



Original Article

Comparison of Subarachnoid Space Depth Using Anthropometric and Usg in Population of BMI >25kg/M2

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ABSTRACT

Background; Identification of the subarachnoid space during spinal anaesthesia becomes difficult in overweight and obese patients because of poorly palpable anatomical landmarks and increased skin-to-subarachnoid space depth. Accurate prediction of spinal depth is important for improving the success and safety of spinal anaesthesia. Ultrasonography has emerged as a useful tool for estimating subarachnoid space depth in such patients.

Aim; To compare subarachnoid space depth estimated using anthropometric parameters and ultrasonography (USG) with the measured subarachnoid space depth during spinal anaesthesia in patients with BMI >25 kg/m².

Materials and Methods; This prospective observational comparative study was conducted in the Department of Anaesthesiology at Kasturba Medical Hospital from May 2024 to December 2025. A total of 100 adult patients with BMI >25 kg/m² undergoing surgeries under spinal anaesthesia were included. Subarachnoid space depth was estimated using anthropometric parameters and preprocedural ultrasonography. The measured depth during successful spinal anaesthesia was recorded. Correlation between the different methods and measured subarachnoid space depth was analysed using Pearson's correlation coefficient. Statistical significance was considered at p<0.05.

Results; The mean BMI of the study population was 30.4 ± 3.8 kg/m². The mean anthropometric predicted depth was 5.12 ± 0.64 cm, the ultrasonographic depth was 5.48 ± 0.58 cm, and the measured subarachnoid space depth during spinal anaesthesia was 5.56 ± 0.61 cm. Ultrasonographic measurements showed a very strong positive correlation with measured subarachnoid space depth (r=0.93, p<0.001), whereas anthropometric prediction demonstrated moderate correlation (r=0.71, p<0.001). A strong positive correlation was also observed between BMI and measured subarachnoid space depth (r=0.82, p<0.001).

Conclusion; Ultrasonographic assessment was more accurate and closely correlated with measured subarachnoid space depth compared to anthropometric prediction methods in patients with BMI >25 kg/m². Preprocedural ultrasonography may improve the success and safety of spinal anaesthesia in overweight and obese individuals.

Keywords: Subarachnoid space depth, Ultrasonography, Anthropometry, Spinal anaesthesia, Obesity, BMI.

INTRODUCTION

Spinal anaesthesia is one of the most commonly employed regional anaesthetic techniques for lower abdominal, pelvic, perineal, and lower limb surgeries because of its rapid onset, reliability, cost-effectiveness, and favourable safety profile. Successful spinal anaesthesia depends on accurate identification of the subarachnoid space and precise needle placement. However, localization of spinal landmarks becomes increasingly difficult in overweight and obese individuals due to excessive adipose tissue, poorly palpable bony landmarks, and increased skin-to-subarachnoid space depth. These factors

may lead to multiple needle insertion attempts, increased patient discomfort, procedural failure, and higher complication rates (1,2).

The prevalence of obesity has risen substantially worldwide and has become an important concern in anaesthetic practice. Body Mass Index (BMI) is commonly used to classify overweight and obesity, and patients with BMI >25 kg/m² often present technical difficulties during neuraxial procedures (3). Conventional landmark-guided spinal anaesthesia may not always provide an accurate estimation of spinal depth in such patients, thereby increasing the likelihood of failed attempts.

Anthropometric methods based on patient characteristics such as height, weight, and BMI have been used to estimate the depth of the subarachnoid space. Several predictive formulas have been proposed to facilitate spinal needle placement. Although these methods are simple, inexpensive, and easily applicable, their accuracy may vary among different populations and body habitus (4,5). Therefore, reliance solely on anthropometric measurements may not provide optimal precision in obese individuals.

Ultrasonography (USG) has emerged as a valuable adjunct in regional anaesthesia and neuraxial procedures. Preprocedural ultrasound imaging allows visualization of vertebral anatomy, identification of intervertebral spaces, and estimation of the distance from the skin to the dura mater. Several studies have shown that ultrasound guidance improves first-pass success rates, reduces needle attempts, and enhances patient safety, especially in patients with difficult spinal anatomy (6,7).

