Clinical Investigation

Spinal anaesthesia in poliomyelitis patients with scoliotic spine: A case control study

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ABSTRACT

Background: There is limited data to predict the course of sub-arachnoid block in poliomyelitis patients with scoliotic spine. So we intended to study the course of intrathecal anaesthesia in these patients in comparison to patients with normal spine using 0.5% bupivacaine (heavy). **Methods:** In this prospective observational study, 41 poliomyelitic patients scheduled for lower limb corrective surgeries under spinal anaesthesia were enrolled. Patients were studied in two groups (Scolotic spine, n=20; Normal spine, n=21). All patients were injected 2 ml of 0.5% bupivacaine heavy intrathecally in the sitting position. The extent of block, bilateral spread, regression of sensory block and motor block were recorded. Demographic data were analysed using the unpaired t test or the chi square test as applicable. Block characteristics were analysed using the Mann Whitney U test. **Results:** There was statistically significant difference in bilateral spread of sensory block in between the groups. However, there was no significant difference in the maximum extent of the sensory block and the time taken for two segment regression of sensory block. There was no significant difference in time taken to reach complete motor block and for complete recovery from motor block to its preoperative value. **Conclusions:** Bilateral symmetrical spread of local anaesthetics through intrathecal route cannot be predicted accurately in patients with scoliotic spine. Spinal anaesthesia can be safely administered in poliomyelitis patients with scoliosis with less adverse effects.

Key words: Anaesthesia, bupivacaine, orthopaedics surgery, poliomyelitis, scoliosis, spinal

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INTRODUCTION

Poliomyelitis is a neuromuscular disorder caused by poliovirus (enterovirus). This disease was largely eradicated from western countries with the success of vaccination programs, but it is still a problem in tropical countries. Polio virus is transmitted through faeco-oral route. It selectively damages motor and autonomic nervous systems. Most commonly affected areas are neurons in anterior horns of the spinal cord, vital centres in the medulla, cranial nerve nuclei and nuclei in the roof of the cerebellum. These result in tightness of the neck, back and hamstring muscles with varying degrees of muscle weakness as paralysis sets in. Once infection subsides, victim may experience improvements in muscle strength and control in upper extremities but permanent damage usually occurs in the lower extremities. The overall estimated risk of paralytic polio in infected individuals is 1-2%.[1] Almost 50% of those with acute muscle weakness develop postparalytic permanent loss of motor function affecting limbs and respiratory function.[2] Flexion deformity of lower limbs is a sequelae of the disease process. This requires release of these deformities at hip and knee joint to improve the mobility with the aid of callipers.

Poliomyelitis is associated with scoliosis in 30%[3] of

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patients when compared to its prevalence in general population which is 0.3-15.3%.[4-6] However the prevalence is less than 3% for curves more than 10° and less than 0.3% for curves more than 30°. It is more common in adolescents and has male to female ratio of about 1:3. Central neuraxial block (CNB) is controversial in these patients and poses an anaesthetic challenge, in view of difficulties in palpating anatomical landmarks, performing lumbar puncture, risk of dural puncture and difficulty in predicting the extent of block.[7-9] Several case reports published show that spinal anaesthesia is safe in these set of patients.[9,10]

Till date, there is no case series available. We have undertaken this study to assess the extent, bilateral spread and regression of sensory block, time for motor block and its recovery to preoperative grading following administration of spinal anaesthesia in these patients.

METHODS

This was a prospective observational study approved by the Institutional ethical committee. An individual informed consent was taken from all the patients enrolled in the study. The study was undertaken between September 2010 and May 2011. All the patients affected with poliomyelitis belonging to American Society of Anaesthesiology physical grade I/II, between age group 18 and 50 years posted for elective lower limb orthopaedic corrective surgeries under spinal anaesthesia were included in the study. Patients with metabolic problems, history of chronic obstructive pulmonary disease (COPD), past history of respiratory failure, cardiovascular problems, abnormal renal/hepatic function, spinal cord dysfunction, coagulopathy, patient's refusal for regional anaesthesia and pregnant patients were excluded from the study. Patients who underwent prior corrective surgery for scoliosis were also excluded from the study.

