ORIGINAL ARTICLE

Comparison of infraclavicular brachial plexus block versus wide-awake local anesthesia no-tourniquet technique in the management of radial shortening osteotomy

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Kienbock's disease is the avascular necrosis of the lunate, which can lead to progressive wrist pain and abnormal carpal motion.[1,2] There are several options for the treatment of Kienbock's disease, including both conservative and surgical options. Surgical options are temporary scaphotrapeziotrapezoidal pinning, joint leveling procedure, radial wedge osteotomy, vascularized bone grafts, distal radius core decompression, partial wrist fusions, proximal row carpectomy, wrist fusion, and total wrist arthroplasty.[3,4] In patients with negative ulnar variance, radial shortening osteotomy markedly reduce the load on the lunate and has proven to be an effective treatment option for Kienbock's disease.[5]

Radial shortening osteotomy can be performed under different anesthesia options, including interscalene regional block, supraclavicular block,

ABSTRACT

Objectives: The aim of this study was to evaluate the feasibility of the wide-awake local anesthesia no-tourniquet (WALANT) technique in radial shortening osteotomy and to compare it with the infraclavicular brachial plexus block (IBPB).

Patients and methods: Between January 2020 and January 2021, a total of 26 patients (16 males, 10 females, mean age: 40±4.9 years; range, 29 to 45 years) with Kienbock's disease who underwent radial shortening osteotomy were retrospectively analyzed. The patients were divided into two groups according to the type of anesthesia as WALANT (Group 1, n=11) and IBPB (Group 2, n=15) anesthesia. Visual Analog Scale (VAS) during surgery, time from anesthesia to surgical incision, surgical time, overall patient satisfaction regarding the anesthesia was assessed. The Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) and handgrip strengths were compared at the final follow-up and short-term outcomes were analyzed.

Results: Age (p=0.896), sex (p=1.000), and dominant side involvement (p=1.000) were similar between the groups. Waiting time to start surgery in both groups was similar (27 *vs*. 25 min; p=0.053). Intraoperative VAS-pain scores and the satisfaction from the anesthesia type of both groups were also similar (p=0.546 and p=0.500).

Conclusion: The WALANT may be another anesthesia technique for radial shortening osteotomy with favorable outcomes. This technique adequately allows the surgeon to perform osteotomy and obtain a stable reduction without undue risk of tourniquet pain and palsy.

Keywords: Kienbock's disease, radial shortening osteotomy, regional block, wide-awake local anesthesia no-tourniquet.

infraclavicular block, axillary block, and Bier's block.[6,7] Recently, the wide-awake local anesthesia no-tourniquet (WALANT) technique has been advocated as a safe and effective anesthetic alternative for various hand surgery procedures. This technique also allows intraoperative examination of repair strength, failure, and gapping during active range of motion.[8-12]

The WALANT technique is a widely accepted and developing technique. It was primarily used in soft tissue surgery, but later it was also used for bone procedures, and many benefits were shown. There is insufficient information about the use of the WALANT technique in the surgical treatment of Kienbock's disease in the literature. In the present study, we describe the management of wrist radial shortening osteotomy under WALANT anesthesia, comparing infraclavicular block results in the patients who underwent radial osteotomy in Kienbock's disease.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Antalya Training and Research Hospital, Department of Orthopedics and Traumatology, Hand Surgery Unit between January 2020 and January 2021. Patients who underwent radial shortening osteotomy were screened. All patients had Stage II to III-B Kienbock's disease with negative ulnar variance. A single hand surgeon performed the radial shortening osteotomy and all surgical procedures, including the WALANT technique. The hand surgeon was a Level III specialist according to Tang's criteria.[13] Patients under anticoagulation medication and who had a history of allergy to local anesthetics were excluded from the study. A total of 26 patients (16 males, 10 females, mean age: 40±4.9 years; range, 29 to 45 years) were included in the study. A written informed consent was obtained from each patient. The study protocol was approved by the Antalya Training and Research Hospital, Ethics Committee (No: 2021-131). The study was conducted in accordance with the principles of the Declaration of Helsinki.

The patients were divided into two groups: those who underwent the WALANT technique (Group 1, n=11) and infraclavicular brachial plexus block (IBPB) (Group 2, n=15). The clinical and demographic data of the patients were obtained from hospital records. Age, sex, side, type of anesthesia, waiting time from the application of anesthesia until the beginning of surgery, surgery time, patient satisfaction for anesthesia were reviewed. All patients were administered the Quick Disabilities of the Arm, Shoulder and Hand (Q-DASH) and Visual Analog Scale (VAS). Grip strength was measured for both hands.

