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PREDICTION OF DEPTH FROM SKIN TO SUBARACHNOID SPACE BASED ON PREOPERATIVE ANTHROPOMETRIC ASSESSMENT: AN OBSERVATIONAL STUDY

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ABSTRACT

Background and aim: An accurate placement of spinal needle is crucial while injecting drugs to avoid a failed sub arachnoid block (SAB). A pre puncture estimation of skin to subarachnoid depth (SSD) may guide accurate spinal needle placement. This study is aimed to predict the depth from skin to subarachnoid space based on pre-operative anthropometric assessment and to find out formula for predicting SSD, best suited in terms of accuracy when compared with observed depth. **Method:** In this hospital based, prospective, observational study, a total of 120 patients, of which 68 were men, and 52 were women (non-pregnant) with a mean age of 59.75 ±14.1 kilograms. The SSD was measured after SAB was performed. This SSD was compared with the predicted SSD calculated using the Abe's, Bonadio's, Craig's, Stocker's, and Chong's modified formulae. Analysis was done using unpaired t test for quantitative data to determine best suited formula to predict SSD in our population in terms of both accuracy and ease of application. Pearson correlation test was also done. **Results:** The observed SSD in the overall study population was 4.96 ± 0.67 cm. Stocker's formula is closest with a mean difference of 0.17cm. In males the mean observed depth was (5.06±0.60 cm) more than that in the non-pregnant female population (4.83±0.74cm). These anthropometric variables were statistically significant with a presentation value of <0.001. **Conclusion:** Among various formulae Stocker's formula can most accurately predict the SSD when applied to Indian population.

INTRODUCTION

Subarachnoid block is performed as a routine anaesthetic procedure in orthopaedic surgery. Various factors may affect the success of correct placement of spinal needle. A pre-puncture estimate of skin to subarachnoid space depth may guide spinal needle placement apart from having a clear knowledge of spine anatomy and technical expertise. A failure in obtaining cerebrospinal fluid despite spinal needle being inserted further than the estimated depth requires it to be withdrawn and redirected for success [1]. An estimation of skin to subarachnoid space depth helping to guide spinal needle placement also results in less traumatic or bloody lumbar puncture and reduces

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unsuccessful and repeated attempts which causes discomfort to patients [1]. While there are several studies on distance from skin to epidural space, studies on SSD are relatively few so we have designed this observational study to evaluate the variation of SSD among male and non-pregnant female population and to determine which of the suggested formulae Abe's, based on height and weight, Bonadio's based on BSA, Craig's based on height, Stocker's based on weight, and Chong's modified for predicting SSD best suited in our population in terms of both accuracy and ease of application. [2-6]

Methodology

This hospital based, prospective, observational study was done in a tertiary care hospital, with due permission from the institutional ethics committee and research review board (168/MC/EC/2020. CTRI No.: CTRI /2020/06/025865). A total of 120 patients of age group 20-50 years, ASA I/II underwent lower limb surgery under spinal anaesthesia, were included in the study population.

PAE was done and patient's anthropometric variables were noted a day prior to surgery. On the day of surgery patient's written informed consent and fasting status was checked, patient's vitals (heart rate, blood pressure, oxygen saturation) were measured, Intravenous (IV) line was secured and under all aseptic precautions subarachnoid block was given in the sitting position. After painting and draping of the lumbar area a 25 G Quincke's spinal needle was introduced in L3-L4 intervertebral space by midline approach.

Free flow of cerebrospinal fluid (CSF) was confirmed and hyperbaric 0.5% bupivacaine was injected depending upon type of surgery and patient's variables. After intrathecal injection, spinal needle was firmly grasped between thumb and index finger and removed from patient's back. Depth of needle was measured by using a standard scale and noted. Patient was placed in the supine position. When adequate level of sensory block and motor block was achieved, surgery was started. After completion of surgery patient was shifted to recovery room.
Demographic variables including age, gender, height, weight, body surface are (BSA), Body mass Index (BMI).

BSA was calculated using Mostellar formula: $BSA\ (m2) = ([Height(cm) \times Weight(kg)]/3600)½$ and BMI using Quatelet index: $BMI = Weight\ (kg)/Height\ (m2\ )$.

