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Anthropometric Determinants of Skin – to – Subarachnoid Space Distance in Patients Undergoing Lower Limb Orthopedic Surgery Under Spinal Anesthesia: A Retrospective Observational Study

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ABSTRACT

Background: Lumbar puncture is a difficult medical skill and used by anesthetists for administering local anesthetics to the subarachnoid space. Prior knowledge of how far the needle needs to be inserted from skin to the subarachnoid space distance (SSD) has a paramount role to guide spinal needle placement and reduce complications related to lumbar puncture. Therefore, we aimed to determine the depth of spinal needle insertion and its associated factors among patients who underwent surgery under spinal anesthesia.
Methods: This is a retrospective observational study design was conducted among 102 patients that underwent lower limb Orthopedic surgeries under spinal anesthesia. Once the subdural space was entered, the distance from skin entry point to the tip of the spinal needle was measured. The data were entered into an MS Excel spreadsheet and analyzed using SPSS v21. Descriptive analysis, student T test and Pearson's correlation coefficient was used.
Results: 102 case files were taken of patients undergoing lower limb surgeries under spinal anaesthesia. 48 were male with a mean age of 36.77 +/- 12.62 years. In the study with a mean height, weight and body mass index (BMI) of 158.32 cm, 56.8 kg, and 24.2 kg/m2 respectively. The mean distance from skin to the subarachnoid space was 5.61 ± 0.72 cm ranging from 3.7 to 7.5 cm. Age, weight and BMI had statistically significant effect on the mean SSD ($p < 0.001$, $p < 0.001$ and $p = 0.014$) respectively.
Conclusions: The distance from the skin to the subarachnoid space was differed among individuals. The SSD was affected by individuals' age, BMI and weight. Hence, to minimize complications, these factors should be taken into consideration at the time of spinal needle insertion.

Keywords: *Lumbar puncture, lower limb surgeries, BMI, CSF.*

INTRODUCTION

Anesthetists frequently use lumbar punctures to inject local anaesthetics into the subarachnoid space. Spinal needle placement may be guided by a pre-puncture estimate of the skin to subarachnoid space distance (SSD), in addition to technical proficiency and anatomy knowledge. Failure to collect CSF despite spinal needle insertion may indicate the offline point and inclination for needle retraction and redirection. For a patient who is slim, a standard spinal needle might be too long, while for an obese patient, it might not be long enough, leading to repeated punctures and failed attempts, which would cause more suffering for the patient.

Therefore, choosing a spinal needle with the proper length would be made easier with an understanding of SSD [2,3]. SSD shown statistically significant correlations with height, weight/height ratio, body surface area (BSA), BMI, and body weight, according to a number of research [[4], [5], [6]]. On the other hand, these studies also showed that there is no

relationship between SSD and age, gender, or ethnicity. Under spinal anaesthesia, a variety of lower extremity and lower abdominal procedures are carried out. The potential consequences of spinal anaesthesia may be minimized if the distance the needle must be placed to reach the subarachnoid area is known in advance. However, lumbar punctures can be difficult for a minority of people, such as those who are obese, elderly, or have underlying structural spinal abnormalities. The operation is time-consuming, frequently ineffective, and can cause severe discomfort in these individuals [3, 7]. Inability to insert the needle easily into the subarachnoid area raises the risk of headaches following the puncture, brain injury, and epidural hematoma. The most common cause of a traumatic tap and dry tap (which is characterized as a tap with macroscopic blood) is when the needle is inserted overly laterally or moved too far anteriorly [8].

MATERIALS AND METHODS:

This was a retrospective study performed in the Department of Anaesthesiology at a tertiary care hospital. This study included 102 patients that underwent lower limb orthopedic elective Surgery.

The participants were given aseptic precautions (a standard procedure for giving spinal anaesthesia) and positioned in a sitting position with their backs fully flexed. Using the Tuffier's line as a reference, the L3-L4 or L4-L5 intervertebral spaces were where the lumbar puncture was done. The site of needle entry was palpated and found to be the depression in the spinous processes of the spine situated above and below the point at which to be used. A 25 gauge Quincke spinal needle was used to puncture the dura via the midline route. The spinal needle was placed horizontal to the skin and progressed till there was no more resistance, which was verified by the CSF starting to flow freely. The needle was extracted from the patient's back after local anaesthetics were injected into the subarachnoid space. It was removed by pinching it between the thumb and index finger. A standard ruler was then positioned in the room to measure the depth of insertion. Using the given checklist, the senior anesthetist and postgraduate anaesthesia students conducted the measurement.

