Original Article

Correlation of preprocedural ultrasound estimated epidural depths in transverse median and posterior sagittal oblique view and body mass index with procedural epidural depths in patients scheduled for surgery under lumbar epidural anaesthesia

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ABSTRACT

Background and Aims: Preprocedural lumbar ultrasound (US) is employed for the estimation of epidural depth (ED). This study observed the correlation of preprocedural ED in transverse median (TM), parasagittal oblique (PSO) view, and body mass index (BMI) with procedural ED. **Methods:** In a prospective study, 100 female patients, aged 40–65 years, with American Society of Anesthesiologists physical status I/II, BMI 18.5–30 kg m^{-2} scheduled for surgeries under lumbar epidural blocks were included. In the TM group, preprocedural ultrasonography (USG) was performed in TM view and ED was calculated, whereas in the PSO group, the paramedian sagittal view was used and corresponding markings were done for epidural needle insertion in the midline and paramedian planes, respectively. The primary outcome was the correlation of procedural ED and preprocedural ED in TM and PSO views, respectively. The secondary outcomes included correlation of procedural ED with BMI, comparability of preprocedural, and procedural ED in TM and PSO views. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) v19.0 (International Business Machines, USA). **Results:** The preprocedural and procedural ED was less in the TM group (4.43 ± 0.75 and 4.44 ± 0.75 cm) in comparison to those in the PSO group (4.86 ± 0.53, 4.90 ± 0.54; $P = 0.001$). Strong correlation was observed in preprocedural and procedural ED [$r^2 = 0.996$ and 0.995]. The procedural ED had strong correlation with BMI [$r^2 = 0.600$, $P = 0.001$] in the TM group, and weak correlation [$r^2 = 0.367$] in the PSO group [$P = 0.01$]. The procedural ED was comparable to preprocedural ED in TM and PSO groups. **Conclusion**: Preprocedural US scanning provides an accurate estimate of actual EDs in TM and PSO view.

Key words: Analgesia, epidural, point-of-care, ultrasonography

INTRODUCTION

Preprocedural ultrasound (US) assisted epidural block is commonly utilised for landmarking of the epidural space and estimating the skin-to-epidural space depth (SED) for proper needle insertion. Preprocedural ultrasonography (USG) has been observed to have an excellent correlation with the US-measured depth from the skin to the epidural space and the actual needle depth in previous studies.[1-3] The SED can

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be determined by visualising the posterior dura/ligamentum flavum complex or the epidural space if seen between these. The transverse median (TM) plane is primarily suggested for measuring the SED. However, the paramedian sagittal oblique (PSO) approach can be used as well.[4]

Regarding the correlation of the body mass index (BMI) with epidural depth (ED), a significant correlation has been observed with ED and BMI in nonobese patients and a weak correlation in obese patients.[5]

We conducted this prospective, randomised study to correlate the preprocedural US estimated EDs and BMI in the TM and PSO plane with procedural EDs in patients scheduled for surgery under lumbar epidural anaesthesia.

METHODS

After approval by the institutional ethics committee and obtaining written informed consent, a prospective, randomised study was carried out in 100 female patients aged 40–65 years, American Society of Anesthesiologists (ASA) physical status I/II having BMI of 18.5–30 kg m^{-2} in a tertiary health care institute. The patients were scheduled for surgeries under lumbar epidural block from September 2019 to September 2020. The trial was registered with the Clinical Trials Registry, India (CTRI 2019/08/02069501). Patients refusing epidural anaesthesia, those with a history of previous spinal surgery, anticipated difficult spinal block, infection at the puncture site, coagulopathies, and any other contraindication to neuraxial block were excluded from the study. Parturients and patients with BMI >30 kg m^{-2} were also excluded. All patients were kept nil by mouth for 6 h for solid foods and 2 h for clear liquids. The patients were explained the procedure in detail in the preoperative visit. After obtaining informed consent, a computer-generated block randomisation schedule was used to allocate patients in a 1:1 ratio in TM and PSO groups.

In the operating room, intravenous access was established with an 18-G cannula and co-loading was done with normal saline [10 mL/kg]. The monitoring included non-invasive blood pressure, oxygen saturation, and five-lead electrocardiography.

