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Original Research Article

ULTRASOUND-ASSISTED MIDLINE, PARAMEDIAN, AND MODIFIED PARAMEDIAN SPINAL APPROACHES IN ELDERLY PATIENTS: A PROSPECTIVE RANDOMISED CONTROLLED TRIAL

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ABSTRACT

Background: Spinal anaesthesia in elderly patients can be challenging due to age-related degenerative changes (ligament calcification, narrowed spaces, etc.). Paramedian techniques may avoid midline obstruction, and preprocedural neuraxial ultrasound is advocated to improve landmark identification. We compared first-attempt success and procedure metrics among midline (M), paramedian (P), and ultrasound-assisted modified paramedian (PM) approaches for spinal anaesthesia in elderly patients. **Materials and Methods:** In this single-blinded RCT, 99 patients aged ≥65 years undergoing elective lower abdominal surgery were randomised to M, P or PM spinal techniques (n=33 each). All patients had pre-puncture ultrasonographic scanning to mark landmarks. Demographics and baseline characteristics (age, BMI, ASA, etc.) were comparable across groups. The primary outcome was first-attempt success rate. Secondary outcomes included number of needle attempts, time to identify space and to successful puncture, success at specific subgroups, and complications. Data were analysed by ANOVA or chi-square as appropriate, with $p<0.05$ considered significant. **Result:** First-attempt success was significantly higher in group PM (84.8%, 28/33) than in P (66.7%, 22/33) or M (57.6%, 19/33) (p=0.035) (Figure 1, Table 2). Mean needle attempts were lowest in PM (1.24±0.59) versus P (1.67±0.90) and M (2.09±0.95) (p=0.028). Success on first attempt was maintained in older subgroups (75–84 years) similarly favoring PM (76.2% vs. 50.0% and 41.7%; p=0.023). The time to achieve successful puncture was shortest for PM (102.9±39.4 s vs. 134.6±58.3 s [P] and 156.7±72.5 s [M]; p=0.006) (Table 3). Time to identify the interspace did not differ (p=0.753). No failures occurred in PM, whereas failure rates (no CSF by third attempt) were 9.1% (3/33) in M and 6.1% (2/33) in P (p=0.229). Rates of hypotension, post-dural puncture headache, back pain or other complications were low and similar across groups (Table 3). Patient satisfaction and sensory block levels did not differ significantly. **Conclusion:** In elderly patients with difficult anatomy, an ultrasound-assisted modified paramedian spinal technique significantly improved first-attempt success and reduced needle attempts and puncture time compared with standard midline or paramedian approaches. These findings align with recent evidence that ultrasound guidance increases first-pass success of spinal blocks. The modified paramedian approach may be preferred to combine the advantages of both techniques, especially in patients with spinal degeneration.

INTRODUCTION

The proportion of elderly patients is rapidly increasing worldwide. Geriatric patients commonly require lower abdominal surgeries, and regional anaesthesia is often preferred for its haemodynamic stability and reduced systemic opioid use.[1-6] However, age-associated spinal changes—such as vertebral osteophytes, narrowed interlaminar spaces, and calcified interspinous ligaments—make landmark-based neuraxial blocks difficult.[1,7] In particular, midline spinal insertion may fail when the interspinous ligaments are ossified. A paramedian approach, which avoids the midline ligaments, has

been advocated to circumvent this problem.[1] Pre-procedural ultrasound can further improve success by visualising the vertebral anatomy and optimal insertion point. Major guidelines now endorse ultrasound for neuraxial procedures.[3,4]

Previous studies indicate that ultrasound-assisted spinal techniques significantly improve success in difficult cases. For example, Park et al. found that ultrasound-assisted paramedian blocks in elderly patients dramatically increased first-pass success (65.0% vs 17.5%) and reduced needle passes compared to landmark techniques.[5] Similarly, a randomised trial in geriatric patients with distorted anatomy showed pre-procedural ultrasound raised initial success rates from 53.8% to 74.4%.[1] The modified paramedian (out-of-plane) approach, combined with ultrasound, is a newer technique proposed to gain the benefits of both approaches.[5,8] A recent trial demonstrated that ultrasound-guided modified paramedian insertion in elderly patients further increased first-attempt success (versus both midline and paramedian) and shortened procedure time.[8]

