Original Article

Comparison of neuraxial acoustic target window of the spine among rider sitting, cross leg, hamstring stretch, and classical sitting position: An observational study

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Abstract

Background and Aims: To compare ultra-sonographic dimensions of acoustic target window of the spine in the participants at four different sitting positions namely cross leg sitting (CLP), hamstring stretch (HSP), classical sitting (CSP) and riders sitting position (RSP). The primary objective of this study was to measure the neuraxial acoustic target window (defined as interlaminar distance between L3-L4 lamina). The secondary objective was to compare ultra-sonographic measurements of the depth of ligamentum flavum from the skin, and to compare the diameter of intrathecal space and comfort score in the four different sitting positions.

Material and Methods: This study is a prospective observational study. Eighty participants were included and positioned in four different sitting positions to perform an ultra-sonographic scan and measure various parameters of the acoustic neuraxial window. The interlaminar distance, the distance of skin from the ligamentum flavum, and the diameter of the spinal canal or intrathecal space was measured in the L3-L4 intervertebral space in different positions.

Results: The mean value of interlaminar distance among four sitting positions was ranging from 1.40 cm to 1.44 cm (*P* value 0.725.) The distance of ligamentum flavum from skin and diameter of intrathecal space was also comparable in all the groups. The comfort score in CSP was significantly better when compared to other groups with a median score of 4 (*P* value < 0.001).

Conclusions: There is no statistically significant difference in interlaminar distance in various sitting positions. All four positions are equally effective and can be used as an alternative to spinal/epidural intervention, but the CSP came out to be the most comfortable and more emphasis should be given to the comfort as it increases the chance of success rate of the procedure.

Keywords: Neuraxial acoustic window, Cross leg sitting position, Classical sitting position, Hamstring stretch position, Interlaminar distance, neuraxial anesthesia, Rider sitting position

Introduction

Patient positioning plays an essential role in the success of neuraxial blocks. Easier identification of landmarks, interlaminar distance, and the diameter of intrathecal space can significantly affect the success of neuraxial blockade. Filho *et al*. have mentioned that the success rate of spinal needle placement in subarachnoid space is influenced by the anatomy of vertebrae, appropriate patient position, and the experience of the anesthesiologist.[1,2] In some conditions, when the patient cannot sit in traditionally defined positions, alternative positions such as cross-leg sitting,

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hamstring stretch, or fetal position can be helpful.[3] Proper positioning with an adequate wide interlaminar space can significantly increase the chances of successful needle placement manifold.[4] Preprocedural ultrasound of the spine can help identify various dimensions of the acoustic target window of the spine, measure the optimal depth of needle insertion and extent of ligamentum flavum, and reduce the chances of multiple bones being hit during the procedure.[5,6] Various suggested positions aim to reduce lordosis by optimizing the flexion of the spine and opening the intervertebral space.[7]

There is a scarcity of literature about changes in the acoustic neuraxial window with different sitting positions during neuraxial blocks. Therefore, this study was planned to observe the effect of different positions, including the classical sitting position (CSP), the rider sitting position (RSP), hamstring stretch position (HSP), and crossed-leg position (CLP). We aimed to determine if there is any difference in the ultrasound-guided estimation of interlaminar distance, the distance of ligamentum flavum from the skin, and the diameter of intrathecal space in the above-mentioned positions. This study will probably give us insight into a suitable sitting position for neuraxial blockade with maximal interlaminar distance, considering the patient's comfort and increasing the intervention's overall success. To date, there is no data on neuraxial sono-anatomy of the Indian population, along with comfort scoring in all these positions.

