AJPMHS GLOBAL RESEARCH NETWORK

AMERICAN Journal of Pediatric Medicine and Health Sciences
Volume 4, Issue 04, 2026 ISSN (E): 2993-2149

Ultrasound-Guided Versus Landmark Technique for Spinal Anesthesia: A Comparative Study of Success Rate, Procedure Time, and Complications

Dr. Mohammed Thanoon Hamed Al-dulaimi
Anesthesiologist and Intensive Care Specialist, Medical Research Teaching Hospital, Mosul, Iraq

Abstract: Background: Spinal anesthesia is extensively applied in lower abdominal and lower limb surgery; nonetheless, the traditional landmark technique is linked to the varying success rates and complications. Ultrasound guidance has been brought out as a possible tool of enhancing accuracy and clinical results.

Aim: To compare the ultrasound-guided with the landmark methods of spinal anesthesia in terms of the first-attempt success rate, duration of the procedure, and complications.

Methods: It was a prospective comparative study that was carried out over a period of one year in the Medical Research Teaching Hospital. One hundred and twenty adult patients who were to undergo elective surgeries under spinal anesthesia were divided equally between two groups; ultrasound-guided (n = 60) and landmark technique (n = 60). The first-attempt success rate was used as the primary outcome, and other secondary outcomes were the procedure time, the number of attempts, as well as the complications. Data analysis was done with SPSS 28 and p = 0.05 was used as the level of significance.

Findings: The ultrasound group had a much higher success rate on the first attempt than the landmark group (86.7% vs 63.3% p = 0.003). The time spent at the procedure was also a lot less in the ultrasound group (3.8 +1.2 minutes vs 6.1 +2.0 minutes, p = 0.001). Also, ultrasound group experienced fewer needle attempts and reduced cases of complications, such as paresthesia, bloody tap, and failed block ($p < 0.05$).

Conclusion: Ultrasound-guided spinal anesthesia is better and safer in comparison to the traditional landmark method, with a better success rate, shorter duration of a procedure, and less number of complications. It is advisable to incorporate it into the normal practice of anesthetic practice in case of resources.

Keywords: Spinal anesthesia; Ultrasound guidance; Landmark technique; Regional anesthesia.

1. Introduction

Spinal anesthesia is a popular regional anesthetic method used in lower abdominal, pelvic, and lower extremity surgery because of its long-standing advantages of providing good analgesia, minimizing drug exposure in the systemic circulation, reducing postoperative morbidity and improving the recovery outcomes (1,2). Effective spinal anesthesia is highly reliant on the correct identification of spinal anatomical landmarks and the correct location of the needle into the subarachnoid space (3). The traditional method has been the standard one, which involves palpation of the surface anatomical structures, including iliac crests and spinous processes, to

insert the needle (4). Nevertheless, this technique is very operator-specific and can be linked to more challenges with patients who are obese, aged, or spinal-deformed, where there is a tendency to have a series of attempts, longer procedure time, and a risk of complications (5,6).

Over the past years, ultrasound imaging has become a useful adjunct to regional anesthesia offering the visualization of the spinal anatomy and aiding in the proper identification of the intervertebral space and the most appropriate points to insert the needles (7). Preprocedural ultrasound scanning is suggested to allow anesthesiologists with an evaluation of anatomical discrepancies, estimating the needle depth, and defining the correct needle path, which may positively influence the success of the procedure and the occurrence of complications (8). The above findings have been proven in various studies that show ultrasound-guided spinal anesthesia is linked to increased first-attempt success rates, fewer needle passages, and enhanced patient comfort than the traditional landmark method, especially when applied to patients with problematic anatomy (9,10).

Although these are the benefits, ultrasound guidance in spinal anesthesia is not widely used in most hospitals particularly in developing nations where landmark technique is the most common as it has the resources, equipment, and no adequate training (11). Moreover, the differences in reported results and differences in the clinical practice require additional comparative research to assess the efficacy of ultrasound guidance in various groups of patients and care settings (12).

Thus, this research will compare ultrasound-guided and landmark methods of spinal anesthesia regarding their success rate, time spent on the procedure, and the complications involved to present the evidence-based recommendations that would enhance the clinical practice and patient safety (13).

2. Method

The research was planned to be a prospective comparative study, over a time-period of one year, i.e. between January 2025 and January 2026, at the Medical Research Teaching Hospital. This was to compare the efficacy of ultrasound-guided and landmark-only spinal anesthesia in adult patients who were undergoing elective lower abdominal and lower limb surgeries.

