

EASE OF ACCESS TO THE SUBARACHNOID SPACE AND ITS ASSOCIATION WITH SPINOUS PROCESS DIMENSIONS, IN PATIENTS UNDERGOING SPINAL ANAESTHESIA

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ABSTRACT

BACKGROUND

Spinal anaesthesia is a procedure commonly performed by the anaesthesiologist. Various reasons can lead to a difficulty in performing a lumbar puncture, leading to multiple attempts, thereby increasing chances of complications. Quality of anatomical landmarks is one of the predictors of successful performance of subarachnoid block.

MATERIALS AND METHODS

245 patients scheduled for surgery under spinal anaesthesia were enrolled. Interspinous gap and spinous process width were the measured study variables. Patients were classified as either having easy access to subarachnoid space or not, as the outcome variable. Association between these was measured using Chi-square test.

RESULTS

Confirm that there is obvious association between the ease of access to the subarachnoid space and the interspinous gap and the spinous process width. On further analysis, after dividing the study population based on gender, it was found that the association between the study variables and outcome variable was statistically insignificant in the female population.

CONCLUSION

Techniques based on surface anatomy of landmarks provide only less than 70% first attempt success rate in performing subarachnoid block. Interspinous gap measured from surface landmarks by palpation correlates consistently with ease of access to subarachnoid space. Imaging confirmation of the palpated measurements for further validation may be considered in future studies.

KEYWORDS

Spinal anaesthesia, vertebral column, lumbar puncture, interspinous gap.

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BACKGROUND

Technique of lumbar puncture was first demonstrated in a safe and predictable method by Quincke in 1891.¹ Quincke's technique was used by August Bier in 1898 to inject local anaesthetic, cocaine into subarachnoid space to produce spinal anaesthesia.² At present spinal anaesthesia is a commonly used technique in anaesthetic practice for lower abdominal, pelvic and lower limb surgeries. It is also used as part of combined epidural and spinal anaesthesia for suitable surgeries and labour analgesia. Spinal anaesthesia being a landmark based technique can be difficult in certain patients for reasons that may remain unclear. Multiple attempts at performing lumbar puncture increases the rate

of complications like neuraxial haematomas,³ post dural puncture headache⁴ and trauma to neuraxial structures.⁵

This necessitated an investigation to the reasons for difficulty in its performance. Studies have shown that independent predictors associated with successful placement of spinal needle in subarachnoid space are quality of anatomical landmarks, level of experience of the provider and adequacy of positioning.⁶ Grading and scoring systems have been devised to classify the quality of anatomical landmarks.⁷ Only very few studies have been published in our population so far in this regard. This study was designed with the aim of using the spinous process dimensions the interspinous gap and the spinous process width which serve as palpable landmarks in determining the ease of performing lumbar puncture in our population.

Aims and Objectives

Aim

To study the association between the ease of access to the subarachnoid space and the spinous process dimensions viz the interspinous gap (ISG) and the spinous process width (SPW).

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Objectives

Primary Objective- To find out what proportion of patients undergoing spinal anaesthesia has got easy access to sub arachnoid space.

Secondary Objective- To determine whether the spinous process width (SPW) and interspinous gap (ISG), are associated with the ease of access to the subarachnoid space while performing spinal anaesthesia.

MATERIALS AND METHODS

Study Design- Prospective observational study.

Study Setting- Dept. of Anaesthesia, Govt. medical college, Thiruvananthapuram.

Study Population- All patients satisfying the inclusion and exclusion criteria, who give consent to take part in the proposed study.

Inclusion Criteria

Patients of age 18 years and above, belonging to ASA PS 1 and 2, scheduled for elective surgery under spinal anaesthesia.

Exclusion Criteria

Conditions leading to difficulty in positioning the patient, like deformities of the spine, distended abdomen as in pregnancy and painful conditions involving the pelvis or hip.

