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Original Research Article

ULTRASOUND ASSISTED TECHNOLOGY VERSUS THE CONVENTIONAL LANDMARK LOCATION TECHNIQUE IN SPINAL ANAESTHESIA FOR CAESAREAN DELIVERY IN OBESE PARTURIENTS

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ABSTRACT

Background: Aim: The primary aim of this study is to compare the efficacy of ultrasound-assisted technology versus the Conventional landmark location technique in spinal anaesthesia for caesarean delivery in obese parturients.
Materials and Methods: This observational comparative study was conducted over one year at the Department of Anaesthesiology and Critical Care, Tezpur Medical College and Hospital, Assam, India. Sixty obese pregnant women (BMI ≥30 kg/m²) scheduled for elective caesarean section were included and divided into two groups: ultrasound-guided spinal anaesthesia (USG group, n=30) and landmark-guided spinal anaesthesia (LMG group, n=30). The primary outcome was the first-attempt success rate of dural puncture. Secondary outcomes included the number of skin punctures, number of needle passes, procedural time, complications, and patient satisfaction measured using the Visual Analogue Scale (VAS).
Results: The first-attempt success rate was significantly higher in the USG group compared with the LMG group (86.7% vs 53.3%, p=0.004). The ultrasound-guided technique required fewer skin punctures and needle passes. Although the time taken to identify the puncture site was slightly longer with ultrasound, the time to cerebrospinal fluid flow and total procedural time were significantly shorter. Complication rates were low in both groups, while patient satisfaction scores were significantly higher in the ultrasound group.
Conclusion: Ultrasound-guided spinal anaesthesia significantly improves first-attempt success rates, reduces needle manipulations, and enhances patient satisfaction compared with the conventional landmark technique in obese parturients undergoing elective caesarean delivery. It may be considered a valuable adjunct in obstetric anaesthetic practice, particularly in patients with difficult anatomical landmarks.
Keywords: Ultrasound, obstetric anaesthetic practice, observational comparative study.

INTRODUCTION

Spinal anaesthesia is the predominant neuraxial technique employed for elective and emergency Caesarean deliveries due to its rapid onset, reliable sensory and motor blockade, and favourable maternal and neonatal outcomes.[1] The efficacy of spinal anaesthesia, however, hinges critically on the precise identification of intervertebral spaces and the successful placement of the spinal needle in the subarachnoid space. In most parturients, particularly those with normal or low body mass index (BMI), the

standard practice of employing surface anatomical landmarks—such as the iliac crests and spinous processes—provides a sufficiently accurate guide to perform the procedure safely and effectively.[2]

However, the increasing prevalence of obesity among pregnant women has significantly altered this landscape. Obesity, defined by the World Health Organization (WHO) as a BMI ≥30 kg/m², poses unique challenges in administration of spinal anaesthesia.[3] Globally, the rate of maternal obesity has risen sharply, driven by sedentary lifestyles, poor nutritional choices, and metabolic conditions.[4] In developed countries, the prevalence of obesity among pregnant women is reported to be as high as 25-35%, and similar trends are emerging in low- and middle-income countries.[5] This epidemic is of critical concern in obstetric anaesthesia, not only because of the direct health risks to mother and foetus but also because it significantly complicates regional anaesthetic procedures.[6]

Excess adipose tissue in the lumbar region obscures spinous processes, alters surface topography, and reduces the accuracy of palpation-based interspace identification.[7] As a result, the landmark technique often yields higher failure rates, increased procedural times, and multiple needle insertions. These complications heighten patient discomfort, increase the risk of accidental dural puncture, and may lead to a need for conversion to general anaesthesia—a less desirable option in the obstetric population due to associated risks of aspiration, airway management difficulties, and neonatal depression.[8]

n contrast, the conventional landmark-based technique relies solely on palpation of anatomical landmarks, such as the iliac crests (Tuffier's line), which are used to approximate the L3-L4 or L4-L5 interspaces.[9] This method assumes normal anatomical relationships and consistency in surface markings—assumptions that break down in obese individuals due to altered body habitus and fat distribution.