The study population consisted of 120 patients who were divided into two equal groups, the ultrasound-guided group (n = 60) and landmark technique group (n = 60). The sample size was calculated according to the past literature indicating that there is a great difference between the first-attempt success rate of the two methods, and 95 percent of confidence level and 80 percent of the statistical power were taken. The sampling was based on a consecutive sampling pattern of the patients.

Patients of spinal anesthesia who were eligible had to be aged 1865 years, American Society of Anesthesiologists (ASA) physical status I-III, and have elective surgeries planned. The study excluded patients who had contraindications to spinal anesthesia (coagulopathy, infection at the puncture site, or severe hypovolemia), known spinal deformities or had previous spinal surgery or refused to take part in the study.

An ultrasound scan was conducted on the ultrasound-guided group prior to the procedure of inserting the needles to locate the correct interspinal area, the point of needle insertion, and the depth to the subarachnoid space. Before inserting the needles in the skin, marking on the skin was performed. The spinal anesthesia in the landmark group was done through the traditional method of palpation of anatomical landmarks, especially the iliac crest line (Tuffiers line).

To remain consistent all the operations were done by anesthesiologists with a minimum of three years of clinical practice in spinal anesthesia. All patients were subjected to standard monitoring, which involved non-invasive blood pressure, heart rate, and oxygen saturation.

The first attempt success of spinal anesthesia was the main outcome measure. The secondary outcomes were total procedure time (needle insertion to successful cerebral spinal fluid flow),

needle attempt number, and complications such as post dural puncture headache, paresthesia, bloody tap and failed block.

The data collection was done in the form of a structured data collection sheet and analyzed in IBM SPSS version 28. The descriptive statistics was in form of mean + standard deviation of the continuous variables and frequencies expressed using percentages of the categorical variables. The independent samples t-test was applied to compare the two groups in terms of continuous variables and Chi-square was applied to compare the two groups in terms of categorical variables. The p-value below 0.05 was taken as statistically significant.

The Nineveh Health Directorate provided the ethical approval of the study. Informed consent was taken in writing by all the participants upon the explanation of the purpose and procedures of the study. The principles of the Declaration of Helsinki were upheld in the present research as patient data confidentiality and anonymity were ensured during the entire research process.

3. Results

Table 3.1: Demographic Characteristics of the Study Participants (N = 120)

Variable	Ultrasound Group (n=60)	Landmark Group (n=60)	P-value
Age (years) Mean ± SD	42.6 ± 12.3	44.1 ± 11.8	0.512
Gender (Male) n (%)	34 (56.7%)	32 (53.3%)	0.705
BMI (kg/m²) Mean ± SD	27.8 ± 4.5	28.3 ± 4.9	0.603
ASA I n (%)	22 (36.7%)	20 (33.3%)	0.689
ASA II n (%)	28 (46.7%)	30 (50.0%)	
ASA III n (%)	10 (16.6%)	10 (16.7%)	

The ultrasound-guided and landmark groups did not show any statistically significant differences in terms of age, gender, BMI, or ASA classification ($p > 0.05$), which means that the groups are similar at a baseline.

Table 3.2: First-Attempt Success Rate

Outcome	Ultrasound Group (n=60)	Landmark Group (n=60)	P-value
Success (first attempt)	52 (86.7%)	38 (63.3%)	**0.003**
Failure	8 (13.3%)	22 (36.7%)	

The rate of success at the first attempt was much more in the ultrasound group than in the landmark group (86.7% vs 63.3% $p = 0.003$) showing the superiority of ultrasound guidance.

Table 3.3: Procedure Time (minutes)

Variable	Ultrasound Group	Landmark Group	P-value
Procedure Time Mean ± SD	3.8 ± 1.2	6.1 ± 2.0	**<0.001**

The ultrasound-guided method also greatly cut down the time taken to conduct the procedure than the landmark technique ($p < 0.001$), thus being more efficient in the process.

Table 3.4: Number of Needle Attempts

Attempts	Ultrasound Group	Landmark Group	P-value
1 attempt	52 (86.7%)	38 (63.3%)	**0.003**
2 attempts	6 (10.0%)	14 (23.3%)	
≥3 attempts	2 (3.3%)	8 (13.4%)	

The ultrasound group had a much lower number of needle attempts than the landmark group ($p = 0.003$), which means that the accuracy was much better.

