Midline Approach

For epidural anesthesia,

a sudden loss of resistance (to injection of air or saline) is encountered as the needle passes through the ligamentum flavum and enters the epidural space.
Anatomic Approach

B. Paramedian Approach

The paramedian technique may be selected, particularly if epidural or subarachnoid block is difficult, particularly in patients who cannot be positioned easily (eg, severe arthritis, kyphoscoliosis, or prior spine surgery) (Figure 45–15). Many clinicians routinely use the paramedian approach for thoracic epidural puncture.
FIGURE 45-4 Lumbar epidural anesthesia; midline approach.

FIGURE 45-15 Paramedian approach.
Two techniques make it possible to determine when the tip of the needle has entered the potential (epidural) space: the “loss of resistance” and “hanging drop” techniques.
Technique

Patients are placed in the left lateral/sitting position

Activating an Epidural

The quantity (volume and concentration) of local anesthetic needed for epidural anesthesia is larger than that needed for spinal anesthesia. Toxic side effects are almost guaranteed if a “full epidural dose” is injected intrathecally or intravascularly. Safeguards against toxic epidural side effects include test dosing and incremental dosing. These safeguards apply whether the injection is through the needle or through an epidural catheter.
A test dose is designed to detect both subarachnoid and intravascular injection. The classic test dose combines local anesthetic and epinephrine,

Unfortunately, epinephrine as a marker of intravenous injection is not ideal. False positives (a uterine contraction causing pain or an increase in heart rate coincident to test dosing) and false negatives (bradycardia and exaggerated hypertension in response to epinephrine in patients taking β-blockers) can occur. Simply aspirating prior to injection is insufficient to avoid inadvertent intravenous injection; most experienced practitioners have encountered falsenegative aspirations through both a needle and a catheter.
Incremental dosing is a very effective method of avoiding serious complications (“each dose is a test dose”). If aspiration is negative, a fraction of the total intended local anesthetic dose is injected, typically 5 mL. This dose should be large enough for mild symptoms (tinnitus or metallic taste) or signs (slurred speech, altered mentation) of intravascular injection to occur, but small enough to avoid seizure or cardiovascular compromise. This is particularly important for labor epidurals that are to be used for cesarean delivery.
If the initial labor epidural bolus was delivered through the needle, and the catheter was then inserted, it may be erroneously assumed that the catheter is well positioned because the patient is still comfortable from the initial bolus. If the catheter was inserted into a blood vessel, or after initial successful placement, has since migrated intravascularly, systemic toxicity will likely result if the full anesthetic dose is injected. Catheters can migrate intrathecally or intravascularly from an initially correct epidural position at any time after placement, but migration is most likely to occur with movement of the patient.
Indications

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
Indications

Continue...

• May be used in
  – Poor risk patients
  – Cardiac diseases
  – Pulmonary diseases
  – Metabolic disturbances
  – When GA is contraindicated
  – When spinal anesthesia is contraindicated
  – Painful conditions including post-op pain relief
Contraindications – similar to spinal

• Severe hemorrhage
• Coagulation defects (hematoma formation)
• Previous laminectomy
• Uncooperative, Patient refusal
• Local inflammation at site
Advantages

• Well-defined area of anesthesia
• Longer duration
• More severe disturbances of spinal anesthesia minimized
• Return of gastrointestinal function generally occurs faster than with general anesthesia
• The ability to use the epidural catheter for postoperative analgesia
• Less respiratory effects
• Patent airway
• Decreased incidence of deep vein thrombosis and pulmonary emboli formation compared to general anesthesia
Disadvantages

• Technically more difficult
• Muscle relaxation not complete
• Large volume necessary
• Danger of dural puncture
• 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.
Thank you!