Original Article

Median ulnar nerve selective blockage versus brachial plexus blockage in carpal tunnel release surgery

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Abstract

Aim: This study aimed to evaluate the feasibility of median ulnar nerve selective blockage vs. brachial plexus blockage in day procedures such as carpal tunnel release surgery. We hypothesized that selective median and ulnar blockage is a feasible classic axillary approach.

Material and Methods: This randomized, controlled, double-blind, single-center study included 60 patients. Patients were randomly allocated to two groups; namely, the plexus blockage group (control) and selective group. Patients in the plexus blockage group were administered with 15 ml of local anesthetic for axillary plexus, and in the selective group, 2.5 ml of local anesthetic was applied under USG guidance. We evaluated of full sensory and motor block.

Results: The onset of motor block time was observed to be longer and recovery time was shorter in the selective group than in the plexus blockage group (P<0.05).

Conclusion: Selective nerve block has been shown to be more advantageous than the classic axillary approach of brachial plexus block for day procedures such as carpal tunnel release surgery.

Keywords: Carpal tunnel syndrome; brachial plexus blockage; ultrasonography; ulnar nerve block; median nerve block

INTRODUCTION

Carpal tunnel syndrome (CTS) is a pathological condition caused by median nerve compression in the carpal tunnel of the wrist. As the most common peripheral nerve entrapment syndrome, CTS often occurs in middle-aged women, with a female-to-male ratio of 2.07. CTS treatment consists of surgical release, which is applied in the majority of cases, and nonsurgical methods. Usually, patients with mild and acute symptoms and who are not allowed or unwilling to undergo hand surgery choose conservative interventions, such as splinting, steroids, activity modification, nonsteroidal anti-inflammatory drugs, diuretics, vitamin B6 supplementation, and ultrasonography (USG), among others. Nevertheless, only splinting and steroid approaches are supported by high-quality evidence (1,2). Surgical treatment is proven to be effective for patients with invalid conservative treatment or moderate to severe symptoms (1,2).

In the surgical routine required for hand operation, blockage of the median nerve in the axillary plexus is obtained. As ambulatory surgery is becoming widespread worldwide, general anesthesia and brachial plexus blockage have been studied in this setting, and it was found that brachial plexus blockage led to earlier patient discharge (3). In recent years, the use of USG has become widespread in peripheral nerve blocks (4). As a result of USG use, blockage success has increased, the time to onset of surgery has shortened, complication rates have decreased, and the volume of local anesthetic use has decreased. With an axillary approach in brachial plexus blockage, radial, ulnar, and median nerve blockage is applied, but blockage of the median nerve only in this region is not possible (4-6).

We hypothesized that selective median and ulnar blockage is a feasible classic axillary approach and, when applied as surgical anesthesia, could have advantages in day procedures such as carpal tunnel release surgery. This study aimed to evaluate the feasibility of median ulnar nerve selective blockage vs. brachial plexus blockage in day procedures such as carpal tunnel release surgery.

MATERIAL and METHODS

Design and study population

This randomized, controlled, double-blind, single-center study included 60 patients aged 18-65 years, with American Society of Anesthesiologists (ASA) I-II risk, who underwent carpal tunnel release surgery. Approval for the study was granted by the local ethics committee (Study Trial Number; E-15-626), and informed consent was obtained from all patients. The research protocol was performed according the ethical principles of the Declaration of Helsinki.

The exclusion criteria were as follows: ASA III, IV, or V risk ; presence of severe cardiac, respiratory, hepatic, or renal disorders; impaired mental status; coagulopathy; pregnancy; allergy to local anesthetics; neurological or neuromuscular disease; infection or scar in the application area; or unwillingness of the patient to participate in the study.

The primary outcome of the study was the evaluations of full sensory block; in other words, the time to onset of surgical anesthesia and full motor block. The secondary outcomes were the evaluations of postoperative analgesia, operating time, time to recovery of motor block, time to recovery of sensory time, to first requirement for additional analgesia, patient satisfaction, surgeon satisfaction, and side effect profile.

Randomization for group allocation was performed using a computer-generated random sequence (http://www.random.org/) to produce a series of sealed envelopes containing allocation instructions. Patients were randomly allocated to groups according to the order of presentation as the plexus blockage group (control) and selective group. Patients in the plexus blockage group were administered with 15 ml of local anesthetic for axillary plexus blockage under USG guidance. In the selective group, selective median and ulnar nerve blockage was applied under USG guidance with 2.5 ml of local anesthetic applied to the median nerve and 2.5 ml to the ulnar nerve.