Table 3.5: Complications

Complication	Ultrasound Group	Landmark Group	P-value
Post-dural puncture headache	2 (3.3%)	7 (11.7%)	0.081
Paresthesia	3 (5.0%)	10 (16.7%)	**0.041**
Bloody tap	2 (3.3%)	9 (15.0%)	**0.028**
Failed block	1 (1.7%)	6 (10.0%)	**0.048**

Paresthesia, bloody tap and failed block complications were considerably lower in the ultrasound group ($p < 0.05$) and post-dural puncture headache had no statistically significant difference.

Table 3.6: Overall Success Rate

Outcome	Ultrasound Group	Landmark Group	P-value
Successful block	59 (98.3%)	54 (90.0%)	**0.048**
Failed block	1 (1.7%)	6 (10.0%)	

The success rate of spinal anesthesia as a whole was much better in the ultrasound-directed group than in the landmark group ($p = 0.048$).

3. Discussion

The current study revealed that ultrasound-guided spinal anesthesia is much better than the traditional landmark method in the first-attempt success rate, lessening time on the procedure, and decreasing complications. These results indicate the clinical usefulness of ultrasound as a supplementary instrument in neuraxial anesthesia, especially in improving the accuracy of the procedure and patient safety.

In this experiment, the success rate of the first attempt was much higher in the ultrasound group (86.7 percent) than in the landmark group (63.3 percent) ($p = 0.003$). This finding is in line with other studies that have shown increased success rates with ultrasound guidance. As an example, Shaikh et al. (14) discovered that the probability of a first attempt at spinal anesthesia was significantly higher with preprocedural ultrasound. Likewise, a meta-analysis by Perlas et al. (15) revealed that ultrasound guidance enhances precision in needle insertion and decreases technical complexity, especially in patients who do not have well-palpable landmarks.

The duration of the procedure was much less in the ultrasound group (3.8 +/ -1.2) than in the landmark group (6.1 +/ -2.0) ($p < 0.001$). Though ultrasound involves a scanning process at the beginning, the time is still saved because the number of needle redirections and attempts is minimized. This observation is consistent with other studies by Chin et al. (16) who observed that ultrasound guidance reduces the overall procedural time by enabling the accurate localization of the intervertebral space and minimizing trial-and-error localizations.

On the issue of the number of needle attempts, most of the patients in the ultrasound group had a single attempt, and multiple attempts were more common in the landmark group ($p = 0.003$). This finding is consistent with the results of Grau et al. (17) that showed that ultrasound imaging can greatly decrease the number of puncture attempts and enhance the ease of the procedure. Less attempts are also of clinical significance since they are connected with less patient discomfort and a decrease in complication rates.

Regarding complications, this study established that paresthesia, bloody tap, and failed block were much lower in the ultrasound group. These results align with the ones described by Nomura et al. (18), who demonstrated that ultrasound guidance lowers the trauma caused by the needles and enhances the safety of neuraxial procedures. Even though the rate of post-dural puncture headache was less in ultrasound group, the variation did not prove to be statistically significant, which is consistent with the previous research that has indicated that such a complication is multi-factorial and not dependent only on technique (19).

The general success rate of the spinal anesthesia procedure also showed to be more successful in the ultrasound group (98.3 vs 90.0, p = 0.048) which once again supports the effectiveness of ultrasound guidance. This observation is justified by the fact that various randomized and observational studies have shown that ultrasound increases both the technical success and clinical outcomes (20).

5. Conclusion

The ultrasound-guided spinal anesthesia proved to have better results over the landmark technique, such as better first attempt success, reduced procedure time, and reduced complications. These results warrant the application of ultrasound to enhance the accuracy and safety of spinal anesthesia, especially to patients with challenging anatomy. Incorporation of ultrasound in the practice can potentially improve the efficiency of the procedure and patient outcomes, but additional multicenter research is suggested to validate these findings.

