Managing Epidurals in Children

Kenneth Goldschneider, MD, FAAP, Cincinnati Children’s Hospital Medical Center; John Rose, MD, FAAP (Moderator), Children’s Hospital of Philadelphia; Suresh Thomas, MD, Children’s Hospital of Arkansas; and Lynda Wells, MD, DABPM, University of Texas Health Sciences Center at San Antonio.

Over the last 25 years a renaissance of pediatric epidural analgesia has occurred. Although regional anesthesia is rarely employed as the sole means of providing surgical anesthesia for pediatric patients, it is increasingly used in combination with general anesthesia to reduce the amount of general anesthetics administered, attenuate the stress response of surgery, facilitate a rapid emergence from general anesthesia, and most importantly to provide incomparable postoperative analgesia.

Many of the principles of safe pediatric epidural anesthesia practice are adopted from those developed for adult patients. However, children are not small adults and several principles have been modified so that children can enjoy the benefits of epidural anesthesia. Most notably, epidural anesthesia is routinely performed with the adult patient awake or lightly sedated so that they can report symptoms during the block. A report of paresthesias during the placement of the block needle or during the injection of local anesthetic heralds the close proximity of the needle to neural structures or an intraneural injection prompting an immediate cessation of the block and avoidance of nerve injury. The fully conscious adult can also report symptoms of ringing in the ears or a metallic taste indicating an inadvertent intravascular injection. However, the performance of epidural blocks can be associated with significant discomfort which is to be avoided in children and can result in severe anxiety, an inability to cooperate, and sudden, unpredictable movement. Finally, children are not able to understand the concept of paresthesia nor can they reliably differentiate between pain and pressure at the site of the block and paresthesia. Thus the performance of epidural anesthesia in awake children can be difficult and dangerous, and the information obtained from a conscious child during the block may be unreliable or misleading. Consequently, as has been recently expressed in an editorial, many pediatric anesthesiologists believe that regional anesthesia must be performed in sedated or anesthetized children (Krane et al. The Safety of Epidurals Placed During General Anesthesia. Regional Anesthesia and Pain Medicine 23: 433-438; 1998). This belief is based on mounting clinical data involving pediatric patients and the collective experience and judgement of pediatric anesthesiologists from around the world. The actual risk of permanent neurological injury as a consequence of placing epidural catheters in anesthetized children is unknown but believed to be small. In fact there is no data to suggest that performing regional blocks in awake children reduces these complications. Many Pediatric anesthesiologists believe that complications such as neural injury, soft tissue injuries, dural puncture, and block failure would be increased by routinely performing regional anesthesia in awake children.

In this workshop we will be exploring several topics pertaining to the practice of pediatric epidural analgesia including a review of neurological complications of epidural analgesia, thoracic epidural analgesia in neonates and small infants, the pharmacology of epidural analgesia, and troubleshooting common problems that occur in children receiving epidural analgesia.
1. Baby Epidurals: A Review of Techniques

Kenneth R. Goldschneider, MD, FAAP
kenneth.goldschneider@cchmc.org

Objectives:
At the end of the workshop, participants will be able to:
1. identify approaches to the thoracic epidural space in neonates and infants
2. discuss the pros and cons of each approach
3. appreciate issues in post-operative management of such epidurals

Introduction:
There are both limitations as well as advantages to the technical approach to the neuraxis in neonates. The emphasis here is on epidurals whose site of action is the thoracic level. Four approaches present themselves, and can be used for infants of any age; we use them most for infants under 6 months of age. Before proceeding with any neuraxial procedure in neonates, one must check the sacrum for evidence of spinal dysraphism (sinus tract, deep pit, hair patch).

Thoracic Approach:
Proponents of this technique suggest using a Crawford needle, due to its very blunt bevel. There are those who consider the risks of spinal cord injury too high with this approach and do not perform it. Certainly, it is not a technique for beginners, and will not be discussed further.

Lumbar to thoracic Approach:
The depth at the lumbar levels is deeper than in the thoracic levels. Additionally, the risks pursuant to a dural puncture are less, assuming that the puncture occurs below the conus medullaris. Note, however, that the conus is found at the L2-3 level in neonates, as opposed to the L1 level in older children and adults. LOR to saline with continuous pressure is preferred. Coaxing the catheter into the thoracic region can be challenging. Fluoroscopic guidance can be very helpful here, as there can be a tendency for the catheter to loop in the lumbar epidural space.

Modified Taylor Approach:
This approach is my preferred technique. The reasons are several. The L5-S1 interspace is the largest in the neuraxis, allowing easy identification, and manipulation of the needle (see below). The ligament is relative thick promoting good LOR, and a dural puncture here would fall well below the conus medullaris in all neonates. In addition, the space is high enough above the anus to reduce the risk of stool contamination.

