ORIGINAL ARTICLE

# Comparative Study Between the Efficacy of Ultrasound-Guided Forearm Verves Block vs Anatomic Landmark-Based Wrist Nerves Block in Elective Patients Undergo Hand Surgery

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Abstract

*Background: Nerve block for hand and wrist surgery is a useful anesthetic technique for early hospital discharge, reduced recovery time after surgery, and postoperative pain management. As of right now, the perineural injection approach is known to be more effective when this nerve block is carried out under ultrasound supervision.*

*Aim and objectives:* ***To compare the effectiveness of anatomic landmark-based wrist nerve blocks (wrist blocks) with ultrasound-guided forearm nerve blocks (forearm nerve blocks) in providing hand anesthesia for patients undergoing hand surgeries.***

*Subjects and methods:* ***This prospective randomized single-blinded study was carried out on 116-patients underwent hand operation admitted to Al-Hussein University Hospital, Cairo, Egypt between March 2024 and January 2025.***

*Results:* ***When comparing the two groups' VAS scores at various points before and after analgesia, there was no statistically significant difference at 5, 10, 15, 20, 25, 30, and 35 minutes intraoperatively or at 1, 5, 6, 8, 12, 16, and 24 hours postoperatively. After 40, 45, and 50 minutes of surgery, as well as 2, 3, and 4 hours postoperatively, Group I had a substantially lower VAS compared to Group II.***

*Conclusion:* ***For hand procedures, ultrasound-guided forearm nerve blocks are preferable to anatomic landmark-based wrist nerve blocks because they enhance surgical anesthesia, reduce postoperative pain scores, postpone the necessity for rescue analgesia, and boost patient satisfaction.***

*Keywords:* Forearm nerves block; Wrist nerves blocks; Ultrasound; Hand surgery

## 1. Introduction

When operating on the upper limbs, regional anesthesia is often used. Ultrasound has made nerve blocks safer and more dependable. Hence, ultrasound-guided proximal brachial plexus blockage is considered the gold standard for distal upper extremity operations under regional anesthesia. Additional benefits, such as the prevention of pneumothorax and phrenic paralysis, are offered by distal peripheral nerve blocks. Not only that, but these peripheral distal blocks can keep your fingers dexterous and your proximal muscles functioning.[1]

A higher satisfaction rate may be related to distal nerve blocks, which preserve motor function, than to proximal brachial plexus blocks, according to some research. The patient's safety could be guaranteed. Furthermore, a block chamber may enhance operating room efficiency when doing peripheral nerve block procedures, as opposed to general anesthetic or intravenous regional anesthesia(IVRA).[1]

It is common practice to numb the patient's hand in the emergency department(ED) before treating or manipulating wounds such as lacerations, fractures, dislocations, abscesses, or burns.[2] For the treatment or management of wounds such as lacerations, fractures, dislocations, abscesses, or burns, a hand anesthetic is often necessary in the emergency department(ED).[3]

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From our clinical experience, we know that ultrasound-guided blocks are more effective than landmark-based blocks; therefore, we set out to discover the scientific answer to this question. One of the most common procedures in emergency medicine(EM) these days is an ultrasound-guided nerve block, and its use has steadily increased in recent years, with the training in ultrasound.[4]

The aim of this study was to compare the effectiveness of anatomic landmark-based wrist nerve blocks(wrist blocks) with ultrasound-guided forearm nerve blocks(forearm nerve blocks) in providing hand anesthetic for patients undergoing hand surgeries.

## 2. Patients and methods

This prospective randomized single-blinded study was carried out on 116-patients underwent hand operation admitted to Al-Hussein University Hospital, Cairo, Egypt between March 2024 and January 2025.

Al-Azhar University's Faculty of Medicine Ethics Committee in Cairo, Egypt, gave its stamp of approval to the research. Every patient had to sign an informed consent form. Ensuring participant privacy and data confidentiality is adequately addressed.

