Original Research Article

Indian Journal of Anesthesia and Analgesia
2018; 5(3): 409-414
DOI: http://dx.doi.org/10.21088/ijaa.2349.8471.5318.9

Evaluation of Spinal Anaesthesia in Paediatric Patient undergoing Lower Abdominal and Lower Limb Surgeries

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Abstract

Purpose: Spinal anaesthesia is a useful technique for infraumbilical and lower limb surgeries. The misconceptions regarding its overall safety, feasibility and reliability can be better known with greater use, its applications and research. We have designed this study to analyze the success rate, complications, and hemodynamic stability related to spinal anaesthesia in paediatric patients aged 5 years to 12 years.

Methods: Total 60 patients were included in this study. Spinal anaesthesia was given with injection hyperbaric bupivacaine (0.5%) in a dose of 0.3 mg/kg. Demographic data, vital parameters, number of attempts for lumbar puncture, sensory-motor block characteristics and complications were noted.

Results: Lumbar puncture was successful in 1st attempt in 46 (76.66%) patients and 2nd attempt was required in 14 (23.34%) patients. Vital parameters were not altered. Mean peak sensory level achieved was $T_{7.1 \pm 1.67}$ (T_{4-12}) and mean time for two segment regression was 45.33±4.71 minutes. Modified Bromage score was 3 in all patients. Sensory and motor block recovery was complete in all patients. Mean duration of surgery was 77.2 ± 11.88 minutes. The incidence of complications was minimal with hypotension and bradycardia.

Conclusion: Our study concludes that spinal anaesthesia in paediatric patients is feasible owing to its safety, higher success rate, and very low complications. Due to its early motor recovery, batter postoperative analgesia with minimal physiological alteration, no risk of respiratory depression and pulmonary aspiration, it reduces overall morbidity and mortality. Hence it is a preferred technique for daycare lower abdominal and lower limb surgeries.

Keywords: Spinal Anaesthesia; Lower Limb Surgery; Lower Abdominal Surgery; Pediatric Spinal Anaesthesia; Bupivacaine.

Introduction

Spinal anaesthesia is the technique of regional anaesthesia whereby anaesthesia is obtained by blocking the spinal nerves in subarachnoid space. The anaesthetic agent is deposited in the subarachnoid space and act on spinal nerve roots and not on the substance of the cord. Spinal anaesthesia is a useful technique in infraumbilical and lower limb surgeries [1]. Infants and children are at more risk for General Anaesthesia (GA) related complications [2-5]. Thus, spinal anaesthesia could also be indicated as a substitute to GA, principally in circumstances such as potentially difficult airway, malignant hyperthermia, and chronic respiratory disease [6-11]. Spinal anaesthesia in children has been associated with decreased incidence of hypoxia, bradycardia, postoperative apnoea and hypotension as compared to GA [12-16] thus, providing a high degree of cardiovascular and respiratory stability.

Spinal anaesthesia, however, gaining popularity in children, the misconceptions regarding its overall

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Received on 28.12.2017, **Accepted on** 24.01.2018

safety, feasibility, complications, and reliability can only be better known with its greater use, its applications and research. There is no scientific research that shows results of spinal anaesthesia in children regarding its success rate, safety, tolerability and complications in the Indian scenario. This inspired us to design this study in which we have prospectively analyzed the success rate, complications, and hemodynamic stability related to spinal anaesthesia in paediatric patients aged 5 years to 12 years.

Material and Methodology

After obtaining Institutional Ethical Committee approval we have conducted this study. Informed consent was obtained from parents of each patient for participation in the study. 60 paediatric patients aged 05 to 12 years of age group, having American Society of Anaesthesiology (ASA) physical status I – II of either sex, weighing 15 – 35 kg, were given spinal anaesthesia for infraumbilical or lower extremity surgery. Parents not willing to participate their children in the study, patients with infection at the local site, coagulopathy disorder, cardiovascular and neurological abnormalities, history of psychiatric illness, and congenital abnormalities were excluded from the study.

