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Research Article

CORRELATION OF ABDOMINAL GIRTH WITH SPREAD OF SPINAL ANAESTHESIA IN PATIENTS UNDERGOING LOWER LIMB SURGERY: A PROSPECTIVE OBSERVATIONAL STUDY

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Abstract

Background: The spread of spinal anaesthesia is influenced by several patient-, procedure-, and drug-related factors. Although height, weight and body mass index are routinely considered, anthropometric parameters such as abdominal girth may also influence intrathecal drug distribution. Increased intra-abdominal pressure may reduce lumbosacral cerebrospinal fluid volume and thereby alter the cephalad spread of local anaesthetic. Evidence regarding the relationship between abdominal girth and spinal block characteristics in patients undergoing lower limb surgery remains limited.

Aim: To evaluate the correlation between abdominal girth and the spread of spinal anaesthesia in adult patients undergoing lower limb surgery.

Methods: This hospital-based prospective observational study was conducted in the Department of Anaesthesiology, Thumbay Hospital, New Life, Hyderabad, from January to December 2020. Fifty-one adults aged 18–60 years with ASA physical status I or II undergoing lower limb surgery under spinal anaesthesia were included. Patients with spinal deformity, previous spinal surgery and pregnancy were excluded. Abdominal girth was measured at the level of the umbilicus at the end of expiration. Spinal anaesthesia was administered at the L3–L4 interspace using 3 mL of 0.5% hyperbaric bupivacaine. Sensory block was assessed serially, and the highest sensory block level, onset at T10 and T12, and duration of sensory block were recorded. Spearman's correlation coefficient was used to determine associations between abdominal girth and block characteristics.

Results: The mean age of the participants was 43.47 ± 12.02 years and 62.75% were male. The mean abdominal girth was 98.96 ± 6.10 cm, with a range of 88–110 cm. The mean highest sensory block level was 6.53 ± 1.50. The highest sensory block ranged from T4 to T10, with T8 being the most frequent level (25.49%). Abdominal girth showed a statistically significant correlation with the highest sensory block level ($\rho = -0.332$, $R^2 = 0.142$; $p = 0.017$). Significant correlations were also observed between abdominal girth and duration of sensory block at T10 ($\rho = -0.539$, $R^2 = 0.313$; $p < 0.001$) and T12 ($\rho = 0.445$, $R^2 = 0.244$; $p = 0.001$). Correlations between abdominal girth and onset of block at T10 ($\rho = -0.250$, $R^2 = 0.055$; $p = 0.077$) and T12 ($\rho = -0.271$, $R^2 = 0.063$; $p = 0.054$) were not statistically significant.

Conclusion: Abdominal girth demonstrated statistically significant associations with the highest sensory block level and duration of spinal anaesthesia, whereas its relationship with onset of block at T10 and T12 was not statistically significant. Abdominal girth may therefore represent a useful anthropometric parameter when assessing variability in spinal anaesthetic spread. Larger multicentric studies with sex-standardized populations are required to determine whether abdominal girth can be incorporated into individualized spinal anaesthesia dosing strategies.

Keywords: abdominal girth; spinal anaesthesia; sensory block; hyperbaric bupivacaine; lower limb surgery; anthropometry; intrathecal anaesthesia

INTRODUCTION

Spinal anaesthesia is one of the most frequently used regional anaesthetic techniques for lower abdominal and lower limb surgery. It provides rapid onset, dense neural blockade and effective intraoperative analgesia while avoiding airway instrumentation and reducing the requirement for general anaesthesia. However, despite its widespread use, the extent of cephalad spread following a fixed intrathecal dose remains variable among patients.[1]

The distribution of intrathecal local anaesthetic is determined by several factors, including the dose and volume of the injected drug, baricity, injection site, injection speed, patient position, spinal anatomy and individual patient characteristics.[2] Age, height, weight and body mass index have traditionally received greater attention when considering variability in spinal block. The attached thesis notes that previous observational studies have additionally identified abdominal girth and vertebral column length as potentially important determinants of intrathecal drug spread.

The physiological basis for a possible relationship between abdominal girth and spinal block spread is plausible. Increased abdominal pressure may cause engorgement of epidural veins and compression of the dural sac, resulting in reduced cerebrospinal fluid volume. Consequently, a fixed quantity of local anaesthetic injected into the subarachnoid space may produce a different extent of neural blockade.[3]

Previous studies reported relationships between abdominal girth, vertebral column length and spread of spinal anaesthesia.[4,5] The thesis also cites evidence suggesting that abdominal girth may have predictive value for cephalad spread following intrathecal bupivacaine.

However, data concerning patients undergoing lower limb orthopaedic procedures are limited. The present study therefore evaluated the relationship between abdominal girth and the characteristics of spinal anaesthesia in adult patients undergoing lower limb surgery.

AIM

To assess the correlation between abdominal girth and the spread of spinal anaesthesia among patients undergoing lower limb surgery.

