Experimental and Applied Medical Science, 6, 1: 44-56, 2025. DOI: 10.46871/eams.1560450
**Clinical Research**

# Comparison of Supraclavicular or Infraclavicular or Axillary Blocks Accompanied by Ultrasonography and Nerve Stimulator for Upper Extremity Surgery

Asuman Ocaklar[1*], Riza Hakan Erbay[1]

[1]*Pamukkale University, Faculty of Medicine, Anesthesiology and Reanimation Department, Denizli, Turkiye.*

**Abstract**

***Objective:*** *Supraclavicular (SC), infraclavicular (IC) and axillary (Ax) brachial plexus blocks can be applied for upper extremity surgeries. In this study, we aimed to compare the infraclavicular or supraclavicular or axillary block types using a combination of fentanyl and 0.5% bupivacaine, accompanied by USG and nerve stimulator.*

***Materials and methods:*** *In this prospective randomized study, after obtaining the approval of the Local Institutional Ethics Committee, 91 patients aged between 18-65 years with ASA I-II physical status who underwent upper extremity surgery by the departments of Orthopedics and Traumatology and Plastic and Reconstructive Surgery were included in the study. Patients were allocated into three groups: Group SC (n=31), Group IC (n=30), Group Ax (n=30). Two patients who underwent unsuccessful block in Group Ax were excluded from the study. The patients were evaluated preoperatively and verbal and written consents were obtained by giving information about the anesthesia method to be applied. Demographic data of the patients, ASA scores, onset times of motor and sensory blockades, postoperative block resolution times, complications during or after the procedure, patient and surgical satisfaction data were recorded.*

***Results:*** *The performance time in Group SC was found to have a shorter compared to the other two groups. Although motor and sensory block onset times were slightly longer in Group Ax, there is no statistical differences between the all three groups at the end of 30 minutes. It was observed that postoperative sensory and motor functions returned faster in Group Ax than in the other two groups.*

***Conclusion:*** *All the three brachial plexus block techniques could be used in cases requiring upper extremity surgery. It was thought that the application of the appropriate type of block for the patient, accompanied by ultrasound and nerve stimulator, with an experienced practitioner will increase the success of the block and decrease the complication rate.*

***Key Words:*** *Axillary block, Infraclavicular block, Supraclavicular block, Ultrasonography (USG)*

*** Corresponding author:** Asuman Ocaklar, e-mail: Asuman-kcygt@hotmail.com, ORCID ID: 0009-0003-2456-1398

## Introduction

Currently, regional anesthesia and analgesia techniques are considered to be more reliable and preferable than general anesthesia due to their many advantages (1, 2). Among the factors considered to be the advantages of regional anesthesia over general anesthesia are the following: preservation of airway reflexes and no need for tracheal intubation, low consumption of analgesics and antiemetics, stable hemodynamics, no additional time required for awakening and extubation, shorter length of stay in postanesthesia care unit (PACU) and hospital, adequate intraoperative muscle relaxation, adequate intraoperative and postoperative analgesia, increased blood flow in the extremity with sympathetic blockade, and positive contribution to postoperative wound healing (3, 4).

The development of ultrasonography (USG) and the increasing use of peripheral nerve blocks have made safer, faster and more comfortable block application possible (5). Direct visualization of the spread of local anesthetic around the nerve with USG increases the success of the block and shortens the duration of the block application. One of the most important advantages of USG in regional block application is that it reduces the dose of local anesthetic, the risk of local anesthetic toxicity and complications (6).

In this study, we aimed to compare the infraclavicular or supraclavicular or axillary block types using a combination of fentanyl and 0.5% bupivacaine, accompanied by USG and nerve stimulator.

## Material and Methods

In this study, 91 patients aged between 18-65 years and with ASA I-II physical status who applied to Departments of Pamukkale University Medical Faculty Hospital Orthopedics and Traumatology and Plastic &Reconstructive Surgery for upper extremity surgery were included. Ethical approval for the study was obtained with the decision of Pamukkale University Non-Interventional Clinical Research Ethics Committee dated 30.01.2018 and numbered 03.

