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RESEARCH ARTICLE

PRE-PROCEDURAL ULTRASOUND ASSISTED LANDMARK IDENTIFICATION FOR EPIDURAL CATHETERIZATION: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Placement of thoracic epidural is technically challenging and demands precise anatomical knowledge. This study used pre-procedural ultrasound for thoracic epidural catheter placement in high BMI patients undergoing oncosurgeries. Accuracy of ultrasound assisted method and palpation method in locating and measuring thoracic epidural space depth is studied. Additionally, the study seeks optimal needle insertion point to minimize the attempts. **Methods:** A prospective observational study included ASA I and II patients aged > 18, with BMI >/=25, scheduled for elective oncosurgeries with thoracic epidural for pain relief. Forty eligible patients who had thoracic epidural placement were observed and studied. The time for skin markings, loss of resistance, and number of attempts, needle skin puncture, and needle redirection were recorded and analysed. **Results:** Age and BMI were comparable between two groups. Mean time for epidural needle placement to achieve loss of resistance in group A (159.300sec) and group B(379.150sec) respectively (P = 0.015). Ultrasound assisted skin marking took 92.550 sec for A and 39.950 sec for B (P = 0.379). Number of attempts for group A was 1.650 and B was 1.900(P = 0.293). Ultrasound assistance for skin marking, depth of epidural space, number of attempt, needle skin puncture and needle redirection were comparable. **Conclusion:** Pre-procedural ultrasound markedly reduced time for loss of resistance. However, factors like time for skin marking, number of attempts, depth of epidural space, needle skin puncture and redirection not significantly different compared to palpation.

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INTRODUCTION

Thoracic epidural analgesia is widely used for postoperative pain relief in thoracic and abdominal surgeries, but palpation for placement can be challenging, especially in obese patients (1,2). Neuraxial ultrasound offering a more feasible and effective approach. The efficacy of ultrasound in neuraxial procedures has been limited by the effectiveness of conventional techniques and challenges in adult spine ultrasonography. However enhances safety and efficacy by ensuring accurate depth measurement and epidural space localization, visualize structures for precise needle passage (3,4,5). Our study aimed to find out whether ultrasound guidance decreases attempts and time in placing thoracic epidural catheter , minimizing patient discomfort for BMI >/= 25 patients undergoing oncosurgeries.

METHODS

After approval of the institutional review board and Ethical committee clearance, this prospective observational study was conducted at Regional Cancer Centre, Thiruvananthapuram between September 2020 and September 2021. Written informed consent was obtained from all patients for participating in the study. Patients undergoing gastrointestinal and uro-gynecological oncosurgeries with thoracic epidural catheterization were studied.

The inclusion criteria were patients aged above 18 years, ASA I & II, BMI ≥25 of both genders, scheduled for elective thoracic and abdominal surgery. The patients with severe scoliosis, previous spine injury in thoracic region, pregnancy, coagulopathy, infection, local anesthetics allergies were excluded from the study. Forty eligible patients who fulfilled the inclusion criteria were recruited in to the study. Epidural anesthesia was performed under sterile precautions with continuous monitoring of noninvasive blood pressure, pulse oximetry and ECG during the procedure. Supplemental oxygen and sedation were provided, and emergency airway equipments and resuscitation drugs also kept available. Patient were positioned in lateral decubitus and prepared for the procedure. Ultrasound guided marking of thoracic spine on skin was performed using an ESAOTE portable ultrasound machine with a curvilinear probe (1-8MHz). Both longitudinal, paramedian sagittal oblique, and transverse scan were done. Once optimal images of the interspace structures are obtained, the transducer was stabilized and skin markings made were made at midpoint of cephalad and caudad aspect and at midpoints of the right and left aspect of transducer, then transducer removed and lines drawn to connect these marks. Intersection of these two lines were the puncture point. Depth to the ligamentum flavum from the skin measured using inbuilt caliper of USG machine. For patients undergoing palpation technique, skin marking was performed by palpation alone. Using index finger and middle finger side by side we palpated spinous processes by sliding up and down the midline.