In the TM group (n = 50), under all aseptic conditions and with the patients in the sitting position, preprocedural US imaging of the spine was performed using a 2–5-MHz curved array (SonoSite® MicroMaxx® US system, SonoSite INC, Bothell, WA) probe covered with a sterile sleeve. Initially, the paramedian sagittal oblique view was used to identify the specific lumbar interspaces with the procedure starting at the sacrum and moving cephalad to identify the successive laminae (L5, L4 and L3). The L3-L4 intervertebral interspace was identified and the USG probe was rotated to 90° in the transverse midline plane. The spinous process was identified as a small hyperechoic signal beneath the skin. The upper or lower intervertebral spaces were identified in an acoustic window followed by visualisation of the ligamentum flavum–dura mater complex posterior complex (PC) and posterior longitudinal ligament-vertebral body termed as anterior complex (AC). Thereafter, the image having PC and the AC as midline structures producing a hyper echoic "=" sign in the middle of the interspace was obtained [Figure 1]. The depth of the epidural space was measured using a built-in calliper from the skin to the inner surface of the PC. With the transducer in the same position, the midpoints of the upper and lower horizontal border were marked on the skin by using a skin marker. Similarly, the midpoints of both the lateral borders of the probe were marked. Thereafter, two lines were drawn joining the respective marks. The needle insertion site was the point of intersection of both the lines. In group PSO (n = 50), initially, the curvilinear array probe was positioned 2–3 cm laterally to midpoint starting at the sacrum, and the probe was moved cephalad to identify the successive laminas (L5, L4 and L3). At the L3-L4 interspace, the probe was positioned to obtain the clearest ultrasound image in the form of sawtooth appearance, and with the interspace in the middle of the screen, the

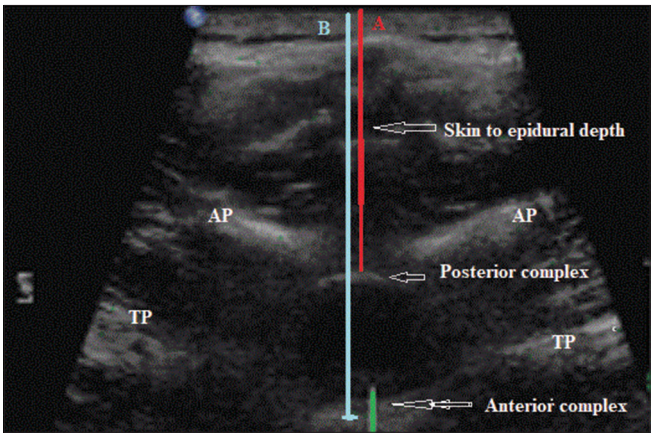

Figure 1: Preprocedural USG spine at L3-L4 interspace in TM view. TP: Transverse process, AP: Articular process

midpoint of the long and short borders of the probe was marked. The intersecting point at the midpoint of the long border of the probe with the midpoint of the line drawn between the two short borders of the probe was used as the paramedian insertion point for the epidural needle [Figure 2]. At the same level, TM view was obtained and the midline was marked as described earlier. This marking was used to guide the medial angulation of the epidural needle. After freezing the monitor, the SED with the built-in calliper of the US device was measured.

Following skin marking, clearing the gel and under all aseptic conditions, the epidural block in both groups was performed by maintaining the patient in the same position after antisepsis, placement of sterile surgical fields and local anaesthesia of the skin and deeper planes with 5 mL of 1% lidocaine. An 18-G Tuohy needle was inserted in the point and angulation determined previously. Epidural space localisation was done with conventional loss of resistance to saline by the anaesthesiologist unaware of the ED measured by USG. The needle was marked by the marker nearest to the skin to measure the depth of epidural space.

The MS Excel® and Statistical Package for the Social Sciences version 19 (SPSS Inc., Chicago, IL, USA) software packages were used for data entry and analysis. The quantitative variables were expressed as mean ± standard deviation (SD) and compared using the Student's *t* test. Categorical variables were expressed as frequency and percentage and compared using Chi-Square test. Mann–Whitney test was used to compare non-parametric variables. Correlations were analysed using Spearman's rho correlation coefficient. $P < 0.05$ was considered significant.

The sample size was based on the study by Canturk *et al*.[6] with correlation coefficient 0.992 between procedural and preprocedural EDs in the TM and PSO groups in parturients. Assuming the power of 80% at 5% significance level, the sample size came to 45 in either group. Therefore, we enroled 50 patients in each group.

