Can We Perform Distal Nerve Block Instead of Brachial Plexus Nerve Block Under Ultrasound Guidance for Hand Surgery?

El Cerrahisi Geçirecek Olan Hastalara Ultrason Rehberliğinde Brakiyal Pleksus Bloğu Yerine Distal Sinir Bloğu Uygulanabilir mi?

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ABSTRACT

Objective: Distal nerve blocks are used in the event of unsuccessful blocks as rescue techniques. The primary purpose of this study was to determine the sufficiency for anesthesia of distal nerve block without the need for deep sedation or general anesthesia. The secondary purpose was to compare block performance times, block onset times, and patient and surgeon satisfaction.

Materials and Methods: Patients who underwent hand surgery associated with the innervation area of the radial and median nerves were included in the study. Thirty-four patients who were 18–65 years old and American Society of Anesthesiologists grade I–III and who were scheduled for elective hand surgery under conscious nerve block anesthesia were randomly included in an infraclavicular block group (Group I, n=17) or a radial plus median block group (Group RM, n=17). The block performance time, block onset time, satisfaction of the patient and surgeon, and number of fentanyl administrations were recorded.

Results: The numbers of patients who needed fentanyl administration and conversion to general anesthesia were the same in Group I and Group RM and there was no statistically significant difference ($p>0.05$). The demographics, surgery times, tourniquet times, block perfomance times, and patient and surgeon satisfaction of the groups were similar and there were no statistically significant differences ($p>0.05$). There was a statistically significant difference in block onset times between the groups ($p<0.05$).

Conclusions: Conscious hand surgery can be performed under distal nerve block anesthesia safely and successfully.

Keywords: Distal nerve block, proximal nerve block, radial nerve, median nerve, brachial plexus

ÖZ

Amaç: Distal sinir blokları başarısız proksimal blok uygulamalarında tamamlayıcı blok olarak kullanılmaktadır. Bu çalışmanın primer amacı genel anestezi ve derin sedasyona ihtiyaç olmadan distal sinir bloklarının yeterli anestezi sağlayıp sağlamadığını değerlendirmektir. İkinci amacı ise blok uygulama ve blok gelişme zamanları, hasta ve cerrah memnuniyetlerini karşılaştırmaktır.

Gereç ve Yöntem: 18-65 yaş, ASA I-III, Radial ve median sinir innervasyon alanlarını içeren elektif el cerrahisi geçirecek 34 hasta çalışmaya alındı ve hastalar randomize olarak infraklavikular blok grubu (Grup I, n=17) ve radial + median blok grubuna (Grup RM, n=17) dahil edildi. Blok uygulama ve blok gelişme zamanları ile hasta ve cerrah memnuniyetleri kayıt altına alındı.

Bulgular: Genel anesteziye dönüş ve fentanil ihtiyacı olan hasta sayısı her iki grupta da aynıydı ve istatistiksel bir fark tespit edilmedi ($p>0,05$). Demografik veriler, ortalama cerrahi zamanı, turnike zamanı, blok uygulama zamanı, hasta ve cerrah memnuniyeti açısında gruplar arasında anlamlı bir istatistiksel fark yoktu ($p>0,05$). Blok gelişme zamanlarında ise gruplar arasında istatistiksel olarak anlamlı bir farklılık tespit edildi ($p<0,05$).

Sonuç: Uyanık el cerrahisi distal sinir blokları ile güvenli ve başarılı bir şekilde uygulanabilir.

Anahtar Kelimeler: Distal sinir bloğu, proksimal sinir bloğu, radial sinir, median sinir, brakiyal pleksus

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Introduction

Ultrasound (US)-guided regional anesthesia is a common anesthetic technique for patients undergoing hand surgery [1]. The advent of US, as a noninvasive method, allows the nerves and anatomical structures to be viewed directly. US also has many advantages, of which the avoidance of nerve damage, control of the distribution of local anesthetics, correction of needle position, faster block onset time, improved block qualities, and a reduction in volumes of local anesthetics represent the majority [2]. There are different proximal approaches to peripheral nerve blocks such as axillary, infraclavicular, supraclavicular, and interscalene brachial plexus nerve blocks. Peripheral nerve block of the distal nerves of the brachial plexus, namely, the radial, median, and ulnar nerves, under US guidance has been performed as a rescue block in the

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literature [3, 4]. A few studies have presented distal nerve blocks as a primary anesthetic technique [4, 5]. We hypothesized that hand surgery can be performed under distal peripheral nerve block with US guidance. The aim of this study was to evaluate the sufficiency of US-guided distal peripheral nerve block for hand surgery as a primary anesthetic technique.

