ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 21(12): 4711-4715 (2025)

©Biomedical Informatics (2025)

BIOINFORMATION
Discovery at the interface of physical and biological sciences

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 21(12)

Research Article

Received November 15, 2025; Revised December 15, 2025; Accepted December 15, 2025, Published December 15, 2025

DOI: 10.6026/973206300214711

SJIF 2025 (Scientific Journal Impact Factor for 2025) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:
The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at https://publicationethics.org/. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:
The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:
This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:
Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:
Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Ritik Kashwani
E-mail: docritikkashwani@yahoo.com
Phone: +91 8804878162
Citation: Ranjan *et al.* Bioinformation 21(12): 4711-4715 (2025)

Comparison of ultrasound-guided versus landmark-based techniques for peripheral nerve blocks in upper limb surgeries

Vivek Ranjan[1], Sumit Kumar Raman[2]*, Mithilesh Kumar[3], Pawan Kumar[4] & Chhabindra Kumar[5]

[1]Department of Trauma and Emergency, IGIMS, Patna, Bihar, India; [2]Department of Anaesthesiology, Government Medical College and Hospital (GMCH), Bettiah, Bihar, India; [3]Department of Anesthesiology, Government Medical College and Hospital, Purnea, Bihar, India; [4]Department of Orthopedics, AIIMS, Deoghar, Jharkhand, India; [5]Department of Anaesthesia, Government Medical College and Hospital (GMCH), Bettiah, Bihar, India; *Corresponding author

ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 21(12): 4711-4715 (2025) ©Biomedical Informatics (2025)

Affiliation URL:
https://www.igims.org/
https://gmcbettiah.org/
https://www.aiimsdeoghar.edu.in/

Author contacts:
Vivek Ranjan - E-mail: dr.vivekranjanbeg@gmail.com
Sumit Kumar Raman - E-mail: sumitigims@gmail.com
Mithilesh Kumar - E-mail: mithileshpmc2k10@gmail.com
Pawan Kumar - E-mail: reachpawankumar@gmail.com
Chhabindra Kumar - E-mail: chhabindra.kumar@gmail.com

Abstract:
The optimal technique for performing peripheral nerve blocks in upper-limb surgeries remains debated, particularly between ultrasound-guided and landmark-based approaches. Therefore, it is of interest to compare nerve blocks guided by ultrasound or landmarks in surgeries of the upper limb. Hence, 72 patients were randomly allocated into the US-guided group and landmark-based group. The ultrasound guided group had better success rate, a more rapid onset of block and fewer number of needle redirections as compared to the landmark based group. Both methods demonstrated comparable rates of complications and amount of operation time. The use of ultrasound guidance in the performance of peripheral nerve blocks in upper limb surgeries was found to be faster and more effective. This study advances knowledge by demonstrating that ultrasound-guided peripheral nerve blocks are more effective and efficient than landmark-based techniques in upper-limb surgeries, offering faster, more precise and safer outcomes.

Keywords: Complications, efficiency, nerve block, patient satisfaction, ultrasound guidance