The application area was prepared by the appropriate sepsis-antisepsis preparation before the procedure. Using a 6-12 MHz linear ultrasound probe (LOGIQ, General Electric, USA), the axillary artery was identified in the axillary fossa. In the plexus blockage group, the ulnar, radial, and median nerves were visualized around the artery. Blockage was applied by injecting local anesthetic to the plexus using a 5-cm peripheral nerve block needle. In the selective group, only the median and ulnar nerves were visualized on USG, and local anesthetic was administered. To relieve tourniquet pain, blockage was applied to the musculocutaneous nerve between the biceps and coracobrachialis muscles with 2 ml of local anesthetic, as standard in all patients.

Blockage was evaluated by a researcher blinded to the group allocation. Sensorial block was evaluated with touch sensation of a finger along the course of the median nerve, by performing a cold test, and by comparison with the contralateral arm using the three-point sensation scale: 0 = no block, 1 = reduced sensation compared to contralateral side, and 2 = full sensorial block (no feeling of touch). For motor blockage, a three-point scale was used: 0 = no block, 1 = partial block and 2 = full block. Median nerve blockage was evaluated with loss of thumb adduction. Evaluations were made every 5 min for a total of 45 min. Patients determined to have block failure within 45 min were administered balance laryngeal mask airway anesthesia.

Block application

In the operating room, routine anesthesia monitoring was applied to all patients, including non-invasive blood pressure monitoring, electrocardiography, and pulse oximetry. Patients were positioned supine with the arm and forearm in 90° abduction. The skin and probe were prepared according to asepsis and antisepsis conditions. A linear USG probe 6-12 MHz linear ultrasound probe (LOGIQ, General Electric, USA) was placed transversely on the pectoralis major muscle to visualize the brachial plexus. Image quality was adjusted to be in a focus range of 1 cm within a depth of 2 cm. On visualization of the axillary artery and the median (superficial and lateral to the artery), ulnar (superficial and medial to the artery), and radial (superficial and medial to the artery) nerves around the artery, the block procedure was started. A 5-cm needle (21 G, Locoplex, Ecouen, France) was introduced parallel to the long axis from the lateral edge of the transducer. The needle was first directed to apply musculocutaneous nerve blockage and blockage to the skin and subcutaneous tissue together: blockage was applied in the plexus blockage group by directing the needle to each target nerve in the plexus and in the selective group by directing the needle to the median nerve only. A total of 5 ml of local anesthetic was used for the musculocutaneous nerve, skin, and subcutaneous tissues. To avoid intravascular placement, an aspiration test was performed for each 0.5 ml of local anesthetic given, and to avoid placement in the nerve sheath, the injector pressure test was applied. Blood aspiration and high pressure were recorded as complications (7,8).

Anesthesia application time

The anesthesia application time was measured starting from the block needle touching the skin and finishing with the local anesthetic injection. The onset of motor and sensory block was considered as the moment at which the nerve score was reduced from 2 to 1 for each nerve according to the three-point scale test, and the time of block termination as the moment at which the score was 0 for each nerve. Patients were evaluated with respect to pain in the postoperative period using the visual analogue scale (VAS) of 0−10 on a 10-cm ruler. The time to requirement for first additional analgesia was considered to be the time when a VAS score >4 was recorded. Patient satisfaction and surgeon satisfaction were evaluated as very good, good, fair, or poor.

Statistical Analysis

Values are presented as mean and standard deviation. IBM SPSS 25.0 (Copyright IBM Corporation and its licensors 1989, 2017) .statistical pocket program was used for statistical analysis. Categorical data were analyzed using the Pearson correlation coefficient, Yates correction, Chi-square test, or Fisher exact test, as appropriate. Normality of data distribution was determined using the Shapiro-Wilk test and Kolmogorov-Smirnov test. The independent samples t test was used to compare groups. For the primary outcome, $P < 0.05$ was considered statistically significant.

Assuming a similar effect size, 80% power, and α = 0.05 using a two-sample test of proportions, we estimated that 30 subjects per group would be required. G∗Power analysis was made using 3.1.9.2 (Franz Faul, Universitat Kiel, Germany) statistical pocket programme and power (1-β) =0.86.

