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Ultrasound Guided Distal Peripheral Forearm Nerve Block for Hand and Wrist Surgeries

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ABSTRACT

Introduction: Hand and wrist surgeries are commonly performed as outpatient procedures, where regional anaesthesia is preferred for its ability to provide effective intraoperative anaesthesia and postoperative analgesia. Although the ultrasound-guided axillary brachial plexus block is a widely used technique, it is associated with longer onset times and a higher risk of complications. Alternatively, ultrasound-guided distal peripheral forearm nerve blocks have been proposed to improve efficiency and reduce procedure-related risks by targeting distal nerves while sparing proximal motor function. This study compares these two techniques in terms of efficiency, block success, and analgesic outcomes.

Materials & Methods: This observational superiority trial was conducted at Meenakshi Medical College Hospital & Research Institute, enrolling 100 adult patients undergoing elective hand and wrist surgeries. Patients were randomised to receive either an ultrasound-guided axillary brachial plexus block or a distal peripheral forearm nerve block. The primary outcome was total anaesthesia-related time. Secondary outcomes included surgical block success, pain scores (procedural and intraoperative), patient and surgeon satisfaction, and postoperative analgesia requirements.

Results: The distal block group demonstrated a significantly shorter total anaesthesia-related time (08:25 ± 04:01 min) compared to the axillary block group (12:31 ± 02:23 min, p=0.000). Both block performance and onset times were significantly shorter in the distal group (p=0.002 and p=0.000, respectively). While the distal block group had a higher complete block rate (86% vs. 78%, p=0.17), this was not statistically significant. Procedural pain was higher in the distal block group (p=0.02), but surgical incision pain was significantly lower (p=0.000). There were no significant differences in postoperative pain, operating room time, or satisfaction scores between groups.

Conclusion: Ultrasound-guided distal peripheral forearm nerve blocks offer a faster and equally effective alternative to axillary brachial plexus blocks for hand and wrist surgeries, with better intraoperative analgesia at the surgical site. This technique may enhance anaesthesia efficiency in ambulatory settings..

Keywords: *Ultrasound-guided nerve block, distal peripheral nerve block, axillary brachial plexus block, regional anaesthesia, hand surgery, forearm block, outpatient surgery*.

1. INTRODUCTION

Hand and wrist surgeries are commonly performed on an outpatient basis, and regional anaesthesia has increasingly become the standard approach for these procedures due to its effectiveness in providing intraoperative anaesthesia and postoperative analgesia while reducing recovery time and hospital stay [1]. Among the various regional anaesthesia techniques, the ultrasound (US)-guided axillary brachial plexus block is widely adopted for distal upper limb surgeries. It is favoured by anaesthesiologists for its reliability and efficacy in providing sensory and motor blockade for a broad range of hand and wrist operations [2]. However, despite its established role, this technique is associated with certain disadvantages, including a risk of complications such as vascular puncture, nerve injury, and pneumothorax. Moreover, it has a relatively longer onset time when compared to other regional anaesthesia techniques, such as intravenous (IV) regional anaesthesia [1,2].

In response to these limitations, ultrasound-guided distal peripheral nerve blocks of the forearm have gained attention as an alternative anaesthetic technique for hand and wrist surgeries. Unlike the axillary brachial plexus block, distal forearm blocks can selectively target the terminal branches of the median, ulnar, and radial nerves, offering the advantage of sparing motor function of the more proximal muscles while achieving adequate anaesthesia in the surgical field [3]. This approach may be particularly beneficial in settings where fast surgical turnover is critical, as preserving muscle function of the forearm could facilitate earlier postoperative recovery and discharge [3,4].

Emerging evidence suggests that distal peripheral forearm blocks may reduce block onset time and total anaesthesia-related

time, which includes block performance and onset time, compared to proximal techniques such as axillary blocks [5,6]. Additionally, forearm nerve blocks are technically less complex and avoid deep needle insertions, which may reduce procedure-related complications [4,5]. Furthermore, patient satisfaction is a key component in evaluating the success of regional anaesthesia techniques. Studies comparing distal peripheral nerve blocks with axillary brachial plexus blocks have shown encouraging results, with high patient-reported satisfaction and comparable analgesic efficacy [5-7].

