THE EFFECT OF INCREASING THE DOSE AND VOLUME OF EPIDURAL INJECTATE IN COMBINED SPINAL EPIDURAL ANAESTHESIA

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ABSTRACT: BACKGROUND: Augmentation of the level of spinal sensory block after an epidural injection in combined spinal epidural anesthesia may be explained by a dual mechanism: a volume effect due to the compression of the thecal sac and a local anesthetic effect. **AIMS:** The purpose of our study was to investigate the effect of increasing the dose and volume of epidural injectate in combined spinal epidural technique. **SETTINGS AND DESIGN:** Prospective randomized controlled and double blind. **METHODS AND MATERIAL:** Fifty adult patients scheduled for lower limb surgery under combined spinal epidural anesthesia were randomly allocated to one of the five groups comprising 10 patients each. All patients received a combined spinal epidural injection using a needle through needle technique. An intrathecal injection of 10 mg (2ml) of 0.5% hyperbaric bupivacaine was given and an epidural catheter inserted in all the cases. After the maximal level of sensory blockade was attained, an epidural injection was administered according to the designated randomization code. Group I received nothing and served as the control. Groups II, III, IV & V received 20 ml of 0.25% Bupivacaine, 20ml of saline, 10ml of 0.25% Bupivacaine & 10ml of saline respectively through the epidural catheter. **STATISTICAL ANALYSIS:** The observations were analyzed using Chi square and paired t test. **RESULTS:** Significant rise in the level of sensory analgesia was observed in groups II to V following the epidural injection while no change was observed in the control group. Maximum rise was observed in Group II where the dose as well as volume was maximum. **CONCLUSION:** We conclude that increasing the dose and volume of injectate increases the effective sensory block when utilizing the epidural volume extension technique; even after maximal sensory blockade of spinal has been achieved. **KEYWORDS:** Combined spinal epidural, epidural volume extension, epidural top up, needle through needle technique.

INTRODUCTION: Combined spinal epidural anesthesia (CSEA) is a technique summing the virtues of both spinal and epidural anesthesia; namely quick and reliable onset, prolongation and extension of the block when desired along with post-operative pain relief. The disadvantages of each method taken individually are more or less compensated by this technique. Epidural volume extension (EVE) is a modification where an epidural injection of saline or local anesthetic is found to extend the level of sensory block obtained after subarachnoid injection.^{1, 2, 3}

The mechanism of EVE has been shown to be cephalad spread of intrathecal drug due to thecal compression⁴ and the migration of local anesthetic from epidural space to the cerebrospinal fluid (CSF).^{5, 6} The purpose of our study was to investigate the effect of increasing the dose and volume of epidural injectate in combined spinal epidural technique.

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MATERIAL AND METHOD: After due approval of the hospital ethics committee and informed written consent from the subjects 50 ASA (American Society of Anesthesiologists) grade I & II adult patients; aged 18 to 70 years; scheduled for lower limb surgery under combined spinal epidural anesthesia were included in the study.

The study design was prospective randomized controlled and double blind. The patients were allocated to one of the five groups depending on the epidural top up administered: No epidural top up (Group I), 20 ml of Bupivacaine 0.25% (Group II), 20 ml of saline (Group III), 10 ml of Bupivacaine 0.25% (Group IV), 10 ml of saline (Group V). Randomization was achieved using 50 sealed envelopes containing the 5 group codes that were only available to the anesthesiologist administering the CSE.

All patients were preloaded with 500 ml Ringer's lactate before performing the block. Monitoring in the operating room included lead II electrocardiography, pulse oximetry and noninvasive blood pressure measurement. All blocks were performed at L3-4 interspace with patients in left lateral position using the 18G needle-through-needle CSE set (Portex).

Epidural space was identified with an 18G Tuohy needle using loss of resistance to saline; taking care to limit entry of saline into epidural space. 2ml (10mg) of hyperbaric Bupivacaine (0.5%) was administered intrathecally through the 26 gauge spinal needle (start of the Spinal Phase- T_0). Subsequently an 18 gauge lateral eye catheter was introduced 5 cm into the epidural space and fixed after confirming absence of blood and CSF through it. The patient was then positioned supine.

