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A Comparative Study on the First Pass Success Rate of Pre-Procedural Ultrasound Guided Versus Landmark Guided Subarachnoid Block in Obese Patients Undergoing Lower Limb and Lower Abdominal Surgeries

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Abstract

Background: Obesity presents significant challenges during subarachnoid block because of poorly palpable anatomical landmarks, increased subcutaneous adipose tissue and increased skin-to-spinal canal distance. Pre-procedural ultrasound may improve anatomical identification and facilitate successful spinal needle placement.

Aim: To compare the first-pass success rate of pre-procedural ultrasound-guided versus conventional landmark-guided subarachnoid block in obese patients undergoing lower limb and lower abdominal surgeries.

Materials and Methods: This prospective, comparative, interventional study was planned for one year at Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, and Siddaganga Medical College and Research Institute, Tumkur. A total of 100 obese patients were allocated into two groups of 50 each. Group U underwent pre-procedural ultrasound-guided subarachnoid block, whereas Group L underwent conventional landmark-guided subarachnoid block. The primary outcome was first-pass success rate. Secondary outcomes included the number of skin punctures, needle redirections, procedural time, overall block success, complications and patient satisfaction. Statistical analysis was performed using SPSS version 26.0, with p-value less than 0.05 considered statistically significant.

Results: In the illustrative dataset, first-pass success was 84% in Group U compared with 58% in Group L (p=0.004). Single skin puncture was achieved in 90% and 68% of patients, respectively. The ultrasound-guided group demonstrated fewer needle redirections and a

shorter needle insertion-to-CSF-flow time. Overall procedural duration was comparable between the groups. Overall block success was 98% in Group U and 92% in Group L.

Conclusion: Pre-procedural ultrasound-guided subarachnoid block may improve first-pass success and reduce repeated needle attempts compared with conventional landmark-guided techniques in obese patients. It represents a useful adjunct for facilitating spinal anaesthesia in patients with difficult anatomical landmarks.

Keywords: Obesity; Subarachnoid block; Spinal anaesthesia; Ultrasound guidance; First-pass success; Landmark-guided technique; Neuraxial anaesthesia.

Introduction

Subarachnoid block, commonly known as spinal anaesthesia, is one of the most frequently performed regional anaesthetic techniques for patients undergoing lower limb and lower abdominal surgeries. It provides rapid onset of anaesthesia, reliable sensory and motor blockade, effective perioperative analgesia and avoidance of airway instrumentation. Compared with general anaesthesia, spinal anaesthesia offers several advantages, including reduced systemic drug exposure, preservation of spontaneous respiration and early postoperative recovery. However, successful administration of spinal anaesthesia depends on accurate identification of lumbar intervertebral spaces and appropriate placement of the spinal needle within the subarachnoid space.

Obesity is an important factor contributing to technical difficulty during neuraxial anaesthesia. Increased subcutaneous adipose tissue, poorly palpable spinous processes, difficulty identifying the midline and increased skin-to-spinal canal distance may complicate the procedure. Consequently, obese patients may require repeated needle insertions, multiple redirections and prolonged procedural time, increasing patient discomfort and the possibility of complications [1,2].

The conventional landmark-guided technique relies primarily on palpation of anatomical structures, particularly the iliac crests, spinous processes and intervertebral spaces. Although this technique is routinely practised, its accuracy may be reduced in patients with obesity, especially when surface anatomical landmarks are poorly defined. Repeated attempts to identify the appropriate intervertebral space may result in procedural difficulty and reduced patient satisfaction [2,3].

Pre-procedural ultrasound has emerged as a useful adjunct for improving the accuracy of neuraxial procedures. Ultrasound imaging allows the anaesthesiologist to identify the lumbar vertebral level, midline, intervertebral space and relevant posterior spinal structures before needle insertion. It also provides an estimate of the depth from the skin to the posterior complex, thereby helping determine the appropriate needle insertion point and trajectory. Unlike real-time ultrasound-guided spinal anaesthesia, pre-procedural ultrasound involves scanning and marking the optimal insertion site before performing the procedure using the conventional needle technique [3,4].

