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A comparison between axillary brachial plexus block and elbow block using ultrasound in patients undergoing surgeries of wrist and hand

Amit Kumar Biswas[1], Debojyoti Das[2], Sarfraaz Rahman[3], Sandip Maji[4], Sandip Sinha[5], Mohanchandra Mandal[6]

[1,3,4]Post Graduate Trainee, [2]Assistant Professor, [6]Professor, Department of Anaesthesiology, Institute of Post Graduate Medical Education and Research/S.S.K.M. Hospital, [5]Professor, Department of Anaesthesiology and CCU In-charge, College of Medicine and Sagore Dutta Hospital, Kolkata, West Bengal, India

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ABSTRACT

Background: Both the axillary brachial block and elbow block are easy to learn and perform. Elbow block was previously used to as a rescue block to supplement the inadequacy of proximal nerve plexus block. Recently, elbow block is emerging as a primary anesthetic technique for wrist and hand surgeries. However, no such study in Indian scenario exists comparing axillary brachial plexus block and elbow block using ultrasound (US) guidance during wrist and hand surgeries. **Aims and Objectives:** The present study was designed to compare axillary brachial plexus block and elbow block for hand and wrist surgery in terms of duration of post-operative analgesia (Primary outcome), procedure times, other characteristics of block, patient satisfaction, and adverse events. **Materials and Methods:** This open-label parallel-group randomized study was performed in 78 adults, aged 18–70 years, ASA I-II, undergoing elective surgeries of wrist and hand. The patients were randomly allocated into two equal groups to receive either axillary brachial plexus block (Group A, n = 39) or elbow block (Group B, n = 39), both under US guidance. The time to first rescue analgesia was the primary outcome measure. Other outcome measures were different characteristics of nerve blocks, procedure duration, 24-h analgesic consumption, patient's satisfaction score, and adverse events. **Results:** The time to first analgesic administration was considerably higher in axillary block compared with elbow block (15 vs. 14 h, $P < 0.001$). However, the post-operative analgesia with elbow block was not clinically insignificant. The onset of blocks was faster with axillary block compared with elbow block (sensory block 15 vs. 24 min, $P < 0.001$; motor block 20 vs. 30 min, $P < 0.001$). Overall, a higher number of patients were more satisfied with elbow block. **Conclusion:** Using US, elbow block can be a better alternative to axillary block for hand surgeries in terms of sufficient post-operative analgesia, comparatively shorter motor block, and better patient satisfaction.

Key words: Axillary block; Brachial plexus block; Distal peripheral nerve blocks; Elbow block; Ultrasound guidance

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INTRODUCTION

Ultrasound (US)-guided axillary brachial plexus block is often used nowadays for surgery on the elbow, forearm, and hand due to the facts that it is relatively simple to perform, which provides sufficient distal extremity blockade and devoid of serious complications.[1,2] US-guided distal peripheral nerve blocks (PNBs) around elbow such as radial, median, and ulnar nerves, has been utilized as a rescue block.[3,4] Distal nerve blocks around elbow have also been utilized as primary anesthetic technique in the recent past.[4-6] Elbow block can be useful especially for surgeries of hand and wrist.

Address for Correspondence:
Prof. Dr. Mohanchandra Mandal, Professor, Department of Anaesthesiology, Institute of Post Graduate Medical Education and Research/ S.S.K.M. Hospital, Kolkata, West Bengal, India. **Mobile:** +91-9433072820. **E-mail:** drmcmandal@gmail.com

There is paucity of the literature that has studied the US-guided selective nerve block at elbow.

Elbow block has been found to be safe and acceptable primary anesthetic technique compared with axillary[7,8] and infraclavicular.[9] All the three studies[7-9] focusing comparison of axillary block with blocks at or around elbow were performed in the population abroad. To the horizon of our knowledge, no study has yet been performed in Indian context to compare US-guided axillary brachial plexus block and elbow block in patients undergoing surgeries of wrist and hand. This was identified as the lacunae in the existing literature. Hence, the present study was designed to compare axillary brachial plexus block and elbow block using US guidance in patients undergoing surgeries of wrist and hand.

