

Correlation between Interspinous Gap and the Ease of Spinal Anaesthesia: A Prospective Observational Study

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Abstract

Context: Spinal anaesthesia is a blind landmark based procedure, it can be challenging in some patients. The subarachnoid space should preferably be identified at the first attempt, as multiple punctures are associated with pain and patient discomfort, increase risk of postdural puncture headache, spinal hematoma formation, trauma to neural structures and permanent neurological sequelae. Predictors to assess the difficulty of spinal anaesthesia increases the chances of success with this blind technique prevent multiple attempts and add to patient comfort, thus increasing the quality of healthcare. **Aims:** We formulated this study to assess the ease/difficulty of spinal anaesthesia based on width of interspinous gap (ISG) and patient's characteristics. **Settings and Design:** A prospective observational study conducted in 77 ASA I and II patients of either sex and age between 18-65 years, posted for elective or emergency surgery under spinal anaesthesia. **Methods and Material:** The ISG was measured using vernier caliper at L4-L5 level in optimal flexed sitting position before spinal anaesthesia. The number of attempts, redirections and requirement of another spinal level were recorded. **Statistical analysis used:** Mean and Standard Deviation, Chi-square test, Independent t-test and p value. **Results:** The demographic data like age, gender, body mass index and type/gauge of spinal needle did not have any correlation with the ease of spinal anaesthesia while ISG was found to be significantly lower ($p = 0.000$) in patients who required more number of redirections, attempts and levels. **Conclusions:** ISG is a good predictor for the ease of spinal anaesthesia.

Keywords: Difficult Spinal Anaesthesia, Interspinous Gap, vernier caliper

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Introduction

Spinal anaesthesia (SA) is safe and effective alternative to general anaesthesia, and has multiple benefits like reduction in the rate of venous thromboembolism, myocardial infarction, requirement for postoperative analgesia, reduced sympathetic response to surgical stimulation,

reduction in morbidity and mortality, thereby it is also economical.¹ SA is a first choice in below umbilical abdominal, lower extremity, urologic, gynecologic, and anorectal surgeries.²

But it is a landmark based blind technique and sometimes become technically challenging and very difficult. Traumatic placement of a needle

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requiring multiple attempts and change of level has been related to many complications. Some are transient, such as postdural puncture headache and transient neurological symptoms, however, some are severe like trauma to neural structures, spinal hematoma causing permanent neurologic deficits and long-term disability.³ Multiple punctures are also associated with pain and patient discomfort due to which patients may be reluctant to undergo surgical procedure under spinal anaesthesia in future and opt for general anaesthesia.⁴ So, efforts have been made in order to predict the difficult neuraxial blockade for the purpose of minimizing the risk caused by traumatic placement of the needle. Several factors thought to be associated with technically difficult neuraxial block like age, gender, body mass index (BMI), and spine deformities were demonstrated in earlier studies.

Based on the quality of anatomical landmarks assessed by palpatory method, various predictors were mentioned earlier for the ease of performing spinal anaesthesia but as all were qualitative methods so the chances of subjective bias were possible. Shankar et al conducted a study by measuring spinous process width (SPW) and interspinous gap (ISG) with caliper and it was found that SPW is not associated with ease of spinal anaesthesia and ISG is a better predictor for the ease of performance of spinal anaesthesia.⁵ Atallah, et al have also attempted to devise difficulty scores for spinal anaesthesia based on radiological characteristics of lumbar spine.⁶

However, no absolute clinical predictors have been found so far. Hence, we formulated this study to assess the ease/difficulty of spinal anaesthesia based on width of ISG and patient's characteristics. This study can further add evidence and emphasis to the sparse literature on predictors for the ease of spinal anaesthesia.

Materials and Methods

The present study was a prospective observational study. 77 patients of either sex and age between 18-65 years of ASA I and II, posted for elective or emergency surgery under spinal anaesthesia were included in the study. Patients with spine deformities, previous history of spine surgery, any contraindication for spinal anaesthesia, not willing to give consent and pregnant patients were not included for the study. After obtaining the Informed consent, demographic details of patients including age, gender, height, weight, BMI were recorded. The lumbar puncture for spinal anaesthesia was performed by an experienced anaesthesiologist with more than 5 years of experience.

On the day of surgery, after the patient was brought to the operation theatre, intravenous access was established and intravenous fluid started. Standard monitors-SpO₂, NIBP, and ECG were connected. The patient was held by an assistant in optimal flexed sitting position. L4-L5 level was taken as the primary point of entry. These levels were estimated based on the Tuffier's line corresponding to L4-L5 level. The spinous process above and below the level were palpated and marked with a skin marker (Fig. 1).

