Journal of Neonatal Surgery 2017; 6:79
Doi: 10.21699/jns.v6i4.665

OPEN ACCESS

REVIEW ARTICLE

Regional Anaesthesia for the Neonate

Bharti Wadhwa,* Neha Hasija, Kirti N Saxena

Department of Anesthesia , MAMC, New Delhi

How to cite: Wadhwa B, Hasija N, Saxena KN. Regional anaesthesia for the neonate. J Neonatal Surg. 2017; 6:79.

ABSTRACT

Numerous regional and local anaesthesia techniques are available for safe use in neonates and can be administered either in combination with general anesthesia or in the awake neonate. Regional anaesthesia provides effective analgesia with reduced drug requirement which is especially beneficial in view of the immature physiology and metabolism in the neonate. The reduced requirement of anaesthetic drugs facilitates stable hemodynamics, faster recovery and a decreased length of stay in the neonatal intensive care unit.

INTRUDUCTION

Over the last few decades, there has been a realization that neonates and infants also experience pain and demonstrate significant and vigorous pain behaviours [1]. This has led to a paradigm shift in the peri-operative pain management strategies for the neonate. Regional anaesthesia is a technique that produces effective analgesia with minimal drug requirement and fewer side effects. In infants undergoing major abdominal surgery, administration of epidural analgesia was found to be associated with a significantly beneficial modification of the neuro-endocrine stress response when compared with postoperative morphine infusions alone [2]. Further, a reduced need for postoperative mechanical ventilation has been observed in neonates who had received epidural analgesia for tracheo-oesophageal fistula repair [3]. Neonates who did not receive a penile block or in cases where eutectic mixture of lidocaine and prilocaine (EMLA) was not applied for neonatal circumcision had an exaggerated pain response to later vaccinations as compared with neonates treated with a local anaesthetic technique [4]. Finally, safety data generated from large, prospective studies and audits clearly show that the use of paediatric regional anaesthetic techniques is safe and of great benefit in the neonate [5].

IV analgesics alone: are they not sufficient?

The use of systemic opioids carries a significant risk of respiratory depression in the neonate who has an already depressed respiratory system. Their use is associated with considerable clinical side effects such as pruritus, nausea and vomiting which are difficult to assess in neonates but maybe expressed as being irritable, fussy and unsettled. Increased morbidity and mortality may be attributed to increased residual effects of anaesthesia along with excessive sedation. Co-administration of regional anaesthesia can prevent opioid induced hyperalgesia characterised by a paradoxical increase in pain in the post-operative period [7-9].

Benefits of regional anaesthesia in the neonate

- Superior quality of pain relief.
- Reduced requirement of anaesthetics, facilitating stable haemodynamics and faster recovery [1,10-13].
- Decreased length of stay in the neonatal intensive care unit (NICU).
- Reduced requirement of muscle relaxants.
- Neuraxial blockade aids in the reduction of omphalocoele, gastroschisis, diaphragmatic hernia as well as incarcerated inguinal hernia by causing relaxation of abdominal wall musculature [14-16].

Correspondence*: *: Dr Bharti Wadhwa, Professor, Department of Anesthesiology and Intensive Care, Maulana Azad Medical College and associated Lok Nayak Hospital, New Delhi, India

E mail: drbhartitaneja@gmail.com
Submitted: 20-08-2017
Conflict of interest: Nil

Accepted: 25-09-2017
Source of Support: Nil

- Early return of gastrointestinal motility, improved splanchnic perfusion and early resumption of oral feeding which may be especially beneficial in necrotising enterocolitis as well as after gastroschisis repair [15].
- Local anaesthetics (LA) stimulate natural killer cells that play an important role in nonspecific cellular-mediated and antitumor immunity [17].
- In addition, local anaesthetics bestow antimicrobial activity and inhibit bacterial growth [17-19].