Aims and objectives

The study aimed at determining the effect of blocks on duration of post-operative analgesia (Primary outcome). In addition, the procedure duration, other block characteristics, patient satisfaction, and adverse events were evaluated.

MATERIALS AND METHODS

This open-label parallel-group randomized controlled study was conducted in the orthopedic operating room under Department of Anesthesiology, IPGME&R, SSKM Hospital. The study was started after approval by the Institutional Ethics Committee (IPGMER/IEC/2021/307, dated April 21, 2021) and it spanned over 18 months (April 2021–September 2022). Informed consent from each patient was documented before recruitment.

Seventy-eight adult patients of aged 18–70 years, conforming to ASA physical status I and II, undergoing elective surgeries of wrist and hand under regional anesthesia were recruited for this study after satisfying the inclusion and exclusion criteria. The surgical procedures were Open Reduction and Internal Fixation for fractures involving either of the following sites such as both bones of forearm, distal end of radius, and distal end of ulna.

Exclusion criteria

Patients with peripheral neuropathy, having neurological deficit, or motor weakness were excluded from the study. The patients who had seizures, local site infection, bleeding diatheses, or taking anticoagulation medication were excluded from the study. The patients having considerable cardiac, respiratory, hepatic or renal disorders, or any other uncontrolled systemic illness were not considered for this study. Patients having history of allergy to local anesthetics, or history of pneumothorax were excluded from the study. Pregnant patients and those who refused to give consent were kept out of this study.

Sample size

From a previous study,[7] the standard deviation for "time to first rescue analgesic" was noted as 72 min in the control group (axillary block). We assumed that detecting at least 50 min of difference in the "time to first rescue analgesia" would be clinically relevant (effect size). Presuming two-tailed hypothesis, with 80% power and allowing alpha error of 5%, the sample size was calculated to be around 33 for each group.[10] Considering the possibility of 15% drop out, the sample size was adjusted to 78.

The patients were randomly allocated into two equal groups using sequentially numbered opaque sealed envelopes.

- Group A (n=39): Patients who received US-guided axillary brachial plexus block
- Group B (n=39): Patients who received US-guided elbow block.

A detailed pre-anesthetic evaluation was performed in each patient, including detailed history and thorough physical examination, airway examination, and routine pre-operative investigations. The patients were explained about the procedure and the risks and benefits involved. Visual analog scale (VAS) score was explained to all patients.

After receiving the patient in the operating room, an intravenous line (iv) was established with 18-G cannula in a large peripheral vein in the forearm opposite the surgical side, and Ringer's lactate solution was given. All patients were administered intravenous midazolam 0.03 mg/kg as premedication. Standard monitoring was done using five-lead electrocardiography, non-invasive blood pressure, and pulse oximeter. Capnography monitoring was done using side-stream analyzer by attaching gas sampling tube with face mask. Anesthesia machine, airway equipment, drugs for general anesthesia, and resuscitation were kept ready before starting the procedure.

Pre-operative baseline values of heart rate (HR), mean arterial pressure (MAP), and oxygen saturation (SpO_2) were recorded. According to group allocation, the patients received the respective blocks (Figures 1-4) as per standard methods[11,12] with aseptic precautions using high frequency (7–13 MHz) linear ultrasound probe, placed in a sterile sheath. Bupivacaine 0.5% with dexmedetomidine at a dose 1 mcg/mL of solution was used for all the nerve blocks.