Total 20 poliomyelitis patients with scoliosis were enrolled during the period and matching group with normal spine was taken during the same period. Totally 41 patients were included and were classified into two groups – 20 patients having scoliosis spine with Cobb's angle of >15° (Group SS) and 21 patients with normal spine (Group NS). The course of sub-arachnoid block was compared between the groups. The various corrective surgeries performed were hip abductor release, knee release and Soutter's release. In all cases total duration of surgery was less than 1.5 hours.

All patients included in the study were evaluated preoperatively. The patient's back was inspected and palpated and a neurological examination for assessment of muscle strength in lower limbs was done as per the Medical Research Council (MRC) scale (0 – No contraction; 1 – Flicker of contraction; 2 – Active movement with gravity eliminated; 3 – Active movement against gravity; 4 – Active movement against resistance but incomplete; 5 – Normal power). The severity of scoliosis was assessed by subjective clinical judgment and radiological assessment of spine for the measurement of Cobb's angle. When Cobb's angle was more than 70°, pulmonary function tests and arterial blood gas analysis were performed as per institutional protocol and were taken up for the study.

Patients were premedicated with Tab Alprazolam 0.5 mg the previous night and on the morning of surgery. In the operation theatre, a large bore intravenous line was secured and patients were preloaded with Ringer Lactate (15 ml/kg). Monitoring was done with electrocardiography (ECG), noninvasive blood pressure (NIBP) and pulse oximetry. Under strict aseptic precautions with patient in the sitting position, lumbar puncture was performed at L3-L4 intervertebral disc space using 25G Quincke needle via midline approach. When free and clear flow of cerebrospinal fluid (CSF) was noted, 2 cc of injection bupivacaine 0.5% heavy was given intrathecally. The operation table was kept in the neutral position throughout the procedure.

The patients were made to lie down immediately, the time of which was defined as 'zero'. The sensory block was assessed on either side of abdomen at 5, 10, 15, 30, 60 and 120 min with short bevel end of a 27G dental needle using pinprick method. The maximum height of sensory block, bilateral spread and time taken for two segment regression of sensory block from maximum height were noted. The motor block was assessed using the modified Bromage scale (1 – Unable to move feet or knees; 2 – Able to move only the feet; 3 – Starts to move the knees; 4 – Detectable hip weakness in the supine position along with complete knee flexion; 5 – No detectable hip weakness in the supine position; 6 – Able to bend knees partially while standing). Time taken for complete motor block and time taken for complete recovery from motor block to its preoperative MRC grading were noted.

The following parameters were measured: heart rate (HR) by three-lead electrocardiogram (ECG), systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) by the non-invasive automatic oscillometric method, arterial oxygen saturation (SpO_2) by pulse oximetry and respiratory rate (RR) throughout the procedure. Hypotension (defined as 25-30% decrease in systolic blood pressure from baseline) was treated with inj mephenteramine 6 mg IV bolus, as and when required along with crystalloids 0.9% NS/RL. Bradycardia (HR <60 bpm) was treated with inj atropine 0.6 mg IV bolus. Inadequate block was considered when level of block was at L1/below L1 or when patients complained of pain during surgery and they were administered general anaesthesia to facilitate the surgical procedure. After completion of the surgery and when the sensory block recedes by two segments, patients were shifted to post-operative ward and monitored till complete recovery.

Statistical analysis was conducted with software package SPSS 14 (spss Inc, Chicago, IL, USA). Continuous variables were presented as Mean (±SD). The demographic data was analyzed using the unpaired '*t*' test or the Chi-square test as applicable. Categorical data like maximum extent of spread, bilateral spread, complete motor block and intervention in each group were compared using the two-tailed Mann Whitney U test and time for two segment regression of sensory block, time for complete motor block and complete recovery from motor block was analyzed with the Student *t* test. Adverse effects like inadequate block, hypotension and bradycardia were analysed using the Chi-square test and the Fisher exact test as applicable. A $P<0.05$ was considered to be statistically significant.

