COMBINED SPINAL AND EPIDURAL ANAESTHESIA (CSEA) USING SEPARATE INTERSPACE TECHNIQUE

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Background:
The CSEA technique cannot be considered simply as an isolated spinal block followed by an isolated epidural block as combining the techniques may alter the characteristics of each block. This study was made to evaluate the clinical characteristics of CSEA.

Methods:
The study included 50 patients, undergoing elective lower limb and lower abdominal surgeries. An epidural catheter was secured at L_2-L_3 and subarachnoid block was performed at L_3 – L_4 interspace with 2ml of bupivacaine heavy 0.5%. Sensory blockade and haemodynamics were monitored at regular intervals. At 30^{th} minute epidural catheter was activated with 10 ml of bupivacaine 0.5% and monitoring was continued till the 60^{th} minute of the study.

Results:
Maximum levels of sensory blockade in spinal phase were T_{10} – 24%; T_9 – 30%; T_8 – 24% and in epidural phase were T_6 – 26%; T_5 – 34%; T_4 – 26%. Average onset times were 12.56 and 11.20 minutes in spinal and epidural phases respectively. Segmental increase in epidural phase averaged 3.8 segments. Percentage population with significant (≥3 segments) increment was 78%. Most with a significant segmental increase had a lower level of sensory blockade in the spinal phase (i.e., T_{11}, T_{10} & T_9). The rate of rise of sensory blockade showed an initial rapid phase followed by a sustenance phase. The magnitude of haemodynamic change from the baseline was computed from the "effect size of Cohen". Pulse rate, systolic, diastolic and mean blood pressure showed a positive effect, peaking twice, once in the spinal and another in the epidural phase.

Conclusion:
A preexisting subarachnoid block can be rapidly and significantly raised by an epidural injection of the drug, long after the spinal blockade had taken its full effect. In those who develop a lower level of sensory blockade in the spinal phase, the likelihood of significant rise in the epidural phase is high. The rate of rise of fixed sensory blockade in the epidural phase is rapid and predictable, especially in its initial part.

The CSEA technique has been used increasingly over the last decade. The technique cannot be considered simply as an isolated spinal block followed by an isolated epidural block as combining the techniques alter the behavior of the block altogether, the mechanism of which has been attributed to a volume effect and/or a local anaesthetic effect. Spinal anaesthesia requires a small mass (i.e., volume) of drug, to produce profound, reproducible sensory analgesia. In contrast, epidural anaesthesia necessitates use of a mass (i.e., large volume) of local anaesthetic which may be associated with side effects and complications unknown with spinal anaesthesia.

The introduction of combined spinal and epidural techniques blurs some of these

differences but also adds flexibility to clinical care.[1] This study was made to evaluate the clinical characteristics of the CSEA technique to assess:

1. The progress of the sensory blockade.
2. The haemodynamic changes.

Materials & Methods

The study included 50 patients belonging to either sex undergoing elective surgeries of lower limb and lower abdomen under neuraxial blockade. Inclusion criteria were American Society of Anesthesiologists physical status class 1 and 2, age between 20 and 55 years, height between 150 and 170 cms, weight within ± 2 standard deviation of the ideal weight for the height. This study was conducted after obtaining ethical committee clearance, institution approval and informed consent from the patients. Standard fasting guidelines were followed and patients were pre-medicated with oral diazepam 0.2 mg/kg (not exceeding 10 mg) on the night prior to the surgery. On the day of surgery, in the pre-medication room, baseline pulse rate and blood pressure were recorded and preloaded with 10 ml/kg of lactated Ringer's solution over 10 to 15 minutes.