Intraoperative vitals (HR, MAP, and SpO_2) were recorded every 5, 15, 30, 60, 90, and 120 min. The incidences of adverse events (bradycardia, hypotension, and sedation) were also recorded. Bradycardia (<50 beats/min) was

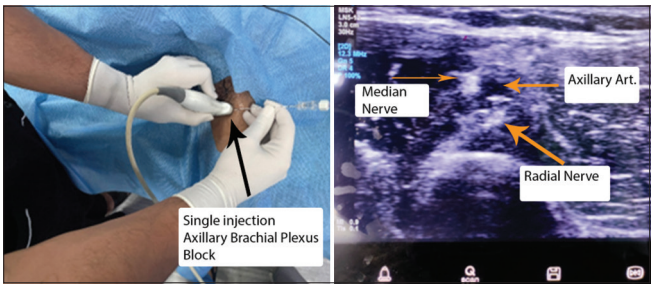

Figure 1: Probe position and corresponding sonographic view during Axillary brachial plexus block. The probe was positioned in the short axis orientation to identify the axillary artery about 1–3 cm from skin surface. 8 mL of local anesthetic was deposited posterior to the artery for radial nerve and 12 mL was injected around median and ulnar nerves after redirecting the needle tip

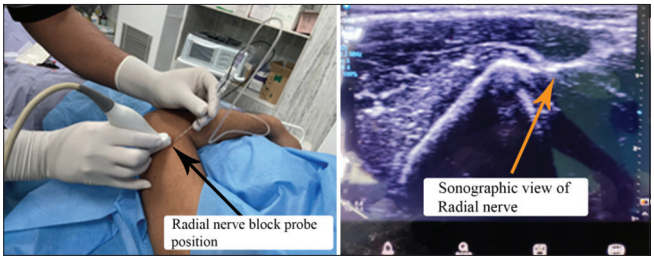

Figure 2: Probe position and corresponding sonographic view for radial nerve block. Ultrasound probe was placed over the lateral aspect of the arm over the lateral epicondyle. The needle was inserted in-plane from lateral to medial direction, and 6 mL of solution was deposited in between brachialis and brachioradialis from where radial nerve emerges.

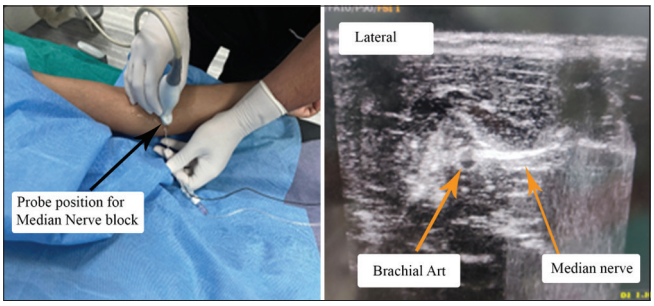

Figure 3: Probe position and corresponding sonographic view of median nerve block. The injection site is slightly below the elbow joint where the nerve can be visualized medial to the brachial artery. The ultrasound probe was placed just distal to the elbow. The needle was inserted in-plane from medial to lateral and 6 mL of the solution was deposited.

managed with 0.6 mg atropine iv bolus. Hypotension (MAP <60 mm Hg) was managed by a bolus of iv crystalloids or increments of mephentermine 3 mg iv.

Block success was assessed every 5 min from the end of injection until readiness for surgery. Onset of motor block was considered when there is decreased motor strength with ability to move only fingers. Sensory block was assessed by the pin-prick using 22G needles over the lateral side of the forearm and thumb, segments

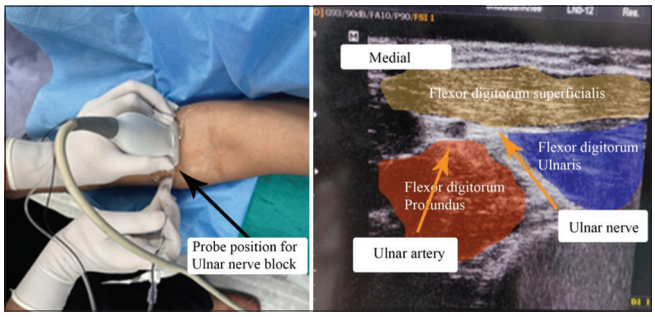

Figure 4: Probe position and corresponding sonographic view of ulnar nerve block. The target is the ulnar nerve 3–4 fingerbreadths distal to the elbow joint. The US probe was placed on the ventromedial aspect of the forearm. At this level, the nerve is situated just medial to the flexor carpi ulnaris, between the flexor digitorum profundus and superficialis. The needle was inserted in-plane medial to lateral direction and 6 mL of LA solution was deposited around the nerve.

