Considerations for Thoracic Epidural and Paravertebral Analgesia

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Acknowledgements

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General

Thoracotomies are among the most painful of surgical incisions. Postoperatively, the movement of the chest with each breath increases the pain, and patients often “splint” to the point of hypercapnea or hypoxia. Substantial analgesia is required to avoid postoperative respiratory complications, but heavy opioid use blunts the respiratory drive and may itself be associated with postoperative complications. Thoracic epidural and paravertebral analgesia can provide this relief, but are sometimes avoided due to anesthesiologists’ concerns about potential difficulty of placement, and the additional dangers of performing an epidural catheter placement in the thoracic region.

There are significant differences between the lumbar and thoracic epidural anatomy, and thus the technique also needs to be different. The anatomy of the thoracic spine is considerably different from the lumbar region, the spinal cord lies easily within needle range, and pneumothorax is always a possibility. As seen in Figure 1, the posterior spinous processes of T6-T10 are significantly more angled and thus overlap one another more than in the cervical or epidural region. This overlap and the downward angle require that a midline approach requires a needle placement of at least 45 degrees to the spinal column, as opposed to the nearly 90 degree approach possible in the lumbar region. This angle can be acute enough that the needle actually impacts the underside of the upper spinous process prior to entering the epidural space. As can be appreciated by examining a skeleton, there are articulating surfaces on the underside of the spinous processes that can obstruct the passage of a needle advanced in the midline. As will be demonstrated in the workshop, and can been seen in the Figure 2, a paramedian and/or paravertebral approach is highly beneficial in the thoracic region. For epidural placement, it permits a significantly less angled approach, so that the epidural space will be encountered at a predictable depth in most patients.

Thoracic Epidural

Patients should be monitored with a 3 lead ECG (heart rate and rhythm during test dose); blood pressure, and pulse oximetry.
Patient positioning is critical to easy and accurate thoracic epidural placement. The patient should be sitting, with the legs supported on a chair. The patient should rest their arms on a bedside table or grasp pillows, so that they can curve their spine as much as possible. It is advantageous to prep widely and place the sterile drape below the targeted interspace, so that the cervical and upper thoracic spine is visible. A suggested procedure is as follows:

- Identify the thoracic interspace in the midline
- Place the index finger of the left hand in this space, and the middle finger in the space above. The “window” to the epidural space will be located 1-1.5 cm to the right (or left), and midway between the two fingers.
- Use the local anesthetic placement to identify the path to the epidural space—i.e., use the 21 gauge needle to go directly down to the upper medial part of the lamina, anesthetizing all the way. When contact is made with the lamina, redirect the needle toward the midline, and slightly upward. Walk the needle off the lateral process, AND STOP! The epidural space should be found 1-1.5 cm further in the same line. Note the depth of the 21 G needle—this alerts one to depth of the epidural space when you place the Tuohy needle.
- Now that you know the “path”, reproduce what you just did with the epidural needle. Loss of resistance with air/saline or hanging drop can be used to identify the epidural space after passing through the ligamentum flavum. Once the epidural space is entered, thread the catheter. IF THE CATHETER DOES NOT THREAD, YOU ARE NOT IN THE EPIDURAL SPACE. Do not inject saline to help the catheter thread; START OVER. The thoracic epidural space seems to be much “cleaner” and more open than the lumbar epidural space, and catheters thread easily once you have found the true space.
- Test dose—3 mL of 1.5% lidocaine is a good test dose. Another clue that you are in the space is that the HR generally decreases 3-5 BPM during injection—not every time, but usually. If the blood pressure remains stable, another 2-3 mL should be sufficient to generate an analgesic band that can be identified using ice. BE VERY CAREFUL AND PATIENT—5 mL of 1.5% in the thoracic region can result in significant hypotension, especially in older patients. Thoracic epidurals seem to “set up” faster than lumbar epidurals, but still can take 10-15 minutes.

Paravertebral

Introduction: The thoracic paravertebral block is a technique of injecting local anesthetic in the vicinity of the thoracic spinal nerves emerging from the intervertebral foramen with the resultant ipsilateral somatic and sympathetic nerve blockade. The resultant anesthesia or analgesia is conceptually similar to a "unilateral" epidural anesthesia. Higher or lower levels can be chosen to accomplish a unilateral, band-like, segmental blockade at the desired levels without significant hemodynamic changes. This technique is one of the easiest and most time efficient to perform, but more challenging to teach because it requires stereotactic needle maneuvering. A certain "mechanical" mind or sense of geometry is necessary for mastering it. This block is performed in
our practice most commonly for surgery in patients undergoing breast (mastectomy and cosmetic breast surgery) and thoracic surgery. A catheter can also be inserted for continuous infusion of local anesthetic, even in patients on anticoagulants.