Despite these promising findings, the utility of ultrasound-assisted spinal anaesthesia specifically for Caesarean delivery in obese parturients remains underexplored. Current literature is limited by small sample sizes, heterogeneity in ultrasound techniques, and variability in operator experience. There is also an ongoing debate about the practicality of routine ultrasound use in high-volume obstetric settings, where time constraints, equipment availability, and staffing limitations can hinder its implementation. Consequently, there exists a pressing need for robust, well-designed clinical studies that directly compare the outcomes of ultrasound-assisted and conventional landmark-based spinal anaesthesia techniques in this high-risk population.

The clinical implications of improving spinal anaesthesia techniques in obese parturients are profound. First-attempt success in neuraxial blocks correlates strongly with improved patient satisfaction, reduced procedural anxiety, and lower complication rates.[10] Moreover, minimizing the need for repeated attempts or conversion to general anaesthesia is particularly beneficial in obstetric patients, where maintaining maternal consciousness and minimizing foetal drug exposure are paramount. Efficient and effective spinal anaesthesia also contributes to better perioperative workflow, reduced operative delays, and more predictable surgical timelines—all of which are vital in resource-constrained healthcare settings.[11]

The primary aim of this study is to compare the effectiveness and safety of ultrasoundassisted spinal anaesthesia versus the conventional landmark location technique in obese parturients undergoing Caesarean delivery.

MATERIALS AND METHODS

Study Design and Ethical Approval

This observational comparative study was conducted over a period of one year in the Department of Anaesthesiology and Critical Care at Tezpur Medical College and Hospital (TMCH), Assam, India. Ethical approval was obtained from the Institutional Ethical Committee of TMCH prior to commencement of the study. Written informed consent was obtained from all participants before enrolment.

Study Setting and Population

The study was carried out specifically in the Caesarean Operation Theatre (OT) at TMCH. A total of 60 obese parturients scheduled for non-emergency caesarean delivery under spinal anaesthesia were recruited using a consecutive sampling technique.

Sample Size Calculation

The sample size was calculated using the formula: $n = (Z\alpha + Z\beta)^2 [P1Q1 + P2Q2] / (P1 - P2)^2$, where Zα = 1.96 (for 95% confidence interval), Zβ = 0.84 (for 80% power),

P1 = 52.5%, Q1 = 47.5%, according to **Li et al. (2019)**

P2 = 87.5%, Q2 = 12.5%, according to **Li et al. (2019)**

The calculated sample size was 23 per group. Considering potential dropouts, 30 participants were included in each group, resulting in a total sample size of 60.

Inclusion Criteria

- Age ≥18 years,
- Normal singleton pregnancy with gestational age ≥37 weeks,

Materials and Methods

- Body Mass Index (BMI) ≥30 kg/m².

Exclusion Criteria:

- Refusal of spinal anaesthesia,
- Inability to provide informed consent,
- Marked spinal deformities,
- History of spinal surgery,
- Contraindications to subarachnoid block (e.g., infection at puncture site, coagulopathy, allergy to local anaesthetics, hypovolemia, or abnormal spinalanatomy),

- Requirement for urgent or emergency caesarean delivery.

Participants were categorized based on World Health Organization obesity classes: Class I (BMI 30–34.9 kg/m²), Class II (BMI 35–39.9 kg/m²), & Class III (BMI ≥40 kg/m²).

Group Allocation

Subjects were divided into two groups:

- **Ultrasound Group (n = 30)**: Underwent pre puncture ultrasound-guided spinal anaesthesia.
- **Landmark Group (n = 30)**: Underwent conventional landmark-guided spinal anaesthesia.

Preoperative Assessment and Monitoring

A day prior to surgery, participants' height, weight, and BMI were measured by nursing staff. Upon arrival in operating room, standard monitoring was initiated, including non- invasive blood pressure, pulse oximetry, and three-lead electrocardiography. Intravenous access was established, and baseline characteristics such as age, gestational age, height, weight, and BMI were recorded. Monitoring was conducted with patient in a 15°–20° left lateral tilt to prevent aortocaval compression. No sedation had administered before or during spinal anaesthesia.

Operators

The procedures were performed by a trained and experienced anaesthesiologist from Department of Anaesthesiology under supervision of the Head of The Department. All ultrasound examinations were performed by a single investigator to ensure consistency.