WALANT technique

The benefits and risks of the WALANT technique and all other available options were told to the patients in detail. Patients freely decided on the anesthesia technique. The WALANT was applied in the orthopedic ward before the patient was moved to the operating theater. The orthopedic ward was fully equipped to cope with adverse allergic reactions and possible cardiovascular arrest. A total of 50 mL local anesthetic mixture was prepared that included 25 mL 2% lidocaine (20 mg/mL), 1 mL adrenalin (0.5 mg/mL), 19 mL 0.9% isotonic sodium chloride, and 5 mL of 8.4% sodium bicarbonate. The total dose of lidocaine was adjusted according to the patient's weight, and it was ensured that the maximum dose of lidocaine (7 mg/kg) was not exceeded.[8,9,11,12] After proper washing and skin preparation with povidone-iodine, a 27-gauge needle was used for the injection.

The injection was applied to the one-third distal volar face of the forearm, around the Henry incision, starting from the proximal part to the distal (Figure 1). A total of 20 mg of the solution was injected into the subepidermal region at a 90° angle. After subcutaneous swelling was observed, another 20 mg was injected under the fascia. Ten mg of the solution was injected into the periosteum at the level

FIGURE 1. Local anesthesia injection to the volar surface of the forearm in the WALANT technique.

WALANT: Wide-awake local anesthesia no-tourniquet.

of the radial osteotomy. The radial artery pulse was palpated, and the needle was kept at least 5 mm away from the arterial trace. The anesthesia effect was tested 20 min after the injection. Surgery was started around 20 to 30 min after the injection, when the anesthetic effect was established. All patients waited for the routine fasting period (6 to 8 h fasting) to start the operation due to the elective nature of surgery. All patients were monitored for cardiac rhythm, blood pressure, and oxygen saturation with pulse oximetry. None of the patients required additional analgesia. A total of 1,000 mg of cefazolin was administered intravenously (IV) to all patients before surgery. The VAS scores were measured before surgery.

Infraclavicular brachial plexus nerve block

A senior anesthesiologist performed IBPB under ultrasound guidance in the preoperative care unit. Standard monitoring, including non-invasive blood pressure, electrocardiogram, and pulse oximetry, was applied. Premedication was provided with 0.04 mg/kg IV midazolam. Patients were placed supine, the arm was adducted, and the head was turned to the opposite side. The skin was cleaned with chlorhexidine and anesthetized with 2 to 4 mL of 2% of lidocaine. The probe was covered with a sterile cover. A 10 MHz linear ultrasound probe (Min-dray, Shenzhen, China) with a sterile cover was placed in the sagittal plane, just 1 cm in front of the intersection between the coracoid process and the clavicle. When the cords of the axillary artery vein and brachial plexus were visualized, a 21-gauge 100 mm needle (B. Braun Stimuplex, Melsungen, Germany) was inserted by following per under the in-plane technique. A single dose of 20 mL of 0.5% bupivacaine was infiltrated around the axillary artery between 3 and 11 o'clock in a 'U' shape distribution after hydro-dissection.[6-8]

Surgical procedures and postoperative follow-up

A tourniquet was applied to the proximal humerus after the Esmarch bandage exsanguination to ensure a blood-free surgical field ad hemostasis in Group 2. The incision was marked on the skin. A traditional Henry approach was used to expose the radius. A blunt, flat retractor was placed beneath the posterior cortex of the radius to protect the soft tissues. A 0.7-cm-wide reciprocating saw was used to cut the bone. A 2-mm bone block was removed from the distal radius. The osteotomy cuts were reduced to with anatomic distal volar plate. An anteroposterior and lateral fluoroscopy view of the radius was obtained to ensure proper reduction. The pronator muscle was resutured to its insertion site. The wound was sutured routinely.[14] The intraoperative image

of the patient who performed radial shortening osteotomy under WALANT is presented in Figure 2. Short arm splint was applied to the wrist in neutral, metacarpophalangeal joint in 60° flexion, and interphalangeal joint in full extension. Patients were observed for 2 h for possible side effects of local anesthetics. Their vital signs were recorded for each half-hour. Paracetamol plus codeine was prescribed, and the patients were discharged with postoperative advice on the same day.

