Estimation of Skin to Subarachnoid Space Depth: An Observational Study

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ABSTRACT

Introduction: In a patient, the skin to Subarachnoid Space Depth (SSD) varies considerably at different levels of the spinal cord. It also varies from patient to patient at the same vertebral level as per age, sex and Body Mass Index (BMI). Estimation of the skin to SSD reduces complications related to spinal anaesthesia.

Aim: To measure the skin to SSD in the Indian population and to find a formula for predicting this depth.

Materials and Methods: Three hundred adult patients belonging to American Society of Anaesthesiologist class I and II, undergoing surgery using spinal anaesthesia in various surgical specialities of Gauhati Medical College were selected by systemic sampling for this prospective, observational study. Patients were divided into three groups: Group M containing male patients, Group F containing non-pregnant female patients, and Group PF containing pregnant female’s patients. SSD was measured after performing lumbar puncture. The relationship between SSD and patient characteristics were studied, correlated and statistical analysis was used to find a formula for predicting the skin to SSD. Statistical analysis was done using Statistical Package for Social Sciences (SPSS 21.0, Chicago, IL, USA). One-way ANOVA with post-hoc (Bonferroni correction factor) analysis was applied to compare the three groups. Multivariate analysis was done for the covariates followed by a multivariate regression analysis to evaluate the covariates influencing SSD for each group separately.

Results: Mean SSD was 4.37±0.31cm in the overall population. SSD in adult males was 4.49±0.19cm which was significantly longer than that observed in female’s 4.18±0.39cm which was comparable with SSD in parturient 4.43±0.19 cm. The formula for predicting the skin to SSD in the male population was 1.718+0.077×BMI+0.632×Height, in nonpregnant female population was 1.828+0.077×BMI+0.018×Height+0.007×Age and 0.748+0.209×BMI+4.703×Height-0.054×weight in parturient females, respectively.

Conclusion: Skin to SSD correlated with the BMI in all the patients in our study.

INTRODUCTION

Local anaesthetic injected into the spinal subarachnoid space, acting on the spinal nerve roots is the principal site for central neuraxial blockade. Depending on the dose, concentration or volume of local anaesthetic used, posterior spinal nerve root blockade interrupt the somatic and visceral sensations, whereas anterior spinal nerve root blockade interrupt efferent motor and autonomic outflow. Spinal anaesthesia is a safe, inexpensive, reliable and effective method for providing regional anaesthesia for caesarean sections and lower abdominal surgeries [1,2]. Lumbar puncture with subarachnoid injection is a difficult medical skill to acquire, where success depends on the skill and experience of the physician, patient spine anatomy and patient positioning [3]. Epidural anaesthesia though widely practiced in developing countries, is costlier and requires more technical skill in comparison to spinal anaesthesia. Hence, spinal anaesthesia is ideally suited for use in resource constrained developing countries. Additional benefits with spinal anaesthesia include the preservation of spontaneous respiratory effort, eliminating unnecessary airway manipulations, risk reduction for aspiration pneumonia and surgical haemorrhage with lowered incidence of post-operative ileus. Spinal anaesthesia related complications include Post-Dural Puncture Headache (PDPH), urinary retention, lower back pain, etc [4].

An estimation of the skin to Subarachnoid Space Depth (SSD) has been shown to reduce the number of unsuccessful attempts, repeated attempts, traumatic or bloody lumbar punctures, often acting as a depth guide for proper spinal needle placement [5]. A failure in obtaining Cerebrospinal Fluid (CSF) despite proper spinal needle placement(beyond the estimated depth) would suggest an offline track, requiring needle redirection. The SSD varies considerably at different levels of the spinal column in an individual, inter-individual variation also exists at the same vertebral level [6]. So a pre-puncture estimation of the skin to the SSD may be a good guide for proper spinal needle placement [7]. Adequate knowledge of the SSD often aids in selection of an appropriate sized spinal needle. A conventional spinal needle may often be too long for a lean patient, while it may fall short of length for an obese patient resulting in multiple unsuccessful punctures, causing patient discomfort [7]. Therefore, a co-relation might exist between physical parameters like age, sex, height, weight and Body Mass Index (BMI) with SSD. By determining this co-relation between the physical parameters (age, sex, BMI) we may successfully and precisely predict the skin to SSD. Studies estimating the skin to SSD in the adult Indian population are relatively few and have been rarely evaluated based on gender, age, BMI [8]. Therefore, we designed an observational study to evaluate the variation of SSD among male, non-pregnant female and parturient female population in a tertiary care hospital in India.

MATERIALS AND METHODS

After proper approval from the institutional ethical committee this prospective, observational, analytical study was conducted under the Department of Anaesthesiology and Critical Care at Gauhati Medical College and Hospital from January to August, 2015. Convenience sampling of 300 patients aged 18 to 60 years, belonging to either sex, American Society of Anaesthesiologists (ASA) physical status I and II, parturient females, scheduled to undergo elective abdominal or lower limb surgeries under spinal
anaesthesia using midline approach were chosen as the sample population. Informed consent was obtained from the participants. They were further divided into three groups, GROUP M (containing 100 male patients), GROUP F (containing 100 non-pregnant female patients) and GROUP PF (containing 100 parturient female patients). Exclusion criteria included patients with neurological disorders, seizure disorder, spinal anomaly, low back pain, prior spine surgery, skin infection at the needle puncture site, sepsis, neuraxial anaesthetic drug allergy, coagulation disorders, associated medical illness with relatively contraindication to spinal anaesthesia, pregnant patients with hypertensive disorders & patients in whom paramedian approach of spinal anaesthesia had to be used were excluded from the study population.