In the operation room using midline approach in sitting position, the L_{2-3} and L_3-L_4 interspaces were infiltrated with lignocaine 2%. After 2 to 3 minutes an 18G Touhy epidural needle was introduced in the L_2-$_3$ interspace and epidural space identified using loss of resistance to air technique. After negative aspiration for blood and CSF, epidural catheter was threaded through the needle approximately 3 to 4 cm into the space. The placement of the catheter was confirmed by aspiration for absence of blood and cerebrospinal fluid and by injecting a test dose of 3 ml of lignocaine 2% with adrenaline (1:200,000). The epidural catheter was fastened to the back using sterile, transparent, adhesive skin dressing (10 x 12 cm). In the lower interspace i.e., at L_3-L_4 interspace, lumbar puncture was carried out using a 25G spinal needle (Quincke type). After confirming free flow of cerebrospinal fluid, 2 ml of bupivacaine heavy 0.5% was injected. Epidural catheter was secured to the back with micropore plaster and patient was positioned supine immediately with a pillow under the occiput. Pulse rate, blood pressure and the level of sensory blockade using 'loss of pain to pin prick' were monitored and recorded at 5 minutes interval till the 30th minute. Once maximum level of sensory blockade was established, the patient was suitably positioned with the trunk in neutral position and surgery was commenced. At 30th minute, bupivacaine (without dextrose) 0.5%, 10 ml was injected through the epidural catheter and monitoring continued as before at 5 minute intervals till 60th minute. Pulse rate < 50 beats/minute was treated with atropine 0.6 mg intravenously . A fall in mean blood pressure (MBP) of ≥ 30% of baseline value was treated with rapid infusion of intravenous fluids, intravenous mephentermine in bolus doses (6 mg at a time).

***Spinal Phase**: 0 minute to 30th minute.*

0 minute - point of completion of spinal injection.

Maximum level of sensory blockade - no further increase in level of sensory blockade during 3 consecutive measurements at 5 minutes interval.

Onset time - the time from the subarachnoid injection to the maximum level of sensory blockade first recorded.

***Epidural Phase**: 30th minute to 60th minute.*

Maximum level of sensory blockade - no further increase in level of sensory blockade during 3 consecutive measurements at 5 minutes interval.

Onset time - the time from the epidural injection to the maximum level of sensory blockade first recorded over and above the pre-existing block.

Significant increment - ≥3 segments over and above the pre-existing spinal blockade

Results

Demographic data:

- Females - 12 % Males - 88%
- Age distribution - 40.00±14.08 years
- Height distribution - 162.46±4 cms
- Weight distribution - 58.35±4.38 kgs

Table 1: Patient distribution No (/%) in terms of maximum level of sensory blockade achieved in the spinal and epidural phases

Spinal level	Epidural level					
	T7	T6	T5	T4	T3	Total
T11	-	1 (2.0)	1 (2.0)	2 (4.0)	-	4 (8.0)
T10	2 (4.0)	7 (14.0)	-	3 (6.0)	-	12 (24.0)
T9	1 (2.0)	2 (4.0)	7 (14.0)	2 (4.0)	3 (6.0)	15 (30.0)
T8	-	3 (6.0)	5 (10.0)	4 (8.0)	-	12 (24.0)
T7	-	-	2 (4.0)	-	1 (2.0)	3 (6.0)
T6	-	-	2 (4.0)	2 (4.0)	-	4 (8.0)
Total	3 (6.0)	13 (26.0)	17 (34.0)	13 (26.0)	4 (8.0)	50 (100.0)

In T_{11} and T_{10} groups, all the patients have achieved a significant increment in the epidural phase (Table 1), whereas in the T_9 group, it is over 90%.