Data Collection Methods

Interview and observation

<p>Sample size: calculated using the formula $n = \frac{(Z\alpha)^2 XpXq}{d^2 (10\% \text{ of } p)}$</p>
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With reference to an earlier study,⁸

$n = \frac{1.96^2 \times 0.62 \times 0.38}{0.003844} = 245$

Operational Definitions-

Ease of Access to Subarachnoid Space

Access is said to be easy if free flow of CSF is obtained in a single attempt with less than or equal to 2 redirections.

Attempt

Every reinsertion after withdrawal of the needle out of the skin and/or every new skin puncture at a different level will be considered as a new attempt.

Redirection

Redirection is defined as every withdrawal of the needle to less than one cm from the skin edge prior to changing the direction of advancement.

Interspinous Gap

Distance between the centres of two adjacent spinous processes of the space used for lumbar puncture in millimetres as measured from the surface markings using a calliper.

Spinous Process Width

Width of a spinous process measured in millimetres from the surface markings of the edges of the caudal spinous process of the space used for lumbar puncture.

Procedure

Institutional approvals were obtained. 245 patients scheduled for surgery under spinal anaesthesia were enrolled prospectively. The population of patients belonged to Thiruvananthapuram and nearby areas and were of the same ethnicity. Inclusion and exclusion criteria were satisfied in determining patient selection. Informed consent was obtained from each patient. Demographic data viz age, gender, height and weight were recorded prior to performing the spinal anaesthesia. ECG, pulse oximeter and non-invasive blood pressure monitors were attached for every patient. Intravenous access was secured in the upper limb with 18 or 16G cannula and crystalloid co loading was done while performing the procedure. The patient was held by an assistant by flexing the spine in the lateral decubitus position to the maximum extent possible by drawing the knees to the chest and flexing the neck until the measurement of dimensions and performing the block was completed. This minimised the positional changes in measurement. The block was performed by an anaesthesiologist with more than five years of experience after acquiring post graduate qualification. The spinous processes above and below the level determined by the anaesthesiologist for accessing the intrathecal space (L3-L4/L2-L3) were palpated and the edges marked on the skin with a skin marker with a thin point. The L3-L4 space was used in 95 percent of cases. The ISG and SPW as defined were measured with a calliper from the surface markings. The interspinous gap was measured as the distance between the centre points of adjacent spinous processes to decrease errors in measurement and to compensate for the variations in shapes of spinous processes. The spinous process width was measured as the vertical distance between the edges of the caudal spinous process through the centre point with the patient in the lateral position. 23 G Quincke type spinal needle was used for all patients. Patients were classified as either having easy access to the subarachnoid space or not as per the set criteria.

RESULTS

This study was carried out on a total number of 245 patients operated under spinal anaesthesia. Descriptive statistical analysis was carried out for the variables

Demographic Data

Age

Mean age of patient population studied was 43.1 with standard deviation of 16.3.

Age	Count	Percent
<30	60	24.5
30 - 39	54	22.0
40 - 49	50	20.4
50 - 59	25	10.2
>=60	56	22.9
Mean ± SD	43.1 ± 16.3	

Table 1. Percentage Distribution of Sample According to Age (in yrs.)

Gender

Of the total study population 58% were males and 42% females

Sex	Count	Percent
Male	142	58.0
Female	103	42.0

Table 2. Percentage Distribution of Sample According to Gender

Height

Mean height of study population was 165.8 with a standard deviation of 7.2. Maximum height was 182 cm and minimum was 142 cm.

Mean	165.8
SD	7.2
Median	168
Minimum	142
Maximum	182

Table 3. Descriptive Statistics for Height (in cm)

Weight

Mean weight of the study population was 64.6 kg with a standard deviation of 11.3. Minimum weight was 40 kg and maximum was 92 kg.

Mean	64.6
SD	11.3
Median	62
Minimum	40
Maximum	92

Table 4. Descriptive Statistics for Weight (in kg)

Study Variables

Inter spinous gap: Mean interspinous gap was 35.6 mm with a standard deviation of 4.8. maximum value was 45 mm and minimum was 25 mm.

