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Pediatric Spinal Anesthesia for Lower Limb & Lower Abdominal Surgery; A Study of 140 Cases

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ABSTRACT
Background: Even after a vast safety record, the role of spinal anesthesia (SA) as a primary anesthetic technique in children remains contentious and is mainly limited to specialized pediatric centers. It is usually practiced on moribund former preterm infants (<60 weeks post-conception) to reduce the incidence of post-operative apnea when compared to general anesthesia (GA).
Aim of the study: The aim of the study was to find out the outcome Pediatric Spinal Anesthesia for Lower Limb & Lower Abdominal Surgery.
Methods: This is a multicentre prospective study, a total of 140 patients were enrolled and analyzed in this study. The study was conducted at the Dhaka Shishu Hospital, Dhaka, Bangladesh from January 2016 to July 2018.
Result: In this prospective study, we analyzed 140 patients. According to surgery, 92 patients had closed illizarov surgery, 5 patients had lengthening lower limb surgery, 39 patients had herniotomy and 4 patients had other surgery. In this study, there were 131(93.6%) patients had no problem, 6(4.3%) patients had a problem with the head and upper limb movement, 2(1.4%) patients had vomiting and only one patient had shivering (Table 1). According to associated factors, 131 patients had no problems and 9 patients with problems.
Conclusion: Paediatric spinal anaesthesia is safe feasible & effective anaesthetic technique for subumbilical surgeries of limited duration (70-80) minutes with negligible side effects.

Keywords: *Paediatric, spinal anaesthesia, infraumbilical, complications, hemodynamics*

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INTRODUCTION

Spinal anaesthesia , also called spinal block, subarachnoid block, intradural block and intrathecal block,[1] is a form of neuraxial regional anaesthesia involving the injection of a local anaesthetic or opioid into the subarachnoid space, generally through a fine needle, usually 9 cm (3.5 in) long. It is a safe and effective form of anesthesia usually performed by anesthesiologists that can be used as an alternative to general anesthesia commonly in surgeries involving the lower extremities and surgeries below the umbilicus. The local anesthetic with or without an opioid injected into the cerebrospinal fluid provides locoregionalanaesthesia: true analgesia, motor, sensory and autonomic (sympathic) blockade. Administering analgesics (opioid, alpha2-adrenoreceptor agonist) in the cerebrospinal fluid without a local anaesthetic produces locoregional analgesia: markedly reduced pain sensation (incomplete analgesia), some autonomic blockade (parasympathetic plexi), but no sensory or motor block. Locoregional analgesia, due to mainly the absence of motor and sympathic block may be preferred over loco regional anaesthesia in some postoperative care settings. The tip of the spinal needle has a point or small bevel. Recently, pencil point needles have been made available (Whitacre, Sprotte, Gertie Marx and others).[2] Regional anesthesia in children was first studied by August Bier in 1899. Since then, spinal anesthesia was practiced for years, and a number of cases were published in 1909-1910.[3,4,5] After some years, it fell into disuse owing to the introduction of various muscle relaxants and inhalational agents. In early 1980s, it was reintroduced as an alternative to general anesthesia (GA), especially in high-risk and preterm infants. Spinal anesthesia though gaining popularity in infants and children, the misconceptions regarding its overall safety, feasibility, and reliability can only be better known with greater use and research. There is no published study from India that highlights the experience of spinal anesthesia in children regarding its safety, success rate, and complications. This made us design this study in which we had prospectively analyzed the success rate, complications, and hemodynamic stability-related to spinal anesthesia in pediatric patients aged 2 to 12 years over a period of 2.6-years. The aim of the study was to find out the outcome of Pediatric Spinal Anesthesia for Lower Limb & Lower Abdominal Surgery.

METHODOLOGY & MATERIALS

This is a single centre prospective study, a total of 140 patients were enrolled and analyzed in this study. The study was conducted at the Dhaka Shishu Hospital, Dhaka, Bangladesh *from January 2016 to July 2018.* Informed consent was obtained from the parents of each patient for participation in the study. All patients were not allowed to take solid food for 6 h and clear fluid for 2 h before anaesthesia. No overnight premedication was given. After the establishment of intravenous access, all were preloaded with crystalloid solution (ringer lactate, isolate P) 10 ml/kg. Heart rate, blood pressure, and oxygen saturation were measured and noted as baseline values. Injection atropine 0.01 mg/kg was given as premedication. All children except those who were co-operative and calm were sedated on the operating table before subarachnoid block using ketamine 1 mg/kg, fentanyl 1-2 mcg/kg, or midazolam 0.03 mg/kg IV to provide an immobile patient for lumbar puncture.