Sample size calculation:

The required sample size was calculated using the G Power program 3.1.9.4. Based on previous studies5, the minimal sample size in each GroupGroup is patients to get power level of 0.80, an error of 0.05 and confidence level 0.95. The calculated sample size was 52 with adding 10% for drop out to have 58 patients in each GroupGroup with total of 116-patients.

Inclusion criteria:

Patients undergoing hand surgery without a tourniquet must be between the ages of 20 and 60 and of either sex, meet the criteria for American Society of Anesthesiologists(ASA) physical status I or III.

Exclusion criteria:

Infections of the skin close to the injection location, issues with local anesthetic allergy, patients who are resistant to treatment, those who take opioids regularly, and those who suffer from diseases affecting the central or peripheral nervous systems.

Randomization and blindness:

An opaque sealed envelope was employed to store each patient's code, and computer-generated randomization numbers were utilized for random allocation. Two parallel groups of patients were randomly assigned at a 1:1 ratio:

Group-U(N=58): Patients underwent hand operation by ultrasound-guided forearm nerves block; Group-C(control group) (N=58): Patients underwent hand operation by anatomic landmark-based wrist nerves block (without ultrasound-guided).

Primary outcome:

The efficacy of intraoperative VAS on the success rate.

Secondary outcome:

Patient satisfaction is measured by patient satisfaction score, and post-operative pain relief is measured by post-operative VAS.

Preoperative:

We took the patients' medical and surgical histories, examined them clinically, and performed basic lab tests, including electrocardiograms, liver and kidney function profiles, and blood counts.

All patients completed the recommended fasting hours(6–8hours for solid and 2hours for clear fluid). Each patient was instructed about pain assessment using the Visual Analogue Scale. VAS (0 represents “no pain” while 10 represents “the worst pain imaginable”).[6]

Intraoperative:

Routine monitoring:

After establishing intravenous(IV) access and starting a maintenance rate of IV fluid infusion, routine ECG, noninvasive blood pressure, and pulse oximetry monitoring are applied. IV midazolam boluses of 0.05 mg/kg relieve anxiety.

Anesthetic techniques:

For Group U, we used a SonoSite M-Turbo ultrasound machine from Fujifilm, Japan, with a high-frequency linear transducer of 13-6MHz. For each block, we inserted an Echogenic Ultrasound Needle from B. Braun Medical Inc., Melsungen, Germany, with a 22-gauge 50mm needle. We made sure to approach the injection site in the same plane as the patient and deposited 3-5mL of a local anesthetic, which was a 50:50 mixture of lidocaine and bupivacaine (Figure 1).

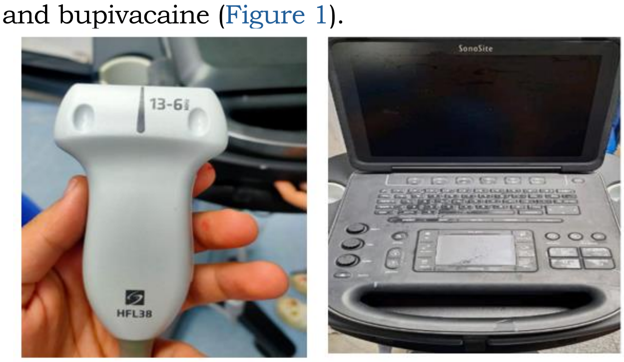


Figure 1. SonoSite M-Turbo ultrasound machine(Fujifilm, Japan)
with a high-frequency linear transducer(13-6MHz).

The forearm block approach for the median nerve proximal electrocardiogram(ECG) involves supine positioning of the arm, disinfection of the skin, and transverse positioning of the transducer in the crease. Locate the median nerve on the inside of the artery. To locate the median nerve, slide the transducer distally until it is wedged between the flexor digitorum superficialis and profundus, which are located in the proximal portion of the forearm. From the transducer's lateral to medial side, the needle is placed in a plane. Injecting three to five milliliters of local anesthetic follows negative aspiration (Figure 2).