Materials and Methods

After obtaining the approval of the local ethics committee (Ataturk University School of Medicine), we included 34 patients who were American Society of Anesthesiologists grades I–III and 18–65 years old and who underwent elective hand surgery involving the innervation area of the radial and median nerves. Informed consent was obtained from patients. The patients were randomly allocated to an infraclavicular block group (Group I, n=17) and a radial plus median block group (Group RM, n=17). The exclusion criteria were hand surgery involving the innervation area of the ulnar nerve, coagulopathy, infection of the injection site, allergy to the local anesthetics used, and patients who requested general anesthesia.

After arrival at the regional anesthesia room, an intravenous (iv) catheter was placed in the side contralateral to the surgical site and all the patients were premedicated with 1–2 mg midazolam through the iv catheter.

The patients who underwent hand surgery involving the innervation area of the radial and median nerves received infraclavicular brachial nerve block (Group I) or radial plus median nerve block (Group RM). The blocks were performed by the same anesthesiology staff member, who is experienced in US-guided peripheral nerve blocks, and a 10–18 MHz linear probe (Esaote MyLab™ 30Gold, Genoa, Italy) was used for the nerve block in both groups.

The patients who were included in Group RM were placed in the supine position and the arm that was to be blocked was abducted and rotated externally. We tried to view the nerves before performing nerve blocks and marked the skin where the radial and median nerves could be viewed clearly at the mid-forearm or above (Figure 1). After identification of the radial and median nerves and disinfection of the puncture site using chlorhexidine, a US probe was dressed with a sterile cover and placed at the marked level of the forearm. At first, a subcutaneous local anesthetic was injected. Secondly, a 22G 50 mm US-visible needle (Stimuplex D Plus, B Braun Medical, Germany) and 5 mL local anesthetic (mixture of 0.5% bupivacaine and 2% lidocaine) were used to block each nerve. The radial nerve is located laterally of the radial artery. However, it is possible to encounter anatomical variations. The US probe was placed on the marked area of skin of the forearm, the needle was inserted and advanced from the lateral to the medial side toward the radial nerve using an in-plane technique, and 5 mL local anesthetic was injected around the radial nerve. In this procedure, we blocked only the superficial sensory branch of the radial nerve. We did not try to block the deep motor branch of the radial nerve. The median nerve block was performed without removing the needle at the same puncture site. When the US probe was moved from the lateral to the medial side, the median nerve was viewed easily, the needle was advanced toward the median nerve, and 5 mL local anesthetic was injected. If necessary, the needle was redirected to view the proper spread of the local anesthetic (Figure 2).

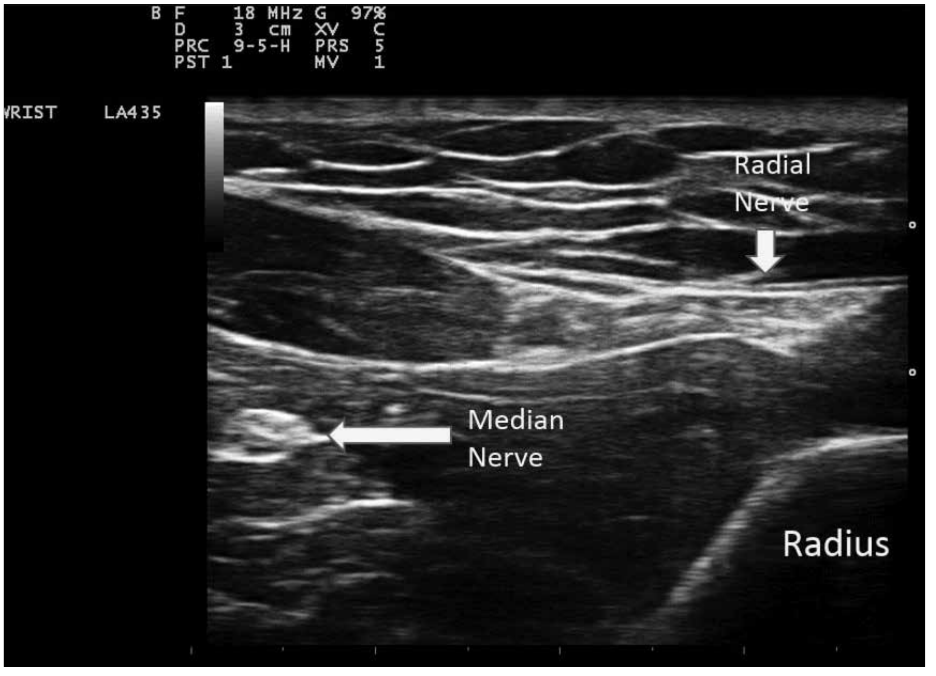

Figure 1. Simultaneous visualization of the radial and median nerves on an ultrasound screen.