Regional block in the preterm neonate

- Infants born prematurely are more prone to peri-operative respiratory complications including postoperative apnoea, hypoxia and bradycardia following general anaesthesia up to 60 weeks post conceptual age [20].
- The depressant effects of halogenated agents on intercostal muscles, lung volumes, chemoreceptor, baroreceptor responses as well as associated conditions like bronchopulmonary dysplasia further add to the burden of post-anaesthetic complications. Difficult weaning from mechanical ventilation is a major concern in such patients. Parents and the neonatologist frequently desire to avoid the risks involved with general anaesthesia and re-intubation of the trachea [21-23]. The awake regional technique is a useful alternative in such patients.

Technical and pharmacological differences in the neonate with regard to central neuraxial block

Precision is required in neonates while establishing regional anaesthesia as absolute distances are very small and anatomical relationships with landmarks also differ (Table 1 & Figure 1).

Administering Regional Anaesthesia in the awake neonate

Surgeries such as circumcision and simple inguinal herniotomy can be safely performed under regional block in the awake neonate. Topical local anaesthetics at site of the block as well as IV cannula site, keeping the baby warm and a pacifier coated with 10% dextrose does the trick [24].

Standard monitoring devices (blood pressure cuff, pulse oximeter, electrocardiogram leads) should be applied prior to performing the block. During placement of the block use of nitrous oxide 50% and inhalational agent may help in the vigorous and active neonate. Sedation maybe used as appropriate, keeping in mind the baby`s general condition and the length of procedure. Since the duration of subarachnoid block is short (30-60 minutes), it necessitates an experienced surgeon and simple surgeries while avoiding it in complex or bilateral procedures.

Table 1: Technical and pharmacological differences and anaesthetic implications

Technical Differences	**Anaesthetic Implications**
Dural sac ends at lower level (S4) (Fig. 1)	Increased chances of inadvertent dural puncture with single shot caudal
Spinal cord ends at lower level (L3) (Fig. 1)	Spinal to be attempted at L4-5/ L5-S1
Pharmacological Differences	**Anaesthetic Implications**
Increased CSF volume (ml/kg)	Increased Local Anaesthetic dose requirement
Increased vascularity and cardiac output	Decreased duration of action Not beneficial for long/complex surgeries
Loose epidural fat	Allows for more even spread of local anaesthetic
Increased level of free drug, hepatic immaturity, decreased clearance	Increased chances of toxicity- use dilute solutions use less cardio-toxic drugs like levobupivacaine, lidocaine, ropivacaine
Thinner nerve fibres, less myelin, closer location of nodes of Ranvier	Lower concentration of LA effective, rapid onset of block

Techniques available

There are various techniques available to suit the surgical needs, caudal anaesthesia being the single most important technique (Figure 2). These can be used with sedation alone or in combination with general anaesthesia (Table 2).

Assessing the level of sensory block achieved:

Assessing the level of blockade may prove difficult in neonates, particularly if the neonates are sedated or concomitant general anaesthesia has been administered. Pin prick or response to cold stimuli (e.g., an alcohol swab) may be used as well as observation of vitals, rate and pattern of ventilation.

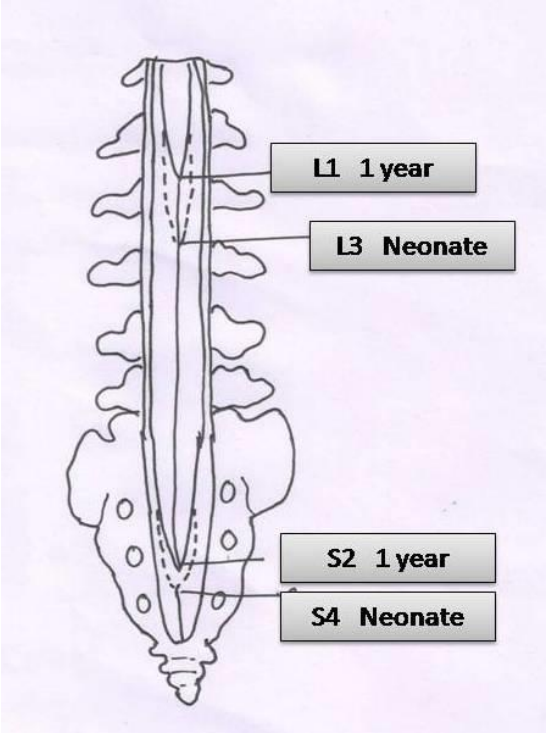

Figure 1: Anatomical differences in neonatal and paediatric spinal cord

Table 2: Various techniques and the surgeries where they can be used.