RESULTS

Demographic data was comparable with respect to age, gender distribution and ASA status. There was statistically significant difference in weight between the two groups. The mean weight of the patients in scoliosis group was significantly low when compared with the normal group (Group SS; 38.9±2.0; Group NS; 47.6±1.9; *P*=0.022) [Table 1].

None of the patients had normal motor power at baseline value. There was no statistically significant difference in the mean motor power in between the groups [Table 1].

There was statistically significant difference in bilateral spread of spinal anaesthesia (*P*=0.001). All patients (*n*=20) in the scoliosis group had disparity in extent of spread of sensory anaesthesia compared to six patients in the normal group. In the scoliosis group, three patients had a sensory level disparity between two sides of more than six segments and nine patients had a disparity of three to five segments. In the normal group, no patients had a disparity in the extent of spread of sensory anaesthesia of more than six segments, while only one patient had a disparity of three segments, four patients had two segment and one patient with one segment of sensory level spread disparity between two sides [Table 2].

However, there was no significant difference in maximum height of block achieved between the two groups after administration of spinal anaesthesia (*P*=0.332) and there was also no statistically significant difference in two segment regression of spinal anaesthesia from its maximum block (*P*=0.214) [Table 2].

Table 1: Demographic data

Variables	Gr SS	Gr NS	*P* value
Age (year)	23.75±1.24	23.95±1.33	0.912
Sex (male/female), *n*	11/9	11/10	0.558
ASA I/II	16/4	17/4	1.000
Weight (kg)	38.9±2.0	47.6±1.9	0.022
Motor power preoperatively			
Right	2.75±0.55	2.81±0.51	0.722
Left	3.05±0.76	2.76±0.70	0.214

ASA – American society of anaesthesiologist physical grading; *n* – number of patients; Gr SS – Scolotic spine group; Gr NS – Normal spine group

Table 2: Course of subarachnoid block

Variables	Gr SS	Gr NS	*P* value
Maximum extent of sensory blockade			0.332
T5-T4 (*n*)	14	10	
T8-T6 (*n*)	4	8	
T10-T9 (*n*)	2	3	
Disparity in bilateral spread of sensory block			0.001
No segment spread (*n*)	0	15	
1 segment spread (*n*)	0	1	
2 segment spread (*n*)	8	4	
3-5 segment spread (*n*)	9	1	
≥6 segment spread (*n*)	3	0	
Two segment regression time (min) for sensory block	73±7.35	65±6.42	0.214
Time taken for complete motor block (sec)	80.25±17.81	72.86±11.02	0.116
Time taken for complete recovery of motor block to its preoperative level (min)	104.5±30.52	91.43±28.86	0.167

n – Number of patients; Gr SS – Scolotic spine group; Gr NS – Normal spine group

There was no significant difference among the groups for the time taken to achieve the complete motor block (*P*=0.214) and also for the complete recovery from motor block (*P*=0.167).

We noticed inadequate blockade (unilateral block) in one patient in the scoliosis group, and as the scheduled surgical procedure was on the contra lateral limb, we administered general anaesthesia to this patient. Hypotension and bradycardia were noted in two patients in the scoliosis group and one patient in normal group which were treated with inj mephenteramine 6 mg IV bolus along with crystalloids and inj atropine 0.6 mg IV, respectively [Table 3].

DISCUSSION

Scoliosis is defined as a lateral curvature of the spine. The incidence of scoliosis in the general population is approximately 0.3-15.3%.[4-6] It is twice more common in women than in men.[11] Majority of cases (75-90%) of scoliosis are of Idiopathic , out of which adolescent type is the most common. Remaining 10-25% cases are associated with neuromuscular diseases, congenital abnormalities including heart disease, trauma and mesenchymal disorders.[12]

Surgical correction of scoliosis is performed when Cobb's angle exceeds 50° in thoracic and 40° in lumbar region as these patients are associated with restrictive pulmonary dysfunction.[13] However, patients having a varied Cobb's angle may present to surgical department for various non-spine corrective surgeries. None of our patients were operated previously for scoliosis correction. We have chosen to give regional anaesthesia in these patients as there is a definitive evidence that regional anaesthesia would be better than general anaesthesia in these patients.[14,15] Anaesthetic concerns for providing general anaesthesia to patients with poliomyelitis and/or scoliosis are increased sensitivity to sedative drugs, prolonged effect of non-depolarizing neuromuscular blocking agents, dysfunctional autonomic nervous system, underdeveloped muscles of respiration making extubation difficult.