The block characteristics and hemodynamic parameters were recorded every 5 minutes by an independent observer blinded to the anesthetic technique. The level of sensory blockade was checked by determining the loss of sensation to pin prick in the anterior axillary line using a 24 G needle and the degree of motor block assessed according to the modified Bromage scale.

The sensory and motor block was assessed every 5 minutes for 20 minutes in the spinal phase. During this phase the highest level where no pin prick sensation was felt was noted. Establishment of maximal level of sensory blockade (S_{max}) was defined as no further increase during three consecutive assessments or more than 20 minutes after subarachnoid injection.

The time of onset of maximal sensory blockade (T_{max}) was defined as the time from subarachnoid injection (T_0) to the time of first recording of the maximal level of sensory blockade (S_{max}). After achieving S_{max} , the observer assessing block characteristics left the room. The designated epidural was administered to the patients in groups II to V and was simulated in patients in group I.

The time of completion of this injection marked the start of the epidural phase and was designated as (T_E). The observing anesthetist returned, to continue assessing sensory and motor blockade at 5 minute intervals for a period of 30 minutes in the epidural phase.

The maximal sensory blockade during this phase (S_{maxE}) and the time when (S_{maxE}) was first noted were recorded (T_{maxE}). The study concluded at the end of this observation period and the epidural catheter was used for intra-operative block augmentation and post-operative analgesia.

The maximal motor blockade attained and the time taken to achieve it were recorded in both the phases.

Statistical Analysis: The recorded observations were analyzed statistically using the Chi-square and the paired t test.

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RESULTS: The five groups were statistically comparable in terms of age, weight, height and sex distribution (Table-1). Data on maximum level of sensory blockade and onset times are summarized in Table-2. The maximal levels of sensory blockade (S_{max}) and the onset times during the spinal phase (T_{max}) were comparable among the five groups (Table -2). In the Epidural phase, the maximum level of sensory blockade (S_{maxE}) increased with respect to (S_{max}) in all groups except in group I where epidural was simulated.

Group	No.	Mean Age(yrs)	Mean Weight(kg)	Mean Height(cm)	Sex	
					M	F
I	10	41.80	60.30	158.20	4	6
II	10	41.60	59.00	157.90	3	7
III	10	40.40	59.80	158.50	5	5
IV	10	41.00	60.70	158.30	4	6
V	10	42.80	59.20	158.40	4	6

Table-1
DEMOGRAPHIC DATA

		Group I (n=10)	Group II (n=10)	Group III (n=10)	Group IV (n=10)	Group V (n=10)
Spinal phase	Maximal sensory level(S_{max})	T8.40±0.96	T8.30±0.94	T8.80±1.03	T8.60±0.96	T8.50±0.97
	Onset time(min)	14.50±3.68	14.00±3.94	13.50±3.37	13.50±3.37	14.00±3.94
Epidural phase	Maximal sensory level(S_{maxE})	T8.40±0.96	T3.90±1.28	T6.40±1.34	T6.10±0.73	T6.70±0.94
	Onset time(min)	0	14.50±3.68	14.00±3.94	13.50±3.37	14.00±3.16
	Segmental increase (S_{maxE} - S_{max})	0	4.4±1.28	2.4± 0.96	2.5± 0.84	1.8± 0.63
P value(spinal vs epidural)		>0.05	<0.0001	<0.0001	<0.0001	<0.0001

Table -2

Data are mean + SD

Group I = no epidural top-up, Group II= epidural top-up with 20ml of 0.25% bupivacaine, Group III = epidural top-up with 20ml saline, Group IV = epidural top-up with 10 ml of 0.25% bupivacaine, Group V = epidural topup with 10 ml saline.

$p < 0.001$ = Highly Significant, $p < 0.05$ = Significant, $p > 0.05$ = Nonsignificant.

ORIGINAL ARTICLE

In group II mean rise in level was 4.4 (+1.28) segments whereas in group III, IV and V it was 2.4(+0.96), 2.5(+0.84) and 1.8(+0.63) segments respectively. When compared to sensory block level in spinal phase (S_{max}) this was statistically significant in the groups II to V ($p<0.05$). Figure-1 shows the mean sensory levels at different time intervals in the spinal and epidural phase. A graphical representation of the S_{max} and S_{maxE} of individual patients is shown in Figure 2.