supplied by the radial, median, or ulnar nerves. Onset of sensory block was considered when there was a dull sensation to pin-prick in any of the above-mentioned areas. The block was considered as *incomplete* when the patient still felt pain even after 30 min of injection. Duration of sensory and motor blockade was assessed every hour till the recovery of sensations by the same anesthesiologist. Patients with incomplete block had received general anesthesia and they were excluded from the study (Figure 5).

Post-operative pain was assessed with use of VAS on an 11-point scale (0= no pain to 10=worst pain). The time to first analgesic request was recorded. It was defined as the time from recovery until VAS score ≥4. Rescue analgesia was given with iv diclofenac 1 mg/kg body weight. In the post-operative day 1, the patients were evaluated with a questionnaire on a five-point scale to assess the patient satisfaction about the procedure (from 1=not satisfied, 2=dissatisfied, 3=neutral, 4= satisfied, and 5=fully satisfied). Higher scores indicated about more satisfaction. This was the end-point of the study.

Baseline demographic parameters, such as age, weight, sex, duration, and type of surgery, were recorded. The following parameters were recorded: Time of onset of sensory and motor block, duration of sensory and motor block, duration of procedure, time to first point of rescue analgesia, 24-h analgesic consumption, and patient's satisfaction score. Any adverse events such as pneumothorax, difficulty in breathing, weakness and paresthesia in the arm, or any incidence of post-operative nausea and vomiting were recorded.

The data were tabulated in Microsoft Excel and analyzed with the Statistical Packages for the Social Sciences version 22.0. The continuous variables are presented with

