Review Article

Paediatric Spinal Anaesthesia

***Md. Habibur Rahman, S. O. Shafiullah, Mizanur Rahman**

*Department of anaesthesia, Sher-e-Bangla Medical College, Barisal

Corresponding Author: E-mail dr.habib20@gmail.com

Abstract

Spinal anesthesia was probably the earliest form of regional anesthesia that was considered a useful practice for children. Since that time, spinal anesthesia have become an important anesthetic technique for reducing the incidence of postoperative apnea in premature and ex-premature infants .Spinal anaesthesia provides a good alternative to general anaesthesia in newborns with increased anaesthesia-related risk, and for infants undergoing lower abdominal or lower extremity surgery during the first 6 months of life. It is most successful as a single shot technique, limited to surgery lasting less than ninety minutes. Spinal anaesthesia in children requires the technical skills of experienced anaesthesia providers.

Key words *Paediatric, Spinal Anaesthesia, Regional Anaesthesia*

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Introduction

Spinal anaesthesia consists of inserting a spinal needle into the subarachnoid space and, when a free flow of cerebrospinal fluid (CSF) is obtained, injection of a solution of local anaesthetic directly into the CSF. Spinal anaesthesia (SA) was first described in children in 1909 [1]. But did not become part of routine practice until the 1980s when regional anaesthesia increased in popularity. Since that time, spinal anesthetics have become an important anesthetic technique for reducing the incidence of postoperative apnea in premature and ex-premature infants. Infants who have continuing apnea at home or haematocrit less than 30% are at particular risk for postoperative apnoea. Spinal anesthesia may also reduce the need for postoperative mechanical ventilation in those infants who are less than 60 weeks' postconceptual age after hernia repair [2]. Although spinal anaesthesia may be used in any age group, there are relatively few true indications for a spinal anesthetic in older children. Older children may be at increased risk of postdural puncture headaches [3].

Indications

1. Ex-premature neonates who may prove difficult to extubate even after limited surgery. The classic operation involved is repair of inguinal hernia which is common in premature infants. There is evidence that these patients experience a lower rate of postoperative apnoea after spinal, compared with general anaesthesia[4].
2. Older children with muscular or neuromuscular disease who are increase risk of the complications of general anaesthesia; performing a spinal block in these children is essentially the same as in adults, with a small amount of sedation, sensible 12-year-olds will cooperate sufficiently to allow successful spinal anaesthesia[4].
3. SA has been used for general surgery (rectal biopsy, incision of rectal abscess), urological surgery (orchidopexy, circumcision), lower limb orthopaedic surgery and may be of particular use in developing countries as an alternative to general anaesthesia[8].
4. Family history of malignant hyperthermia or a full stomach with. aspiration risk[8].
5. GA in children undergoing complex surgery
6. SA has also been described for use in chronic pain management[6].

Contraindications

1. Coagulation abnormalities
2. Systemic sepsis or local infection at the puncture point
3. Uncorrected hypovolaemia
4. Parental refusal or an uncooperative child

5. Neurological abnormalities such as spina bifida, increased intracranial pressure
6. Procedures lasting more than 90 minutes.

Anatomy

Several anatomic differences between adults and children affect the performance of regional anesthetic techniques. The conus medullaris (the terminus of the spinal cord) in neonates and infants is located at the L3 vertebral level, which is more caudal than in adults. It does not reach the adult level at L1 until approximately 1 year of age owing to the difference in the rates of growth between the spinal cord and the bony vertebral column[7]. A line connecting the top of the iliac crests crosses the spinal axis at the L5-S1 level in neonates and infants up to one year of age and at the L4-L5 level in older children. The dural sac in a newborn ends at S3. To avoid the risk of spinal cord puncture in a neonate, a spinal should be performed at the L4-5 interspace. After the first year of life, the spinal cord is in its adult position with the dural sac at S1 and conus medullaris at L1 The distance between the skin and the subarachnoid space is influenced by age –approximately 10 mm at birth and 16 mm at 3 years. The distance between skin and subarachnoid space can be related to height or weight using the formulae:

Distance from skin to subarachnoid space (cm) = 0. 03 x height in cm (cm)

Distance from skin to subarachnoid space (cm) = (2 x weight in kg) + 7(mm)[15]

The subarachnoid space in newborns is very narrow (0.6 to 0.8cm) and successful lumbar puncture in this population requires great precision and avoidance of lateral deviation. The volume of cerebrospinal fluid in infants is 4 mL/kg (2 mL/kg in adults) with 50% being in the spinal canal compared with 25% in adults. These factors produce proportionately more dilution of local anaesthetic solution in the cerebrospinal fluid in children than in adults and contribute to the short duration of subarachnoid anaesthesia in children[8].