The onset time to maximum sensory blockade (T_{maxE}) after epidural top up in all the groups was also comparable. Changes in pulse rate, Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) & Respiratory Rate (RR) were insignificant in all the groups. All the five groups had an intense motor blockade with comparable mean time taken for grade 3 block.

Fig. 1: Showing rising spinal sensory level after epidural top up in all the groups.

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Fig. 2: Individual data on the maximal level of sensory blockade during the spinal and epidural phases.

DISCUSSION: An epidural top up during combined spinal epidural anesthesia is known to extend the spinal sensory blockade, a technique known as epidural volume extension (EVE). Several theories have been postulated to explain its mechanism of action. The probability of local anesthetic migrating to CSF through the dural hole created by the spinal needle was suggested by Rawal et al.⁶

Another proposal by Carrie et al was the existence of “subclinical” analgesia due to low concentration of local anesthetic in the CSF above the highest level of sensory block after a subarachnoid injection, which was brought to full strength with relatively small doses of epidurally administered local anaesthetic.⁷ Blumgart et al. proposed an epidural volume effect to explain higher sensory levels achieved after epidural injection in CSEA.

It was thought that the epidural injectate compressed the dural sac resulting in a cephalad shift of the CSF containing local anaesthetic.⁴ This proposal was based on their findings that similar volumes of saline and local anesthetic produced similar block augmentation. This postulate has been confirmed in myelographic study by Takiguchi et al who demonstrated 25% reduction in subarachnoid space with 10ml of saline.⁸ This volume effect is known to be additive where increasing injectate volumes lead to increased percentage of thecal compression.

Our study also yielded similar results and epidural injections with both Bupivacaine and saline caused a significant increase in the maximum sensory blockade obtained after subarachnoid block. The injections were made after maximal sensory effect of spinal was achieved and we successfully augmented the sensory level which was in contrast to a previous study.⁹

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The rise in $S_{\max}$ increased both with the increase in dose of drug and the volume of the epidural top up. The sensory block augmentation with epidural saline is most likely explained by a volume effect and the fact that an increase in volume of epidural injectate produces higher sensory levels further supports this theory. This finding is in conjunction with the previous studies. Group I served as the control and the sensory level obtained after spinal anesthesia did not change.

Maximum rise in level of sensory block was noted in group II where 20 ml of 0.25% Bupivacaine was used for epidural top-up. The dose of Bupivacaine as well as the total volume used was maximum in this group. This was considerably higher than that observed in group III where same volume of epidural saline was used (4.40+1.28 in Group II vs 2.40+0.96 in Group III). This finding suggests that the volume effect is not solely responsible for the EVE; the local anesthetic also exerts its effect. In group IV the $S_{\max E}$ was 2.50 segments higher than $S_{\max}$ which was similar to 2.40 in group III.

Here the volume used (10ml) was exactly half of that in group III (20ml), but similar rise in sensory level further potentiates the theory of dose effect. This suggests that lower volume of LA is required to yield block augmentation equivalent to that produced with epidural saline. In group V where 10 ml of epidural saline was used the spinal block was extended by only 1.80+0.63 segments which was lesser than the 2.50+0.84 with 10 ml of 0.25% Bupivacaine.

These findings suggest that increasing the volume of injectate from 10ml to 20ml increased the level of effective sensory block. Same is observed on increasing the dose of Bupivacaine from 25mg to 50 mg. But in our study the increase in dose was also associated with an increase in volume which could have confounded the results.

The incidence of hypotension and bradycardia was comparable in all the five groups which reiterates the fact that EVE is a safe method to produce sensory block augmentation and is useful even when maximum sensory blockade with spinal anesthesia has been established. Another significant finding noted was the early sensory regression in the groups where epidural saline was used. However these observations were beyond the study period; therefore we cannot comment conclusively upon them.

In conclusion, both dose of local anesthetic and volume of solution influence the subsequent rise of sensory block in CSEA when epidural top up is given even after maximal sensory block in subarachnoid block is achieved. The extent of rise depends on the dose as well as volume of injectate and increasing either of these extends the block further.

This technique can be safely recommended where sufficient level of sensory block for surgery is not obtained despite a successful spinal block. 20ml of 0.25%Bupivacaine appears to be a more appropriate choice for the same. Whether there is any difference in the duration of sensory block between saline and Bupivacaine groups; could not be ascertained and needs to be investigated further.

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ORIGINAL ARTICLE

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