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Original Article

Effect of Spinal Anaesthesia in Children of 4–10 Years

Md. Ashraful Islam[1], Easnem Khanum[2], Md. Rezaul Karim[3], Nelufa Tahera Rahman[4], Md. Rezaul Haque[5]

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Abstract

***Background**: Though paediatric spinal anaesthesia has been used since early 20th century in developed countries even in neonates, still it is not common in our country. Spinal anaesthesia can be given in neonates and children for infraumbilical surgeries with an expert and experienced anaesthesiologist. **Objective**: The objective of this study was to establish spinal anaesthesia as a safe and effective regional anaesthetic procedure in children of 4–10 years. **Materials and Methods**: The study was done in the Department of Anaesthesiology & Intensive Care Unit of Enam Medical College & Hospital during the period of June 2012 to May 2014. A total of 102 patients aged from 4 to 10 years with American Society of Anaesthesiologists (ASA)-I and II were selected. After proper preoperative anaesthetic evaluation spinal anaesthesia was administered. All patients were premedicated with atropine, preloaded with crystalloid solution and sedated with ketamine 1 mg/kg or midazolam 0.03 mg/kg. 0.5% hyperberic bupivacaine was injected at L4/5 or L5/S1 level with spinocaine needle. After establishment of desired block, surgery was performed. All vital parameters, number of attempts for lumbar puncture, sensory and motor block were monitored and recorded. **Results**: Almost all patients achieved desired block (T8–T10) within 5 to 10 minutes. The success rate in our study was 96.1% and remaining 3.9% were considered as failure. No remarkable changes were observed in vital parameters after spinal anaesthesia. Lumbar puncture was successful in first attempt in 60 (58.82%) cases and in second attempt in 42 (41.18%) cases. Hypotension occurred in 2%, shivering in 3% and 3% developed restlessness. **Conclusion**: Spinal anaesthesia produces a reliable, profound and uniformly distributed block with rapid onset, good muscle relaxation, complete control of cardiovascular and stress responses compared with epidural or GA. There is also rapid recovery and minimal complications without special drugs or expensive equipments. However, greater acceptance and experience are still desired for this technique to become more popular.*

***Key words**: Spinal anaesthesia; Children; Paediatric spinal anaesthesia*

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Introduction

Postoperative apnoea is a life-threatening complication in young children of 4–10 years.[1] Regional anaesthesia (RA) is alternative to general anaesthesia (GA) for children. Benefits include lower incidence of postoperative complications. Spinal anaesthesia in children has been in use since the early 20th century, but was overlooked for many years due to the introduction of inhalational anaesthetics and neuromuscular blockers. It regained popularity in 1979. Before that, Tyrell Gray, a British surgeon, published a series of 200 cases of lower abdominal surgeries in infants and

1. *Associate Professor, Department of Anaesthesiology & Intensive Care Unit (ICU), Enam Medical College & Hospital, Savar, Dhaka*
2. *Associate Professor, Department of Anaesthesiology & ICU, Enam Medical College & Hospital, Savar, Dhaka*
3. *Associate Professor, Department of Paediatric Surgery, Enam Medical College & Hospital, Savar, Dhaka*
4. *Medical Officer, Department of Anaesthesiology & ICU, Enam Medical College & Hospital, Savar, Dhaka*
5. *Professor, Department of Anaesthesiology & ICU, Enam Medical College & Hospital, Savar, Dhaka*

***Correspondence** Md. Ashraful Islam, Email: drashrafulislam3@gmail.com*

children under spinal anaesthesia during 1909–1910.[2] In early 1980s, it was reintroduced as an alternative to general anaesthesia (GA) as children are at an increased risk for GA-related complications.[3] Thus, spinal anaesthesia could also be indicated as an alternative to GA, especially in situations such as chronic respiratory disease, potentially difficult airway and malignant hyperthermia.[4-6] Spinal anaesthesia in infants has been associated with decreased incidence of hypotension, hypoxia, bradycardia and postoperative apnoea as compared to GA providing a high-degree of cardiovascular and respiratory stability.[7-10] However, paediatric spinal anaesthesia never achieved its popularity because of continuous discoveries of newer and better volatile agents and muscle relaxants for general anaesthesia. In the last decade, many centres begun to advocate spinal anaesthesia in children due to increasing knowledge on pharmacology, safety information and of specialised equipments for regional anaesthetic techniques and monitoring in children. In future, paediatric spinal anaesthesia will not only be used in cases where general anaesthesia is risky or contraindicated but also be the preferred choice in most lower abdominal and lower extremity surgeries in children.[11] Technological advances and better training of intensive care unit staffs have increased the survival rate. Spinal anaesthesia has been proposed as the single anaesthetic technique with the aim of decreasing immediate postoperative apnoea. Though spinal anaesthesia is gaining popularity in children, the misconceptions regarding its overall safety, feasibility and reliability can only be better known with more use and research.[11] Very few studies are available highlighting the experience of spinal anaesthesia in children regarding its safety, success rate and complications. So we designed this study to prospectively analyse the success rate, complications and haemodynamic stability related to spinal anaesthesia in paediatric patients of 4–10 years over a period of two years.