The ISG between the adjacent spinous processes was then measured with a vernier caliper by the primary investigator. Vernier caliper is an instrument to measure very small distances even less than 1 mm with the help of main scale and vernier scale.⁷⁻⁹ After measuring the ISG, type and gauge of spinal needle was decided by the



anaesthesiologist who was performing spinal anaesthesia and was blinded to the measurement of ISG. The number of attempts, redirections and requirement of another spinal level were recorded.

An Attempt was defined as a new skin puncture, using a different interspace for giving spinal anaesthesia or change of needle.⁵

A Redirection was defined as withdrawing the needle to skin and changing its direction before advancing again. The success or failure as determined by the need for additional anaesthesia was also noted. The outcome measures that were used to assess the difficulty in performing the lumbar puncture for spinal anaesthesia are ≥ 3 redirections, >1 attempt and >1 level. These cut-offs were the same as used in an earlier study correlating the spinous process dimensions with the ease of spinal anaesthesia.

Indian study by Shankar et al reported that 28% patients required more than 3 redirections.⁵ The required sample size was calculated based on this prevalence, for 95% confidence interval and 10% precision and arrived as 77 patients. The value of $p < 0.05$ was considered statistically significant. Data was entered in Microsoft excel 2007 and SPSS version 19.0 (Statistical Packages for social sciences) was used for analysis. Chi-square test was done for comparing the categorical data like difficulty and ease in insertion, no of attempts, levels etc. Mean and SD were calculated for Age, Weight, BMI and ISG. Independent t-test was done to compare the difference in the mean ISG in one attempt & more than one attempt. The value of p is considered significant if $p \leq 0.05$.

Results

Table 1 summarizes the mean and standard deviation of the demographic characteristics and ISG. In our study, 70.1% patients were male and 29.9% patients were female. According to Table 2, it is clear that 3 or more than 3 redirections, more than 1 attempt and more than one level attempt was required in 27.3%, 28.6% & 9.1% patients respectively.

Table 1: Descriptive statistics

Variables	Mean \pm SD
AGE (years)	43.82 \pm 13.045
SEX(Male: Female)	54:23
BMI(Kg/m ²)	26.0388 \pm 4.18964
ISG(mm)	7.2306 \pm 0.69245

Twenty-one patients who required ≥ 3 redirections has a mean ISG of 6.44 (± 0.32)mm in contrast to 7.52 (± 0.54) mm in those with < 3 redirections ($p = 0.000$). 22 patients required > 1 attempt with a mean ISG of 6.45 (± 0.31) mm in contrast to 7.54 (± 0.53) mm in those with 1 attempt ($p = 0.000$) statistically significant. 7 patients with a mean ISG of 6.32 (± 0.37)mm required more than one level in

Table 2. Relationship between various factors & number of redirections, attempts and levels used (n=77)

Variable	≥ 3 redirections 21 (27.3%) (mean \pm SD)	< 3 redirections 56 (72.7%) (mean \pm SD)	p value	> 1 attempt 22(28.6%) (mean \pm SD)	1 attempt 55 (71.4%) (mean \pm SD)	p value	> 1 level 7 (9.1%) (mean \pm SD)	1 level 70 (90.9%) (mean \pm SD)	p value
Age(year)	42.43 \pm 13.62	44.34 \pm 12.91	0.45	41.45 \pm 14.05	44.76 \pm 12.62	0.25	44.00 \pm 15.52	43.80 \pm 12.90	0.96
Sex (%) Male:Female	24.07:34.78	75.92:65.21	0.33	25.92:34.78	74.07:65.21	0.43	7.40:13.04	92.59:86.95	0.43
BMI(Kg/m ²)	25.64 \pm 2.72	26.19 \pm 4.64	0.96	25.49 \pm 2.75	26.26 \pm 4.65	0.71	24.87 \pm 2.73	26.16 \pm 4.31	0.52
ISG(mm)	6.44 \pm 0.32	7.53 \pm 0.55	0.00	6.45 \pm 0.32	7.54 \pm 0.54	0.00	6.33 \pm 0.37	7.32 \pm 0.65	0.00

Table 3: Correlation Between Number of Attempts and Type/ Gauge of Spinal Needle

Type of needle	Size of needle	No. of patient	1 attempt	> 1 attempt	p -value
Whitacre	27	31	18	13	0.108
	25	45	37	8	
Quincke	23	1	0	1	

contrast to 70 patients with mean ISG of 7.32 (± 0.65) mm who required single level ($p = 0.000$). Also the table shows that the number of redirections, attempts and levels required have no significance in relation to age, gender and BMI. Table3 suggests no correlation between ease of spinal anaesthesia and size/type of the spinal needle used ($p = 0.108$).