The patients were preoperatively evaluated, and verbal and written consents were obtained by giving information about the anesthesia method to be applied. Demographic data and ASA scores of the patients were recorded. Those who refuse the regional block, cannot cooperate, have coagulopathy, have known allergy to any of the drugs used, have infection at the injection site or have anatomical disorders, neuropathy in the arm to be blocked, pregnant and severe chronic obstructive

pulmonary disease (COPD), morbidly obese (BMI>40) patients were excluded from the study.

Ninety one patients were included in the study, randomization was done by the closed envelope method. Cases that were planned to be operated on the hand, wrist, forearm and elbow and with brachial plexus block were included in the study. The patients were divided into three groups. The first group was defined as infraclavicular group (Group IC), the second group as supraclavicular group (Group SC), and the third group as axillary group (Group Ax).

The patients were taken to the operation room and ECG monitoring was performed, peripheral oxygen saturation ($SpO_2$) was monitored, and blood pressure (BP) follow-ups with 5-minute intervals were taken. All patients were premedicated with 1-2 mg midazolam and 25µg fentanyl. 0.5% bupivacaine 20 mL + 50 µg (1 mL) fentanyl was administered to all patients for the block procedure. All blocks were performed with ultrasonography (GE Logiq-e, USA, 5-13 MHz linear probe) and nerve stimulator (Braun, Stimuplex Dig RC, Germany). In all blocks, stimulation at 1 mA was obtained with a nerve stimulator, and when the stimulation disappeared at 0.5 mA, local anesthetic was administered. Demographic data, ASA scores, motor and sensory block onset times, intraoperative data, block resolution time, early complications, and patient and surgical satisfaction were recorded for all patients.

Data were analyzed with the SPSS 24 (SPSS Inc, Chicago, IL, USA) package program. Demographic data and continuous variables were expressed as mean ±standard deviation, and categorical variables were expressed as numbers and percentages. The conformity of the examined variables to the normal distribution was examined with the Shapiro-Wilk test. ANOVA and Kruskal Wallis analysis of variance were used in independent groups. In dependent groups, analysis of variance and Friedman test were used for repeated measurements. Differences between categorical variables were analyzed by Chi-square analysis. $p<0.05$ was considered statistically significant in all analyses.

**Results**

The study was started with 91 patients, and these 2 patients were excluded because 2 patients had unsuccessful block after the block procedure and they were returned to general anesthesia. All patients were given 2L/min oxygen by nasal cannula. ECG monitoring was performed, heart rate (HR), peripheral oxygen saturation ($SpO_2$) were monitored, and blood pressure (BP) follow-ups were taken at 5-minute intervals. All patients were premedicated with 1-2 mg midazolam and 25 µg fentanyl.

Demographic data and ASA scores of the patients were similar (Table 1).

Two of 91 patients were excluded from the study because of the failure of the regional block. Then general anesthesia was given to these two patients. Oxygen was given at 2 L/min by nasal cannula. ECG monitoring was performed, heart rate (HR), peripheral oxygen saturation ($SpO_2$) were monitored, and blood pressure (BP) follow-ups were taken with 5-minute intervals. All patients were premedicated with 1-2 mg midazolam and 25 µg fentanyl (Table 1).

**Tablo 1.** Demographic data of patients (Mean±SD), n (%).

| | **Group IC (n=30)** | **Group SC (n=31)** | **Group Ax (n=28)** | |
|---|---|---|---|---|
| | **Mean ± S.S** | **Ort ± S.S** | **Ort ± S.S** | p |
| **Age** | 36,47±15,25 | 37,81±16,27 | 41,29±13,43 | 0,460† |
| **Height** | 169,50±7,56 | 171,19±8,55 | 171,43±8,85 | 0,625† |
| **Weight** | 70,17±12,97 | 71,97±10,15 | 75,18±5,50 | 0,167† |
| **BMI** | 24,37±3,78 | 24,53±2,68 | 25,77±3,33 | 0,145† |
| **Gender (Female/Male)** | 5/25 | 6/25 | 5/23 | 0,963‡ |
| **ASA 1/2** | 21/9 | 24/7 | 18/10 | 0,538‡ |

*p< 0.05 statistically significant difference; †: One-way Analysis of Variance (ANOVA) ‡: Chi-square Analysis, Mean: mean, sd: standard deviation.

59 patients (66.1%) out of 89 patients included in the study, were patients who underwent wrist surgery, 27 patients (30.7%), sub-elbow surgery with forearm tendon and muscle incision and 3 (3.2%) patients were going to undergo elbow surgery.