Materials and Methods

This study was conducted in the Department of Anaesthesiology and ICU, Enam Medical College & Hospital, Savar, Dhaka for 2 years duration (1st June, 2012 to 30th May, 2014). Total 102 subjects were included in the study. Informed written consent was obtained from parents of each patient for participation in the study and the various aspects of regional technique along with the risks involved were explained in details. There is also an obvious need to assess the risk involved in the procedure on an individual case basis versus the benefits expected depending on the nature and duration of surgery, general condition of the patient and the availability of institutional care intra- and postoperatively. All paediatric patients of 4–10 years of age who were given spinal anaesthesia were included in the study. All patients under study were subjected to detailed pre-anaesthetic evaluation. The standard preoperative fasting guidelines were followed before elective spinal anaesthesia. There are important anatomic differences between children and adults, which are related to the child's development stage that should be considered at spinal blockade. The important factor is CSF volume which in the adult is 140 mL with 75 mL in the spinal space. In children, total volume varies from 40 to 60 mL with half of it in the spinal space.[12] So, although a reduced total volume in children, the relative volume is higher (2 mL/kg in adults and 4 mL/kg in children). Children's spinal cord is highly vascularised allowing a fast local anaesthetic clearance.[13]

After establishment of intravenous access, all were preloaded with crystalloid solution (baby saline) 10 mL/kg within a period of 30–40 minutes. 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 cooperative 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. All patients received spinal anaesthesia via midline approach under aseptic precautions with patients in lateral position. Lumbar puncture was performed in L4-L5 intervertebral space using standard 25G or 27G quincke spinal needles (9 cm). After getting free flow of CSF, hyperbaric bupivacaine heavy (0.5%) was injected in the subarachnoid space (in a dose of 0.5 mg/kg for children <5 kg, 0.4 mg/kg for children 5–15 kg, 0.3 mg/kg for children >15 kg[14]). Sensory level was assessed by lack of response to firm skin pinch to the dermatomal level and also using modified Bromage score[15]. Desired peak sensory level was aimed to be T10 for assessing the success rate of spinal anaesthesia. Sensory block characteristics, motor block characteristics and complications related to anaesthesia such as vomiting, shivering, postdural puncture headache and any manifestation suggestive of neurological injury were also recorded. The patients were monitored until full recovery.

Results

In this study, mean age of the subjects was 6.90 ± 1.67 years (4 to 10 years). Eighty five (83.3%) subjects were males and 17 (16.7%) were females. Mean weight of the subjects was 28.53 ± 6.73 (18–40) kg. Spinal anaesthesia was given for different types of surgeries (Table I). Mean duration of surgery was 52.5 ± 17.058 (35–100) minutes.

Table I: Distribution of study subjects according to types of surgeries (n=102)

Types of surgeries	Number	Percentage
Circumcision	54	52.94
Lower limb orthopaedic surgeries (Debridement, tendon repair etc)	26	25.49
Herniotomy	18	17.65
Appendicectomy	4	3.92

Mean preanaesthetic fasting period was 5.94 ± 0.89 hours. Injection atropine 0.01 mg/kg was given as premedication. At the time of entering the operation theatre, 92 (90.2%) patients who were older in age (>7 years) were conscious and calm and 10 (9.8%) patients were crying. On the operation table, 98 (97.1%) patients received sedative drug to prevent any untoward movement during subarachnoid block (SAB). Most of the patients were given ketamine either alone (n=56, 54.9%) or with midazolam (n=23, 22.5%). Other drugs used were diazepam (n=1, 1%) and fentanyl (n=7, 6.9%). Baby saline was the most frequently used fluid. It was given to 99 (97.1%) patients in the operation theatre. Mean quantity of fluid given before SAB was 163.82 ± 67.61 mL. Lumbar puncture was successful in first attempt in 60 (58.82%) patients and 42 (41.18%) patients required second attempt. There was no significant change in the mean value of systolic blood pressure, diastolic blood pressure, respiratory rate, and oxygen saturation after SAB at all time periods. Pulse rate increased significantly in 11.3% cases after 5 minutes of SAB as compared with baseline. This can be attributed to atropine and ketamine which were used for premedication and sedation respectively. However, mean pulse rate showed no significant change from baseline afterwards. Only 2 (2%) patients had a single episode of hypotension after 10 minutes of SAB, which was successfully managed. Fig 1 shows the vital parameters at different time periods.

