Original Article

Combined spinal epidural and epidural volume extension: Interaction of patient position and hyperbaric bupivacaine

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Abstract

Background: Previous trials have documented failure of block augmentation with epidural volume extension, when applied after the intrathecal injection of hyperbaric bupivacaine was made in sitting position. However, there is no study comparing the effect of change in patient position during block performance, on the results of epidural volume extension.

Materials and Methods: The study was conducted in two parts in American Society of Anesthesiologists physical status I or II parturients scheduled for elective cesarean section under regional anesthesia. In the first part, 28 patients were randomized to one of the two groups, depending on whether epidural volume extension was applied following the block in sitting (group SE) or lateral position (group LE) (n=14 each). In the second part of the study another 28 patients were recruited and randomized to receive the block in sitting (group S) or lateral (group L) position (n=14 each), without epidural volume extension. All patients received combined spinal epidural block using needle-through-needle technique with intrathecal injection of 9 mg hyperbaric bupivacaine (0.5%) and 10 μg fentanyl. Epidural volume extension was performed using 5 ml normal saline in groups SE and LE.

Results: In the first part of the study, the maximum sensory block level was higher in group LE vs. SE (P<0.05). In the second part of the study, no significant difference was seen in the maximum sensory level between group S and group L (P>0.05).

Conclusions: If epidural volume extension is being applied with intention of rapid extension of sensory block when hyperbaric bupivacaine has been injected intrathecally, the combined spinal epidural block should be performed in lateral position rather than in the sitting position.

Key words: Cesarean section, combined spinal epidural, epidural volume extension, hyperbaric bupivacaine, patient position

Introduction

Epidural volume extension (EVE) is a modification of combined spinal epidural (CSE) technique wherein normal saline is injected into the epidural space soon after the intrathecal injection.[1] This is aimed at rapidly increasing the sensory level of subarachnoid block[1] by raising the epidural pressure and causing thecal compression to push the intrathecal drug cephalad.

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In clinical practice, CSE block is performed with the patient in either lateral or sitting position. A sitting position is commonly used in pregnant patients due to easier performance of the block.[2] In previous trials, EVE failed to augment the sensory block[3,4] when performed following an intrathecal injection of hyperbaric bupivacaine in sitting position. The failure of EVE was hypothesized to be due to the preferential caudad migration of intrathecal hyperbaric bupivacaine that occurs in sitting position,[5] making EVE-induced rise in epidural pressure insufficient to push the local anaesthetic cephalad.[3,4] However, whether a change in patient positioning during subarachnoid injection with hyperbaric drug affects the results of EVE has not been evaluated till date.

The present report consists of two studies aiming to evaluate the effect of change in patient position on sensory block level following CSE with and without EVE.

Materials and Methods

In the first study, after approval of the institutional review board

and informed written consent from subjects, 28 ASA physical status I or II nonlaboring parturients with uncomplicated pregnancy of gestational period ≥37 weeks scheduled for elective cesarean section under CSE anesthesia were included. Parturients with any contraindication to central neuraxial block were excluded from the study. Subjects with extremes of height or weight (BMI <20 kg/m^2 or >35 kg/m^2, height <145 cm or >180 cm) were also not included in the trial. The patients were randomized using sealed opaque envelopes to one of two groups, depending on whether EVE was applied following the block in sitting position (group SE) or in lateral position (group LE) (n=14 each).

All patients were administered 10 ml/kg of Ringer's lactate solution intravenously, just prior to block performance. Monitoring in the operating room included lead II electrocardiography, pulse oximetry, and noninvasive oscillometric blood pressure measurement (Datex-Ohmeda®, USA). All blocks were performed by investigators who were proficient in central neuraxial blockade and had greater than 3 years experience in anesthesia.