Material and Methods

This prospective observational study was conducted in a tertiary care teaching hospital after approval from the institutional ethics committee (AIIMS/IEC/2021/3745) and CTRI registration (CTRI/2021/12/038865) from January 2022 to June 2022. Written informed consent was taken from all the healthy volunteers in the scanning area. Volunteers aged between 18 and 45 years who could understand and sit in all the desired positions were included in the study. Subjects having any spinal deformity, previous spinal surgery, lower back pain, pelvic or knee trauma, pregnancy, or BMI >35 kg/m^2 were excluded from the study. All participants' ages, weights, heights, and BMI were recorded in the scanning area. All the positions were explained again, and individuals were asked to position themselves sequentially in all four positions. All subjects were asked to bend forward and curve out their back maximally. Anesthesiologist performing ultrasound-guided neuraxial scan should have experience with at least 25 neuraxial scans, before doing it for this study. Ultra-sonographic measurements of the lumbar spinal canal were done in a CSP followed by HSP, RSP, and CLP, respectively. During CSP, the knees are flexed approximately 90 degrees, the hip on abduction, and the feet on stool support [Figure 1]. In the HSP, the volunteer is to be seated with the legs supported by the operating table and asked for knee extension and hip adduction [Figure 2]. In the RSP, participants were positioned on the table as if riding a horse with their knees flexed to 90 degrees and their feet swinging freely [Figure 3]. In CLP, participants had to sit on the table with knees, hips flexed, legs and ankles crossed, and arms were hugging a pillow [Figure 4]. Ultrasonographic parameters were measured and recorded by the same anesthesiologist for all the positions of a single volunteer. After adequate positioning, a linear ultrasonography probe 6–13 MHz (SonoSite M-Turbo, Bothell, WA, USA) was placed in a longitudinal paramedian position, 1–2 cm lateral to the spinous process. Initially, an articular process view was obtained, then the probe was slightly tilted medially to beam the lamina of L3, L4, and L5 vertebrae, and then the saw-like image of the lumbar vertebra was recognized as Chin *et al.*[8] defined in their study. L3-L4 interlaminar spaces, ligamentum flavum, and posterior dura were identified, and these displays were stored in the ultrasound memory. The interlaminar distance, the distance between the skin and the ligamentum flavum, and the distance between anterior and posterior dura defined as intrathecal space were measured in the paramedian sagittal plane at L3-L4 intervertebral space using built-in calipers. The acoustic shadows of the L3 and L4 lamina were determined [Figure 5 and 6]. The interlaminar distance was measured as the distance between the edges of acoustic shadow between L3-L4 lamina. All the above-defined parameters were recorded in four positions for every participant (three measurements for every position); thus, there were 12 measurements for every subject. Volunteer comfort scoring was also done for every position using a Likert scale: 1 = very uncomfortable, 2 = uncomfortable, 3 = neutral, and 4 = comfortable.

Sample Size calculation

The sample size was calculated using open epi software. The mean interlaminar distance in a CSP was 3.39 ± 0.37 cm, HSP was 3.19 ± 0.36 cm, and the RSP was 3.61 ± 0.41 cm in the study by Toker M *et al.*[9] Sharma *et al.*[10] showed mean interlaminar distance in cross-leg sitting position as 3.29(0.47) cm. The mean difference between the CSP and HSP was compared, and the sample size was calculated assuming power 90%, CI 95%, and 10% dropout rate. Finally, 80 participants were enrolled.

Statistical analysis

For parametric distributions, data were detailed with mean ± standard deviation and analyzed using the analysis of variance test. ANOVA and *post hoc* tests were performed using the least significant difference for pairwise comparisons.

Figure: 1 Patient sitting in classical sitting position

Figure:2 Patient sitting in Hamstring stretch position

Figure: 3 Patient sitting in rider sitting position

Figure :4 Patient sitting in cross leg position

Figure:5 Position of probe for neuraxial scan

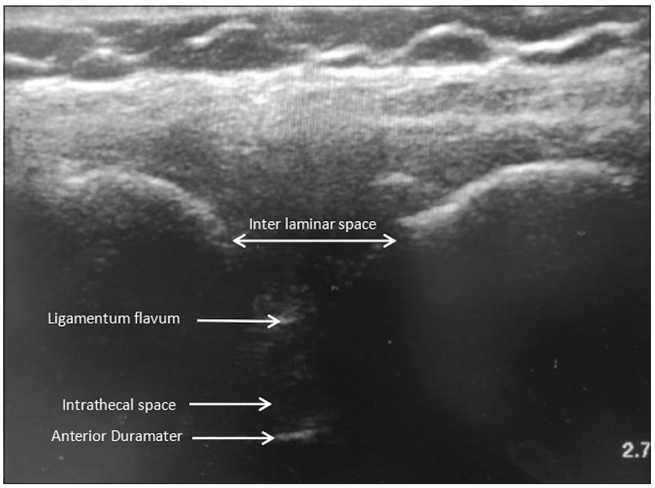

Figure:6 Neuraxial acoustic window

Analyses were performed using Statistical Package for Social Science (SPSS) version 22 (SPSS Incorporated, Chicago, Illinois, USA). A P value of < 0.05 was considered statistically significant.