All patients were evaluated for pre-anaesthetic check up and not allowed to take solid food for 6 hours and clear fluid for 2 hours before anaesthesia. No overnight premedication was given. After the establishment of intravenous access, all patients were preloaded with a crystalloid solution (Ringer's lactate) 10 ml/kg. Heart rate, respiratory rate, blood pressure, and oxygen saturation were measured and noted as baseline values. All patients were premedicated with injection Ondansetron 0.08 mg/kg i.v.injection Glycopyrrolate 0.004mg/kg i.v. and injection Midazolam 0.04 mg/kg i.v.

All children except those who were co-operative and calm were sedated on the operating table before subarachnoid block using ketamine 1 mg/kg i.v. to provide an immobile patient for lumbar puncture.

All patients received spinal anaesthesia via midline approach with patients in lateral position under aseptic and antiseptic precautions. Lumbar puncture was performed in L_{4-5} interspace using standard 25G or 27G quincke spinal needles (9 cm). After getting free flow of cerebrospinal fluid (CSF), hyperbaric bupivacaine (0.5%) in a dose of 0.3 mg/kg was injected in the subarachnoid space over 10 seconds.

Patients were positioned supine immediately after the administration of intrathecal agent. Fluid therapy was maintained with lactated Ringer's solution and other appropriate intravenous fluids. The end of injection was taken as time 'zero' for further data recording. Above mentioned technique is the usual spinal anaesthetic technique being followed in children in our institute for children. Data were recorded for this observational study. The sensory level was assessed by loss of pinprick sensation by 23-gauge hypodermic needle bilaterally along the midclavicular line and facial expression, (lack of response to firm pinprick to that dermatome level) [17]. We used T_2- as baseline point for normal sensation. The test was performed every 5 seconds till the onset of sensory block at shin of tibia, then every 1 minute till it reached T_{10} dermatome, thereafter every 10 minutes till its full recovery. The onset of sensory block was taken as the time interval between the completion of local anaesthetic solution injection to the achievement of complete loss of sensation at shin of tibia (L_4). Time taken to achieve complete sensory blockade at T_{10} level were, maximum sensory level and two segment regression times were noted. The total duration of sensory block was taken from the onset of sensory block to return of pinprick sensation at the heel of feet (S_1).

Similarly, Modified Bromage score [18] (0: Free movement of leg and feet with the ability to raise extended leg, 1: Inability to raise extended leg and decreased knee flexion decreased, 2: Inability to raise or flex knees; flexion of ankle and feet present, 3: Inability to raise leg, flex knee or ankle, able to move toes) was assessed and noted. After 10 min of the subarachnoid block if the peak sensory level achieved was at least T_{10} and Modified Bromage score 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 T_{10} and modified Bromage score <3, the case was classified as a failed spinal block and was given GA with intubation and was excluded from the study. Demographic data, vital parameters, number of attempts for lumbar puncture, sensory-motor block characteristics and complication 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 in the patient's case record form and analyzed using MS Excel 2007 and SPSS version (Statistical Package for the Social Sciences).

Result

Demographic Data

The mean age group of the patients was 8.83±2.44 years in our study. The mean weight in the patients was 23.67±5.37 kg in our study. There were 43 male patients and 17 female patients. Spinal anaesthesia provided was for a variety of surgeries [Table 1]. Mean duration of surgery was 77.2±11.88 minutes.

In our study, mean time of onset of the sensory blockade at shin of the tibia was 173.47±23.81 Seconds, mean time to reach T_{10} Dermatome was 6.45±1.08 minutes, mean of peak sensory level achieved $T_{7.1 \pm 1.67}$ ($T_{4\text{-}12}$) and mean time to two segment regression was 45.33±4.71 minutes. The total duration of sensory blockade was 104.80±11.57 minutes. The mean time to achieve the modified Bromage score 3 was 8.27±1.35 minutes. The mean time to return of Modified Bromage score 0 was 95.08±10.17 minutes. Sensory and motor block recovery was complete in all the patients [Table 2].