All epidurals were performed using 18 gauge Touhy needle and 20 gauge catheter. Using loss of resistance technique epidural catheter placed by attending anaesthesiologist or a senior resident with at least two year experience in epidural placement. The Touhy needle was inserted perpendicular to skin at the desired interspace and needle advanced till loss of resistance was acheived. During the procedure time taken to make the skin markings with both procedures, time to loss of resistance, number of attempts, needle skin puncture were documented. Time to loss of resistance denoted the period from the initial Tuohy needle insertion to final loss of resistance. The number of attempts to place the needle into epidural space, needle tip movement towards midline and cephalad were considered as a single pass. Additional passes were counted if the needle returned to plane parallel to skin after withdrawal. Needle skin punctures were documented as complete needle withdrawals from skin followed by re-insertion at new location.

STATISTICAL ANALYSIS

The variables were summarized using appropriate descriptive statistics: mean, standard deviation, median, interquartile range, frequency and percentages. The association between two categorical variables assessed using Chi-Square / Fisher's exact Test. The significant difference between two groups for continuous variable was tested using independent sample t-test (Normally distributed variables) or Mann-Whitney U test (Non Normal variables). A p-value < 0.05 was considered to be significant.

RESULTS

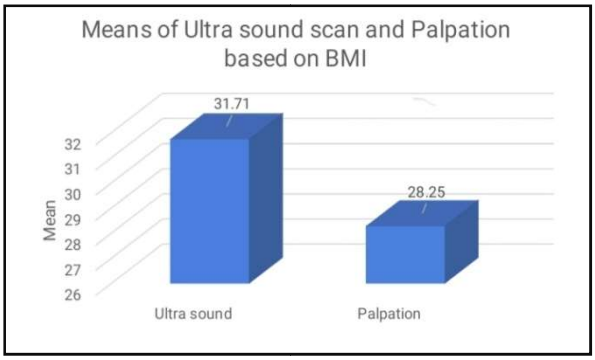
Forty patients (20 in each group) undergoing elective onco-surgeries for colorectal and uro-gynecological cancer (i.e large intestine, kidney, bladder, uterus, ovarian cancer) over a period of one year were included in the study. Data were entered for statistical analysis in Microsoft Excel and Statistical Packages for Social Sciences (SPSS; Windows ver. 17.0, SPSS Inc., Chicago, IL). For quantitative data mean and standard deviation were calculated. Qualitative data were described by frequency distribution. To compare between two groups, qualitative variables were assessed and analysed by Chi Square test, Mann-Whitney U test and quantitative variables by student's t test. When p-value of <0.05 is acquired, results were regarded statistically important. NS: Not Significant (P>0.05)

*: Significant at 5% (P<0.05)
**: Significant at 1% (P<0.01)

Observations were recorded both graphically and numerically. Mean age in group A and group B are 59.15 and 51.30 (p= 0.038). Mean BMI of group A was 31.710 and group B was 28.250 (P=0.005),(Table 1,graph 1). The age and BMI between the two groups were not comparable. Study group comprised of 1 (2.5%) male and 39 (97.5%) females, making M:F ratio of 1:39 which was not comparable. 95% of patients in group A and all patients in group B had comorbidities in the present study, which was comparable. In this study 52.5% of the participants underwent gynecological surgeries, 15.0% underwent genitourinary surgeries and 32.5% underwent GIT surgeries. Time for skin marking in group A and group B were 92.550sec and 39.950 (P = 0.379) which is not considered statistically significant. The mean time of LOR in group A and group B was found out as 159.300 and 379.150 respectively which is statistically significant (P = 0.015). The mean difference in the depth of epidural space in group A was 4.275 and group B was 4,550 (p=0.316) which was not statistically significant. The number of attempts for group A was 1.650 and for group B was 1.900(P = 0.293) which was not statistically significant. In this study redirection was needed in 55.0% of patients in group A but not in 45.0%, while redirection was done in 80 percent of patients in group B and is absent in 20 percent of patients.