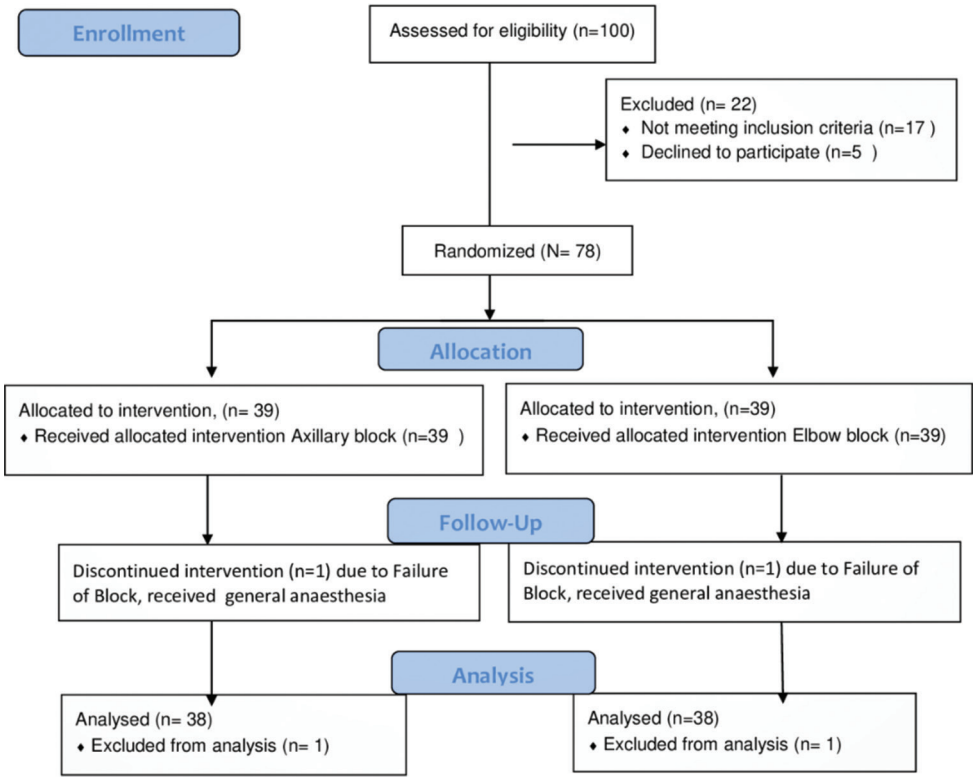

Figure 5: Consort flow of patient recruitment

mean and standard deviation. The categorical variables are presented with frequency and percentage. Independent t-test and Chi-square test were used for the comparisons. P<0.05 is considered statistically significant.

RESULTS

The present study spanned from April 2021 to September 2022. One patient in each group had failed block and received general anesthesia. Hence, data from 76 patients were available for analysis.

The demographic data and duration of surgery were comparable between the two groups (Table 1).

The distributions of different types of surgeries were comparable between the two groups (Table 2).

The procedure duration was considerably more in patients receiving axillary block (Group A) compared with elbow block (Group B). The onset of sensory block was considerably faster in patients receiving axillary block (Group A), and the motor block onset was also faster in patients receiving axillary block (Group A) compared with elbow block (Group B). The duration of sensory block was considerably shorter in patients receiving PNBs around elbow (Group A), and the motor block duration was also considerably shorter in patients receiving PNBs around elbow (Group A) compared with axillary block, as shown in Table 3. The time to first rescue analgesic was found to be considerably longer in Group A receiving axillary block compared with elbow block. The total analgesic

Table 1: Demography and surgery duration

Parameter	Group A (n=38)	Group B (n=38)	P-value
Age (in year)	39.32±12.66	41.5±11.95	0.442
Sex (male/female)*	22/16	21/17	0.817
ASA physical status (I/II)*	27/11	28/10	0.798
Weight (in kg)	66.03±11.71	64.79±10.13	0.624
Duration of surgery (in minutes)	81.95±10.10	82.82±8.67	0.689

Continuous data are presented as mean±SD and analyzed with Student's unpaired t-test. The categorical data marked with * are analyzed using Chi-square test. *P*<0.05 is considered as statistically significant. Group A, patients receiving axillary brachial plexus block; Group B, patients receiving elbow block

Table 2: Distribution of types of surgery

Type of surgery	Group A (n=38) (%)	Group B (n=38) (%)	P-value
ORIF both bones of forearm	15 (39.5)	17 (44.7)	
ORIF on distal end of radius	13 (34.2)	12 (31.6)	0.896
ORIF on distal end of ulna	10 (26.3)	9 (23.7)	

Categorical data, presented as number of patient (proportion), analysed using Chi-square test. P<0.05 is considered as statistically significant. Group A, patients receiving axillary brachial plexus block; Group B, patients receiving elbow block. ORIF: Open reduction and internal fixation

Table 3: Block characteristics

Parameters	Group A (n=38)	Group B (n=38)	P-value
Procedure duration (in min)	7.8±1.56	4.41±0.43	<0.001
Onset of block (in minutes)			
Sensory block	15.26±1.7	24.45±1.59	<0.001
Motor block	19.83±1.93	30.02±1.85	<0.001
Duration of block (in hours)			
Sensory block	14.56±0.64	13.5±0.72	<0.001
Motor block	12.61±0.75	11.54±0.75	<0.001
Post-operative analgesia			
Time to first analgesic (in hours)	15.09±0.57	14.13±0.67	<0.001
Total analgesic requirement (in mg)	76.97±6.83	78.82±10.36	0.363

Continuous data are presented as mean±SD and analyzed with Student's unpaired t-test. Group A, patients receiving axillary brachial plexus block; Group B, patients receiving elbow block. *P*<0.05 is considered as statistically significant