The median nerve: proximal forearm block technique with the arm abducted and supinated, the skin is disinfected, and the transducer is positioned transversely in the crease. The median nerve should be identified on the medial side of the artery. Sliding the transducer distally follows the median nerve till the proximal third of the forearm, until the nerve is sandwiched between the flexor digitorum superficialis and profundus. The needle is inserted in-plane from the lateral to the medial side of the transducer. After negative aspiration, 5mL of local anesthetic is injected.

The Ulnar Nerve: Proximal forearm block technique with the transducer positioned on the medial aspect of the forearm, the ulnar artery is located and medial to that the honeycomb appearance of the ulnar nerve is identified. At this level a needle is inserted inplane from medial to lateral beneath the transducer. After negative aspiration, 5mL of local anesthetic is injected.

The Radial Nerve: Proximal forearm block. The arm is kept abducted and pronated. Once the skin is disinfected, the transducer is positioned anterior to the elbow joint. The radial nerve is visualized between the extensor carpi radialis muscles and the brachioradialis. The needle is inserted in the plane, and its tip is placed next to the radial nerve. After negative aspiration, 5mL of local anesthetic is injected.

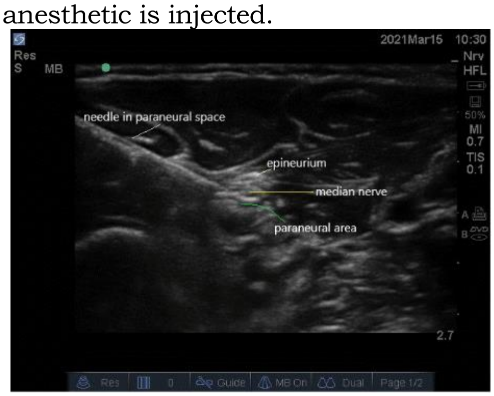


Figure 2. Median nerve in Axial scan with needle tip in close approximation to the median nerve.

As a result of using the proximal forearm block technique and placing the transducer on the medial aspect of the forearm, we can find the ulnar artery and, next to it, the ulnar nerve, which is fashioned like a honeycomb. Underneath the transducer, a needle is placed at this level in a medial to lateral plane. Next, 3-5 milliliters of local anesthetic is injected following negative aspiration,(Figure 3).

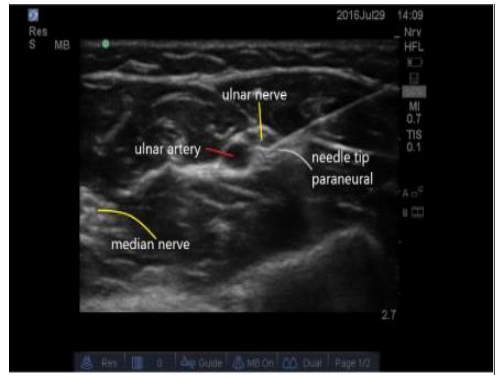


Figure 3. Ulnar nerve in axial scan

Radial Nerve: Blocking the Forearm. Pronation and abduction of the arm are maintained. After cleansing the skin, the transducer is placed in front of the elbow joint. In the space between the brachioradialis and extensor carpi radialis muscles, one may see the radial nerve. The radial nerve is positioned near the needle's tip after it has been put in a plane. Next, 3-5 milliliters of local anesthetic are injected following negative aspiration (Figure 4).

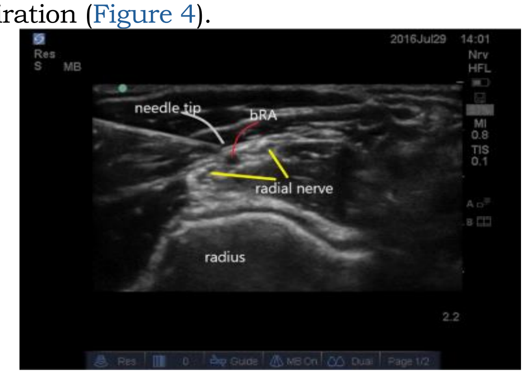


Figure 4. Radial nerve in axial scan

Every injection in Group C's wrists was administered using a 22-gauge B-beveled block needle manufactured by B. Braun Medical Inc. of Melsungen, Germany. The local anesthetic, a 50:50 blend of 2% lidocaine and 0.5% bupivacaine, was injected, with an amount ranging from three to five milliliters.