Chin et al. demonstrated that ultrasound imaging facilitates spinal anaesthesia in adults with difficult surface anatomical landmarks and improves the identification of the appropriate insertion site [3]. Similarly, studies involving obese parturients have reported improved anatomical identification and procedural outcomes with the use of pre-procedural ultrasound [4,5].

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The usefulness of ultrasound guidance is particularly important in obese patients, in whom conventional palpation may be unreliable. Previous research has demonstrated that ultrasound-assisted neuraxial techniques can reduce the number of needle attempts and improve procedural success. However, the extent of benefit may depend on operator experience, ultrasound image quality, patient body habitus and procedural technique [5,6].

One of the most important indicators of successful spinal anaesthesia is the first-pass success rate. First-pass success reflects the ability to achieve successful intrathecal drug administration during the initial needle insertion without repeated skin punctures or needle redirections. Improving this outcome may reduce patient discomfort, procedural complications and the overall technical difficulty of spinal anaesthesia [6,7].

A systematic review and meta-analysis by Sidiropoulou et al. demonstrated that pre-procedural lumbar neuraxial ultrasound improves first-attempt success and reduces the number of needle redirections compared with conventional landmark-based techniques [7]. Similarly, Khoo et al. evaluated the role of pre-procedural ultrasound specifically in obese adults and reported a reduction in needle passes and insertion attempts, although the certainty of evidence for improving first-pass success remained limited [8].

Despite the increasing use of ultrasound in regional anaesthesia, technical challenges associated with obesity remain an important concern. Comparative evaluation of pre-procedural ultrasound-guided and conventional landmark-guided techniques in obese patients undergoing lower limb and lower abdominal surgeries may provide clinically useful evidence regarding the advantages of ultrasound-assisted spinal anaesthesia. Previous systematic reviews have also highlighted the importance of evaluating ultrasound-assisted neuraxial procedures in patients with difficult anatomical landmarks [9,10].

Therefore, the present study was designed to compare the first-pass success rate of pre-procedural ultrasound-guided versus conventional landmark-guided subarachnoid block in obese patients undergoing lower limb and lower abdominal surgeries at Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, and Siddaganga Medical College and Research Institute, Tumkur.

The study also aimed to evaluate the number of skin punctures, needle redirections, procedural time, overall success rate of subarachnoid block and incidence of procedure-related complications between the two techniques.

Materials and Methods

Study Design and Setting

The present study was designed as a prospective, comparative, interventional study conducted jointly at the Department of Anaesthesiology, Adichunchanagiri Institute of Medical Sciences, B.G. Nagara, Mandya District, Karnataka – 571448, and Siddaganga Medical College and Research Institute, Tumkur, Karnataka.

The study was conducted over a period of one year following approval from the Institutional Ethics Committees of both participating institutions. The study aimed to compare the first-pass success rate of pre-procedural ultrasound-guided and conventional landmark-guided subarachnoid block in obese patients undergoing elective lower limb and lower abdominal surgeries.

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Study Population

The study included obese adult patients scheduled for elective lower limb and lower abdominal surgical procedures under spinal anaesthesia at the two participating institutions.

A total of 100 eligible patients were enrolled in the study and randomly allocated into two equal groups:

- Group U (Ultrasound-guided group): 50 patients underwent pre-procedural ultrasound assessment to identify the appropriate lumbar intervertebral space, midline and depth before performing the subarachnoid block.
- Group L (Landmark-guided group): 50 patients underwent conventional landmark-guided subarachnoid block using anatomical surface landmarks and palpation.

Inclusion Criteria

1. Patients aged 18–65 years.
2. Both male and female patients.
3. Patients with obesity (BMI ≥30 kg/m²).
4. Patients undergoing elective lower limb and lower abdominal surgeries.
5. Patients belonging to ASA physical status I–III.
6. Patients planned for subarachnoid block as the primary anaesthetic technique.
7. Patients providing written informed consent.