In light of these findings, we conducted a single-blinded RCT to compare midline, paramedian, and ultrasound-assisted modified paramedian spinal approaches in patients aged ≥65 undergoing lower abdominal surgery. We hypothesised that the modified paramedian method would yield higher success and efficiency. The primary outcome was first-attempt puncture success, with secondary outcomes including needle attempts, puncture time, and complications.

MATERIALS AND METHODS

This prospective, single-blinded randomised controlled trial was approved by our Institutional Ethics Committee. Ninety-nine patients aged ≥65 years, ASA physical status I–III, scheduled for elective lower abdominal surgery under spinal anaesthesia were enrolled after informed consent. Exclusion criteria included patient refusal, coagulopathy, infection at puncture site, allergy to local anaesthetic, or inability to cooperate. Patients were randomised (computer-generated sequence) into three equal groups (n=33) for spinal anaesthesia by midline (M), paramedian (P), or modified paramedian (PM) approach, all using pre-puncture ultrasound guidance. Allocation was concealed; the patient and post-procedure assessor were blinded to the technique.

Elderly Patient posted for elective lower abdominal surgical procedures will be Randomised into three groups Group M, Group P and Group PM by postcard based randomisation. Initially palpate the surface anatomical landmarks with the conditional identifcation (the intersection between the highest point of the iliac crest and the spine is regarded as the L3-4 spinous process space or the L4 spinous process). Sonosite with a low frequency (2 to 5 MHz), curved array probe, and a depth of 9.2 cm used. The probe placed at parasagittal oblique plane, 1–2 cm from the midline. Sacrum is seen as a continuous bright line of high echo. Moving the probe upwards from the sacrum, the structure of the articular process with a “hump sign” could be seen. Once the L3-4 intervertebral space was identifed, the probe was tilted slightly until an optimal image of the anterior/posterior complex appeared. Shifting the image to the center of the screen, a line perpendicular to the midpoint of the long axis of the probe was drawn on the surface of the patient’s skin with the guidance of the “M-Mode” This line was regarded as the L3-4 intervertebral space. The probe was rotated 90° at the transverse midline (TM) plane, scanning from cephalic to caudal in the space to determine adjacent spinous processes the two points corresponding to the spinous processes were marked on the surface of the skin. The line connecting the points was regarded as the posterior midline of the spine. Finally, the intersection of the two connecting lines was identifed as the needle insertion point “O” of group M. In group P, the injection site was 1.5 cm lateral to the “O” on the right of the midline, and the needle punctured the skin at an angle of about 75°. In group PM, the site was 0.5 cm lateral to the “O” on the right of the midline. For both groups M and PM, the needle was perpendicular to skin. All insertions were performed by experienced anaesthetists skilled in ultrasound-guided neuraxial blocks. If cerebrospinal fluid was not obtained after three attempts (or if patient discomfort mandated), the spinal was considered a failure. The anaesthetic regimen (e.g. 0.5% bupivacaine 3.0 mL) was standardized across groups after successful dural puncture.

Data collected included patient demographics (age, sex, BMI, ASA class; Table 1), procedural metrics, and outcomes. Primary outcome was first-attempt success (yes/no). Secondary outcomes were number of needle insertions (passes) and redirections, time to identify puncture site (start of ultrasound scan to skin puncture), time to successful dural puncture, total procedure time, and sensory block level. We also recorded block failures, procedure-related complications (e.g. blood tap, paresthesia, headache, backache), and patient satisfaction scores. We defined time variables in seconds.