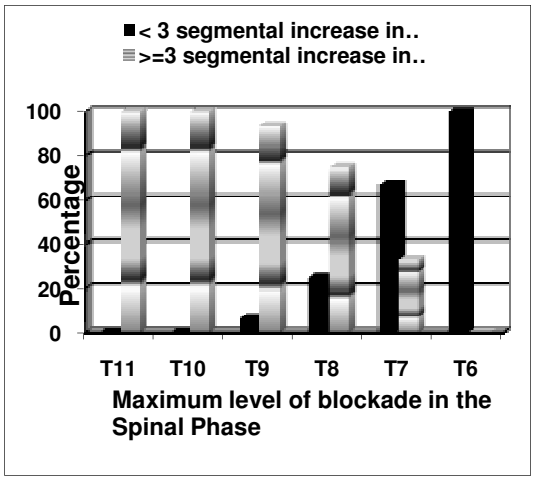

Figure 1: Percentage distribution of segmental level in the epidural phase with respect to the level attained in the spinal phase

Average onset time in spinal phase and epidural phases were 12.56 and 11.2 minutes respectively. Fig. 2 and Fig. 3 shows the relationship between the onset time and the maximum level of sensory blockade attained in the spinal and epidural phases respectively. Regression and correlation analysis is used to find out the relationship between the two. Both the phases show a near linear relationship with the slope of +1.6558 minutes and +1.4392 minutes respectively.

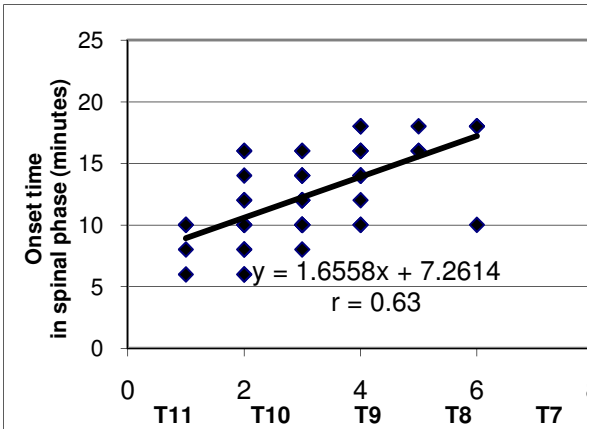

Figure 2: Relationship between the onset time and the maximum level of sensory blockade in the spinal phase

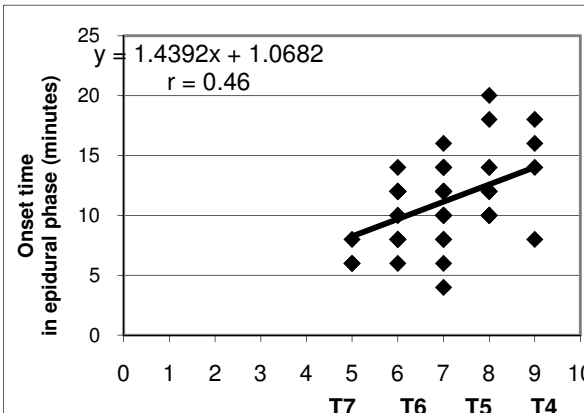

Figure 3: Relationship between the onset time and the maximum level of sensory blockade in the epidural phase