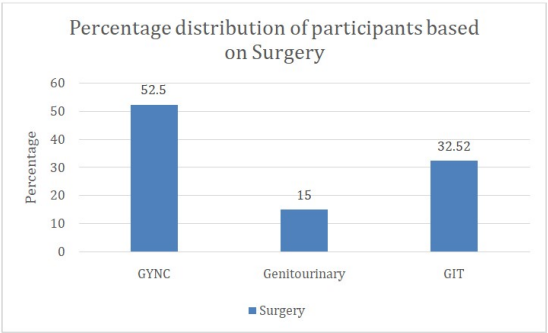
Table 1. Comparison of sample based on Body Mass Index (BMI)

	Group	Mean	Std. Deviation	P-value
BMI	A	31.710	4.618	0.005**
	B	28.250	3.018	



Graph 1. Comparison of Means of group A and group B based on BMI

From the above table, 60.0 percent of patients in group A had gynaecological surgery, 15.0 percent had genitourinary surgery, and 25.0 percent had GIT surgery. However, patients in group B- 45.0% had gynaecological surgery, 15.0% had genitourinary surgery, and 40.0%underwent GI surgery.



Graph 2. Diagrammatic representation of percentage distribution of participants based on Surgery

Table 2. Frequency and Percentage distribution of group A and group B based on Surgery

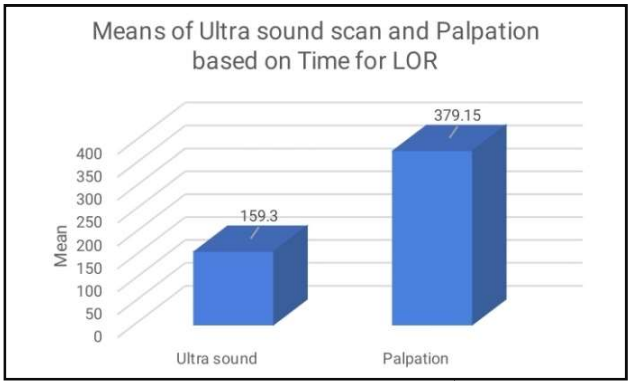
		SURGERY			Total
		Gynaecological Surgery	Genitourinary surgery	GIT surgery	
GROUP A- US/ B -PALPATION	US	12(60.0%)	3(15.0%)	5(25.0%)	20(100%)
	Palpation	9(45.0%)	3(15.0%)	8(40.0%)	20(100%)
Total		21(52.5%)	6(15%)	13(32.5%)	40(100%)

From the above table, group A had a mean timing of 92.550 seconds and mean time for group B (palpation) was 39.950 seconds.But the mean difference in the time for skin marking between patients who underwent an ultrasound and those who underwent a palpation method was not statistically significant. From the above table, the Mann-Whitney U test shows a statistically significant (P<0.05) difference between the mean of patients who received palpation and ultrasonography based on the time for LOR.

Table 3: Mann-Whitney U test of group A and group B based on Time for skin marking

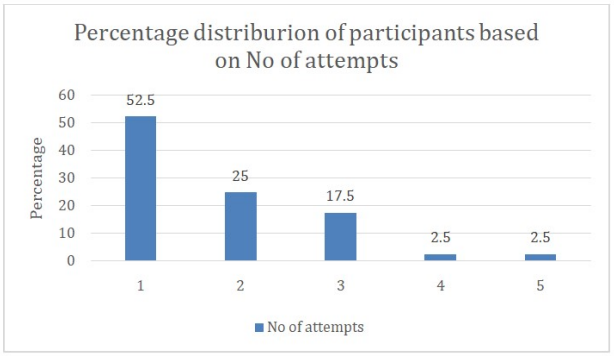
	Group	Mean	Std. Deviation	P-value
TIME FOR SKIN MARKING(SEC)	A	92.550	162.742	0.379NS
	B	39.950	31.401	

NS: Not significant



Graph 3. Diagrammatic representation of Means of group A and group B based on Time for LOR

From the above table, Mann-Whitney U test shows that patients' means for group A and group B based on the depth of epidural space are 4.275 and 4.550 respectively (P > 0.05). In other words, the mean difference in the depth of epidural space between group A and group B was not statistically significant.