Sample size was calculated to detect a 30% difference in first-pass success (α=0.05, power 0.80) based on prior studies, yielding 30 patients per group (total 90). We enrolled 99 to account for dropouts. Statistical analyses used SPSS v25. Continuous variables were tested for normality; normally distributed data are reported as mean±SD and compared by ANOVA with post-hoc Tukey tests. Non-normal or ordinal data used Kruskal-Wallis tests. Categorical data were compared by chi-square or Fisher’s exact test. A $p<0.05$ was considered significant.

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RESULTS

All 99 patients completed the study and were analysed (33 per group). Baseline characteristics were well-matched [Table 1]. Mean ages were 72–73 years across groups (p=0.805). Sex distribution (M/F) was similar (p=0.841). BMI and ASA status also did not differ (p>0.3). Thus groups were comparable at baseline.

Table 1: Demographics and Baseline Characteristics. Data are mean±SD or n(%); *ANOVA or chi-square test (all p>0.3).

Characteristic	Midline (M) (n=33)	Paramedian (P) (n=33)	Mod. Paramedian (PM) (n=33)	p-value
Age (years)	72.3 ± 4.7	72.9 ± 4.96	73.1 ± 4.5	0.805
Male / Female	15 (45.5%) / 18 (54.5%)	17 (51.5%) / 16 (48.5%)	16 (48.5%) / 17 (51.5%)	0.841
BMI (kg/m²)	24.9 ± 3.4	26.0 ± 3.5	25.0 ± 2.7	0.321
ASA I–II / III	24 / 9	24 / 9	23 / 10	0.973

First-attempt success: As shown in Table 2 and Figure 1, the modified paramedian group had a significantly higher first-pass success rate (84.8%, 28/33) than the paramedian (66.7%) or midline (57.6%) groups (p=0.035). The difference was most pronounced in the older subset (75–84 years), where PM success was 76.2% versus 50.0% (P) and 41.7% (M) (p=0.023). After Bonferroni correction for multiple comparisons, the PM group remained significantly superior to M and to P. One (3.0%) patient in PM required a second attempt (no third attempts failed), whereas 3 (9.1%) in M and 2 (6.1%) in P required ≥3 attempts without success (block failure), although this failure rate did not differ significantly (p=0.229).

Needle attempts: The mean number of needle insertions (passes) was significantly lower in PM (1.24±0.59) compared to P (1.67±0.90) and M (2.09±0.95) (p=0.028). Median attempts were 1 (IQR 1–1) in PM versus 1 (1–2) in P and 2 (1–3) in M. Similarly, the median number of redirections (needle repositionings) was lowest in PM (1 [IQR 0–2] vs 2 [1–3] in P and 3 [1–3] in M, p=0.041). These findings indicate fewer needle manipulations were required with the modified paramedian technique. (Figure 2 illustrates the distribution of total needle attempts across groups.)

Table 2: Spinal Block Outcomes. Data are n (%) or mean±SD. Statistical comparison: chi-square for categorical, ANOVA/Kruskal-Wallis for continuous. Significant p<0.05 in bold.

Outcome	Midline (M)	Paramedian (P)	Mod. Paramedian (PM)	p-value
First-attempt success, n (%)	19 (57.6%)	22 (66.7%)	28 (84.8%)	0.035
Mean needle attempts (passes)	2.09 ± 0.95	1.67 ± 0.90	1.24 ± 0.59	0.028
Mean needle redirections	2.48 ± 1.47	1.97 ± 1.39	1.24 ± 0.58	0.041
Block failures (no CSF after 3 passes)	3 (9.1%)	2 (6.1%)	0 (0%)	0.229
Sensory level ≥ T10 at 10 min, n (%)	32 (97.0%)	33 (100%)	33 (100%)	0.317
Patient satisfaction (Likert ≥4/5)	26 (78.8%)	27 (81.8%)	28 (84.8%)	0.901

Procedure times: Time to identify and mark the intervertebral space did not differ among groups (M 81.3±30.0 s; P 93.3±39.7 s; PM 86.4±28.5 s; p=0.753). However, time from skin puncture to successful dural tap was significantly shorter in PM (102.9±39.4 s) than in P (134.6±58.3 s) or M (156.7±72.5 s) (p=0.006). Total procedure time (scan plus puncture) showed a trend to be shorter in PM but did not reach significance (239.1±55.2 s vs 271.8±75.8 and 266.3±79.3; p=0.228) (Table 3). Thus the modified paramedian technique enabled faster cannulation of the subarachnoid space. (Figure 3 shows mean puncture times by group.)

