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Original Research Article

Comparative study of ultrasound assisted versus conventional surface landmark guided technique for combined spinal epidural anaesthesia in patients with increasaed body mass index and difficult surface anatomy of lower back and spinal deformity

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ABSTRACT

Background: Palpatory method is traditionally used in clinical practice to locate the puncture site of combined spinal epidural (CSE) block, but locating the puncture site accurately in obesity and patients with difficult landmark or spinal deformity is usually difficult. For a successful CSE block, the puncture site must be accurately identified. The goal of this study was to see how ultrasonography (USG) affected the success rate of CSE puncture in these patients.

Materials and Methods: This prospective randomized study included 100 patients requiring CSE (needle through needle technique) of American Society of Anaesthesiologists (ASA) grade I/II, age 18-60years, obese (BMI upto 35 kg/m2), patients with difficult landmark, spinal deformity and were randomly assigned to one of two groups: Ultrasound assisted group (USG) (n=50) or Surface landmark group (SLG) (n=50). The primary outcome was to compare the first-pass needle success rate for establishing CSE, with secondary outcomes including the number of needle puncture attempts, time to establish landmarks (t1), time to complete CSE (t2), total procedure time (t), block associated pain and complications.

Results: The USG group had a significantly greater first pass needle success rate (92%) than the SLG group (60%) p<0.001. The number of attempts to accomplish CSE in the USG group was lower than in the SLG group (p = 0.001). The USG group had a longer t1 (1.50±0.42) minutes than the SLG group (0.80±0.28), p<.0001. The USG group had a shorter t2 (1.60±0.45) than the SLG group (3.37±1.25) minutes (p <0.001). Block associated pain score was less in USG group as compared to SLG group (p=0.0003).

Conclusion: Preprocedural USG improves first pass needle success rate and reduces the number of needle puncture attempts, decrease the procedural time thus lowering the risk of trauma, block associated pain, and discomfort to the patient.

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1. Introduction

Central neuraxial block (CNB) is defined as modality that blocks the sympatho-somatic out flow from the spinal cord at different levels. Combined spinal epidural (CSE) anaesthesia is one of the techniques of CNB. Two commonly employed techniques in CNB are intrathecal or subarachnoid injection of local anaesthetic and epidural injection of local anaesthetic. These procedures differ in aspects like extent of block, repeatability, onset and duration of action.[1] With CSE block can be achieved rapidly using the spinal component while the epidural catheter can be used to prolong or modify the block as well as provide post-operative analgesia or labour analgesia.

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Conditions like obesity, kyphosis, scoliosis and degenerative spinal diseases cause obliteration and distortion of surface anatomy of lower back and pose considerable challenge to the anaesthesiologist in performance of CSE with conventional Surface Landmark Guided (SLG) technique. SLG approach could lead to an increase in technical difficulties and associated adverse out comes like more time consumption, increased number of needle puncture attempts, increased incidence of post dural puncture headache, spinal hematoma, and pain.[2] Bogin and Stulin were the first to use ultrasound for central neuraxial interventional procedure to perform lumbar puncture. Since then, there has been varied research in its utility in performing CNB.[3]

Incidence of obesity is at an increasing trend in Indian and South Asian countries. The anaesthetic complications related to the same are at an alarming rate of incidence as the proportion of patient population coming for surgery with obesity has increased. According to ICMR, the generalised obesity and abdominal obesity prevalence in India is high. As one of the major life style diseases, latest data suggests that more than 26% of the adult population in India are above the ICMR standard for obesity which is BMI of 25 kgm^{-2}. There is higher incidence of abdominal obesity with comparatively lower values of BMI in Asian population, increasing the complications related to anaesthesia as well as CNB.[4] Usually, the patients with increased BMI and with history of degenerative spinal diseases have difficult surface anatomy pf lower back.

Purpose of present study was to compare the first pass needle success rate to establish successful CSE (needle through needle technique) via median approach between Ultrasound group (USG) and Surface Landmark Group (SLG) in patients with difficult anatomical landmark and obesity. Primary outcome of the study was to determine the first pass needle success rate while the secondary outcomes were to compare the number of needle puncture attempts to establish successful CSE, time taken to establish landmarks, time taken to accomplish CSE and complications. We hypothesized that the use of preprocedural ultrasound scan would result in higher first pass needle success rate and would decrease the number of needle puncture attempts and complications as compared with conventional surface landmark guided CSE.