$SpO_2$ measurements of the patients during the surgery were similar. SAB-DAB measurements were similar in group SC and group IC, they were significantly higher in Group Ax. HR values were found to be significantly higher between group Ax and IC only at the 15th minute measurement.

When the block application time was examined, Group SC had a statistically shorter application time than the other two groups (p=0,0001) (Table 2). There was no statistically significant difference between the groups in the onset of sensory block and motor block initiation times (Table 2). No statistically significant difference was found between the groups in the time of onset of surgery and duration of surgery (Table 2).

**Tablo 2:** Block procedure times and operation times.

| | Group IC (n=30) | Group SC (n=31) | Group Ax (n=28) | |
|---|---|---|---|---|
| | **Mean ± S.D** | **Mean ± S.D** | **Mean ± S.D** | **p** |
| **Block Procedure Time (min)** | 7,56 ± 2,44 | 5,13 ± 1,51 | 8,57±2,74 | 0,0001* |
| **Sensory Block(min)** | 11,10 ± 2,85 | 11,40 ± 4,27 | 12,30±4,66 | 0,496 |
| **Motor Block (min)** | 15,17 ± 5,06 | 14,26 ± 4,91 | 17,04±5,48 | 0,116 |
| **Surgery start time(min)** | 13,43±3,80 | 13,72±5,65 | 14,14±4,91 | 0,856 |
| **Operation Time(min)** | 64,67±31,97 | 74,58±34,16 | 65,07±32,55 | 0,418 |

* p<0.05 statistically significant difference; †: One-way analysis of variance (ANOVA); ‖: Friedman testmean: mean, sd: standard deviation.

Additional analgesic measurements required an average of 62.86 µg in 7 patients in Group IC, 46.88 µg in 8 patients in Group SC, and 75.00 µg in 12 patients in Group Ax. Failed block did not occur in Group IC and Group SC. In Group Ax had two failed blocks. These two patients who underwent general anesthesia in Group Ax were not included in the study (Table 3).

**Tablo 3:** Additional analgesic requirement and complications.

| | Group IC (n=30) | Group SC (n=31) | Group Ax (n=30) |
|---|---|---|---|
| | **Mean ± S.D** | **Mean ± S.D** | **Mean ± S.D** |
| **Additional Analgesic** | (n=7) 62,86 ± 33,40 | (n=8) 46,88 ± 16,02 | (n=12) 75,00 ± 30,15 |
| **Failed Block (yes/no)** | 0/30 | 0/31 | 2/28 |
| **Complications*** | 0 | 3 | 5 |
| **General anesthesia (yes/no) **** | 0/30 | 0/31 | 2/28 |

*Complications seen = vascular puncture ;Mean: mean, sd: standard deviation, **Two patients who returned to general anesthesia were excluded from the study.

While no complications were observed in Group IC, vascular puncture was observed in 3 patients in Group SC and 5 patients in Group Ax. No pneumothorax was observed in any patient and respiratory distress did not develop in the follow-up. There was no statistically significant difference between the groups when the postoperative motor functions were compared at the 24th hour.

There was no significant difference between patient and surgeon satisfaction (Table 4).

**Tablo 4:** Patient and surgeon satisfaction between groups.

| | **Group IC (n=30)** | **Group SC (n=31)** | **Group Ax (n=28)** | |
|---|---|---|---|---|
| | **Good/Medium/Bad** | **Good/Medium/Bad** | **Good/Medium/Bad** | **Intergroup p** |
| **Patient Satisfaction** | 25/5/0 | 25/6/0 | 21/7/0 | 0,724 |
| **Surgeon Satisfaction** | 30/0/0 | 29/2/0 | 27/1/0 | 0,377 |

*p< 0.05 statistically significant difference; chi square test

While the recovery of postoperative block was faster in the axillary group, it was found to be similar between the other two groups (Table 5).

