Original Article

Age-based Local Anesthetic Dosing in Pediatric Spinal Anesthesia: Evaluation of a New Formula – A Pilot Study in Indian Patients

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Abstract

Background: Spinal anesthesia is a safe alternative to general anesthesia and often the anesthetic technique of choice in many lower abdominal and lower limb surgeries in children. As the vertebral column and spinal cord grows variedly with age and not weight, we planned to administer an age-based dosing schedule of hyperbaric bupivacaine in the intra-thecal space in select infra umbilical surgeries in children. The aim was to find out the efficacy and complications associated with this dosage. **Methodology:** Twenty-five pediatric patients between 2 and 12 years, posted for elective infra umbilical surgeries were given a sedation as a combination of effective doses of pentazocine, midazolam, and atropine. In all those patients, spinal anesthesia was administered at a dose of age/5 of hyperbaric bupivacaine. The number of attempts, the onset of blockade, the mean sensory level, and the duration of anesthesia were noted. Any other complications were also noted. **Results:** The mean and standard deviation of age is 7.68 ± 2.49 years. Intra-thecal anesthesia was administered successfully in the first attempt in 88% of cases whereas the remaining needed the second attempt. Three patients needed intravenous ketamine of 0.25 mg/kg additionally for preoperative sedation. The sensory level was between T6 and T10 with a mean of T8.5. There were no intra-operative complications. In all patients, surgery was finished within the duration of anesthesia of approximately 60 min. There was no conversion to general anesthesia in any case, but a three patients required dose of 0.25 mg/kg of intravenous ketamine as a calming dose. **Conclusion:** Administration of age-based local anesthetic dosing of hyperbaric bupivacaine in the intra-thecal space by utilizing a new formula of age/5 (Partha formula) is successful in a pilot study in Indian children for infra-umbilical surgeries. There were no observed complications.

Keywords: Anesthesia, dose, pediatric, spinal

Introduction

Spinal anesthesia in infants and children is regaining its popularity in recent times. Pediatric spinal anesthesia is not only a safe alternative to general anesthesia but often the anesthesia technique of choice in many lower abdominal and lower limb surgeries in children.[1] The misconceptions regarding its overall safety, feasibility, and reliability have been revealed with various researches.[2-4] Although spinal anesthesia would seem to be a logical alternative to general anesthesia for many surgical procedures, it remains an underutilized technique.[5] Pediatric spinal has been found to be safe even in preterm babies.[6] In most of the studies, dosage of local anesthetic was decided based on bodyweight of the patients.[2] There is a great variation in the body weight among the same age group babies. Hence, calculating spinal dose with body weight may vary with the higher incidence of complications. Hence, we decided to formulate the spinal dose with age of the patient. Moreover, the growth of the spinal cord is constant with age. We hypothesize that age could be a better parameter for calculating the dose for spinal anesthesia in pediatrics and designed this study.

Aims and objectives

The aim is to find adequacy of anesthesia provided by local anesthetic drug bupivacaine heavy at a dose of age/5 in terms of onset of blockade, level of sensory blockade, and level of

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motor blockade. The objectives are to find out the incidence of perioperative complications, necessity of sedatives for giving the block, duration of blockade.

Methodology

After necessary research committee approval and informed consent from parents, 25 pediatric patients belonging to the American Society of Anesthesiologist 1 and 2, between 2 and 12 years, posted for elective infra umbilical surgery in a hospital near Puducherry, were included in our study by continuous sampling. The duration was between August and October 2016. The exclusion criteria included parents who were not willing and patients with local infection, coagulation abnormalities, and spinal anomalies. All the children were kept nil per oral for 2 h for clear fluids and 4 h for milk. All the children were premedicated with syrup promethazine 0.5 mg/kg per oral night before and in the morning 2 h before surgery. Most of the children were counseled slowly to the operating room. In those, who were not cooperative, an artificial nipple was used for parental separation. Intravenous cannula was secured. Intravenous pentazocine (0.3 mg/kg), midazolam (0.05 mg/kg), and atropine (30 μ/kg) were given for sedation to maintain immobility while performing subarachnoid block. After adequate sedation, the patients were put in lateral position and under strict aseptic precaution, spinal anesthesia was given with 25 gauge Quincke's needle in the L4–L5 inter-space. The 0.5% bupivacaine heavy was administered at the dose of age divided by 5 in ml. This formula (Partha formula) was arrived after analyzing 100 children with ideal body weight based dosing and age based dosage. This was confirmed with adequate anesthesia in three cases. Followed by the success of this formula, we decided to conduct in a series of cases. The age in months after the completion of a year was noted and considered as next age if it is more than 6 months and the same age if it is <6 months. Examples of dosage of hyperbaric spinal bupivacaine

- Eight years child – 8/5 = 1.6 ml
- Nine years and 8 months – 10/5 = 2 ml
- Four years and 4 months – 4/5 = 0.8 ml.

During spinal technique, if sedation was insufficient, additional intravenous ketamine in 0.25 mg/kg was given and noted. After giving spinal anesthesia patients were turned supine and level of sensory and level of motor blockade were assessed at every 2 min interval for 10 min. The onset of blockade meant either sensory loss at any dermatome or sudden fall of leg. The hemodynamic parameters were monitored throughout the surgery. Sensory level was assessed by the lack of response to firm pin-prick to the dermatomal level. Motor blockade was assessed using modified Bromage score as follows.

- 0: Free movement of leg and feet with the ability to increase extended leg
- 1: Inability to increase extended leg and knee flexion decreased
- 2: Inability to increase or flex knees; flexion of ankle and feet present
- 3: Inability to increase leg, flex knee or ankle, move toes.