Vital Parameters

There was no significant change in the mean value of systolic blood pressure, diastolic blood pressure, respiratory rate, and oxygen saturation after subarachnoid block at all time periods (Figure 1)

The total duration of postoperative analgesia in our study was 111.33±8.11 minutes as shown in Figure 2.

Table 1: Type of surgery

Type of Surgery	No. of Patients
Herniotomy	5
Appendicectomy	4
Urogenital surgeries (circumcision,hydrocele)	10
Orthopaedic (nailing, debridement, biopsy, tendon repair)	41

Table 2: Block characteristics

Block characteristics	
Sensory Block	
Onset (Shin of Tibia – L4)	173.47 ± 23.81 (Seconds)
Time to reach T10 Dermatome	6.45 ± 1.08 (Minutes)
Peak sensory level achieved	T7.1 ± 1.67 (T4-T12)
Two segment Regression Time	45.33 ± 4.71 (Minutes)
Total duration of Blockage	104.80 ± 11.57 (Minutes)
Motor Block	
Time to achieve Bromage score 3	8.27 ± 1.35 (Minutes)
Time to return Bromage score 0	95.08 ± 10.17 (Minutes)

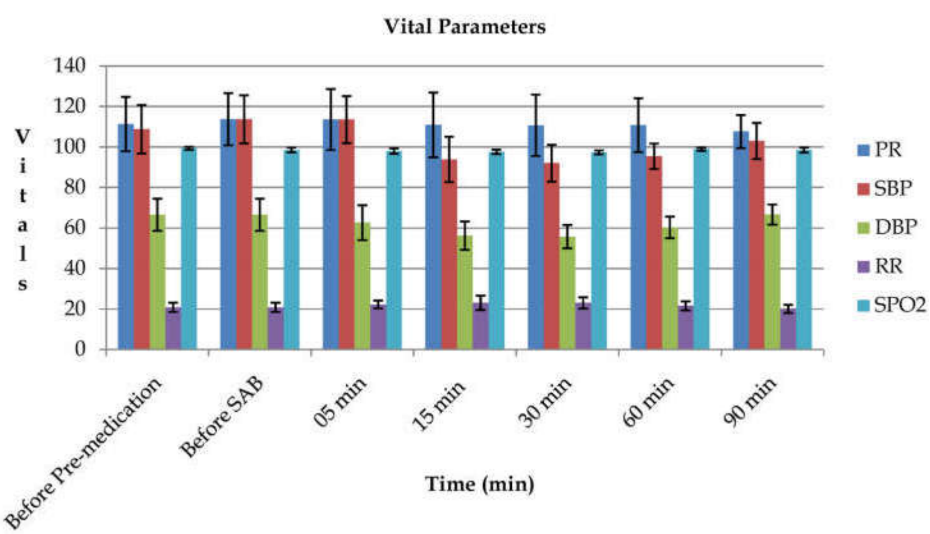

Fig. 1: Vital parameters

Table 3: Complication

Complication	No of patients
Bradycardia	1
Shivering	0
Hypotension	1
Nausea	0
Respiratory depression	0

Discussion

This study was undertaken to evaluate the safety and efficacy of spinal anaesthesia in the paediatric population aged 5 to 12 years. Spinal anaesthesia in paediatrics is a safe and cost-effective technique ideal for daycare surgeries. It provides intense and uniformly distributed sensory block with better muscle relaxation. The stress response to surgery is decreased and recovery is faster following spinal anaesthesia [19, 21].

The line joining the two superior iliac crests (inter-cristal line) crosses at L_5 S_1interspaces at birth, at L_5 vertebra in young children and at L_{3-4}inter spaces in adults. Because of this reason, the lumbar puncture is done at a level below which the cord ends; safest being at or below the inter-cristal line [19]. In our study, lumbar puncture was successful in 1st attempt in 46 (76.66%) patients and 2nd attempt was required in 14 (23.34%) patients. None of the patients required more than two attempts for lumbar puncture, which shows the ease and feasibility of lumbar puncture technique in the paediatric population.

Sensory and Motor Blockade

In our study, the mean time for onset of sensory block at shin of tibia was 173.47±23.81 seconds and motor block was 322.5±61.33 seconds. These results are consistent with the findings of H. Kokki and H. Hendolin [20].