Discussion

Spinal anaesthesia technique being an indispensable part of modern anaesthesia practice, every effort should be made for adequate preoperative prediction of difficult neural blockade to make the procedure less traumatic and more acceptable to patients. Ultrasound is useful in preoperative assessment of spine anatomy, especially if spine deformities are present but this requires expertise and not done routinely because of limited availability.¹⁰⁻¹¹

In the present study, we are focusing on ISG, which is a bony landmark as the predictor of ease of spinal anaesthesia. Our study has shown that the ISG is one of the most important predictor for the ease of spinal anaesthesia. In our study we measured ISG of 77 patients undergoing spinal anaesthesia and found that ISG was significantly higher ($p = 0.000$) in patients who required only one intervertebral space, one attempt and < 3 redirections. The results were similar to the study done by Shankar et al, there was a decreasing trend of difficulty with increased ISG.⁵ Hence, by measuring ISG using a vernier caliper which is a cheaper and much easier technique, we can predict easy/difficult neuraxial block and can choose the best intervertebral space for successful central neuraxial block.

Our study did not find any significance between the age of the subject and number of redirections, attempts or spaces used. Chien et al.², Shankar et al.⁵ and Khoshrang et al.¹² reported that age was not associated with the first-level success or first attempt success, which was similar to our study. In a study done by Ruzman, et al., it was found that the block was easier to perform in younger patients ($p = 0.007$), which might be expected due to less incidence of spine deformities and probably better compliance during the procedure in younger patients.¹³ However, no patient was older than 65 years in our study, which could be the cause of no correlation seen between age and difficult spinal anaesthesia.

In our study relation with gender of the patient was also not significant which was similar to the study by Khoshrang et al.,¹² Sprung et al.,¹⁴ where there was no significance between the gender and the ease of spinal anaesthesia.

Our study did not find BMI to be the predictor in assessing the ease of spinal anaesthesia which was similar to the study of Shankar et al.⁵ and Sprung et al.¹⁴ Contrary to this, Ruzman et al. showed difficulties in performing the block were often associated with higher BMI 28.79 ± 5.70 ($p = 0.020$) as compared to patients who had first attempt success of neuraxial block (BMI 27.23 ± 5.39).¹³ In our study the mean BMI was 26.3 ± 4.19 lesser than at which the difficulty was found in their study.

The highest percentage of successful blocks in the study by Ruzman et al.¹³ was found with finer gauge spinal needle (27 G) ($p = 0.000$). However, in our study there was no statistically significance correlation found between the successful block and gauge/type of needle used which was similar to the study by Sprung et al.¹⁴ & Tarkkila et al.¹⁵ This could be explained by the fact that 27G needle was mostly used in young patients with normal spine anatomy and normal BMI in Ruzman et al study.

Hence, lesser ISG is likely to be associated with more number of attempts for spinal anaesthesia and thus more complications like backache, postdural puncture headache (PDPH), intraspinal haematoma formation, arachnoiditis, meningitis, neural Injury like nerve root damage, spinal cord damage, cauda equina syndrome etc.⁵ Among general population back injury is the most feared complication of the neuraxial anaesthesia.¹⁶ According to United Kingdom NHS audit, the overall rate of permanent nerve injury is 0.1 per 10000 mostly associated with procedure related risk factors like paresthesia or radicular pain during the procedure.^{17,18} Difficult or traumatic needle insertion, coagulopathy and

female gender are important risk factor associated with spinal epidural hematoma formation.¹⁹⁻²⁰ Although it is very rare complication but it's devastating nature caused US Food and drug administration to issue a warning in 1997 for the concurrent use of low molecular weight heparin and spinal/epidural anaesthesia.²¹⁻²² Traumatic and difficult neuraxial block also increases the chances of epidural abscess formation.²³

The Quality of anatomical landmarks was considered to be the single most important predictor of difficulty for neuraxial access and our study showed that ISG is a good predictor of difficulty for neuraxial access and routine preoperative measurement of ISG could enable us to predict the difficulty of performing the neuraxial blockade and would forewarn us to be prepared in preventing the incidence of complications associated with spinal anaesthesia which could be crippling and life threatening.² As pregnant patients were not included, so the results could not be generalized. Also patient's movements could have altered ISG dimensions and affected the precision of the ISG measurements. And radiological measurement of ISG was not done which could possibly increase the accuracy of measurements. These are the limitations of this study. So to conclude, ISG is a good predictor for the ease of spinal anaesthesia and there is no statistical significance correlation between ease of spinal anaesthesia and age, BMI, gender or needle size/type. We also recommend that measurement of ISG should be done before performing neuraxial block in order to minimize the complications.

Key Messages: Preoperative measurement of interspinous gap using vernier caliper is a cheaper and easier technique, to predict easy/difficult neuraxial block and can help in choosing the best intervertebral space for successful central neuraxial block.

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