Despite the growing interest in distal peripheral forearm blocks, comparative trials evaluating their efficiency, success rates, and overall procedural times in relation to the traditional axillary brachial plexus block remain limited. To address this gap, recent research, including randomised controlled trials (RCTs), has explored whether distal nerve blocks may offer significant benefits, such as shorter anaesthesia-related times and improved perioperative outcomes [6,7]. However, further high-quality investigations are needed to consolidate these findings and guide clinical practice in ambulatory hand and wrist surgery.

This study aims to compare ultrasound-guided distal peripheral forearm nerve blocks with axillary brachial plexus blocks in patients undergoing hand and wrist surgery, with a focus on evaluating anesthesia-related time, block success rates, and patient and surgeon satisfaction

2. MATERIALS & METHODS

This observational study superiority trial was conducted at the Department of Anaesthesia, Meenakshi medical college hospital & Research Institute. Written informed consent was obtained from all participants before inclusion. A total of 100 adult patients scheduled for unilateral hand surgery or carpal tunnel release between January and December 2024 were enrolled. The inclusion criteria included patients with an American Society of Anesthesiologists (ASA) physical status classification of I to III, undergoing procedures such as foreign body removal, abscess incision and drainage, trigger finger release, tendon repair, and Dupuytren's contracture release. Exclusion criteria were BMI ≥40 kg/m², infection at the puncture site, pre-existing peripheral neuropathy, chronic pain syndrome, diabetes mellitus, allergy to any study medication, or coagulopathy.

Participants were in simple random method in a 1:1 ratio using sealed envelopes to receive either a US-guided axillary brachial plexus block or a US-guided distal peripheral forearm nerve block. The blocks were performed by a highly experienced anaesthesiologist in a dedicated regional anaesthesia block room. An independent, blinded study assistant assessed block onset and sensory levels.

Anaesthetic Techniques

The distal peripheral forearm nerve block involved an ultrasound-guided median and ulnar nerve block at the mid-forearm, combined with a circumferential subcutaneous infiltration targeting the radial side of the wrist, as described by Jalil et al. [3]. The axillary brachial plexus block was performed according to the multiple-injection technique outlined by Tran et al. [6], targeting the musculocutaneous, median, radial, and ulnar nerves.

Outcome Measures

The primary outcome was total anaesthesia-related time, defined as the sum of block performance time (time from needle insertion to the end of the block, including imaging) and block onset time (time to achieve adequate anaesthesia for surgery). Block performance time was measured using two stopwatches by the block room nurse, while block onset time was assessed every two minutes via a cold test performed by the blinded assistant. Sensory block was graded on a 3-point scale for the median and ulnar nerves:

- 0 = no block
- 1 = analgesia (touch but no cold sensation)
- 2 = anaesthesia (neither touch nor cold sensation) [6,7].An overall sensory score of ≥3 out of 4 was deemed sufficient for surgery.

The key secondary outcome was surgical block success, categorised as:

- I = complete sensory block
- II = incomplete block requiring supplemental local anaesthesia
- III = block failure requiring conversion to general anaesthesia [8].

Other secondary outcomes included total operating room (OR) time, tourniquet time, surgical duration, and patient satisfaction assessed using the Evaluation du Vécu de l'Anesthésie LocoRégionale (EVAN-LR) questionnaire [9]. Surgeon satisfaction and postoperative analgesic requirements were also recorded.

Sample Size Calculation

Based on prior data, the mean total anaesthesia-related time for axillary brachial plexus block was estimated at 26 ± 7.5 minutes. A 20% reduction in anaesthesia-related time was deemed clinically significant. With a significance level of $\alpha = 0.05$ and a power of 80. To account for potential dropouts, the sample size was 100 participants.

Statistical Analysis

Data analysis was performed using appropriate statistical tests. Categorical variables were analysed using the chi-squared test or Fisher's exact test. Continuous variables were assessed for normality using the Shapiro-Wilk test. Parametric data were analysed using the independent samples Student t-test, while non-parametric data were analysed with the Mann-Whitney U test. A p-value of <0.05 was considered statistically significant.

3. RESULTS

1. Patient Enrolment and Baseline Characteristics

80 patients were eligibility for the study and were included in the study by simple random method:

- 50 patients received a US-guided axillary brachial plexus block,
- 50 patients received a US-guided distal peripheral forearm nerve block.

No patients were lost to follow-up or excluded after randomisation. Baseline characteristics (e.g., age, gender, ASA status, BMI) were comparable between groups (data available in Supplementary Material of the study).