The mean peak sensory level achieved was $T_{7.1 \pm 1.67}$ (T_{4-12}). The mean time of two segments regression was 45.33±4.71 minutes since the level of surgery was below T_{10} in all the patients, adequate dermatome level was present till the end of surgery. Thus, none of the patients required supplemental anaesthesia during surgery in our study. This finding is similar to Verma et al [21].

Ahmed et al [22] 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 widevariation of height from T_1 to T_7, which is consistent with our study. In our study, the mean time to achieve T_{10} sensory blockade was 6.45±1.08 minutes. With regard to the highest sensory level 10% patients attained T_4 level, 36.66% achieved T_6 level, 35% achievedT_8 level, 11.66% achieved T_{10} levels and 6.66% achieved T_{12} levels.

Jean P. Racleetal [23] observed in their study that time for two-segment regression (min) were 108±7min in group I (bupivacaine + normal saline) and 126±12min in group II (bupivacaine + epinephrine) and 171±12 min in group III (Bupivacaine + Clonidine.) In our study, the time for 2 segment regression was 45.33±4.71 minute. This difference in results might be attributable to the difference in age groups of patients selected. This can be explained by the fact that the drug uptake is faster in the subarachnoid space in infants owing to proportionally greater blood flow to the spinal cord as compared to adults [24]. 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 generally restricted to 1 hour duration surgeries only. Duration, however, can be prolonged with the addition of opioids and clonidine [19].

Time for Complete Sensory and Motor Recovery

Duration of sensory block was 104.80 minutes which was less in our study compared to adults. Motor effect faded away earlier than sensory. Duration of motor effect in our study was 95.08 minutes. The results are consistent with the findings of Veronique Mahey and Claude Ecoffey [25] where they also noted shorter duration of motor block in children as compared to an adult. C.I. Junkin [26] in his study also noted the same findings as Verma et al. [21] and concluded that spinal anaesthesia in children is only meant for surgeries of shorter duration.

This can be explained on the basis that children have more CSF volume (4ml/kg) than adults (2ml/kg) and hence drug is diluted more. Also, there can be age-related differences in the diameter and surface area of spinal cord and nerve roots and rate of absorption of local anaesthetic from subarachnoid space [27]. These authors further pointed out the difficulty in locating the subarachnoid space and injecting the drug while giving spinal anaesthesia. This may be due to fear of complication like trauma to cord or cauda equina which could cause neurological deficit. In present, study no difficulty was faced in locating subarachnoid space as we have taken due care in selecting space (L_{4-5}) and used small gauge needle. Cardiovascular changes related to spinal anaesthesia are less common in children than in adults. Children younger than 8 years of age have immature sympathetic nervous system and relatively small intravascular volume in the lower extremities and splanchnic system, which limits the venous pooling in this group [21,28].

It has been recommended that SpO_2 should remain more than 94% in children [29]. In present study, the SpO_2 level was more than 97% throughout the study. Respiratory rate was also not altered after spinal anaesthesia. Mean duration of analgesia is about 111.33min. C.I. Junkin [26] in his studies noted that duration of spinal anaesthesia is short in children but provides post operative analgesia satisfactorily in children.

Intraoperative hypotension (>20% fall in systolic blood pressure) was seen only in 1 (1.66%) patient which was treated with fluid and 3 mg mephentermine i.v.. Bradycardia was observed in 1 patient who was treated by injection Atropine 0.01mg/kg i.v. which are similar findings with the previous study [22]. No other complications like nausea, vomiting, respiratory depression or post-dural puncture headache was noted [Table 3].

Conclusion

Our study concludes that spinal anaesthesia in paediatric patient is feasible owing to its safety, higher success rate, and very low complications. Due to its early motor recovery, batter postoperative analgesia with minimal physiological alteration, no risk of respiratory depression and pulmonary aspiration, it reduces overall morbidity and mortality. Hence it is a preferred technique for daycare lower abdominal and lower limb surgeries.

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