Landmark-Guided Technique

In landmark group, puncture site was identified through palpation of anatomical landmarks. Line joining posterior superior iliac spines was used as a surface marker for L4 vertebral level. Midline was identified by palpation of spinous processes. Needle insertion sites were marked at L2–L3 & L3–L4 interspaces.

Ultrasound-guided technique

In ultrasound group, scanning was performed using a Sono Scape ultrasound machine equipped with a low-frequency (2–5 MHz) curvilinear probe. Scanning was carried out in both longitudinal para-sagittal & transverse midline planes, following techniques described in earlier studies. Needle insertion sites at L2–L3 & L3–L4 interspaces were identified as intersection points of longitudinal & transverse scanning lines. In both ultrasound & landmark groups, determined needle insertion sites were marked over skin. After skin marking, parturients were instructed to remain still, followed by immediate subarachnoid puncture.

Anaesthesia technique

Before subarachnoid puncture, full aseptic precautions were maintained. Spinal anaesthesia was administered through a midline approach using a 25-gauge, 90-mm pencil-point spinal needle introduced via a 20-gauge introducer needle. After confirmation of free flow of cerebrospinal fluid, 0.5% hyperbaric bupivacaine was injected 2 mL, with buprenorphine 0.2ml as adjuvant.

Needle bevel was directed cephalad, while injection was given at an approximate rate of 0.2 mL per second.

L3–L4 interspace was selected for first attempt, whereas L2–L3 interspace was reserved for later attempts when required. A maximum of three skin-puncture attempts, involving complete needle withdrawal followed by reinsertion, were permitted for each interspace, while up to five needle passes, defined as redirections without full withdrawal, were allowed for each skin-puncture attempt. In cases where dural puncture remained unsuccessful at L2–L3 interspace in landmark group, operator was allowed to use alternative methods for locating a lumbar interlaminar space, including paramedian or ultrasound-guided approaches.

Immediately after administration of spinal anaesthesia, patients were placed in lefttilted supine position. Successful spinal anaesthesia was defined as achievement of bilateral T4 sensory block within five minutes after injection.

Outcome measures

Primary outcome

- First-attempt success rate of dural puncture.

Secondary outcomes

- Number of skin punctures (each counted as a separate attempt),
- Number of needle passes (needle redirections),
- Total procedural time.

In ultrasound group, time required for identification of insertion site was measured from placement of ultrasound probe to skin marking. In landmark group, this time was measured from initial palpation to skin marking. Needle insertion time was defined as interval between contact of local anaesthetic needle with skin & visualization of cerebrospinal fluid. Total procedural time was calculated as sum of site-identification time & needle-insertion time.

RESULTS

Table 1: Demographic and Baseline Characteristics (n=60)

Variable	USG Group (n=30)	LMG Group (n=30)	*P* Value
Age (years)	29.4 ± 4.8	30.1 ± 5.2	0.561
BMI (kg/m²)	36.2 ± 3.1	35.8 ± 3.4	0.682
Gestational Age (weeks)	38.4 ± 1.2	38.1 ± 1.4	0.343
Gravidity	2.3 ± 1.0	2.4 ± 0.9	0.774

**Statistically significant, Chi square test used*

Inference: The demographic and baseline characteristics between the ultrasoundguided (USG) and landmark-guided (LMG) groups showed no statistically significant differences. The mean age, BMI, gestational age, and gravidity were comparable across both groups ($p > 0.05$).

Table 2: ASA criteria in the patients (n=60)

ASA status	USG Group (n=30)	LMG Group (n=30)	P Value
I	19 (63.3)	22 (73.3)	0.823
II	11 (36.7)	8 (26.7)	
Total	30 (100)	30 (100)	

**Chi square test used*

Inference: There was no statistically-significant difference in ASA physical status classification between the USG and LMG groups ($p = 0.823$). The majority of patients in both groups were ASA I, indicating that most were healthy with no systemic disease.

Table 3: First-Attempt Success Rate in the patients (n=60)

Success	USG Group (n=30)	LMG Group (n=30)	P Value
Success	26 (86.7)	16 (53.3)	0.004
Failure	4 (13.3)	14 (46.7)	
Total	30 (100)	30 (100)	

*Statistically significant, Chi square test used

Inference: A significantly higher first-attempt success rate was observed in the USG group (86.7%) compared to the LMG group (53.3%), with a p-value of 0.004.