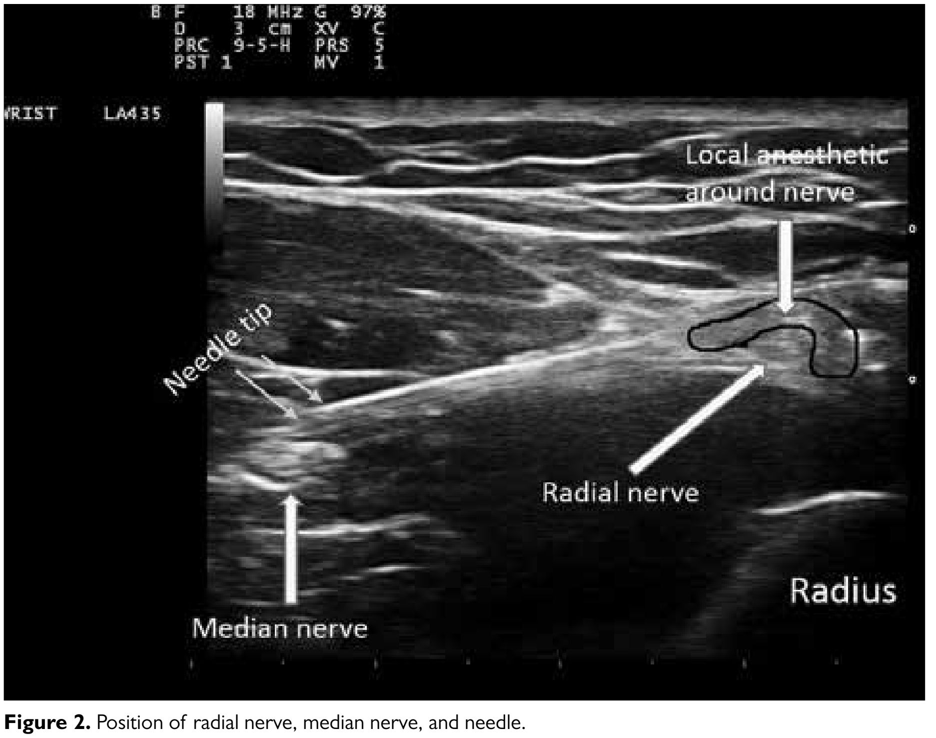

Figure 2. Position of radial nerve, median nerve, and needle.

Figure 3. Esmarch bandage on forearm.