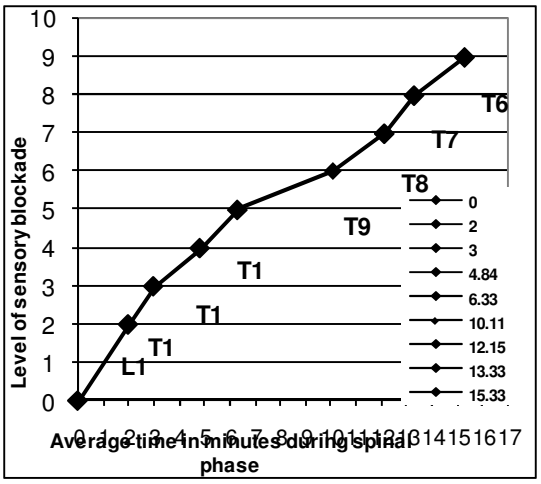

Figure 4: Rate of rise of segmental blockade in the spinal phase

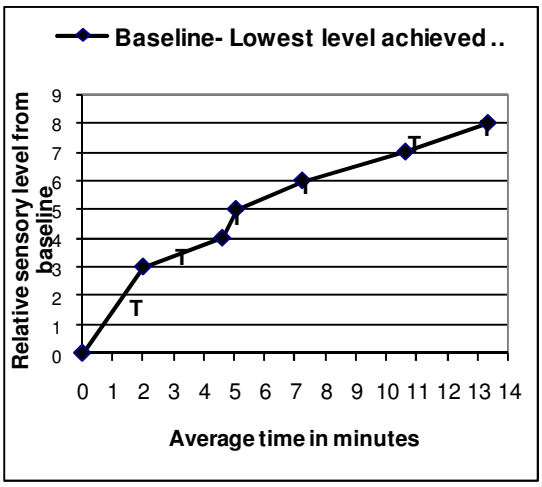

Figure 5: Rate of rise of segmental blockade in the epidural phase

It can be observed that in the spinal phase (Fig. 4) the rate of rise of sensory blockade is a uniform and a gradual phenomenon whereas in epidural phase (Fig. 5) the rate of rise shows an initial steep phase for 3 segments, followed by a gradual phase for the rest.

Haemodynamic Changes:

The magnitude of change from the baseline value is computed using "effect size of Cohen". An increase from the baseline value is considered as a negative effect, whereas a decrease from the baseline values, a positive effect. Fig 6 shows two peaks in effect size plot, one corresponds to the onset time in the spinal phase, whereas another peak corresponds to the onset time in the epidural phase which is larger than the first. This reveals the fact that the patients were subjected to additional haemodynamic stresses in the epidural phase.

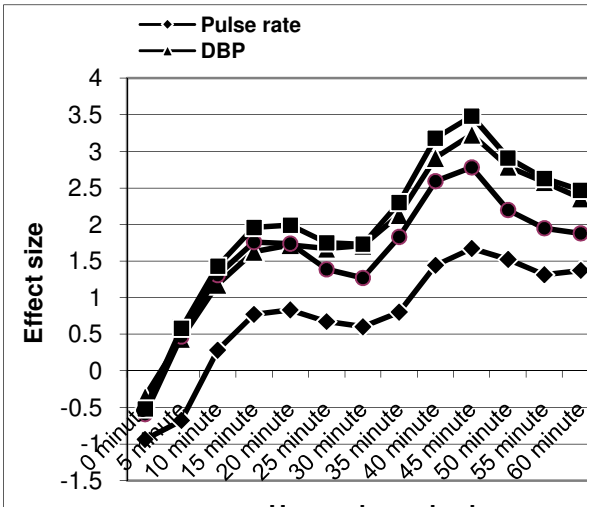

Fig 6: Haemodynamic changes observed in terms of effect size of Cohen

In the spinal phase only 2 patients received treatment for hypotension, whereas in the epidural phase 30 patients have received treatment with rapid intravenous crystalloid infusion, mephentermine in bolus doses (6 mg at a time). This striking difference clearly signifies that, patients would be subjected to additional haemodynamic stresses in the epidural phase. Prompt intervention is a must and this should be anticipated well in advance.

Discussion

In our study we followed double interspace technique as we felt it to be safer, technically easier and cost-effective. The present study was undertaken in 50 patients posted for lower limb orthopaedic procedures and lower abdominal surgeries. Males outnumbered females in this study, because majority of the patients underwent post-traumatic orthopaedic procedures with obvious male dominance.

The age range i.e., 20-55 years, is not known to produce a significant difference on the level of neuraxial blockade, although several studies have shown that the level of blockade obtained after subarachnoid injection of a hyperbaric local anaesthetic solution may be

approximately 3-4 spinal segments higher in the elderly compared with younger patients.[2,3,4]

Only extremes of height is said to have some effect on the distribution of local anaesthetic in cerebrospinal fluid. When all other factors that affect distribution are kept constant, weight of the patient has no demonstrable effect on the distribution of local anaesthetic.[5]

Maximum levels of sensory blockade in the spinal phase were T10 - 24%; T9 - 30%; T8 – 24% and in the epidural phase T6 – 26%; T5 – 34%; T4 – 26%. The average increment of sensory blockade over and above the spinal phase was 3.8 segments, with 78% of the population showing a significant rise (≥ 3 segments). The average onset times of spinal & epidural phases were 12.56 and 11.2 minutes respectively.