Technique	Surgeries
Central Neuraxial block	
Subarachnoid	Inguinal Herniotomy, orchidopexy, Lower limb surgery
Caudal (Fig. 2)	Lower limb surgeries, inguinal herniotomy, orchidopexy, circumcision, lower abdominal surgeries
Epidural	Upper and lower abdominal, pelvic and lower limb surgeries
Peripheral and other blocks	
Penile block	Circumcision, hypospadias surgery
Ilioinguinal/ Iliohypogastric Nerve block	Inguinal herniotomy, hydrocele
Infraorbital Nerve block	Cleft lip repair, repair of lip laceration
Femoral Nerve block	Muscle biopsy, skin grafting, PICC line insertion
Intercostal block	PDA ligation, post thoracotomy, chest tube placement, thoracoabdominal and renal surgery
Interpleural block	CDH Repair, TEF repair
Tranverse abdominis plane block	Infraumbilical surgeries

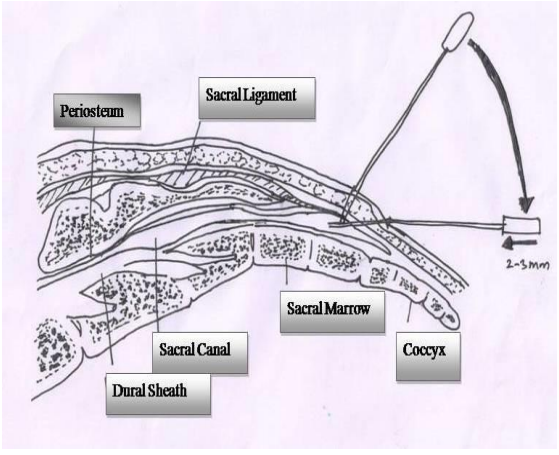

Figure 2: Caudal block- the most commonly used regional block in neonates

Intra-operative Concerns:

Placing an electrocautery grounding pad on an infant's back by lifting the lower extremities will result in a trendelenburg position leading to an extremely high spinal level following the block. Therefore, while placing the cautery pad the baby should be lifted as a whole after spinal anaesthesia rather than lifting the lower extremities.

Special attention should be given while positioning the neonate for spinal anaesthesia as flexion of neck can lead to airway obstruction.

Central neuraxial block is not associated with clinically significant hypotension or bradycardia attributable to neonate's relative immaturity of sympathetic nervous system, lower vascular tone and relative smaller volume in lower extremities.

Routine fluid loading is unnecessary; however a working venous access must be obtained prior to performing spinal anaesthesia in neonates.

Ultrasound guided regional blocks in the neonate

The use of ultrasound (US) guidance when performing regional anaesthesia allows performance of regional block safely and effectively by allowing better recognition of the anatomy and localization of adjacent structures during needle placement. Another benefit is that lower volumes of local anaesthetic solutions are required which minimises the risk of local anaesthetic toxicity [25].

The use of US is of particular value in the neonate as the largely cartilaginous posterior vertebral column of neonates enables better penetration of the ultrasound radiation in order to visualize spinal

structures [26]. Furthermore, loss-of-resistance technique to identify the epidural space is difficult as the spinal ligaments are less fibrous. In a study on sixty neonates who received ultrasound guided block, good visibility of structures within the spinal canal, including the dura mater, ligamentum flavum and the termination of the spinal cord was reported [27].

Keeping in mind the advantages and with improvement in equipment, the use of ultrasound guided blocks in the neonate US guidance for peripheral and central neuro-axial blocks may become the norm rather than the exception.

COMPLICATIONS

There is a general apprehension amongst paediatric/ neonatal surgeons regarding regional anaesthesia in the neonate. Results from a prospective study performed by ADARPEF on more than 24,000 paediatric regional blocks demonstrated that the incidence of complications was approximately 1/1000 of which those attributed to epidural block was only 1/10,000, none of which resulted in any major or any long-term complication [5]. The use of inappropriate adult-sized equipment in paediatric patients was found to be associated with 50% of complications [5,6]. Presently, age-specific appropriate regional anaesthesia equipment is easily available.