Table 3: Intraoperative variables during subarachnoid block

Variables	Gr SS	Gr NS	*P* value
Hypotension and bradycardia (*n*)	2	1	0.606
Inadequate block (*n*)	1	0	0.488

n – number of patients; Gr SS – Scolotic spine group; Gr NS – Normal spine group

The present study demonstrated significant asymmetric distribution of sensory block following spinal anaesthesia in poliomyelitis patients with scoliosis (*P*=0.001). Other parameters like maximum extent of sensory block, time taken to achieve complete motor block and its regression are similar to that of normal spine patients. The beneficial effect noted from the study is that the spinal anaesthesia could be safely given in scoliosis patients with less adverse effects.

The literature shows that there is no significant difference in the success rates of epidural and spinal anaesthesia (80% and 73%, respectively) in uncorrected scoliosis patients.[16] The most common causes attributed to block inadequacy in them were patchy (8%), asymmetric (8%) or unilateral analgesia (8%).[16] There are other isolated case reports which suggest asymmetric distribution of analgesia in this group of patients.[17]

Although the optimal technique for central neuraxial blockade has not been studied adequately both successful spinal and epidural anaesthesia had been reported in parturients with scoliosis.[18,19] Some authors prefer epidural anaesthesia in scoliosis patients because of less haemodynamic changes.[20] There is also a case report saying that spinal anaesthesia is successful and safe when compared to epidural anaesthesia in patients with abnormal vertebral anatomy.[21] We opted for spinal anaesthesia in our patients because the planned surgical procedures were of short duration and it is technically more easier than epidural anaesthesia.

Inappropriate sensory blockade is a well-known phenomenon in scoliosis patients. The cause attributed to this type of unilateral block is probably due to layering of hyperbaric bupivacaine in the dependent areas of spinal column.[22] Moran *et al*.[22] suggested addition of 0.5% isobaric bupivacaine or increasing the total mass of local anaesthetics to produce the desired regional anaesthetic level.[22] But this is possible only if one is administering local anaesthetics through a continuous spinal technique. In our study, only one patient from the scoliosis group had unilateral block and since we have used single shot spinal anaesthesia we had no option other than converting to general anaesthesia to facilitate the surgical procedure.

The most probable mechanism for unilateral or asymmetric cephalad extension of sensory block could be due to altered distribution of local anaesthetic solution along the convexity of the scoliosis spine curves and therefore exposing a substantial difference in fixing of local anaesthesia to nerve roots on either side of vertebral column. It may also be due to the rotation of the spine.

Nevertheless, the present study had limitations. First, only small number of patients were enrolled, whether this effect can be extrapolated to a larger group of patients needs further research; second, we could not relate the course of subarachnoid block in relation to the height of the patient as all the patients had flexion deformity of lower limbs due to post polio residual paralysis and were disabled and third, we have not measured, variability in Cobb's angle for assessment of the spread of local anaesthetics.

Future research options in these patients are first, the spread of local anaesthetics with respect to variability in Cobb's angle; second, measuring the height of patient; third, the paramedian approach for administering spinal anaesthesia; fourth, various manoeuvres like flexion of both limbs at hip and knee joint after administering spinal anaesthesia to eliminate the scoliotic curve and finally ease of administering spinal anaesthesia in lateral position along the concavity of scoliotic curve on the table.

CONCLUSIONS

There is always a possibility of asymmetry in spread of sensory block in scoliosis patients with poliomyelitis but this usually goes without any clinically significant relevance. The choice of technique depends upon clinical assessment and individual judgment.

From our study we can conclude that spinal anaesthesia with a fixed volume of 2 ml of 0.5% hyperbaric bupivacaine is an effective and safe option for patients with scoliosis undergoing lower limb surgeries.

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