Clinical Investigation

Paramedian epidural with midline spinal in the same intervertebral space: An alternative technique for combined spinal and epidural anaesthesia

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ABSTRACT

Background: Although different techniques have been developed for administering combined spinal epidural (CSE) anaesthesia, none can be described as an ideal one. **Objectives:** We performed a study to compare two popular CSE techniques: Double segment technique (DST) and single segment (needle through needle) technique (SST) with another alternative technique: Paramedian epidural and midline spinal in the same intervertebral space (single space dual needle technique: SDT). **Methods:** After institutional ethical clearance, 90 consenting patients undergoing elective lower limb orthopaedic surgery were allocated to receive CSE into one of the three groups (n=30 each): Group I: SST, Group II: SDT, Group III: DST using computerized randomization. The time for technique performance, surgical readiness, technical aspects of epidural and subarachnoid block (SAB) and morbidity were compared. **Results:** SDT is comparable with SST and DST in time for technique performance (13.42±2.848 min, 12.18±6.092 min, 11.63±3.243 min respectively; P=0.268), time to surgical readiness (18.28±3.624 min, 17.64±5.877 min, 16.87±3.137 min respectively; P=0.42) and incidence of technically perfect block (70%, 66.66%, 76.66%; respectively P=0.757). Use of paramedian route for epidural catheterization in SDT group decreases complications and facilitates catheter insertion. There was a significant number of cases with lack of dural puncture appreciation (SST=ten, none in SDT and DST; P=0.001) and delayed cerebrospinal fluid reflux (SST=five, none in SDT and DST; P=0.005) while performance of SAB in SST group. The incidence of nausea, vomiting, post-operative backache and headache was comparable between the three groups. **Conclusion:** SDT is an acceptable alternative to DST and SST.

Key words: Combined spinal epidural, double segment, needle through needle, paramedian

INTRODUCTION

The combined spinal epidural (CSE) anaesthesia technique is an important tool in the anaesthesiologist's armamentarium.[1-3] Various techniques as well as instruments have been designed and improvised upon, but controversy about the ideal CSE technique still remains unresolved.[1-5] In techniques where subarachnoid block (SAB) is performed before epidural catheterization like needle through needle (NTN) technique; problems exist with interpretation of the test dose, failure of SAB, risk of metallic particle toxicity.[1] There is risk of damage to the epidural catheter or spinal needle if SAB is carried out after epidural catheterization.[1] Furthermore, the paramedian approach to epidural catheterization has been reported to be advantageous than the midline approach.[6,7] In an attempt to resolve the controversy regarding the best CSE technique, we conducted this study, wherein epidural catheterization was performed by paramedian approach and SAB in midline, both at the same intervertebral space and this technique was compared with the standard double segment technique (DST) and single segment (NTN) technique (SST).

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METHODS

The study was conducted between September 2005 and December 2006 after due clearance from the hospital protocol committee. Sample size of 30 was calculated by taking failure of spinal component in CSE as 16% with α error of 0.05 and power of 90. After obtaining written informed consent, 90 patients of either sex and with age between 15 years and 65 years, belonging to ASA grade I/II and scheduled for elective lower limb orthopaedic surgery were allocated (using computer generated random numbers) into one of the three groups of 30 each: Group I - SST (NTN), Group II - single space dual needle technique (SDT), Group III - DST. Exclusion criteria were patient refusal, local infection, spinal deformity, raised intracranial tension, heart disease, coagulopathy, platelet count <75000/ cumm and neurological disease.

In the operation theatre; standard monitors were attached and all patients were preloaded with Ringer's lactate (10 ml/kg). CSE was performed under all aseptic precautions in the sitting position at L_{2-3}/ L_{3-4} intervertebral space after local infiltration with 2% lignocaine. SDT was performed by one of the consultants who performed the procedure atleast 50 times previously while SST/DST was done by any consultant anaesthesiologist.

In Group I (SST), Portex® CSEcure® (Smiths Medical ASD, Inc, USA) set was used to perform CSE by NTN technique. Epidural space was located in midline. The spinal needle (26 G, length 117 mm) was introduced through epidural needle (16 G) and after confirming spinal tap; 2.5 ml of 0.5% hyperbaric bupivacaine was injected intrathecally followed by removal of the spinal needle. Thereafter, epidural catheter was introduced through the epidural needle followed by removal of epidural needle.