To determine predicted SSD in overall population Abe's, Bonadio's, Craig's, modified Chong's and Stocker's formula was applied to study population. These formulas are as follows:

$$Abe's\ formula\ SSD\ (cm) = 17\ weight\ (kg)\ /\ height\ (cm)\ + 1 \quad [2]$$

$$Bonadio's\ formula\ SSD\ (cm) = 0.77\ cm\ +\ 2.56\ \times\ BSA\ (m2) \quad [3]$$

$$Craig's\ formula\ SSD\ (cm)\ = 0.03\ cm\ \times\ height\ (cm) \quad [4]$$

$$Stocker's\ formula\ SSD\ (mm) = 0.5\ \times\ weight\ (kg)\ + 18 \quad [5]$$

$$Chong's\ modified\ formula\ SSD\ (cm) = 10\ [weight\ (kg)/height\ (cm)]\ + 1 \quad [6]$$

The data was entered into Microsoft Excel spreadsheet. Analysis was done using SPSS version 20 (IBM SPSS Statistics Inc., Chicago, Illinois, USA) Windows software program. Descriptive statistics included computation of percentages, means and standard deviations. The unpaired t test (for quantitative data to compare two independent two groups) was used for quantitative data comparison of all clinical indicators. Pearson correlation test was also done. The trend of confidence would be kept 95% for all statistical analysis. Level of significance was set at $P \leq 0.0$

Results: The study population comprised of 120 (68 males and 52 female) patients who underwent orthopaedic surgery under spinal anaesthesia. Patient characteristics and skin to SSD were observed in this study using a predesigned proforma. The demographic parameters like age were 38 ±9.17 years, height was 165.18±10.0 centimetres, the weight was 59.75 ±14.1 kilograms, the BMI was 21.73±3.93 kg/m^2, and the BSA was 1.64±.23(m^2) [Table 1].

Table1: Anthropometric variables of study population

	Mean	S.D.
Weight(kg)	59.75	14.15
Height(cm)	165.18	10.0
BMI (kg/m^2)	21.73	3.92
BSA(m^2)	1.64	0.23

In our study SSD, both observed and predicted using various formulae, in the overall study populations were calculated. (Table 2) The observed SSD in the overall study population was 4.96± 0.67 cm, predicted by Bonadio's formula was 4.99±0.59 cm, predicted by Craig's formula was 4.95±0.29 cm, predicted

by Abe's formula was 7.13±1.20 cm, predicted by Stocker's formula was 4.79±0.68 cm, and predicted by Chong's modified formula was 4.60±0. 70cm. [Table 2]

Table2: Mean of observed depth and predicted depth using various formulas in study population:

Variables	Mean ± SD (cm.)
Observed SSD	4.96 ± 0.67
Predicted Bonadio	4.99 ± 0.59
Predicted Craig	4.95 ± 0.29
Predicted Abe	7.13 ± 1.20
Predicted Stocker	4.79 ± 0.68
Predicted Chong's modified	4.61 ± 0.70

The mean difference between predicted depth by Abe's, Stocker's, Chong's modified formula and observed depth were statistically significant (p values 0.001). Among the statistically significant differences, the least difference was between predicted depth by Stocker's and the observed depth (0.174 cm), followed by difference between predicted depth by Chong's modified and observed depth (0.36 cm) and then by difference between predicted depth by Abe's and observed depth (2.16 cm). (Table 3)

Table 3: Mean difference between predicted SSD using various formulas and observed depth in the overall study population

	Mean difference (cm)	95% CI	P value
Predicted Bonadio	0.02	-.161-0.143	0.9
Predicted Craig	-0.01	-.099-0.153	0.67
Predicted Abe	2.16	-2.38- (-1.91)	0.001(S)
Predicted Stocker	-0.17	-4.415-(-4.175)	0.001(S)
Predicted Chong's modified	-0.36	0.208-0.54	0.001(S)

In our study when we compared Anthropometric variables between male and female population it was found statistically significant (p 0.001). In male population mean Weight was 64.65±13.80 kg, mean Height was 169±0.09cm, Mean BMI was 22.26±3.73 kg/m2 and mean BSA was 1.73±0.22 m^2. In female mean Weight was 53.73±11.04 kg, mean Height was 159±0.06cm, Mean BMI was 21.19±4.03 kg/m^2 and mean BSA was 1.53±0. 17m^2.