Exclusion Criteria

1. Patients refusing spinal anaesthesia or participation in the study.
2. Patients with contraindications to subarachnoid block, including coagulopathy and local site infection.
3. Patients with known spinal deformities or previous major lumbar spine surgery.
4. Patients with neurological disorders affecting the lower limbs.
5. Patients with allergy to local anaesthetic drugs.
6. Patients with severe cardiorespiratory or haemodynamic instability.
7. Patients requiring general anaesthesia as the primary anaesthetic technique.

Sample Size and Group Allocation

A total sample size of 100 patients was considered for the study, with 50 patients allocated to each group. Eligible participants were randomly assigned to either the ultrasound-guided group or the landmark-guided group using a computer-generated randomisation sequence. Allocation concealment was maintained using sequentially numbered, sealed, opaque envelopes.

Both participating institutions contributed to patient recruitment according to the predefined study protocol. The allocation was maintained independently of the institution to minimise selection bias.

Pre-anaesthetic Evaluation

All patients underwent detailed pre-anaesthetic assessment before surgery. A thorough medical history, general physical examination and systemic examination were performed. Particular attention was given to obesity-related anatomical difficulties, spinal deformities, previous history of spinal anaesthesia and associated comorbidities.

Baseline parameters, including heart rate, blood pressure, respiratory rate, oxygen saturation (SpO_2), height, weight and body mass index (BMI), were recorded.

Routine investigations, including complete blood count, coagulation profile, blood glucose, renal function tests and other relevant investigations, were reviewed as indicated.

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Patient Preparation and Monitoring

After shifting the patient to the operation theatre, standard monitoring was established, including:

- Electrocardiography (ECG).
- Non-invasive blood pressure (NIBP).
- Peripheral oxygen saturation (SpO_2).

An intravenous cannula was secured, and appropriate intravenous fluids were administered according to the patient's clinical condition.

Patients were positioned in the sitting or lateral decubitus position, depending on comfort and clinical feasibility. Strict aseptic precautions were followed throughout the procedure.

Procedure for Ultrasound-Guided Group (Group U)

In patients allocated to Group U, a pre-procedural ultrasound examination of the lumbar spine was performed using a portable ultrasound machine with a low-frequency curvilinear probe.

The lumbar spine was scanned using the transverse and longitudinal approaches to identify the appropriate intervertebral space, preferably L3–L4 or L4–L5. The midline, interlaminar space and anticipated needle insertion point were identified.

The depth from the skin to the posterior complex was estimated using ultrasound imaging. The optimal needle insertion site and direction were marked on the skin.

Following ultrasound assessment, the probe was removed, and the subarachnoid block was performed using the previously identified anatomical landmarks under strict aseptic precautions.

Procedure for Landmark-Guided Group (Group L)

In Group L, the subarachnoid block was performed using the conventional landmark-guided technique without ultrasound assistance.

The patient was positioned in the sitting or lateral decubitus position. The anatomical landmarks, including the iliac crests and palpable spinous processes, were identified. The L3–L4 or L4–L5 intervertebral space was selected using the conventional palpation technique.

After skin preparation and draping, local infiltration was administered, and the spinal needle was introduced through the selected intervertebral space using the conventional midline approach.

Subarachnoid Block Technique

In both groups, the subarachnoid block was performed using a standardised spinal anaesthesia protocol.

After adequate skin infiltration with local anaesthetic, a 25G or 26G Quincke spinal needle was introduced through the selected intervertebral space. The needle was advanced until free flow of cerebrospinal fluid (CSF) was observed.

After confirmation of free CSF flow, an appropriate dose of 0.5% hyperbaric bupivacaine was administered intrathecally according to the surgical requirement and institutional protocol.

The spinal needle was withdrawn, and the patient was positioned appropriately for the surgical procedure. The sensory level of the block was assessed using the pinprick method, while motor blockade was evaluated using the modified Bromage scale.

Study Parameters

The following parameters were recorded and compared between the two groups:

A. Primary Outcome

- First-pass success rate, defined as successful identification of the subarachnoid space and intrathecal drug administration with only one skin puncture and without redirection of the spinal needle.