RESULTS

This study included 60 patients and distributed to the selective and plexus blockage (control) groups.

No difference in age, height, weight, or body mass index was found between the groups (P>0.05) (Table 1). No sex difference was found between the groups (P>0.05) (Table 1). A statistically significant difference in the duration of procedure was found between the groups (P<0.05). The procedure was determined to be longer in the selective ulnar + median group (Table 1). A difference was found between the groups with respect to surgeon satisfaction (P<0.05) (Table 1). Surgeon satisfaction was better in the selective group. No difference in patient satisfaction was found between the groups (P>0.05) (Table 1).

When the surgical anesthesia status was evaluated with sensory examination of the median, radial, and ulnar nerves, no difference was seen in the median and ulnar nerves of the selective and plexus blockage groups, and less blockage was determined in the radial nerve of the selective group than in the plexus blockage group (P<0.05) (Table 1)

When the surgical anesthesia status was evaluated with motor examination of the median, radial, and ulnar nerves, a difference was seen in the median, radial, and ulnar nerves of the selective and plexus blockage groups, and less blockage was determined in the selective group than in the plexus blockage group (P<0.05) (Table 1).

No significant difference in block success was noted between the groups (P>0.05) (Table 1). No difference in the need for additional anesthesia was observed between the groups (P>0.05) (Table 1).

In the selective group, 14 cases had no motor block of the ulnar and radial nerves, of which 4 (28%) were unsuccessful. No motor block was determined in the median nerve in 9 cases, of which 3 (33%) were unsuccessful.

The selective group was found to have an earlier need for first analgesia than the plexus blockage group (P>0.05) (Table 1). The recovery of motor and sensory blocks was seen to be earlier in the selective group than in the plexus blockage group (P<0.05).

No difference in the time to onset of sensory block was found between the groups (P>0.05). The time to onset of motor block was observed to be longer in the selective group than in the plexus blockage group (P<0.05).

DISCUSSION

According to the study hypothesis, selective median and ulnar blockage is a feasible classic axillary approach and, when applied as surgical anesthesia, could have advantages in day procedures such as carpal tunnel release surgery. In this study, successful surgical anesthesia was provided to a total of 60 patients in the selective and plexus blockage groups. Both of them can be useful for surgery; motor-sensory block was reversed quickly in the selective group; and our hypothesis is true for ambulatory surgery and carpal tunnel release surgery.

One of the basic differences in the results of this study was the evaluation of motor function. Motor blockage occurred at a lower rate in the selective median and ulnar nerve group. Alternatively, there was earlier regression in these groups. Several studies reported that the formation of a long-term motor blockage was a disadvantage, and this was seen in the classic axillary approach group (9).

In addition to the known results of the classic axillary approach, safe and effective surgical anesthesia was provided with extremely low doses of local anesthetic in selective median and ulnar nerve blockage, and a long pain-free period was recorded postoperatively. There may be some advantages of selective median and ulnar nerve blockage compared to the classic approach. Injection of local anesthetic around the ulnar, median, and radial nerves at the level of the forearm (forearm block) is a safe and effective technique to achieve anesthesia or analgesia of the hand (7,8,10,11). This approach to perineural blockade has been associated with a lower incidence of upper extremity weakness compared to proximal brachial plexus blocks (7,10,11). The ideal regional anesthetic technique provides dense intraoperative anesthesia, postoperative analgesia, and minimisation of motor block. Dufeu et al. combined a short-acting brachial plexus block with single-injection forearm blocks using a long-lasting local anesthetic in a series of patients undergoing hand surgery (11). In their case series, the blocks were limited in duration (<12 hours), and a substantial proportion of patients reported suboptimal pain control. As seen in the present study, despite the later onset and low local anesthetic volume, the desired duration of surgical anesthesia was provided, and there was early return of extremity functions, thereby allowing early examination and movement. In the classic approach, the forearm and hand cannot be used for a long period.