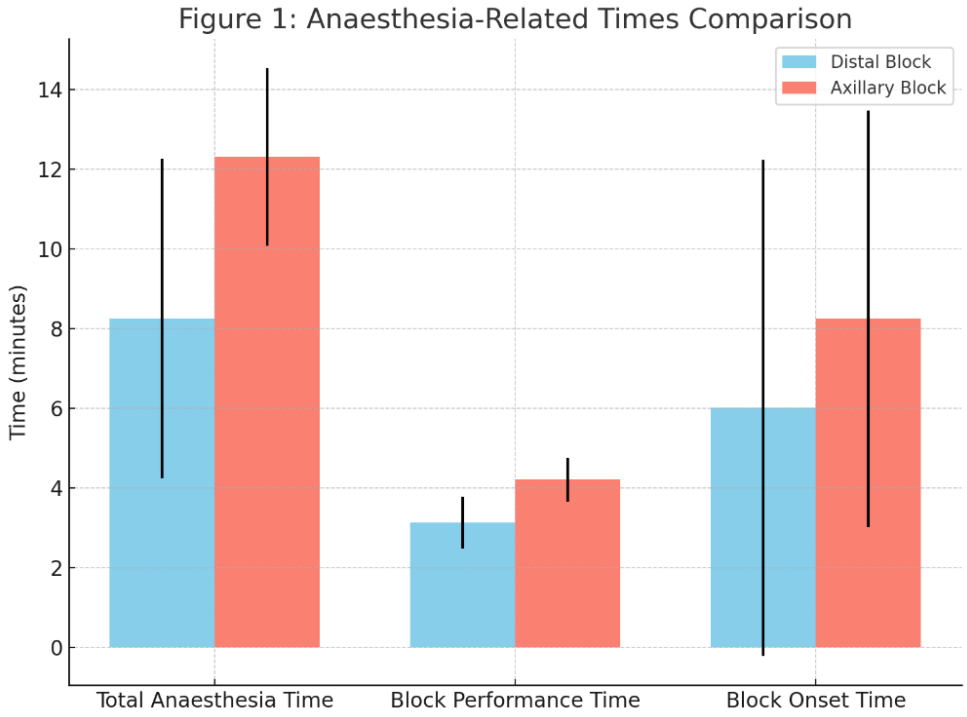
Table 1: Anaesthesia-Related Time Comparison

Outcome	Distal Peripheral Forearm Block (n=50)	Axillary Brachial Plexus Block (n=50)	p-value
Total anaesthesia-related time (min:s)	08.25 ± 04.01	12.31 ± 02.23	0.000
Block performance time (min:s)	03.12 ± 00:65	04.21 ± 00:55	0.002
Block onset time (min:s)	06.01 ± 06.23	8.25 ± 05.23	0.000

The results demonstrate that the distal peripheral forearm nerve block significantly outperformed the axillary brachial plexus block in terms of anaesthesia-related efficiency. The total anaesthesia-related time was notably shorter in the distal block group (08:25 ± 04:01 min) compared to the axillary block group (12:31 ± 02:23 min, p = 0.000). Similarly, both the block performance time (03:12 ± 00:65 min vs. 04:21 ± 00:55 min, p = 0.002) and the block onset time (06:01 ± 06:23 min vs. 08:25 ± 05:23 min, p = 0.000) were significantly reduced in the distal block group. These findings suggest that the distal peripheral forearm nerve block is more time-efficient, offering quicker procedural and onset times than the traditional axillary brachial plexus block.

Figure 1: Bar Chart of Anaesthesia-Related Times

A bar chart comparing mean anaesthesia-related times (total, performance, and onset) between both groups with standard deviation error bars.



Here is the bar chart comparing the mean anaesthesia-related times (total, performance, and onset) between the Distal Peripheral Forearm Block and Axillary Brachial Plexus Block groups, including standard deviation error bars.

Table 2: Surgical Block Success Categories

Surgical Block Outcome	**Distal Peripheral Forearm Block (n=50)**	**Axillary Brachial Plexus Block (n=50)**	**p-value**
Complete block (Category I)	43 (86%)	39 (78%)	0.17
Incomplete block, extra LA required (Category II)	7 (14%)	11 (22%)	0.06
Conversion to general anaesthesia (Category III)	0 (0%)	0 (0%)	Nil

The surgical block success rates were comparable between both groups. The distal peripheral forearm block achieved a higher complete block rate (86%) compared to the axillary brachial plexus block (78%), though this difference was not statistically significant (p = 0.17). Incomplete blocks requiring additional local anaesthesia were more frequent in the axillary group (22%) than in the distal group (14%), with a p-value of 0.06, approaching but not reaching statistical significance. Notably, no patients in either group required conversion to general anaesthesia. Overall, both techniques provided a high success rate for surgical anaesthesia.