The peri-operative complications of particular importance include:

- Infection at site of administration of block or meningeal spread: To prevent the risk of infection spreading to the central neuraxis, epidural catheters (unless tunnelled) should be removed if visibly soiled, associated with signs of infection (fever, erythema at the insertion site) or within 72 hours of placement. Caudally placed epidural catheters in diapered children are difficult to maintain and is the most common reason for premature removal of a catheter [28].
- Local anaesthetic toxicity: Local anaesthetic overdose typically manifest in either neurotoxicity (seizures) or cardiotoxicity (malignant ventricular dysrhythmia). In a neonate, the maximum recommended dose of bupivacaine is limited to 1.5-2mg/kg for single injections and to 0.2mg/kg/h for continuous infusions as outlined by Berde, though higher doses have been given without complications [29-31]. Algorithms for management of Local anaesthetic toxicity should be in place and use of intralipid in neonates is also documented [32].
- Bleeding/ hematoma with compression or compartment syndrome,
- Rarely, direct nerve injury.

Contraindications

Contraindications to regional anaesthesia include anatomic deformities, infection at the puncture site and presence of an underlying coagulopathy. Spinal and epidural anaesthesia should be avoided in hemodynamic instability, presence of a ventriculo-peritoneal (or other ventricular) shunt, increased intracranial pressures and poorly controlled seizures.

CONCLUSIONS

Numerous regional and local anaesthesia techniques are available for safe use in neonates; the advancement in ultrasound technology has further supplemented the safety profile by minimising the injuries and decreasing the drug dosages. The key to success is adherence to dosage guidelines, sufficient knowledge and precision of technique as well as keeping anatomical differences in mind thereby minimising complications. Regional anaesthesia may offer immense benefits for our smallest and most susceptible patients.

REFERENCES

1. American Academy of Pediatrics Committee on Fetus and Newborn, American Academy of Pediatrics Section on Surgery, Canadian Paediatric Society Fetus and Newborn Committee, Batton DG, Barrington KJ, Wallman C. Prevention and management of pain in neonates: an update AAP and Canadian Pediatric Society. Pediatrics 2006;118: 2231-4. (Re-affirmed May 2010).
2. Wolf AR**.** Effects of regional analgesia on stress responses to pediatric surgery. Pediatr Anesth 2012;22:19–24.
3. Bosenberg A, Flick RP Regional anesthesia in neonates and infants. Clin Perinatol. 2013;40:525-38.
4. Taddio A, Katz J, Ilersich AL, Koren G. Effect of neonatal circumcision on pain response during subsequent routine vaccination. Lancet 1997; 349:599-603.
5. Uguralp S, Mutus M, Koroglu A, Gurbuz N, Koltuksuz U, Demircan M. Regional anesthesia is a good alternative to general anesthesia in pediatric surgery: Experience in 1,554 children. J Pediatr Surg. 2002; 37:610-3
6. Llewellyn N, Moriarty A. The national pediatric epidural audit. Paediatr Anaesth. 2007; 17:520-33.
7. Polaner DM, Taenzer AH, Walker BJ, Bosenberg A, Krane EJ, Suresh S et al. Pediatric Regional Anesthesia Network (PRAN): a multi-institutional study of the use and incidence of complications of pediatric regional anesthesia. Anesth Analg. 2012;115:1353–64.
8. Morton NS, Errera A. APA national audit of pediatric opioid infusions. Paediatr Anaesth 2010;20:119–25.

9. Dahan A, Aarts L, Smith TW. Incidence, reversal and prevention of opioid induced respiratory depression. Anesthesiology. 2010;112:226–38.

10. Moriarty A. In praise of the epidural space. Paediatr Anaesth. 2002;12:836.

11. Bosenberg AT, Johr M, Wolf AR. Pro con debate: the use of regional vs systemic analgesia for neonatal surgery. Paediatr Anaesth. 2011;21:1247–58.