Mean	35.6
SD	4.8
Median	37
Minimum	25
Maximum	45

Table 5. Descriptive Statistics for Interspinous Gap (in mm)

Inter Spinous Gap	Count	Percent
<=35	102	41.6
>35	143	58.4

Table 6. Percentage Distribution of the Sample According to Inter Spinous Gap (in mm)

Spinous process width Mean spinous process width was 17.7 mm with standard deviation of 2.7. Maximum value observed was 25 mm and minimum was 12 mm.

Mean	17.7
SD	2.7
Median	18
Minimum	12
Maximum	25

Table 7. Descriptive Statistics for Spinous Process Width (in mm)

Spinous Process Width	Count	Percent
<=17	121	49.4
>17	124	50.6

Table 8. Percentage Distribution of the Sample According to Spinous Process Width (in mm)

Outcome Variable

Outcome variable studied was ease of access to the subarachnoid space. Ease of access according to the definition was present in 68.6% of the total population.

Ease of Access	Count	Percent	95% CI
Absent	77	31.4	62.8 – 74.4
Present	168	68.6	

Table 9. Proportion of Ease of Access

Analysis of Association

The association between the study variables and the outcome variable was analysed using the chi square test.

Interspinous Gap

Study population was grouped into two based on the ease of access. The easy access group comprised of 168 patients and non-easy access group had 77 patients. Maximum value of interspinous gap in the easy access group was 45 mm and minimum value was 25 mm. For the non-easy access group maximum interspinous gap measured was 41 mm and minimum was 25 mm. Mean value of interspinous gap was 37.4 with SD 4 in the easy access group. For the non-easy access group, the mean value was 31.6 with SD 3.7. Chi square test was performed by dividing the study population into two groups i.e. those with and without easy access and grouping the inter spinous gap values into two based on mean value of 35 mm.

Inter Spinous Gap	Absent		Present		Odds
	Count	Percent	Count	Percent	
<=35	64	62.7	38	37.3	1
>35	13	9.1	130	90.9	16.84 (8.39 – 33.82)

Table 10. Comparison of Inter Spinous Gap (in mm) based on Ease of Access

$\chi^2 = 79.53^{**}$, $p = 0.000$ **: - Significant at 0.01 level

Statistical analysis showed that there is significant association between interspinous gap and ease of access to the subarachnoid space with an increased ease of access with increase in interspinous gap.

Spinous Process Width

Among the 168 patients who had easy access to the intrathecal space the maximum value of spinous process width was 25 mm and minimum value was 13 mm. Mean value of spinous process width was 18.2 with standard deviation 2.9 in the easy access group. Among 77 patients who belonged to the non-easy access group, maximum value of spinous process width was 23mm and minimum was 12 mm. Mean value was 16.7 with standard deviation 2.2 in this group. Study population was grouped into two based on the ease of access and the spinous process width values were grouped into two based on the mean value of 17. Chi square test was performed using these values.

Spinous Process Width	Absent		Present		Odds
	Count	Percent	Count	Percent	
<=17	49	40.5	72	59.5	1
>17	28	22.6	96	77.4	2.33 (1.34 – 4.07)

Table 11. Comparison of Spinous Process Width (in mm) based on Ease of Access

$\chi^2 = 9.12^{**}$, $p = 0.000$ **: - Significant at 0.01 level.

The study population was divided into two based on gender and the association between study variables and the outcome variable were studied in male population and female population separately using chi square test.

Inter Spinous Gap	Absent		Present		Odds
	Count	Percent	Count	Percent	
<=35	22	64.7	12	35.3	1
>35	11	10.2	97	89.8	16.17 (6.32 – 41.39)

Table 12. Comparison of Inter Spinous Gap (in mm) based on Ease of Access for Male Population

$\chi^2 = 43.09^{**}$, $p = 0.000$ **: - Significant at 0.01 level.