**Tablo 5.** Comparison of postoperative sensory function test (pinprick) measurements and postoperative motor functions (Bromage) between groups.

| | **Mean± S.S** | **Group IC (n=30)** | **Group SC (n=31)** | **Group Ax (n=28)** | **p** |
|---|---|---|---|---|---|
| | 30. min | 0,00 ± 0,00 | 0,00 ± 0,00 | 0,00 ± 0,00 | - |
| **Postoperative** | 2. hour | 0,00 ± 0,00 | 0,00 ± 0,00 | 0,21±0,50 | 0.005*(Ax-SC, Ax- IC) |
| **Sensory** | 4. hour | 0,23 ± 0,43 | 0,19 ± 0,4 | 0,82±0,82 | 0.0001*(Ax-SC, Ax- IC) |
| **Function** | 6. hour | 0,8 ± 0,61 | 0,84 ± 0,52 | 1,54±0,69 | 0.0001*(Ax-SC, Ax- IC) |
| **(pinprick)** | 12. hour | 1,63 ± 0,56 | 1,74 ± 0,44 | 1,96±0,33 | 0.023*(Ax- IC) |
| **0/1/2** | 24. hour | 2,03 ± 0,18 | 2 ± 0 | 2,04±0,18 | 0.587 |
| | p | 0.0001* | 0.0001* | 0.0001* | |
| | 30. min | 2,73 ± 0,45 | 2,9 ± 0,3 | 2,46±0,51 | 0.001*(Ax-SC, Ax- IC) |
| **Postoperative** | 2. hour | 2,7 ± 0,47 | 2,81 ± 0,4 | 2,14±0,65 | 0.0001*(Ax-SC, Ax- IC) |
| **Motor** | 4. hour | 2,33 ± 0,71 | 2,19 ± 0,48 | 1,39±0,79 | 0.0001*(Ax-SC, Ax- IC) |
| **Function** | 6. hour | 1,5 ± 0,63 | 1,68 ± 0,65 | 0,58±0,74 | 0.0001*(Ax-SC, Ax- IC) |
| **(Bromage)** | 12. hour | 0,57 ± 0,68 | 0,48 ± 0,63 | 0,07±0,38 | 0.004*(Ax-SC, Ax- IC) |
| **0/1/2/3** | 24. hour | 0 ± 0 | 0 ± 0 | 0 ± 0 | - |
| | p | 0.0001* | 0.0001* | 0.0001* | |

* p<0.05 statistically significant difference; †: One-Way Analysis of Variance (ANOVA); Friedman Test ; Mean: mean, sd: standard deviation.

## Discussion

Regional anesthesia has some advantages over general anesthesia. These include not requiring tracheal intubation, increasing blood flow in the extremity, providing a mild transition to pain control, low consumption of analgesics and antiemetics, and short postoperative care unit and hospital stay (1, 3). Considering that a significant portion of trauma patients have a full stomach in emergency conditions, it is possible to avoid the possible complications of general anesthesia with regional anesthesia to be applied in these

patients (7).

However, in addition to these positive factors, complications due to regional block procedure or local anesthetic drugs can also be seen in regional anesthesia applications (7). As with any regional anesthesia technique, there is a possibility of nerve injury and nerve damage in brachial plexus block (8). Ultrasound guidance aids in real-time visualization of the needle and the relevant anatomy. The use of ultrasound has also resulted in faster block performance time and onset time (9). As the practitioner gains experience in the use of USG, the success rate of the block increases, the onset time of the block gets shorter, the side effects and the volume of local anesthetic decrease. Thus, the quality of the block increases, complications decrease, and the need for additional anesthetic and analgesics decreases (10, 11).

In the study presented here, we planned to compare the supraclavicular, infraclavicular and axillary block methods for brachial plexus block by applying them with USG and peripheral nerve stimulator (PSS) in suitable patients. More than 40 different intervention methods have been reported in the literature for brachial plexus block, which is the most common major peripheral nerve block to provide anesthesia in upper extremity surgeries. Mainly; interscalene, supraclavicular, axillary and infraclavicular intervention methods are used (12, 13). The choice of the technique and intervention method to be used in the patient for whom brachial plexus block will be performed should be decided by considering various factors such as whether the surgery is for diagnostic, therapeutic or operative purposes, the location and duration of the surgery, the need for postoperative analgesia, the general condition of the patient, the presence of an additional disease (respiratory, renal, etc.) and whether the operation will be performed on an outpatient.

In this study, we aimed to both increase the success rate of the block and decrease the incidence of complications by performing the block procedure using a nerve stimulator accompanied by ultrasonography. It is recommended to obtain a motor response with a current equal to or less than 0.5 mA prior to local anesthetic injection. It is thought that the success rate of the block will increase as the distance between the nerve and the needle tip will decrease in localizations below 0.5 mA (14). For this purpose, under the guidance of USG, we received a stimulus at 1 mA and fixed the needle at the point where the stimulus disappeared at 0.5 mA, and we preferred to inject local anesthetic there.