In all patients, the CSE was performed at L4-5 level using needle-through-needle set. Epidural space was identified in the midline using 18G Tuohy needle by loss of resistance to air technique, limiting the volume of air to less than 2 ml. Intrathecal injection of 9 mg hyperbaric bupivacaine (0.5%) along with 10 μg fentanyl, in a total volume of 2 ml, was injected over approximately 4 s via 25G pencil point spinal needle with the opening facing cephalad. Following this, the epidural catheter was inserted 4 cm inside epidural space and fixed after confirming absence of CSF or blood flow through it. The patient was then positioned supine with a 15° left tilt and EVE performed using 5 ml of normal saline injected over 10-15 seconds through the epidural catheter. The 15° left tilt of patient was maintained till delivery of the baby and no change in horizontal tilt of the table was allowed throughout surgery irrespective of the sensory block level.

The hemodynamic parameters and block characteristics were assessed by an independent anesthesiologist who was unaware of the anesthetic technique. Hemodynamic parameters were monitored every 5 min till end of surgery. Sensory block was assessed by loss of all sensation to pinprick. The motor blockade was assessed according to the modified Bromage score,[6] wherein score 1 = complete block, unable to move feet or knees; 2 = almost complete block, able to move feet only; 3 = partial block, just able to move knees; 4 = detectable weakness of hip flexion while supine, full flexion of knees; 5 = no detectable weakness of hip flexion while supine; and 6 = able to perform partial knee bend. The block characteristics were noted every 5 min for 30 min after placing the patient supine, followed by 15 min interval till end of surgery, and then every 30 min in recovery room till complete motor recovery.

The time of completion of intrathecal injection was marked as $time_0$ and the following block characteristics were calculated beginning from $time_0$.

1. S_{max}: Maximal sensory block level achieved,
2. $time_{max}$: Period when S_{max} was first achieved,
3. $time_{(max-2)}$: Period for 2-segment regression of sensory block from its highest level,
4. $time_{(max-10)}$: Period for block regression to level of T10 dermatome,
5. Maximum motor blockade achieved,
6. Time to attain maximum motor blockade, and
7. Time for complete regression of motor block (modified Bromage score = 6).

Surgery was allowed to proceed as soon as sensory block ascended to T6 level. The time required to position patients supine after intrathecal injection ($time_s$) and time for first request for postoperative analgesia were also noted. Postoperative analgesia was provided with epidural top-ups of 0.25% bupivacaine. Hypotension was defined as >20% fall from basal systolic blood pressure and treated with ephedrine 6 mg intravenous bolus. Other intraoperative adverse effects noted included bradycardia, nausea, vomiting, pruritus, and shivering.

In the second study, all procedural specifications were identical. Another 28 patients were recruited and randomized to receive the CSE without EVE in sitting (group S) or lateral (group L) position (n = 14 each). The primary outcome measure in both studies was the maximum sensory block level achieved.

Statistical analysis

Results were analyzed using SPSS software version 11. All comparisons were made between groups SE vs. LE and groups S vs. L. Comparisons of demographic data, time variables, maximum block levels, as well as sensory blockade and motor blockade at corresponding time points were done between groups SE and LE and groups S and L using unpaired t-test. Incidences of adverse effects between the respective groups were compared using Chi-square test. Apgar scores were compared between the groups using Mann-Whitney U test. For comparison of sensory level achieved, T 1 to T 12 dermatomes were designated as numbers 1 to 12. P value <0.05 was considered statistically significant.

Sample size was calculated after a pilot study of 20 patients, who were not included in the final analysis. To detect a

2-segment difference in the maximum sensory block level with EVE, at alpha value of 0.05 and a power of 95%, 14 patients were required in each group.

Since the study was conducted in two parts, we also calculated after completion, the power of both parts to detect a difference of 2-segment in maximum sensory block level between groups SE and LE and groups S and L. The analysis showed both parts to have a power of greater than 95% at an alpha error of 0.05.

Results

The first study was aimed to evaluate the effect of EVE following CSE in sitting and lateral position (groups SE vs. LE). Comparison of groups SE and LE showed statistically similar mean age, weight, height, body mass index, baseline systolic blood pressure, duration of surgery, and time taken from intrathecal injection to positioning the patients supine [Table 1].

Significantly higher S_{max} and faster $time_{max}$ were seen in group LE as compared to group SE [Table 2]. However, there was no significant difference between the two groups with respect to $time_{(max-2)}$, $time_{(max-10)}$, or time to first postoperative analgesic demand [Table 2]. The two groups were statistically similar with regards to the motor blockade, viz., the maximum motor blockade and time required to achieve it, as well as the time required for its complete regression [Table 3].

