Neuraxial anaesthesia in paediatrics

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Abstract

Neuraxial anaesthesia is a valuable aid in the practice of paediatric anaesthesia. Spinal and epidural blockade are used as either the sole anaesthetic or as an adjunct to general anaesthesia, and often confer significant postoperative analgesia. Caudal epidural anaesthesia is used extensively for lower abdominal, urological, and orthopaedic procedures in the setting of outpatient surgery. Lumbar and thoracic epidural infusions via a catheter can provide analgesia for chest and upper abdominal procedures. Major complications related to neuraxial catheter placement are uncommon in paediatric anaesthesia, even though block placement is typically after the patient is anesthetized. The use of the ultrasound for real-time visualization during paediatric neuraxial blocks provides an opportunity for observing final catheter position or confirming successful injection into the epidural space.

Keywords Caudal blockade; neuraxial blockade; paediatric thoracic epidural anaesthesia; postoperative analgesia; spinal anaesthesia; ultrasound guided paediatric regional anaesthesia

Royal College of Anaesthetists CPD Matrix: 2G02; 2D05

Learning objectives

After reading this article, you should understand the:

- anatomy and techniques of caudal, epidural and spinal anaesthesia in children
- use and complications of neuraxial blocks in children
- indications and contraindications for caudal and epidural blocks in children
- sonoanatomy and ultrasound landmarks for neuraxial blocks in children

Introduction

Central neuraxial blockade remains an integral part of both perioperative management and postoperative pain control in children. These techniques include spinal, caudal epidural, lumbar epidural, and thoracic epidural analgesia, which are often used as an adjunct to general anaesthesia. However, there is renewed interest in the avoidance of sedation or general anaesthesia altogether in light of growing concerns in popular media regarding neurotoxicity of anaesthetics. Neuraxial techniques may provide the ability to avoid neurotoxicity, but these studies are still ongoing.[1]

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Indications and contraindications

The benefits of neuraxial anaesthesia must be weighed against its risks, and also against those of alternative analgesic methods. Relative contraindications to neuraxial blockade are listed in Box 1. Neuraxial blockade is commonly indicated to improve postoperative analgesia and reduce the need for opioid intravenous analgesic medications. Use of central neuraxial blockade in addition to general anaesthesia has the potential advantages of decreasing general anaesthetic requirements and opioid use that in turn allows for a more rapid recovery as well as providing postoperative pain control.[2]

Spinal anaesthesia

Indications and safety

Spinal anaesthesia is a safe and effective way to provide anaesthesia for lower abdominal, urological, and lower extremity procedures.[3] It is commonly used as a sole anaesthetic in infants in the interest of avoiding general anaesthesia and opioid medications. A recent study has found that spinal, compared with general anaesthesia, reduces the risk of early postoperative apnoea, but not the overall incidence of apnoea in former premature infants less than 60 weeks postmenstrual age.[4]

Performance

In neonates, the spinal cord terminates at the vertebral level as low as L3 while, in adults, the spinal cord terminates at L1.[5] As a result, spinal anaesthetics should only be performed at or below the L4/L5 interspace level in neonates and infants. Ultrasound imaging may be used to assist with correct identification of the

Relative contraindications to neuraxial blockade

- Lack of parental consent
- Lack of patient assent (for children >12 years old)
- Anatomical variants
- Infection at the site of injection
- Coagulopathy
- Generalized sepsis
- Increased intracranial pressure
- Urinary retention

Box 1

spinal block level, to determine the depth of the subarachnoid space, and to guide needle placement.[6] Neonates and infants rarely exhibit haemodynamic changes after spinal blockade even without prior fluid administration. It has also been reported that former premature infants have an almost absent autonomic response to spinal anaesthetics. High sympathetic blockade has little effect in infants because of the parasympathetic dominance in this age group. Bupivacaine 0.5% 0.8 mg/kg (range 0.5–1 mg/kg) is commonly injected, with the dose decreasing on a mg/kg basis as the age of the patient increases. The dose of local anaesthetic, on a per kg basis, may be larger because of the relatively large spinal canal and larger volume of cerebrospinal fluid on a per kg basis.[7]

Performance of spinal blockade in paediatrics, especially infants and neonates, is made easier by:

- Increased flexibility of the spine, which allows improved access to the interspace.
- Short skin to subarachnoid space distance.
- Wide spinal canal, which is 70% of the adult size at birth.
- The spinal column is flat in young children, which allows drugs injected in the subarachnoid space to spread evenly.