Results

Eighty-seven volunteers were assessed for the eligibility, out of which five did not consent to the procedure and two had a

history of previous spinal surgery and, hence, were excluded. So, a total of 80 volunteers, 57 males and 23 females, were enrolled in the study. The mean age of the study population was 30.06 ± 4.29 years [Table 1]. The mean interlaminar distance (cm) was 1.42 ± 0.24 for CSP, 1.43 ± 0.23 for HSP, 1.40 ± 0.23 for CLP, and 1.44 ± 0.22 for RSP. It was comparable in all four groups. The distance of ligamentum flavum from the skin and the diameter of intrathecal space was also comparable in all four positions [Table 2]. The comfort score was significantly better with CSP with a *P* value of <0.001 [Table 3]. In total, 74 volunteer out of 80 has a comfort score of 4 in CSP in comparison to only 3 in RSP [Figure 7].

Discussion

In this study, we compared the ultrasound-guided interlaminar distance at the L3-L4 level, the distance between the skin to ligamentum flavum, and the diameter of intrathecal space along with comfort score in four different sitting positions. This study was conducted to identify any advantage of alternative sitting positions over the conventional sitting position in terms of neuraxial acoustic window and comfort scoring. The mean value of interlaminar distance among four sitting positions was between 1.40 and 1.44 cm with a *P* value of 0.725, which demonstrated that interlaminar distance in all four positions was similar. No position had any advantage over the other in terms of opening the interlaminar space.

Our study is in contrast with the study by Toker M *et al.*[9] in which a comparison of three different sitting positions (CSP, HSP, and RSP) for the neuraxial acoustic window was done, and they concluded that RSP had significantly increased interlaminar distance with a mean of 3.61 cm. They measured interlaminar distance as space between the apexes of the acoustic shadows between L3 and L4 lamina. In our study, mean interlaminar distance was around 1.40 cm as we have taken the distance from the edge of one lamina to the other (L3-L4 lamina) because that is the actual path that is traversed by the needle for successful needle placement.

Sandoval *et al.*[11] compared measured interspinous distance in three different positions using ultrasound and concluded that the mean intervertebral distance at L4-L5 was between 1.91 and 2.02 cm, which was comparable. This corresponds to the results of our study. Manggala *et al.*[12] compared the CLP and traditional sitting position (TSP) for the ease of spinal anesthesia and found comparable first-attempt successful needle placement in the groups.

Chauhan *et al.*[13] conducted a study to evaluate the skin-to-epidural depth distance by using ultrasound and conventional loss of resistance technique by visualizing needle depth. They concluded that a preprocedural ultrasound guided scan in the transverse plane provides an accurate needle entry site with a high success rate in a single attempt for lumbar epidurals.

The sitting position during spinal anesthesia optimizes lumbar lordosis and provides easier access for spinal needle placement.[14] The thecal sac is pushed to a superficial position with lumbar flexion and different tried positions for spinal anesthesia as traditional sitting, hamstring stretch, squatting, and pendant can have different effects on the position and diameter of the thecal sac.[2,15]

In our study, mean distance from skin to ligamentum flavum ranged from 3.68 cm (CSP) to 3.75 cm (HSP) with a

Table 1: Demographic parameters

Parameters	Mean±Standard deviation
Age (Years)	30.06±4.29
Weight (Kg)	62.11±3.12
Height (cm)	159.43±6.53
BMI (Kg/m^2)	27.12±2.8
Gender (M/F)	57/23

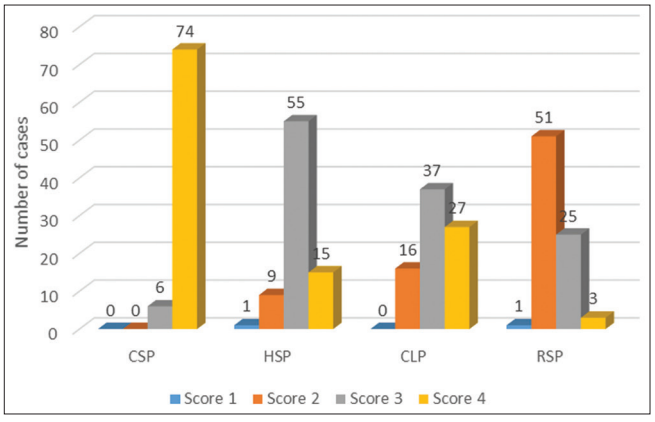

Figure:7 Patient satisfaction score in different sitting positions

Table 2: Comparison of parameters of neuraxial acoustic target among all four sitting positions