Landmarks include the posterior superior iliac spines, which are almost exactly at the L5-S1 level. The spinous processes are not prominent, but the interspace feels like a large, soft depression in the midline. We use a Crawford needle and styletted catheter. The distance form the level of insertion to the desired final dermatome is measured prior to needle insertion. The initial approach is a modestly angled rostrally, using LOR to saline with continuous pressure. Once LOR is felt, we inject a small amount of saline to open the space, and drop the angle of the needle to ~20-30 degrees (almost parallel with the lumbar spine). The catheter is then inserted, being very careful not to use undue pressure to advance the catheter to the premeasured distance.
If any resistance is felt, the catheter is withdrawn, and rotated slightly and readvanced. Sometimes a twisting motion can aid smooth advancement of the catheter. Other times, a little more saline is useful, or dropping the angle of the needle will give the desired result. The catheter usually ends up where you want it, although fluoroscopy can be quite helpful. Although the Tsui nerve stimulation technique was described for caudal catheters, it could be used here as well.

**Caudal to Thoracic Approach:**
There are a couple techniques to consider. One technique is to use a Crawford (or Touhy) needle with LOR to saline. A small amount of saline is injected to open the space, and the catheter advance carefully to the desired level. Another approach (the one we use) is to insert an 18ga IV catheter as one would for a one shot caudal. Care must be taken to prevent advancing the relatively long-beveled stylet needle through the dura. The IV catheter is advanced over the stylet as far as possible, then the epidural catheter inserted through that. Once the epidural catheter is at the correct level, the IV catheter is removed along with the epidural catheter’s stylet. The next issue is dressing the insertion site. The main challenge is that the site is just above, or at, the top of the intergluteal fold. Finding a way to prevent the dressing from being lifted off of the skin and stool from tracking along the intergluteal fold and under the dressing requires generous amount of mastic gum or benzoic acid and creative use of dressing materials.

**Post-Operative Issues:**
Once the catheter is in proper position, an infusion of medication can be started. We use either 0.1% bupivacaine with 2μg/mL Fentanyl at ~0.2mL/kg/hr or 1.5% chloroprocaine at rates between 0.3 – 1 mL/kg/hr. We monitor all neonates and infants for apnea and bradycardia. One of the larger practical issues to deal with is coordination of care with the neonatology team. Epidural analgesia is still a rather new modality in many NICUs. You may need to educate the nursing staff and medical staff about the use of epidurals, the function and management of the pumps, what the site should look like, and the role for adjunct medications.
2. Epidural Pharmacology

Suresh Thomas, M.D.
University of Arkansas Medical Center

The role of epidural anesthesia and analgesia in reducing the incidence and severity of perioperative physiologic derangements, in addition to relieving pain has been confirmed by many studies. There is a lot of information now available regarding the use of different agents either exclusively or in various combinations in the epidural space. The increased clinical use of these additives has increased our understanding of both the advantages and disadvantages these additives. The commonly used additives include local anesthetics, different opioids, clonidine, ketamine and neostigmine. It is important to have a clear understanding of the pharmacology of the different additives, to help make the right choice of which additives to use, based on the particular needs of each individual patient during the perioperative period in order to provide a high quality of pain control.

Learning Objectives
At the completion of this activity, participants should be able to:

- Discuss the ever-expanding role of different epidural additives to provide improved postoperative outcomes.
- Understand the potential benefits/risks of each of these additives in children.
- Discuss their dosing recommendations.
- Formulate an appropriate epidural perioperative analgesic plan for individual patients based on their surgical and postoperative requirements.

References


3. Troubleshooting epidural catheters and optimizing epidural analgesic management

Lynda T. Wells, M.D., DABPM

The problems most commonly encountered when managing epidural analgesia involve catheters, infusion pumps, failure of efficacy and side effects. A review of epidural morbidity in pediatric patients revealed that the majority of complications arose from using inappropriate equipment\(^1\). This was most likely to occur in non-Children’s hospitals. Drug administration errors accounted for the remaining complications\(^1\).

Many problems can be mitigated by appropriate education and infrastructure: applying the premise that “prevention is better than cure”. In our Institution (a University teaching hospital, with a pediatric floor and no dedicated pediatric OR) introducing a framework for the care of the pediatric patient with epidural analgesia was the most important issue addressed. The recovery room and pediatric nursing staffs, as the interface between the patient and the pain service, played an essential role in guiding policies and procedures. The nursing staff particularly wanted the protocol included with the epidural orders. Consequently the epidural order set currently in use at our Institution has standardized orders on one side and a review of the care of the epidural patient on the reverse (figures 1 & 2). Additionally, all nursing staff and physicians involved in epidural management participated in the selection of the infusion pump. Delivery tubing should not have any injections ports to prevent inadvertent epidural injection. In-service training, with periodic refresher courses, is provided regularly and memory cards describing basic pump use are provided to all personnel.