Supine positioning of the patient's forearm, skin cleaning, and needle advancement at the wrist crease, more precisely, at the angle of 45 degrees between the palmaris longus and flexor carpi radialis tendons, make up the technique for a median nerve block. If the palmaris longus tendon is absent, as happens in 15% of people, a needle is inserted in the palmar crease, one cm medial to the flexor carpi radialis tendon. As the needle is advanced into the flexor retinaculum, the site of injection will experience less resistance.

While lying on their back, patients undergoing radial nerve blocks should maintain the following positions: thumb up, ulnar side flat on the table, and thumb facing up. Inserting the needle into the subcutaneous tissue, approximately 1-2cm lateral and proximal to the radial styloid process, requires an angle of 10-20 degrees. The agent is administered subcutaneously by injection.

In the ulnar nerve block position, the palm of the forearm should face up on the table. The angle at which the needle is inserted is 45 degrees. Located 2centimeters from the tendon that flexes the wrist to the side, this region, immediately adjacent to the ulnar styloid process, is where the agent is injected.

Assessment of block:

Block testing: Assessing the blocked nerve's adequate sensory distribution with cold feeling testing using an alcohol swab. Three nerves were tested: the ulnar, median, and radial. The ulnar nerve was evaluated on the inside of the fifth digit's distal phalanx, the median nerve on the inside of the second digit's distal phalanx, and the radial nerve on the inside of the first metacarpal. Following the completion of each block, the test was administered every five minutes for a total of twenty minutes.

Postoperative:

Postoperative Assessment of pain by VAS every hour for the first 6 hours, then at 8, 12, 16, and 24 hours after the procedure. Rescue analgesia by receiving paracetamol 1 g when VAS≥4. Maximum 4 g during the post-operative 24 hours

Statistical analysis:

The SPSS v27 software, developed by IBM(Armonk, NY, USA), was used for statistical analysis. To determine if the data were normally distributed, the Shapiro-Wilks test and histograms were employed. The unpaired Student's t-test was used to analyze quantitative parametric data, which was reported as mean and standard deviation(SD). Median and interquartile range(IQR) were used to display quantitative non-parametric data, which were examined using the Mann-Whitney test. We used the Chi-square test or Fisher's exact test to assess qualitative variables when applicable, and we presented the results as frequency and percentage(%). It was deemed statistically significant if the two-tailed P-value was less than 0.05.

## 3. Results

Twelve patients did not fulfill the requirements, ten patients declined to take part, and nine patients had incomplete blocks out of 147 who were considered eligible for this study. Two equal groups, each with 58 patients, were formed from the remaining patients through random assignment.

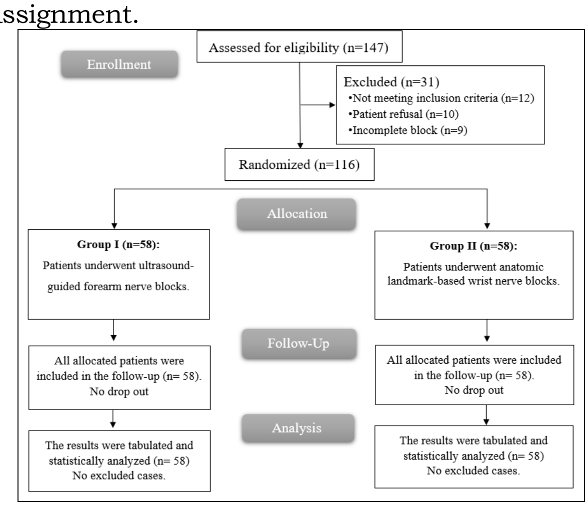

Figure 5. CONSORT flow diagram of the participants through each stage of the trial.