Complications

A list of common and uncommon complications of spinal anaesthesia can be found in Box 2. Overall, failure rates are reported to be low, 1–5% depending on the study reported.[3,8] Furthermore, use of the ultrasound in real-time reduces the number of failures and improves the ease of the procedure in obese patients.[9] Post-dural puncture headache in neonates and infants is thought to be very low, but the exact incidence is unknown following spinal blockade. However, the incidence in children 2–15 years of age is probably similar to adult populations, less than 5% overall.[7] The incidence of backache, like other complications, has been difficult to quantify in young nonverbal infants, but spinal anaesthesia may not be associated with an increased risk of backache compared to general anaesthesia.[7] Although total spinal anaesthesia rarely occurs, it must be identified quickly. Treatment includes airway support, sedation, and haemodynamic monitoring until spinal blockade subsides.

Caudal epidural anaesthesia

Indications and safety

Caudal anaesthesia is a popular regional anaesthetic technique to provide analgesia for paediatric patients. Single-shot caudal epidural blockade can be completed for most urological, lower extremity and lower abdominal procedures.[10] Placement of a caudal catheter can extend its use to upper abdominal and thoracic surgical procedures with the added utility of continuous analgesia in the postoperative period.[11] Caudal blockade is normally performed in conjunction with general anaesthesia which allows for a lighter plane of anaesthetic to be used. This reduces the time of recovery from anaesthesia and time to discharge from the hospital for outpatient procedures.

It is possible to use caudal blockade as the sole anaesthetic for many cases. The duration and anatomic location of the surgical procedure as well as the need for prolonged postoperative analgesia may guide the decision to choose single shot versus catheter placement for caudal anaesthesia. Single shot caudal blocks are an incredibly safe technique when used for postoperative pain control, as recently confirmed in a prospective collection of data on over 18,000 single-shot caudal blocks in the Pediatric Regional Anesthesia Network.[12] However, care must be taken to not exceed potentially toxic dose thresholds for local anaesthetics.

Performance

The caudal epidural space is reached through the sacrococcygeal membrane at the sacral hiatus. Sacral anatomy in young children and infants is unique in that the sacral fat pad is usually absent in this age group and ossification of the sacrum does not completely occur until 8 years of age. Thus, one is more readily able to identify landmarks such as the sacral cornua in paediatric as opposed to adult patients.[13] Techniques in performing caudal blockade start by placing the patient in the lateral decubitus or prone position. Knee, leg, and neck flexion in the lateral position shifts the termination of the dural sac cephalad, which may improve the safety margin in young children. A useful check is to flex the upper leg in the lateral position to 90° at the hip. Then, a line through the midline of the lateral aspect of the thigh and the tip of the greater trochanter of the femur will usually pass through the sacrum at the level of the sacral hiatus. The most common error for the novice is to aim too low on the sacrum and coccyx.

Identification of the sacral cornua should be followed by sterile preparation with a 70% alcohol solution with chlorhexidine or iodine. Though epidural abscess is extremely rare, using alcoholic chlorhexidine solution rather than povidone iodine for site preparation decreases colonization of epidural catheters in children.[14] Use of alcohol-containing solutions is extremely variable across neonatal intensive care units due to safety concerns, one should follow the local policies regarding appropriate skin preparation.

A variety of needles may be used for performance of the caudal epidural injection. Some centres prefer the use of styletted caudal needles to decrease the theoretical risk of epidermoid tumour development after caudal injection, but it is more a theoretical concern rather than practical concern with this injection.[15] Blunt-tipped rather than sharp-bevelled needles may increase tactile sensation of 'popping' or puncturing the sacrococcygeal membrane.

The needle is inserted in the midline at the level of sacral cornua at an angle of 45–60°. After puncturing the skin, advancement through the sacrococcygeal membrane is felt. The

Complications of spinal blockade

- Post-dural puncture headache
- Backache
- Total spinal anaesthetic
- Subcutaneous infection
- Meningitis
- Epidural haematoma
- Failed block

Box 2