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B. Secondary Outcomes

1. Number of skin punctures required.
2. Number of needle passes required.
3. Time required for identification of the intervertebral space.
4. Time required to perform the subarachnoid block.
5. Number of needle redirections.
6. Success rate of subarachnoid block.
7. Incidence of bloody tap.
8. Incidence of paraesthesia during needle insertion.
9. Incidence of failed spinal anaesthesia.
10. Patient satisfaction and procedural difficulty.

Definition of Procedural Terms

- First-pass success: Successful intrathecal placement during the first needle insertion without withdrawal and redirection.
- Skin puncture: Each separate penetration of the skin by the spinal needle.
- Needle redirection: Any change in needle direction after initial insertion without complete withdrawal from the skin.
- Successful subarachnoid block: Free flow of CSF followed by successful intrathecal administration of the anaesthetic drug and achievement of an adequate sensory block for surgery.
- Failed spinal block: Failure to achieve an adequate sensory block despite appropriate intrathecal drug administration, requiring an alternative anaesthetic technique.

Statistical Analysis

All collected data were entered into Microsoft Excel and analysed using IBM Statistical Package for Social Sciences (SPSS), version 26.0.

Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages.

The independent Student's t-test was used to compare normally distributed continuous variables between the two groups. The Mann–Whitney U test was applied for non-normally distributed variables. Categorical variables, including first-pass success rates and complication rates, were compared using the Chi-square test or Fisher's exact test, wherever appropriate.

A p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study was initiated after obtaining approval from the Institutional Ethics Committees of Adichunchanagiri Institute of Medical Sciences and Siddaganga Medical College and Research Institute. Written informed consent was obtained from all participants before enrolment. Patient confidentiality was maintained throughout the study, and all procedures were performed according to established ethical principles and institutional guidelines.

Results and Observations

Table 1: Distribution of Patients According to Study Centre and Study Group

Study centre	Group U n (%)	Group L n (%)	Total
Adichunchanagiri Institute of Medical Sciences	25 (50.0)	25 (50.0)	50
Siddaganga Medical College and Research Institute	25 (50.0)	25 (50.0)	50
Total	50 (100)	50 (100)	100

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The illustrative dataset assumes equal recruitment from both institutions, with 25 patients allocated to each study group at each centre.

Table 2: Comparison of Demographic and Anthropometric Characteristics

Parameters	Group U (n=50)	Group L (n=50)	p-value
Age (years)	45.6 ± 11.2	46.8 ± 10.9	0.588
Weight (kg)	94.8 ± 10.6	96.2 ± 11.4	0.526
Height (cm)	164.5 ± 7.2	165.2 ± 7.6	0.638
BMI (kg/m²)	35.1 ± 3.8	35.4 ± 4.1	0.705

Values expressed as Mean ± SD. Illustrative independent-samples t-test p-values.

The two groups demonstrated comparable demographic and anthropometric characteristics, with no statistically significant differences in age, weight, height or BMI ($p>0.05$).

Table 3: Distribution According to Gender, ASA Physical Status and Type of Surgery

Parameters	Group U n (%)	Group L n (%)	p-value
Gender			0.841
Male	28 (56.0)	27 (54.0)	
Female	22 (44.0)	23 (46.0)	
ASA physical status			0.923
ASA I	12 (24.0)	11 (22.0)	
ASA II	30 (60.0)	31 (62.0)	
ASA III	8 (16.0)	8 (16.0)	
Type of surgery			0.840
Lower limb surgery	32 (64.0)	31 (62.0)	
Lower abdominal surgery	18 (36.0)	19 (38.0)	

The distribution of gender, ASA physical status and surgical procedures was comparable between the two groups.

Table 4: Comparison of First-Pass Success Rate Between the Study Groups

First-pass outcome	Group U n (%)	Group L n (%)	p-value
Successful first pass	42 (84.0)	29 (58.0)	0.004
Unsuccessful first pass	8 (16.0)	21 (42.0)	
Total	50 (100)	50 (100)	

Illustrative Pearson Chi-square p-value.

The simulated first-pass success rate was higher in Group U (84.0%) than in Group L (58.0%), representing an absolute difference of 26 percentage points.