In Group II (SDT) Portex® Minipack® (Smiths Medical ASD, Inc., USA) epidural set was used for epidural block and 26 G pencil point spinal needle (length 95 mm) was used for SAB. The spinal needle was introduced through the midline route and after a successful dural puncture stilette was re-inserted into the spinal needle. The epidural space was then located at the same intervertebral space using 16 G Tuohy's needle by the paramedian route and epidural catheter was inserted. SAB was performed by removal of spinal needle stilette and intrathecal injection of 2.5 ml of 0.5% hyperbaric bupivacaine.

In Group III (DST), epidural space was identified in midline using 16 G Tuohy's needle by loss of resistance technique followed by epidural catheterization [Portex® Minipack® (Smiths Medical ASD, Inc., USA)]. Then SAB (26 G pencil point spinal needle, length 95 mm) was performed in midline at the lower interspace using 2.5 ml of 0.5% hyperbaric bupivacaine.

In all the patients, epidural catheter was inserted 4 cm into the epidural space with the hub of epidural needle pointed in the cephalad direction and after fixation on the back it was flushed with 2 ml normal saline. Patients were made supine and surgery was allowed to start after achieving T_{10} sensory block. Haemodynamic and respiratory parameters, level of analgesia to pin prick were monitored every 5 min for the first 20 min followed by every 10 min thereafter. While performing the epidural block following were recorded: Presence of fluid (blood/cerebrospinal fluid (CSF)/saline) at the tip of Tuohy's needle or epidural catheter, difficulty or failure in advancement of epidural catheter, malposition of catheter, paraesthesias during the catheter insertion. While performing SAB; a record of the following were made: Appreciation of dural puncture, delay in reflux of CSF (reflux after 5 s of dural puncture) and dry tap. Any relevant fall in blood pressure i.e.: More than 20% fall from the baseline value or systolic blood pressure less than 90 mm Hg within 30 min of intrathecal drug injection was attributed to SAB and treated with intravenous fluids followed by vasopressor. Time taken from part preparation to epidural catheter fixation was noted as t_1 (technique performance time). Time taken from part preparation to achievement of analgesic level of T_{10} was noted as t_2 (time to surgical readiness). Incidence of a technically perfect block was calculated in each group i.e., localization of epidural space in first attempt, subarachnoid tap in first attempt and uneventful insertion of catheter in the first attempt.[8] At the end of surgery or with the wearing of motor blockade epidural test dose was given with three ml of 2% lignocaine with adrenaline (1 in 200000) after negative aspiration. Epidural top ups were given after a negative test dose using increments of 4 ml of 0.5% bupivacaine in the intra-operative period, 8 ml of 0.25% bupivacaine with 0.325 mg buprenorphine in the post-operative period. Failure to achieve T_{10} analgesic level was defined as failure of spinal component of CSE. Failure to extend analgesia after epidural top up was defined as failure of epidural component. After 24 h, the last analgesic epidural top up was given and the epidural catheter was removed.

Patients were also evaluated for headache, backache, nausea and vomiting.

Statistical analysis

SAS version 8.0 software was used for statistical analysis. Mean and standard deviation were calculated for continuous variables. Frequency distributions and their percentage have been applied to categorical variables. For categorical variables, analysis of variance was applied to assess the significance across the three groups, whereas Bonferroni test was used for comparison between consecutive groups. Non-categorical variables were analysed using Chi-square test.

RESULTS

The three groups were comparable for age, sex, height and weight of the patients [Table 1]. The most common surgical procedure performed was interlocking femur (22) followed by interlocking tibia (15), hip arthroplasty (13), dynamic hip screw placement (11), total knee replacement (seven), knee arthroscopy (seven) and others (15). There was no significant haemodynamic variation in any group during the surgery and also no significant variation in haemodynamic variables between the three groups at any given point of time during the surgery.

There was no significant difference between the three groups with regard to t_1, t_2 and incidence of technically perfect block [Tables 2 and 3].

The number of cases with various technical problems during epidural localization and catheterization can be seen in Figure 1. The incidence was least in SDT group; although, results were not statistically significant (P>0.05). Accidental dural puncture with epidural needle occurred in one case each in SST group and SDT group (P value 0.355) following which epidural catheterization was not done and surgery carried under SAB alone in SST group, the epidural space was relocated at a lower level in SDT group.

While performing SAB, dural puncture was well-appreciated in all cases with SDT, DST and in only 20 cases with SST (P value 0.001). Dural puncture was followed by instant reflux of CSF in all cases in SDT and DST groups and in 25 cases in SST group [P value 0.005, Table 4].