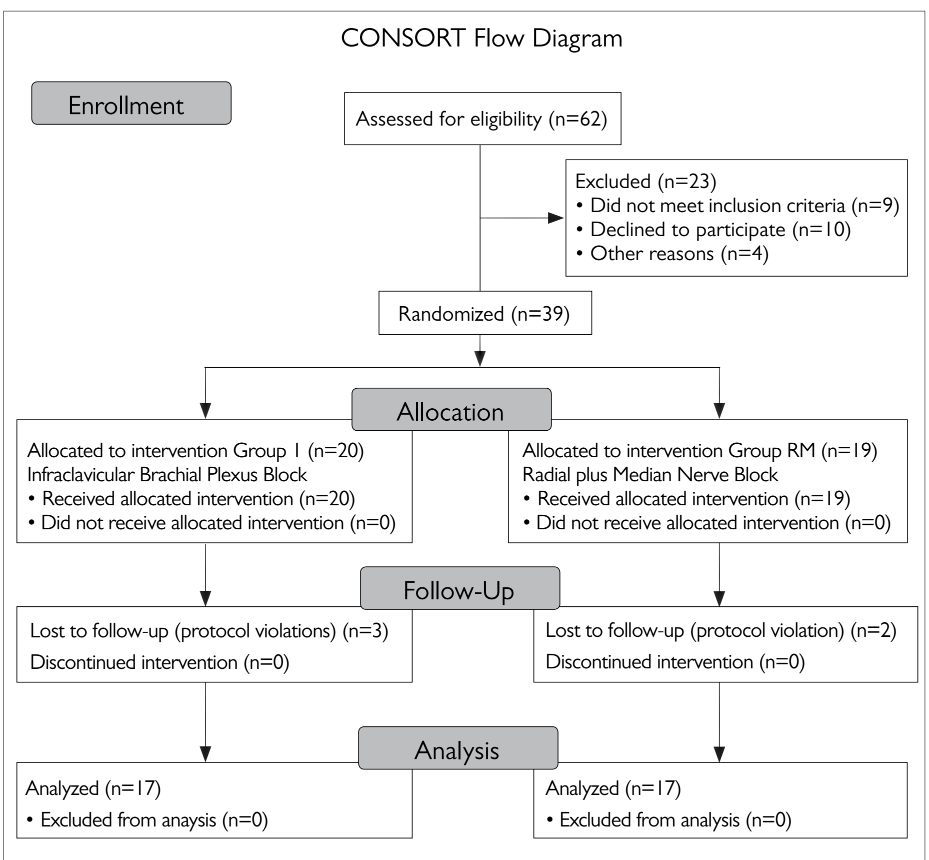

Figure 4. Consolidated Standards of Reporting Trials (CONSORT) flow diagram of patient distribution.

The patients who were included in Group I were placed in the supine position and the head of the patient was turned toward the side opposite to the operation site. We tried to view the brachial plexus cord around the axillary artery before performing brachial plexus block. After disinfection of the puncture site using chlorhexidine, a linear US probe was dressed with a sterile cover and placed in a sagittal plane. Following subcutaneous infiltration of local anesthetic, a 22G 80 mm US-visible block needle (Stimuplex D Plus, B Braun Medical, Germany) was placed between the posterior cord and the axillary artery, 20 mL local anesthetic (mixture of 0.5% bupivacaine and 2% lidocaine) was administered, and the U-shaped spread of the local anesthetic around the axillary artery was viewed under US guidance.

The block performance time was defined as the time interval between the insertion and removal of the needle in both groups. Motor and sensory blocks were assessed every 5 minutes for 30 minutes, whereupon the block needle was removed from the patient. Sensory block was determined via the sensation of cold (0–lack of sensation of cold, 1–decreased sensation of cold, 2–unaltered sensation of cold) in comparison with the contralateral side (6). Surgical anesthesia was considered to be adequate if the cold sensation score was 0 (lack of sensation of cold). If the patient felt pain at the beginning of surgery in Group I, a rescue distal nerve block or general anesthesia was performed and the patient was excluded from the study. In Group RM, brachial plexus nerve block or general anesthesia was performed and the patient was excluded from the study.

An Esmarch bandage was applied to the forearm in all surgical procedures to avoid tourniquet pain, as shown in Figure 3.

Patient and surgeon satisfaction was recorded on a numerical scale. The grades of this scale were defined as Grade 5=perfect, Grade 4=good, Grade 3=acceptable, Grade 2=poor, and Grade 1=unsuccessful.

Statistical analysis

IBM Statistical Package for the Social Sciences 20.0 (SPSS Inc.; Chicago, IBM Corp; Armonk, NY, USA) software was used to perform statistical analysis. The distribution of the variables was assessed for normality using the Kolmogorov–Smirnov test. Descriptive statistics were expressed as the mean±standard deviation (SD). Categorical variables were analyzed using Fisher's exact test or the chi-square test. Normally distributed data comprising continuous variables were analyzed

Table 1. Demographic data

	Group I n=17	Group RM n=17	p
Age (years)	33.53±9.70	33.35±10.54	0.96[a]
Weight (kg)	71.70±10.89	74.41±11.26	0.48[a]
Height (cm)	166.11±8.26	168.88±9.25	0.36[a]
Gender (M/F)	9/8	10/7	0.73[b]

Group I: infraclavicular brachial plexus block group; Group RM: radial plus median nerve block group. Values are expressed as the mean±SD.
[a]p>0.05, Student's t-test; [b]p>0.05, chi-square test
n: number of patients; M: male; F: female

