Spinal Cord Injury in a Child After Single-Shot Epidural Anesthesia

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Nearly 20 years have passed since the earliest reports appeared regarding the feasibility and effectiveness of thoracic epidural analgesia (TEA) in infants and children (1,2). TEA has gained tremendous popularity and is now routinely practiced by many anesthesiologists around the world (3–8). Nevertheless, studies comparing the benefits of epidural analgesia with conventional systemic analgesia in pediatric patients are few (9,10). Further investigations are required to demonstrate the superiority of TEA over conventional systemic analgesia as well as other forms of regional analgesia in various clinical scenarios. Also, despite the increasing experience with pediatric TEA, little is known about the absolute risks of this procedure, especially with regard to spinal cord injuries resulting in temporary or permanent neurologic deficits.

In the largest and only prospective study of morbidity associated with pediatric regional anesthesia, 135 thoracic epidurals were performed and none of these children experienced a complication (5). In the other reports also, no serious complications were reported (1–4,6–8). However, it cannot be concluded that TEA is without risk of spinal cord injury based on the few existing reports because the total number of children receiving TEA in these reports is small and spinal cord injuries are expected to occur infrequently, similar to the rate of occurrence in adults (11). Although rare, these complications can be devastating. At the present time, our knowledge of spinal cord injuries associated with TEA and lumbar epidural analgesia in children is limited to a few case reports. Spinal cord hematoma, transient paresthesias, paraplegia, and injury to sacral parasympathetic nerves caused by an intraspinal hematoma have all been reported in association with lumbar epidural analgesia (5,7,12–14). Epidural abscess and transient neurologic symptoms are the only neurologic complications reported in association with thoracic epidural anesthesia in children (15,16).

In this issue of Anesthesia & Analgesia, Kasai et al. (17) report on the case of a child with temporary bilateral lower-extremity neurologic deficits associated with spinal cord injury after a single-shot thoracic epidural block performed during general anesthesia for emergency appendectomy. This case report is important because it reminds us that there are serious risks associated with TEA in children and that we must carefully weigh the risks and benefits of this procedure in any child considered to be a candidate for TEA. In the absence of clinical data demonstrating the risks and benefits of TEA, adherence to the recommendations of experts and the exercise of sound clinical judgement are mandatory. This report also focuses our attention on several other issues, including a newly proposed mechanism of injury in an anesthetized child, options to consider after encountering a dural puncture during attempted epidural placement, the evaluation of a child with unexpected pain and sensory and motor deficits in the lower extremities after combined general and regional anesthesia, and the practice of performing regional anesthesia in anesthetized children.

Do the benefits of single-shot TEA provided by Kasai et al. (17) outweigh the risks in this child? The stated purposes for performing the block were to provide effective perioperative analgesia, to reduce the volume of local anesthetic required as compared with the volume that would be required if epidural analgesia were performed at the lumbar or caudal levels, and to avoid the use of muscle relaxants and opioid analgesics. Epidural analgesia is rarely considered for children with acute appendicitis undergoing emergency appendectomy at my institution for several reasons. First, this surgery is performed laparoscopically or via a small incision in the right lower quadrant and is not associated with severe or prolonged postoperative pain. Excellent postappendectomy analgesia is

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could explain the bilateral, asymmetric deficits observed in this child. Kasai et al. (17) suggest that a spinal cord injury occurred as a result of the neurotoxic effects of preservatives present in the local anesthetic that entered the subarachnoid space via the dural puncture. However, dural puncture is a relatively common complication of epidural analgesia and I am not aware of any other cases of spinal cord injury attributed to this mechanism. All local anesthetics are known to be neurotoxic, especially when administered in large doses intended for epidural anesthesia in the subdural or subarachnoid space (18). The cauda equina syndrome and the recently described syndrome of transient neurologic symptoms are thought to be related, at least in part, to local anesthetic neurotoxicity (19–21). Bupivacaine, although less toxic than lidocaine or tetracaine, has been implicated in such injuries. Transient neurologic symptoms have been reported after bupivacaine epidural anesthesia in adults as well as in a child (16,21). Transient paresthesias were reported to occur in only 2 of 2396 children who had lumbar epidural analgesia in a large prospective study of morbidity in pediatric regional anesthesia (5). But in a smaller pediatric study, the incidence of transient paresthesias was 3% (7). Total spinal anesthesia did not occur in the child reported by Kasai et al. (17) because spontaneous ventilation was maintained throughout the procedure. However, a partial spinal block could have occurred and bupivacaine neurotoxicity may be responsible for this child’s injury. Another plausible mechanism by which this child was injured is an unrecognized spinal cord puncture during attempts to locate the epidural space. Kasai et al. (17) believe that the lack of an associated hemorrhage or hematoma argues against this, but direct trauma to the spinal cord by a needle without hemorrhage in or around the spinal cord has been reported in adults (22–24).