**Anatomy:** The thoracic paravertebral space is a wedge-shaped area that lies on either side of the vertebral column. Its walls are formed by the parietal pleura anterolaterally, vertebral body, the intervertebral disk, and intervertebral foramen medially, and the superior costo-transverse process posteriorly. The spinal nerves in the paravertebral space are organized in small bundles submerged in the fat of the area. At this location, a thick fascial sheath does not envelop the spinal nerves. Therefore, they are relatively easily anesthetized by injection of local anesthetic. The thoracic paravertebral space is continuous, with the intercostal space laterally, epidural space medially, and the contralateral paravertebral space via the prevertebral fascia. The mechanism of action of a paravertebral blockade includes direct penetration of the local anesthetic into the spinal nerve, extension laterally along with the intercostal nerve, and medial extension through the intervertebral foramina.

**Distribution of Effect:** Thoracic paravertebral blockade results in ipsilateral dermatomal anesthesia. The location of the resulting dermatomal distribution of anesthetia or analgesia is a function of the level blocked and the volume of local anesthetic injected.

**Patient position:** The patient is positioned in the sitting or lateral decubitus position and supported by an attendant. The back should assume kyphosis, similar to a position required for neuraxial anesthesia. The patient's feet are rested on a stool to allow for greater patient comfort and a greater degree of kyphosis. This increases the distance between the adjacent transverse processes and facilitates advancement of the needle beyond the contact with the transverse process.

**Equipment** Sterile towels and 4"x4" gauze packs, 20-mL syringes with local anesthetic, Sterile gloves, marking pen, and surface electrode, One 1½” 25-gauge needle for skin infiltration, A 10-cm long, 22-gauge, Quincke or Tuohy tip spinal needle

**Landmarks** The following surface anatomy landmarks are used to identify spinal levels and estimate the position of the transverse processes:

1. Spinal process at the desired thoracic dermatomal levels (midline)
2. Tips of scapulae (corresponds to T7)
3. Paramedial line 2.5 cm lateral to the midline

**TIPS:**

- It should be noted that labeling the position of each individual transverse process at the level to be blocked is, at best, a rough estimation.
- It is more practical to outline the midline instead and simply draw the line 2.5 cm lateral to it. All injections will be along this line. Once two first transverse processes are identified, the rest will follow the same cranial-caudal spacing.

**Technique** After cleaning the skin with an antiseptic solution, 6-8 mL of dilute local anesthetic is infiltrated subcutaneously alongside the line (2.5 cm lateral to midline) where the injections will be
made. The injection should be carried out slowly to avoid pain on injection. New needle reinsertions should be made through already anesthetized skin.

**Needle Insertion**  The needle is inserted perpendicular to the skin, while constantly paying attention to the depth of needle insertion and the medial-lateral needle orientation. The utmost care should be paid to avoid medial needle direction (risk of epidural or spinal injection). After the transverse process is contacted, the needle is withdrawn to the skin and redirected superior or inferior to walk off the transverse process. The ultimate goal is to insert the needle to a depth of 1 cm past the transverse process. A certain "give" occasional can be felt as the needle passes through the costotransverse ligament, however, this is nonspecific and should not be relied on.

**TIP:** The block procedure essentially consists of 3 maneuvers

1. Contact the transverse process of the individual vertebrae and note the depth at which the process was contacted (usually 2-4 cm), needle #1.
2. Withdraw needle to the skin level and reinsert at a 10° caudal or cephalad needle angulation.
3. Walk off the transverse process 1 cm deeper to the transverse process and inject 3-5 mL of local anesthetic
4. Once the transverse process is contacted, the needle should be regripped so that the gripping fingers allow 1 cm deeper insertion
5. While some authors suggest using a loss of resistance technique to identify the paravertebral space, such a change of resistance is very subtle and nonspecific at best. For this reason, we do not pay attention to the loss of resistance but carefully measure the skin to transverse distance and simply advance the needle 1 cm past the process.
6. Never redirect the needle medially because of the risk of intra-foraminal needle passage and a consequent spinal cord injury.
7. Use common sense in advancing the needle. The depth at which the transverse processes are contacted vary with a patient's body habitus and the level at which the block is performed. The deepest levels are at the high thoracic (T1,2) and low lumbar levels (L4,5) where the transverse process is contacted at a depth of 6-8 cm in average sized patients. The shallowest depth is at the mid-thoracic levels (T5,10) where the transverse processes are contacted at 2-4 cm in an average sized patient.
8. Never disconnect the needle from the tubing or syringe with local anesthetic in while the needle is inserted. Instead, use a stopcock to switch from syringe to syringe during injection.