Epidural catheter was aspirated before each epidural top up. In two cases in SST group, blood was aspirated. Epidural catheters were removed and these patients did not receive any epidural top ups. Test dose was

Table 1: Demographic profile

Demographic parameter	Group I (SST)	Group II (SDT)	Group III (DST)	*P* value
N	30	30	30	
Age (years)	40.13±5.042	41.03±13.330	36.17±12.221	0.340
Sex (male/female)	19/11	20/10	18/12	0.866
Height (cm)	162.9±6.239	166.20±9.023	166.30±6.846	0.112
Weight (kg)	56.80±7.471	57.50±8.978	57.43±7.843	0.841

SST – Single segment technique; SDT – Single space dual needle technique; DST – Double segment technique

Table 2: Time for anaesthetic technique performance (t_1) and time to surgical readiness (t_2)

Time	Group I (SST)	Group II (SDT)	Group III (DST)	*P* value
t_1 (minutes)	12.18±6.092	13.41±2.848	11.63±3.243	0.268
t_2 (minutes)	17.64±5.877	18.28±3.624	16.87±3.137	0.462

SST – Single segment technique; SDT – Single space dual needle technique; DST – Double segment technique

Table 3: Incidence of technically perfect block

Number of attempts	Group I (SST) (%)	Group II (SDT) (%)	Group III (DST) (%)	*P* value
Single attempt for each procedure	20 (66.67)	21 (70)	23 (76.67)	0.757
More than one attempt	10 (33.33)	9 (30)	7 (23.33)	0.686

SST – Single segment technique; SDT – Single space dual needle technique; DST – Double segment technique

Table 4: Characteristics of SAB

Characteristic of SAB	Group I (SST) (%)	Group II (SDT) (%)	Group III (DST) (%)	*P* value
Appreciation of dural puncture	20 (66.67)	30 (100)	30 (100)	0.001
Reflux of CSF within 5 s	25 (83.3)	30 (100)	30 (100)	0.005

SST – Single segment technique; SDT – Single space dual needle technique; DST – Double segment technique; CSF – Cerebrospinal fluid; SAB – Subarachnoid block given to remaining patients, which was negative in all recipients. Timely epidural top ups were given to these patients, which provided the necessary surgical or post-operative analgesia. Thus, there was intravascular placement in 6.6% cases in SST group. There was no subarachnoid placement or migration of the catheter.

The three groups were comparable for incidence of post-operative nausea, vomiting, headache and backache [Table 5].

DISCUSSION

Paramedian route for epidural catheterization is known to facilitate cephalad catheter placement and decrease dural puncture, bloody tap and paraesthesias.[6,7] Thus, incorporation of paramedian epidural catheterization can be advantageous for CSE as well.

The incidence of a technically perfect CSE was comparable (P value 0.757) in the three groups (SST: 66.66%, SDT: 70%, DST: 76.66%). It has been reported between 60% and 82% for SST (NTN) depending on the device used and can be up to 100% for DST.[8,9] While attempting to localize the epidural space; dural tap occurred in one case each (3.3%) in SST, SDT. There was no case of accidental dural tap in DST group (P=0.355).