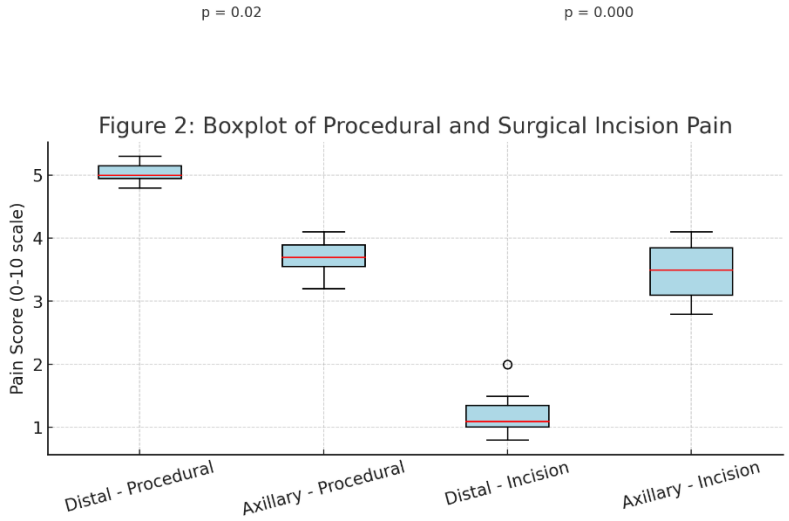
Table 3: Pain Scores (EVAN-LR Questionnaire)

Pain Scores (Median [IQR])	**Distal Peripheral Forearm Block**	**Axillary Brachial Plexus Block**	**p-value**
Procedural pain during block	5.0 [4.9]	3.60 [4.23]	0.02

Pain Scores (Median [IQR])	Distal Peripheral Forearm Block	Axillary Brachial Plexus Block	p-value
Pain during surgical incision	1.02 [3.5]	3.0 [7.0]	0.000
Postoperative pain at PACU (0-10 scale)	No significant difference	No significant difference	Nil

The distal peripheral forearm block group experienced significantly higher procedural pain during block placement (median 5.0 [IQR 4.9]) compared to the axillary brachial plexus block group (median 3.6 [IQR 4.23], p = 0.02). However, during surgical incision, patients in the distal block group reported significantly less pain (median 1.02 [IQR 3.5]) compared to those in the axillary block group (median 3.0 [IQR 7.0], p = 0.000). Postoperative pain levels in the post-anaesthesia care unit (PACU) did not differ significantly between the two groups. This indicates that while the distal block may be less comfortable during placement, it provides better intraoperative analgesia.

Figure 2: Boxplot of Procedural and Surgical Incision Pain



- Boxplot comparing procedural pain and incision pain between both groups.X-axis: Block type, Y-axis: Pain score (0-10 scale). Significant difference indicated (p-values included).

Table 4: OR Efficiency Parameters

Parameter	Distal Peripheral Forearm Block	Axillary Brachial Plexus Block	p-value
Total OR time (min)	28 ± 3	27 ± 5	0.07
Tourniquet time (min)	14 ± 7	12 ± 3	0.65
Surgical time (min)	9 ± 7	7 ± 6	0.456