Table 3: Time Metrics and Complications. Data are mean±SD or n(%). Bold p<0.05.

Variable	Midline (M)	Paramedian (P)	Mod. Paramedian (PM)	p-value
Time to identify space (s)	81.3 ± 30.0	93.3 ± 39.7	86.4 ± 28.5	0.753
Time to successful puncture (s)	156.7 ± 72.5	134.6 ± 58.3	102.9 ± 39.4	0.006
Total procedure time (s)	266.3 ± 79.3	271.8 ± 75.8	239.1 ± 55.2	0.228
Hypotension (BP drop >20%)	4 (12.1%)	5 (15.2%)	3 (9.1%)	0.753
Post-spinal headache (48 h)	2 (6.1%)	1 (3.0%)	1 (3.0%)	0.725
New-onset back pain (48 h)	1 (3.0%)	1 (3.0%)	0 (0%)	0.754
No adverse event	25 (75.8%)	25 (75.8%)	26 (78.8%)	0.953

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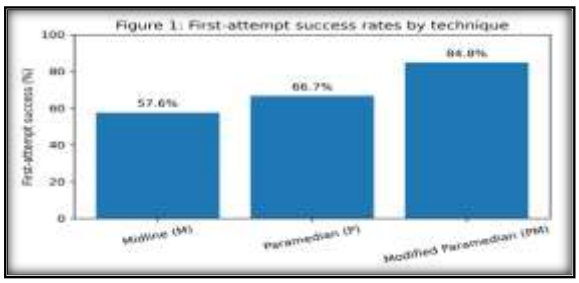

Figure 1. First-attempt success rates. Bar graph of percentage of patients with successful dural puncture on first needle insertion in each group (p=0.035; chi-square).

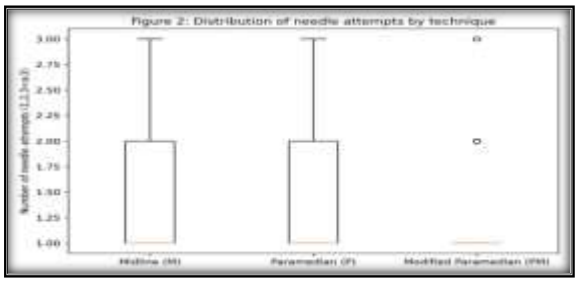

Figure 2: Total needle attempts. Box plot of number of needle passes required for success. Median (IQR) attempts are lower in PM vs P and M (p=0.028, Kruskal–Wallis).

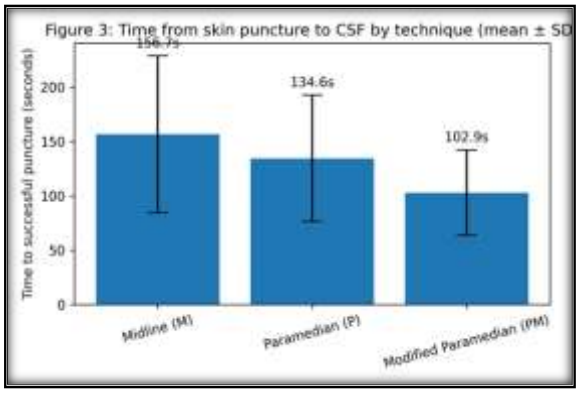

Figure 3: Time to spinal puncture. Mean (±SD) time from skin puncture to CSF arrival. p=0.006 (ANOVA).

In summary, the ultrasound-assisted modified paramedian approach significantly improved first-pass success and efficiency without increasing complications. The conventional paramedian approach showed intermediate results, while the standard midline approach had the lowest success rate. No technique-related major complications occurred in any group.