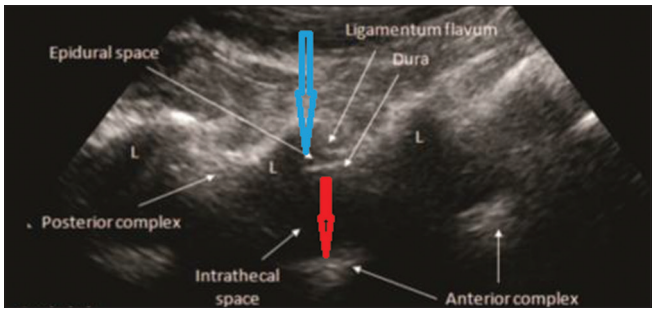

Figure 2: USG assisted sonoanatomy of L3-L4 interspace utilising PSO view depicting epidural space

RESULTS

One hundred patients were randomly divided into two groups. In the TM group (n = 50), the patients underwent preprocedural US imaging of the spine in the TM view, whereas in the PSO group (n = 50), the preprocedural USG imaging for epidural block was instituted through the PSO view as mentioned earlier.

Patients in the two groups were comparable with regard to age, BMI and ASA physical status [Table 1]. In our study, preprocedural and procedural depth of epidural space was significantly less in the TM group [4.43 ± 0.75 and 4.44 ± 0.75] in comparison to those in the PSO group (4.86 ± 0.53 and 4.90 ± 0.54; $P = 0.001$). The procedural ED was (mean ± SD = 4.90 ± 0.54) comparable to the preprocedural ED as measured by US (4.86 ± 0.53 cm) in the PSO group ($P = 0.056$). Similarly, the procedural ED in the TM group (4.44 ± 0.75) cm was comparable to the preprocedural ED (4.43 ± 0.75; $P = 0.740$) [Figure 3]. A strong positive correlation between preprocedural and procedural epidural needle depth ($r^2 = 0.996, 0.995$; $P = 0.0001$) was observed in the study [Figure 4]. In the TM group, the procedural ED had a strong correlation with the BMI ($r^2 = 0.600$, $P = 0.0001$) [Figure 5]. However, procedural ED had a weak correlation with the BMI ($r^2 = 0.367$) in the PSO group ($P = 0.01$).

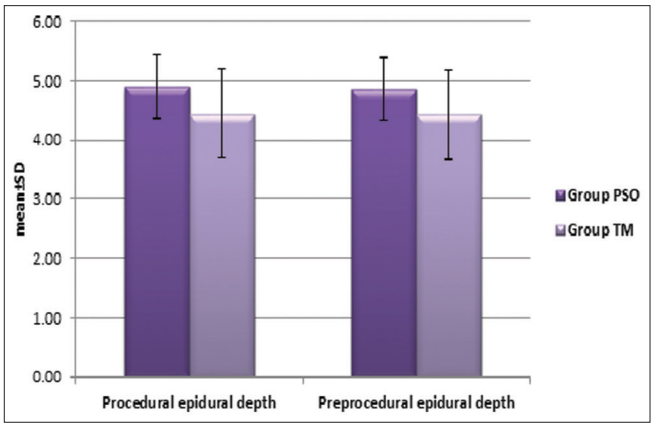

Figure 3: Graphical representation of preprocedural and procedural epidural depth in TM and PSO views [$P < 0.05$]

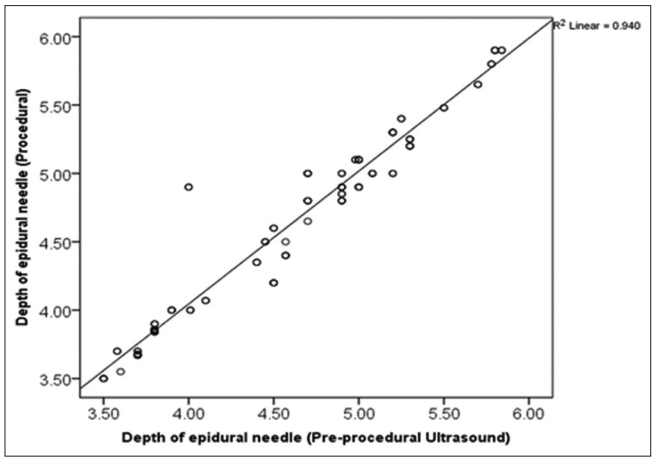

Figure 4: Scatter diagram depicting the correlation between procedural and preprocedural skin to epidural depth