- **Inclusion criteria**:
  Patients aged from 2 to 12 years who were given spinal anaesthesia for lower limb & lower abdominal surgery during the study period were included.

- **Exclusion criteria**:
  Patients aged more than 12 years were excluded from the study and patients with a known contraindication to lumbar puncture were excluded.

All patients received spinal anaesthesia via midline approach with patients in lateral position under aseptic precautions. Lumbar puncture was performed in the L4-L5 interspace using standard 25G or 27G quicken spinal needles (9 cm). After getting free flow of cerebrospinal fluid (CSF) hyperbaric bupivacaine (0.5%) in a dose of 0.5 mg/kg (for child <5 kg), 0.4 mg/kg (for 5-15 kg), 0.3 mg/kg (for >15 kg) was injected in the subarachnoid space. The end of the injection was taken as time zero for further data recording. The above-mentioned technique is the usual spinal anaesthetic technique followed in children in our institute. However, we did not standardize it for all cases. It was left to the discretion of the anesthesiologist conducting the case and data were recorded for this observational study. The sensory level was assessed by lack of response to firm skin pinch to the dermatomal level [6]. Desired peak sensory level was aimed to be T10 for assessing the success rate of spinal anaesthesia. Similarly, the modified Bromage score[7]. After 10 min of SAB if the peak sensory level was at least T10 and Bromage score was 3 (complete motor block), surgery was allowed to start. If there was no response to surgical stimuli it was considered as a successful spinal block. If the peak sensory level was below T10 and Bromage score <3, the case was classified as a failed spinal block. The case was given GA with intubation and was excluded from the study for further data analysis. In all cases carried out under spinal anaesthesia, sedation was maintained with propofol infusion at the rate of 50-75 mcg/kg/min. If intraoperative pain or lack of relaxation complained, supplemental anaesthesia was accordingly given, and the case was considered as a partially successful block. At the end of the surgery, all patients received paracetamol rectal suppository (20 mg/kg) on 12 h basis. Demographic data, indication, type and duration of surgery and vital parameters were noted. The requirement of supplemental sedation, the size of the spinal needle, the local anaesthetic dose used and the number of attempts for lumbar puncture were noted. Sensory block characteristics, motor block characteristics and complications related to anaesthesia such as vomiting, shivering, post-dural puncture headache, and any manifestation suggestive of neurological injury were also recorded. The patients were monitored until full recovery. The data were recorded on the patient's assessment performed and analyzed using MS Excel and IBM SPSS 16.0 (Statistical Package for the Social Sciences).

RESULT

In this prospective study, we analyzed 140 patients. Figure 1 shoe the gender distribution of the study population based on the type of surgery; 96 patients were male and 44 patients were female. According to surgery, 92 patients had closed illizarov surgery, 5 patients had lengthening lower limb surgery, 39 patients had herniotomy and 4 patients had other surgery. In this study, there were 131(93.6%) patients had no problem, 6(4.3%) patients had a problem with the head and upper limb movement, 2(1.4%) patients had vomiting and only one patient had shivering (Table 1). According to associated factors, 131 patients had no problems and 9 patients with problems. Table 3 shows the logistic regression of the study population, the odds ratio was 0.858 for age, the odds ratio for weight was 1.151 and the odds ratio for duration was 1.094.