As per institutional protocol, the depth of insertion was measured as the distance in skin-to-subarachnoid space in cm. Age, sex, height, weight, BMI, WHR, and kind of operation were also recorded.

RESULTS

102 case files were taken of patients undergoing lower limb surgeries under spinal anaesthesia. 48 were male with a mean age of 36.77 +/- 12.62 years. In the study with a mean height, weight and body mass index (BMI) of 158.32 cm, 56.8 kg, and 24.2 kg/m2 respectively. The mean distance from skin to the subarachnoid space was 5.61 ± 0.72 cm ranging from 3.7 to 7.5 cm the population was further divided into two groups

Table 1: - variables assessed

variables	mean	SD
age	36.77	12.62
height	158.32	21.55
weight	56.8	9.63
BMI	24.2	1.89
depth of insertion	5.61	0.72

A- SSD less than 4 cm
B- SSD more than or equal to 4 cm

The above two groups were corelated with various demographic parameters obtained from the case records. Age, weight and BMI had statistically significant effect on the mean SSD ($p < 0.001$) respectively.

Table 2: - correlation of mean depth of SSD with variables

DEPTH OF INSERTION	BMI > 24	HEIGHT > 160	AGE > 40
< 4 CM	24	30	68
>= 4 CM	53	57	34

DISCUSSION

The goal of the current study was to quantify the distance between the skin and the subarachnoid space and to forecast its model, with a particular focus on the ideal depth at which to put a spinal needle in a patient's lumbar region to minimize difficulties. The body mass index (BMI), height, weight, age, and sex all had an impact on the distance. Age, weight, and BMI were the confounding variables that had a statistically significant impact on the mean distance between the skin and the subarachnoid space.

Across the entire study cohort, the mean SSD was 5.13 ± 0.69 cm, with a range of 3.5 to 7.1 cm. The participants' ages ranged from 18 to 78 years old, with a mean age of 32.9 ± 11.8 years.
However, in order to prevent the procedure's negative effects, the prior research were limited to a specific population—pediatrics [12,13]. The SSD in the parturient population (5.54 ± 0.64 cm) was substantially bigger than the SSD in the male (4.78 ± 0.51 cm) and female non-pregnant population (4.74 ± 0.52 cm) populations.

Compared to the Western population, the mean SSD of the study participants is relatively shorter [7,14,15]. Research conducted in Turkey, Greece, and the USA revealed that the mean SSD was
5.40 ± 0.66 cm, 5.4 ± 0.7 cm in patients who were male, and 5.61 cm, respectively [3,11,16]. Our population's shorter mean SSD is most likely caused by anthropometric variations among the research participants. Conversely, the mean SSD was lower in the populations of Egypt (4.99 ± 0.48 cm) and India (4.71 ± 0.31 cm) [1,2].

A statistically significant link between the SSD and obesity/BMI was shown in a number of research conducted in India, the United States, Iran, Turkey, Belgium, and France [[2], [3], [4], [5], [6],11,14]. In a similar vein, our research revealed a statistically significant correlation between a greater BMI and an SSD. The layer that varies the greatest in relation to a patient's weight is the subcutaneous tissue. Nonetheless, a Greek investigation revealed that in adult male patients, there was no obvious statistically significant correlation between the SSD and BMI [16.

CONCLUSION

Age, weight and BMI significantly influence the SSD, and thereby the difficulty of performing the lumbar puncture during spinal anaesthesia for lower limb orthopedic surgeries. However, further prospective surgeries are necessary to compare the effect of various surgeries as well as correlate it with imaging of the subcutaneous tissue to assess the importance of SSD.

DECLARATIONS

Ethics Approval and Consent to Participate: Ethical approval was not required for the above study. Informed consent was waived owing to the retrospective, de-identified nature of the study. Conflict of Interest: The authors declare no conflicts of interest.

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Data Availability: De-identified data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to institutional data governance approvals

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