

Evaluating The Vertebral Structure Using Ultrasound Examination At Manually Identified Midpoint Of Intracristal Line In Pregnant Women

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Cite this paper as: Dr. Mohd Faheem Ansari, Dr. Akshat Agarwal, Dr. Edamakanti Swetha Soni, Dr. Razi Shahid, Dr. M Srinivas Rao, (2025) Evaluating The Vertebral Structure Using Ultrasound Examination At Manually Identified Midpoint Of Intracristal Line In Pregnant Women. *Journal of Neonatal Surgery*, 14 (15s), 1-7.

ABSTRACT

Introduction: In order to deliver subarachnoid blocks, the intercrystal line and associated vertebral level have historically been found by manual palpation. However, an alternate method for precise vertebral identification is ultrasound examination.

Aim and Objective: To study the vertebral structure using ultrasound examination at manually identified midpoint of intracristal line in pregnant women.

Material and Methods: This was a cross-sectional study conducted in the Department of Surgery with collaboration with Department of Anesthesia. It involved 200 pregnant women at term. Two independent observers estimated the vertebral space at the intercrystal line– one using manual palpation and the other using ultrasound guidance. Determining the vertebral structure utilising ultrasound examination at the manually designated midway of the intercrystal line in term pregnant women was the main outcome evaluated. Assessing the accuracy of manual palpation in identifying vertebral levels in comparison to ultrasound examination and analysing variables like Body Mass Index (BMI) that may affect the accuracy of vertebral level identification were the secondary outcomes evaluated.

Results: The study included 200 pregnant women with a mean age was 22.81 ± 3.75 years in the study population. The mean gestational age (weeks) was 38.95 ± 1.15 in the study population. The minimum gestational age was 37 weeks, and the maximum was 41 weeks. The mean pre-pregnant weight (kg) was 52.85 ± 9.50 in the study population. The ultrasonographic assessment revealed that the manually palpated intercrystal line corresponded to the L4 vertebra level in 50% of cases, the L3-L4 intervertebral space level in 30%, the intended L4-L5 intervertebral space level in 15%, the L5 vertebra level in 3%, and the L3 vertebra level in 2%. ultrasound examination showed that the manually palpated intercrystal line was higher than the L4 vertebra or L4-L5 intervertebral space in 32% of the pregnant women.

Conclusion: According to the study, ultrasound examination, as opposed to manual palpation, may provide a more accurate way to identify spinal structures in pregnant women at term.

Keywords: Palpation, Pregnancy, Spinal anaesthesia, Ultrasonogram

1. INTRODUCTION

For caesarean deliveries, territorial anaesthesia techniques like spinal or epidural anaesthesia are frequently used and provide amazing pain relief while working [1]. For conclusion or mediation, medical professionals use anatomical points of interest to identify the spine [2]. In order to ensure compelling postoperative pain relief with minimal adverse effects, anaesthesiologists need the proper positioning of epidural/spinal catheters for anaesthesia [3].

Spinal anesthesia remains a recognized and acceptable technique as an alternative to general anesthesia for sub-umbilical and lower extremity surgical procedures in infants. Although initially used to avoid the adverse physiologic effects of general anesthesia in patients with comorbid conditions or to avoid apnea following halothane anesthesia, there has been a renewed interest in its use given the potential long-term neurocognitive impact of general anesthetic agents in this population.

The intercrystal line is thought to be higher during pregnancy due to the enhanced lumbar lordosis, however it is known to most commonly cross the L4-5 interspace or the L4 spinous process. It has been demonstrated that using the intercrystal line for clinical vertebral level measurement. Awake spinal anesthesia continues as an alternative to general anesthesia for infants. Standard clinical practice includes the manual palpation of surface landmarks to identify the desired intervertebral space for lumbar puncture (LP) measurement is frequently inaccurate.

The nonexistent line that runs on a level plane between the back iliac peak is known as Tuffier's line, Jacoby's line, or the intercrystal line. It is used as an anatomical point of interest to determine vertebral levels in order to control neuraxial anaesthesia. Complications will arise if the vertebral levels are misidentified [4,5].

Cephalad development of the spinal analgesic sedate is too an critical complication if there is any alter in the distinguishing proof of the spinal levels. The most common strategy to decide the spinal level is by clinically palpating of iliac peaks, a strategy that has regularly been related with mistakes [6]. This seem be due to deviation of the vertebral life structures in the affiliation between the intercrestal line and Tuffier's line [7]. Tuffier's line, which crosses the spine at the level of the L4 or the L4-L5 interspace, is defined as the transverse line that faces the predominant angles of the iliac peaks on an X-ray. According to the writing, there is a substantial inaccuracy or variance about the crossing point level [8].