Pre-anaesthetic evaluation with proper explanation of the procedure to be undertaken was done. The age, height, weight of the patients was recorded pre-operatively. Body Mass Index (BMI) was calculated using Quetelet index [3] (BMI = Weight in kg/height in meter). Patients were kept nil orally for 6 hours. On arrival at the operating room peripheral I.V. access was secured with a standard 18 gauge intravenous cannula, standard ASA monitors were attached and baseline vitals were noted. All patients were pre-medicated as per hospital protocol and received 10ml/kg of Ringer's Lactate solution over a period of 15 minutes before administering spinal anaesthesia. Following all aseptic and anti-septic precautions spinal anaesthesia was administered between the third and fourth lumbar inter-vertebral space with the patient in lateral recumbent position. A skin wheal was raised with the 1% lignocaine solution at the selected interspace and lignocaine solution was injected unto the interspinous ligament. Then a skin nick was made with the triangular knife over the wheal. Dural puncture was performed with a 23/25 gauge Quincke (3.5 inch/ 9cm) spinal needle using the midline approach with a slight cephalad angle to the skin. The needle was slowly advanced, when dural puncture was felt, the stylet was removed to observe for back flow of CSF. When free flow of CSF was observed the stellate was reinserted partially and the length of the needle was marked with a skin marker at the site of skin entry, later measured using slide callipers. The local anaesthetic was then injected into the subarachnoid space. The dose of intrathecal local anaesthetic was decided as per our hospital protocol, the patient characteristics and the surgical requirement. Traumatic lumbar puncture, any alteration in the angulation of the spinal needle compared to the angulation at the time of insertion, use of paramedian approach were eliminated from analysis of SSD. Following intrathecal injection, the spinal needle was marked and withdrawn and later the depth of insertion was measured using slide callipers to analyse the SSD. Surgery was started after desired level surgical blockade was achieved. Intra-operative monitoring as per standard protocol was done. Patients were managed on case by case basis by the concerned consultant anaesthesiologist.

STATISTICAL ANALYSIS
Statistical Package for Social Sciences (SSPS 21.0, Chicago, IL) was used for the analysis. Descriptive statistics for overall sample and group wise (Group M, Group F and Group PF) were calculated for all the variables. Data was expressed as mean and standard deviation. Demographic parameters and SSD were compared using one-way ANOVA with post-hoc (Bonferroni correction factor) analysis to observe significant differences among the study groups. Multivariate analysis was done. Forward step wise multivariate regression analysis was performed to see important covariates influencing SSD for each group separately. The p-value 0.05 (two tailed) was considered as statistically significant. Sample size calculation was based on a total of 6901(2308 male, 2260 non-pregnant female, 2332 parturient female) number of patients who were operated under spinal anaesthesia in the various surgical departments of the hospital, over a span of 8 months previously. Taking a confidence interval of 0.95 and using systemic sampling technique, a total sample size of 290 patients was determined (Group M=97, Group F=95, Group PF=98).

RESULTS
The study population comprised of 100 male, 100 non-pregnant female and 100 parturient female patients who underwent surgery under spinal anaesthesia under various departments such as Gynaecology, Orthopaedics, General surgery, Urology etc., in Gauhati Medical College and Hospital. Patient characteristics and skin to SSD were observed in this study using a predesigned proforma (Annexure 1). The overall mean and standard deviation of demographic parameters observed in our study population were an age of 35.48±12.38 years, the height of 156±0.06 centimeters, and the weight of 55.98±7.13 kilograms, the BMI was observed was 22.88±2.39 kg/m² [Table/Fig-1].

The demographic characteristics and skin to SSD observed in the three groups, Group M, Group F and Group PF are depicted in [Table/Fig-2]. The overall mean SSD was 4.37±0.31cm [Table/Fig-3].

Age in Group M and Group F was significantly different from Group PF. Height in Group M was significantly different from those in Group F and PF. BMI values in Group M were comparable with those in Group F but significantly different from those in Group PF. The age, height, weight and BMI values showed a statistically significant difference among the two groups. There was significant difference in BMI values among the 3 groups. Post-hoc Bonferroni correction factor comparisons after ANOVA analysis showed that, the observed SSD in Group M was significantly different from Group F but was comparable with Group PF [Table/Fig-4].

Multivariate regression analysis was performed to determine the covariates (age, height, weight, BMI) that influence SSD in our population. Informed consent was obtained from the participants. The study population comprised of 100 male, 100 non-pregnant female and 100 parturient female patients who underwent surgery under spinal anaesthesia under various departments such as Gynaecology, Orthopaedics, General surgery, Urology etc., in Gauhati Medical College and Hospital. Patient characteristics and skin to SSD were observed in this study using a predesigned proforma (Annexure 1). The overall mean and standard deviation of demographic parameters observed in our study population were an age of 35.48±12.38 years, the height of 156±0.06 centimeters, and the weight of 55.98±7.13 kilograms, the BMI was observed was 22.88±2.39 kg/m² [Table/Fig-1].

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The formulae to predict the SSD is applicable only for midline approach and not for paramedian approach of spinal anaesthesia. Other limitations of our study include non-randomisation of sample population. Multicentric prospective studies are required for the validation of the formulae.

**CONCLUSION**

Spinal anaesthesia is a reliable anaesthetic technique for lower abdominal, caesarean section, urological and lower limb surgeries. Based on our study findings, it can be concluded that there is a variation in skin to SSD based on age, sex and BMI, with a greater SSD being observed in male and pregnant female patients compared to the nonpregnant female patients. Skin to SSD may be correlated with the BMI as suggested by our study results. But multicentric studies taking larger population needs to be undertaken to further confirm our study results.
REFERENCES