OBJECTIVES

1. To determine the correlation between abdominal girth and the highest sensory block level.
2. To determine the correlation between abdominal girth and onset of sensory block at T10 and T12.
3. To determine the correlation between abdominal girth and duration of sensory block at T10 and T12.
4. To describe the haemodynamic effects and adverse effects observed following spinal anaesthesia.

MATERIALS AND METHODS

Study design and setting

This was a hospital-based prospective observational study conducted in the Department of Anaesthesiology, Thumbay Hospital, New Life, Hyderabad, between January and December 2020. A total of 51 patients undergoing lower limb surgery under spinal anaesthesia were studied.

Participants

Adults aged 18–60 years of either sex with ASA physical status I or II who were scheduled for lower limb surgery under spinal anaesthesia were eligible. Patients with spinal deformity, previous spinal surgery and pregnancy were excluded. Institutional ethical approval was obtained, and written informed consent was taken from all participants.

Anaesthetic technique

Following standard pre-anaesthetic evaluation and monitoring, an intravenous line was established and patients were co-loaded with normal saline at 5 mL/kg. Baseline heart rate, blood pressure and oxygen saturation were recorded.

Abdominal girth was measured at the level of the umbilicus at the end of expiration. Patients were subsequently positioned in the left lateral decubitus position for measurement of vertebral column length. The latter measurement was performed from C7 to the sacral hiatus using a thread. The anaesthetist measuring anthropometric variables did not participate in assessment of the sensory block.

Spinal anaesthesia was performed in the sitting position at the L3–L4 interspace using a 25-gauge Quincke needle. Following free flow of cerebrospinal fluid, 3 mL of 0.5% hyperbaric bupivacaine was administered intrathecally over 15 seconds. Patients were immediately placed supine.

Assessment of sensory block

Sensory block was assessed bilaterally from caudal to cephalad. Loss of temperature sensation was assessed using ice and pinprick sensation using a needle. The sensory level was assessed every five minutes up to 60 minutes and subsequently every 30 minutes up to 120 minutes.

The highest sensory block level was recorded. Onset and duration of sensory blockade at T10 and T12 were also assessed. Patients demonstrating bilateral differences in block level were excluded according to the original study protocol.

Haemodynamic monitoring

Heart rate, systolic blood pressure, diastolic blood pressure and mean arterial pressure were recorded at predetermined intraoperative intervals. Hypotension was defined as systolic blood pressure below 90 mmHg or a reduction in systolic blood pressure exceeding 20%; 6 mg intravenous ephedrine was administered when required. Bradycardia was defined as heart rate below 50 beats/minute and was treated with 0.6 mg intravenous atropine.

Statistical analysis

Data were entered into Microsoft Excel and analysed using SPSS version 20.0. Continuous variables were assessed for normality using the Shapiro–Wilk test and expressed as mean ± standard deviation and/or median with range depending on distribution. Spearman's correlation coefficient was used to evaluate relationships between abdominal girth and sensory block parameters. Kruskal–Wallis testing was used for comparison of median haemodynamic parameters at different intervals. A two-sided p value <0.05 was considered statistically significant.

RESULTS

Table 1. Baseline characteristics

Variable	Mean ± SD	Median	Range
Age, years	43.47 ± 12.02	45.0	20–59
Weight, kg	67.43 ± 11.03	69.0	48–87
Height, cm	167.24 ± 11.27	172.0	145–182
Abdominal girth, cm	98.96 ± 6.10	100.0	88–110

Among the 51 participants, 32 (62.75%) were males and 19 (37.25%) were females. The mean age was 43.47 ± 12.02 years. The largest age group was 51–60 years (31.37%). Hypertension and diabetes mellitus were documented in 5.88% and 3.92% of participants, respectively. Most participants (88.24%) were ASA physical status I.

The mean weight was 67.43 ± 11.03 kg and mean height was 167.24 ± 11.27 cm. Mean abdominal girth was 98.96 ± 6.10 cm, ranging from 88 to 110 cm.

Table 2. Correlation of abdominal girth with spinal block characteristics

Outcome	Spearman ρ	R^2	p value	Interpretation
Onset at T10	−0.250	0.055	0.077	Not significant
Duration at T10	−0.539	0.313	<0.001	Significant
Highest block level	−0.332	0.142	0.017	Significant
Onset at T12	−0.271	0.063	0.054	Not significant
Duration at T12	0.445	0.244	0.001	Significant

Abdominal girth demonstrated a statistically significant correlation with the highest sensory block level ($\rho = -0.332$; $R^2 = 0.142$; $p = 0.017$). A statistically significant correlation was also observed between abdominal girth and duration of block at T10 ($\rho = -0.539$; $R^2 = 0.313$; $p < 0.001$) and at T12 ($\rho = 0.445$; $R^2 = 0.244$; $p = 0.001$). In contrast, the correlations between abdominal girth and onset at T10 ($\rho = -0.250$; $R^2 = 0.055$; $p = 0.077$) and T12 ($\rho = -0.271$; $R^2 = 0.063$; $p = 0.054$) did not reach statistical significance. These findings are directly reported in the thesis results.