Figure 1: First-Attempt Success Rate in the patients (n=60)

Table 4: Number of Skin Punctures in the patients (n=60)

Success	USG Group (n=30)	LMG Group (n=30)	P Value
1 Attempt	26 (86.7%)	16 (53.3%)	0.038*
2 Attempts	4 (13.3%)	8 (26.7%)	
≥3 Attempts	0 (0%)	6 (20%)	
Total	30 (100)	30 (100)	

**Statistically significant, Chi square test used*

Inference: Participants in the USG group required significantly fewer skin punctures than those in the LMG group ($p = 0.038$). A single attempt was sufficient in 86.7% of USG cases compared to only 53.3% in the LMG group. Additionally, no patients in the USG group required three or more attempts, unlike 20% in the LMG group.

Table 5: Number of Needle Passes in the patients (n=60)

Needle Passes	USG Group (n=30)	LMG Group (n=30)	P Value
≤2 Passes	27 (90%)	14 (46.7%)	<0.001*
3–5 Passes	2 (6.7%)	8 (26.7%)	
>5 Passes	1 (3.3%)	8 (26.7%)	
Total	30 (100)	30 (100)	

**Statistically significant, Chi square test used*

Inference: The USG group had a significantly lower number of needle passes compared to the LMG group ($p < 0.001$). Ninety percent of USG patients required ≤2 passes, whereas only 46.7% in the LMG group met this threshold. Moreover, 26.7% of LMG cases required more than five passes, compared to just 3.3% in the USG group.

Table 6: Procedural time parameters in the patients (n=60)

Procedure Component	USG Group (Mean ± SD)	LMG Group (Mean ± SD)	P Value
Time to Identify Site (s)	150.7 ± 30.2	130.8 ± 25.0	0.021*
Time to CSF Flow (s)	45.6 ± 10.8	75.3 ± 20.8	<0.001*
Total Procedure Time (s)	210.2 ± 35.3	275.6 ± 45.4	<0.001*

**Statistically significant, unpaired student's t-test used*

Inference: Although the time taken to identify the puncture site was slightly longer in the USG group (150.7 ± 30.2 seconds vs. 130.8 ± 25.0 seconds, $p = 0.021$), the time to cerebrospinal fluid (CSF) flow

was significantly shorter (45.6 ± 10.8 seconds vs. 75.3 ± 20.8 seconds, p < 0.001), resulting in a notably shorter total procedure time for the USG group (210.2 ± 35.3 seconds vs. 275.6 ± 45.4 seconds, p < 0.001).

Table 7: Complications in the patients (n=60)

Complication	USG Group (n=30)	LMG (n=30)	Group	p-value
Vascular puncture	1 (3.3%)	2 (6.7%)		0.412
Transient paraesthesia	0 (0%)	2 (6.7%)		0.337
Failed spinal block	0 (0%)	2 (6.7%)		0.337
PDPH (post-dural puncture headache)	0 (0%)	1 (3.3%)		0.121

Chi square test used

Inference: The incidence of complications such as vascular puncture, transient paraesthesia, failed spinal block, and post-dural puncture headache was low in both groups, with no statistically significant differences (p > 0.05). Notably, all complications occurred only in the LMG group except for one vascular puncture in the USG group.

Table 8: Post procedural ("post puncture'') VAS score in the patients (n=60)

Parameter	USG Group (Mean ± SD)	LMG Group (Mean ± SD)	P Value
Mean VAS score	8.7 ± 0.6	7.5 ± 0.9	0.001*

Statistically significant, unpaired student's t-test used

Inference: Mean postprocedural visual analogue scale (VAS) scores were significantly higher in the USG group (8.7 ± 0.6) compared to the LMG group (7.5 ± 0.9), with a pvalue of 0.001.