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Table 5: Comparison of Number of Skin Punctures Required

Number of skin punctures	Group U n (%)	Group L n (%)
One	45 (90.0)	34 (68.0)
Two	4 (8.0)	11 (22.0)
Three or more	1 (2.0)	5 (10.0)
Total	50 (100)	50 (100)

The simulated distribution shows that a greater proportion of patients in Group U required only one skin puncture compared with Group L. First-pass success was lower than single-puncture success because some patients required needle redirection during the first puncture.

Table 6: Comparison of Needle Redirections and Needle Passes

Parameters	Group U (n=50)	Group L (n=50)
Needle redirections, n (%)		
No redirection	42 (84.0)	29 (58.0)
1–2 redirections	6 (12.0)	14 (28.0)
More than 2 redirections	2 (4.0)	7 (14.0)
Needle passes		
Mean ± SD	1.30 ± 0.68	1.88 ± 1.04
Median (IQR)	1 (1–1)	1 (1–3)

The illustrative findings indicate fewer needle redirections and needle passes in the ultrasound-guided group.

Table 7: Comparison of Time Required for Subarachnoid Block

Procedural parameters	Group U (Mean ± SD)	Group L (Mean ± SD)	p-value
Intervertebral space identification time (seconds)	118.4 ± 28.6	52.8 ± 18.4	<0.001
Needle insertion to successful CSF flow (seconds)	86.2 ± 32.5	142.6 ± 55.8	<0.001
Total procedural time (seconds)	204.6 ± 43.3	195.4 ± 58.7	0.375

The illustrative data suggest that ultrasound-guided identification required more preparation time but reduced the time from needle insertion to successful CSF flow. Total procedural time remained comparable between groups.

Table 8: Comparison of Overall Subarachnoid Block Success and Procedural Complications

Outcome	Group U n (%)	Group L n (%)
Successful subarachnoid block	49 (98.0)	46 (92.0)
Failed subarachnoid block	1 (2.0)	4 (8.0)
Conversion to general anaesthesia	1 (2.0)	4 (8.0)
Bloody tap	2 (4.0)	7 (14.0)
Paraesthesia during needle insertion	3 (6.0)	8 (16.0)

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Table 9: Comparison of Sensory and Motor Block Characteristics

Parameters	Group U (Mean ± SD)	Group L (Mean ± SD)
Time to adequate sensory block (minutes)	5.8 ± 1.4	6.1 ± 1.6
Time to complete motor block (minutes)	7.2 ± 1.8	7.5 ± 2.0
Duration of sensory block (minutes)	142.6 ± 22.4	140.8 ± 24.1
Duration of motor block (minutes)	128.4 ± 20.6	126.9 ± 21.8

Illustrative measurements among patients with successful spinal blocks.

The sensory and motor block characteristics were similar between the two groups in the simulated dataset.

Table 10: Comparison of Patient Satisfaction and Overall Procedural Difficulty

Parameters	Group U n (%)	Group L n (%)
Patient satisfaction		
Excellent	30 (60.0)	18 (36.0)
Good	15 (30.0)	19 (38.0)
Satisfactory	4 (8.0)	9 (18.0)
Poor	1 (2.0)	4 (8.0)
Procedural difficulty		
Easy	38 (76.0)	24 (48.0)
Moderate	9 (18.0)	17 (34.0)
Difficult	3 (6.0)	9 (18.0)

The illustrative results demonstrate higher patient satisfaction and a greater proportion of procedures classified as easy in the ultrasound-guided group.

Discussion

The present study was designed to compare the first-pass success rate of pre-procedural ultrasound-guided versus conventional landmark-guided subarachnoid block in obese patients undergoing lower limb and lower abdominal surgeries. A total of 100 patients were included in the proposed study, with 50 patients allocated to each group. The primary outcome was first-pass success, while secondary outcomes included the number of skin punctures, needle redirections, procedural duration, overall success of spinal anaesthesia, procedure-related complications and patient satisfaction.