In our study we found gender-based differences in SSD, observed SSD in males was more as compared to females but it was not statistically significant (p value 0.05). [Table 4]

Table 4: Mean of anthropometric variables and various depths in males and females.

A. Anthropometric variables	**Male**	**Female**	**P value**
Weight(kg)	64.65±13.80	53.73±11.04	0.001(S)
Height (cm)	169.0±0.09	159.0±0.06	0.001(S)
BMI (kg/m2)	22.26±3.73	21.19±4.03	0.001(S)
BSA(m2)	1.73±0.22	1.53±0.17	0.001(S)
B. Skin to subarachnoid depth (cm)	**Male**	**Female**	**P value**
Observed	5.07±0.60	4.83±0.74	0.05(NS)
Predicted Bonadio	5.22±0.58	4.67±0.46	0.001(S)
Predicted Craig	5.09±0.283	4.77±0.21	0.001(S)
Predicted Abe	7.44±1.21	6.69±1.13	0.001(S)
Predicted Stocker	5.03±0.71	4.47±0.56	0.001(S)
Predicted Chong's Modified	4.79±0.71	4.35±0.66	0.001(S)

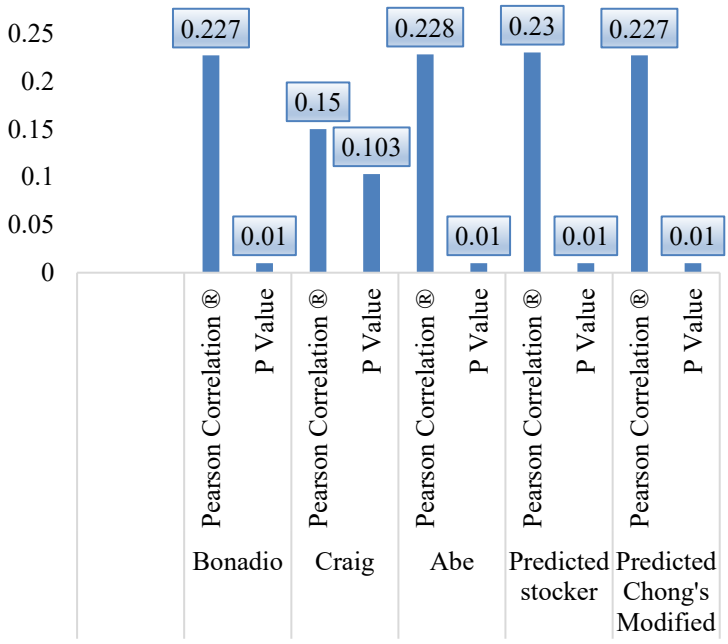

Fig 1. Skin to Subarachnoid Depth in Males and Females

In our study there was a positive Pearson correlation between observed depth and other formulas and all were statistically significant (p.01). Among the positive correlated depths Stocker's formula had the strongest correlation (0.23) with our observed depth and was statistically significant whereas observed depth and Craig's were found to be least correlated with Pearson correlation (0.15). [Table 5]