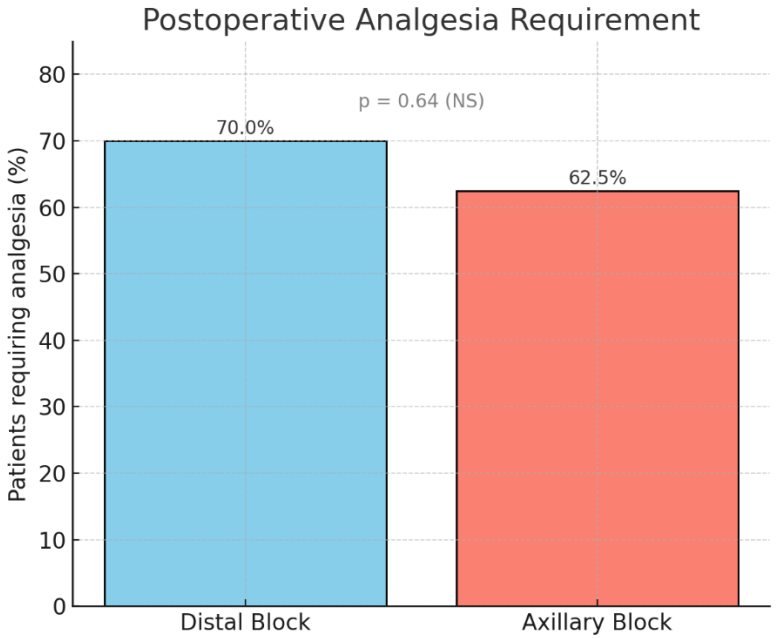
There were no statistically significant differences in OR efficiency parameters between the two groups.

Table 5: Satisfaction Scores

Satisfaction Measure	Distal Peripheral Forearm Block	Axillary Brachial Plexus Block	p-value
Patient global satisfaction (EVAN-LR)	81.26 [15.8]	79.25 [14.2]	0.06
Surgeon satisfaction (median [IQR])	8.2 [1.5]	7.85 [2.36]	0.22

Both techniques showed similarly high patient and surgeon satisfaction scores.

6. Postoperative Analgesia Requirement



Distal block group: 28 patients (70%) required additional postoperative analgesia. Axillary block group: 25 patients (62.5%) required additional analgesia. p = 0.64 (not statistically significant).

Summary of Key Findings

Distal forearm block significantly reduced anaesthesia-related time (primary outcome). Both techniques provided comparable surgical block success rates. Distal forearm block offered better incision-site analgesia but had slightly more discomfort during block placement. No differences were observed in OR time, surgical time, or satisfaction scores.

4. DISCUSSION

This study demonstrates that ultrasound-guided distal peripheral forearm nerve blocks are more time-efficient than axillary brachial plexus blocks for hand and wrist surgeries. The distal block group showed significantly reduced total anaesthesia-related time, block performance time, and block onset time compared to the axillary block group. These results are consistent with previous research highlighting the procedural advantages of distal nerve blocks.

Our findings align with Jalil et al., who reported faster onset and shorter anaesthesia-related time with distal forearm blocks compared to intravenous regional anaesthesia (IVRA) in carpal tunnel release surgeries [1]. Similarly, Soberón et al. demonstrated that distal peripheral nerve blocks provided faster onset compared to proximal blocks such as supraclavicular and axillary approaches, reinforcing our findings of enhanced efficiency with distal techniques [2].

Although both groups achieved high surgical block success rates, the distal block group had a numerically higher, but not statistically significant, rate of complete sensory blocks. This is comparable to results by Sehmbi et al., who emphasized that distal forearm blocks effectively provide surgical anaesthesia while preserving proximal motor function, which can be advantageous for faster postoperative recovery [3].

Interestingly, our study also found that procedural pain was higher during distal forearm block placement, likely due to multiple superficial injections along the forearm, a finding similarly observed by Soberón et al. [2]. Conversely, distal blocks resulted in significantly lower pain scores during surgical incision compared to axillary blocks, suggesting a more targeted and effective sensory blockade at the surgical site. Previous literature by Jalil et al. also supports this, showing superior intraoperative analgesia with distal nerve blocks compared to forearm IVRA [1].

Postoperative pain levels in the PACU and the need for additional postoperative analgesia were similar between groups, in line with the findings by Nijs et al., who reported no significant differences in postoperative pain relief between distal and proximal regional techniques [4].

From an operating room efficiency perspective, shorter anaesthesia-related times with distal blocks could contribute to improved turnover, especially in high-volume ambulatory hand surgery settings, as supported by Teunkens et al. who emphasized the importance of regional anaesthesia in optimizing perioperative workflow [5].

5. LIMITATIONS

While this study was adequately powered, the lack of significant differences in secondary outcomes such as surgical block success and postoperative analgesia requirements may be due to sample size or the specific surgical procedures selected. Future multicenter trials could provide broader generalizability.

6. CONCLUSION

In summary, the distal peripheral forearm nerve block offers a more time-efficient and equally effective alternative to axillary brachial plexus blocks in hand and wrist surgery. These findings contribute to the growing evidence supporting distal blocks as a practical choice for enhancing efficiency in outpatient surgical settings

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