The use of ultrasonography for assessing subarachnoid space depth has gained increasing importance in overweight and obese individuals because it provides a non-invasive and individualized estimation of spinal depth compared to conventional landmark techniques. Correlation between ultrasonographic measurements and measured spinal depth has been reported to be high in several studies (8). However, data comparing anthropometric and ultrasonographic methods specifically in patients with BMI >25 kg/m² remain limited in the Indian population.

Therefore, the present study was undertaken to compare subarachnoid space depth estimated using anthropometric parameters and ultrasonography with the measured subarachnoid space depth during spinal anaesthesia in patients with BMI >25 kg/m². The study also aimed to evaluate the correlation between BMI and subarachnoid space depth and to determine the accuracy of ultrasonography in predicting spinal depth.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational comparative study was conducted in the Department of Anaesthesiology at Kasturba Medical Hospital over a study duration from May 2024 to December 2025.

Study Population

The study included 100 adult patients with BMI >25 kg/m² who were scheduled to undergo surgeries under spinal anaesthesia.

Inclusion Criteria

- Patients aged between 18 and 65 years
- Either gender
- BMI >25 kg/m²
- American Society of Anesthesiologists (ASA) physical status I and II
- Patients willing to provide written informed consent

Exclusion Criteria

- Patients with spinal deformities such as scoliosis or kyphosis
- Previous history of spinal surgery
- Infection at the puncture site
- Coagulopathy or anticoagulant therapy
- Neurological disorders affecting the spine
- Pregnancy
- Patients unwilling to participate in the study

Methodology

After obtaining approval from the Institutional Ethics Committee and written informed consent from all participants, demographic and anthropometric parameters including age, gender, height, weight, and BMI were recorded. The subarachnoid space depth was assessed using both anthropometric measurements and ultrasonography.

Anthropometric Assessment

The predicted depth of the subarachnoid space was calculated using anthropometric parameters such as weight, height, and BMI-based predictive formulas. The estimated distance from the skin to the subarachnoid space was recorded before spinal anaesthesia.

Ultrasonographic Assessment

Preprocedural ultrasonography of the lumbar spine was performed using a low-frequency curvilinear probe (2–5 MHz). Patients were positioned in the sitting posture. Lumbar intervertebral spaces (L3–L4 or L4–L5) were identified using the paramedian sagittal oblique or transverse approach. The distance from the skin to the posterior complex/dura mater was measured and recorded as ultrasonographic subarachnoid space depth.

Spinal Anaesthesia Procedure

Under strict aseptic precautions, spinal anaesthesia was administered using a standard spinal needle at the identified intervertebral space. The measured depth from the skin to successful cerebrospinal fluid (CSF) flow was recorded and considered as the measured subarachnoid space depth.

Outcome Measures

Primary Outcome

- Comparison between anthropometric predicted depth and ultrasonographic measured depth of the subarachnoid space.

Secondary Outcomes

- Correlation of BMI with measured subarachnoid space depth
- Correlation between USG findings and measured spinal depth
- Accuracy of anthropometric prediction in overweight and obese patients

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) version 25.0. Continuous variables were expressed as mean \pm standard deviation (SD), while categorical variables were expressed as frequencies and percentages. Correlation between anthropometric measurements, ultrasonographic depth, and measured subarachnoid space depth was assessed using Pearson's correlation coefficient. Comparison between methods was performed using paired t-test. A p-value <0.05 was considered statistically significant.

RESULTS AND OBSERVATIONS

A total of 100 patients with BMI >25 kg/m² were included in the study. The observations regarding demographic profile, anthropometric measurements, ultrasonographic findings, and measured subarachnoid space depth are presented below.