The varieties in precisely distinguishing the spinal level by palpating the iliac peaks may be due to anatomical contrasts affected by components like sexual orientation, stature, and BMI [9]. To account for these inconstancy presented by palpation, ultrasound imaging has been utilized to move forward exactness in finding anatomical points of interest for neuraxial anesthesia [10,11]. Particularly in pregnancy, ultrasound estimation is much more viable as variables like hyperlordosis, dynamic pelvic turn over the long pivot of the spinal column, and maternal weight pick up would meddled the estimation of spinal levels by palpation [12]. These variables moreover have a higher probability of incorrectly deciding the cephalic relationship to the vertebral column. The show think about pointed to decide the vertebral structure utilizing ultrasound examination at the physically stamped midpoint of the intercrystal line in pregnant ladies at term. This ponder was embraced as there were not numerous ponders done in the south Indian populace, whose body habitus shift significantly when compared with other populace bunches.

Ultrasound imaging has been used to increase the accuracy of identifying anatomical landmarks for neuraxial anaesthesia in order to account for the variability introduced by palpation [10,11]. Ultrasound assessment is particularly more accurate during pregnancy because palpation-based spinal level estimation would be hampered by conditions such hyperlordosis, increasing pelvic rotation over the long axis of the spinal column, and maternal weight growth [12,13].

The cephalic connection to the spinal column is likewise more likely to be incorrectly determined by these circumstances.

Thus, the current investigation was conducted to examine the vertebral structure in pregnant women utilising ultrasound examination at the manually determined midpoint of the intracristal line.

2. MATERIALS AND METHODS

This was a cross-sectional study conducted in the Department of Surgery with collaboration with Department of Anesthesia at a tertiary care centre for a period of 12 months i.e, January 2024 to January 2025. The Informed written consent was obtained before the study started, and confidentiality was maintained throughout.

Inclusion criteria: Term pregnant women over 20 years, classified as American Society of Anaesthesiologists (ASA) Physical Status Risk I or II were included in the study.

Exclusion criteria: Term pregnant women who were unable to maintain the required position or had a spinal deformity were excluded from the study.

Sample size calculation: from patients with pregnancy

SAMPLE SIZE :- $SS(n) = \frac{4PQ}{L^2}$ [14]

Where,

P=Prevalence,

Q= 100-p,

L= Allowable error,

If the allowable error is 5%

$$SS(n) = 56 \times 86 / 5^2$$

$$\text{Sample Size } (n) = 4816 / 25 = 192$$

So, in order to coverup the lost- to-follow-up, drop-out rate and non-response rate the sample size taken in our research study was 200.

Study Procedure

Two independent, mutually blinded observers made the study's observations while the patient was seated, with the foot comfortably resting on a footrest and the neck, hip, and back flexed. An average of five years of experience was possessed by the observer who carried out manual palpation. In contrast, the individual who conducted an ultrasound-guided estimation had received two weeks of instruction in the interpretation of spinal ultrasonography.

The first observer marked the middle of the intercrystal line and performed manual palpation. At the manually designated midway of the intercrystal line, the second observer conducted the ultrasonic scan and determined the vertebral level. In addition to these results, each study participant's height, weight, and pre-pregnancy BMI were noted.

Outcome studied: Determining the vertebral structure utilising ultrasound examination at the manually designated midway of the intercrystal line in term pregnant women was the main outcome evaluated. Assessing the accuracy of manual palpation in identifying vertebral levels in comparison to ultrasound examination and evaluating variables like body mass index (BMI) that may affect the accuracy of vertebral level identification were the secondary outcomes evaluated.

3. STATISTICAL ANALYSIS

The data was collected and analysis was done in Msexcel. Descriptive analysis was performed using frequency and proportion for categorical variables. Continuous variables were presented as mean±SD. One-way ANOVA was utilised to compare the mean±SD of continuous variables among more than two groups.

4. RESULTS

A total of 200 subjects were included in the final analysis. The mean age was 22.81±3.75 years in the study population. The mean gestational age (weeks) was 38.95±1.15 in the study population. The minimum gestational age was 37 weeks, and the maximum was 41 weeks. The mean pre-pregnant weight (kg) was 52.85±9.50 in the study population. The minimum pre-pregnant weight was 33 kg, and the maximum was 76 kg [Table 1].