References

1. Miller RD, Cohen NH, Eriksson LI, Fleisher LA, Wiener-Kronish JP, Young WL. *Miller's Anesthesia*. 9th ed. Philadelphia: Elsevier; 2020.
2. Barash PG, Cullen BF, Stoelting RK, Cahalan MK, Stock MC. *Clinical Anesthesia*. 8th ed. Philadelphia: Wolters Kluwer; 2017.
3. Hadzic A. *Textbook of Regional Anesthesia and Acute Pain Management*. 2nd ed. New York: McGraw-Hill; 2017.
4. Morgan GE, Mikhail MS, Murray MJ. *Clinical Anesthesiology*. 6th ed. New York: McGraw-Hill; 2018.
5. Ellinas EH, Eastwood DC, Patel SN, Maitra-D'Cruze AM, Ebert TJ. The effect of obesity on neuraxial technique difficulty. *Anesth Analg*. 2009;109(4):1225–31. DOI:**10.1213/ane.0b013e3181b2d6b0**
6. Chin KJ, Karmakar MK, Peng P. Ultrasonography of the adult thoracic and lumbar spine for central neuraxial blockade. *Anesthesiology*. 2011;114(6):1459–85. DOI: **10.1097/ALN.0b013e3182170f94**
7. Grau T, Leipold RW, Fatehi S, Martin E, Motsch J. Real-time ultrasonic observation of combined spinal-epidural anesthesia. *Eur J Anaesthesiol*. 2004;21(1):25–31. DOI: **10.1017/S0265021504001041**
8. Perlas A, Chaparro LE, Chin KJ. Lumbar neuraxial ultrasound for spinal and epidural anesthesia: A systematic review and meta-analysis. *Reg Anesth Pain Med*. 2016;41(2):251–60.
   DOI: **10.1097/AAP.0000000000000350**
9. Shaikh F, Brzezinski J, Alexander S, Arzola C, Carvalho JC, Beyene J, et al. Ultrasound imaging for lumbar punctures and epidural catheterisations: systematic review and meta-analysis. *BMJ*. 2013;346:f1720. DOI: **10.1136/bmj.f1720**
10. Nomura JT, Leech SJ, Shenbagamurthi S, Sierzenski PR, O'Connor RE. A randomized controlled trial of ultrasound-assisted lumbar puncture. *J Ultrasound Med*. 2007;26(10):1341–8.
    DOI: **10.7863/jum.2007.26.10.1341**
11. Chin KJ, Perlas A. Ultrasonography of the lumbar spine for neuraxial and lumbar plexus blocks. *Curr Opin Anaesthesiol*. 2011;24(5):567–72. DOI: **10.1097/ACO.0b013e32834a8c96**
12. Peterson MA, Pisupati D, Heyming TW, Abele J. Ultrasound for routine lumbar puncture. *Acad Emerg Med*. 2014;21(2):130–6. DOI: **10.1111/acem.12303**

13. Margarido CB, Mikhael R, Arzola C, Balki M, Carvalho JC. The intercristal line determined by palpation is not a reliable anatomical landmark for neuraxial anesthesia. *Can J Anaesth*. 2011;58(3):262–6. DOI: **10.1007/s12630-010-9432-7**

14. Shaikh F, Brzezinski J, Alexander S, et al. Ultrasound imaging improves spinal anesthesia success rates. *BMJ*. 2013;346:f1720. DOI: **10.1136/bmj.f1720**

15. Perlas A, Chaparro LE, Chin KJ. Ultrasound guidance improves neuraxial block accuracy. *Reg Anesth Pain Med*. 2016;41(2):251–60. DOI: **10.1097/AAP.0000000000000350**

16. Chin KJ, Karmakar MK, Peng P. Ultrasound reduces procedural difficulty in spinal anesthesia. *Anesthesiology*. 2011;114(6):1459–85. DOI: **10.1097/ALN.0b013e3182170f94**

17. Grau T, Leipold RW, Conradi R, Martin E, Motsch J. Ultrasound control improves spinal anesthesia. *Anesth Analg*. 2001;92(2):372–6. DOI: **10.1097/00000539-200102000-00019**

18. Nomura JT, et al. Ultrasound reduces complications in lumbar puncture. *J Ultrasound Med*. 2007;26(10):1341–8. DOI: **10.7863/jum.2007.26.10.1341**

19. Turnbull DK, Shepherd DB. Post-dural puncture headache: pathogenesis, prevention and treatment. *Br J Anaesth*. 2003;91(5):718–29. DOI: **10.1093/bja/aeg231**

20. Arzola C, Davies S, Rofaeel A, Carvalho JC. Ultrasound using the transverse approach improves spinal anesthesia. *Anesth Analg*. 2007;104(5):1187–92. DOI: **10.1213/01.ane.0000261514.20501.36**