In our study, we applied low volume LA using the multiple injection technique with USG guidance. Thus, we aimed to keep the local anesthetic volume low while increasing the success of the block. In the study of Vazin et al. (15), it is recommended that multiple injections be performed with USG for success in block volumes as low as 20 mL. In many studies, it has been shown that successful block can be obtained by using low-volume local anesthetic in blocks performed with USG (4, 16, 17). Contrary to our study, there are also studies in the literature that say that the use of low volume LA will not be sufficient. Schroeder et al. (18) stated that the volume of local anesthetic used for axillary block (48±8 mL) was significantly higher than the volume of local anesthetic used for supraclavicular (39±7mL) and interscalene block (41±12 mL).

In the literature, there are studies suggesting that the volume of local anesthetic should be kept high in order to block Nervus musculocutaneus with the axillary approach (18, 19). In our study, we compared IC, SC, and Ax blocks by using a combination of bupivacaine as a local anesthetic and fentanyl as an opioid analgesic in equal volume (21mL) for all groups with multiple injection technique accompanied by USG and PSS.

As far as we have experienced while applying the blocks, we think that in supraclavicular and axillary blocks where the nerves are more superficial, USG alone may be sufficient for the block procedure, but in infraclavicular block where the nerves are more deeply located, it should be performed with a nerve stimulator.

In our study, the block application time was found to be statistically significantly shorter in Group SC compared to the others. We think that this is due to the fact that the plexus is more superficial and tightly packed in a sheath in the supraclavicular region, and the number of needle guidance is less in this block (20). In the study of Vazin et al. (15), who compared the three blocks in a similar way, the block application times were found to be similar. In the study of Tran et al. (21), the block application time was found to be longer in the Ax group than in the SC and IC groups, and no difference was found between these two groups.

In our study, IC, SC and Ax groups were found to be similar in terms of onset time of sensory block, onset time of motor block, time to start of surgery and duration of surgery. Sufficient motor and sensory block was observed at the end of 30 minutes in all groups. Similarly, in a randomized controlled study conducted by Dhir et al. (22), SC and IC blocks were compared and no significant difference

was found between the blocks in terms of sensory block.

In the study of Koscielniak-Nielsen et al. (13) and Abnihaya et al. (23) comparing SC and IC blocks, the sensory block was completed faster in the IC group, and no significant difference was found between the IC and SC groups in terms of motor block. Also, Kyung et al.(24) comparing IC and SC block, no significant difference was found between the blocks in terms of block application time, motor and sensory block, but it was observed that the radial or ulnar nerve block did not fit or remained incomplete in the IC block. Again in this study, complication rates were higher observed in SC block.

In our study, although the Ax block was slightly lower, the success of the block was similar. We think that this slight decrease in Group Ax is due to the distance of the musculocutaneous nerve from other nerves. In the study of Vazin et al. (15) that compared Ax, SC and IC blocks with multiple injection technique, the success of the block was also compared, and the success of the block was found to be more unsuccessful in the Ax group; There was no significant difference between the IC and SC groups. In the same study, while the time to block application and pain associated with the application were similar between the groups, the onset time of block was found to be significantly shorter in the SC group compared to the other groups. They stated that the separation of the radial nerve in the Ax group and the medial cord in the IC group were difficult.

One of the most important causes of unsuccessful peripheral nerve block is the initiation of the operation before the local anesthetic applied completely creates an effective block. This time can be as short as 5 minutes or as long as 30 minutes.

Premature insertion of the needle to test adequacy of anesthesia (pinprick test); may cause the patient to lose confidence in successful anesthesia (25). So that, it is stated that the first tests to evaluate the anesthesia should be done after sufficient time (15-20 minutes) for the local anesthetics to become effective (26).

In order for sufficient block to occur, different times are specified for each intervention method, which are close to each other. It has been reported that it is usually sufficient to wait for 15-20 minutes for local anesthesia to become effective (26). In another study, it was stated that at least 20 minutes should be waited for the maximum effect to occur in major nerve block (27). In our study, sufficient sensory block was achieved in all groups starting from the 20th minute.