Table 1. Groups' demographic information and the total time spent in surgery.

| | | GROUP-I (N=58) | GROUP-II (N=58) | P-VALUE |
|---|---|---|---|---|
| AGE(YEARS) | Mean±SD | 37.81±8.78 | 36.86±7.27 | 0.528 |
| | Range | 23-58 | 26-54 | |
| SEX | Male | 30(51.72%) | 27(46.55%) | 0.577 |
| | Female | 28(48.28%) | 31(53.45%) | |
| WEIGHT(KG) | Mean±SD | 76.1±8.73 | 75.6±7.72 | 0.744 |
| | Range | 59-91 | 64-89 | |
| HEIGHT(CM) | Mean±SD | 167.9±7.37 | 169.26±5.63 | 0.266 |
| | Range | 156-181 | 160-179 | |
| BMI(KG/M$^2$) | Mean±SD | 27.17±4.09 | 26.41±2.67 | 0.243 |
| | Range | 20.5-37 | 22.4-33.9 | |
| ASA PHYSICAL STATUS | I | 28(48.28%) | 27(46.55%) | 0.614 |
| | II | 21(36.21%) | 18(31.03%) | |
| | III | 9(15.52%) | 13(22.41%) | |
| DURATION OF SURGERY(21) | Mean±SD | 37.67±11.44 | 38.02±9.36 | 0.859 |
| | Range | 20-55 | 25-50 | |

BMI:Body mass index, ASA:American society of anesthesiologists.

None of the demographic variables(age, sex, weight, height, BMI, ASA physical status, and surgery length) differed substantially between the two groups,(table 1;figure 6).

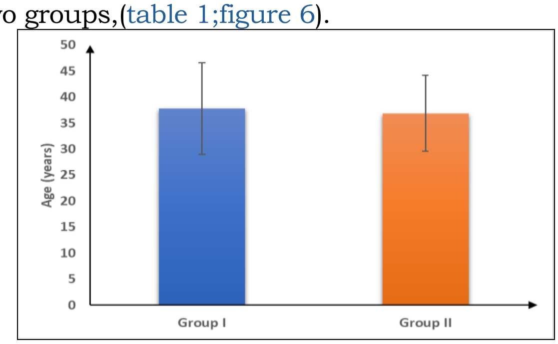

Figure 6. Age of the studied groups.

Table 2. Assessments of the research subjects'

heart rates.

| | GROUP-I (N=58) | GROUP-II (N=58) | P-VALUE |
|---|---|---|---|
| BASELINE | 77.95±7.54 | 79.57±6.41 | 0.215 |
| 10MIN | 75.12±7.47 | 77.1±6.46 | 0.129 |
| 20MIN | 72.09±7.54 | 75.52±6.6 | 0.012* |
| 30MIN | 68.09±7.83 | 72.28±6.28 | 0.013* |
| 40MIN | 67.78±7.24 | 70.82±5.56 | 0.123 |
| END OF SURGERY | 72.98±7.54 | 74.02±6.39 | 0.427 |

Data presented as mean±SD, *:Significant as P-value≤0.05.

At the beginning, 10-minutes, 40-minutes, and completion of the procedure, there was no significant difference in the heart rate readings between the two groups. However, at the 20-minute and 30-minute marks, group-I had considerably lower heart rates than group-II(P=0.012 and 0.013, respectively),(table 2 ; figure 7).

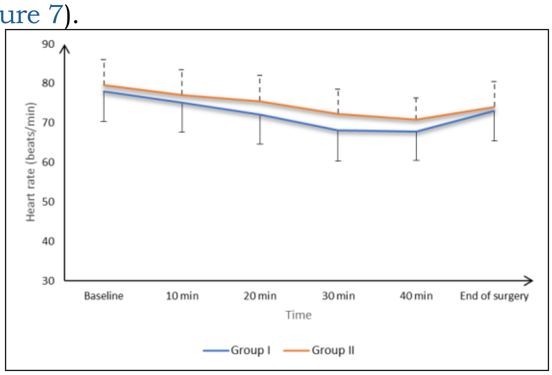


Figure 7. Heart rate measurements of the studied groups.