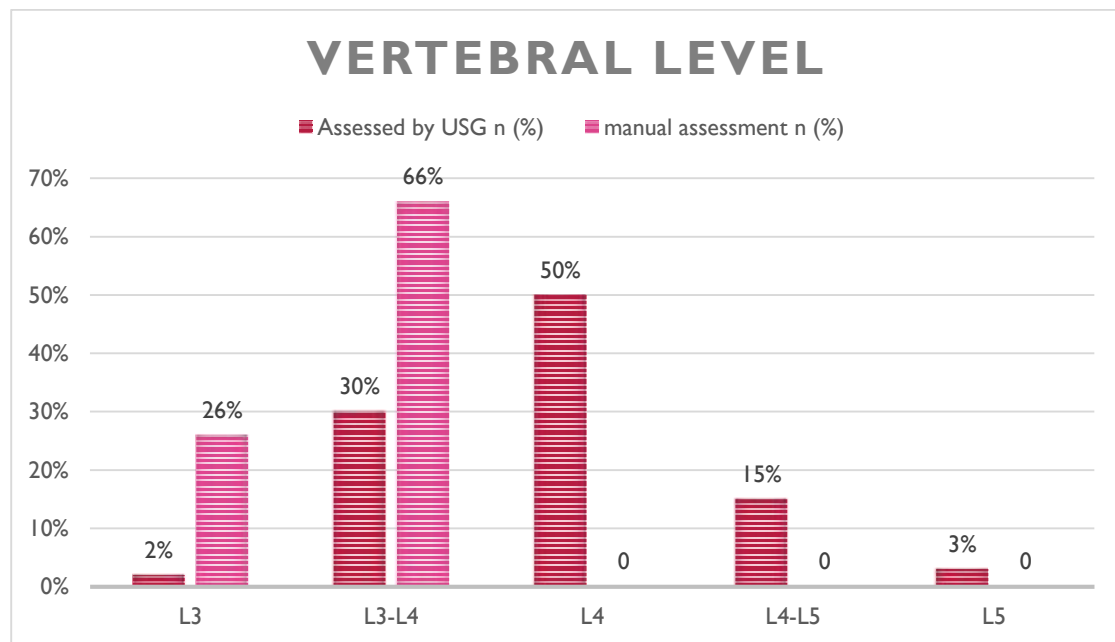
Demographic parameters	Summary
Age (years)	22.81±3.75
Height (cm)	155.22±5.17
Weight (kg)	61.57±10.09
BMI (kg/m2)	25.86±3.98
Maternal parameters	
Gestational age (weeks)	38.95±1.15
Prepregnant weight (kg)	52.85±9.50

Table 1: demographic parameters in the study population (n=200)

Ultrasound examination revealed that the manually palpated midpoint of the intercrystal line corresponded to the L4 vertebra level in 50% of patients, the L3-L4 intervertebral space level in 30%, the L4 L5 intervertebral space level in 15%, the L5 vertebra level in 3%, and the L3 vertebra level in 2% of patients. The manually drawn intercrystal line was above the level of the L4 vertebra or the L4-L5 intervertebral space in 32% of patients. However, manual palpation assessment showed disagreement with the ultrasound findings, with the intercrystal line being identified at the L3 vertebra level in 26% of patients and the L3-L4 intervertebral space level in 66% of patients [table 2].

Vertebral level	Assessed by USG n (%)	Manual assessment n (%)
L3	4(2%)	52 (26%)
L3-L4	60(30%)	132 (66%)
L4	100 (50%)	16 (8%)
L4-L5	30(15%)	-
L5	6(3%)	-

Table 2: Vertebral levels at the Intercristal line as assessed by USG (N=200). L1, L2,L3,L4,L5- Vertebral levels.



The mean difference in BMI (kg/m²) across different vertebral levels was statistically not significant (p-value=0.3771)

Parameter	vertebral level					p-value (AnOvA)
	L3 (n=4)	L3-L4 (n=60)	L4 (n=100)	L4-L5 (n=30)	L5 (n=6)	
	mean±SD	mean±SD	mean±SD	mean±SD	mean±SD	
BMI (kg/m ²)	31.61±9.63	25.67±3.65	25.67±3.65	25.73±2.90	25.67±1.62	0.37

[Table 3]: Comparison of BMI (kg/m²) with vertebral levels assessed by USG. L1, L2, L3, L4, L5- Vertebral levels.

5. DISCUSSION

Traditionally, CNBs are performed using a combination of surface anatomical landmarks, the operator's perception of tactile sensation (loss of resistance) during needle advancement, and/or visualizing the free flow of cerebrospinal fluid. Although the spinous processes are relatively reliable surface anatomical landmarks in many patients, they are not always easily recognizable in patients with obesity, edema, underlying spinal deformity, or previous back surgery. Tuffier's line, which connects the highest points of the iliac crests, is another surface anatomical landmark that is widely used to estimate the location of the L3–L4 interspace; however, the correlation is inconsistent.

The clinical estimation of vertebral levels through manual palpation of anatomical landmarks is often inaccurate when compared to advanced imaging modalities such as Magnetic Resonance Imaging (MRI), radiography, and ultrasound examination [15,16]. These imaging techniques provide direct visualisation of the vertebral structures and can reveal discrepancies between the clinically palpated level and the actual vertebral anatomy [17].