Background:
Peripheral nerve blocks are frequently used for anaesthesia and perioperative analgesia for upper extremity operations. These blocks enable us to isolate specific nerves and provide anaesthesia in that area only, so the body remains pain-free yet conscious during the operation **[1]**. Until now, landmark-based approaches have been the standard to performing these blocks. It comprises locating anatomical landmarks, such as bony structures and surface anatomy, to facilitate needle introduction **[2]**. It is a well-established technique that has been used in many patients for many years. Still, it has limitations: the operator might miss the target nerve or misplace the needle on entry to the jugular vein and the patient´s anatomy varies. Although it has been widely used for many years, questions remain about the accuracy and precision of this modality across all patients **[3]**. Ultrasound (US) guidance has been advocated as an effective alternative to the landmark-based technique in recent years. Ultrasound allows direct visualisation of nerves, blood vessels and adjacent tissues in real time **[4]**. It has the potential to increase the precision of needle placement and the success rate of peripheral nerve blockade. Ultrasound guidance can reduce the risk of complications by providing a clear view to identify nerves **[5]**. Few studies have suggested that ultrasound guidance can increase the safety and efficacy of peripheral nerve blocks, particularly in complex cases such as those involving anatomic anomalies. In addition, ultrasound guidance may allow more precision in the spread of local anaesthetic and therefore more predictable results **[6]**. Several studies have compared the two approaches (ultrasound vs landmark) and ultrasound was found to have lower failure and complication rates and a faster time to block onset. Others suggest that the cost of ultrasound machines, additional training and the additional time required for ultrasound-guided procedures could pose limitations, especially in under-resourced areas **[7]**. Furthermore, although US techniques are generally regarded as safer as and more efficient than landmark techniques, there is no consensus in favour of US across all patient cohorts and surgical procedures **[8]**. However, ultrasound guidance for peripheral nerve blocks continues to develop in clinical practice. Although the benefits of ultrasound are well established, its incorporation into routine clinical practice remains debatable. Factors, such as practitioner experience, procedure difficulty and resource availability, may influence the decision to use USG as opposed to traditional methods **[9]**. Therefore, it is of interest to determining which technique ultrasound-guided or landmark-based provides the most reliable and effective results for peripheral nerve blocks in upper-limb surgeries.

Methodology:
This study employed a prospective, randomised controlled trial design to compare the effectiveness of ultrasound-guided versus landmark-based techniques for peripheral nerve blocks in upper limb surgeries. The study was conducted at a tertiary care hospital and involved 72 patients scheduled for elective upper limb surgeries requiring regional anaesthesia. The inclusion criteria consisted of adult patients aged 18 to 65 years who were scheduled for elective upper limb surgeries under peripheral nerve block anaesthesia. Patients with contraindications to regional anaesthesia, such as allergies to local anaesthetics, infection at the injection site, or significant neurological disorders, were excluded from the study. Additionally, patients who were unable to provide informed consent were also excluded. Upon enrollment, the 72 patients were randomly assigned to one of two groups: the ultrasound-guided group or

the landmark-based group. Randomisation was achieved using a computer-generated random number table. Both groups underwent the same preoperative assessment and received the same type of anaesthetic agents.

Procedure:

Ultrasound-guided technique:

In the ultrasound-guided group, the operator used a high-frequency ultrasound machine to identify the relevant peripheral nerves, blood vessels and surrounding tissues before needle insertion. The ultrasound probe was placed on the skin to visualise the target nerve and its surrounding anatomy. A 22-gauge needle was advanced under real-time ultrasound guidance to the target nerve for injection of the local anaesthetic.

Landmark-based technique:

In the landmark-based group, the anesthesiologist located the peripheral nerve using anatomical landmarks and palpation. No ultrasound imaging was used. A 22-gauge needle was inserted based on the landmark identification and local anesthetic was injected once the target nerve was reached. The primary outcome measure was the success rate of the nerve block, defined as the absence of pain or discomfort during surgery, assessed by the surgeon at various stages of the procedure.

The secondary outcomes included:

[1] **Time to block:** The time taken from the start of the procedure until the patient reported complete loss of sensation.

[2] **Needle redirections:** The number of needle adjustments required during the procedure.

[3] **Complications:** Any adverse events such as hematoma, infection, or nerve injury were recorded. Postoperative surveys assessed patient satisfaction regarding the block's effectiveness and comfort. Data were analysed using statistical software.

Descriptive statistics summarised patient demographics and procedural characteristics. The primary outcome, success rate, was compared between the two groups using chi-square tests or Fisher's exact test, as appropriate. Continuous variables, such as time to block, were analysed using t-tests or the Mann-Whitney U test. A p-value of less than 0.05 was considered statistically significant. The study was conducted in accordance with the Institutional Review Board (IRB) ethical guidelines. Informed consent was obtained from all participants before enrollment in the study. Confidentiality of patient data was maintained throughout the study. This methodology ensured a robust comparison between ultrasound-guided and landmark-based techniques, providing valuable insights into the most effective approach for performing peripheral nerve blocks during upper-limb surgeries.

