Original Article

Comparison of ultrasonographic anatomy of spine in traditional sitting position versus crossed leg position in term pregnancy: A prospective, observational, crossover study

Sai Sumalika Sree Godha, A Chaitanya Pratyusha, Gopinath Ramachandran, CH Rama Krishna Prasad[1], Aparajitha S D'souza[2], Suneeth Jogi[3]

Departments of Anaesthesia, [2]Obstetrics and Gynaecology and [3]Radiology, ESIC Medical College, Hyderabad, Telangana, [1]Department of Anaesthesiology All India Institute of Medical Sciences, Bibinagar, Telangana, India

Address for correspondence:
Dr. A Chaitanya Pratyusha, Flat 301, Sri Sai Enclave, Naveennagar Colony, Banjara Hills Road Number 1, Hyderabad, Telangana, India.
E-mail: chaitanyapa9@gmail.com

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ABSTRACT

Background and Aims: The traditional sitting position (TSP) and crossed leg sitting position (CLSP) are positions used for neuraxial anaesthesia. This study compared the interspinous space (ISS) distance using ultrasound assessment of the spine in these positions in parturients in term gestation. **Methods:** This prospective, observational study involved ultrasonographic spine assessment in 100 parturients in term gestation with them in either TSP or CLSP. The median sagittal view measured the crescent-shaped hyperechoic reflections of the spinous processes and ISSs in L3–L4, L4–L5 and L5–S1 levels. The paramedian sagittal oblique view showed interlaminar spaces (ILSs). Paired *t*-test and Chi-square test were used for continuous and categorical variables, respectively. **Results:** The ISS distance (cm) increased in CLSP compared to TSP at levels L3–L4 (1.44 [0.34] [1.34–1.54] versus 1.22 [0.30] [1.12–1.32], $P = 0.04$), L4–L5 (1.34 [0.39] [1.20–1.48] versus 1.14 [0.30] [0.96–1.32], $P = 0.01$) and L5–S1 (1.28 [0.33] [1.17–1.39] versus 1.18 [0.23] [1.11–1.26], $P = 0.02$). The ILS distance (cm) increased in CLSP compared to TSP at interspaces L3–L4 (1.27 [0.34] [1.18–1.36] versus 1.12 [0.20] [1.08–1.16], $P = 0.001$), L4–L5 (1.26 [0.33] [1.17–1.35] versus 1.19 [0.32] [1.12–1.26], $P = 0.01$) and L5–S1 (1.28 [0.33] [1.18–1.38] versus 1.16 [0.27] [1.09–1.23], $P = 0.001$). **Conclusion:** Crossed leg sitting position for neuraxial anaesthesia in term pregnancy results in more widening of both interspinous and interlaminar spaces compared to traditional sitting position.

Keywords: Anaesthesia, interlaminar spaces, interspinous spaces, lordosis, pregnancy, sitting position, spine assessment, ultrasonography

INTRODUCTION

Positioning during neuraxial anaesthesia is vital in determining the procedure's success.[1] The sitting position for neuraxial anaesthesia has gained popularity due to better lumbar flexion and easier identification of landmarks. The literature describes various variants for administering neuraxial anaesthesia in a sitting position, such as the traditional sitting position (TSP), the Hamstring stretch position, the squatting position and the crossed leg sitting position (CLSP).[2] CLSP, a variant of the sitting position, involves sitting with hips abducted and flexed and knees flexed. The knee and hip flexion resulted in posterior pelvic leaning and reduced lumbar lordosis.[3] There is no literature on the effect of CLSP on increased lumbar lordosis

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associated with pregnancy. A meta-analysis on lumbar neuraxial ultrasound by Sidiropoulou *et al*.[4] established a good correlation between preprocedural ultrasound findings and technical difficulties during needle insertion.

The study's primary objective was to compare interspinous space (ISS) distance using ultrasound assessment of the spine in TSP with CLSP. Secondary objectives were comparing the interlaminar space (ILS), skin to ligamentum flavum (LF) distance and width of the dural sac and patient comfort in TSP with CLSP and the effect of body mass index (BMI) on the changes in ISS dimensions with the two positions.

METHODS

This prospective, non-blinded, observational study was conducted after approval from the Institutional Ethics Committee (vide approval number ESICMC/SNR/IEC-F392/09-2021, dated 26 November 2021). The study was registered with the Clinical Trials Registry-India (vide registration number CTRI/2022/10/046911, http://ctri.nic.in/). The study is in accordance with the ethical principles for medical research laid down by the Declaration of Helsinki, 2013. All the subjects were explained the nature of the study, and written informed consent was obtained for participation in the study and use of the patient data for research and educational purposes. Parturients of age above 18 years, in term gestation, admitted for either a normal vaginal delivery or a planned caesarean section were included in the study. Subjects with spine deformities, a history of previous spine surgery, inability to sit in TSP or CLSP, American Society of Anesthesiologists (ASA) physical status III or more, or those already in labour were excluded from the study. Subjects who could not tolerate either of the study positions during the assessment were excluded as a part of the withdrawal criteria. The parturients were approached in the antenatal ward during their stay, well before the scheduled delivery. At this time, the ultrasonography examination of the spine and a complete assessment of all the study parameters were done. Initially, the subject was seated in TSP with legs hanging by the side of the bed with feet propped up on a chair and hugging a pillow [Figure 1a]. Ultrasound assessment of the spine was done using a curved array transducer of 2–5 MHz frequency (Sonosite Edge II, Fujifilm Sonosite. Inc, Worldwide Headquarters, Bothell, WA, USA). All the subjects were assessed by the same operator experienced in ultrasound assessment

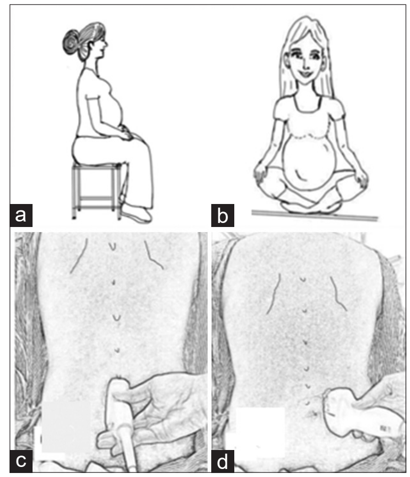

Figure 1: Images showing the two study positions and transducer positions. (a) Patient in traditional sitting position. (b) Patient in crossed leg sitting position. (c) Transducer position in the median sagittal plane. (d) Transducer position in the paramedian sagittal oblique plane

of the spine to avoid operator bias. A curved array transducer was initially placed longitudinally over the spine in the midline [Figure 1c] to get a median sagittal spinous process view. The crescent-shaped hyperechoic reflections of the spinous processes and the ISSs were identified. The transducer was moved caudally to visualise the sacrum, and a gap seen between the sacrum and the spinous process of the L5 vertebra was the L5–S1 ISS. The L4–L5 and L3–L4 ISSs were located by counting upwards while moving the transducer in a cranial direction [Figure 2a]. ISS measured as the distance between the caudal border of the upper spinous process and the cranial border of the lower spinous process was measured in the median sagittal interspinous view [Figure 2b]. The transducer was then positioned in the paramedian sagittal oblique plane to visualise the L5–S1, L4–L5 and L3–L4 spaces [Figure 1d].[5] The L5–S1, L4–L5 and L3–L4 ILSs were located by counting upwards after identifying the sacrum [Figure 2c].[6] The interlaminar distance, skin-to-epidural space distance and the width of the dural sac were assessed at three levels, that is, in the paramedian sagittal oblique view [Figure 2d]. The interlaminar distance was measured from the upper lamina's caudal border to the lower lamina's cranial border. Skin-to-LF distance was measured from the skin to the outer border of the LF–dura mater unit. The width of the dural sac was measured from the inner border of the LF–dura mater unit to the vertebral body [Figure 2d]. All the measurements were taken with the aid of a built-in calliper. Patient comfort was assessed in the two positions based on the participant's response to inquiring. It was given a score of 0 if the