*Table 3. Mean arterial pressure measurements of the studied groups.*

| | GROUP-I (N=58) | GROUP-II (N=58) | P-VALUE |
|---|---|---|---|
| BASELINE | 89.09±3.41 | 89.91±3.92 | 0.227 |
| 10MIN | 86.16±3.6 | 87.45±3.97 | 0.069 |
| 20MIN | 82.94±3.58 | 85.79±3.99 | <0.001* |
| 30MIN | 81.03±3.27 | 84.03±3.92 | 0.001* |
| 40 MIN | 79.57±3.6 | 81.64±3.37 | 0.053 |
| END OF SURGERY | 84.59±3.48 | 85.9±3.94 | 0.060 |

P-value ≤0.05 indicates significance. Data are displayed as mean±SD.

The two groups' mean arterial pressure readings were not substantially different at baseline, 10-minutes, 40-minutes, or at the end of operation, although they were significantly lower in group-I at 20 and 30-minutes than in group-II(P-value<0.001 and 0.001 respectively),(table 3;figure 8).

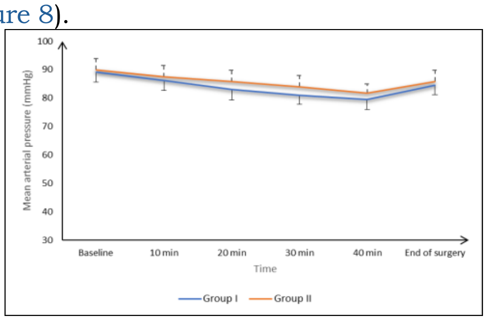


Figure 8. Average arterial pressure readings for the groups under study.

Table 4. Surgical anesthesia sufficient and fentanyl consumptions of the groups under study.

| | | GROUP-I (N=58) | GROUP-II (N=58) | P-VALUE |
|---|---|---|---|---|
| SURGICAL ANESTHESIA SUFFICIENT | Complete block | 58(100%) | 58(100%) | --- |
| NEED OF FENTANYL CONSUMPTION | | 3(5.17%) | 7(12.07%) | 0.322 |
| FENTANYL CONSUMPTION(μG) | Mean±SD | 36.67±5.77 | 38.57±3.78 | 0.545 |
| | Range | 30-40 | 30-40 | |

*:Significant as P-value≤0.05.

In both groups, every patient experienced complete block. There was a negligible difference between group I and group II in terms of fentanyl usage and requirement,(table 4;figure 9).

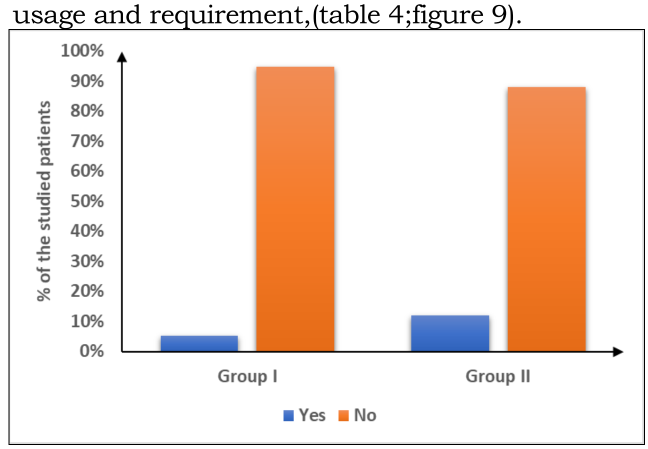


Figure 9. Need of fentanyl consumption of the groups under study.

*Table 5. Time to first request of rescue analgesia of the groups under study.*

| | | GROUP-I (N=58) | GROUP-II (N=58) | P-VALUE |
|---|---|---|---|---|
| TIME TO FIRST REQUEST OF RESCUE ANALGESIA(H) | Mean±SD | 5.21±0.77 | 3.07±0.81 | <0.001* |
| | Range | 4-6 | 2-4 | |

*:Significant as P-value≤0.05.

Time to first request of rescue analgesia was significantly delayed in group-I(5.21±0.77) than group-II(3.07±0.81) (P-value<0.001),(table 5;figure 10).