A comparative study conducted by Kim SH et al., investigated the position of the intercrestal line in pregnant versus non pregnant women when placed in the lateral decubitus position. Their anatomical milestones is frequently inaccurate when compared to advanced imaging modalities similar as glamorous Resonance Imaging(MRI), radiography, and ultrasound examination. These imaging ways give direct visualisation of the vertebral structures and can reveal disagreement between the clinically palpated position and the factual vertebral deconstruction. A relative study conducted by Kim SH et al., delved the position of the intercrestal line in pregnant versus non pregnant women when placed in the side decubitus position. Their findings revealed that the intercrestal line covered at a advanced vertebral position in pregnant individualities compared to their non pregnant counterparts. Specifically, the non pregnant group displayed a mean intrcrestal position corresponding to the L4 backbone (6.4 ± 0.9 vertebral situations), whereas pregnant women demonstrated a lower mean position around L3 (3.0 ± 1.0 vertebral situations). This difference between the two cohorts was statistically significant(p -value<0.05), indicating that pregnancy status substantially influences the anatomical landmark of the intercrestal line relative to the vertebral column when patients are positioned laterally [18].

Another study with ultrasound in non pregnant patients reported that the level of the intercrystal line palpated clinically corresponded to the L3-L4 level in 73% of cases as evaluated by USG [11]. A study conducted by Whitty R et al., reported that the vertebral level identified clinically was at least one interspace higher than the level located by ultrasound in 32% of the patients [19]. Present study showed similar results with the manually drawn intercrystal line being above the level of the L4 vertebra or L4-5 intervertebral space in 32% of patients. Shiraishi N and Matsumura G conducted a radiograph study of non pregnant females in the sitting position with flexion of the spine and found none with an intercrystal line level above L4. This difference was due to increased lumbar lordosis in pregnancy and also difficulty in flexion of the spine during pregnancy [20]. The projection of the intercrystal line is directly related to pelvic lordosis [21].

In individuals presenting with severe oedema and obesity, palpation techniques may be hindered, potentially leading to inaccuracies in clinical assessment. Present study also found that BMI was not significantly associated with the disparity between the vertebral levels determined by ultrasound examination. The mean difference in BMI (kg/m²) in vertebral level was statistically not significant in the current study, which was consistent with a study by Lee AJ et al., [13]. Malik M and Ismail S showed that obesity with or without pregnancy was found to be a significant factor in which the palpatory method was found to be an inaccurate estimate for the L4-L5 vertebral interspace [22].

There was another study which was in support to the current study where Allison J. Lee et al., stated that the clinical estimates of the spinal level of the intercrystal line agreed with the ultrasound measurement 14% of the time (14 of 101; 95% confidence interval [CI]: 8%, 22%). The clinical estimates were 1 level higher than the ultrasound measurement 23% of the time (23 of 101; 95% CI: 16%, 32%) and !1 level higher 25% of the time (25 of 101; 1-tailed 95% CI: !18%). The distribution of the clinical estimates found clinicians locating the intercrystal line at L3 or L3-4 54% of the time (54 of 101; 95% CI: 44%, 63%) and at L2-3 or higher 27% of the time (27 of 101; 1-tailed 95% CI: !20%) [23].

Another study found that the actual intervertebral spaces that were marked as determined by ultrasonography were L4-5 in twenty-one patients (42%), L3-4 in twenty-four patients (48%) and L2-3 in five patients (10%) infants [24].

Study by Kim SH et al., demonstrated that based on MRI, the tip of the conus medullaris is positioned between the T12 body and female L2 body, and Tuffier's line was between L3-L4 and L5-S1 in female patients. While MRI may offer superior accuracy, ultrasound guidance still presents a practical, real-time, and comparatively cost-effective alternative to manual palpation for precisely identifying the intended intervertebral space in pregnant women at term [18].

Ultrasound examination of the vertebral structure offers several benefits, including real-time visualization, radiation-free imaging, and the ability to identify anatomical landmarks and assess soft tissues, aiding in procedures like spinal anesthesia and surgery.

In order to increase accuracy and safety during epidural implantation, this study emphasises the differences between manual palpation and ultrasound guidance in defining the L4 L5 intervertebral space. Ultrasound is still a useful technique for real-time vertebral level identification, reducing the hazards associated with incorrect epidural needle placement in the obstetric

population, even though more sophisticated imaging modalities like MRI may offer even more precision [24].

6. CONCLUSION

Incorrect estimation of the vertebral level carries the risk of neural damage. To ensure patient safety, routine use of preprocedure USG is recommended in pregnant women to assess the vertebral level before a subarachnoid block.

DECLARATIONS:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: There is consent to participate.

Consent for publication: There is consent for the publication of this paper.

Authors' contributions: Author equally contributed the work.

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