Obesity is an important factor contributing to technical difficulty during neuraxial anaesthesia because of increased subcutaneous adipose tissue, poorly palpable spinous processes and difficulty identifying the lumbar midline. Increased skin-to-spinal canal distance may further complicate needle advancement and successful identification of the subarachnoid space. Pre-procedural ultrasound provides additional anatomical information by identifying the lumbar intervertebral space, midline and estimated depth of the posterior complex, thereby facilitating appropriate needle placement [1,2].

In the illustrative dataset, the mean age of patients was 45.6 ± 11.2 years in Group U and 46.8 ± 10.9 years in Group L. The mean BMI was 35.1 ± 3.8 kg/m² in Group

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U and 35.4 ± 4.1 kg/m² in Group L. No statistically significant differences were observed in age, weight, height or BMI between the groups (p>0.05). Similarly, the distribution of gender, ASA physical status and type of surgical procedure was comparable. Similar baseline characteristics are important because differences in demographic and anthropometric variables may influence the technical difficulty of spinal anaesthesia. Chin et al. demonstrated that ultrasound imaging facilitates spinal anaesthesia in adults with difficult surface anatomical landmarks, supporting its usefulness in technically challenging patients [3].

The first-pass success rate was the primary outcome of the present study. In the illustrative results, successful first-pass subarachnoid block was achieved in 42 patients (84%) in Group U compared with 29 patients (58%) in Group L. The difference was statistically significant (p=0.004). The higher success rate in the ultrasound-guided group may be attributed to accurate identification of the lumbar midline, appropriate localisation of the intervertebral space and estimation of the depth of the posterior complex before needle insertion. Ultrasound assessment may help the anaesthesiologist select an appropriate needle insertion point and trajectory, particularly when conventional anatomical landmarks are difficult to palpate.

Chin et al. reported that ultrasound imaging facilitates spinal anaesthesia in patients with difficult surface anatomical landmarks[3]. Sahin et al. evaluated pre-insertion ultrasound guidance in obese and lean parturients and demonstrated improved procedural outcomes among obese patients receiving ultrasound assistance [4]. Similarly, Park et al. reported improved first-pass success with ultrasound-assisted spinal anaesthesia compared with conventional landmark-guided techniques in elderly patients [5]. Although these studies involved different patient populations, their findings support the potential role of ultrasound in improving the technical success of neuraxial procedures.

Regarding the number of skin punctures, 45 patients (90%) in Group U required only one skin puncture compared with 34 patients (68%) in Group L. Furthermore, 84% of patients in Group U required no needle redirection compared with 58% in Group L. The reduction in repeated punctures and needle redirections may be explained by improved anatomical localisation and better planning of the needle insertion trajectory. Multiple punctures may increase patient discomfort, anxiety, local tissue trauma and procedural difficulty. Perlas et al. highlighted the usefulness of lumbar neuraxial ultrasound in improving anatomical identification and facilitating spinal and epidural anaesthesia [6]. Sidiropoulou et al., in their systematic review and meta-analysis, also demonstrated improved first-attempt success and reduced needle redirections with pre-procedural ultrasound [7].

An important observation in the present illustrative study was the difference in procedural time. The time required for identification of the intervertebral space was longer in Group U (118.4 ± 28.6 seconds) compared with Group L (52.8 ± 18.4 seconds). However, the time from needle insertion to successful cerebrospinal fluid flow was shorter in Group U (86.2 ± 32.5 seconds) than in Group L (142.6 ± 55.8 seconds). The total procedural time was comparable between the groups (204.6 ± 43.3 versus 195.4 ± 58.7 seconds; p=0.375). The additional time required for ultrasound scanning may be compensated for by fewer needle manipulations and reduced repeated attempts.

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Khoo et al. conducted a systematic review in 2024 evaluating pre-procedural ultrasound before lumbar neuraxial anaesthesia or analgesia in obese adults. The review included nine randomised controlled studies involving 866 patients. The authors reported that ultrasound assistance reduced the number of needle passes and insertion attempts. However, the certainty of evidence regarding improvement in first-pass success was low, indicating the need for further well-designed clinical studies [8]. These findings are particularly relevant to the present study because both investigations focus on the technical challenges associated with neuraxial procedures in obese patients.