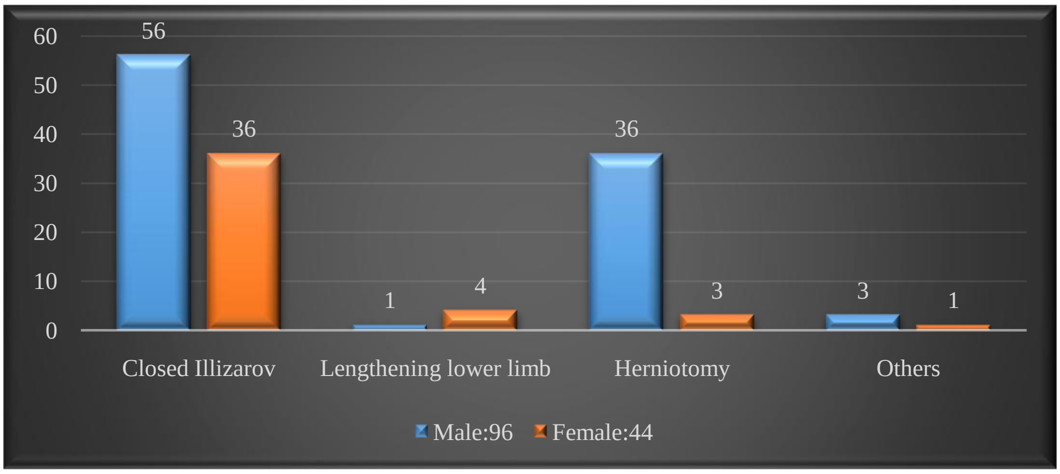

Figure 1: Gender distribution of the study population based on the type of surgery.

Table 1: Distribution of the patient's problem of the study population.

Problems	Frequency	Percentage
No Problem	131	93.6
Movement of the head and upper limb	6	4.3
Vomiting	2	1.4
Shivering	1	0.7
Total	140	100

Table 2: Assessment of the associated factors.

Factors	No Problem (N=131)	With Problem (N=9)	Total	p
Age	7.07±2.65	8.56±2.79	-	0.11
Weight	18.39±5.26	22.44±7.80	-	0.03
Duration	54.73±18.19	77.22±11.21	-	<0.001
Sex				
Male	92 (95.8)	4 (4.2)	96	0.17
Female	39 (88.6)	5 (11.4)	44	
Total	131 (93.6)	9 (6.4)	140	
Operation				
Closed Illizarov	83 (90.2)	9 (9.8)	92	0.17
Lengthening lower limb	5 (100)	0	5	
Herniotomy	39 (100)	0	39	
Others	4 (100)	0	4	
Total	131 (93.6)	9 (6.4)	140	

Table 3: Logistic Regression of the study population.

Variables	Odds Ratio (95% CI)	P-value
Age	0.858 (0.536-1.37)	0.522
Weight	1.151 (0.95-1.401)	0.161
Duration	1.094(1.03-1.16)	0.003