**Choice of local anesthetic**

It is almost always beneficial to achieve longer acting anesthesia/analgesia in thoracic paravertebral blockade by using longer acting local anesthetic. Unless lower lumbar levels (L2-5) are planned to be blocked, paravertebral blocks do not result in motor block of an extremity and do not impair patient's ability to ambulate or take care of themselves. In addition, relatively small volumes injected at several levels do not present a concern for local anesthetic toxicity.
<table>
<thead>
<tr>
<th>Local Anesthetic</th>
<th>Onset (min)</th>
<th>Anesth (hours)</th>
<th>Analg (hours)</th>
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</thead>
<tbody>
<tr>
<td>1.5% Mepivacaine (plus HCO3; plus epinephrine)</td>
<td>10-20</td>
<td>2-3</td>
<td>3-4</td>
</tr>
<tr>
<td>2% Lidocaine (plus HCO3 + epinephrine)</td>
<td>10-15</td>
<td>2-3</td>
<td>3-4</td>
</tr>
<tr>
<td>0.5% Ropivacaine</td>
<td>15-25</td>
<td>3-5</td>
<td>8-12</td>
</tr>
<tr>
<td>0.75% Ropivacaine</td>
<td>10-15</td>
<td>4-6</td>
<td>12-18</td>
</tr>
<tr>
<td>0.5% Bupivacaine (plus epinephrine)</td>
<td>15-20</td>
<td>4-6</td>
<td>12-18</td>
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<tr>
<td>0.5% I-Bupivacaine (plus epinephrine)</td>
<td>12-25</td>
<td>4-6</td>
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**TIP:** In patients receiving multiple level blockade, consider using alkalinized 3-chloroprocaine for skin infiltration to decrease the total dose of the more toxic long-acting local anesthetic. Chloroprocaine is rapidly metabolized by plasma cholinesterase on its absorption.

**Block Dynamics and Perioperative Management**  Placement of the paravertebral block is associated with moderate patient discomfort. Adequate sedation (midazolam 2-4 mg or propofol) is always necessary to facilitate placement of the block. However, excessive sedation should be avoided because the positioning becomes difficult when patients cannot keep their balance in the sitting position. The blockade depends on anesthetic dispersion within the space to reach the individual roots at the level of the injection. The first sign of the blockade is the loss of pin-prick sensation at the dermatomal distribution of the root being blocked. The higher the concentration and volume of the local anesthetic used, the faster the onset can be expected.

**Complications and How to Avoid Them**

*Infection:* Strict aseptic technique

*Hematoma:* Avoid multiple needle insertions in anticoagulated patient

*Local Anesthetic Toxicity:* This is rare but may occur with large volumes of long-acting anesthetic. Be cautious with older and frail patients. Consider using chloroprocaine for skin infiltration to decrease the total dose/volume of the more toxic, long-acting local anesthetic

*Nerve Injury:* Local anesthetic should never be injected when a patient complains of severe pain or exhibits a withdrawal reaction on injection

*Total Spinal Anesthesia:* Avoid medial angulation of the needle, which can result in an inadvertent epidural or subarachnoid needle placement. Aspirate before injection (for blood and CSF)

*Quadriceps muscle weakness:* This can occur when the levels are not accurately determined and the levels below L1 are blocked (femoral nerve; L2-4)

*Paravertebral muscle pain:* Paravertebral muscle pain, resembling a muscle spasm, is occasionally seen, particularly in young, muscular men and when a larger gauge Tuohy needle is used. Injection of local anesthetic into the paravertebral muscle before needle insertion and the use of a smaller gauge (e.g. 22 gauge) Quincke tip needle is suggested to avoid this side effect

*Pneumothorax:* Careful aspiration for air, do not advance needle greater than one cm past transverse process.