Complications such as pneumothorax,

phrenic nerve palsy, Horner's syndrome (stellate ganglion block), vascular injury (hematoma), subarachnoid injection/ dissemination can be observed in upper extremity blocks. When our study was evaluated in terms of complications, no complications other than vascular puncture were observed in the patients and there was no respiratory distress in the first 24 hours follow-up of the patients. Vascular puncture was observed in 3 patients in the SC group and in 5 patients in the Ax group.

The needle tip was noticed on USG and the needle direction was changed without injection, after blood came out with aspiration. However, hematoma did not occur in any of these patients, and no neurological damage was observed in the patient follow-ups. Vascular puncture was not observed in the IC group. Pneumothorax, Horner's syndrome, local anesthetic toxicity, etc. other complications were not seen in any of the patients.

In our study, additional analgesics were needed in 12 patients in Group Ax, 8 patients in Group SC, and 7 patients in Group IC; however, general anesthesia was applied in only 2 patients in Group Ax because adequate analgesia/anesthesia did not occur in the operation area. The success rate in Group Ax was 93.3%, which was similar to other studies in the literature (21).

Most of the patients stated that they were satisfied with the anesthesia method applied when their postoperative satisfaction was questioned. There was no statistically significant difference between the three groups in terms of complications that developed during and after the block, and patient and surgeon satisfaction. Similar to our study, patient satisfaction was found to be similar between the groups in Vorobeichik et al.'s study (28) and Yang et al.'s study (29) comparing IC and SC blocks.

**The limitations of this study**

1. Sample Size and Diversity: The number of patients included in the study (91) is limited, and results obtained from studies with larger sample sizes may be more generalizable. Additionally, the exclusion of patients from different hospitals or with varying demographic characteristics may restrict the generalizability of the results.

2. Single-Center Nature: The study was conducted in a single medical center (Pamukkale University Faculty of Medicine Hospital). This can limit the applicability of the methods and results when compared with studies conducted in different medical centers.

We believe that more multicenter studies would be beneficial to improve our results.

## Conclusion

It was determined that all three brachial plexus block techniques could be used in cases requiring upper extremity surgery. It was concluded that the application of the block type that is suitable for the patient and experienced by the operator, accompanied by ultrasound and nerve stimulator, will increase the success of the block and decrease the complication rate.

## References


1. Brown AR, Weiss R, Greenberg C, Flatow EL, Bigliani LU. Interscalene block for shoulder arthroscopy: comparison with general anesthesia. Arthroscopy 1993; 9(3): 295-300.
2. Heath P, Brownlie G, Herrick M. Latency of brachial plexus block The effect on onset time of warming local anaesthetic solutions. Anaesthesia 1990; 45(4): 297-301.
3. Mirza F, Brown AR. Ultrasound-guided regional anesthesia for procedures of the upper extremity. Anesthesiol Res and Practic Volume 2011; 2011: 2-5
4. O'donnell BD, Ryan H, O'sullivan O, Iohom G. Ultrasound-guided axillary brachial plexus block with 20 milliliters local anesthetic mixture versus general anesthesia for upper limb trauma surgery: an observer-blinded, prospective, randomized, controlled trial. Anesth Analg 2009; 109(1): 279-283.
5. Klaastad Ø, Sauter AR, Dodgson MS. Brachial plexus block with or without ultrasound guidance. Current Opinion in Anesthesiology 2009; 22(5): 655-660.
6. Kossoff G. Basic physics and imaging characteristics of ultrasound. World J Surgery 2000; 24(2): 134-142.
7. Davis WJ, Lennon RL, Wedel DJ, editors. Brachial plexus anesthesia for outpatient surgical procedures on an upper extremity. Mayo Clin Proc 1991; 66(5): 470-473
8. Horlocker TT. Neurologic complications of neuraxial and peripheral blockade. Can J Anaesth 2001; 48: 72-76.
9. Faiz SHR, Mohseni M, Imani F, Attaee MK, Movassaghi S, Rahimzadeh P. Comparison of Ultrasound-Guided Supra-scapular Plus Axillary Nerve Block with Interscalene Block for Postoperative Pain Management in Arthroscopic Shoulder Surgery; A Double-Blinded Randomized Open-Label Clinical Trial. Anesth Pain Med. 2021; 11(2): e112540.
10. Liu SS, Ngeow J, John RS. Evidence basis for ultrasound-guided block characteristics: onset, quality and duration. Reg Anesth Pain Med 2010; 35(2): 26-35.
11. Eren G, Altun E, Pektas Y, Polat Y, Cetingok H, Demir G, et al. To what extent can local anesthetics be reduced for infraclavicular block with ultrasound guidance? Anaesthesist 2014; 63(10): 760-765.
12. Brown DL, Fink BR. The history of neural blockade and pain management.In: Cousins MJ, Bridenbaugh PO, eds. Neural blockade in clinical aneshesia and management of pain, 3rd ed. Philadelphia: JB Lippincott 1998; 3-21.
13. Wright BD. A new use for the block-aid monitor. Anesthesiology: The Journal of the American Society of Anesthesiologists 1969; 30(2): 236-7.
14. De Andrés J, Sala-Blanch X. Peripheral nerve stimulation in the practice of brachial plexus anesthesia: a review. Reg Anesth Pain Med 2001; 26: 478-483.
15. Vazin M, Jensen K, Kristensen DL, Hjort M, Tanggaard K, Karmakar MK, et al. Low-volume brachial plexus block providing