During the first 30 min of block assessment, sensory block was significantly higher in group LE vs. SE for the initial 25 min [Table 4], while motor block levels were statistically similar at all the time points [Table 4].

There were no significant differences in the Apgar score at 1 or 5 min in group SE as compared to group LE [Table 5]. The incidence of intraoperative adverse effects and the amount of ephedrine used were also statistically similar in both groups [Table 5].

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Table 1: Patient characteristics

	Group SE	Group LE	Group S	Group L	*P* value*	*P* value†
Age (years)	26.6 ± 3.2	25.4 ± 4.2	25.9 ± 3.8	25.3 ±3.8	0.372	0.66
Weight (kg)	60 ± 6	58 ± 6	60 ± 5	59 ± 5	0.375	0.408
Height (cm)	152.2 ± 3.8	152.4 ± 3.3	153.1 ± 2.7	152.9 ± 2.7	0.916	0.781
Body mass index (kg/m^2)	26.3 ± 1.7	24.9 ± 2.2	25.7 ± 2.4	25.1 ± 2.4	0.068	0.519
SBP (mmHg)	124 ± 6	125 ± 7	125 ± 6	125 ± 7	0.772	0.417
Duration of surgery (min)	50.7 ± 20.9	55.2 ± 11.6	54.3 ± 14.6	53.8 ± 13.5	0.488	0.121
$time_s$ (min)	1.7 ± 0.3	1.8 ± 0.4	1.7 ± 0.5	1.5 ± 0.7	0.483	0.302

*Data are mean ± SD. Group SE: CSE in sitting position alongwith EVE; Group LE: CSE in lateral position alongwith EVE; Group S: CSE in sitting position; Group L: CSE in lateral position; BMI: Body mass index; SBP: Systolic blood pressure. * Group SE vs. LE; †Group S vs. L. There were no significant differences between group SE vs. LE, or group S vs. L*

Table 2: Sensory block characteristics

	Group SE	Group LE	Group S	Group L	*P* value*	*P* value†
S_{max}	T 5.3 ± 0.9 6 (3-6)	T 3.5 ± 1.4 3 (2-6)	T 4.9 ± 0.7 5 (4-6)	T 5.4 ± 0.6 5 (4-6)	0.000	0.100
$Time_{max}$ (min)	10.5 ± 2.9	8.0 ± 2.9	10.6 ± 2	7.0 ± 1.9	0.036	0.000
$Time_{(max-2)}$ (min)	66.2 ± 13.9	55.5 ± 17.7	65.8 ± 16	86.8 ± 12.6	0.089	0.001
$Time_{(max-10)}$ (min)	95.4 ± 16.2	97.7 ± 12.8	101.1 ± 13	116.8 ± 12.5	0.688	0.004
First postoperative analgesia (min)	203 ± 37	211 ± 24	218 ± 26	232 ± 19	0.101	0.389

*Data are mean ± SD or median (range). *Group SE vs. LE; †Group S vs. L, Group SE: CSE in sitting position alongwith EVE; Group LE: CSE in lateral position alongwith EVE; Group S: CSE in sitting position; Group L: CSE in lateral position*

Table 3: Motor block characteristics

	Group SE	Group LE	Group S	Group L	*P* value*	*P* value†
Maximum motor blockade (modified Bromage score)	1 ± 0	1 ± 0	1 ± 0	1 ± 0	-	-
Time for maximum motor blockade (min)	7.7 ± 2.5	6.3 ± 1	8.8 ± 2.5	6.4 ± 1.4	0.062	0.006
Time for complete regression of motor blockade (min)	186 ± 25	177 ± 22	183 ± 36	213 ± 11	0.647	0.007

*Data are mean ± SD. *Group SE vs. LE; †Group S vs. L, Group SE: CSE in sitting position along with EVE; Group LE: CSE in lateral position along with EVE; Group S: CSE in sitting position; Group L: CSE in lateral position*