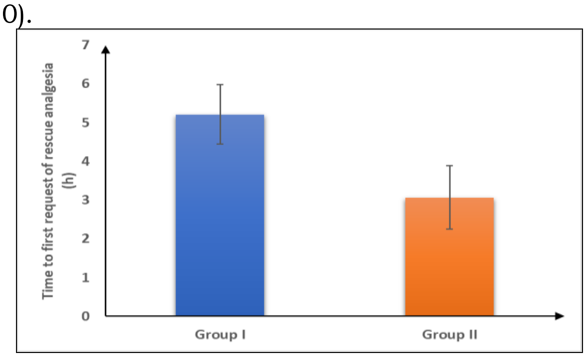


Figure 10.Time to first request of rescue analgesia of the groups under study.

*Table 6. VAS of the groups under study.*

| | | Group-I (n=58) | Group-II (n=58) | P-value |
|---|---|---|---|---|
| Before analgesia | | 5(4-5) | 5(4-6) | 0.654 |
| Intraoperative | 5min | 2(1-3) | 2(1.25-3) | 0.165 |
| | 10min | 2(1-2) | 2(1-2) | 0.858 |
| | 15min | 1(1-2) | 2(1-2) | 0.328 |
| | 20min | 0(0-1) | 0.5(0-1) | 0.853 |

| | | | | |
|---|---|---|---|---|
| | 25min | 0(0-1) | 1(0-1) | 0.707 |
| | 30min | 1(0-1) | 1(0-1) | 0.235 |
| | 35min | 1(0-1) | 1(0-1) | 0.157 |
| | 40min | 1(0-1) | 1(1-1.75) | 0.009* |
| | 45min | 1(0-1) | 1(1-1.75) | 0.003* |
| | 50min | 1(1-1) | 1(1-2) | 0.012* |
| 1h | | 1(1-2) | 1(1-2) | 0.133 |
| 2h | | 1(1-2) | 3(2-4) | <0.001* |
| 3h | | 2(1-3) | 3(2-4) | <0.001* |
| 4h | | 3(2-3) | 3(3-5) | 0.009* |
| 5h | | 3(2-4) | 3(2-4) | 0.839 |
| 6h | | 3(2-5) | 3(2-5) | 0.63 |
| 8h | | 3(2-4) | 3(2-4) | 0.086 |
| 12h | | 3(2-4) | 3.5(2.25-4) | 0.072 |
| 16h | | 3(2-4) | 3(2-4) | 0.595 |
| 24h | | 3(3-4) | 3(3-4) | 0.117 |

VAS:Visual analoge scale, Data presented as median(IQR).

VAS was insignificantly different before analgesia, at(5min, 10min, 15min, 20min, 25min, 30min and 35min) intraoperative and(1h, 5h, 6h, 8h, 12h, 16h and 24h) postoperative between both groups. VAS was significantly lower at(40min, 45min and 50min) intraoperative and(2h, 3h and 4h) postoperative in group-I than group-II(P-value<0.05),(table 6).

## 4. Discussion

The most common lesions in the body are hand injuries, which account for 6.6% to 28.6% of all musculoskeletal injuries. Working-class men under 40 who are economically active are the most frequently impacted demographic.[7]

For wrist and hand surgery, nerve block is a useful anesthetic technique for postoperative pain management, shortened recovery times, and early hospital discharge.[8]

At 20 and 30 minutes, the present investigation found that GroupGroup I had a substantially lower heart rate and mean arterial pressure than GroupGroup II. Every single patient in both groups experienced complete block. Group-I had a much longer time to initially request rescue analgesia compared to group-II.

The results of the recent study may be explained by the fact that the occurrence of complete blocks in both groups indicates that both methods are effective when performed correctly. The key differences may lie in secondary factors like patient comfort, procedural time, or the incidence of complications, which could favor one technique over the other. However, in terms of achieving a nerve block, the reliability of the techniques and the careful application of anesthetic principles contribute to this outcome.[9]

The results of the recent study are consistent with previous research on forearm peripheral nerve blocks guided by ultrasonography. Conducting research, looking back, Mariano et al.,[10] additionally noted that following an ultrasound-guided median and ulnar nerve block in the mid-forearm area for carpal tunnel release, there were no postoperative problems or intraoperative changes to general anesthesia.