Rudolf Steinstra and colleagues[6], in their study to elucidate the mechanism of action of an epidural top-up in CSEA have found that the maximum level of sensory blockade with 2 ml of 0.5% bupivacaine in the spinal phase varied between T8.1±4.5 to T9.7±2.7 in various groups, with onset times of 15.0±9.1 and 15.5±4.4 respectively, which is comparable with our study. In the epidural phase the maximum sensory level reached in the group who have received 10 ml of bupivacaine through the catheter was T4.9±2.3 with a segmental increase of 4.8±1.6 which is again comparable with our study. Those who have received 10 ml of saline in the epidural phase showed a segmental increase of 2.0±2.0, which is less than what we have observed in our study. This was attributed to the fact that in addition to the volume effect, the local anaesthetic injected into the epidural space has its own role in bringing about the final segmental increment over and above that of spinal phase in CSEA. The same group[7] have studied the relative importance of volume and the dose of epidural top-up in CSEA. They found that with 2 ml of 0.5% bupivacaine the maximum sensory level in the spinal phase varied between T 8.5 (T_4-L_2) to T 5.5 (T_4-L_1) with the average onset time of 18±5.9 and 13 ±4.8 respectively, which is comparable with our study. In the epidural phase, those who have received 10 ml of 0.25% bupivacaine, showed a segmental increase of 2.5 (0-7), which is lesser compared to our study. Here, a question of total dose of drug actually required to show a significant segmental increment in the epidural phase comes into picture. In order to find an answer they divided 50 patients into 5 groups of 10 each. In the epidural phase, patients in Group 1 received 10 ml of bupivacaine 0.25%; patients in Group 2 received 10 ml of saline; Group 3 received 5 ml of bupivacaine 0.5%; Group 4 received 5 ml of saline; Group 5 received no epidural top-up. In groups 1-4, the maximum level of sensory blockade increased significantly and there was no significant difference in the maximum level of sensory blockade among Groups 1-4. They concluded that, there is no difference between 5 and 10 ml with regard to the volume effect of an epidural top-up in CSEA and that to produce an additional local anaesthetic effect with bupivacaine, the dose must be larger than 25 mg. This implies that in CSEA, an epidural “top-up” may increase the maximum level of sensory blockade by means of a volume effect and a local anaesthetic effect. In our study we have used 50 mg of bupivacaine in 10 ml volume in the epidural phase. Though, we have not included a comparison group in order to find out the relative importance of dose versus volume, both factors must have contributed in bringing about the significant result in the epidural phase. In the two previous studies mentioned, the epidural top-up was administered only after the maximum level of sensory blockade had been established. Similarly, in our study, the epidural top-up was administered after 30 minutes of spinal injection, which is well beyond the average onset time of the spinal phase i.e., 12.56 minutes.

A. Sivasenthil and colleagues[8], in their study have observed an extension of preexisting blockade even after 60 minutes of spinal injection. Regarding the rate of rise of segmental blockade following epidural top-up in CSEA, studies have proved that, there is an

