Pediatric epidurals

Pediatric central neuraxial blocks have a history dating back a century. Bainbridge published a report on spinal anesthesia in an infant of 3 months, in May 1900, for the repair of a strangulated hernia. The first publication mentioning caudal blocks in children was written by Campbell in 1933 and the second one by Leigh and Belton in 1951. In 1954, Rouston and Stringer of Canada described lumbar epidural anesthesia for inguinal hernia repair in infants and children. In 1967, Fortuna from Brazil reported a series of 170 patients between the ages of 1–10 years who received caudal epidural anesthesia.[1] However, pediatric epidurals remain an underutilized modality of perioperative pain relief. Although "kiddy caudals" employing local anesthetics (with or without additives) are universally used for intraoperative and postoperative infraumbilical surgery in children, caudal epidural catheters are less often used and routine use of lumbar and thoracic epidural catheters, especially in infants, is still uncommon.[2]

Epidural analgesia offers numerous benefits in the pediatric surgical patient. It is commonly used to augment general anesthesia and to manage postoperative pain (for 48–72 h) with minimal hemodynamic alteration. The latter stems from low resting sympathetic tone and reduced blood in lower extremities in children.[1] Effective postoperative pain relief from epidural analgesia facilitates early recovery, rapid weaning from ventilators with reduced PICU costs, reduced time spent in a catabolic state, and lowered circulating stress hormone levels. Precise placement of epidural needles and catheters for single-shot and continuous epidural anesthesia ensures that the dermatomes involved in the surgical procedure are selectively blocked with resultant lower doses of local anesthetics.[3,4]

Notwithstanding the multiple benefits of central neuraxial blocks and widespread usage in adults and children, epidural and spinal regional analgesia via catheters in infants and neonates remains controversial. The performance of regional blocks in anesthetized patients is generally proscribed in adults but accepted and often inevitable in children. Although neurologic sequelae are rare, thoracic and high lumbar epidural catheters should be placed with due care.[4] Besides pediatric epidural catheters (commonly 19G needle with 22G and 23G uniport catheters) may not always be available. There is often a reluctance or inexperience in placing epidural catheters in babies with need for concomitant follow-up. Caudal catheters have a greater risk of bacterial colonization as compared to epidural catheters (29% versus 9%), with *Staphylococcus epidermidis* responsible for the majority of colonization and tunneling of caudal catheters has been shown to reduce (to 11%) the risk of infection.[5] Some authorities suggest that compartment syndrome may be masked by epidural infusions. However, adequate pain management does not "hide" this complication but can facilitate early diagnosis since the increase in requirement for pain medication precedes other clinical symptoms by an average of 7.3 h.[6]

Bupivacaine and ropivacaine are the two most commonly used local anesthetics for neuraxial anesthesia in children. For bolus dosing either 0.2% bupivacaine or 0.2% ropivacaine may be employed with 1 ml/kg for "kiddy caudals" and 0.3–0.5 ml/kg for thoracolumbar epidurals. For continuous intraoperative epidural infusion, 0.1–0.2% of either bupivacaine or ropivacaine is generally used, in dose of 0.2 mg/kg/h (in neonates) and 0.4 mg/kg/h (in older children). For postoperative pain relief adjuvants such as morphine, fentanyl, ketamine, midazolam, neostigmine, clonidine, and recently, dexmedetomidine have all been used with varying success. Fentanyl (1–2 μg/ml) added to 0.1% bupivacaine for postoperative continuous epidural infusions is justifiably popular in well monitored neonates and children.[4]

Epidural catheter placement in neonates and infants is decidedly different though not necessarily difficult. The lateral decubitus position with midline approach is commonly chosen though some advocate the paramedian approach.[7] In neonates, the intercristal line bisects L5 (unlike L3/4 interspace in adults) and the spinal cord ends at L3 (unlike L1 in adults). The epidural space is more superficial with a more subtle "give" as the ligamentum flavum is pierced. Generally, the epidural space will be found at 1 mm/kg of body weight from the skin, with significant individual variation.[4] The pediatric epidural catheter also tends to kink or recoil and suggestions for facilitating catheter insertion include use of 21 G instead

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of 23 G catheters, increasing cephalad angulation of the epidural needle, flexing (or extending the spine), use of "blue" introducer, and injection of saline to open up the epidural space.[7]

Cephalad advancement of epidural catheters to the thoracic region via the caudal route has been shown to be feasible in neonates and small infants as epidural fat is loosely packed and there is absence of lumbar lordosis. The position of one-third of caudally placed thoracic epidural catheters in infants was considered to be inadequate after review of confirmatory radiograph.[8] In a recent article, the authors have compared the advancement of 18G epidural catheter with 23G catheter from lumbar to thoracic space in children, with successful catheter placement in only 10-15% but significant analgesia in 87%. The clinical significance of precise catheter placement in children may be open to question. The authors have advocated radiocontrast studies to confirm catheter position in case of inadequate analgesia, notwithstanding exposure to ionizing radiation. Newer modalities of epidural catheter tip confirmation include use of stimulating epidural catheters (the "Tsui test") for segmental localization, and ultrasound guidance for real-time observation of needle puncture and catheter advancement, which may be a better option than exposing the child to radiation.[9]

Pediatric epidurals are increasing in popularity and offer distinct benefits. However, their true place in pediatric anesthesia needs to be established by prospective, randomized, controlled trials addressing all aspects of the technique.

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