Physiological effects of spinal anaesthesia

Hemodynamic consequences of SA

Cardiovascular changes related to the SA are less common in children than in adults. In children under 5 years of age, minimal changes in heart rate and blood pressure have been reported [8]. In older patients (>8 years old), the sympathetic block can induce bradycardia or hypotension. A few studies of SA in newborns have noted hypotension ten minutes after injection of the local anaesthetic. Cardiovascular changes due to spinal block are generally short lasting and respond to a bolus of intravenous fluid (10ml.kg- 1) [9]. Cardiovascular stability in infants undergoing SA is probably related to smaller venous capacitance in the lower limbs leading to less blood pooling, and to relative immaturity of the sympathetic nervous system resulting in less dependence on vasomotor tone to maintain blood pressure.

Respiratory effects of SA

Respiratory effects of SA are generally seen in association with high motor block above T6 [8].Children with severe chronic lung disease should receive supplemental oxygen or Continuous Positive Airway Pressure (CPAP) during SA.

Technique

1. The technique is similar to adult subarachnoid block.
2. Performed with the infant held in the sitting or the lateral position. This is largely matter of personal preference. Care is taken to avoid flexing the neck and obstructing the airway[8].
3. IV access is mandatory
4. The skin is infiltrated with a minute quantity of 1% lidocaine (less than 0.25 mL should be sufficient; use a 30-gauge needle on an insulin syringe), or a small amount of EMLA cream is applied to the infant's lumbar area at least 1 hour before spinal placement [7].
5. The lumbar puncture is performed using a midline approach with a 22-gauge 1.5-inch stiletted spinal needle. Using a needle without a stylet is not recommended since epithelial tissue can be deposited in the intrathecal space and may cause dermoid tumours of the neural axis[7].
6. Lumbar puncture is performed only at the L4-L5 or L5-S1 interspaces [7].
7. Assessing the block is difficult. The response to cold spray can be useful, as may observation of paradoxical respiratory muscle movement and loss of response to a low amperage tetanic stimulus
8. Spread of the block is less predictable than in adults and high blocks are relatively common[10].
9. The feet must not be raised above the head, e.g. when placing a diathermy pad, or a high block may be produced [7].
10. Sedation is not given in this group because, like general anaesthesia, it carries the risk of postoperative apneas [11].

Dose of local anaesthetic for SA in children:[8]

Weight	<5 kg	5 to 15 kg	>15 kg
Isobaric or Hyperbaric	1ml.kbg-1	0.4mg.kg-1	0.3mg.kg-1
bupivacaine 0.5%	[0.2ml.kg-1]	[0.08ml.kg-1]	[0.06ml.kg-1]
Isobaric or Hyperbaric		0.4mg.kg-1	.4mg.kg-1
tetracaine 0.5%		[0.08ml.kg-1]	0[0.08ml.kg-1]
Postoperative care			

Children are discharged from the post anaesthesia care unit when the block disappears, i.e. free lower limb movement returns. Children are allowed to feed on demand, provided there are no surgical restrictions. All infants younger than 60 week post conception are monitored on the ward for 24 hours after SA.

Complications

There are a number of potential complications of SA that are listed below:

1. Relatively high failure rate of 10-20% [4].
2. Potential traumatic puncture with spinal damage. Careful technique with the appropriate equipment and a trained assistant is essential [8].
3. Although hypotension is rare, bradycardia occasionally occurs
4. Respiratory (+/-cardiovascular) insufficiency due to high SA or secondary to intravenous sedation. Resuscitation measures must be taken (ABC) - tracheal intubation and volume resuscitation may be required [8].
5. Convulsions due to overdose of local anaesthetic. All doses should be calculated carefully and checked with another practitioner [8].
6. Post dural puncture headache. This has been reported in children >8 years old, but the incidence in younger children is unknown, in part since headaches in infants and young children are difficult to assess [8,3].
7. Total spinal block with respiratory arrest and bradycardia is another complication of spinal anesthesia [14].
8. Infectious complications such as meningitis. The incidence like meningitis is very low – careful aseptic technique must be used at all times and multidose ampules of local anaesthetic must never be used [8].

Conclusion

The incidence of serious complications associated with SA is very low even in small premature infants. We think that this technique provides a good alternative to general anaesthesia in newborns with increased anaesthesia-related risk and for infants undergoing lower abdominal or lower extremity surgery during the first 6 months of life. SA may be used to avoid GA in patients outside the neonatal period, if needed combined with intravenous sedation. SA is most successful as a single shot technique, limited to surgery lasting less than 90 minutes. SA in children requires the technical skills of experienced anaesthesia providers. Neonates and infants are at high risk of complications during surgery, irrespective of the type of anaesthesia, and the presence of clinician trained in paediatric anaesthesia is mandated.

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