2. Materials and Methods

This study was conducted in the Department of Anaesthesiology of a Tertiary Care hospital in North India after the approval of the Institutional Ethical Committee. 100 patients belonging to American Society of Anaesthesiologist (ASA) I and II elective cases with BMI > 25 kg/m^2 and/ or with spinal deformity like scoliosis, kyphosis and degenerative spinal diseases requiring CSE were enrolled. After getting written and informed consent, allocation concealment was done with sealed numbered opaque slips into two groups of 50 each. Ultrasound assisted group (USG): (n=50) Patients back assessed using ultrasound, most appropriately appreciated vertebral space marked and CSE (needle through needle) conducted through midline approach. Surface Landmark Guided group (SLG) (n=50) Patients back assessed using the traditional surface land mark technique, the most appropriate vertebral space marked and CSE (needle through needle) conducted through midline approach.

Detailed history, general physical and systemic examination of the patient was done and anaesthetic procedure explained a day prior to surgery for both the groups. Patients were kept fasting for 6 hours prior to surgery. Tablet alprazolam (0.25 mg) and tablet ranitidine (150 mg) per oral was given as premedication, a night before the surgery with a sip of water. USG group was subjected to preprocedural ultrasound scan in preoperative room on the day of surgery and SLG group was taken directly to the operation room. In USG group palpation of surface landmarks was not done till the time CSE was performed. The patients back were palpated and categorized as mild, moderate, difficult and impossible to palpate the bony landmarks on spinal assessment. R System Sono MB technology Fujconvex probe (5-9Hz) in sitting position.placed transversely in the midline in lumbar region to visualize the spinous process which appeared as linear hypoechoic acoustic shadow. Whereever the best view of the spinous process was seen, M- Mode of ultrasound was used to mark the central point of the long border of the probe and a vertical line drawn with surgical skin marking pen (Figure 1). This corresponds to the midline of central neuraxis, which guided us in angulation of ultrasound probe and Tuohy's needle to midlinecaudally to the level of the sacrum, to visualize the straight sacral delineation, then moved cephalad and the individual lamina of the vertebrae was identified, counting startof L. The probe was rotated transversely (90°see the transverse view of the vertebral canal, visualizing the anterior segment, posterior segments (ligamentum flavum– dura mater unit), vertebral body, transverse process and articulating process (Figure 2). The ultrasound probe was angulated to visualize the structures best. The skin was marked at this level (centre point of the probe denoted as horizontal line. Two inter vertebral spaces at L2-L3/ L3-L4 were marked.

Monitoring of non-invasive blood pressure (NIBP), mean arterial pressure (MAP), continuous heart rate (HR), electrocardiogram (ECG) and oxygen saturation (SpO_2) was done. Intravenous line was secured and crystalloid infusion (15-20ml/kg) started according to fasting status. CSE was given with Portex® Combined Spinal / Epidural Minipack with Lock Pencil Point Spinal Needle 27G/18G, Made in UK in both the groups.

Fig. 1: Showing marking of landmark for needle puncture point in transverse view

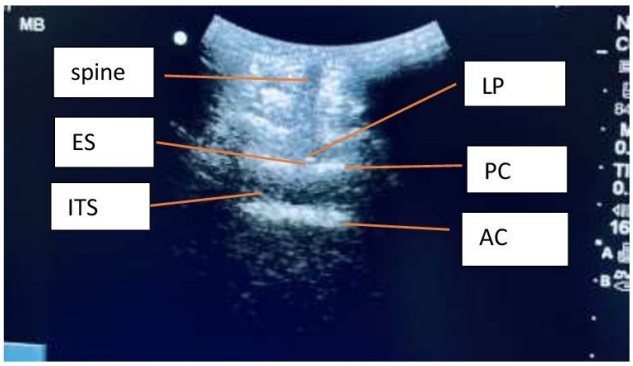

Fig. 2: Sonoanatomy of spine in transverse median view showing; LP: Ligamentum flavum; PC: Posterior dural complex; AC: Anterior dural complex; ITS: Intrathecal space; ES: Epidural space; Spine of L4

Patient was positioned in sitting position, skin of back was prepared under aseptic precaution, with due care to preserve the skin marking. In USG group palpation of the surface landmarks was not done and Tuohy needle was guided according to the USG scanned skin marking at the measured angulations of the probe. In the SLG group the surface landmarks was palpated and the best felt vertebral space was used to guide the Tuohy needle. In both the groups skin and underlying tissue was infiltrated with local anaesthetic in the midpoint marked (USG group)/ felt (SLG group). An 18 G Tuohy needle was inserted through midline approach and epidural space was identified using "loss of resistance technique" (LOR).