Table 2. Details of operations and anesthesia-related data

	Group I n=17	Group RM n=17	p
Duration of surgery (min)	35.06±9.70	38.58±8.43	0.18[a]
Duration of tourniquet (min)	18.76±3.99	19.58±5.72	0.63[a]
Block performance time (sec)	107.53±32.78	111.58±32.41	0.72[a]
Block onset time (min)	9.58±1.91	7.71±1.21	0.002*
Fentanyl administration (n)	3	3	0.67[b]
Satisfaction of patient (n/NS)	15/5, 2/4	13/5, 4/4	0.32[b]
Satisfaction of surgeon (n/NS)	16/5, 1/4	15/5, 2/4	0.50[b]

Group I: Infraclavicular brachial plexus block group; Group RM: Radial plus median nerve block group. Values are expressed as the mean±SD.
[a]p>0.05, Student's t-test; *p=0.002, Student's t-test; [b]p>0.05, Fisher's exact test
n: number of patients
NS: numerical scale; Grade 5=perfect; Grade 4=good; Grade 3=acceptable; Grade 2=poor; Grade 1=unsuccessful

Table 3. Surgical procedures

	Group I n=17	Group RM n=17
First finger fracture (ORIF)	2	3
Thumb fracture (ORIF)	1	1
Ganglion cyst excision	2	1
Lipoma excision	3	2
Trigger finger	4	5
Hand incision	2	2
Hand tendon repair	1	1
Finger mass excision	1	1
Finger amputation	1	0
Digit incision with tendon repair	0	1

Group I: infraclavicular brachial plexus block group; Group RM: radial plus median nerve block group. Values are expressed as the number of surgical procedures.
n: number of patients

using Student's t-test. A value of p<0.05 was considered to be statistically significant.

According to Lenth's Piface Java module, we determined that the number of patients required in each group was 17 on the basis of a power of 80% and an alpha error of 0.05 with a 15% difference in the rate of conversion to general anesthesia.

Results

Thirty-four patients were enrolled in the study, which is presented in a Consolidated Standards of Reporting Trials (CONSORT) flow diagram (Figure 4). The patient demographic data are shown in Table 1, and there were no statistical differences with regard to sex, weight, age, and height between Group I and Group RM. Details of surgery and anesthesia are shown in Table 2. No statistical significance was determined on comparing surgery times, tourniquet times, and block performance times between the two groups (p>0.05). On the other hand, block onset times were significantly shorter in Group RM [7.70±1.21 min] than in Group I [9.58±1.90 min] (p=0.002).

We applied in all surgical procedures an Esmarch bandage on the forearm alone, as shown in Figure 3. A pneumatic tourniquet was not applied, to avoid tourniquet pain. We recorded patients who needed intraoperative analgesia. Fentanyl was administered for intraoperative pain relief, and 3 out of 17 patients needed fentanyl during surgery in both groups. There was no statistically significant difference between the groups, as shown in Table 2 (p>0.05).

The surgical procedures are listed in Table 3. There was no statistically significant difference between Group I and Group RM.

The success of the nerve blocks was assessed using the cold sensation score, as described in the Methods section of this current study. The nerve blocks were successful in all patients in both groups, and there was no conversion to general anesthesia in any patient.

Complications, namely, local anesthetic toxicity, paresthesia, vascular puncture, and pneumothorax, did not occur in either group.

Patient and surgeon satisfaction did not differ between Group I and Group RM (p>0.05). According to the numerical scale described in the Methods section of this manuscript, in Group I 15 patients were graded perfect and 2 patients were graded good and in Group RM 13 patients were graded perfect and 4 patients were graded good (Table 2).

Discussion

Distal peripheral nerve blocks may be applied successfully for hand surgery as proximal brachial plexus blocks. Distal peripheral nerve blocks are applied to supplement an insufficient brachial plexus block (7) or an anesthetic technique for minor hand surgery [1, 8]. We have listed our surgical procedures in Table 3. Our surgery team performed surgical procedures of different types under distal peripheral nerve block, even in cases of bone fracture. Fracture cases comprised 23.5% of all surgical procedures in Group RM and 17.6% of all surgical procedures in Group I. The surgery took place under conscious block anesthesia and there was no conversion to general anesthesia in either group. The numbers of patients who needed fentanyl were the same and there were no statistically significant differences between the groups. With regard to our results, distal peripheral nerve block may be performed even for major hand surgery such as fractures.

