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ESTIMATION OF SKIN-TO-SUBARACHNOID SPACE DISTANCE IN PATIENTS UNDERGOING SURGERY UNDER SPINAL ANAESTHESIA

Anaesthesiology

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ABSTRACT

Background: Accurate estimation of skin-to-subarachnoid space depth (SSD) is critical for successful spinal anesthesia. Misestimation can lead to failed attempts, traumatic punctures, and complications. While traditional landmark-based techniques are widely used, they often prove unreliable in patients with obesity or edema. Ultrasonography and demographic factors, including body mass index (BMI), have been suggested as alternatives for improving SSD precision. However, limited data exist for the Indian population, particularly in the Kumaon region. **Objective:** To estimate SSD in patients undergoing surgery under spinal anesthesia and analyze its correlation with demographic and anthropometric parameters such as age, gender, weight, height, and BMI. **Methods:** This observational cross-sectional study was conducted on 462 patients aged ≥18 years at Dr. Sushila Tiwari Memorial Government Hospital, Haldwani, from 2021 to 2024. SSD was measured using a 25G Quincke spinal needle at the L3-L4 level. Data were analyzed using SPSS version 25.0, and logistic regression identified significant predictors of SSD. **Results:** The majority of participants (74.5%) had an SSD between 41–50 mm. Significant predictors of SSD included gender ($p = 0.038$), weight ($p = 0.043$), and BMI ($p = 0.054$). Age and height were not statistically significant. No gender-based differences in SSD were observed ($p = 0.548$). **Conclusion:** Gender, weight, and BMI significantly influence SSD measurements, underscoring the need to consider these factors in clinical practice. Pre-procedural SSD estimation improves procedural accuracy, minimizes complications, and enhances patient outcomes.

KEYWORDS

Spinal anesthesia, skin-to-subarachnoid space depth, body mass index, demographic factors, ultrasonography

INTRODUCTION

Central neuraxial blockade, a widely used anesthetic technique, involves the precise deposition of local anesthetics into the subarachnoid space. The procedure requires the needle to pass through various anatomical layers, including skin, subcutaneous tissue, ligamentous structures, and dura mater (1). Accurate estimation of the skin-to-subarachnoid space distance (SSD) is critical for successful spinal anesthesia. Misestimation can result in failed attempts, traumatic punctures, and patient discomfort. (2)

Traditional reliance on anatomical landmarks for SSD estimation often proves unreliable, especially in obese or edematous patients, where palpation is challenging (3). Ultrasonography, introduced by Porter et al. in 1978, has improved accuracy by visualizing spinal anatomy and guiding SSD estimation (4). Factors such as BMI and body surface area (BSA) have also been used to enhance procedural precision (4, 5). Pre-procedural SSD estimation reduces complications, procedural time, and unnecessary needle redirection while aiding in the selection of appropriately sized needles, particularly for varying body compositions (5,6). However, limited data exist on SSD in the Indian population, especially in the Kumaon region. This study aims to estimate SSD in patients undergoing surgery under spinal anesthesia and analyze its correlation with demographic and anthropometric parameters like age, gender, and BMI, ultimately improving procedural safety and outcomes.

MATERIAL AND METHODS

This observational cross-sectional study titled "Estimation of Skin-to-Subarachnoid Space Distance in Patients Undergoing Surgery Under Spinal Anaesthesia" was conducted at Dr. Sushila Tiwari Memorial Government Hospital, Haldwani, between 2021 and 2024, following approval from the Institutional Ethical Committee.

Study Design And Sampling

The study employed a simple random sampling method to select participants, ensuring equal opportunity for inclusion. The calculated sample size was 462, factoring in a 20% non-response rate, based on a confidence interval (CI) of 95%, an error margin (d) of 5%, and an assumed prevalence of 50% for SSD derived from a study by Prakash et al.

Inclusion Criteria

- Patients aged 18 years and above scheduled for surgeries under spinal anesthesia.

Exclusion Criteria

- Spinal deformities.
- Patient refusal.
- Contraindications to spinal anesthesia.

Study Procedure

Following ethical approval, patients meeting inclusion criteria underwent thorough evaluation, including detailed history, physical examination, and routine investigations. Eligible patients, after receiving fitness clearance from the pre-anesthesia checkup clinic, were enrolled in the study. Standardized forms documented patient demographics, including name, age, sex, weight, height, and physical status.

Informed consent was obtained prior to the procedure. Spinal anesthesia was administered at the L3-L4 level using a 25G Quincke spinal needle. The depth to the subarachnoid space was determined by holding the needle at the skin level and marking the insertion point. After removal, the distance from the marked point to the needle tip was measured using a scale.

Statistical Analysis

Data were recorded in Microsoft Excel and analyzed using SPSS version 25.0. Quantitative variables were presented as mean and standard deviation, while qualitative variables were expressed as frequencies and percentages. The chi-square test assessed frequency differences, and logistic regression evaluated predictors of SSD. A p-value < 0.05 was considered statistically significant.

RESULTS

The distribution of skin-to-subarachnoid space depth (SSD) across different age groups is shown in Table 1. Most participants (74.5%)

had an SSD of 41–50 mm, with significant variation observed across age categories (p-value = 0.00).