Table 1: Demographic Characteristics of Study Population

Variable	Mean \pm SD / Number (%)
Age (years)	46.8 \pm 11.2
Male	58 (58%)
Female	42 (42%)
Height (cm)	164.5 \pm 8.1
Weight (kg)	82.6 \pm 10.4
BMI (kg/m ²)	30.4 \pm 3.8

The mean age of the study participants was 46.8 \pm 11.2 years. Majority of the participants were males (58%). The mean BMI of the study population was 30.4 \pm 3.8 kg/m².

Table 2: Distribution of Patients According to BMI Category

BMI Category (kg/m ²)	Number of Patients	Percentage
25–29.9	54	54%
30–34.9	32	32%
≥ 35	14	14%

Most patients belonged to the overweight category, while 46% were obese.

Table 3: Comparison of Anthropometric, Ultrasonographic, and Measured Subarachnoid Space Depth

Measurement Method	Mean Depth (cm)	Standard Deviation
Anthropometric Prediction	5.12	0.64
Ultrasonographic Measurement	5.48	0.58
Measured Subarachnoid Space Depth	5.56	0.61

The mean ultrasonographic subarachnoid space depth was closer to the measured subarachnoid space depth compared to anthropometric prediction.

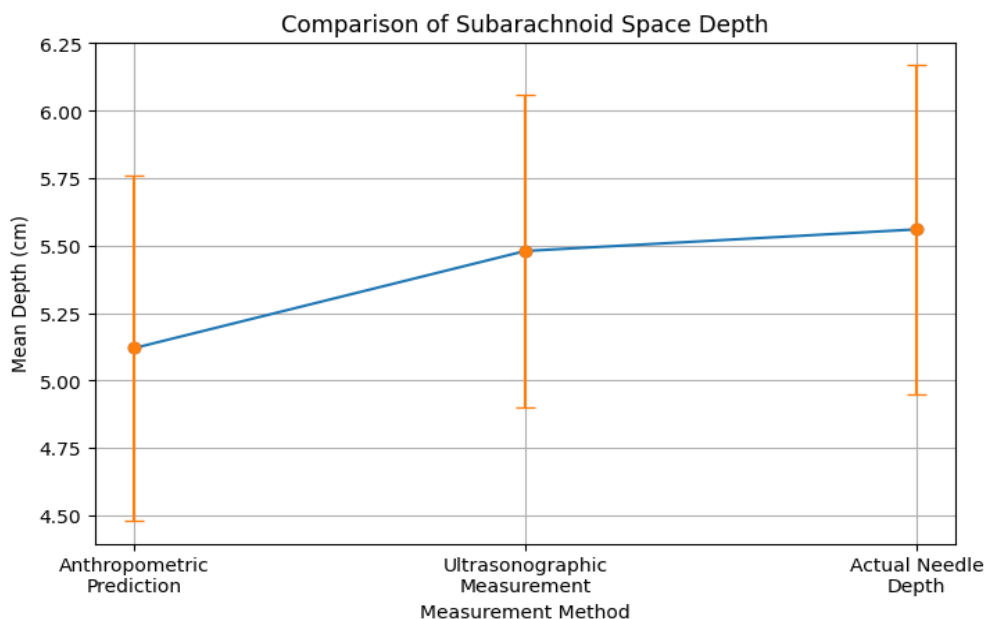


Table 4: Correlation of Different Methods with Measured Subarachnoid Space Depth

Variable Compared	Correlation Coefficient (r)	P-value
Anthropometric Prediction	0.71	<0.001
Ultrasonographic Measurement	0.93	<0.001

Ultrasonographic measurement showed a very strong positive correlation with measured subarachnoid space depth, whereas anthropometric prediction demonstrated moderate positive correlation.

Table 5: Comparison Between Predicted and Measured Subarachnoid Space Depth

Comparison	Mean Difference (cm)	P-value
Anthropometric vs Measured Depth	0.44 ± 0.26	<0.001
USG vs Measured Depth	0.08 ± 0.11	0.084

The difference between ultrasonographic and measured subarachnoid space depth was minimal and statistically non-significant, whereas anthropometric prediction showed significant difference.