DISCUSSION

Pregnancy is a unique condition both anatomically and physiologically. It has got a wide impact on the society – involving mother, child and whole family including the country and world as a whole. Managing pregnant women during caesarean section and other operations also remained a challenge in all era. Regional anaesthesia (RA) is the preferred method for managing pain during labour and delivery as it provides superior pain relief while minimizing drug exposure to the foetus compared to general anaesthesia (GA) and other systemic options. For anaesthesiologists, the pregnant patient presents unique challenges due to significant physiological and anatomical changes that begin as early as the first trimester. The core principles of obstetric regional anaesthesia (RA) include maternal safety, foetal well-being and last but not the least is participation of mother, as it allows the mother to remain awake and alert facilitating early bonding and breast feeding immediately after birth. As per know there is a normal shift in pregnancy in weight gain, oedema and lumbar lordosis which can obscure the landmarks making placement of needle more technically challenging. So now ultrasound is often used to improve accuracy in these cases.

The present study was conducted to compare the effectiveness of ultrasound-guided spinal anaesthesia with the conventional landmark technique in obese parturients undergoing elective caesarean delivery. Sixty patients were included and divided into ultrasound-guided and landmark-guided groups. Outcomes evaluated included firstattempt success rate, number of skin punctures, needle passes, procedural time, complications, and patient satisfaction.

The present study demonstrated that both study groups were comparable with respect to demographic and baseline characteristics, indicating appropriate group allocation and minimizing potential confounding effects. The mean age of patients in the ultrasound-guided group was 29.4 ± 4.8 years, whereas the landmark group had a mean age of 30.1 ± 5.2 years. Similarly, the mean BMI was 36.2 ± 3.1 kg/m² in the ultrasound group and 35.8 ± 3.4 kg/m² in the landmark group. Gestational age was also comparable between groups (38.4 ± 1.2 weeks vs 38.1 ± 1.4 weeks), as was gravidity (2.3 ± 1.0 vs 2.4 ± 0.9). These findings suggested that the study groups were demographically similar, allowing for a fair comparison of procedural outcomes. Comparable baseline characteristics have also been reported in randomized trials evaluating neuraxial anesthesia techniques in obstetric populations. For example, Li et al. (2019),[12] evaluated ultrasound-assisted spinal anesthesia in obese parturients and reported no significant demographic differences between groups, with comparable age and BMI distribution across intervention arms.

The ASA physical status distribution in the present study also showed similarity between groups, with 63.3% of patients classified as ASA I and 36.7% as ASA II in the ultrasound group, compared with 73.3% ASA I and 26.7% ASA II in the landmark group. The absence of statistically significant differences (p = 0.823) further indicated baseline homogeneity. Similar ASA distributions have been described in obstetric anesthesia studies focusing on neuraxial techniques. Ekinci et al. (2017),[13] conducted a randomized controlled trial comparing ultrasound-guided and conventional spinal anesthesia in obstetric patients and similarly reported comparable baseline characteristics between groups, ensuring unbiased evaluation of outcomes. Likewise, Gayathri et al. (2021),[14] reported similar patient demographics in both ultrasound and landmark groups in their study of spinal anesthesia for caesarean section. The similarity in baseline characteristics across these studies supports the

validity of comparing procedural outcomes between techniques without demographic bias.

First-Attempt Success Rate

One of the principal objectives of the study was to evaluate the first-attempt success rate of spinal anesthesia. In the present study, the ultrasound-guided technique demonstrated a significantly higher first-attempt success rate compared to the landmark technique. Successful dural puncture on the first attempt was achieved in 86.7% of patients in the ultrasound group, whereas only 53.3% of patients in the landmark group achieved success on the first attempt ($p = 0.004$). This finding suggests that ultrasound guidance substantially improves procedural accuracy in obese parturients, where anatomical landmarks are often difficult to palpate due to increased adipose tissue and deeper neuraxial structures.

These findings were consistent with previous literature. Li et al. (2019),[12] reported a first-attempt success rate of 87.5% in the ultrasound group compared with 52.5% in the landmark group, closely mirroring the results of the present study. The authors attributed this improvement to the ability of ultrasound to visualize spinal anatomy and accurately identify intervertebral spaces prior to needle insertion. Similarly, Ni et al. (2021),[63] observed a significantly higher first insertion success rate when ultrasound guidance was used for neuraxial anesthesia in obese parturients (72.5% vs 40.0% with palpation). These findings reinforce the conclusion that ultrasound guidance enhances the likelihood of successful dural puncture on the first attempt.