Graph 4. Diagrammatic representation of percentage distribution of participants based on No. of attempts

Table 4 Mann-Whitney U test of group A and group B based on Time for LOR

	Group	Mean	Std. Deviation	P-value
TIME FOR LOR	A	159.300	285.208	0.015*
	B	379.150	605.952	

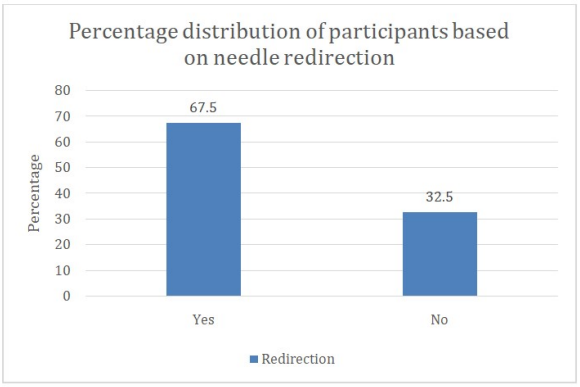
**: Significant (<0.05)

From the above table, Mann-Whitney U test shows that patients' means for group A and group B based on number of attempts are 1.650 and 1.900 respectively (P > 0.05). In other words, the mean difference in the number of attempts between group A and group B was not statistically significant. The Chi-square test for independence showed that, there is no statistically significant (P>0.05)association between the variables. From the above table, Redirection is present in 55.0% of patients in group A but not in 45.0%. While redirection is present in 80 percent of patients in group B and is absent in 20 percent of patients. From the above table, Mann-Whitney U test shows that group A and group B based on the needle skin puncture are equal (P > 0.05). In other words, the mean difference for needle skin puncture between groups A and group B was not statistically significant.

Table 5. Mann-Whitney U test of group A and group B based on Depth of Epidural Space

	Group	Mean	Std. Deviation	P-value
DEPTH OF EPIDURAL SPACE	A	4.275	0.752	0.316NS
	B	4.550	0.872	

NS: Not significant



Graph 5. Diagrammatic representation of percentage distribution of participants based on redirection

Table 6. Mann-Whitney U test of group A and group B based on Number of Attempts

	Group	Mean	Std. Deviation	P-value
NO OF ATTEMPTS	A	1.650	1.039	0.293NS
	B	1.900	0.967	

NS: Not significant

Table 7. Frequency and Percentage distribution of group A and group B based on needle redirection

		REDIRECTION		Total	P value
		Yes	No		
GROUP A- US/ B - PALPATION	US	11(55.0%)	9(45.0%)	20(100%)	0.091NS
	Palpation	16(80.0%)	4(20.0%)	20(100%)	
Total		27(67.5%)	13(32.5%)	40(100%)	

NS: Not significant

Table 8. Mann-Whitney U test of Ultrasound and Palpation based on Needle skin puncture

	Group	Mean	Std. Deviation	P-value
NEEDLE SKIN PUNCTURE	A	1.85	0.366	0.262NS
	B	1.70	0.470	