The first pass success rate, number of needle punctures and redirections done to locate epidural space (ES) was recorded. Subarachnoid block was given by 27 G Whitacre needle by needle through needle technique and after free flow of CSF (Cerebrospinal fluid) was confirmed, 0.5% bupivacane was administered. The epidural catheter was advanced upto desired length and was fixed. The level of sensory block was assessed by response to temperature change (hot and cold) and motor block were assessed by Modified Bromage Scale for both the groups. If CSE could not be accomplished in three attempts alternative techniques were used. First pass needle success rate, number of needle puncture attempts to establish successful CSE, time taken to establish landmarks, time taken to accomplish CSE, block associated pain score (rated by patients immediately after completion of the spinal anesthesia, VAS PAIN scale 0–10) and complications were noted.

Sample size was calculated as 42 patients in each group with 80% power at an alpha 0.05 one sided to detect a 25% difference between two groups. We chose a 20% baseline ratio of successful insertion at first attempt using conventional technique. Factoring a dropout rate of approximately 5%, we calculated that 50 patients in each group would be required to increase the power of the study. Statistical analysis was performed using IBM SPSS Statistics for Windows, version 21 (IBM Corp. Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation (SD). Categorical variables were expressed as frequencies and percentages. Normally distributed continuous variables were compared using Student's t test. Nominal categorical data were compared using Chi Squared test, Fisher's exact test. Non nominal distribution continuous variables were compared using Mann Whitney U test. $P < 0.05$ was considered statistically significant.

3. Results

A total of 100 patients were assessed for eligibility. The patients allocation was depicted in CONSORT flow diagram (Figure 3).

Both groups were comparable in demographic profile like age, weight, body mass index (BMI) and ASA physical status.

46 patients (92%) out of 50 in USG group had successful CSE in single needle puncture in comparison to 30 patients (60%) in SLG group. The difference was statistically highly significant (p= 0.0003) (Table 1). t1 was more in USG group with mean and standard deviation of (1.50±0.42) minutes while in SLG group it was (0.80±0.28) minutes with p <0.001. In USG group (t2) was less (1.60±0.45 minutes) than in SLG group (3.73±1.25 minutes) with p <0.001. Total time (t1+t2) taken for CSE was less in USG group (3.2±0.76) minutes when compared to SLG group (4.50±1.30) minutes with p= 0.007 (Table 2). The mean number of needle puncture required for successful CSE in SLG group was 1.72 as compared to 1.08 in USG group.