initial rapid phase followed by a sustenance phase, whenever a local anaesthetic was administered. This is not so when saline was administered, wherein the sustenance phase was missing. Compression of the dural sac by a volume effect resulting in cranial shift of CSF already containing local anaesthetic seems a plausible explanation for the rapidity by which the level of sensory blockade starts to increase after administration of either epidural saline or local anaesthetic. Based on this finding, it appears that increase in the maximum level of sensory blockade after an epidural top-up with bupivacaine initially occurs by a volume effect, augmented by a local anaesthetic effect. Rudolf Stienstra and colleagues[6], in their study have found that the onset time for the saline group was 9.3±4.5 minutes, where as it was 17.0±6.7 minutes for the bupivacaine group. This shows that the sustenance phase was missing in the saline group. In our study we have observed an initial rapid phase, with a rate of rise of 3 segments in 2 minutes, i.e., from T11 to T 8 (Fig. 7), followed by a sustenance phase taking over 11 minutes to reach its final level (i.e., from T8 to T3). This again substantiates the observations of the studies mentioned previously and adds to the evidence that the extension of an already existing blockade induced by an epidural top-up with a local anaesthetic in CSEA the initial rapid increase being caused by a volume effect; the local anaesthetic itself accounts for an increase in the level that takes more time to develop.

C. H. Blumgart and colleagues[9] in their study concluded that the mechanism of extension of spinal anaesthesia by extradural injection of local anaesthetic is largely a volume effect. They have injected 10 ml of saline in one group and 10 ml of 0.5% bupivacaine in another group into the epidural space, 5 minutes after subarachnoid injection. They have observed a comparable final sensory level of T4.1 (0.6) and T3.7 (0.7) respectively and the rate of rise of sensory level was significant in both the groups when compared to a control group who had received only spinal injection. Initial rapid phase showed a rate of rise of around 3 segments in 5 minutes. The absence of significant difference between 2 groups can be attributed to the fact that the epidural drug was administered well before the subarachnoid block had been fully established.

The study also shows a relationship between the level of maximum sensory blockade in the spinal phase and the segmental increase following the epidural top-up. Almost all patients with a lower level of blockade in the spinal phase i.e., T11, T10 and T9 have showed a significant increment in the epidural phase (≥ 3 segments).

Haemodynamic changes i.e., pulse rate and B.P correlates well with the progression of the blockade. The maximum fall in the pulse rate, SBP, DBP & MBP was observed in the epidural phase, suggesting a further rise in the level of neuraxial blockade over and above that of the fixed subarachnoid block. A. Sivasenthil and colleagues[7] have observed a maximum fall in the pulse rate, SBP, DBP and MBP, 20 minutes after epidural top-up. We have observed a comparable change in the haemodynamic parameters, 15 minutes after epidural top-up.

There is obviously no reason to extend sensory blockade by administering an epidural top-up until sensory blockade starts to regress. However we wanted to activate the epidural phase of the study early in order to minimize the possibility of regression of the sensory level achieved in the spinal phase, so that the actual behavior of the blockade in CSEA could be studied. This unique behavior of the blockade that can be obtained by combining the techniques has potential benefits in certain clinical situations like inadequate spinal blockade and whenever surgeons trespasses beyond the anticipated dermatomal levels with or without prior notice. In such situations, the fixed subarachnoid block can be raised rapidly in a reliable manner. At the same time, the haemodynamic stresses that the patient has to bear must be anticipated and corrected promptly.

To conclude, a preexisting subarachnoid block can be rapidly and significantly raised by epidural injection of the drug, long after the spinal blockade had taken its full effect. In those who develop a lower level of sensory blockade in the spinal phase, the likelihood of significant rise in the epidural phase is higher. Converse is true in those with a higher level of blockade in the spinal phase. The rate of rise of fixed sensory blockade in the epidural phase is rapid, especially in its initial phase. The haemodynamic changes correlates well with the progression of the blockade and it follows the onset times in both phases. The magnitude of change in the epidural phase is over and above that of spinal phase, thus heralding a further rise of already existing block and thereby exposing the patients to further haemodynamic stresses that needs prior anticipation and prompt intervention. The unique behavior of the blockade in CSEA has potential benefits in certain clinical conditions like inadequate subarachnoid block and whenever surgery needs further extension of the block, wherein the existing block can be raised to a required level in a reliable manner.

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