As the number of ambulatory surgeries and health care expenses continue to increase, it is important to use

Table 1. Statistical results of the patients				
		Selective (S) (n=30)	Control (PB) (n=30)	P
Age (year) (mean ± SD)		42.10 ± 14.55	41.37 ± 14.13	0.843*
Length (cm) (mean ± SD)		168.53 ± 9.93	170.17 ± 9.57	0.488*
Weight (kg) (mean ± SD)		73.43 ± 11.96	76.3 ± 10.3	0.321*
Body mass index (kg/m2) (mean ± SD)		25.86 ± 3.69	26.4 ± 3.11	0.544*
Sex, n (%)				
Female		10 (33.3)	11 (36.7)	0.787**
Male		20 (66.7)	19 (63.3)	
Duration was measured in minutes (mean ± SD)		151.4 ± 50.56	123.9 ± 20.2	0.008*
Surgeon satisfaction, n (%)				
Middle		3 (10.0)	2 (6.7)	
Good		4 (13.3)	13 (43.3)	0.036**
Very good		23 (76.7)	15 (50.0)	
Patient satisfaction, n (%)				
Middle		5 (16.7)	3 (10.0)	
Good		14 (46.7)	12 (40.0)	0.530**
Very good		11 (36.7)	15 (50.0)	
Surgical anesthesia status in the sensory examination, n (%)				
Median	no	2 (6.7)	0 (0.0)	0.472**
	yes	28 (93.3)	30 (100.0)	
Radial	no	13 (43.3)	0 (0.0)	<0.001**
	yes	17 (56.7)	30 (100.0)	
Ulnar	no	5 (16.7)	0 (0.0)	0.052**
		25 (83.3)	30 (100.0)	
Surgical anesthesia status in the motor examination, n (%)				
Median	no	9 (30.0)	0 (0.0)	0.002**
	yes	21 (70.0)	30 (100)	
Radial	no	14 (46.7)	0 (0.0)	<0.001**
	yes	16 (53.3)	30 (100)	
Ulnar	no	14 (46.7)	0 (0.0)	<0.001**
		16 (53.3)	30 (100)	
Block success, n (%)				
Good		26 (86.7)	30 (100.0)	0.112**
Not good		4 (13.3)	0 (0.0)	
Additional anesthesia, n(%)				
None		25 (83.3)	28 (93.3)	
Sedoanalgesia		1 (3.3)	0 (0.0)	0.212**
General anesthesia		3 (10.0)	0 (0.0)	
Ulnar nerve block		1 (3.3)	2 (6.7)	
The time to the first rescue analgesic (h) (mean ± SD)		10.6 ± 4.3	17.7 ± 5.9	<0.001*
The recovery of block (h) (mean ± SD)				
Sensory block		7.47 ± 2.83	14.60 ± 3.57	<0.001*
Motor block		6.03 ± 2.82	12.17± 3.04	<0.001*
Time to onset of block (min) (mean ± SD)				
Sensory block		37 ± 14.7	23 ± 11.8	<0.001*
Motor block		32 ± 12.6	30 ± 13.6	0.599*
*: Independent Samples t Test, **: Chi-Square Test, Bold: p<0.05				

anesthetic techniques that provide specific characteristics: rapid onset, adequate pain control, minimal postoperative nausea and vomiting, and rapid resolution of systemic effects (to enhance post-anesthesia care efficiency) are desired components of outpatient anesthesia (7,8,11-15). Upper extremity surgery is commonly performed in the ambulatory setting and is associated with moderate to severe postoperative pain. A low rate or short period of motor blockage can reduce the anxiety felt by patients who cannot use the involved extremity. There is also the advantage of early discharge in day procedures such as carpal tunnel release surgery. These all provide advantages for patients where early physiotherapy is planned. In the present study, despite the use of local anesthetic with a longer time to onset, effective surgical anesthesia was provided for a short period, but in cases where a more rapid anesthesia onset is desired, local anesthetics that have earlier onset of effect can be used (7-15). In addition, a lower dose of local anesthetics can be used. Further studies should be conducted on this subject, and the current authors are planning a similar study. However, it must not be forgotten that agents with a short-term effect will only provide a shorter-term analgesia in the postoperative period. Another point requiring attention in this application is that the use of extremely low-dose local anesthetic requires an experienced anesthetist. Moreover, Soberon et al. reported that selective blockage could be used in forearm and hand surgery (7).

The results of the current study demonstrate that effective surgical anesthesia can be provided by obtaining appropriate nerve blocks in procedures such as carpal tunnel release surgery, which is an operation with a limited surgical field. In addition, Soberon et al (7) reported that distal peripheral nerve blocks in the forearm may only be applied to wrist and hand surgery.