Table 4: Patient satisfaction score

Patient satisfaction score (PSS)	Group A (n=38)	Group B (n=38)	P-value
Score 1 (not satisfied)	10 (26.3%)	0	<0.001
Score 2 (dissatisfied)	26 (68.4%)	4 (10.5%)	
Score 3 (neutral)	2 (5.3%)	21 (55.3%)	
Score 4 (satisfied)	0	13 (17.1%)	
Score 5 (fully satisfied)	0	0	

Categorical data are presented as number of patients (proportion) and are analyzed using Chi-square test. P<0.05 is considered as statistically significant. Group A, patients receiving axillary brachial plexus block; Group B, patients receiving elbow block

requirement in the first 24 h was comparable among the two groups (Table 3).

Out of 38 participants in Group A (Axillary brachial plexus block) ten patients (26.3%) were not satisfied and 26 patients (68.4%) were dissatisfied. Hence, altogether 36 patients in axillary brachial plexus block group had any type of dissatisfaction. On the other hand, in the elbow block group, 21 patients (55.3%) had neutral opinion, and 13 patients (34.2%) were satisfied with elbow block. Thus, it is clear that the number of dissatisfied patients among axillary block group outnumbered to those in the elbow block group. Overall, more patients in the elbow group had a feel-good. It translates in to the fact that, the patients were more satisfied with elbow block (Table 4).

The MAP, HR, and peripheral arterial SpO_2 at different time-points were comparable between the two groups (data not presented). One patient in each group had failed block and received general anesthesia. No serious adverse events such as hematoma, intravascular injection, or neuropraxia occurred in the present study.

DISCUSSION

US-guided brachial plexus block is a common anesthetic technique for patients undergoing hand surgeries. PNBs at the level of the elbow can be an excellent anesthetic choice for carpal tunnel release surgery.[6] A few studies[4,5] only have reported about utilizing distal nerve blocks as a primary anesthetic technique. Subsequently, another two studies[8,9] have compared the distal nerve blocks with axillary[8] or infraclavicular[9] brachial plexus block.

The present study finds that elbow block yields about 14 h of post-operative analgesia which is clinically important. However, on analysis, it was significantly lower (P<0.001) than axillary block. The total analgesic consumption was comparable between the two groups. This observation is in line with that reported by Manoudis et al.,[7] who observed that time to first rescue analgesia was shorter with elbow block compared with axillary brachial plexus block (8±1.3 h vs. 9±1.2 h, respectively).

In the present study, block performance time was found to be considerably shorter with elbow block compared with axillary block. The observation of the present study is in line with study of Lam et al.,[1] where shorter procedural time was reported with distal block (ulnar and median nerves) compared with supraclavicular brachial plexus block (12 min vs. 15 min, respectively). However, contrast finding is reported in a recent (2016) study by Ince et al.,[9] where they found comparable block performance time. The distal nerves are more superficial than the plexus cords, and consequently, the formers can be imaged more easily and faster with US guidance.[13] The time in the operating room may be curtailed if the blocks and tourniquet are applied in the procedure room.[6]

In the present study, the block onset time was longer with elbow block compared with axillary block. The finding of the present study is in line with the study of Manoudis et al.,[7] who also observed a longer block onset times using elbow block compared with axillary block (32 min vs. 15 min for sensory block, and 40 min vs. 20 min for motor block, respectively). In contrast, the block onset times was found to be considerably shorter with distal nerve blocks compared with axillary brachial plexus block in other studies.[1,9]

In the present study, the duration of motor block was significantly shorter in elbow block group compared with axillary brachial plexus block. Similar trend was reported in the literature.[7,8] However, the duration of both the blocks of present study appear to be higher than the reported studies. In the present study, 6 mL of LA solution has been used for each nerve, whereas most of the previous studies[1,8,9,11] have used slightly lower dose that varies from