Clinical assessments

The patients were followed for at least six months, and clinical assessment was performed at six weeks and six months. According to the American Society of Hand Therapists (ASHT) guidelines, the grip strength of both hands was measured using a hydraulic hand dynamometer. Patient satisfaction with the anesthesia technique was rated between 1 and 5 points. Accordingly, 5 points were very satisfied, 4 points were satisfied, 3 points were neutral, 2 points
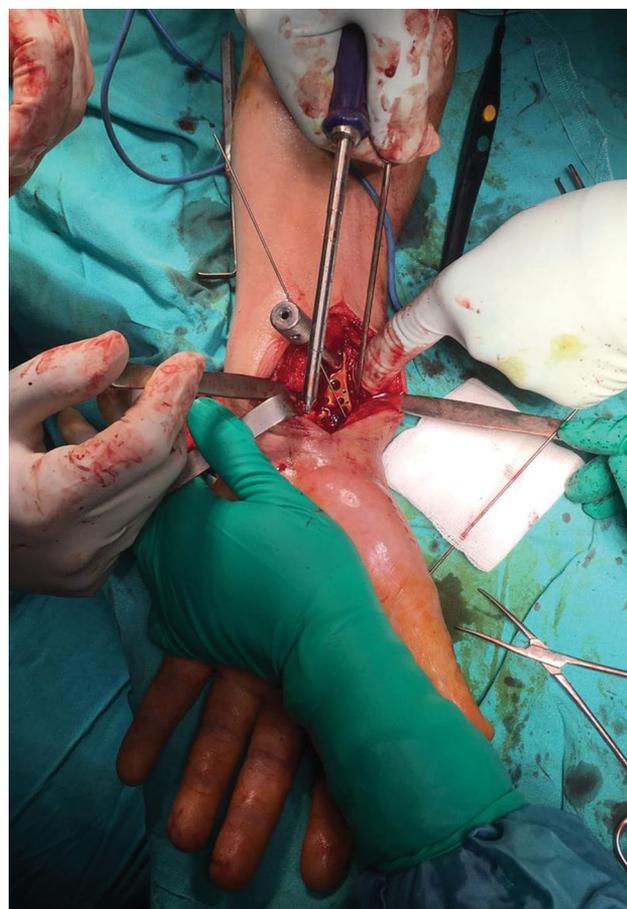
FIGURE 2. The intraoperative image of the patient who underwent radial shortening osteotomy with the WALANT technique.

FIGURE 3. The pre- and postoperative radiographs of the patient. **(a)** preoperative anteroposterior radiography. **(b)** preoperative lateral radiography. **(c)** postoperative anteroposterior radiography. **(d)** preoperative lateral radiography.

were dissatisfied, and 1 point was very dissatisfied. All patients were administered the Q-DASH and VAS. Grip strength was measured for both hands. The pre- and postoperative radiographs of the patient who underwent radial shortening osteotomy under WALANT are presented in Figure 3.

Statistical analysis

Statistical analysis was performed using the IBM SPSS Statistics for Windows version 23.0 software (IBM Corp., Armonk, NY, USA). Continuous variables were expressed in mean ± standard deviation (SD) or median (min-max), while categorical variables were expressed in number and frequency. The chi-square tests were used for the comparison of categorical variables between groups. The conformity of continuous variables to normal distribution was evaluated using visual (histogram and probability graphs) and analytical methods (Shapiro-Wilk tests). Normality analysis revealed that all data

			TABLE I						
	WALANT (n=11)				IBPB (n=15)				
	n	%	Median	Min-Max	n	%	Median	Min-Max	p
Age (year)			38.5	29-44			39	29-45	0.896*
Sex									1.000**
Female	4	36.4			6	40			
Male	7	63.6			9	60			
Side									1.000**
Left	3	27.3			5	33.3			
Right	8	72.7			10	66.7			
Dominant									1.000**
No	4	36.4			5	33.3			
Yes	7	63.6			10	66.7			
Non-union (3rd month)									1.000**
No	10	90.9			14	93.3			
Yes	1	9.1			1	6.7			

WALANT: Wide-awake local anesthesia no-tourniquet; IBPB: infraclavicular brachial plexus block; * Mann-Whitney U test; ** Chi-Square Test.

sets were not distributed in a normal distribution. The Mann-Whitney U test was used for the comparison of data sets that were not normally distributed for the variables. A *p* value of <0.05 was considered statistically significant.