surgical anesthesia for distal arm surgery comparing supraclavicular, infraclavicular, and axillary approach: a randomized observer blind trial. Biomed Res Int 2016.

16. Winnie AP. Perivascular techniques of brachial plexus block. Elsevier Health Sciences 1984; 1: 121-44.
17. Wright BD. A new use for the block-aid monitor. Anesthesiology: The Journal of the American Society of Anesthesiologists 1969; 30(2): 236-7.
18. Schroeder LE, Horlocker TT, Schroeder DR. The efficacy of axillary block for surgical procedures about the elbow. Anesthesia & Analgesia 1996; 83: 747-51.
19. Urmey WF. Upper extremity blocks. Regional Anesthesia and Analgesia 1996; 266-268.
20. Öztürk E. Santral ve Periferik Sinir Blokları: İnfraklaviküler Blok. Ed. Şahin Ş, Logos 2004: 112-8.
21. Tran DQ, Muñoz L, Zaouter C, Russo G, Finlayson RJ. A prospective, randomized comparison between single-and double-injection, ultrasound-guided supraclavicular brachial plexus block. Reg Anesth Pain Med 2009; 34: 420-424.
22. Dhir S, Brown B, Mack P, Bureau Y, Yu J, Ross D. Infraclavicular and supraclavicular approaches to brachial plexus for ambulatory elbow surgery: A randomized controlled observer-blinded trial. J Clin Anesth 2018; 48: 67-72.
23. Abhinaya RJ, Venkatraman R, Matheswaran P, Sivarajan G. A randomised comparative evaluation of supraclavicular and infraclavicular approaches to brachial plexus block for upper limb surgeries using both ultrasound and nerve stimulator. Indian J Anaesth 2017; 61(7): 581.
24. Park S-K, Lee S-Y, Kim WH, Park H-S, Lim Y-J, Bahk J-H. Comparison of supraclavicular and infraclavicular brachial plexus block: a systemic review of randomized controlled trials. Anesth Analg 2017; 124: 636-644.
25. Winnie AP. Perivascular techniques of brachial plexus block. Elsevier Health Sciences 1984; 1: 121-44.
26. Brown DL, Fink BR. The history of neural blockade and pain management.In: Cousins MJ, Bridenbaugh PO, eds. Neural blockade in clinical aneshesia and management of pain, 3rd ed. Philadelphia: JB Lippincott 1998; 3-21.
27. Howell SM UM, Colson JD, Serafini M. Ultrasonographic evaluation of neck hematoma and block salvage after failed neurostimulation-guided interscalene block. J Clin Anesth 2010; 22: 560-561
28. Vorobeichik L, Brull R, Abdallah F. Evidence basis for using perineural dexmedetomidine to enhance the quality of brachial plexus nerve blocks: a systematic review and meta-analysis of randomized controlled trials. Br J Anesth 2017; 118: 167-181.
29. Jiang J-R, Tsai T-H, Jerng J-S, Yu C-J, Wu H-D, Yang P-C. Ultrasonographic evaluation of liver/spleen movements and extubation outcome. Chest 2004; 126: 179-85.

**Consort Diagram**