Parameters (Mean±SD) (Cm)	CSP	HSP	CLP	RSP	*P*
Interlaminar distance	1.42±0.24	1.43±0.23	1.40±0.23	1.44±0.22	0.725
Depth of ligamentum flavum	3.68±0.42	3.75±0.37	3.69±0.36	3.75±0.33	0.409
Diameter of intrathecal space	1.23±0.11	1.22±0.10	1.21±0.11	1.24±0.09	0.444

CSP – Classical sitting position, HSP – Hamstring stretch position, CLP – Cross-leg position and RSP – Rider sitting position

Table 3: Comparison of comfort scores among the study participants in different positions

Measurements	CSP	HSP	CLP	RSP
Mean±SD	3.93±0.27	3.05±0.59	3.14±0.72	2.38±0.58
Median (IQR)	4 (0)	3 (0)	3 (1)	2 (1)
P		*P*<0.001 (S)		

CSP – Classical sitting position, HSP – Hamstring stretch position, CLP – Cross-leg position and RSP – Rider sitting position

P value of 0.409. Studies demonstrated a good correlation between the US-guided skin to ligamentum flavum distance and definite needle depth. Toker *et al.*[9] demonstrated a mean value range for the distance of ligamentum flavum to skin ranging from 4.95 to 5.14 cm among CSP, HSP, and RSP. They concluded that in RSP, this distance is the shortest in comparison to other positions with an average of 4.95 cm. So, it corresponds to the most superficial location of ligamentum flavum in the RSP position. SS Mohammadi *et al.*[16] compared TSP, HSP, and squatting position (SP) and concluded that there was no statistically significant difference regarding the number of needle bone contacts and the ease of finding intervertebral space in the groups. Fisher *et al.*[17] compared TSP and HSP and concluded similar needle bone contacts during epidural labor analgesia in both groups.

The intrathecal space on ultrasound scanning is measured as an anechoic space between the posterior and anterior dura. This space is of considerable importance during spinal anesthesia as the local anaesthetic agent is directly injected into this space. If this space is wider, intrathecal needle placement becomes easier, increasing the chances of a successful neuraxial block. In this study, intrathecal space was comparable in all four sitting positions with a mean ranging from 1.21 to 1.24 cm. MK Toker *et al.*[9] also compared the diameter of the intrathecal sac in three different positions and could not find any clinically significant difference.

Participant's comfort level in different sitting positions provides an edge for choosing a particular position for the procedures as it contributes to their satisfaction with that position and the likelihood of a successful procedure. We calculated the comfort score among the four sitting positions by using the Likert scale and found that CSP produced a statistically significant result (median score 4) with a *P* value <0.001. The CSP was found to be comfortable for the participants followed by HSP and CLP, and RSP was found to be uncomfortable for the participants.

This may be due to the traditional practice of the Indian population for sitting in CLP, making it comfortable for volunteers to sit in their familiar position. The rider's position was less familiar, and subjects might be feeling awkward while sitting like riding on a patient trolley.

Manggala *et al.*[12] on urology patients compared the ease of landmark palpation and needle bone contact and concluded that they were all slightly better but not statistically significant with cross-legged than the TSP. Puthenveettil *et al.*[18] compared the ease of insertion of the epidural catheter in either a TSP or a crossed-legged sitting position and concluded that needle-bone contact and comfort were comparable between the two positions. The CLP was proved to be a better position than the traditional sitting position for the ease of insertion of labor epidural catheter. However, our study population was different, but we also found the CLP to be more comfortable.

This study proved that all four sitting positions are comparable for interlaminar distance, the diameter of intrathecal space, and the distance of ligamentum flavum from the skin. The only difference in positions was that CLP was more comfortable for the subjects when compared to other positions.

Being an adequately powered study, this study adds to the literature on acoustic neuraxial window of different sitting positions. To the best of our knowledge, this is the only study comparing all four positions, namely, CLP, HSP, RSP, and CSP for a neuraxial acoustic window.

Although there are some limitations, as this study was conducted on volunteers and subjects with BMI >35 kg/m^2 and 45 years of age were excluded so these results may not be exactly applicable to the patient population. It was an observational study, so further randomized control trials on the patient population by comparing actual needle placement, bone contact, ease of needle placement, and patient comfort score should provide further evidence.

Conclusions

This study concludes that there is no significant difference in any of the four positions, for the acoustic target window. CLP proved to be most comfortable for the subjects, so position during the procedure can be decided as per the patient's comfort while neuraxial block placement.

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Conflicts of interest
There are no conflicts of interest.

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