DISCUSSION

This study focused on patients with BMI ≥ 25 undergoing onco-surgeries for colorectal and uro-gynecological cancers, specifically in the large intestine, kidney, bladder, uterus, and ovary. We aimed to evaluate the efficacy of pre-procedural ultrasound assisted landmark identification for thoracic epidural catheter placement in the lower thoracic space. The study found that the use of ultrasound resulted in a shorter time duration to achieve loss of resistance (P = 0.015). However, factors like time for skin marking, depth of the epidural space, number of attempts, number of needle skin punctures, and needle redirection were comparable in both groups. Age and BMI showed differences between the groups, possibly due to outlier values affecting the statistical significance. Patients with lower BMI in one group may have contributed to easier landmark identification through the palpatory method. Clear spinal anatomy visualization in the ultrasound group presented an advantage, particularly in patients with BMI ≥ 25 at the thoracic level. Evidence supporting the role of ultrasound in neuraxial anesthesia performance is growing, especially in both lumbar and thoracic spine levels. Poor surface anatomical landmarks are predictive of technical difficulties in neuraxialblockade (6). A study similar to our study conducted by Auyong et al found significant differences in needle skin punctures and postoperative pain scores. However, it did not significantly reduce the time required for thoracic epidural space identification via loss of resistance. Our study demonstrated a reduction in the time for loss of resistance, potentially due to ultrasound visual impact on the exact depth of the epidural space and needle angulation. Previous evidence suggested that

ultrasound accurately measures epidural space depth before the procedure. Additionally, ultrasound has shown benefits in reducing needle attempts and increasing first-pass success rates. Ultrasound guidance is particularly valuable in patients with difficult surface anatomical landmarks, although it may have limitations in obese patients due to tissue attenuation and phase aberration effects. Study by Ki Jinn Chin et al demonstrated that ultrasound-guided spinal anesthesia significantly increased the success rate of dural puncture on the first needle insertion attempt compared to the landmark group. This was particularly beneficial for patients with difficult surface anatomical landmarks (7).

In Issam Khayata et al study showed a good correlation between ultrasound-estimated epidural depth and the actual depth as detected by the loss of resistance technique, indicating that ultrasound can accurately measure epidural space depth before the procedure (8). Grau et al study reported an increased first pass success rate while performing epidural anesthesia in cases with difficult surface anatomy, suggesting that ultrasound guidance can improve procedural outcomes (9). Salman et al study revealed a positive correlation between pre procedural ultrasound-estimated epidural depth and the actual measured needle distance in the thoracic region, though the clinical impact of this correlation remains uncertain. These studies collectively demonstrate the effectiveness of ultrasound guidance in improving the accuracy and success of various epidural procedures, especially in challenging cases (10).

The limitations of our study include

- As we are using palpation technique regularly for epidural catheterization, most anesthesiologist are not used with USG technique which might have affected the outcome. Neuraxial scanning is an advanced level of scanning and requires an advanced level of expertise on the part of the user. Once the technique becomes more widely used by anaesthesiologists the advantages should be analysed with studies.
- The preprocedural marks made with ultrasound guidance are liable to change especially in obese patients as in our study because of the loose adipose tissue over the thoracolumbar area.
- The actual needle trajectory from to the epidural space through the interspinous and interlaminar gaps would have been more precisely visualized if it was done as a real time procedure.
- Angle of insertion of needle was not determined or measured
- In obese patient, probe pressure will cause significant skin tissues elasticity which will lead to in correct identification of landmarks. Obesity and edema frequently obscure anatomic landmark and resulted in technical difficulties.

CONCLUSION

It was found that preprocedural ultrasound assisted landmark identification for lower thoracic epidural catheter placement {T9-T12} in patients with BMI >/=25 undergoing oncosurgeries for colorectal and urogynecological reduced the time to obtain loss of resistance, while time for skin marking , number of attempts , needle redirections, depth of epidural space as compared to the palpation technique were of not significant advantage.

US guidance appears to be a feasible option for facilitating thoracic epidural insertion in obese patients. Whether or not this technique improves the procedural success and quality compared with landmark-based techniques will require additional study. The acquisition and maintenance of competency in neuraxial ultrasound requires practice. Therefore anaesthetists should incorporate neuraxial ultrasound into their clinical practice whenever possible until they attain the desired level of comfort with the ultrasound-assisted approach to central neuraxial block(4).

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