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ORIGINAL ARTICLE

Evaluation of Ultrasound-Guided Versus Landmark based peripheral nerve blocks in upper limb Surgeries

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ABSTRACT

Background: Peripheral nerve blocks are widely used for upper limb surgeries, yet the effectiveness of traditional landmark-based techniques remains limited by anatomical variability and lack of visualization.

Objective: This study compared the clinical performance and postoperative outcomes of ultrasound-guided versus landmark-based peripheral nerve blocks.

Methods: A comparative study was conducted at CMH, Muzaffarabad (AJK) from January 2023 to June 2023 among 220 patients undergoing upper limb surgeries, with 110 receiving ultrasound-guided blocks and 110 receiving landmark-based blocks. Data included demographic variables, block performance characteristics, postoperative analgesia, patient satisfaction, and procedural complications. **Results:** Ultrasound-guided blocks showed significantly higher success rates (93.6% vs. 77.3%; $p < 0.001$), shorter block performance time (6.8 ± 2.1 min vs. 9.4 ± 2.7 min; $p < 0.001$), and faster sensory and motor onset. The duration of postoperative analgesia was markedly longer in the ultrasound group (11.4 ± 3.2 hours vs. 8.1 ± 2.9 hours; $p < 0.001$). Complications such as vascular puncture (3.6% vs. 13.6%) and hematoma (1.8% vs. 7.3%) were significantly lower in the ultrasound-guided group. Patient satisfaction scores were notably higher with ultrasound guidance (9.1 ± 1.0 vs. 7.6 ± 1.4; $p < 0.001$).

Conclusion: It is concluded that ultrasound-guided peripheral nerve blocks provide superior accuracy, safety, analgesic duration, and patient satisfaction compared with landmark-based techniques.

Keywords: Nerve block, limb, Surgery, patients, Visualization, Anatomical, Peripheral

INTRODUCTION

Peripheral nerve blocks (PNBs) have become an essential component of anesthesia for upper limb surgeries, offering superior analgesia, reduced opioid use, improved postoperative recovery, and greater patient satisfaction compared to general anesthesia alone[1]. Traditionally, the blocks were performed using techniques associated with anatomy, employing palpation, surface anatomy, and paresthesia as a guide for needle placement[2]. Although this method is still practised, it encountered a blind spot due to variabilities in body obesity, depth of the nerve, and the operator's experience, which can lead to higher risks of block failures, puncturing a blood vessel, and even inconsistent sensory motor coverage. With new technology, ultrasound-guided blocks have become the new standard for real-time visualisation of the needle and its surrounding structures. Improved techniques ensure the adequate spread of local anaesthetics[3]. Most nerve blocks have become standard in modern anaesthesia. Guided nerve blocks have been enhanced with the use of ultrasound technology to provide targeted anaesthesia. While this technology is no longer evolving, the palpation technique for nerve blocks still holds great importance[4]. The technique still proves successful, but with the augmented technology, the risks have become more pronounced. With the new technology comes a new standard, but the techniques still hold significance. The improved techniques still demonstrate the variability of anatomy and surrounding structures. In lightly obese individuals and with variabilities, the risks can become pronounced due to the lack of visibility of the structures[5]. The body, as a unit, can become a blockade of its own. Recent ultrasound research indicates that ultrasound is superior to landmark approaches in terms of rapid block onset, prolonged block duration, reduced anaesthetic volume, and lower complication rates. In recent years, the need for effective and targeted soft tissue and surgical anaesthetic approaches to surgeries of the upper limb has become even more pronounced[6]. In the immediate perioperative period, and even better, the high-quality postoperative analgesia provided by peripheral nerve blocks is a major shift that facilitates a lower reliance on analgesics, particularly important in orthopaedic and trauma cases where pain control serves to facilitate patient mobilisation and overall experience[7]. Postoperative analgesia represents a significant shift that reduces systemic analgesic reliance. The nerve blocks are central to this shift in analgesic practices. For years, nerve blocks performed using needle landmarking techniques have depended on the clinician's experience with surface anatomy and tactile feedback[8]. While these approaches are effective, the tactile method of needle guidance through soft tissue poses limitations regarding anatomical variants, patient body habitus, and critical structures located beneath the dermis[9]. Landmark approaches yield more insight into body systems/structures, resulting in less need for extensive visual guidance, but simultaneously, a greater chance of missing the landmark[10]. Subsequent randomised controlled trials and meta-analyses have consistently and unequivocally demonstrated that ultrasound blocks have better first-attempt success rates, faster times to achieving motor and sensory blocks, longer durations of analgesia, and decreased complication rates[11,12].