Table 6: Correlation Between BMI and Measured Subarachnoid Space Depth

Parameter	Correlation Coefficient (r)	P-value
BMI vs Measured Subarachnoid Space Depth	0.82	<0.001

A strong positive correlation was observed between BMI and measured subarachnoid space depth.

DISCUSSION

In the present study, comparison of subarachnoid space depth using anthropometric measurements and ultrasonography was carried out in 100 patients with BMI >25 kg/m² undergoing spinal anaesthesia. The findings demonstrated that ultrasonographic assessment showed greater accuracy and stronger correlation with measured subarachnoid space depth compared to anthropometric prediction methods.

The mean BMI of the study population was 30.4 ± 3.8 kg/m², indicating that a substantial proportion of participants belonged to the obese category. Obesity is known to increase technical difficulty during neuraxial procedures because adipose tissue obscures spinal landmarks and increases the skin-to-subarachnoid space distance (9).

In the present study, the mean measured subarachnoid space depth was 5.56 ± 0.61 cm. The ultrasonographic measurement (5.48 ± 0.58 cm) was found to be very close to the measured depth, whereas anthropometric prediction underestimated the depth (5.12 ± 0.64 cm). This finding suggests that ultrasonography provides a more precise estimation of spinal depth in overweight and obese patients.

These findings are comparable with the study conducted by Balki et al., who demonstrated strong correlation between ultrasound-estimated and measured neuraxial depth in obese parturients (10). Similarly, Sahin et al. reported that

preprocedural ultrasound significantly improved identification of spinal landmarks and depth estimation compared to conventional methods (11).

The present study demonstrated a very strong positive correlation between ultrasonographic measurements and measured subarachnoid space depth ($r=0.93$, $p<0.001$), while anthropometric prediction showed moderate correlation ($r=0.71$, $p<0.001$). Similar findings have been reported by Bonazzi et al., who observed high accuracy of ultrasound in estimating spinal depth during lumbar spinal anaesthesia (12).

Another important finding of the study was the strong positive correlation between BMI and measured subarachnoid space depth ($r=0.82$, $p<0.001$). Increasing BMI was associated with greater spinal depth, which supports previous studies suggesting that obesity contributes to increased soft tissue thickness and difficulty during neuraxial procedures (13).

The comparison between predicted and measured depth showed that the difference between ultrasonographic and measured subarachnoid space depth was minimal and statistically non-significant, whereas anthropometric estimation differed significantly. This further emphasizes the accuracy and clinical utility of ultrasound guidance in overweight and obese individuals. Ultrasound imaging helps anaesthesiologists identify the optimal puncture site and needle trajectory, thereby reducing failed attempts and patient discomfort (14).

Although anthropometric formulas are simple and inexpensive, they may not adequately account for anatomical variations among individuals. Ultrasonography, on the other hand, provides real-time anatomical assessment and individualized estimation of spinal depth.

However, the study had certain limitations. It was conducted at a single tertiary care centre with a relatively limited sample size. Operator expertise in ultrasonography may also influence measurement accuracy. Further multicentric studies with larger sample sizes are recommended to validate these findings and establish standardized predictive models. Overall, the findings of the present study indicate that ultrasonography is a reliable and superior modality for estimating subarachnoid space depth in patients with BMI >25 kg/m² and may improve the success and safety of spinal anaesthesia procedures.

CONCLUSION

The present study demonstrated that ultrasonographic assessment of subarachnoid space depth was more accurate and showed a stronger correlation with measured subarachnoid space depth during spinal anaesthesia compared to anthropometric prediction methods in patients with BMI >25 kg/m². Ultrasonography provided a reliable estimation of spinal depth and may improve the success rate and safety of spinal anaesthesia in overweight and obese patients. Increasing BMI was significantly associated with greater subarachnoid space depth, highlighting the usefulness of preprocedural ultrasound guidance in patients with difficult spinal anatomy.

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