After puncturing the dura accidentally, is it reasonable to repeat the block at the same interspace (T10–11) and to use bupivacaine with preservatives intended for epidural use but not spinal anesthesia? Kasai et al. (17) acknowledge that repeating the epidural at the same interspace is questionable. My preference is to remove the epidural needle, move to an adjacent interspace (preferably above the dural puncture), repeat the epidural placement, thread an epidural catheter cephalad, reduce the dose of local anesthetic, and use a test dose to ensure that a spinal block does not develop. Total spinal anesthesia has been reported in adults after epidural injection of local anesthetic after inadvertent dural puncture at the same or adjacent interspace (25). Another option is to leave the needle in place and convert to a spinal anesthetic with an appropriate anesthetic and dose. A final option is to abandon the technique. Because it is unclear to me that this child’s injury is related to preservatives, I can only
state that it is inadvisable to repeat the block at the same level after accidental dural puncture and that caution must be exercised because total spinal anesthesia can result.

Another aspect of this case that merits comment is the timing of the first MRI at 5 days. When confronted with a child in the postanesthesia care unit who has unexplained neurologic deficits or pain involving both lower extremities after the performance of a thoracic (or lumbar) epidural block during general anesthesia, a spinal epidural hematoma should be suspected and a thorough neurologic examination performed. An MRI should be obtained as soon as the possibility that the findings represent lingering local anesthetic effects has been ruled out. In adults, the best chance for complete recovery of neurologic function after spinal epidural hematoma is when surgical decompression occurs within the first eight hours of the onset of symptoms (26).

The case for performing regional anesthesia in anesthetized children has been well stated (27). If children, especially infants and preadolescent children, are to enjoy the benefits of epidural analgesia, then the block will need to be performed during general anesthesia in the vast majority of patients. Needle and procedure phobia is extremely common in children and can result in severe anxiety, an inability to cooperate, and sudden, unpredictable movement that can result in accidental dural puncture and musculoskeletal, vascular, nerve root, or spinal cord trauma. Spinal cord injury has been reported in an adult who suddenly moved during local anesthetic infiltration before the insertion of a thoracic epidural catheter (22). Children are not able to understand the concept of paresthesia and they cannot reliably differentiate between pain and pressure at the site of the block and paresthesias. Thus, the placement of epidural catheters in awake children can be difficult and dangerous, and the information obtained from the conscious child during a regional block may be unreliable and misleading. Consequently, most anesthesiologists believe that regional anesthesia, including the placement of thoracic and lumbar epidural catheters, must be performed in anesthetized or deeply sedated children (27). It should also be pointed out that it is unclear whether performing regional anesthesia in anesthetized adults is more dangerous than in awake adults because no controlled, prospective trials have been completed (18). There is some evidence that epidurals can be placed safely in anesthetized adults (28,29). Would the child in the report by Kasai et al. (17) have been spared his injury by having the block performed awake? None of the proposed mechanisms of injury would have necessarily been avoided by performing the block with the child awake.

Conclusions

What can we learn from this case and how can we prevent this type of injury from occurring in the future? First and foremost, careful patient selection is essential before undertaking TEA. It is an invaluable aid in the management of severe, prolonged postoperative pain involving thoracic dermatomes in children. Thoracic epidural catheters are usually placed after the induction of general anesthesia in children undergoing extensive thoracic or abdominal surgeries or in children who are having less extensive thoracic or abdominal surgery, but because of associated medical conditions (i.e., cystic fibrosis, cerebral palsy, obstructive sleep apnea), are expected to experience (and tolerate poorly) respiratory or central nervous system depression associated with conventional systemic opioid analgesia (1,3,4,27,30). Second, after accidental dural puncture, repeating the epidural at the same spinal level is not advised because total spinal anesthesia may result. Third, when confronted with a child in the postanesthesia care unit who has unexplained bilateral lower-extremity sensory and motor deficits, and especially when these deficits are accompanied by pain, prompt and thorough neurologic examination and MRI studies are indicated to ensure that a spinal epidural hematoma is not present. Fourth, although there is tremendous worldwide experience with TEA in children, a large, prospective, multicenter study is needed to define the precise risks of this procedure in children. And finally, in this era of evidence-based medicine, randomized, prospective trials of TEA versus conventional systemic analgesia in children are required to confirm the broadly held belief that epidural analgesia is associated with better postoperative analgesia and other benefits such as a reduction in perioperative morbidity, shorter hospital stay, and a reduction in costs.

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References