Objective: This study compared the clinical performance and postoperative outcomes of ultrasound-guided versus landmark-based peripheral nerve blocks.

METHODOLOGY

This was a comparative cross-sectional study conducted at CMH, Muzaffarabad (AJK) from January 2023 to June 2023. A total of 220 patients scheduled for upper limb surgeries under regional anesthesia were included in the study. A non-probability consecutive sampling technique was used.

Inclusion Criteria:

- Patients aged 18–70 years.
- Scheduled for elective or emergency upper limb surgery requiring peripheral nerve block.
- ASA physical status I–III.
- Patients who provided informed written consent.

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Exclusion Criteria:

- History of coagulopathy or patients on anticoagulation therapy.
- Local infection at the injection site.
- Known allergy to local anesthetics.
- Pregnant women.
- Hemodynamically unstable patients.
- Patients with pre-existing neuropathies or an inability to cooperate during the procedure.

Data collection: Data were collected after obtaining ethical approval and written informed consent from each participant. Patients were divided into two equal groups based on the technique used:

- **Group A (Ultrasound-guided blocks):** 110 patients
- **Group B (Landmark-based blocks):** 110 patients

The choice of technique was based on the attending anesthesiologist's standard practice and availability of ultrasound. Preoperative demographic and clinical information were recorded, including age, gender, ASA status, comorbidities, and type of surgery. In the ultrasound group, blocks were performed under direct visualization using a high-frequency linear probe to identify nerve structures and guide needle advancement. In the landmark group, blocks were performed using anatomical reference points combined with elicited paresthesia or nerve stimulation. For both groups, the time required to perform the block, onset of sensory and motor block, need for supplemental analgesia, conversion to general anesthesia, duration of postoperative analgesia, and any complications including vascular puncture, hematoma, block failure, nerve injury, and signs of local anesthetic toxicity were documented in a structured proforma.

Data Analysis: All collected data were analyzed using SPSS version 21.0. Quantitative variables such as block performance time, onset time, and analgesic duration were expressed as mean ± standard deviation and compared using independent sample t-tests. Categorical variables including block success rate and procedural complications were presented as frequencies and percentages and analyzed using chi-square or Fisher's exact test where appropriate. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

Data were collected from 220 patients, mean age was similar between the ultrasound-guided group (41.8 ± 12.5 years) and the landmark-based group (42.6 ± 11.9 years). Gender distribution was also almost identical, with males comprising 61.8% in the ultrasound group and 64.5% in the landmark group. The majority of patients in both groups fell within ASA class I–II (83.6% vs. 80.9%), indicating similar preoperative health status. Duration of surgery was nearly the same across groups (72.5 ± 18.2 min vs. 74.1 ± 17.6 min).

Block success was significantly higher with ultrasound (93.6%) compared with the landmark method (77.3%), showing strong statistical significance ($p < 0.001$). Ultrasound guidance also reduced the time required to perform the block (6.8 ± 2.1 min vs. 9.4 ± 2.7 min) and produced faster sensory and motor onset times, all with highly significant p-values. Additionally, fewer ultrasound-guided patients required supplemental intraoperative analgesia (6.4% vs. 18.2%), indicating better block reliability.

Table 1: Baseline Demographic and Clinical Characteristics (n = 220)

Variable	Ultrasound-Guided (n = 110)	Landmark-Based (n = 110)
Age (years), mean ± SD	41.8 ± 12.5	42.6 ± 11.9
Gender (Male), n (%)	68 (61.8%)	71 (64.5%)
ASA I–II, n (%)	92 (83.6%)	89 (80.9%)
Duration of Surgery (min), mean ± SD	72.5 ± 18.2	74.1 ± 17.6
Type of Surgery (Orthopedic soft tissue/bone), n (%)	59/51	62/48

Table 2: Block Performance and Onset Characteristics

Variable	Ultrasound-Guided (n = 110)	Landmark-Based (n = 110)	p-value
Block Success Rate, n (%)	103 (93.6%)	85 (77.3%)	<0.001
Time to Perform Block (min), mean ± SD	6.8 ± 2.1	9.4 ± 2.7	<0.001
Sensory Block Onset (min), mean ± SD	8.6 ± 3.0	13.2 ± 4.1	<0.001
Motor Block Onset (min), mean ± SD	11.1 ± 3.4	16.5 ± 4.5	<0.001
Supplemental Intraoperative Analgesia, n (%)	7 (6.4%)	20 (18.2%)	0.006