DISCUSSION

This trial demonstrates that an ultrasound-assisted modified paramedian spinal technique greatly enhances procedural success in elderly patients compared to conventional midline or paramedian methods. The first-attempt success of 84.8% in the modified paramedian group was markedly higher than 57–67% in the others [Table 2], a difference both statistically and clinically significant. This finding is consistent with recent reports. Zeng et al. reported similar advantages of a modified paramedian approach in elderly Chinese patients (higher first-pass success and fewer needle attempts).[8] Likewise, Park et al. showed ultrasound-guided paramedian blocks in older adults increased first-pass success to 65% vs 17.5% for landmark techniques.[5] These results align with systematic reviews: Kamimura et al.'s network meta-analysis found both preprocedure and real-time ultrasound significantly improve first-pass success of neuraxial puncture (RR≈1.6–1.9).[9] In short, our data add to robust evidence that ultrasound guidance boosts the technical success of spinal anaesthesia in challenging patients.[5,9]

Our study is one of the first to directly compare three ultrasound-assisted variants. The modified paramedian approach likely combined advantages: by entering laterally, it bypasses calcified midline ligaments and allows a more horizontal needle path. This may explain the significantly shorter puncture time and fewer manipulations [Table 3]. In contrast, the standard midline route in elderly is hindered by ligamentum flavum ossification.[1] A number of papers have noted that paramedian blocks reduce incidences of bone contact and headache.[2,10] Indeed, meta-analysis suggests paramedian may lower PDPH and paresthesia,[10] though our study was underpowered for minor complications. We did observe slightly fewer failures and complaints with PM, but differences were not significant [Table 3].

The improved efficiency with ultrasound guidance is reflected in our secondary outcomes. Both needle passes and total redirections were fewer in PM [Table 2], reducing tissue trauma. This mirrors previous work: Coviello et al. found that novice trainees using ultrasound-assisted spinal techniques required significantly fewer attempts and had less patient discomfort.[3] In terms of time, our finding that PM had the shortest dural puncture time (mean ~103 s) is consistent with Bagcilar et al., who observed markedly reduced procedure time with paramedian versus midline technique in geriatric hip fracture patients (median 18 s vs 41 s to puncture; p<0.001).[11] The ability of ultrasound to pre-identify optimal depth and angle likely contributes to these gains.

Given the robust benefits, guidelines now encourage neuraxial ultrasound. For instance, the UK's NICE suggests using ultrasound as a pre-procedural tool for epidurals/spinals to assess anatomy.[3] The European PERSEUS guidelines state that evidence is currently limited to preprocedure identification (as used here) but emphasize ultrasound's potential value in neuraxial blocks.[4] Our findings support that pre-puncture scanning and modified technique should be incorporated into practice, especially for elderly patients with difficult anatomy.

We acknowledge limitations. The attending anaesthetists could not be blinded, which may introduce performance bias. However, all anaesthetists were experienced with each technique,

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and the outcomes are mostly objective (success rates and times). We did not assess longer-term outcomes such as late pain or mobility. Also, our study was conducted at a single centre, which may limit generalisability; multicentre validation would be valuable. Finally, while patient satisfaction was high and similar in all groups, formal blinding of patients to technique was difficult; nonetheless, satisfaction rates did not differ [Table 2].

In conclusion, ultrasound-assisted modified paramedian spinal anaesthesia significantly improves first-attempt success and reduces procedural burden in elderly patients, without added risk. We recommend that anaesthetists consider this approach for geriatric neuraxial blocks, complementing existing evidence and guidelines on neuraxial ultrasound.[3,9]

CONCLUSION

Elderly patients often present challenging spinal anatomy that reduces the success of traditional midline spinal anaesthesia. In this prospective RCT, we show that an ultrasound-assisted modified paramedian approach markedly increases first-attempt success and reduces needle insertions and puncture time compared to both midline and standard paramedian techniques. The modified paramedian approach thus appears to combine the advantages of ultrasound guidance with a lateral needle trajectory, making it a valuable option in geriatric spinal anaesthesia. Future studies could explore training requirements and patient-centered outcomes, but current data support wider adoption of this technique in appropriate patients.