Other investigators have reported comparable benefits. Young et al. (2021),[15] conducted a meta-analysis of 22 randomized trials involving 2,462 obstetric patients and reported that ultrasound guidance significantly improved first-pass success with a pooled risk ratio of 1.46. These findings collectively support the observation that ultrasound guidance facilitates more accurate needle placement and improves procedural success rates in difficult neuraxial procedures.

Number of Skin Punctures

The number of skin punctures required to achieve successful spinal anesthesia is an important indicator of procedural difficulty and patient discomfort. In the present study, ultrasound guidance significantly reduced the number of skin punctures required. A single puncture was sufficient in 86.7% of patients in the ultrasound group, compared with 53.3% in the landmark group. Furthermore, 20% of patients in the landmark group required three or more attempts, whereas no patient in the ultrasound group required more than two attempts ($p = 0.038$).

The authors attributed this reduction to improved visualization of spinal structures, which enabled more accurate identification of needle insertion points.

Similarly, Kakaraddi et al. (2023),[16] reported that ultrasound guidance markedly improved successful needle placement, with an overall success rate of 77.5% compared with 25% in the landmark group. The study also found that ultrasound guidance reduced the number of needle insertion attempts and improved procedural accuracy.

These findings support the conclusion that ultrasound imaging facilitates accurate localization of the intervertebral space and midline, thereby minimizing repeated punctures and reducing patient discomfort during spinal anesthesia.

Number of Needle Passes

Another important indicator of technical difficulty in spinal anesthesia is the number of needle passes required to obtain cerebrospinal fluid. In the present study, ultrasound guidance significantly reduced needle redirections. Ninety percent of patients in the ultrasound group required two or fewer needle passes, compared with only 46.7% in the landmark group. Additionally, 26.7% of patients in the landmark group required more than five passes, whereas only 3.3% of ultrasound-guided cases required this many passes ($p < 0.001$).

Similarly, Yang et al. (2023),[17] demonstrated that ultrasound-assisted positioning significantly reduced the number of puncture attempts and needle manipulations in obese patients undergoing combined spinal-epidural anesthesia. The authors also reported a higher first-attempt success rate and improved patient satisfaction with ultrasound guidance.

Adi et al. (2024)18 reported that ultrasound guidance facilitated accurate identification of the L3–L4 interspace in a morbidly obese pregnant patient, minimizing the need for repeated needle passes.

Procedural Time

Procedural time is an important practical consideration in clinical practice. In the present study, the time required to identify the puncture site was longer in the ultrasound group (150.7 ± 30.2 seconds) compared with the landmark group (130.8 ± 25.0 seconds, $p = 0.021$). However, once the insertion site was identified, the ultrasound group achieved cerebrospinal fluid flow significantly faster (45.6 ± 10.8 seconds vs 75.3 ± 20.8 seconds, $p < 0.001$). Consequently, the total procedural time was significantly shorter in the ultrasound group (210.2 ± 35.3 seconds) compared with the landmark group (275.6 ± 45.4 seconds).

These findings are consistent with previous studies. Khan et al. (2022)19 found that ultrasound guidance increased the time required for landmark identification but significantly reduced the overall time required to complete the neuraxial block.

However, some studies have reported contrasting results.

CONCLUSION

The present study evaluated the effectiveness of ultrasound-guided spinal anaesthesia compared with the conventional landmark-guided technique in obese parturients undergoing elective caesarean delivery.

The findings demonstrated that ultrasound guidance significantly improved procedural success and patient experience. A higher first-attempt success rate was observed in the ultrasound group compared with the landmark group. Additionally, the ultrasound-guided technique resulted in fewer skin punctures and needle passes, indicating greater procedural accuracy and reduced technical difficulty.

Although the time required to identify the puncture site was slightly longer in the ultrasound group, the time taken to achieve cerebrospinal fluid flow and the total procedural time were significantly shorter. These findings suggest that the initial time spent performing ultrasound scanning is offset by improved needle placement accuracy and reduced need for repeated attempts. The ultrasound-guided technique was also associated with fewer complications and significantly higher patient satisfaction scores, reflecting a more comfortable procedural experience.

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