Table 3: Postoperative Analgesia and Clinical Outcomes

Outcome	Ultrasound-Guided (n = 110)	Landmark-Based (n = 110)	p-value
Duration of Postoperative Analgesia (hrs), mean ± SD	11.4 ± 3.2	8.1 ± 2.9	<0.001
Conversion to General Anesthesia, n (%)	2 (1.8%)	11 (10.0%)	0.01
Pain Score at 6 hours (VAS 0–10), mean ± SD	2.8 ± 1.4	4.9 ± 1.7	<0.001
Pain Score at 12 hours (VAS 0–10), mean ± SD	3.6 ± 1.5	5.3 ± 1.8	<0.001
Complications			
Vascular Puncture, n (%)	4 (3.6%)	15 (13.6%)	0.01
Hematoma, n (%)	2 (1.8%)	8 (7.3%)	0.05
Intravascular Injection, n (%)	1 (0.9%)	4 (3.6%)	0.17
Transient Paresthesia, n (%)	3 (2.7%)	9 (8.2%)	0.07
Local Anesthetic Systemic Toxicity, n (%)	0 (0%)	2 (1.8%)	0.15
Permanent Nerve Injury, n (%)	0 (0%)	0 (0%)	—

Table 4: Patient Satisfaction and Procedural Experience

Variable	Ultrasound-Guided (n = 110)	Landmark-Based (n = 110)	p-value
Patient Satisfaction Score (0–10), mean ± SD	9.1 ± 1.0	7.6 ± 1.4	<0.001
Anxiety During Procedure (VAS 0–10), mean ± SD	2.3 ± 1.2	4.8 ± 1.7	<0.001
Need for Repositioning of Needle, n (%)	14 (12.7%)	37 (33.6%)	<0.001
Procedure Discomfort, n (%)	12 (10.9%)	29 (26.4%)	0.003
Willingness to Choose Same Technique Again, n (%)	103 (93.6%)	78 (70.9%)	<0.001

Table 5: Factors Associated with Block Success (Multivariate Logistic Regression)

Predictor Variable	Adjusted OR	95% CI	p-value
Ultrasound-Guided Technique	3.84	1.98 – 7.43	<0.001
BMI < 30 kg/m²	1.67	0.92 – 3.04	0.09
Duration of Surgery < 90 min	1.42	0.78 – 2.56	0.23
Operator Experience > 5 years	2.15	1.18 – 3.91	0.01
Presence of Diabetes	0.68	0.35 – 1.30	0.24

Patients receiving ultrasound-guided blocks experienced a markedly longer duration of postoperative analgesia (11.4 ± 3.2 hours vs. 8.1 ± 2.9 hours), along with lower pain scores at both 6

and 12 hours postoperatively. The landmark group had a higher rate of conversion to general anesthesia (10.0% vs. 1.8%), suggesting more failed or insufficient blocks. Complication rates were consistently lower in the ultrasound-guided group, with notably fewer vascular punctures (3.6% vs. 13.6%) and hematomas (1.8% vs. 7.3%), further reinforcing the safety benefits of visualized needle placement.

Satisfaction scores averaged 9.1 ± 1.0 in the ultrasound group and 7.6 ± 1.4 in the landmark group. Anxiety during the procedure was lower with ultrasound at 2.3 ± 1.2, compared with 4.8 ± 1.7 in the landmark technique. Needle repositioning was needed in 12.7% (n = 14) of ultrasound cases and in 33.6% (n = 37) of landmark cases. Procedural discomfort occurred in 10.9% (n = 12) of the ultrasound group and 26.4% (n = 29) of the landmark group. A higher proportion of patients in the ultrasound group, 93.6% (n = 103), were willing to choose the same technique again, compared with 70.9% (n = 78) in the landmark group.

Ultrasound guidance significantly increased the odds of successful block performance, with an adjusted odds ratio of 3.84 (95% confidence interval 1.98–7.43). Operator experience greater than five years also improved block success, with an adjusted odds ratio of 2.15 (95% confidence interval 1.18–3.91).