Catheter-related problems include kinking, occlusion, migration, disconnection and leakage. Kinking is more likely to occur when smaller gauge (e.g. 24-22 FG) catheters are used, especially when employing a catheter over the needle technique. The largest catheter that can be accommodated through or over the needle should be used. Single orifice catheters are described as being more prone to occlusion than those with many orifices. However, care must be taken when using multi-orifice catheters to ensure that all the openings are within the epidural space or inadequate analgesia may ensue. Commercial infusion pumps cannot overcome the high resistance to flow through narrower catheters at high flow rates and will indicate “occlusion” even when patent. If narrow catheters are to be used with continuous infusions of medication, formulations should be selected to allow administration at a low flow rate.

Children with good analgesia are active and at risk for catheter dislodgment. Catheters can be made more secure by tunneling, or the application of mastisol® and steristrips® prior to placing an occlusive dressing and taping the edges and catheter to the skin. Securing the catheter connection on the anterior/superior aspect of the shoulder usually protects it from accidental disconnection while allowing the child to lie and play comfortably.

Leakage is significant if it prevents delivery of a therapeutic dose or causes local irritation. Application of a gauze pad and compressive dressing may be effective. Application of adhesive solutions, e.g. mastisol®, around the catheter site may create a better seal between the catheter and the skin. Tunneled catheters are less likely to leak than those not tunneled.
Failure of efficacy requires thorough evaluation by history and physical examination. Is the pain complained of in the area of previous epidural analgesia? Is there a separate and different pain, e.g. headache? Has the epidural ever provided effective analgesia? Is changing the epidural infusion rate, concentration, drug, bolus dosing likely to improve the quality of analgesia? Some lack of efficacy can be attributed to technique in epidural placement. Loss of resistance to air is more likely to cause a patchy block with “missed segments” than loss of resistance to saline. It is recommended that the minimum volume necessary to establish loss of resistance be injected to minimize this risk. Check the infusion mixture and pump settings. Ensure that the injectate contains the correct drug(s) and concentration(s) and that it is being administered at an appropriate rate. Check the epidural catheter to ensure it has not migrated in or out of the skin, that the solution is not leaking from the skin and that all the tubing connections are firm and intact.

Assess the level of the block by report and examination. Is the catheter too low or too high? Relying on threading a catheter from a lower level to a higher level, e.g. caudal approach to the thoracic space, is more likely to be associated with a sub-optimal catheter tip level. Imaging the catheter, or using Tsui’s Epidural Stimulation2 or ECG guided3 methods, improves the likelihood of correct tip placement. Signs of drug toxicity indicate drug accumulation or intravascular catheter migration. In our Institution the standard bupivacaine concentration infused is 0.0625% at a rate of 0.1-0.2ml/kg/h, usually in combination with an opioid. This formulation rarely causes discernable sensory or motor blockade. New onset of sensory or motor block can indicate catheter migration into the intrathecal space. The infusion should be discontinued and efforts made to confirm the exact location of the catheter tip before resuming epidural analgesia. The total dose of drug administered per kg/day should be calculated. If catheter migration is suspected, the catheter should be removed and replaced or an alternative analgesic regimen instituted. If an overdose of medication is identified resume the infusion at a lower dose. Care must be taken to prevent damage to skin and joints in children who have a motor or sensory block. Increased vigilance on the part of care providers is indicated.

Use of non-epidural analgesics should be limited to non-opioid drugs when epidural opioids are in use as the risk of respiratory depression is high in this setting. If local anesthetic solutions alone are used epidurally then any class of oral or parenteral analgesic can be administered concomitantly.

Pruritis is the commonest side effect experienced with epidural opioids. This is centrally mediated via mu-receptors and is not caused by histamine release. However, symptomatic relief from antihistamines does occur. The distribution of pruritis can assist in differentiating epidural opioid-induced itching from that of other causes. Opioid-induced itching always involves the face and scalp and is not associated with a rash. Opioid-induced pruritis that does not respond well to antihistamines should be treated with a mu antagonist, e.g. naloxone 1-2µg/kg IV or nalbuphine 0.1mg/kg IV to a maximum of 3mg. Changing the opioid, e.g. from fentanyl to hydromorphone, may also alleviate this symptom.

In general, following the basic principles of analgesic provision will optimize outcome and minimize complications. These include careful patient selection (parents who would not
countenance epidural analgesia themselves are unlikely to accept this technique in their children); education (of physicians, nurses, patients and their families regarding what the technique involves and accurate expectations of the therapy); full documentation of techniques and monitoring; management provided by designated, competent individuals; emergency management protocols; and regular audit to provide quality assurance and identify educational needs. Attention to detail and frequent review will ensure optimal outcomes in most patients.

References:


Useful additional information: