Section: Anaesthesiology

Original Research Article

COMPARATIVE STUDY OF PREPROCEDURAL ULTRASOUND GUIDED VS LANDMARK GUIDED PARAMEDIAN SPINAL ANAESTHESIA

Arun Kumar K.H.[1], S.Chitralekha[2], Akila K.[3]

[1]Senior Resident, Department of Anaesthesiology, Nandha Medical College & Hospital, Erode, Tamilnadu, India.
[2]Senior Assistant Professor, Department of Anaesthesiology, K.P.A.V Government Medical College, Trichy, Tamilnadu, India.
[3]Senior Assistant Professor, Department of Anaesthesiology, K.A.P.V Government Medical College, Trichy, Tamilnadu, India.

Received : 12/01/2026
Received in revised form : 24/02/2026
Accepted : 08/03/2026

Keywords:
Anesthesia, Spinal; Ultrasonography; Paramedian Spinal Anesthesia; Pain, Procedural; Anesthesia Techniques, Regional.

Corresponding Author:
Dr. Arun Kumar K.H.,
Email: drarunkh08@gmail.com

DOI: 10.47009/jamp.2026.8.4.216

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (4); 1293-1298

ABSTRACT

Background: Preprocedural ultrasound may improve the accuracy of paramedian spinal anaesthesia by identifying the intervertebral space and planning needle trajectory. This study compared ultrasound-assisted and landmark-guided paramedian techniques in adults undergoing elective surgery. **Materials and Methods:** This prospective, randomised controlled study included 80 adults aged 21–60 years undergoing elective surgery under spinal anaesthesia. Patients were randomly allocated to ultrasound-assisted paramedian spinal anaesthesia (Group U, n=40) or landmark-guided paramedian spinal anaesthesia (Group L, n=40). The primary outcome was the number of needle passes required for successful dural puncture. Secondary outcomes included needle insertion attempts, landmark identification time, anaesthesia administration time, periprocedural pain, and procedural complications. **Results:** The mean number of needle passes was significantly lower in Group U than in Group L (1.28 ± 0.45 vs. 2.73 ± 0.60; $P < 0.001$). The mean number of insertion attempts was also lower (1.00 ± 0.00 vs. 1.63 ± 0.49; $P < 0.001$). Landmark identification required more time with ultrasound (60.48 ± 6.88 vs. 12.28 ± 2.00 seconds; $P < 0.001$), whereas administration of anaesthesia was faster (29.13 ± 4.71 vs. 47.03 ± 7.03 seconds; $P < 0.001$). Periprocedural pain was lower in Group U (2.38 ± 0.98 vs. 3.90 ± 1.24; $P < 0.001$). Radicular pain and bloody tap occurred in 0 versus 3 (7.5%) patients, respectively ($P = 0.241$), while no paresthesia occurred in either group. **Conclusion:** Preprocedural ultrasound-assisted paramedian spinal anaesthesia reduced needle passes, insertion attempts, and periprocedural pain compared with the landmark-guided technique, although landmark identification required additional time.

INTRODUCTION

The ideal technique for spinal anaesthesia requires successful dural puncture with a single needle pass. Multiple puncture attempts and needle redirections are associated with an increased risk of needle trauma, post-dural puncture headache, spinal haematoma, backache, and paraesthesia.[1-4] Minimising the number of needle passes, and insertion attempts is therefore desirable to reduce the risk of complications and improve patient comfort and satisfaction during spinal anaesthesia.[5-7]

Spinal anaesthesia has traditionally relied on a technique guided by surface anatomical landmarks. However, identification of surface landmarks may be difficult in some patients, and multiple punctures or redirections of the needle may be required to achieve successful dural puncture. Ultrasonography is a non-invasive technique that provides visualisation of spinal structures and may improve the efficacy of spinal anaesthesia.[8-10] Preprocedural ultrasound can assist in accurate identification of the intervertebral level, estimation of the depth of the intrathecal space, and identification of the interlaminar window that permits needle passage.[8-10] These features may provide useful information before needle insertion and help in planning the direction and depth of the needle.

Paramedian spinal anaesthesia is an alternative approach to the conventional midline technique and uses a lateral entry point to access the subarachnoid space. The paramedian approach provides access through the interlaminar space without requiring passage through the supraspinous and interspinous

ISSN (O): 2687-5365; ISSN (P): 2753-6556

ligaments. The paramedian sagittal oblique (PSO) view provided by ultrasound allows identification of the relevant neuraxial structures and has been used as an ultrasound-assisted technique for spinal anaesthesia.[3,8,11] Compared with landmark-guided techniques, ultrasound-guided spinal anaesthesia has been reported to improve first-pass success and reduce the number of puncture attempts and needle redirections, particularly in patients in whom spinal anaesthesia may be technically difficult.[9-11]

Previous studies have mainly focused on elderly patients or those with technically difficult spinal anatomy. Although ultrasound-assisted paramedian spinal anaesthesia has shown benefits in needle passes, insertion attempts, procedural time, and patient comfort, evidence in general adults undergoing elective surgery remains limited, warranting further evaluation in this population.

The primary objective of this study was to assess whether the ultrasound-assisted paramedian technique could decrease the number of needle passes required for successful dural puncture compared with the landmark-guided paramedian technique in elective cases. The secondary objectives were to compare the number of needle insertion attempts, time to identify landmarks, time required for administering spinal anaesthesia, periprocedural pain score, and the incidence of radicular pain, paresthesia, and bloody tap between the two techniques.

Aim

To assess whether ultrasound-assisted paramedian technique can decrease the number of needle passes for successful dural puncture compared with landmark-guided paramedian technique in elective cases.

MATERIALS AND METHODS

This prospective, randomised controlled study was conducted in the Department of Anaesthesiology, Mahatma Gandhi Memorial Government Hospital, Tiruchirappalli, affiliated with K.A.P. Viswanatham Government Medical College, Tiruchirappalli, India, from December 2022 to December 2023. The study included 80 patients scheduled for elective surgery under spinal anaesthesia. Institutional Ethics Committee approval was obtained before commencement of the study, and written informed consent was obtained from all participants.

Inclusion and Exclusion criteria

Adults aged 21–60 years, classified as American Society of Anesthesiologists (ASA) physical status I–III and scheduled for elective surgery under spinal anaesthesia were eligible for inclusion.

Patients were excluded if they refused participation, had hypersensitivity to local anaesthetics, local infection at the lumbar puncture site, bleeding disorders, hypovolaemia, space-occupying intracranial lesions, pregnancy, vertebral spinal deformity, previous spinal surgery, BMI >35 kg/m², or were unwilling to participate or unable to communicate.

Randomisation and group allocation

Patients were randomly assigned to receive spinal anaesthesia through the paramedian approach using either preprocedural ultrasound guidance (Group U) or conventional landmark guidance (Group L). Randomisation was performed using computer-generated random numbers. Allocation was concealed using sequentially numbered, sealed, opaque envelopes, which were opened by the attending anaesthesiologist immediately before the procedure.

Sample size calculation

The sample size was calculated based on a reference study using the expected difference in the mean number of needle passes between the ultrasound-assisted and landmark-guided groups. The standard deviation (σ) was taken as 3.1, with a two-sided significance level (α) of 0.05 and 80% power.

The assumed mean number of needle passes was 3.3 in the landmark-guided group and 1.3 in the ultrasound-assisted group. The sample size was calculated using the following formula:

$$\mathbf{N = [2 \times \sigma^2 \times (Z\alpha/2 + Z1-\beta)^2] / (\mu1 - \mu2)^2}$$

N= Sample size

Based on a reference study:

σ = Standard deviation= 3.1

α= level of Significance = 0.05; Zα/2= 1.96 (Constant)

1-β= Power of the study = 80%; Z1-β= 0.84 (Constant)

μ1= mean average number of passes of the intervention phase 1 (without ultrasound assistance) = 3.3

μ2= Mean average number of passes of the intervention 2 (with ultrasound assistance) = 1.3

Substituting the values:

$N = [2 \times (3.1)^2 \times (1.96 + 0.84)^2] / (3.3 - 1.3)^2$

$N = [2 \times 9.61 \times (2.80)^2] / (2.0)^2$

$N = 150.69 / 4$

$N = 37.67$

Therefore, the minimum required sample size was 38 patients per group. A total of 80 patients (40 in each group) were included in the study.

Anaesthetic procedure

In the operating room, standard monitoring was established using non-invasive blood pressure, electrocardiography, and pulse oximetry. Baseline systolic blood pressure, diastolic blood pressure, and heart rate were recorded. Intravenous access was secured using an 18-G intravenous cannula. Patients were positioned in the sitting position for spinal anaesthesia.

In Group U, preprocedural ultrasound-assisted paramedian spinal anaesthesia was performed using a 2–5 MHz curvilinear probe. In the transverse midline view, the neuraxial midline was identified and marked on the skin. The probe was then rotated 90° to obtain a PSO view approximately 1–2 cm lateral to the midline. The sacrum was identified first, followed by identification of the individual

ISSN (O): 2687-5365; ISSN (P): 2753-6556

interlaminar spaces from L5–S1 to L2–L3 using the counting-up approach. The interlaminar space showing the posterior complex (ligamentum flavum, epidural space, and posterior dura) and anterior complex (anterior dura, posterior longitudinal ligament, and vertebral body) was clearly centred on the screen. The interlaminar space providing the largest available window was selected for the first attempt. With the probe positioned to obtain the clearest image, the skin was marked at the midpoints of the long and short borders of the probe. The midpoint of the probe was used as the needle insertion point, and a vertical line indicating the centre of the screen represented the imaginary needle trajectory.[8] The medial angle of the probe providing the clearest image in the PSO view was estimated and used as the angle of needle insertion. The required needle insertion depth was estimated by measuring the distance from the skin to the posterior complex. Additional intervertebral levels were marked for use if the first attempt was unsuccessful. After skin marking, the ultrasound gel was removed from the insertion site. In Group U, the anaesthesiologist did not palpate the surface landmarks until completion of the spinal injection.

In Group L, the anaesthesiologist palpated the surface landmarks, and spinal anaesthesia was administered using the conventional paramedian approach. The needle was inserted 1 cm lateral and 1 cm caudal to the caudal edge of the superior spinous process and directed 10–15° off the sagittal plane in the cephalomedial direction.[8]

In both groups, strict aseptic precautions were followed. A 25-G Quincke bevel spinal needle was used. After confirmation of free flow of clear cerebrospinal fluid, 0.5% hyperbaric bupivacaine was administered intrathecally, with the dose determined at the discretion of the attending anaesthesiologist. Intrathecal fentanyl 20 µg could also be administered at the discretion of the anaesthesiologist.

If dural puncture was not achieved after five attempts, an alternative technique could be used. In Group U, this included the midline approach or landmark palpation, while in Group L, the midline approach or ultrasound-assisted technique could be used.

Statistical Analysis

Data were analysed using IBM SPSS Statistics version 21.0 (IBM SPSS Science Inc., Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequency and percentage. Continuous variables were compared between the two groups using the independent-samples t-test. Categorical variables were compared using Fisher's exact test. A two-tailed P value <0.05 was considered statistically significant.

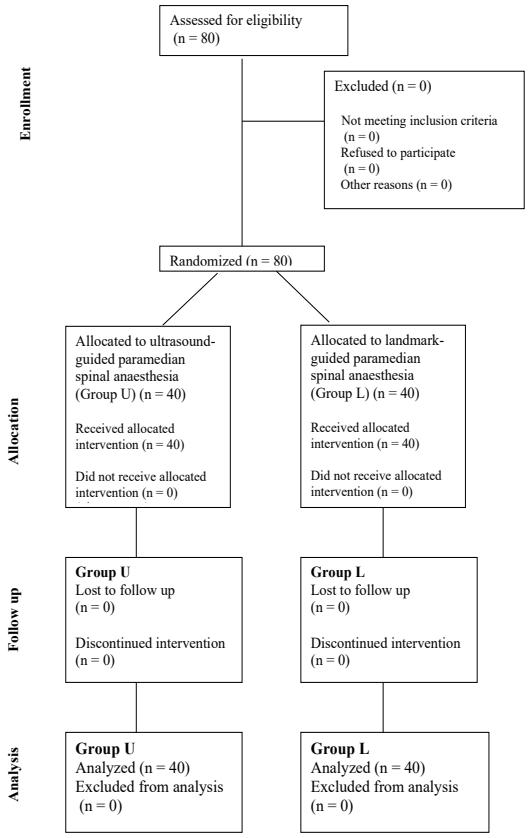

Figure 1: CONSORT flow diagram

RESULTS

The mean age was 41.83 ± 11.89 years in Group U and 43.00 ± 12.73 years in Group L (P = 0.671). The mean height was 1.55 ± 0.05 m and 1.53 ± 0.05 m, respectively (P = 0.231). The mean weight was 64.58 ± 7.99 kg in Group U and 61.85 ± 7.08 kg in Group L (P = 0.111). The mean BMI was 27.02 ± 3.15 kg/m² and 26.43 ± 3.60 kg/m², respectively (P = 0.444). [Table 1]

Table 1: Baseline demographic characteristics

Variable	Group U	Group L	P value
Age (years)	41.83 ± 11.89	43.00 ± 12.73	0.671
Height (m)	1.55 ± 0.05	1.53 ± 0.05	0.231
Weight (kg)	64.58 ± 7.99	61.85 ± 7.08	0.111
BMI (kg/m²)	27.02 ± 3.15	26.43 ± 3.60	0.444

Values expressed as mean ± standard deviation. P < 0.05 was considered statistically significant. Student's t-test.

The mean number of needle passes was 1.28 ± 0.45 in Group U and 2.73 ± 0.60 in Group L (P < 0.001). In Group U, 29 (72.5%) patients required one pass and 11 (27.5%) required two passes, whereas in Group L, 14 (35.0%), 23 (57.5%), and 3 (7.5%) patients required two, three, and four passes. The

ISSN (O): 2687-5365; ISSN (P): 2753-6556

mean number of needle insertion attempts was 1.00 ± 0.00 in Group U and 1.63 ± 0.49 in Group L (P < 0.001). The mean time to identify landmarks was 60.48 ± 6.88 seconds in Group U and 12.28 ± 2.00 seconds in Group L (P < 0.001), while the mean time for administering anaesthesia was 29.13 ± 4.71 seconds and 47.03 ± 7.03 seconds, respectively (P < 0.001). [Table 2]

Table 2: Procedural outcomes

	Variable	Group U	Group L	P value
Number of needle passes		1.28 ± 0.45	2.73 ± 0.60	<0.001
	1 pass	29 (72.5%)	0	-
	2 passes	11 (27.5%)	14 (35.0%)	
	3 passes	0	23 (57.5%)	
	4 passes	0	3 (7.5%)	
Number of needle insertion attempts	Mean	1.00 ± 0.00	1.63 ± 0.49	<0.001
	1 attempt	40 (100%)	15 (37.5%)	-
	2 attempts	0	25 (62.5%)	
Time to identify landmarks (sec)		60.48 ± 6.88	12.28 ± 2.00	<0.001
Time for administering anaesthesia (sec)		29.13 ± 4.71	47.03 ± 7.03	<0.001

Values expressed as mean ± standard deviation or n (%). P < 0.05 was considered statistically significant. Student's t-test was used for continuous variables and Fisher's exact test for categorical variables.

The mean periprocedural pain score was 2.38 ± 0.98 in Group U and 3.90 ± 1.24 in Group L (P < 0.001). Radicular pain occurred in 0 (0%) patients in Group U and 3 (7.5%) in Group L (P = 0.241). Bloody tap occurred in 0 (0%) patients in Group U and 3 (7.5%) in Group L (P = 0.241). Paresthesia was reported in 0 (0%) patients in both groups (P = 1.000). [Table 3]

Table 3: Periprocedural pain and complications

Variable		Group U	Group L	P value
Periprocedural pain score		2.38 ± 0.98	3.90 ± 1.24	<0.001
Radicular pain	Yes	0	3 (7.5%)	0.241
	No	40 (100%)	37 (92.5%)	
Bloody tap	Yes	0	3 (7.5%)	0.241
	No	40 (100%)	37 (92.5%)	
Paresthesia	Yes	0	0	1
	No	40 (100%)	40 (100%)	

Values expressed as mean ± standard deviation or n (%). P < 0.05 was considered statistically significant. Student's t-test was used for the pain score and Fisher's exact test for categorical variables.

DISCUSSION

The current study showed that the ultrasound-assisted paramedian technique was associated with fewer needle passes and insertion attempts than the landmark-guided paramedian technique. It was also associated with lower periprocedural pain. The baseline characteristics, including age, height, weight, and body mass index, were comparable between Group U and Group L, with no significant differences observed.

Park et al. conducted a RCT in 80 patients aged at least 60 years and compared ultrasound-assisted with landmark-guided paramedian spinal anaesthesia. The median number of needle passes was significantly lower in the ultrasound group than in the landmark group (1.0 [1.0–2.0] vs. 4.5 [2.0–7.0], P < 0.001), while first-pass success was higher (65.0% vs. 17.5%, P < 0.001).[12]

In the present study, the Group U required significantly fewer needle passes and insertion attempts than the Group L. Most patients in the Group U required only one or two needle passes, whereas three or four passes were more frequently required in the Group L. All patients in the Group U required only one insertion attempt, compared with 37.5% in the Group L.

Qu et al. reported similar findings in 80 elderly patients undergoing combined spinal-epidural anaesthesia. The first-pass success rate was 70% in the ultrasound group compared with 20% in the landmark group (P < 0.001), while the first-attempt success rate was 85% and 42.5%, respectively (P < 0.001). The median number of attempts was 1 [1,1] versus 2 [1,2], and the median number of needle passes was 1 [1,2] versus 3 [2,4] in the ultrasound and landmark group, respectively (both P < 0.001).13 Khan et al. reported higher first-pass success with ultrasound (86.0% vs. 60.0%, P = 0.001) and fewer attempts (P = 0.023). Ultrasound required more time for landmark identification (1.45 ± 0.47 vs. 0.79 ± 0.34 min, P = 0.003) but less time to accomplish CSE (1.47 ± 0.55 vs. 2.73 ± 1.36 min, P = 0.005).[14] Together, these findings support the use of ultrasound to facilitate needle placement and reduce the number of attempts required for neuraxial anaesthesia.

Uyel et al. also reported similar findings in 156 elderly patients with difficult spinal anatomy. First-attempt success was higher with ultrasound than with landmark guidance (74.4% vs. 53.8%, P = 0.008), while the median number of needle insertion attempts (1 [1–2] vs. 2 [1–3], P = 0.038) and needle redirections (2 [1–4] vs. 3 [2–5], P = 0.028) were lower with ultrasound.15

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Chin et al. studied ultrasound-assisted spinal anaesthesia in 50 patients undergoing total joint arthroplasty. Dural puncture was achieved with one needle insertion attempt in 84% of patients and within two attempts in 98% of patients. The median number of needle insertion attempts was 1, and the ultrasound-measured depth to the intrathecal space showed good correlation with the actual needle insertion depth (concordance correlation coefficient = 0.82). Although this was a prospective descriptive study rather than a direct comparison with landmark guidance, it supports the use of preprocedural ultrasound for identifying lumbar intervertebral spaces before spinal anaesthesia.[11]

Regarding procedure times, the present study found that ultrasound required more time for landmark identification but less time for administering spinal anaesthesia than the landmark-guided technique. Park et al. similarly reported a longer time for establishing landmarks with ultrasound (117.5 s [85.5–150.7] vs. 17.5 s [14.0–23.0]) but a shorter time for administering spinal anaesthesia (39.5 s [31.5–71.3] vs. 77.0 s [45.8–136.5], P < 0.001). However, their total procedure time was longer in the ultrasound group (181.5 s [133.5–212.5] vs. 92.5 s [62.5–176.5]).[12] Khan et al. also reported longer landmark-identification time with ultrasound (1.45 ± 0.47 vs. 0.79 ± 0.34 min, P = 0.003), but shorter time to accomplish CSE (1.47 ± 0.55 vs. 2.73 ± 1.36 min, P = 0.005).14 Qu et al. similarly reported longer locating time and total procedure time but shorter puncture time in the ultrasound group.[13] Thus, preprocedural ultrasound requires additional time for landmark identification, while the subsequent administration or puncture phase may require less time.

The present study also found a lower periprocedural pain score in the Group U than in the Group L. The lower pain score may be related to the lower number of needle passes and insertion attempts. Park et al. similarly reported lower periprocedural pain scores in the Group U compared with the Group L (3 [2–4] vs. 4 [4–6], P = 0.009) and lower discomfort scores (2 [0–3] vs. 5 [2–6], P = 0.003).12 These findings are consistent with the present study and suggest that fewer needle passes may be associated with less periprocedural discomfort.

Regarding adverse events, no cases of radicular pain or bloody tap were reported in the Group U, whereas these events occurred in a small number of patients in the Group L; the differences were not statistically significant. No cases of paresthesia were reported in either group. Qu et al. also reported no significant difference in procedural adverse reactions and postoperative complications between the ultrasound group and landmark group. Thus, no significant difference was observed in the reported periprocedural complications between the two groups.[13]

Limitations

We opted for a preprocedural ultrasound-assisted technique rather than a real-time ultrasound-guided technique. We found the preprocedural approach more practical for our hospital setting. However, this method has some inherent inaccuracy because it uses a curved-array probe, and the insertion angle depends on the anaesthesiologist's memory rather than exact measurements.

CONCLUSION

The preprocedural ultrasound-assisted paramedian technique significantly reduced the number of needle manipulations required for spinal anaesthesia and was associated with lower periprocedural pain and discomfort compared with the landmark-guided paramedian technique.

REFERENCES

1. Chong SE, Mohd Nikman A, Saedah A, Wan Mohd Nazaruddin WH, Kueh YC, Lim JA, et al. Real-time ultrasound-guided paramedian spinal anaesthesia: evaluation of the efficacy and the success rate of single needle pass. Br J Anaesth 2017;118:799–801. https://doi.org/10.1093/bja/aex108.
2. Chin KJ, Perlas A, Chan V, Brown-Shreves D, Koshkin A, Vaishnav V. Ultrasound imaging facilitates spinal anesthesia in adults with difficult surface anatomic landmarks. Anesthesiology 2011;115:94–101. https://doi.org/10.1097/ALN.0b013e31821a8ad4.
3. Kallidaikurichi Srinivasan K, Iohom G, Loughnane F, Lee PJ. Conventional landmark-guided Midline versus preprocedure ultrasound-guided paramedian techniques in spinal anesthesia. Anesth Analg 2015;121:1089–96. https://doi.org/10.1213/ANE.0000000000000911.
4. Zeidan A, Farhat O, Maaliki H, Baraka A. Does postdural puncture headache left untreated lead to subdural hematoma? Case report and review of the literature. Int J Obstet Anesth 2006;15:50–8. https://doi.org/10.1016/j.ijoa.2005.07.001.
5. Rhee WJ, Chung CJ, Lim YH, Lee KH, Lee SC. Factors in patient dissatisfaction and refusal regarding spinal anesthesia. Korean J Anesthesiol 2010;59:260–4. https://doi.org/10.4097/kjae.2010.59.4.260.
6. Sprung J, Bourke DL, Grass J, Hammel J, Mascha E, Thomas P, et al. Predicting the difficult neuraxial block: a prospective study: A prospective study. Anesth Analg 1999;89:384–9. https://doi.org/10.1097/00000539-199908000-00025.
7. Vogt M, van Gerwen DJ, Lubbers W, van den Dobbelsteen JJ, Hagenaars M. Optimal point of insertion and needle angle in neuraxial blockade using a Midline approach: A study in computed tomography scans of adult patients: A study in computed tomography scans of adult patients. Reg Anesth Pain Med 2017;42:600–8. https://doi.org/10.1097/AAP.0000000000000653.
8. Chin KJ, Karmakar MK, Peng P. Ultrasonography of the adult thoracic and lumbar spine for central neuraxial blockade. Anesthesiology 2011;114:1459–85. https://doi.org/10.1097/ALN.0b013e318210f9f8.
9. Neal JM, Brull R, Horn J-L, Liu SS, McCartney CJL, Perlas A, et al. The second American Society of Regional Anesthesia and Pain Medicine evidence-based medicine assessment of ultrasound-guided Regional Anesthesia: Executive summary: Executive summary. Reg Anesth Pain Med 2016;41:181–94. https://doi.org/10.1097/AAP.0000000000000331.
10. Perlas A, Chaparro LE, Chin KJ. Lumbar neuraxial ultrasound for spinal and epidural anesthesia: A systematic review and meta-analysis: A systematic review and meta-analysis. Reg Anesth Pain Med 2016;41:251–60. https://doi.org/10.1097/AAP.0000000000000184.
11. Chin KJ, Perlas A, Singh M, Arzola C, Prasad A, Chan V, et al. An ultrasound-assisted approach facilitates spinal anesthesia for total joint arthroplasty. Can J Anaesth 2009;56:643–50. https://doi.org/10.1007/s12630-009-9132-8.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

12. Park S-K, Yoo S, Kim WH, Lim Y-J, Bahk J-H, Kim J-T. Ultrasound-assisted vs. landmark-guided paramedian spinal anaesthesia in the elderly: A randomised controlled trial: A randomised controlled trial. Eur J Anaesthesiol 2019;36:763–71. https://doi.org/10.1097/EJA.0000000000001029.
13. Qu B, Chen L, Zhang Y, Jiang M, Wu C, Ma W, et al. Landmark-guided versus modified ultrasound-assisted Paramedian techniques in combined spinal-epidural anesthesia for elderly patients with hip fractures: a randomized controlled trial. BMC Anesthesiol 2020;20:248. https://doi.org/10.1186/s12871-020-01172-x.
14. Khan MA, Gupta M, Sharma S, Kasaudhan S. A comparative study of ultrasound assisted versus landmark technique for combined spinal-epidural anaesthesia in patients undergoing lower limb orthopaedic surgery. Indian J Anaesth 2022;66:272–7. https://doi.org/10.4103/ija.ija_775_21.
15. Uyel Y, Kilicaslan A. Preprocedural ultrasonography versus landmark-guided spinal anesthesia in geriatric patients with difficult anatomy: A prospective randomized trial. Eurasian J Med 2021;53:9–14. https://doi.org/10.5152/eurasianjmed.2020.20215.

ISSN (O): 2687-5365; ISSN (P): 2753-6556