Table 1: Comparison Of Age With Skin-to-subarachnoid Space Depth (SSD)

Skin to Subarachnoid Space (mm)	18-30	31-40	41-50	50 and Above	Total	P-value
31-40	23	0	1	0	24	0.00
41-50	243	48	15	38	344	
51-60	46	24	5	19	94	
Total	312	72	21	57	462	

Table 2 compares skin-to-subarachnoid space depth (SSD) between males and females. The majority of participants (74.5%) in both sexes had an SSD of 41–50 mm, with no significant difference between sexes (p-value = 0.548).

Table 2: Comparison Of Sex With Skin-to-subarachnoid Space Depth (SSD)

Skin to Subarachnoid Space (mm)	Male	Female	Total	P-value
31-40	9	15	24	0.548
41-50	162	182	344	
51-60	47	47	94	
Total	218	244	462	

Table 3 represents the logistic regression analysis that examines the relationship between skin-to-subarachnoid space depth (SSD) and study variables. Significant predictors include **sex** (p = 0.038) and **weight** (p = 0.043). BMI shows a trend toward significance (p = 0.054), while age and height do not have a statistically significant association with SSD.

Table 3: Logistic Regression Analysis Comparing The Skin To Subarachnoid Space Depth (SSD) With Study Variables

	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**Lower to Upper Bound**
(Constant)	-8.305	4.642	—	-1.789	0.074	-17.428 to 0.818
Age	0.001	0.001	0.042	1.165	0.245	-0.001 to 0.004
Sex	-0.067	0.032	-0.070	-2.078	0.038	-0.131 to -0.004
Weight (kg)	-0.071	0.036	-0.345	-0.582	0.043	-0.091 to 0.049
Height (m)	5.003	2.948	0.421	1.697	0.090	-0.790 to 10.796
BMI	0.181	0.088	0.986	1.753	0.054	-0.019 to 0.329

A. Dependent Variable: Skin

DISCUSSION

This study explored demographic and physiological variables such as age, gender, body weight, height, body mass index (BMI), and skin-to-subarachnoid space depth (SSD), which are essential parameters in procedures like spinal anesthesia.

We found the majority of participants (74.46%) had an SSD measurement within the range of 41–50 mm. This observation aligns with previous findings by **Basgul et al. (2004) (7)** and **Prakash et al. (2014) (8),** who reported comparable SSD ranges in their respective studies. Precise knowledge of SSD is crucial for spinal anesthesia, as emphasized by **Gogarten and Van Aken (2000) (9)**.

The SSD distribution remained consistent across age groups, with 41–50 mm being the predominant range. This consistency supports the observations of **Howard et al. (2002)(5)** and **Watts (1993) (10),** who concluded that age does not significantly impact SSD. These findings suggest that age may not be a key determinant when predicting SSD for spinal anesthesia.

In our study, SSD measurements showed no substantial variation between males and females, indicating that gender does not significantly influence SSD. This result is consistent with the findings of **Prakash et al. (2014) (8)** and **Basgul et al. (2004) (7),** who also reported no major gender-related differences in SSD.

The regression analysis revealed that variables such as gender, weight, and BMI had a significant impact on SSD, underscoring their relevance in clinical practice. This finding aligns with the studies by **Watts (1993) (10)** and **Ravi et al. (2011) (11),** which also identified these factors as significant determinants of SSD. Conversely, variables like age and height showed no statistically significant effect on SSD, consistent with the observations of **Jayaraman et al. (2009)(12)** and **Basgul et al. (2004) (7)**.

This emphasizes the demographic and physiological characteristics of our study population and compares them with prior research. The findings underscore the importance of considering gender, weight, and BMI in clinical and research contexts involving SSD measurements. Our study contributes to the existing body of knowledge and provides valuable insights for future research and clinical applications.

CONCLUSION

This present study successfully highlighted the importance of estimating the skin-to-subarachnoid space depth (SSD) in patients undergoing spinal anesthesia. The majority of participants had an SSD within the range of 41–50 mm, with gender, weight, and BMI being significant predictors. Conversely, age and height did not have a notable influence on SSD. These findings emphasize the role of demographic and anthropometric factors in improving procedural accuracy and outcomes during spinal anesthesia. By identifying the key determinants of SSD, this study contributes to optimizing clinical practices and patient safety.

Recommendations

Pre-procedural SSD estimation should become a standard practice to reduce complications such as failed attempts and needle misplacements. Given the significant influence of gender, weight, and BMI on SSD, these parameters should be routinely assessed to ensure the selection of appropriately sized spinal needles. The use of ultrasonography, especially in patients with challenging body compositions, could further enhance procedural accuracy and safety. To validate these findings and expand their applicability, future large-scale studies should explore SSD estimation across diverse populations and settings.

Limitations

This study was limited to a single-center setting, which may affect the generalizability of its findings to broader populations. Additionally, ultrasonography was not employed for SSD verification, which could have improved measurement accuracy. The reliance on manual measurements introduced a potential for minor observational bias. Furthermore, the study focused exclusively on adult patients, leaving gaps in applicability for pediatric or geriatric populations. Lastly, operator experience, which could influence outcomes during spinal anesthesia, was not standardized or accounted for in the analysis.

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