REFERENCES

1. 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 Feb;53(1):9-14. doi: 10.5152/eurasianjmed.2020.20215. Epub 2020 Nov 23. PMID: 33716523; PMCID: PMC7929581.
2. Narkhede HH, Kane D, Parekh V, Hemantkumar I. A cohort study of anatomical landmark-guided midline versus pre-procedure ultrasound-guided midline technique of spinal anesthesia in elderly patients undergoing orthopedic surgery. J Anaesthesiol Clin Pharmacol. 2019 Oct-Dec;35(4):522-527. doi: 10.4103/joacp.JOACP_396_17. PMID: 31920238; PMCID: PMC6939569.
3. Coviello A, Iacovazzo C, Piccione I, Posillipo C, Barone MS, Ianniello M, de Siena AU, Cirillo D, Vargas M. Impact of Ultrasound-Assisted Method on Success Rate of Spinal Anesthesia Performed by Novice Trainees: A Retrospective Comparative Study. J Pers Med. 2023 Oct 21;13(10):1515. doi: 10.3390/jpm13101515. PMID: 37888126; PMCID: PMC10608531.
4. Boselli, Emmanuel; Hopkins, Philip; Lamperti, Massimo; Estèbe, Jean-Pierre; Fuzier, Régis; Biasucci, Daniele G.; Disma, Nicola; Pittiruti, Mauro; Traškaitė, Vilma; Macas, Andrius; Breschan, Christian; Vailati, Davide; Subert, Matteo. European Society of Anaesthesiology and Intensive Care Guidelines on peri-operative use of ultrasound for regional anaesthesia (PERSEUS regional anesthesia): Peripheral nerves blocks and neuraxial anaesthesia. European Journal of Anaesthesiology 38(3):p 219-250, March 2021. | DOI: 10.1097/EJA.0000000000001383
5. Park SK, Yoo S, Kim WH, Lim YJ, Bahk JH, Kim JT. Ultrasound-assisted vs. landmark-guided paramedian spinal anaesthesia in the elderly: A randomised controlled trial. Eur J Anaesthesiol. 2019 Oct;36(10):763-771. doi: 10.1097/EJA.0000000000001029. PMID: 31188153.
6. World Health Organization. Ageing and health. Geneva: WHO; 2018.
7. Perioperative Regional Anesthesia in the Elderly – NYSORA. available at https://www.nysora.com/topics/sub-specialties/elderly/perioperative-regional-anesthesia-elderly/
8. Zeng, W., Shi, Y., Zheng, Q. et al. Ultrasound-assisted modified paramedian technique for spinal anesthesia in elderly. BMC Anesthesiol 22, 242 (2022). https://doi.org/10.1186/s12871-022-01751-0
9. Kamimura Y, Yamamoto N, Shiroshita A, Miura T, Tsuji T, Someko H, et al. Comparative efficacy of ultrasound guidance or conventional landmarks for neuraxial puncture: a systematic review and network meta-analysis. Br J Anaesth. 2024;132(5):1097-1111. https://doi.org/10.1016/j.bja.2023.09.006
10. Ng, K.T., Lim, W.E., Teoh, W.Y. et al. Paramedian versus midline approach of spinal anesthesia: a systematic review and meta-analysis with trial sequential analysis. J Anesth 38, 65–76 (2024). https://doi.org/10.1007/s00540-023-03281-6
11. Arslan K, Şahin Ayça S. Should the Paramedian Approach be the First Choice in Spinal Anesthesia of Geriatric Patients? Prospective Randomized Clinical Trial. Bagcilar Medical Bulletin. Vol. 7, no. 3 pp. 240 – 246 (2022). https://doi.org/10.4274/bmb.galenos.2022.2022-06-059.

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