The above score was assessed by the same stimulus (firm pin-prick) given on lower limb (thigh). Superficial abdominal reflexes were tested for identifying motor blockade level above L1. After 10 min of subarachnoid block, the peak sensory level must be at least T10 and a Bromage score of 3 (complete motor block). Only then, the surgery was allowed to start. If there was no response to surgical stimuli, it was considered as successful spinal block. Inadequate level, intraoperative pain or any complaint of the lack of relaxation from surgeons, supplemental anesthesia was given and then the case was considered as partial successful block and noted down. If the peak sensory level was below T10 and Bromage score <3, failed spinal block, then general anesthetic was administered and noted. Demographic data, type, and duration of surgery were noted. The requirement of supplemental sedation, size of spinal needle, local anesthetic dose used, and number of attempts for lumbar puncture were also noted. An attempt was defined as taking the needle out of skin and reinserting. Sensory block characteristics and motor block characteristics were recorded. Complication related to anesthesia such as vomiting, shivering, postdural puncture headache, and any manifestation suggestive of neurological injury were also recorded. The onset of pain or the movement of the legs were approximately considered as termination of action of intra-thecal drug and the duration was calculated from the onset. All the patients were monitored until full recovery. All patients were discharged without any complications. Statistical Analysis: All the data were recorded in Microsoft Office-Excel. Statistical analysis was carried out using SPSS version 19.0 (Armonk,NY:IBM corp) software. Descriptive analyses were reported as mean and standard deviation of continuous variables. As this is a simple pilot study with minimal descriptive analyses, there is no need for complex statistical tests.

Results

The mean and standard deviation of age is 7.68 ± 2.49 years. Out of the 25 cases, 18 were males whereas the remaining seven were females

Table 1 showing the number of cases and the sensory level achieved.

The mean onset of blockade was within 1 min in all the cases. There was satisfactory sensory level in all the cases. The motor blockade coincided with the sensory level in all cases. The patients included tendo-achilles lengthening, lower limb fractures, appendicectomy, orchipexy, and herniotomies. The

Table 1: Differing sensory level and the number of patients

Sensory level	Number of cases
T6	2
T8	14
T10	9

mean duration of surgery was 33 ± 10.99 min. The mean duration of anesthesia was 59.2 ± 8.2 min. All the cases were completed within the anesthetic duration and there was no conversion to general anesthesia.

Discussion

Drug dosage in pediatrics is routinely based on weight, but rarely age and body surface area also become important. They have not been fully evaluated with comparative randomized trials with weight based dosing.[7,8]

e.g., Young's rule

$$\text{Adult dose} \times \left(\frac{\text{age}}{[\text{age} + 12]}\right) = \text{Child's dose}$$

$$\text{Child's dose} = \left(\frac{\text{age of child}}{[\text{age of child} + 12]}\right) \times \text{average adult dose.}$$

Usually in anesthesia, where the anatomical length is concerned, the age-based calculation is only used. For example, the size of the endotracheal tube is age/3 + 3.5. The vertebral column grows with age. The length of spinal column is an essential determinant of spinal dosage of drugs. Hence, we decided to have an age-based dosing schedule of spinal anesthesia and hypothesized that this simple calculation would be enough for routine needs. So far 0.25–0.8 mg/kg have been described for pediatric spinal anesthesia. With this wide variation, it is difficult to arrive at a particular dosage for children. There are a few formulae described for routine drugs with age as basis. In this study, we could achieve central neuraxial block in all the cases in the first attempt in 22 out of the 25 cases. We needed additional ketamine in only three patients. Adequate level of sensory anesthesia was achieved in all the case with a mean spinal level of T8.5. Actually a spinal level of 8.5 may look odd, but it is a simple arithmetic mean of the levels achieved in all the cases. In a study of 262 infants, Frumiento *et al*.[4] achieved successful spinal anesthesia in 97.3% in the first attempt, whereas we did in 88%. This difference could be due to more advanced age and possible noncooperation from the patient side. Further 21.4% received some form of additional anesthesia; we had three out of 25 cases were needed 0.25 mg/kg of intravenous ketamine additionally for preoperative sedation. It is obvious that spinal anesthesia was very effective and that this miniscule dose of ketamine cannot function as a pure anesthetic. Somri *et al*.[9] in their study successfully administered spinal anesthesia for twenty infants undergoing pyloromyotomy with a dose of 0.8 mg/kg. This is in excess to the routine described dose of 0.5 mg/kg. Verma *et al*.[2] in their study of spinal anesthesia for infra umbilical surgeries in children with varied dose of 0.4–0.5 mg/kg with a success rate of 96%. We had 100% success with the age based dosing. They had complications such as shivering and vomiting in 4% of cases, which we did not encounter. They had first attempt success rate of around 60% whereas we had 88%. They had a mean two segment regression time of 45 min while we had a spinal duration of around 60 min possibly due to variation in the method of detection.

Limitations of the study

The limitations of the study is the insufficient sample size, which we accept and plan to undertake comparative studies with weight based dosing in the coming years., we did not take up upper abdominal surgeries, as we had apprehensions about the level. We accept that this study was done in a specific group population. It is difficult to compare the variable length of spine with different races and propose a formula. There may be a need for dosage adjustments for differing population in different countries with a base of age/5. We feel that doses like age/4 for differing surgeries may be suggested in the coming years.

Conclusion

Administration of age-based local anesthetic dosing of hyperbaric bupivacaine by utilizing the different new formula of age/5 is successful in a pilot study in Indian children for infraumbilical surgeries. There was no need for perioperative additional sedation in most of the cases. There were no observed complications. With this base of drug dosage, we opine that minor adjustments could be done to tackle children coming for other surgeries and other races.

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Conflicts of interest

There are no conflicts of interest.

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