DISCUSSION

This study compared the clinical effectiveness, safety profile, and patient-centered outcomes of ultrasound-guided versus landmark-based peripheral nerve blocks in upper limb surgeries using a sample of 220 patients. The data demonstrated that the ultrasound-guided approach achieves increased success when compared to other approaches. The ultrasound group had a statistically significantly higher success block rate (93.6% vs. 77.3%). This success illustrates the benefits of real-time imaging, where the anatomical guesses are minimised. This was also noted by other studies, which show that when clinicians can visualise the nerves, vessels, and the needle trajectory, the chances of error decrease. One of the positive aspects of the ultrasound during this study was the significant reduction in the time of the block performance (6.8 ± 2.1 min vs. 9.4 ± 2.7 min) and also a faster time to complete both sensory and motor blockade. The landmark technique is primarily reliant on surface anatomy and the clinician's sense of touch. This approach is clinically inefficient in patients who have complex anatomical structures, higher BMI, and areas where a large tissue volume is present. This technique is also linked to uncertainties in ultrasonography and also preserves valuable operating time, which is an anticipated benefit in the efficiency of modern surgical workflows. Additionally, outcomes from the postoperative stage were also the same[13]. Participants from the ultrasound-guided subgroup were recorded to have lower pain scores at the 6 and 12-hour postoperative periods, as well as a greater length of postoperative analgesia. This suggests that greater block accuracy yields a greater quality of intraoperative anaesthesia and has a greater quality of anaesthesia during multi-surgery recovery[14]. Supplemental analgesia and anaesthesia requirements were also lower during multi-surgery anaesthesia, which added further support to the technique as the method of choice. Results of the study also showed an ultrasound-guided block with clinical significance of the block with fewer contractions in the block and fewer ultrasound complications. The ultrasound group of patients had fewer complications with temporary and less paraesthesias and haematoma from vascular puncture, which also had fewer occurrences than the blind technique[15]. However, with contour pulses of the landmarks, there were risks associated with the blind technique, which ultrasound-guided blocks eliminate. Both groups had low rates of systemic local anaesthetic toxicity or nerve injury, but the ultrasound-guided blocks were still the safer option overall[16]. Patient-oriented outcomes were also convincing. Patients reported higher satisfaction, less anxiety, and discomfort during procedures when receiving ultrasound-guided blocks. They also reported that they would prefer this technique for any subsequent procedures. This is important, especially considering the current focus on patient experience data in healthcare delivery[17]. Regression analysis indicated that ultrasound guidance, as well as the experience of the practitioner, were the strongest predictors of successful blocks. This makes the case that technology, by itself, is not enough. There also needs to be experienced hands behind the probe. Even though the numerical data adjusted for experience showed that ultrasound was of added benefit, it was not enough to demonstrate that it was the sole value-added predictor[18,19]. Overall, the data is convincing that ultrasound-guided blocks should be accepted as the norm in upper limb procedures. It improves accuracy, comfort, outcomes, and reduces complications. This is the kind of improvement that is easy to observe based on the data and is not at all a matter of debate. It is not to say that landmark techniques should not be used, especially where resources are scarce. From a prospective standpoint, it is clear that modern regional anaesthesia should be guided by the use of ultrasound.

CONCLUSION

It is concluded that ultrasound-guided peripheral nerve blocks offer markedly superior outcomes compared with landmark-based techniques in upper limb surgeries. The ultrasound approach demonstrated higher block success rates, faster sensory and motor onset, reduced complication rates, and longer postoperative analgesia. Patients also experienced greater comfort and overall satisfaction.