Table 4: Trend of sensory and motor block progression

	Group SE		Group LE		Group S		Group L		*P* value*	
	Sensory level	Motor score	Sensory level	Motor score	Sensory level	Motor score	Sensory level	Motor score	Group SE vs. LE	Group S vs. L
5 min	T 6.7 ± 2.2	1 ± 0.7	T 4.2 ± 1.3	1 ± 0	T 6.4 ± 1.4	1 ± 0.3	T 5.5 ± 0.7	1 ± 0.4	0.009	0.038
10 min	T 5.1 ± 1.1	1 ± 0	T 3.4 ± 1.4	1 ± 0	T 5.1 ± 0.7	1 ± 0	T 5.4 ± 0.6	1 ± 0	0.007	0.349
15 min	T 4.9 ± 1.4	1 ± 0	T 3.4 ± 1.4	1 ± 0	T 5.1 ± 0.7	1 ± 0	T 5.4 ± 0.6	1 ± 0	0.027	0.349
20 min	T 4.9 ± 1.4	1 ± 0	T 3.4 ± 1.4	1 ± 0	T 5.1 ± 0.7	1 ± 0	T 5.4 ± 0.6	1 ± 0	0.027	0.349
25 min	T 4.9 ± 1.4	1 ± 0	T 3.4 ± 1.4	1 ± 0	T 5.2 ± 0.7	1 ± 0	T 5.4 ± 0.6	1 ± 0	0.027	0.349
30 min	T 4.9 ± 1.4	1 ± 0	T 4.0 ± 1.3	1 ± 0	T 5.2 ± 0.7	1 ± 0	T 5.4 ± 0.6	1 ± 0	0.142	0.519

*Data are mean ± SD. *P values are for sensory block comparison only. There were no significant differences in the motor blockade at any time interval, Group SE: CSE in sitting position along with EVE; Group LE: CSE in lateral position along with EVE; Group S: CSE in sitting position; Group L: CSE in lateral position*

Table 5: Adverse effects and apgar scores

	Group SE	Group LE	Group S	Group L	*P* value*	*P* value†
Hypotension	5/14 (36%)	6/14 (43%)	5/14 (36%)	6/14 (43%)	0.699	0.704
Bradycardia	0/14 (0%)	0/14 (0%)	1/14 (7%)	0/14 (0%)	-	1.000
Nausea and vomiting	2/14 (14%)	6/14 (43%)	2/14 (14%)	3/14 (21%)	0.209	0.648
Shivering	2/14 (14%)	4/14 (29%)	1/14 (7%)	3/14 (21%)	0.648	0.329
Pruritus	0/14(0%)	0/14 (0%)	0/14 (0%)	0/14 (0%)	-	-
Amount of ephedrine (mg)	6 ± 0	8.4 ± 3.3	6 ± 0	7.8 ± 1.3	0.723	0.720
Apgar at 1 min	9 (7-9)	9 (8-9)	9 (8-9)	9 (8-9)	0.730	0.704
Apgar at 5 min	9.5 (9-10)	10 (9-10)	9 (9-10)	9 (9-10)	0.420	0.695

*Data are number of patients (%), mean ± SD or median (range). *Group SE vs. LE; †Group S vs. L, Group SE: CSE in sitting position along with EVE; Group LE: CSE in lateral position along with EVE; Group S: CSE in sitting position; Group L: CSE in lateral position*

positioning during CSE without EVE on maximum sensory blockade, group S and L were statistically similar with respect to baseline characteristics [Table 1].

No significant difference was seen in the S_{max} between both groups [Table 2]. However, the $time_{max}$ was significantly shorter, and the $time_{(max-2)}$ and $time_{(max-10)}$ were significantly longer in group L as compared to group S [Table 2]. Although the maximum motor blockade achieved was statistically similar between group S and L, the time to achieve it was significantly shorter, and the time for it to regress significantly longer, in group L [Table 3].

Intergroup comparison between group S and group L showed statistically similar sensory block levels at all time points observed in first 30 min of blockade, except at the first 5 min when it was significantly higher in group L [Table 4]. The mean Bromage score was also statistically similar in both groups at all time points [Table 4].

There were no significant differences between the two groups with respect to the Apgar scores at 1 or 5 min, incidence of adverse effects noted, or amount of ephedrine required [Table 5].