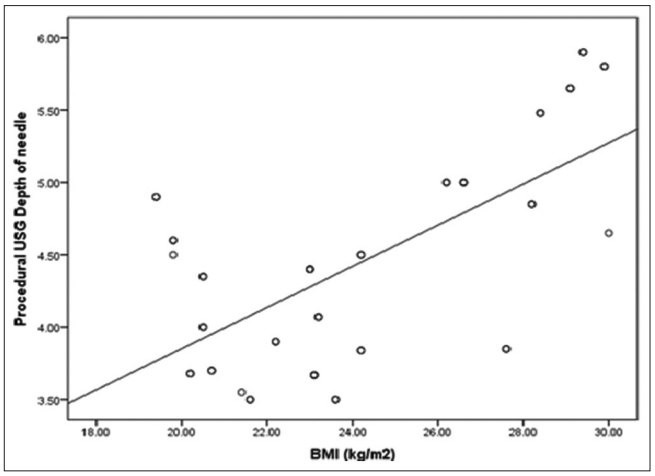

Figure 5: Scatter diagram showing correlation b/w procedural epidural depth and body mass index in transverse median [TM] view

DISCUSSION

Recently, there has been considerable interest in the use of USG for lumbosacral regional anaesthesia, and it has been advocated to be used as a preoperative assessment tool for neuraxial blockade. Pre-puncture US has been observed to increase the success rate of the first attempt, tends to reduce the attempts and improves patient satisfaction.[7-10]

The preprocedural ED (4.43 ± 0.75 vs. 4.86 ± 0.53 cm; P = 0.00) and procedural ED (4.44 ± 0.75 vs. 4.90 ± 0.54 cm; P = 0.00) were significantly less in the TM group in comparison to those in the PSO group (P = 0.001). Similarly, Karmakar *et al*.[11] observed that the procedural ED (4.16 ± 0.40 cm) and preprocedural ED (4.24 ± 0.48 cm) measured in TM plane were significantly less compared to procedural ED (5.84 ± 0.54 cm) and preprocedural ED (5.94 ± 0.71 cm) in PSO plane (P = 0.01). The comparable results were observed in the studies by Canturk *et al*.[6,12] in parturients and non-parturients, respectively.

In our study, procedural EDs are strongly correlated with preprocedural EDs with Spearman coefficient (r^2 = 0.996, P = 0.0001). Our study findings are in concordance with the study by Canturk *et al*.[12] showing a strong positive correlation between the USG measured ED and procedural needle depth. Moreover, Khemka *et al*.[13] reported that the correlation concordance coefficient (CCC) was 0.93 (95% confidence interval (95% CI: 0.81–0.97) and 0.90 (95% CI: 0.74–0.96) in PSO and TM groups, respectively. The procedural ED had a strong correlation with the BMI (r^2 = 0.600) in the TM group (P = 0.0001); however,

Table 1: Demographic profile of patients in the two groups

Parameters	Group PSO (n=50)	Group TM (n=50)
Age (years)*	55.48±6.55	55.24±6.28
BMI (kg/m²)*	26.0±2.15	24.14±3.41
ASA physical status†		
Grade 1	23	22
Grade 2	27	28

Data expressed as *mean±SD and †number as appropriate. BMI: Body Mass Index, ASA: American Society of Anesthesiologists

the PSO group had a weak correlation (r^2 = 0.367, P = 0.01). In another study, the authors observed a positive and weak correlation (r^2 = 0.27) between procedural ED and BMI (P = 0.008) in patients scheduled for thoracic epidural analgesia in upper abdominal surgeries. The preferential distribution of subcutaneous fat accounted for most of the variation in the distance to the epidural space from the skin.[14]

Furthermore, the preprocedural EDs as measured by USG were comparable to the procedural ED in the PSO and TM groups (P > 0.05) respectively. Similarly, in the study by Chauhan *et al*.[15] the preprocedural ED by US (3.96 ± 0.44 cm) was comparable to the procedural ED (4.04 ± 0.52 cm; P = 0.250) in TM plane.

The limitations of this study include the exclusion of patients with BMI more than 30 kg m^{-2}, those with anticipated difficult epidural placements and parturients. We also did not include patients belonging to the geriatric age group.

CONCLUSION

Point of care preprocedural USG is beneficial in assessing EDs in the TM and PSO planes by virtue of

strong correlation and comparability with procedural needle depth. Moreover, a strong correlation of procedural needle depth with BMI is observed in the TM plane. Therefore, in patients with a higher BMI, the PSO plane seems to be a rational approach for assessing preprocedural ED, as the probability of subcutaneous fat compression by the US probe can be minimised. However, further studies are essential to validate the finding and to add more knowledge in this regard.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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