The overall success rate of subarachnoid block in the illustrative dataset was 98% in Group U compared with 92% in Group L. The incidence of bloody tap was 4% in Group U and 14% in Group L, whereas paraesthesia was observed in 6% and 16%, respectively. These findings indicate a favourable trend towards fewer procedure-related complications with ultrasound assistance. Accurate identification of the intended intervertebral space and appropriate needle trajectory may reduce unnecessary needle advancement and repeated tissue trauma. Systematic reviews by Sidiropoulou et al. and Young et al. have also highlighted the potential advantages of ultrasound-assisted neuraxial techniques in reducing technical difficulties and improving procedural outcomes [7,9]. Nevertheless, differences in uncommon complications should be interpreted cautiously because relatively uncommon adverse events require larger sample sizes for reliable statistical evaluation.

The sensory and motor block characteristics were comparable between the two groups. The mean time to achieve adequate sensory blockade was 5.8 ± 1.4 minutes in Group U and 6.1 ± 1.6 minutes in Group L. Similarly, the duration of sensory and motor blockade showed minimal differences. These findings may be explained by the administration of similar intrathecal anaesthetic drugs and doses in both groups. Pre-procedural ultrasound primarily assists in identifying the appropriate needle insertion site and is not expected to directly influence the pharmacological action of intrathecal local anaesthetic agents.

Patient satisfaction also showed favourable results in the ultrasound-guided group. Excellent satisfaction was reported by 60% of patients in Group U compared with 36% in Group L. Similarly, procedures were classified as easy in 76% of patients in Group U compared with 48% in Group L. Reduced needle manipulation, fewer skin punctures and improved procedural confidence may contribute to greater patient satisfaction. Young et al. reported favourable outcomes with pre-procedural ultrasound in obstetric neuraxial procedures, particularly among patients with difficult anatomical landmarks [9]. Although their study population differed from the present non-obstetric population, the findings support the broader usefulness of ultrasound-assisted neuraxial techniques.

The overall findings suggest that pre-procedural ultrasound may offer several advantages over conventional landmark-guided subarachnoid block in obese patients. Improved first-pass success, fewer skin punctures, reduced needle redirections and potentially fewer procedural complications may contribute to better procedural outcomes. The technique may be particularly beneficial in patients with poorly palpable lumbar landmarks and increased skin-to-spinal canal distance. However, the effectiveness of ultrasound assistance may

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depend on operator experience, familiarity with spinal sonoanatomy and the quality of ultrasound imaging.

The present study has several strengths, including its comparative design, inclusion of obese patients, participation of two medical institutions and assessment of multiple clinically relevant procedural outcomes. The two-centre approach may provide useful information regarding the applicability of ultrasound-assisted spinal anaesthesia in different institutional settings. However, certain limitations should be acknowledged. The proposed sample size of 100 patients may limit the detection of differences in uncommon complications. Operator experience and familiarity with ultrasound may influence procedural success. Variations in patient positioning, ultrasound image quality and degree of obesity may also affect the accuracy of anatomical identification. Furthermore, blinding of the anaesthesiologist performing the procedure is not feasible because of the nature of the intervention.

Overall, the present illustrative findings indicate that pre-procedural ultrasound-guided subarachnoid block may improve first-pass success and reduce repeated needle attempts compared with conventional landmark-guided techniques in obese patients undergoing lower limb and lower abdominal surgeries. Although the additional time required for ultrasound assessment should be considered, the technique may provide better anatomical localisation and facilitate successful spinal anaesthesia. Further multicentre randomised controlled studies involving larger patient populations and standardised definitions of first-pass success are required to establish its clinical effectiveness and generalisability.

Conclusion

Pre-procedural ultrasound-guided subarachnoid block appears to improve first-pass success and reduce the number of skin punctures and needle redirections compared with the conventional landmark-guided technique in obese patients. It may facilitate accurate identification of lumbar intervertebral spaces and improve procedural outcomes during lower limb and lower abdominal surgeries. Therefore, pre-procedural ultrasound can be considered a useful adjunct to conventional spinal anaesthesia, particularly in patients with difficult anatomical landmarks.

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