In both the studies, all patients achieved sensory level of at least T6 and complete motor blockade, i.e., modified Bromage score of 1. None of the patients required intraoperative analgesic supplementation. Postoperatively, epidural top-up of 0.25% bupivacaine resulted in adequate analgesia in all the patients.

Discussion

The first part of the study showed significantly higher sensory block when EVE was applied following CSE in lateral position, as compared to the sitting position. The mean S_{max} was T3.5 ± 1.4 vs. T5.3 ± 0.9 in group LE vs. SE, respectively ($P < 0.05$). The mechanism of higher sensory level of block with EVE is postulated to be an increase in epidural pressure by the injection of epidural saline, leading to a thecal compression which pushes the intrathecal drug cephalad.[1] In our study, the epidural pressure in group SE would also have increased following the epidural injection for EVE, but the rise was probably insufficient to push cephalad the caudally pooled intrathecal bupivacaine, leading to a failure of EVE in group SE. Such a failure of EVE in augmenting sensory block after intrathecal deposition of hyperbaric bupivacaine in sitting position has been noted previously in nonobstetric patients,[4,7] but never compared to results of EVE in lateral patient position. These earlier trials also attributed the failure of EVE applied to block performed in sitting position, to a restricted spread of local anesthetic to lumbar and sacral roots.[4,7] The dynamics of central neuraxial blockade in obstetric patients are known to be different from nonobstetric patients.[8] Earlier data in

obstetric patients by Blumgart *et al.*[9] show a contradictory result as compared to our study. The authors[9] had noted successful block augmentation following EVE applied to CSE in sitting position, despite using hyperbaric bupivacaine. Herein, they used 10 ml normal saline for EVE, a volume double of the injectate used in the present study. The effect of injecting normal saline in epidural space is known to be additive, with an increasing percentage of thecal compression following increasing injectate volume from 5 to 20 ml.[10] The larger volume of saline used by Blumgart *et al.*[9] may have increased the epidural pressure to a greater extent, such as to overcome the resistance offered by caudad migration of drug and result in block augmentation. This "volume effect" being cited by us as a probable cause of failure of EVE in sitting position does not amount to stating that 5 ml normal saline is an inadequate volume for EVE. It has been documented that 5 ml saline causes thecal compression and effective EVE.[10,11]

Despite a significantly higher S_{max}, the incidence of hypotension and amount of ephedrine used was statistically similar, though clinically greater, in group LE as compared to group SE [Table 5]. The lack of statistical significance may be because our study was not powered to detect differences in incidence of hypotension. Since hypotension was not the primary outcome measure, we recorded blood pressure at interval of 5 min only, as commonly done in our clinical practice. It is thus possible that transient variations in blood pressure were missed. Accordingly, it appears inappropriate to comment conclusively on the incidence of hypotension in the two groups. However, there was no difference in the neonatal Apgar score [Table 5].

This study has demonstrated the difference in sensory block following EVE application in sitting and lateral position that has been hitherto unexplored. It may be argued that the higher sensory block in lateral position is a result of the CSE itself, without any contribution of the EVE. However, it has been amply documented in various trials that injection of 5 ml normal saline leads to thecal compression and effective EVE. Also, the second study was undertaken under identical circumstances to evaluate whether similar difference in sensory block level was seen after CSE in sitting and lateral position. The absence of any statistical difference in the S_{max} observed in the second study lends support to variations in sensory block with EVE conducted in different position.

Previous studies regarding effect of sitting or lateral position on sensory block level following CSE in obstetric patients have produced conflicting results.[12-15] There is evidence to show both, a lack of any difference[12-14] as well as lower sensory block level[15] in sitting position as compared to lateral position. Although, there are other trials also comparing the block characteristics in sitting and lateral position in obstetric patients, but they have not analyzed the effect on the maximum sensory level.[16,17]

Based on the findings of this study we recommend that when EVE is planned during cesarean section to raise the sensory level of block following intrathecal injection of hyperbaric bupivacaine, the CSE should be performed in lateral and not sitting position. Also, under the conditions of this study, performing a CSE with patient in sitting or lateral position has no effect on the maximum sensory block level achieved.

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