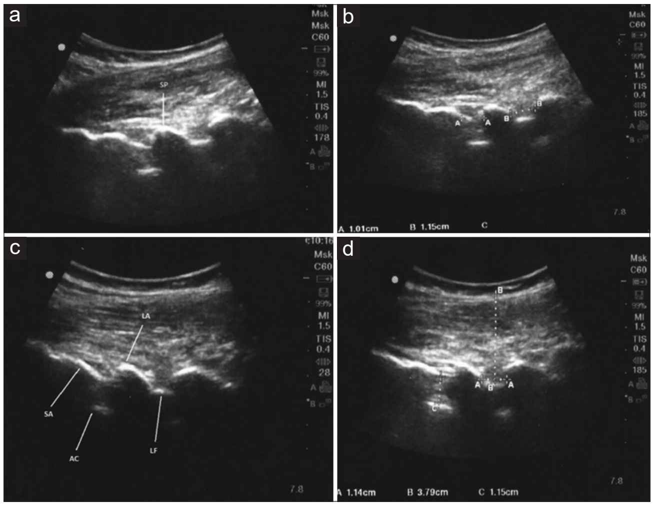

Figure 2: Ultrasound images of lumbosacral spine. (a) Median sagittal view. (b) Median sagittal view with interspinous space measurements. (c) Paramedian sagittal oblique view. (d) Paramedian sagittal oblique view with A indicating interlaminar space, B indicating skin to ligamentum flavum distance and C indicating dural sac diameter measurements. AC = anterior complex, LA = lamina, LF = ligamentum flavum, SA = sacrum, SP = spinous process

patient was comfortable with the positioning and a score of 1 if any discomfort was experienced. The patient was then asked to sit in CLSP with knee and hip flexed and hugging a pillow [Figure 1b], and an ultrasound assessment of the spine was done to measure all the study parameters similarly as previously done in TSP. A total of 12 images were captured in each individual, that is, three images in paramedian sagittal oblique view in TSP, three images in median sagittal interspinous view in TSP, three images in paramedian sagittal oblique view in CLSP and three images in median sagittal interspinous view in CLSP showing L5–S1, L4–L5 and L3–L4 spaces. The best possible image showing all the structures was captured for every interspace. Two investigators analysed all the images, one of them being a radiologist, to get a satisfactory final image quality.

A pilot study on 20 subjects gave an ISS standard deviation (SD), comparing TSP with CLSP, of 0.24. The sample size was calculated to be 89 with a confidence interval (CI) of 95% and a 5% precision. Considering a dropout of 10%, the total sample size was 98, which has been rounded to 100. Statistical analysis was performed using Statistical Package for the Social Sciences Version 21 (SPSS Inc, Chicago, Illinois, USA). Continuous variables such as age, BMI, gestational age, ISS and ILS were presented as mean (SD) and compared using paired t-test. Categorical variables such as patient comfort were presented as absolute numbers and percentages and compared using a Chi-square test. $P < 0.05$ was considered statistically significant.

RESULTS

The mean (SD) (95% CI) age (years) and BMI (kg/m^2) of the study population were 27 (4) (25.55–28.45) and 28 (4) (26.42–29.58), respectively. The mean gestational age (weeks) was 38 (1) (37.4–38.6). Table 1 shows a comparison of all the study parameters in TSP to the parameters in CLSP.