Similarly, Ince et al.,[11] showed a perfect success rate following a combined peripheral median and radial nerve block (superficial, sensory branch) guided by ultrasound for hand surgery, albeit they measured the block's effectiveness using a cold feeling score.

Moreover, Soberon et al.,[12] found that distal peripheral nerve blocks could be used as alternatives to proximal brachial plexus blocks in patients having hand surgery, and they reported that out of 30 patients who underwent combined ultrasound-guided peripheral median, ulnar, and radial nerve blocks in the mid to proximal forearm region, one had to be switched to general anesthesia. As a main anesthetic, peripheral nerve blocks resulted in a 90% success rate for surgeries involving the hands and wrists.

At 40, 45, and 50 minutes into the operation, as well as 2 hours, 3 hours, and 4 hours after the procedure, VAS was considerably lower in Group I compared to Group II.

In agreement with the results of the recent study, Hassan et al.,[13] conducted a prospective study to compare the efficacy and length of time spent blocking peripheral nerves with infiltrating local surgical sites with anesthetics in patients having elective surgery on their hands or wrists. Compared to patients who had local surgery site anesthetic infiltration and anatomical landmark nerve block, those who got ultrasound-guided nerve block experienced longer durations of pain alleviation(p<0.01).

Supporting the results of the recent study, Jalil et al.,[14] conducted a study comparing the effectiveness of ultrasound-guided forearm nerve blocks and forearm intravenous radial anaesthesia(IVRA) in delivering a surgical block and relieving postoperative pain in patients undergoing carpal tunnel release. The trial was designed to be prospective, randomized, observer-blinded, and superior.

This was also confirmed by Liebmann et al.[2] who disclosed that emergency department doctors employ peripheral nerve blocks guided by ultrasonography to alleviate pain during a range of hand surgeries, most commonly for the reduction of fractures in fingers and the repair of complicated lacerations.

Additionally, Amini et al.,[15] was able to successfully administer peripheral nerve blocks guided by ultrasonography to alleviate pain in patients undergoing treatment for fracture-dislocations or dislocations of the fingers. The patients in this study were able to achieve full anesthesia and full sensation restoration before being discharged within 5-minutes of the ultrasound-guided nerve block. In comparison to trials that employed ultrasound-guided forearm blocks to numb the hand, this one takes less time to start working.

Both groups reported substantially differing levels of patient satisfaction in this study. Similar findings were also made in Liebmann et al.,[2] who conducted a prospective study with a convenience sample of eleven adult emergency department patients who presented with hand pathology requiring a procedure to assess the practicability of radial, ulnar, and median nerve blocks guided by forearm ultrasonography as a means of procedural anesthesia for the hand during procedures performed by emergency department physicians. They came to the conclusion that with little training, attending physicians, fellows, and residents may successfully administer radial, ulnar, and median nerve blocks guided by ultrasonography to the forearm in a short amount of time without the need for extra anesthetic, with excellent patient satisfaction.

Similarly, Capek et al.,[16] discussed the benefits of using ultrasound to guide peripheral nerve blocks in the upper limb, and it was found that these blocks have historically relied on surface landmark-based[17] methods facilitated by fascial clicks, resistance reduction, and peripheral nerve neurostimulation including motor control.

### *4. Conclusion*

In comparison to anatomic landmark-based wrist nerve blocks, ultrasound-guided forearm nerve blocks improve surgical anesthesia, decrease postoperative pain scores, delay the time to first request of rescue analgesia, and increase patient satisfaction in patients undergoing hand surgery.

## Disclosure

The authors have no financial interest to declare in relation to the content of this article.

## Authorship

All authors have a substantial contribution to the article


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## Conflicts of interest

There are no conflicts of interest.

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