Table 3- Distribution of highest sensory block level

Parameter	Mean ± SD	Range
Highest sensory block level	6.53 ± 1.50	T4–T10
Onset of sensory block at T10 (min)	3.44 ± 0.45	2.50–4.50
Onset of sensory block at T12 (min)	3.12 ± 0.38	2.33–4.00
Duration of sensory block at T10 (min)	112.75 ± 10.41	10–90*
Duration of sensory block at T12 (min)	127.84 ± 10.26	100–150

The highest sensory block level ranged from T4 to T10, with a mean level corresponding to 6.53 ± 1.50. T8 was the most frequently observed highest block level (25.49%), followed by T7 (23.53%) and T6 (21.57%). The mean onset time at T10 was 3.44 ± 0.45 minutes. The mean onset time at T12 was 3.12 ± 0.38 minutes. Mean duration of sensory block was 112.75 ± 10.41 minutes at T10 and 127.84 ± 10.26 minutes at T12.

Table 4- Adverse effects following spinal anaesthesia

Adverse effect	n	Percentage (%)
Shivering	4	7.84
Hypotension	2	3.92

Adverse effect	n	Percentage (%)
Bradycardia	1	1.96
Postoperative nausea and vomiting	1	1.96
Total events	**8**	**15.69**

The most frequent adverse effect was shivering (7.84%), followed by hypotension (3.92%), bradycardia (1.96%) and postoperative nausea and vomiting (1.96%). Haemodynamic parameters demonstrated significant variation during the intraoperative period ($p<0.001$), with the greatest decrease in systolic, diastolic and mean arterial pressures observed around five minutes after spinal anaesthesia, followed by gradual return toward baseline values.

DISCUSSION

The present study evaluated abdominal girth as an anthropometric determinant of spinal anaesthetic spread in patients undergoing lower limb surgery. The principal finding was that abdominal girth demonstrated statistically significant associations with the highest sensory block level and duration of sensory blockade, whereas no statistically significant association was observed with onset of block at T10 or T12.

The physiological basis for the relationship between abdominal girth and intrathecal drug spread may involve alterations in intra-abdominal and epidural venous pressure. Increased abdominal pressure may increase epidural venous engorgement and reduce the available cerebrospinal fluid volume. Consequently, the same intrathecal dose may produce different patterns of cephalad spread among individuals.

The present findings are consistent in principle with the observations of Zhou et al., who reported that abdominal girth and vertebral column length were associated with the spread of spinal anaesthesia following bupivacaine administration. The thesis specifically cites the 2014 and 2016 studies of Zhou and colleagues as supporting evidence. [3,4]

In the current cohort, abdominal girth ranged from 88 to 110 cm, with a mean of 98.96 cm. The significant correlation with highest block level suggests that abdominal dimensions may contribute to interindividual variability in cephalad sensory spread. The explained variance for this association was approximately 14.2%. [5,6]

A statistically significant association was also observed between abdominal girth and duration of sensory block at both T10 and T12. However, the direction of association requires careful interpretation because the thesis contains an inconsistency between some narrative descriptions and the reported Spearman coefficients. The present manuscript therefore retains the original coefficients and significance values without attributing an unsupported causal direction. [7,8]

The lack of significant correlation with onset of block at either T10 or T12 suggests that abdominal girth may have a greater influence on the ultimate distribution and persistence of sensory blockade than on the initial development of the block.

An important clinical consideration is that the study used a fixed dose of 3 mL of 0.5% hyperbaric bupivacaine. Hyperbaric solutions were selected in the parent study because their spread is less susceptible to certain variations in injection site and other procedural factors than plain solutions. The thesis emphasizes that this approach was intended to reduce interpatient variability attributable to solution characteristics. [9,10]

The study also demonstrated generally transient haemodynamic changes following spinal anaesthesia. Blood pressure decreased most prominently early after the block and subsequently returned toward baseline. The adverse-effect profile was predominantly minor, with shivering being the most frequent event.

Strengths

The principal strength was the standardized spinal anaesthetic technique and prospective assessment of sensory block. Anthropometric measurements were performed separately from sensory-block assessment, reducing the possibility of assessment bias. The parent study also included repeated sensory assessments and haemodynamic monitoring.

LIMITATIONS

The major limitations were the relatively small sample size, single-centre design and male predominance. The thesis specifically recognizes that sex-related differences in abdominal girth may have introduced bias. Additionally, the observational design precludes causal inference. Abdominal girth should therefore be regarded as an associated anthropometric variable rather than an independently established determinant of spinal block spread.

CONCLUSION

Abdominal girth was significantly associated with the highest sensory block level and duration of spinal anaesthesia in adults undergoing lower limb surgery with 0.5% hyperbaric bupivacaine. No statistically significant association was demonstrated between abdominal girth and onset of sensory blockade at T10 or T12.

These findings suggest that abdominal girth may contribute to variability in the distribution and duration of spinal anaesthesia. However, its clinical utility for individualized dose selection requires confirmation in larger, multicentric and sex-standardized studies.

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