The ISS distance (cm) increased in CLSP compared to TSP at levels L3–L4 (1.44 [0.34] [1.34–1.54] versus (vs.) 1.22 [0.30] [1.12–1.32], $P = 0.04$), L4–L5 (1.34 [0.39] [1.20–1.48] vs. 1.14 [0.30] [0.96–1.32], $P = 0.01$) and L5–S1 (1.28 [0.33] [1.17–1.39] vs. 1.18 [0.23] [1.11–1.26], $P = 0.02$). The ILS distance (cm) increased in CLSP compared to TSP at interspaces L3–L4 (1.27 [0.34] [1.18–1.36] vs. 1.12 [0.20] [1.08–1.16], $P = 0.001$), L4–L5 (1.26 [0.33] [1.17–1.35] vs. 1.19 [0.32] [1.12–1.26], $P = 0.01$) and L5–S1 (1.28 [0.33] [1.18–1.38] vs. 1.16 [0.27] [1.09–1.23], $P = 0.001$) [Table 1].

A comparison of patient comfort in TSP to that in CLSP in the total population did not show a significant difference, with the ratio of comfortable to uncomfortable subjects being 86:14 in TSP and 93:7 in CLSP ($P = 0.053$). Patient comfort in subjects with the habit of sitting with crossed legs ($n = 62$) showed a statistically significant difference, with a ratio of comfortable to uncomfortable of 54:8 in TSP and 60:2 in CLSP ($P = 0.023$). Patient comfort in subjects without the habit of sitting with crossed legs ($n = 38$) did not show a statistically significant difference, with a ratio of comfortable to uncomfortable of 32:6 in TSP and 33:5 in CLSP ($P = 0.37$). A comparison of patient discomfort in CLSP in subjects with the habit of sitting with crossed legs (2 out of 62 [4%]) to those who do not have the habit (5 out of 33 [14%]) showed a statistically significant difference ($P = 0.029$). None of the study population had difficulty attaining either of the positions, and all the subjects who expressed discomfort were uncomfortable maintaining the crossed-leg position. The mean duration for attaining all the study parameters under ultrasonographic spine examination was 20 min.

There was a significant increase in ISS with CLSP at only L3–L4 level ($P = 0.002$) in a BMI range of

Table 1: Comparison of study parameters in TSP and CLSP following a crossover study design

Parameter (cm)	TSP (*n*=100)	CLSP (*n*=100)	*P*
L3–L4 ISS	1.22 (0.30) (1.12–1.32)	1.44 (0.34) (1.34–1.54)	0.040
L4–L5 ISS	1.14 (0.30) (0.96–1.32)	1.34 (0.39) (1.20–1.48)	0.010
L5–S1 ISS	1.18 (0.23) (1.11–1.26)	1.28 (0.33) (1.17–1.39)	0.028
L3–L4 ILS	1.12 (0.20) (1.08–1.16)	1.27 (0.34) (1.18–1.36)	0.001
L4–L5 ILS	1.19 (0.32) (1.12–1.26)	1.26 (0.33) (1.17–1.35)	0.019
L5–S1 ILS	1.16 (0.27) (1.09–1.23)	1.28 (0.33) (1.18–1.38)	0.001
L3–L4 skin to LF distance	4.01 (0.55) (3.88–4.14)	4.06 (0.63) (3.9–4.22)	0.425
L4–L5 skin to LF distance	4.12 (0.50) (4.01–4.23)	4.18 (0.64) (4.05–4.31)	0.553
L5–S1 skin to LF distance	4.06 (0.53) (3.99–4.13)	4.15 (0.62) (4.03–4.27)	0.100
Width of dural sac	1.15 (0.23) (1.06–1.24)	1.14 (0.19) (1.06–1.22)	0.335

Values are expressed as mean (standard deviation) (95% confidence interval) in centimetres. CLSP=Crossed leg sitting position, ILS=Interlaminar space, ISS=Interspinous space, LF=Ligamentum flavum, TSP=Traditional sitting position, n=Number

18–25 kg/m^2, while that in the BMI range of 30–40 kg/m^2 showed a significant increase in all three levels, that is, L3–L4, L4–L5 and L5–S1 [Tables 2–4].