12. Lonnqvist PA. Regional anaesthesia and analgesia in the neonate. Best Pract Res Clin Anaesthesiol. 2010;24:309–21.

13. Jöhr M Practical pediatric regional anesthesia. Curr Opin Anaesthesiol. 2013;26:327-32

14. Morton NS. Local and regional anaesthesia in infants. Continuing Edu Anaesth Crit Care Pain. 2004; 4: 148-51.

15. Raghavan M, Montgomerie J. Anesthetic management of gastroschisis– a review of our practice over the past 5 years. Paediatr Anaesth. 2008;18:1055–9.

16. Hodgson RE, Bosenberg AT, Hadley LG. Congenital diaphragmatic hernia repair-impact of delayed surgery and epidural analgesia. S Afr J Surg. 2000; 38:31-4.

17. Holmann MW, Durieux ME, Graf BM. Novel local anaesthetics and novel indications for local anaesthetics. Curr Opin Anaesthesiol. 2001;14:741–9.

18. Forget P, de Kock M. Could anesthesia, analgesia and sympathetic modulation affect neoplastic recurrence after surgery? A systematic review centered over the modulation of natural killer cells activity. Ann Fr Anesth Reanim 2009;109:1464–9.

19. Gore M, Joshi K, Dave N. Combined spinal epidural anaesthesia for gastroschisis Repair. Indian J Anaesth. 2009;53:223-225.

20. Oberlander TF, Berde CB, Lam KH, Rappaport LA, Saul JP. Infants tolerate spinal anesthesia with minimal overall autonomic changes: analysis of heart rate variability in former premature infants undergoing hernia repair. Anesth Analg. 1995;80:20–7.

21. Hoehn T, Jetzek-Zader M, Blohm M, Maytepek E. Early peristalsis following epidural analgesia during abdominal surgery in an extremely low birth weight infant. Paediatr Anaesth. 2007;17:176–9.

22. Craven PD, Badawi N, Henderson-Smart DJ, O'Brien M. Regional (spinal, epidural, caudal) versus general anaesthesia in preterm infants undergoing inguinal herniorrhaphy in early infancy. Cochrane Database Syst Rev 2003;(3):CD003669.

23. Polaner DM, Drescher J. Pediatric regional anesthesia: what is the current safety record. Paediatr Anaesth. 2011;21:737–42.

24. Masters-Harte LD, Abdel-Rahman SM. Sucrose analgesia for minor procedures in newborn infants. Ann Pharmacother. 2001; 35: 947-52.

25. Willschke H, Bosenberg A, Marhofer P, Johnston S, Kettner S, Eichenberger U, et al. Ultrasonographic-guided ilioinguinal/iliohypogastric nerve block in pediatric anesthesia: what is the optimal volume? Anesth Analg 2006;102:1680-4.

26. Marhofer P, Bosenberg A, Sitzwohl C, Willschke H, Wanzel O, Kapral S. Pilot study of neuraxial imaging by ultrasound in infants and children. Pediatr Anesth. 2005;15:671–6.

27. Willschke H, Bosenberg A, Marhofer P, Willschke J, Schwindt J, Weintraud M, et al. Epidural catheter placement in neonates: Sonoanatomy and feasibility of ultrasonographic guidance in term and preterm neonates. Reg Anesth Pain Med. 2007; 32:34-40.

28. Johr M. Regional anaesthesia in neonates, infants and children: an educational review. Eur J Anaesthesiol. 2015; 32:289–97.

29. Gunter JB, Benefit and risks of local anesthetics in infants and children. Paediatr Drugs. 2002;4:649-72.

30. Sethi N, Chaturvedi R. Pediatric epidurals. J Anaesthesiol Clin Pharmacol 2012;28:4-5.

31. Chalkiadis GA, Anderson BJ. Age and size are the major covariates for prediction of levobupivacaine clearance in children. Paediatr Anaesth. 2006; 16:275-82.

32. Shah S, Gopalakrishnan S, Apuya J, Shah S, Martin T. Use of Intralipid in an infant with impending cardiovascular collapse due to local anesthetic toxicity. J Anesthes. 2009; 23:439-41.