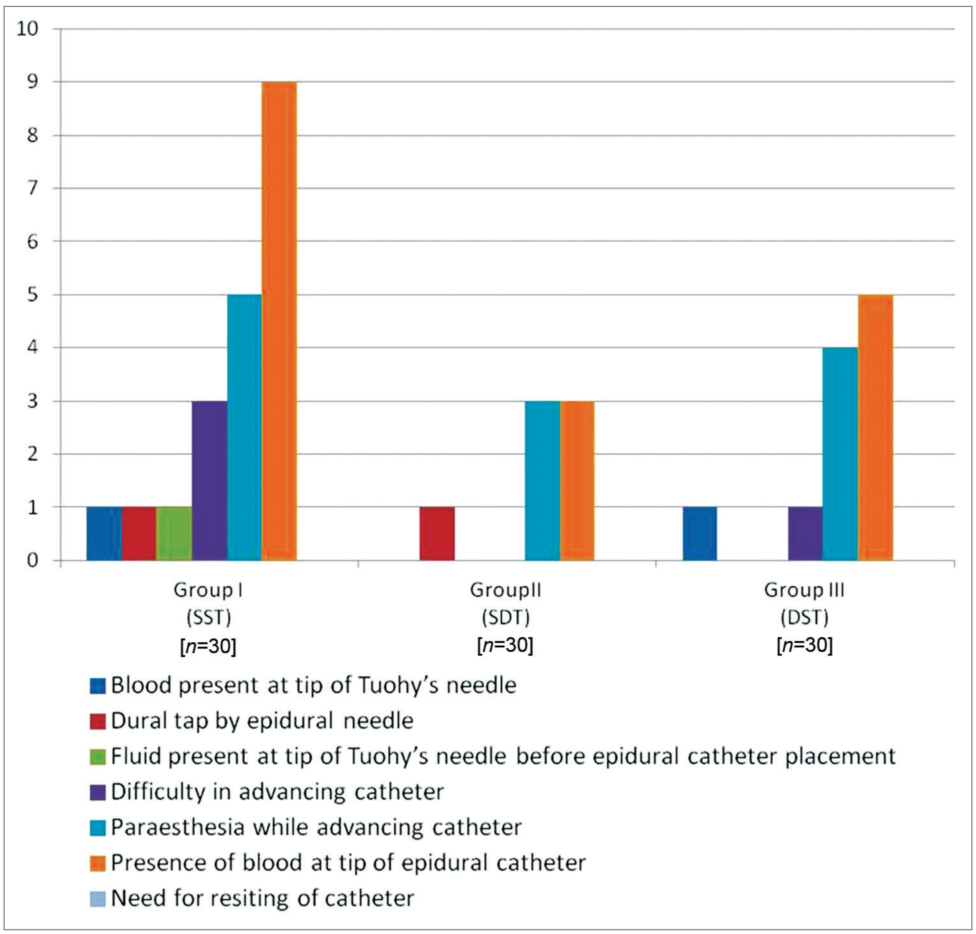

Figure 1: Technical aspects of epidural block

Table 5: Post-operative parameters

Postoperative parameter	Group I (SST) (%)	Group II (SDT) (%)	Group III (DST) (%)	*P* value
Headache	0 (0)	1 (3.3)	0 (0)	0.129
Backache	1 (3.3)	1 (3.3)	1 (3.3)	0.999
Nausea	3 (10)	2 (10)	2 (10)	0.364
Vomiting	2 (6.67)	1 (3.3)	2 (6.67)	0.865

SST – Single segment technique; SDT – Single space dual needle technique; DST – Double segment technique

There was no incidence of blood or fluid at the tip of Tuohy's needle in SDT group. Blood was present at the tip of Tuohy's needle in one case each (3.3%) in SST and DST (*P* value 0.59). Use of midline approach to epidural catheterization in SST and DST is more likely to encounter the epidural venous plexus. Casati *et al*. found no significant difference in the presence of blood at the tip of Tuohy's needle between SST and DST.[10] Difficulty in epidural catheter advancement also occurred only in SST (10%) and DST groups (3.3%). Similar results were obtained in other studies comparing SST with DST.[10,11] Epidural catheterization was not possible in two cases of SST (n=169) in a study by Takahashi *et al*.[12] There was no case with difficulty in advancement of the epidural catheter in SDT group. The influence of the dorsomedian connective tissue band can explain the difficulty in traversing of the midline epidural catheters.[6]

The incidence of paraesthesia while advancement of epidural catheter was 16.67% in SST, 13.33% in DST and 10% in SDT (P=0.91). A higher incidence of paraesthesia with SST versus DST was also quoted by Ahn *et al*. (46.66% vs. 26.66%), but not by Casati *et al*. (10%, vs. 11.6%).[10,13] Paramedian epidural catheterization has been associated with a significantly lower incidence of paraesthesias than use of midline route.[6,7]

Blood was seen at the tip of the epidural catheter in 30% cases in SST, 16.67% cases in DST and 10% cases in SDT (P=0.23). This lower incidence in SDT can be explained by the midline presence of the epidural venous plexus, thus lowering the chances of it been encountered if the paramedian approach is used. The risk of epidural catheter penetrating the duramater through the hole made by spinal needle is a major concern especially with the NTN technique. However, there was no such case in our as well as other studies.[10,14] Epiduroscopy studies have concluded that it is impossible to force epidural catheter through the hole made in dura by a fine spinal needle.[15]

Dural puncture was not possible in two cases (6.6%) in SST group. Spinal needle of CSE cure® set used by us for SST has a protrusion length of 12 mm, which is sufficient to reach the dura as epidural-dural distance is 3-17 mm.[16] However, increasing the total length and fineness of the spinal needle poses difficulty in handling the spinal needle. Any deviation from the midline can lengthen the epidural-dural distance preventing dural puncture by the spinal needle. Incidence of unsuccessful dural puncture in NTN is reported as 5-29% by various authors.[14,17] Lack of appreciation of dural puncture was a significantly common finding (33.335%, *P* value 0.001) in SST group. Paech and Evans could not feel the dural puncture in 6-12% cases while performing CSE by NTN technique.[8] Lack of dural puncture appreciation may lead to failure of SAB in NTN.[1]