Both ultrasound-guided distal peripheral nerve blocks and proximal brachial plexus blocks can be used as the primary anesthetic for outpatient hand surgery, but distal peripheral nerve blocks are superior at preserving motor function of the operative limb and may lead to modest improvements in patient satisfaction (10). The results of the current study demonstrate that effective surgical anesthesia can be provided by obtaining appropriate nerve blocks in procedures such as carpal tunnel release surgery, which is an operation with a limited surgical field. The limitation of this study is that we did not compare distal peripheral nerve blocks and selective nerve block; new studies on this subject are warranted.

CONCLUSION

In light of these results, selective median and ulnar nerve block, which has been shown to be more advantageous than the classic axillary approach of brachial plexus block, can be used in day procedures such as carpal tunnel release surgery. This approach provides effective postoperative analgesia without complications.

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REFERENCES

1. Atroshi I, Gummesson C, Johnsson R et al. Prevalence of carpal tunnel syndrome in a general population. JAMA 1999:282:153−8.

2. Jarvik JG, Comstock BA, Michel K et al. Surgery versus non-surgical therapy for carpal tunnel syndrome: a randomised parallel-group trial. Lancet 2009;374:1074−81.

3. Hadzic A, Arliss J, Kerimoglu B. A comparison of infraclavicular nerve block versus general anesthesia for hand and wrist day case surgeries. Anesthesiology 2004;101:127−32.

4. Marhofer P, Harrop-Griffiths W, Kettner SC et al. Fifteen years of ultrasound guidance in regional anesthesia: Part 1. Br J Anaesth 2010;104:538−46.

5. Avellanet M, Sala-Blanch X, Rodrigo L et al. Permanent upper trunk plexopathy after interscalene brachial plexus block. J Clin Monit Comput 2016;30:51−54.

6. Madison SJ, Humsi J, Loland VJ et al. Ultrasound-guided root/trunk (interscalene) block for hand and forearm anesthesia. Reg Anesth Pain Med 2013;38:226−32.

7. Soberón JR, Bhatt NR, Nossaman B et al. Distal peripheral nerve blockade for patients undergoing hand surgery: a pilot study. Hand (NY) 2015;10:197−204.

8. Liebmann O, Price D, Mills C et al. Feasibility of forearm ultrasonography-guided nerve blocks of the radial, ulnar, and median nerves for hand procedures in the emergency department. Ann Emerg Med 2006;48:558−62.

9. Zhu W, Zhou R, Chen L et al. The ultrasound-guided selective nerve block in the upper   arm: an approach of retaining the motor function in elbow. BMC Anesthesiol 2018;18:143.

10. Lam NCK, Charles M, Mercer D et al. Triple-masked, randomized controlled trial comparing ultrasound-guided brachial plexus and distal peripheral nerve block anesthesia for outpatient hand surgery. Anesthesiol Res Pract 2014;324083.

11. Dufeu N, Marchand-Maillet F, Atchabahian A et al. Efficacy and safety of ultrasound-guided distal blocks for analgesia without motor blockade after ambulatory hand surgery. J Hand Surg Am 2014;39:737–43.

12. Fingerman M. Regional anesthesia for outpatient hand surgery: ultrasound-guided peripheral nerve block march. J Hand Surg 2011;36:3:532–4.

13. Macaire P, Singelyn F, Narchi P et al. Ultrasound- or nerve stimulation-guided wrist blocks for carpal tunnel release: a randomized prospective comparative study. Region Anesth Pain Med 2008;33:363–8.

14. Fredrickson MJ, Wolstencroft PJ, Chinchanwala S et al. Does motor block related to long-acting brachial plexus block cause patient dissatisfaction after minor wrist and hand surgery? A randomized observer-blinded trial. Br J Anesth 2012;109:809–15.

15. Williams B.A, Hackett P.J, Li P et al. Pharmacoeconomics of Regional Anesthesia:Implications in Ambulatory Orthopedic Surgery, Hospital Admission, and Early Rehabilitation. Editor: Admir Hadzic. Hadzic's Textbook of Regional Anesthesia and Acute Pain Management. 2st ed. New York: McGraw-Hill Professional; 2017,1117-38.