3 mL to 5 mL[12,14-16] Landmark-based injections commonly require 5–10 mL to bathe and anesthetize the nerve, whereas an US-guided injection usually requires only 2–5 mL.[17]

In the present study, the number of dis-satisfied patients receiving axillary brachial plexus block were considerably more than those receiving elbow block. Overall, a greater number of patients in the elbow group had a feel-good. It translates in to the fact that overall, the patients were more satisfied with elbow block. Similar trend of better satisfaction was observed with elbow block compared with axillary brachial plexus block.[7] Other studies[1,8] have also reported about less motor block and consequently higher satisfaction in their patients receiving distal nerve blocks in comparison with proximal brachial plexus block. In contrast, a neutral finding has been reported by Ince et al.,[9] who found a comparable patients' satisfaction between distal nerve block and infraclavicular brachial plexus block.

US-guided selective nerve block in upper arm assists in the retention of motor function at the elbow, while the proximal brachial plexus blocks do not.[8] Proximal brachial plexus blocks such as axillary block can lead to a prolonged period of motor paralysis, the so called "dead arm."[8] Many patients experience dissatisfaction from the prolonged arm weakness associated with proximal nerve blocks such as or interscalene block[18] or at the level of C5-6 root/superior trunk[19] brachial plexus block. Some patients experience dissatisfaction with a paralyzed upper extremity, despite reassurance that this is temporary and would return to normalcy with resolution of the primary block.[18]

The shorter procedure time with elbow block compared with axillary block is appealing for its further use. Although, a longer block onset time is observed with elbow block in comparison with axillary block in the present study, it needs further evaluation on bigger sample due to the presence of contrast reports in literature.

To summarize, US-guided elbow block was found to be advantageous than axillary block for hand surgeries in terms of clinically significant post-operative analgesia, considerably shorter block performance time, shorter motor weakness, and better patient satisfaction. However, a longer block onset time and shorter sensory block duration was noted with elbow block in comparison with axillary block. It needs further validation with bigger sample before final comment due to contrast reports in literature.

Limitations of the study

Open-label study is clearly a weakness in the design of the present study regarding elimination of bias. Educational, socioeconomic, and cultural background influences patient's feeling and response to intensity of pain. As those factors were not assessed, it might have led to some misinterpretation of pain score assessment. However, in the present study, an effort was done to familiarize the patients with the assessment tool. Patients belonging to extremes of age groups and conforming to higher ASA-PS class where nerve blocks are mostly preferred were not included. Hence, caution should be exercised to extrapolate the findings of the present study. Prolonged observation beyond 24 h was not done to find any long-term benefits of adverse events. A further study with bigger sample and with addressing these issues may find other important aspects about these nerve blocks.

CONCLUSION

US-guided distal nerve blocks at the level of elbow can be a better alternative to US-guided axillary block for hand surgeries due to prolonged post-operative analgesia and better patient satisfaction with elbow block.

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Authors' Contributions:
AKB- Study design, conduct of study, data collection, first draft; **DD-** Concept, design, data analysis, first draft; **SR-** Study design, data analysis and interpretation, review of literature; **SM-** Data keeping, data analysis, revision; **SS-** Concept, daily guidance, data analysis, logical conclusion, revision of first draft; **MM-** Concept, design, logical conclusion, revision of first draft

Work attributed to:
Institute of Post Graduate Medical Education and Research/S.S.K.M. Hospital, Kolkata, West Bengal, India

Orcid ID:
Amit Kumar Biswas - https://orcid.org/0000-0002-6713-0657
Debojyoti Das - https://orcid.org/0000-0002-3406-151X
Sarfraaz Rahman - https://orcid.org/0000-0001-6641-276X
Sandip Maji - https://orcid.org/0000-0002-3186-1087
Sandip Sinha - https://orcid.org/0000-0002-7165-4680
Mohanchandra Mandal - https://orcid.org/0000-0003-4183-993X

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