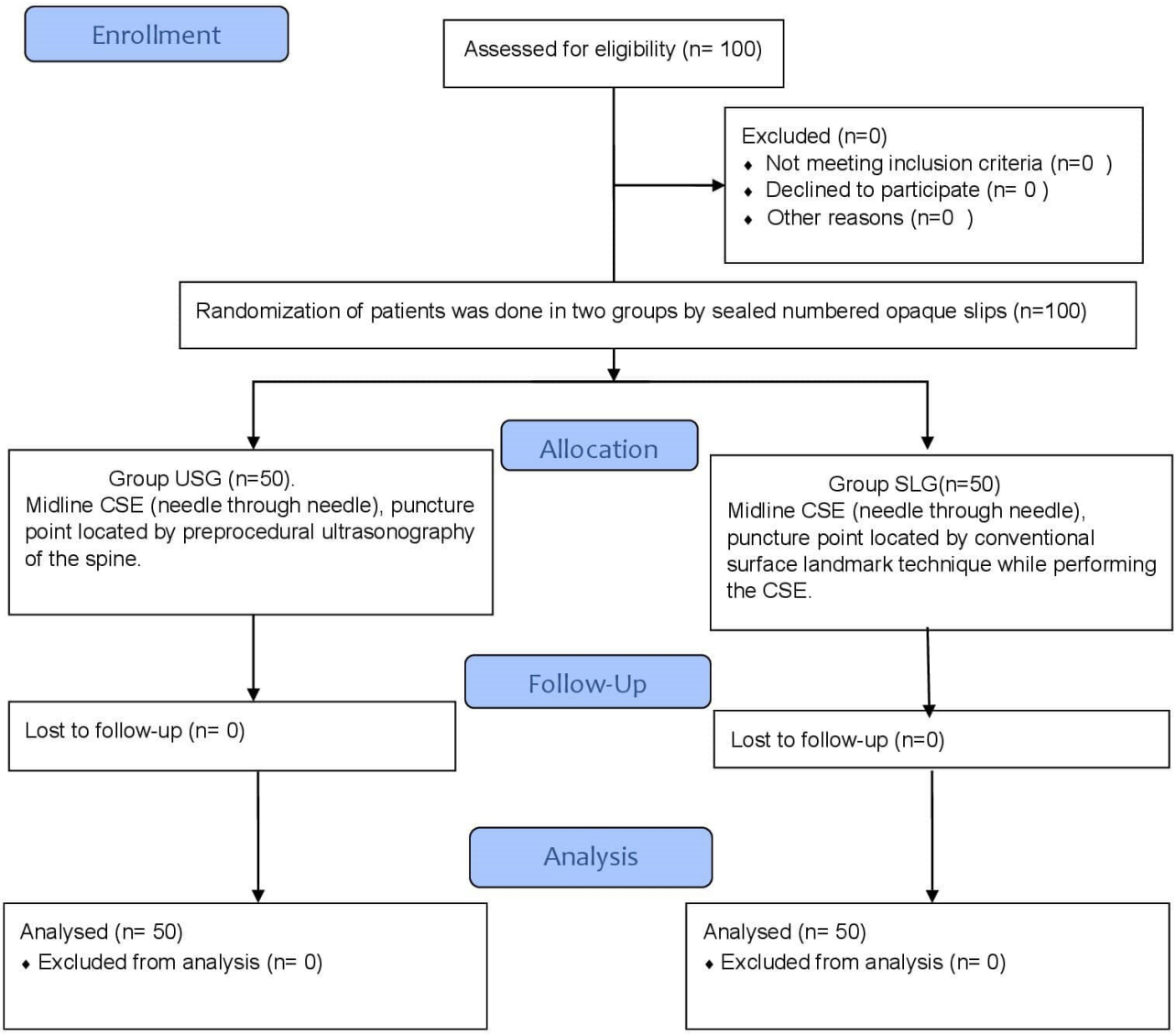

Fig. 3: Consort flow chart

The p value is significant 0.001 (Table 3). The mean value of block associated pain score was 4.32 in SLG and 2.59 in USG group (p value of 0.0003) that was statistically significant (Table 4).

4. Discussion

For years CNB traditionally depends on palpation of bony anatomical landmarks for needle insertion. At times such landmarks may become difficult to identify in conditions like obesity and altered anatomy of spine as seen in age associated degenerative changes and previous spinal surgery.[5–7] These factors may cause difficulty in procedure, increase the number of needle puncture attempts, increased time duration, failure rate, trauma and injury while performing CSE.[8–10] Obesity is on increasing trend and poses an important health concern now a days. Obesity is measured in terms of body mass index (BMI) which is calculated by dividing a person's weight by the square of his/her height (kg/ metre^2) the internationally accepted criteria.Obesity is associated with physiological alterations and comorbidities like obstructive sleep apnea, coronary artery disease metabolic syndrome which increases the perioperative morbidity and mortality rates. Regional anaesthesia is preferred over general anaesthesia to avoid airway manipulations, opioid use and surgical stress response. Regional anaesthesia faces challenges like, difficult positioning, multiple puncture attempts, difficult anatomical landmarks, and increased

Table 1: Successful placement of CSE in first attempt of needle puncture between SLG and USG group

Success at first attempt of needle puncture	SLG	USG	Total	P value
No	20 (40.00%)	4 (8.00%)	24 (24.00%)	0.0003
Yes	30 (60.00%)	46 (92.00%)	76 (76.00%)	
Total	50 (100.00%)	50 (100.00%)	100 (100.00%)	

Table 2: Duration of establishing surface land mark by Spinal assessment (t1), duration of CSE placement (t2), total procedural duration(t1+t2)

1. Duration of establishing landmarks (min.) t 1	SLG	USG	
Sample size	50	50	<.0001
Mean ± St dev	0.80 ± 0.28	1.50 ± 0.42	
Min-Max	0.2-1.8	0.78-2.8	
2. Total duration t1 +t2= t(min)			
Sample size	50	50	<.0001
Mean ± St dev	3.73 ± 1.25	1.60 ± 0.45	
Min-Max	0.9-6.2	0.87-3.21	
3. Total duration t1 +t2= t(min)			
Sample size	50	50	0.022
Mean ± St dev	4.50 ± 1.30	3.2 ± 0.76	
Min-Max	1.65-7.2	1.8-5.71	

Table 3: Comparison of number of needle insertion attempts, redirection and change in vertebral space

Number of attempts needle insertion	SLG	USG	p value
Mean ± St dev	1.72 ± 1.03	1.08 ± 0.27	
Median	1	1	0.0001
Min-Max	1-4	1-2	
Number of needle redirections			
Mean ± St dev	1.26 ± 1.34	0.58 ± 0.91	0.005
Median	1	0	
Min-Max	0-4	0-3	