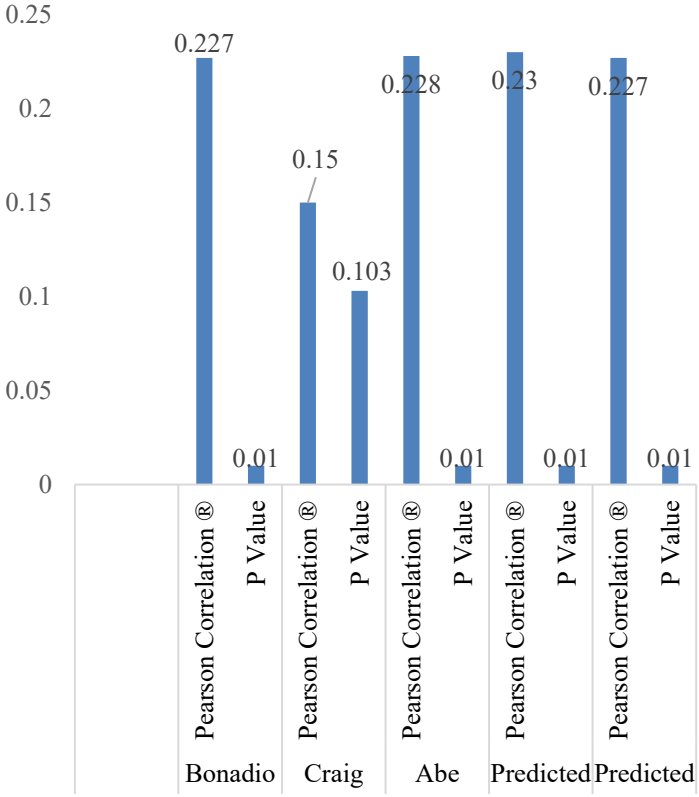

Fig 2. Pearson Correlation of Observed SSD to Depth Based on Other Formulae

DISCUSSION

The observed subarachnoid depth (SSD) in the overall study population was 4.96 ± 0.67 cm. The mean difference between predicted depth by various formulae (Abe's, Stocker's, and Chong's modified) and observed depth was statistically significant. Among statistically significant differences observed depth was found to be closest to Stocker's with a mean difference of 0.17cm. In males the mean observed depth was (5.06±0.60 cm) more than that in the female population (4.83±0.74cm). The Anthropometric variables (weight, height BMI, BSA) between male and female population were found statistically significant. There was a positive Pearson correlation between observed depth and other formulas with strongest positive correlation between observed depth and predicted depth by Stocker's formula (0.230). In our study observed SSD was more as compared to the observed SSD in the study by Prakash et al [1]. It could be possibly because of more weight (59.75 ±14.1 Kgs) of our patients as compared to weight (57.9±12.7kg) of patients in their study.

The shorter SSD 4.96 ± 0.67 cm in our population as compared to other populations is possibly because of anthropometric differences between the study subjects, our patients being shorter and less heavy [7,8].

Taman [7] have done study in Egyptian population and found the difference in mean of actual measured SSD in the overall study population and the calculated means of SSD by different formulae was 3.78 cm, 0.82 cm, 0.15 cm, 0.49 cm, and 0.85 cm when Abe's, Bonadio's, Craig's, Stocker's, and Chong's modified formulae were applied to their study population, respectively. In their study it was least by Craig's formula.

We found gender-based differences in SSD, observed SSD in males (5.06±0.60 cm) was more as compared to females(4.83±0.74cm) but it was not statistically significant (p value 0.05). These results are in agreements with previous studies.

In our study when we compared Anthropometric variables between male and female population the difference was statistically significant (p 0.001). The mean difference in predicted depth by various formulas and actual observed depth was 0.024 for Bonadio's, -0.012 for Craig's, 2.16 for Abe's, -0.174 for Stocker's and -0.3615 for Chong's modified formula. The mean difference between Predicted depth by Craig's and observed depth (4.9675±0.67 cm) was found to be least (0.012cm) followed by the mean difference between predicted depth by Bonadio's and observed depth (0.024cm). They were both statistically insignificant with p values >0.05.

In our study there was a positive Pearson correlation between observed depth and other formulas. The Pearson correlation coefficient with Bonadio was 0.227, with Abe was 0.228, with Stocker was 0.230 and with Chong' modified was 0.227. All were statistically significant (P.01). Among the positively correlated depths Stocker's formula had the strongest correlation (0.230) with our observed depth and was statistically significant. Observed depth and Craig's were found to be least correlated

with Pearson correlation (0.15) and were not significant (p value 0.1). In their study Prakash et al [6] also found Observed depth and Craig's were to be least correlated with Pearson correlation (0.23).

CONCLUSION

Subarachnoid depth skin to subarachnoid depth in adult males has been found to be more than that in nonpregnant females. Among various formulas, Stocker's formula has been found most accurately predict the SSD when applied to Indian population.

FINANCIAL ASSISTANCE

Nil

CONFLICT OF INTEREST

The authors declare no conflict of interest

AUTHOR CONTRIBUTION

Mamta Khandelwal and Ekta Tiwari planned the study, did a literature survey, designed the manuscript, collected the data, and performed the study. Priyanka Jain and Nachiketa Bharadwaj assisted in the statistical analysis and peer review. The final manuscript was read and approved by all authors.

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