In the current study, motor block was seen in all patients in Group I, whereas there was no motor block in Group RM. Patients did not complain of a lack of motor function apart from one patient in Group I. When we reviewed this patient's history, this was the second surgical procedure for the same reason (hand tendon repair) in our hospital and the first procedure had been performed under radial plus median nerve block. We think that patient satisfaction with motor function is dependent on the nerve block anesthesia that the patient has experienced before. When we reviewed the literature, we found different results about patient satisfaction. Frederickson et al. [9]. did not find a difference in patient satisfaction, whereas Lam et al. [1] found a statistically significant difference in their study. The maintenance of motor function is an important advantage of distal nerve blocks because of the need to protect the arm operated on from inadvertent injury [10].

Selective nerve blockade of distal nerves of the brachial plexus reduces motor block and the risk of unnecessary nerve injury [5]. Many hand surgeries are not associated with the innervation area of three nerves (radial, median, and ulnar). We included in our study only the surgical site associated with the distribution of the radial and median nerves so as to perform only one puncture in Group RM. In our opinion, if the number of punctures increases patient satisfaction can decrease and the risk of complications can increase. Distal peripheral nerve blocks seem an alternative to proximal brachial nerve blocks because of these considerations.

We perform ulnar alone, ulnar plus median, and median plus radial nerve blocks in our clinic. Our surgical team is familiar with hand surgery under distal peripheral nerve block. We selected only radial plus median nerve block to achieve standardization in this study, although there are studies on different kinds of distal nerve block in the literature. Whereas Soberon et al. performed radial, ulnar, and median nerve blocks, Lam et al. [1] blocked the ulnar and median nerves in their study (5).

According to the method of this current study, we examined the nerves with US before performing the nerve blocks. Our performance time for nerve block was similar in both groups. However, we could not record the time of total anesthesia preparation. In some studies, the performance time was shorter in the proximal group than in the distal group, whereas there was no statistically significant difference in the study carried out by Soberon et al. [1, 5, 11]. We consider that the identification of nerves by US before the nerve block procedure shortens the performance time.

Local anesthetic toxicity is an important complication in nerve block applications. In this study, we administered 20 mL of a local anesthetic mixture (1:1 lidocaine/bupivacaine) for infraclavicular block, 5 mL of 1:1 lidocaine/bupivacaine for radial nerve block, and 5 mL of 1:1 lidocaine/bupivacaine for median nerve block. The total amount of local anesthetic was 10 mL in Group RM. In the study performed by Soberon et al. [5], the average volume of local anesthetic was 15.5 mL in the forearm block group and 29.9 mL in the supraclavicular block group, with various combinations of local anesthetic. In addition, in the study conducted by Lam et al. [1], the volume of local anesthetic was 10 mL for selective nerve block (5 mL for the ulnar and 5 mL for the median nerve) and 15 mL for supraclavicular block. The avoidance of local anesthetic toxicity after nerve block is an important benefit, and the volume of local anesthetic in the proximal block group is greater than that in the distal peripheral nerve block group, according to these studies. Therefore, the risk of local anesthetic toxicity could be higher in the proximal block group because of the large volume of local anesthetic.

Some important complications of brachial plexus block are pneumothorax, arterial puncture, hematoma, and Horner's syndrome [12]. We observed no complications in Group I in our study, and no complications occurred in Group RM either. There is no risk of major complications such as pneumothorax and Horner's syndrome with distal peripheral nerve block. We consider that the low risk of the occurrence of complications is an important advantage of distal nerve block of the brachial plexus.

A limitation of this current study was that patients who had surgery associated with the innervation area of the radial and median nerves were included in the study. The aim was to perform only one puncture in Group RM, as was carried out in Group I. In the case of surgical procedures that involve the innervation area of three or more nerves in the arm, forearm, or hand, peripheral nerve block can be an uncomfortable technique because of an increase in the number of punctures. Moreover, in our study, the total time of the nerve block procedure was not documented in either group. Only the performance time was documented, as described in the Methods section. The total time of the anesthesia procedure can be documented in further studies to determine the exact time of the procedure. Finally, the volume of local anesthetic was different in both groups and the durations of sensory block and postoperative pain were not determined. The volume of local anesthetic can be standardized, and the time to first postoperative usage of analgesics and the duration of sensory block can be measured and documented in further studies.

Conclusion

Distal peripheral nerve block could be a simple, effective, and safe technique as a primary anesthetic technique for patients undergoing hand surgery.

Ethics Committee Approval: Ethics committee approval was received for this study from Ataturk University School of Medicine.

Informed Consent: Informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - I.I.; Design- I.I., M.A.; Supervision - M.C.; Materials - M.A.; Data Collection - I.I.; Analysis- I.I.; Literature Review - I.I., M.C.; Writing - I.I.

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