There was a significantly lower incidence of cases with instant reflux of CSF in SST group (83.33%) as compared with 100% incidence in both DST group and SST group (*P* value 0.005). The speed of reflux of CSF primarily depends on the gauge of spinal needle used. In our study; a 26 G spinal needle was used in all three groups. However, the spinal needle used in SST was longer (117 mm) than the ones used in DST, SDT (95 mm). The delay in reflux of CSF in SST can probably be attributed to the length of spinal needle, which increases the resistance and hence diminishing the speed of flow of CSF.[18] In all cases with successful dural puncture, a sensory block till at least T_{10} level was achieved. Lyons *et al*. had reported failure of SAB in 16% cases in SST and 5% cases in DST.[19]

There were no significant differences in t_1 and t_2 between the three groups. Time for performance of anaesthetic technique (t_1) was 12.18±6.092 min, 13.41±2.848 min, 11.63±3.243 min in SST, SDT, DST respectively (P=0.268) and time to surgical readiness (t_2) was 17.64±5.877 min, 18.28±3.624 min, 16.87±3.137 min respectively (P=0.462). A significantly lower anaesthetic technique performance time was reported by Lyon *et al*. and Casati *et al*. in SST, but time to surgical readiness were comparable between SST and DST.[10,19]

There was no post-operative migration of the epidural catheter in any group in our study, similar to previous studies.[11,14] No significant difference in post-operative epidural catheter migration between SST and DST was noted by Casati *et al*. and Lyon *et al*.[10,19] The incidence of post-operative headache (SST=0%, SDT=3.3%, DST=0%, *P* value 0.129) and backache (3.3% in all the groups, *P* value 0.999) was comparable between the groups, in accordance with most of the previous studies.[9,10,19] Post-operative nausea and vomiting was also comparable between the groups [Table 5].

Hence, the single space dual needle technique (SDT) has several advantages over the SST and DST. It is comparable in time taken for performance, time to surgical readiness and achievement of a technically perfect block with these previously established techniques. Furthermore, use of SDT offers the advantages of paramedian epidural catheterization over the midline approach used in the other two techniques i.e., lower incidence of presence of blood at the tip of Tuohy's needle or epidural catheter, easier epidural catheter insertion, lesser paraesthesias. Paramedian epidural catheterization is also known to facilitate cephalad positioning of catheter.[6] The provision of adequate epidural analgesia with epidural boluses in all cases in the SDT group is suggestive of correct placement of the epidural catheter and rules out misdirection of the epidural catheter in the SDT group. However; the final position of epidural catheter was not verified. Two well felt intervertebral spaces may not be available in all patients, which may be a limitation with DST. For instance; in obese patients; obscured anatomical landmarks may lead to difficulty in identification of the intervertebral spaces.[20] The authors believe that in such a scenario; DST may prove to be a more difficult technique than SST or SDT, which require only a single intervertebral space. Again, with SST; the length of the epidural needle available with the NTN set is fixed and may be inadequate. SDT, however, can still be performed by using longer epidural and spinal needles,[20] which are more readily available. Currently, there is no study comparing various CSE techniques in the obese population and further studies are required to validate this hypothesis. SST (NTN) also has certain other disadvantages; SAB has to be performed before epidural catheter insertion, which makes interpretation of test dose difficult and might lead to restriction of the height of SAB due to inevitable delay between SAB performance in the sitting position and making the patient supine.[1] This delay can be increased in case of unanticipated problems like blood entering the catheter, occurrence of paraesthesias or difficulty in advancement of catheter; these are again higher with the midline epidural catheterization.[1] Administration of epidural test dose after giving SAB in SST not only makes its interpretation difficult, it can cause a dangerous rise in the level of the emerging SAB. Various authors have recommended delaying the test dose until waning of block, total avoidance of NTN CSE or use of high volume low concentration test dose, but neither of these is a perfect solution to the problem. Hence, it cannot be underemphasised that each epidural top up should be considered as a test dose and given by someone who can treat high spinal block.[1] In the current study, test dose was delayed until wearing of block in the non-SST groups also, so as to eliminate the effect of the test dose lignocaine on the developing SAB, which could impact the value of t_1 and t_2.

CONCLUSION

To conclude, the authors suggest that the SDT (paramedian epidural with midline spinal at the same space) is an acceptable alternative to the SST (NTN) and DST. However, SDT will require further evaluation and familiarization as one has to get used to performing paramedian epidural catheterization when the spinal needle with its stilette is *in situ* in midline that may act as a mechanical hindrance.

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