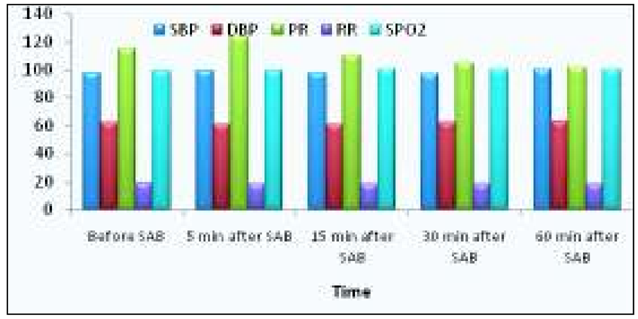

Fig 1. Vital parameters at different time periods

After 10 minutes of SAB 98 (96.1%) patients achieved desired peak sensory level of T10 and Bromage score of 3. Surgery was completed in all these cases without anaesthetic supplementation. The success rate of SAB was 96.1%, only 4 (3.9%) cases required GA.

Discussion

This study was undertaken to evaluate the efficacy and safety of spinal anaesthesia in the paediatric population. General anaesthesia may be associated with several life-threatening complications, especially with co-morbidities like difficulty in intubation, failed intubation, hypoxia, delayed reverse, incomplete reverse, other reversal hazards such as hypothermia, post-operative apnoea, post-operative hypoxia, sore throat, tongue fall back, shivering, cyanosis and perioperative cardiac arrest.[16] In the healthy children, most of the procedures like herniotomy, circumcision, minor urological and orthopaedic procedures are performed as day-case surgeries. Spinal anaesthesia is a very good alternative for such cases where the child can be returned to the family and a lot of stress to the parents is avoided.[11] This method of anaesthesia may avoid the increased incidence of postoperative respiratory complications associated with general anaesthesia. Spinal anaesthesia has been found to be more cost-effective as compared to general anaesthesia. The drugs and equipments required are less and cheaper and length of hospital stay is usually shorter.

The major advantage of spinal anaesthesia in children is the cardiovascular stability.[17] Differently from adults, children have little or no heart rate and blood pressure changes. Factors involved in this extraordinary haemodynamic stability are still not totally defined. One theory is that the relative immaturity of the sympathetic nervous system would make children's vasomotor tone less dependent on this system and that capacitance veins in lower extremities are small and send little blood flow for this region.[18] Respiratory failure or apnoea may occur when sensory and motor block levels are above the first thoracic dermatome (T_1), and may need for ventilatory assistance until blockade regression. It is speculated that the drug uptake is faster in the subarachnoid space owing to proportionally greater blood flow to the spinal cord as compared with adults.[19] With faster drug distribution and elimination, childrens' motor level regression is approximately 5 times faster than in adults. This causes a decreased duration of block. For this reason, spinal anaesthesia alone is generally restricted to one hour duration surgeries only.

In 1984, Blaise et al[20] conducted a study on paediatric spinal anaesthesia in 34 patients aged from 7 weeks to 13 years with ASA-I physical status. In their study, four patients required GA due to failure of lumbar puncture by two attempts. There was no episode of hypotension. In our study four patients needed GA due to failure to achieve desired block after 10 minutes and two patients developed hypotension.

In 1998, Kokki et al[21] studied on paediatric spinal anaesthesia among 100 children aged 2 to 15 months. This was a comparative study between isoberic and hyperberic bupivacaine. The success rate of spinal block was higher in the hyperbaric group. Only one case required GA subsequently. In our study hyperbaric bupivacaine was used and success rate was 96.1% and four cases required GA.

William et al[22] conducted a study in 1554 infants undergoing major abdominal and thoracic surgeries. Success rate was 97.4% which was almost similar to our success rate (96.1%). Most common complications were oxyhaemoglobin desaturation (SpO2<90%) in 10 pateints and bradycardia (HR <100 beats/min) in 24 patients. These might be due to wide range of sample size and types of surgery. In our study such complications were not found.

In 2009, Jamil et al[23] conducted a study among 66 (aged 6 months to 10 years) paediatric patients undergoing surgery of subumbilical region of the body having ASA-I and II at Ayub Teaching Hospital Abbottabad, Pakistan. All patients were premedicated with atropine which was similar to our study. Lumbar puncture was successful in first attempt in 37 (56.1%) patients and second attempt was required in 29 (43.9%) patients. In our study, LP was successful in first attempt in 60 (58.82%) patients and 42 (41.18%) required second attempt. Mean arterial blood pressure was normal in 100 (98.03%) patients and heart rate increased in 11.3% patients.

Overall patient safety, feasibility and reliability are the key features of this technique which will only become better with greater use, experience and research.[11] Among the various drugs approved by Food and Drug Administration for paediatric use, 0.5% bupivacaine heavy is common and popular.

Spinal anaesthesia produces a reliable, profound and uniformly distributed sensory block with rapid onset and good muscle relaxation. It results in more complete control of cardiovascular and stress responses than epidural or opioid anaesthesia. The failure rate of spinal anaesthesia was low in our study. Owing to high success rate (96.1%) and very low complication rates, our study breaks the misconception regarding the feasibility and safety of paediatric spinal anaesthesia.

From our study we can recommend that spinal anaesthesia is ideal, safe and cost-effective for day-case surgeries and there is no additional requirement of any special drugs or equipments for the procedure. Because of these benefits, spinal anaesthesia can be preferred for children undergoing surgery in the lower part of the body. However, further studies with larger sample size are recommended.

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