DISCUSSION

Our study has demonstrated the widening of ISS and ILS at L3–L4, L4–L5 and L5–S1 vertebral levels in the crossed-leg position compared to TSP. Ninety-six per cent of patients who had the habit of sitting with crossed legs were comfortable in CLSP during the assessment of the spine, while 14% of patients without the habit of sitting with crossed legs were able to attain the position without discomfort but were uncomfortable in maintaining CLSP throughout the study period. Still, the discomfort did not interfere with the spine assessment.

The ability to flex the back is one of the strong predictors of neuraxial technique difficulty.[7] CLSP involves flexion at the hip and knee joints, which causes a lumbar flexion widening ISS, thereby opening the spine. Redai and Flood found an increase in lumbar flexion by 10°–15° in CLSP compared to TSP.[8] These findings are consistent with our study's results, where we could demonstrate the opening of ISS and ILS when the position changed from TSP to CLSP.

TSP involves placing the lower limbs side by side and bending forward to achieve a lumbar flexion, which may be difficult in term pregnancy due to abdominal distension. Crossed leg position, in addition to changing the spinal curvature, also provides adequate space to accommodate the distended abdomen in term pregnancy, providing greater comfort for the parturient to maintain the back flexion, thereby making the neuraxial technique easier. Adapting this position to our population could have the advantage of better patient comfort and anatomical advantages as the South Asian population has the habit of sitting on the ground with crossed legs.

Table 2: Comparison of ISS and ILS in TSP with those in CLSP in a BMI range of 18–25 kg/m^2

Parameter (cm)	TSP (*n*=40)	CLSP (*n*=40)	*P*
L3–L4 ISS	1.21 (0.13) (1.15–1.27)	1.43 (0.20) (1.34–1.52)	<0.001
L4–L5 ISS	1.16 (0.20) (0.97–1.35)	1.15 (0.19) (0.99–1.31)	0.436
L5–S1 ISS	1.15 (0.19) (0.97–1.32)	1.15 (0.96) (0.97–1.33)	0.649
L3–L4 ILS	1.09 (0.16) (1.02–1.16)	1.28 (0.22) (1.17–1.39)	0.002
L4–L5 ILS	1.26 (0.39) (1.08–1.44)	1.32 (0.41) (1.12–1.52)	0.219
L5–S1 ILS	1.21 (0.35) (1.05–1.37)	1.36 (0.43) (1.15–1.57)	0.076

Values are expressed as mean (standard deviation) (95% confidence interval) in centimetres. BMI=Body mass index, CLSP=Crossed leg sitting position, ILS=Interlaminar space, ISS=Interspinous space, TSP=Traditional sitting position, n=Number

Table 3: Comparison of ISS and ILS in TSP to those in CLSP in a BMI range of 25–30 kg/m^2

Parameter (cm)	TSP (*n*=44)	CLSP (*n*=44)	*P*
L3–L4 ISS	1.31 (0.39) (1.15–1.47)	1.56 (0.36) (1.40–1.71)	0.051
L4–L5 ISS	1.47 (0.35) (1.24–1.7)	1.55 (0.38) (1.23–1.88)	0.321
L5–S1 ISS	1.29 (0.35) (0.96–1.62)	1.34 (0.33) (1.03–1.65)	0.341
L3–L4 ILS	1.19 (0.22) (1.09–1.29)	1.30 (0.31) (1.17–1.43)	0.034
L4–L5 ILS	1.19 (0.29) (1.06–1.32)	1.23 (0.27) (1.11–1.35)	0.262
L5–S1 ILS	1.17 (0.21) (1.07–1.27)	1.27 (0.27) (1.15–1.39)	0.028

Values are expressed as mean (standard deviation) (95% confidence interval) in centimetres. BMI=Body mass index, CLSP=Crossed leg sitting position, ILS=Interlaminar space, ISS=Interspinous space, TSP=Traditional sitting position, n=Number

The discomfort in maintaining CLSP in subjects who do not have the habit may not have clinical significance as the duration to give a neuraxial block will be shorter than the time we have taken to assess all the study parameters under ultrasonography, and thus, CLSP can be clinically applied in the non-Indian population as well.