Table 4: Comparison of block associated pain score between USG and SLG group

Block Associated Pain Score	USG	SLG	
Sample size	50	50	0.0003
Mean ± St dev	4.56 ± 2.23	2.98 ± 1.04	
Min-Max	2-9	2-6	

rate of failed blocks in patients with obesity. Ultrasound assistance aids in visualizing anatomical structures, needle puncture attempts, trauma, complications and improves block success rate.[11]

Number of needle puncture attempts and time required to perform the procedure are factors that predict the technical difficulty in performing the CNB.[12] Since there are very limited studies on CSE (needle through needle technique) via midline approach using preprocedural ultrasonography to locate the needle puncture mark so this study was planned to assess the utility of preprocedural ultrasound scan in obese patients and patients with spinal deformity or both for performing CSE (needle through needle technique) via midline approach. All the patients of both the groups on assessment of spinal anatomy were having difficult to palpate or unable the palpate the anatomical landmark for performing CSE.

In our study successful CSE could be established in first needle puncture attempt in 92% of patients in USG group as compared to 60% in SLG group. Similar findings were reported by Ki Jin et al and Tao et al as 65% and 98.3% successful first attempt respectively.[13,14] Li et al in a group of 40 obese parturient reported the first pass success rate of spinal anaesthesia as 87.5% concluding that preprocedural ultrasound scan may facilitate spinal anaesthesia in obese parturient (> 35 kg/m BMI ≤ 43 kg/m) and improve the first attempt success rate, reduce number of needle puncture attempts/ the total procedure time, and improve patient satisfaction.[15] Also, the mean number of needle puncture attempt came out to be 1.08 in USG group and 1.72 in

SLG group. The mean redirections found in our study was 0 is USG, and 1 in SLG. This is similar to the study of Ki Jin Chin et al in 50 patients, posted for total joint arthroplasty, reported mean attempt of needle puncture as 1 and mean redirection as 0, with ultrasound facilitated spinal anaesthesia.[16] Grau T et al found median number of needle insertion of 1.5± 0.9 in ultrasound guided group as compared to a 2.6 ± 1. 4 in surface land mark guided group for epidural puncture.[17] Shaikh et al. found mean difference in needle insertion attempts between USG and SLG group to be 0.44(0.64to -0.24) and mean difference in needle direction to be 1.00(1.24to 0.75) respectively.[18] Q. Wang et al in their study found the total number of needle punctures to be less in USG as compared to the SLG group in 60 obese parturient requiring CSE.[12]

Total time taken (t) for performing procedure was less in the USG group (3.2± 0.75) as compared to SLG group (4.45± 1.30) but the time taken to establish the surface landmark was more in the USG (1.45± 0.47) as compared to the SLG (0.79 ± 0.34) group. The time required for performing CSE was less in the USG group as compared to the SLG group. Chin et al., Srinivasan et al.reported similar findings that time required to establish the landmark for needle puncture was more in ultra sound group but for spinal anaesthesia performance time required was less in ultrasound group when compared to surface landmark group, but they did not comment on total time taken for the procedure.[19] The reason for a much longer pre-procedural time could be explained by property of the adipose tissue to cause attenuation of the sonic waves and by varying phase aberration effect of USG. They concluded that preprocedural scanning may help in easy performance of spinal anaesthesia in patients with difficult anatomic landmarks.

We assessed block associated pain score in both the groups during procedure by Visual Analog Pain Score on a scale of 1 to 10 and found a mean pain score of 2.79 in USG group and 4.32 in SLG group. Similar findings were noted by Grau et al in patients with difficult anatomy of back requiring epidural puncture.This can be correlated to the lower mean needle insertion attempts/ redirections and less procedure time in the USG group.[17] In our study we found an increase in the mean heart rate in SLG group compared to USG group after 3 minutes of performing CSE although the blood pressure was comparable between two groups after 3 minutes of procedure. This could be due to more number of needle puncture attempts, longer procedure time causing sympathic stimulation, pain and discomfort to the patient in SLG group.

There are certain limitations in our study as we did not study the effect of real time ultrasonography for performing CSE, enrolled patients with BMI of maximum 35 kg/m^{2}onlyand also we did not included obstetric patients. The utility of ultrasound in these group of patients could not be assessed. Depending on the above finding of our study we conclude that preprocedural USG scanning is a reliable modality to assist in performing CSE (needle through needle technique) via midline approach in patients with difficult surface anatomy of lower back especially obesity, kyphosis, scoliosis, degenerative spinal diseases, increasing the first pass success rate, reducing the number of multiple needle puncture attempts and avoiding trauma, block associated pain and discomfort to the patient.

5. Source of Funding

None.

6. Conflict of Interest

The authors declare no conflict of interest.

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