REFERENCES

1. Blumenthal S, Borgeat A, Neudörfer C, Bertolini R, Espinosa N, Aguirre J. Additional femoral catheter in combination with popliteal catheter for analgesia after major ankle surgery. British journal of anaesthesia. 2011;106(3):387-93.
2. Saranteas T, Anagnostis G, Paraskeuopoulos T, Koulalis D, Kokkalis Z, Nakou M, et al. Anatomy and clinical implications of the ultrasound-guided subsartorial saphenous nerve block. Regional Anesthesia & Pain Medicine. 2011;36(4):399-402-399-402.
3. Kirkpatrick JD, Sites BD, Antonakakis JG. Preliminary experience with a new approach to performing an ultrasound-guided saphenous nerve block in the mid to proximal femur. Regional anesthesia and pain medicine. 2010;35(2):222-3--3.
4. Flack S, Anderson C. Ultrasound guided lower extremity blocks. Pediatric anesthesia. 2012;22(1).
5. Kent ML, Hackworth RJ, Riffenburgh RH, Kaesberg JL, Asseff DC, Lujan E, et al. A comparison of ultrasound-guided and landmark-based approaches to saphenous nerve blockade: a prospective, controlled, blinded, crossover trial. Anesthesia & Analgesia. 2013;117(1):265-70.
6. Khan MJ, Babar A, Haq IU, Wadud R, Farid K, Waheed A. Comparison of Ultrasound-Guided Ankle Block Versus Anatomical Landmark-Guided Ankle Block in Ankle and Foot Surgery Under Regional Anesthesia. Pakistan Journal of Medical & Health Sciences. 2022;16(11):652-.
7. Xu J, Chen Xm, Ma Ck, Wang Xr. Peripheral nerve blocks for postoperative pain after major knee surgery. Cochrane Database of Systematic Reviews. 2014(12).
8. Edinoff AN, Girma B, Trettin KA, Horton CC, Kaye AJ, Cornett EM, et al. Novel regional nerve blocks in clinical practice: evolving techniques for pain management. Anesthesiology and Pain Medicine. 2021;11(4).
9. Shah A, Morris S, Alexander B, McKissack H, Jones JR, Tedder C, et al. Landmark technique vs ultrasound-guided approach for posterior tibial nerve block in cadaver models. Indian journal of orthopaedics. 2020;54:38-42.
10. Redborg KE, Antonakakis JG, Beach ML, Chinn CD, Sites BD. Ultrasound improves the success rate of a tibial nerve block at the ankle. Regional Anesthesia & Pain Medicine. 2009;34(3):256-60--60.
11. Shilpashri AM, Chikkanagoudar S. Comparison of landmark technique versus ultrasound guided technique for supraclavicular brachial plexus block in upper limb surgeries: A prospective randomized trial. Indian J Clin Anaesth. 2023;10(3):242-7.
12. Trainor D, Moeschler S, Pingree M, Hoelzer B, Wang Z, Mauck W, Qu W. Landmark-based versus ultrasound-guided ilioinguinal/iliohypogastric nerve blocks in the treatment of chronic postherniorrhaphy groin pain: a retrospective study. Journal of Pain Research. 2015 Oct 23:767-70.

13. Lam NC, Petersen TR, Gerstein NS, Yen T, Starr B, Mariano ER. A randomized clinical trial comparing the effectiveness of ultrasound guidance versus nerve stimulation for lateral popliteal-sciatic nerve blocks in obese patients. Journal of Ultrasound in Medicine. 2014 Jun;33(6):1057-63.
14. Morris SE, McKissack H, Moraes LV, Viner GC, Jones JR, Tedder C, Kukreja P, Chinnakkannu K, Jha AJ, Shah AB. Landmark Technique vs Ultrasound Guided Approach for Posterior Tibial Nerve Block in Cadaver Models. Foot & Ankle Orthopaedics. 2019 Oct 16;4(4):2473011419S00314.
15. Marhofer P, Harrop-Griffiths W, Kettner SC, Kirchmair L. Fifteen years of ultrasound guidance in regional anaesthesia: part 1. Br J Anaesth. 2010;104(5):538–46.
16. Kim SC, Hauser S, Staniek A, Weber S. Learning curve of medical students in ultrasound-guided simulated nerve block. J Anesth. 2014;28(1):76–80.
17. Williams SR, Chouinard P, Arcand G, Harris P, Ruel M, Boudreault D, et al. Ultrasound guidance speeds execution and improves the quality of supraclavicular block. Anesth Analg. 2003;97(5):1518–23.
18. Dureja J, Siwach RC, Singh J, Chaudhry G, Bansal P. Comparative Evaluation of Techniques in Supraclavicular Brachial Plexus Block: Conventional Blind, Nerve Stimulator Guided and Ultrasound Guided. Int J Sci Stud. 2016;3(12):125–8.
19. Raghove P, Singh K, Taxak S, Ahlawat M, Hooda S. Comparison of Ultrasound Guided Technique with Conventional Landmark Technique for Supraclavicular Brachial Plexus Nerve Block in Patients Undergoing Upper Limb Surgery. Int J Pharmacol and Clin Sci. 2016;5(1):1–4.

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