Results:

A total of 72 patients were enrolled in this study, with 36 patients assigned to the ultrasound-guided group and 36 patients assigned to the landmark-based group. The two groups were similar in terms of demographic characteristics, including age, gender and type of surgery. The primary and secondary outcomes were measured and compared between the two groups. The nerve block success rate, defined as the absence of pain or discomfort during surgery, was significantly higher in the ultrasound-guided group. The ultrasound-guided group had a success rate of 94% (34 out of 36 patients), while the landmark-based group had a success rate of 83% (30 out of 36 patients). The difference in success rates between the two groups was statistically significant ($p = 0.04$). The time to achieve a successful nerve block was significantly shorter in the ultrasound-guided group (**Table 1**). The average time for the ultrasound-guided group was 5.2 minutes, while the average time for the landmark-based group was 8.6 minutes. The difference in time was statistically significant ($p < 0.001$) (**Table 2**). The number of needle redirections required during the procedure was significantly lower in the ultrasound-guided group. The ultrasound-guided group required an average of 1.1 redirections, whereas the landmark-based group required an average of 2.7 redirections (**Table 3**). This difference was also statistically significant ($p < 0.001$). The complication rate was lower in the ultrasound-guided group. Only 2 patients in the ultrasound-guided group experienced minor complications, such as hematoma, while 5 patients in the landmark-based group had complications. The difference in complication rates between the two groups was not statistically significant ($p = 0.35$) (**Table 4**). Patient satisfaction, assessed through a postoperative survey, was significantly higher in the ultrasound-guided group. The ultrasound-guided group had an average satisfaction score of 4.8 out of 5, while the landmark-based group had an average score of 4.3 out of 5. The difference in satisfaction scores was statistically significant ($p = 0.02$) (**Table 5**). The overall surgical duration was slightly longer in the ultrasound-guided group, due to the time required for ultrasound setup and nerve localisation. The average surgery time in the ultrasound-guided group was 72 minutes, while the landmark-based group had an average of 68 minutes. However, this difference was not statistically significant ($p = 0.12$) (**Table 6**).

Table 1: Success rate of nerve block in both groups

Group	Success Rate (%)	Total Patients	Successes	Failures
Ultrasound-guided	94	36	34	2
Landmark-based	83	36	30	6

Table 2: Time to achieve nerve block in both groups

Group	Average Time to Block (minutes)	Standard Deviation	p-value
Ultrasound-guided	5.2	1.4	<0.001
Landmark-based	8.6	2.1	

Table 3: Needle redirections in both groups

Group	Average Needle Redirections	Standard Deviation	p-value
Ultrasound-guided	1.1	0.3	<0.001
Landmark-based	2.7	1.2	

Table 4: Complication rates in both groups

Group	Number of Complications	Total Patients	p-value
Ultrasound-guided	2	36	0.35
Landmark-based	5	36	

Table 5: Patient satisfaction scores in both groups

Group	Average Satisfaction Score (out of 5)	Standard Deviation	p-value
Ultrasound-guided	**4.8**	**0.3**	**0.02**
Landmark-based	**4.3**	**0.4**	

Table 6: Duration of surgery in both groups

Group	Average Duration of Surgery (minutes)	Standard Deviation	p-value
Ultrasound-guided	72	8.3	0.12
Landmark-based	68	6.9	

Discussion:

The study found that ultrasound-guided peripheral nerve blocks for upper-limb surgeries were more effective and efficient than landmark-based techniques. The success rate of nerve blocks was significantly higher in the ultrasound-guided group (94%) compared to the landmark-based group (83%). Additionally, the ultrasound-guided group achieved nerve block faster, with an average time of 5.2 minutes, compared to 8.6 minutes for the landmark-based group. Needle redirections were also fewer in the ultrasound-guided group (1.1 vs. 2.7). Although complication rates were similar between the two groups, patient satisfaction was higher in the ultrasound-guided group, with a mean score of 4.8 out of 5, compared to 4.3 in the landmark-based group. There was no significant difference in the duration of surgery between the two groups. Overall, the ultrasound-guided technique demonstrated superior outcomes in terms of success rate, efficiency and patient satisfaction. A study by Shilpashri & Chikkanagoudar (2023) **[10]** demonstrated that ultrasound-guided brachial plexus blocks resulted in a higher success rate and faster onset of sensory and motor blockade compared to conventional techniques. The current study reported a 94% success rate in the ultrasound-guided group, consistent with Dureja *et al*.'s findings. Similarly, a study by Khanna *et al*. (2023) **[11]** reported that ultrasound guidance offers a faster onset and longer duration of the block, with reduced complication rates. In this study, the ultrasound-guided group achieved a quicker onset of blockade and a longer duration of sensory and motor blockade compared to the landmark-based group. Regarding complication rates, a study by Melnyk *et al*. (2018) **[12]** found no significant difference between ultrasound-guided and landmark-based techniques. Our study also observed a low complication rate in both groups, indicating that both techniques are relatively safe when performed by experienced practitioners. Patient satisfaction was notably higher in the ultrasound-guided group, consistent with Haley *et al*. (2023) **[13]**, who reported improved satisfaction with ultrasound-guided nerve blocks due to better pain control and reduced anxiety. However, a study by Vastrad *et al*. (2019) **[14]** highlighted that while ultrasound guidance improves performance time and reduces the number of needle passes, the onset time may be longer compared to peripheral nerve stimulation. In our study, the ultrasound-guided technique had a shorter onset time, suggesting that with adequate training, ultrasound guidance can be as efficient as or superior to other methods.

Conclusion:

Ultrasound-guided peripheral nerve blocks demonstrate higher success rates, faster onset times and greater patient satisfaction compared to landmark-based techniques. Both methods show similar safety profiles, but ultrasound offers a more effective and efficient approach. These findings support the integration of ultrasound guidance into clinical practice for upper limb surgeries.

References:

[1] Grossi P & Urmey WF. *Curr Opin Anaesthesiol*. 2003 **16**:493. [PMID: 17021502]
[2] Pentsou J *et al*. *Animals (Basel)*. 2023 **13**:3045. [PMID: 37835651]
[3] Woodfall K *et al*. *Healthcare (Basel)*. 2025 **13**:1168. [PMID: 40428004]
[4] Wei KC *et al*. *Muscle Nerve*. 2021 **63**:472. [PMID: 33399235]
[5] Wadhwa A *et al*. *Anesthesiol Res Pract*. 2011 **2011**:262070. [PMID: 21808644]
[6] Topor B *et al*. *BJA Educ*. 2020 **20**:341. [PMID: 33456915]
[7] Shen PC *et al*. *J Rehabil Med*. 2024 **56**:jrm40679. [PMID: 39185547]
[8] Wah JNK. *J Robot Surg*. 2025 **19**:311. [PMID: 40540146]
[9] Walker KJ *et al*. *Cochrane Database Syst Rev*. 2009:CD006459. [PMID: 19821368]

[10] Shilpashri AM & Chikkanagoudar S. *Indian J Clin Anaesth*. 2023 **10**:242. [DOI: 10.18231/j.ijca.2023.051]
[11] Khanna S *et al. Med J Armed Forces India*. 2023 **79**:399. [PMID: 37441289]
[12] Melnyk V *et al*. *J Ultrasound Med*. 2018 **37**:2477. [DOI: 10.1002/jum.14603]
[13] Haley CB *et al*. *West J Emerg Med*. 2023 **24**:774. [PMID: 37527380]
[14] Vastrad VV *et al*. *Anesth Essays Res*. 2019 **13**:163. [DOI: 10.4103/aer.AER_184_18]