Inter Spinous Gap	Absent		Present		Odds
	Count	Percent	Count	Percent	
<=35	42	61.8	26	38.2	1
>35	2	5.7	33	94.3	26.64 (5.89 – 120.37)

Table 13. Comparison of Inter Spinous Gap (in mm) based on Ease of Access for Female Population

$\chi^2 = 26.67^{**}$, $p = 0.000$ **: - Significant at 0.01 level.

Results showed that there is significant association between the interspinous gap and ease of access to the subarachnoid space in both groups.

Spinous Process Width	Absent		Present		Odds
	Count	Percent	Count	Percent	
<=17	15	36.6	26	63.4	1
>17	18	17.8	83	82.2	2.66 (1.18 – 6.01)

Table 14. Comparison of Spinous Process Width (in mm) based on Ease of Access for Male Population

$\chi^2 = 5.76^{**}$, $p = 0.000$ **: - Significant at 0.01 level.

Spinous Process Width	Absent		Present		Odds
	Count	Percent	Count	Percent	
<=17	34	42.5	46	57.5	1.04 (0.41 – 2.65)
>17	10	43.5	13	56.5	1

Table 15. Comparison of Spinous Process Width (in mm) based on Ease of Access for Female Population

$\chi^2 = 0.01$, $p = 0.933$

Regarding spinous process width, significant association was found only in male patients group.

DISCUSSION

Spinal anaesthesia is a time honoured and commonly performed anaesthetic technique. Successful performance of spinal anaesthesia requires necessary skills acquired by experience and a thorough knowledge of the relevant anatomical and physiological aspects which are detailed earlier.

De Filho GR⁹ et al in 2002 published a study regarding the predictors of successful neuraxial block. According to their study the first attempt success rate in performing the neuraxial block was 61.51%. According to available literature, repeated attempts in performing the block increases the chances of complications like post dural puncture headache, spinal haematomas etc. The present study aimed at determining the proportion of patients having easy access to the subarachnoid space according to pre-set definitions for ease of access which were derived with reference to previous studies investigating the causes and associations of a difficult neuraxial blockade. Accordingly, 68.6% of patients had easy access to the subarachnoid space which was not much different from the de Filho et al study.⁹

Various studies done previously, like those by Sprung¹⁰ et al in 1999, De Filho et al in 2002, Atallah⁷ et al in 2003, Kim⁶ et al in 2011 investigated the causes and associations of a difficult neuraxial blockade. According to previous studies, factors determining the difficulty in performing a neuraxial blockade include patient characteristics like anatomical deformities and body habitus, provider's level of experience, quality of anatomical landmarks, needle type and gauge etc.

The bony confines of the spinous processes limit the percutaneous window to access the intrathecal space. The present study specifically focussed on the spinous process dimensions as previous studies had suggested surface landmarks as predictors of difficult access to the intrathecal space. Patients with anatomical deformities and those in whom maintaining the optimum position for performing the block were excluded from the study. All blocks were performed by an anaesthesiologist with more than 5 years of experience after acquiring postgraduate qualification.¹¹ 23-gauge Quincke type of needle was used for all patients. These eliminated various confounding factors so that the study was focussed on the spinous process dimensions. Results confirm that there is obvious association between ease of successful placement of spinal needle in the subarachnoid space and interspinous gap, with increased interspinous gap indicating easy access. Contrary to an earlier study done by Shankar⁸ et al in 2012, the spinous process width was also found to have statistically significant association with ease of access to the subarachnoid space with respect to the entire study population. However, on

further analysis after dividing the study population into two based on gender, results showed that the association between spinous process width and ease of access to the subarachnoid space was insignificant in female patients among the study population.

CONCLUSION

Techniques based on surface anatomy of landmarks provide only less than 70% first attempt success rate in performing spinal anaesthesia in present day anaesthetic practice. The interspinous gap measured from the surface landmarks by palpation correlates consistently with the ease of access to the subarachnoid space. Imaging confirmation of the palpated measurements for further validation may be considered in future studies.

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