The comparison of spine anatomy in different BMI ranges in the two positions showed significant improvement in spine anatomy in CLSP over the entire

Table 4: Comparison of ISS and ILS in TSP to those in CLSP in a BMI range of 30–40 kg/m²

Parameter (cm)	TSP (*n*=16)	CLSP (*n*=16)	*P*
L3–L4 ISS	0.90 (0.08) (0.83–0.97)	1.05 (0.09) (0.98–1.12)	0.038
L4–L5 ISS	0.90 (0.09) (0.83–0.97)	1.00 (0.07) (0.94–1.05)	0.024
L5–S1 ISS	0.86 (0.09) (0.78–0.94)	0.94 (0.06) (0.89–0.98)	0.029
L3–L4 ILS	1.03 (0.92) (0.87–1.19)	1.14 (0.22) (0.95–1.32)	0.011
L4–L5 ILS	1.07 (0.17) (0.92–1.22)	1.16 (0.16) (1.02–1.29)	0.030
L5–S1 ILS	1.05 (0.18) (0.86–1.2)	1.17 (0.19) (1.01–1.34)	0.017

Values are expressed as mean (standard deviation) (95% confidence interval) in centimetres. BMI=Body mass index, CLSP=Crossed leg sitting position, ILS=Interlaminar space, ISS=Interspinous space, TSP=Traditional sitting position, n= Number

lumbar region in subjects with a high BMI, whereas those with normal to overweight range of BMI showed a significant opening of the spine only in the L3–L4 level. CLSP can, therefore, be considered to have good clinical application in obese patients.

Literature shows studies comparing various variants of sitting positions concerning ease of neuraxial procedures, but most of the studies have excluded the pregnant population in their studies.[2,3,9,10] Our study was conducted on parturients in term gestation. A study by Soltani Mohammadi *et al*.[9] excluded pregnant women, comparing TSP to squatting position due to the possible inability to keep them in squatting position, which can be taken as a disadvantage of that position. Puthenveettil *et al*.[11] compared the crossed leg position to TSP for epidural catheter placement for labour analgesia in parturients. They found CLSP superior to TSP in terms of the procedure being successful and patient comfort. The use of ultrasound to assess the anatomy of the spine in the two positions in our study demonstrated the opening of the spine in CLSP, which supports the findings of that study. However, we have chosen a crossover study design and assessed the spine in the two study positions in the same individual to avoid the effect of interindividual variability.

Our study has certain limitations. This is an observational study, without any intervention, involving ultrasonographic assessment of the anatomy of the spine in TSP and CLSP in the antenatal ward. No direct conclusion can be drawn on the ease of dural puncture in the two positions. However, the interspinous gap has been proven to predict difficult spinal needle placement in a study by Shankar *et al*.[12] The results of a study by Özhan *et al*.[10] established a correlation between the grade of ISS identification and the success rates of the neuraxial intervention. Widening of ISSs in CLSP under ultrasound examination can indirectly point towards an easier needle passage. Therefore, the results of our study can be extrapolated to the ease of dural puncture. The use of ultrasonography in neuraxial anaesthesia has gained popularity in recent times.[13-15] The results of our study can be applied to clinical practice. However, it is an observational study, as other studies conducted on preprocedural ultrasound examination of the spine for neuraxial anaesthesia have shown a good correlation with successful lumbar punctures.[16] Blinding was not possible due to the study design. The effect of discomfort during CLSP in maintaining an optimum position for examination was not analysed. However, none of our study participants had intolerable discomfort with the position.

CONCLUSION

In term pregnancy, the crossed-leg sitting position for neuraxial anaesthesia. causes a widening of ISS and ILS compared to TSP, with comparable patient comfort in both positions.

Study data availability

De-identified data may be requested with reasonable justification from the authors (email to the corresponding author) and shall be shared after approval as per the authors' institution policy.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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