DISCUSSION

This study was undertaken to evaluate the efficacy and safety of spinal anaesthesia in the pediatric population. Spinal anaesthesia in children is a safe, cost-effective, single-shot technique and is ideal for daycare surgeries. It provides a dense and uniformly distributed sensory block with good muscle relaxation. The stress response to surgery is decreased, and recovery is fast following spinal anaesthesia.[8] Adequate premedication is important for the smooth regional procedure in children. Various drugs via different routes may be used to achieve a well-sedated child. Analgesia and sedation are important for pediatric spinal anaesthesia in order to prevent any untoward movement during a lumbar puncture. It may be provided by using low-dose intravenous ketamine/propofol or inhalational anaesthetics during the procedure. Anticholinergic drugs may be added to decrease any undesired secretions. During the intraoperative period, sedation was maintained using propofol infusion (50-75 mcg/kg/min) in all patients. Low-dose sedation does not mask the failure of the block. It is better to provide supplemental oxygen during sedation. In a study conducted by Blaise and Roy[9] on pediatric patients aged 7 weeks to 13 years, 4 of 34 patients required GA due to failure of lumbar puncture after two attempts. Sedation prevents movement of the children during lumbar puncture and might have been an important factor for better results of our study. Ketamine induces dissociative anaesthesia causing functional dissociation between the cortical and limbic systems. Protective airway reflexes are maintained during sedation. Ketamine having a high therapeutic index is a suitable drug for sedation in the pediatric population.[10] Sedative effects of the subarachnoid block itself have also been documented in the literature. Hermanns et al., (2006)[11] conducted a study to evaluate sedation during spinal anaesthesia in infants. The presumed mechanism for sedation after SAB is a decreased afferent conduction to reticulo-thalamo-cortical projection pathways which reduces the excitability and the arousal level of the brain. Lumbar puncture was performed in all the patients in the lateral position. During lateral or sitting position the neck should be in extension as cervical flexion does not provide any benefit in children and in fact, may obstruct the airway during the procedure.[8] The spinal cord ends at the L3 level at birth and reaches L1 by 6-12 months. The dural sac is at the S4 level at birth and reaches S2 by the end of the 1st year. The line joining the two superior iliac crests (inter-cristal line) crosses at the L5-S1 interspace at birth, L5 vertebra in young children and L3/4 interspace in adults. It is for this reason that the lumbar puncture is done at a level below which the cord ends, the safest being at or below the intercristal line.[8] None of the patients required more than two attempts for lumbar puncture, which shows the ease and feasibility of the lumbar puncture technique in the pediatric population. The volume of CSF varies with the patient's age. The volume of cerebrospinal fluid CSF is 4 ml/kg, which is double the adult volume. Moreover, in infants half of this volume is in the spinal space, whereas in adults only one-fourth.[8] This significantly affects the pharmacokinetics of intrathecal drugs and explains why larger doses of local anaesthetics are required for spinal anaesthesia in infants and young children. Among the various drugs approved by Food and Drug Administration for pediatric intrathecal use, 0.5% bupivacaine and ropivacaine are common and popular. Baricity is one of the most significant factors affecting the distribution of the local anaesthetic and hence the success and spread of the blockade. Cardiovascular changes related to spinal anaesthesia are less common in children than in adults. Children younger than 5-8 years of age have an immature sympathetic nervous system and relatively small intravascular volume in the lower extremities and splanchnic system, which limits the venous pooling in this group.[12] Since the level of surgery was below T10 in all the patients, an adequate dermatomal level was present until the end of surgery. Thus, none of the patients required supplemental anaesthesia during surgery in our study. Ahmed et al., (2010)[13] conducted a study on 78 children aged between 2 and 6 years undergoing different types of surgery in the lower part of the body and reported that sensory block showed a wide variation of height from T1 to T7, and the median was T4. In a study conducted by Kokki and Hendolin (2000)[14] to compare hyperbaric bupivacaine 0.5% in 0.9% and 8% glucose solutions for spinal anaesthesia in 7-18 years old children, the motor block was completed in 53 (96%) patients in group bupivacaine -0.9% glucose solution ($n = 55$), whereas it was complete in 52 (100%) patients in group bupivacaine -8% glucose solution ($n = 52$). It is speculated that the drug uptake is faster in the subarachnoid space in infants owing to proportionally greater blood flow to the spinal cord as compared with adults.[15] With faster drug distribution and elimination, an infant's motor level regression is approximately 5 times faster than in adults. This causes a decreased duration of the block. Spinal anaesthesia alone, for this reason, is therefore generally restricted to 1 h duration surgeries only. Duration, however, can be prolonged with the addition of opioids and clonidine.[8] Shivering was the most frequent complication in our study, which was seen in 3(2.9%) patients and was treated with tramadol 2 mg/kg. Hypotension was seen in 2 (2%) patients and was treated with intravenous crystalloids and mephentermine. No other complications such as bradycardia, nausea, vomiting, PDPH, and urinary retention were noted. Ahmed et al., (2010)[13] conducted a study to evaluate the characteristics of spinal anaesthesia on 78 children aged between 2 and 6 years and reported that shivering occurred in five patients and vomiting occurred in one patient. Two patients suffered from hypotension, which was treated with ephedrine and bradycardia was seen in one patient, which was treated with atropine.

Limitations of the study: Every hospital-based study has some limitations and the present study undertaken is no exception to this fact. The limitations of the present study are mentioned. Therefore, the results of the present study may not be representative of the whole of the country or the world at large. The number of patients included in the present study was less in comparison to other studies. Because the trial was short, it was difficult to remark on complications and mortality.

CONCLUSION AND RECOMMENDATIONS

In our experience no gross intraoperative hemodynamic changes observed & also no permanent adverse complications occurred. The technique of spinal anaesthesia provides a good alternative to general anaesthesia in paediatric patients with increased general anaesthesia related risks (Malignant Hyperthermia, Difficult airway, Laryngospasm, delayed recovery etc), & for patients undergoing lower abdominal or lower extremity surgery, lasting less than 60-70 minutes of duration. Economically also spinal anaesthesia is very cheap compared to general anaesthesia .Since our number of study patients were very less this topic requires large number of studies of paediatric patients for further confirming our observations.

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