RESULTS

Twenty-six patients, 11 (42.3%) of whom were operated with the WALANT technique and 15 (57.7%) under IBPB, were included in this study. There was no statistically significant difference in the median ages of the two groups (p=0.896). In addition, sex, side, dominant side, and third-month union characteristics are presented in Table I, and there was no statistically significant difference in these variables between the groups. Waiting time for beginning surgery in both groups was similar (p=0.053). In the WALANT group, the median operation duration was 41 (range, 35 to 46) min, while it was 36 (range, 30 to 42) min in the IBPB group (p=0.004). Intraoperative VAS scores of both groups were similar (p=0.546). Figure 4 presents the distribution of patients according to their intraoperative VAS scores. For the VAS scores of the WALANT group, three (27.3%) patients were 0; four (36.4%) patients were 1; three (27.3%) patients were 2; and one (9.1%) patient was 3. For the VAS scores of the IBPB group, five (62.5%) patients were 0; six (40%) patients were 1; and four (26.7%) patients were 2. No significant difference was found in the VAS score distributions of both groups (p=0.691).
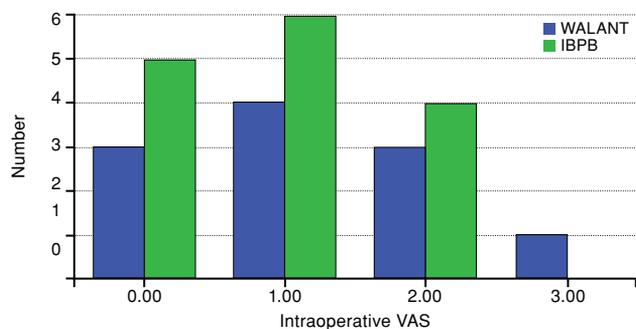
FIGURE 4. Distribution of groups by intraoperative VAS score.
WALANT: Wide-awake local anesthesia no-tourniquet; IBPB: infraclavicular brachial plexus block; VAS: Visual Analog Scale.
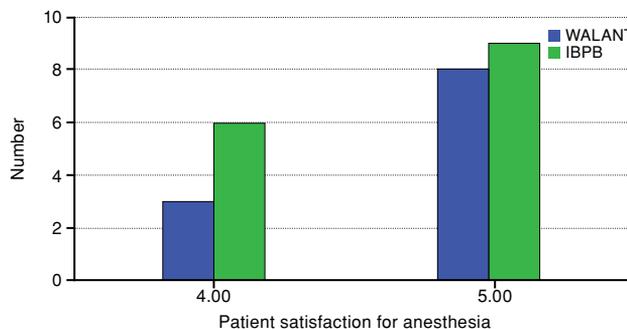
FIGURE 5. Distribution of groups according to anesthesia satisfaction score.
WALANT: Wide-awake local anesthesia no-tourniquet; IBPB: infraclavicular brachial plexus block; VAS: Visual Analog Scale.

| TABLE II					
Clinical and intraoperative characteristics of patients					
	WALANT (n=11)		IBPB (n=15)		
	Median	Min-Max	Median	Min-Max	p
Waiting time for beginning surgery (min)	27	22-33	25	19-28	0.053*
Surgery time (min)	41	35-46	36	30-42	0.004*
Intraoperative VAS	1	0-2	1	0-2	0.546*
Operated side grip strength	28	20-40	31	20-40	0.482*
Healthy side grip strength	34	26-44	35	26-44	0.938*
Patient satisfaction for anesthesia	5	4-5	5	4-5	0.509*
Patient satisfaction surgery	4	2-5	5	4-5	0.009*
Q-DASH 6th month	13.6	4.5-25	159	9.1-227	<0.001*
Postoperative analgesia	350	215-430	490	350-810	<0.001*

WALANT: Wide-awake local anesthesia no-tourniquet; IBPB: Infraclavicular brachial plexus block; VAS: Visual Analog Scale; Q-DASH: Quick Disabilities of the Arm, Shoulder and Hand.

We also observed some advantages and disadvantages related to the WALANT technique. There was slight intramedullary hemorrhage, when the bone cuts were made. Several minutes were lost to obtain a clean surgical field with hematoma aspiration and saline irrigation. We also observed that the sound of the saw during osteotomy caused anxiety in patients. There was no significant difference in anxiety in the IBPB group. When reduction was required by traction, the patient's muscle contractions caused more effort and time to be spent for reduction. Finger movements were also observed by telling the patient to open and bend each finger. The neurovascular examination of the patient could be evaluated in the postoperative follow-up. Finally, bleeding was seen more, as it was performed without a tourniquet and Esmarch bandage application.

When the grip strength levels of the operated and contralateral hands and the anesthesia satisfaction of the patients were compared between the two groups, there was no significant difference (p=0.482, p=0.938, and p=0.509, respectively). The anesthesia satisfaction score of 72.7% (n=8) of patients in the WALANT group and 60% (n=9) of the IBPB group was 5 (p=0.500) (Figure 5). The median surgical satisfaction score was 4 (range, 2 to 5) in the WALANT group and 5 (range, 4 to 5) in the IBPB group, indicating a statistically significant difference (p=0.009). The surgical satisfaction score of 18.2% (n=2) of the patients in the WALANT group and 53.3% (n=8) of the patients in the IBPB group was 5 (p=0.029). The six-month Q-DASH score of the patients in the WALANT group was statistically significantly lower than the IBPB group (p<0.001) (Table II).

DISCUSSION

In the current study, we compared two different regional anesthesia techniques for radial shortening osteotomy. The WALANT technique avoided unnecessary tourniquet pain, the risk of paralysis, the premature start-up time for surgery, the shorter post-operative discharge time for patients, allowing operation without using anesthesia techniques in risky patient groups.[15] The post-surgical functional results were observed to be efficient, the possibility of communicating with the patient during the operation, and the possibility of assessing the patient's neurovascular examination after surgery. These findings showed that the WALANT technique allowed the surgeon to do the osteotomy and to achieve stable reduction. The advantage of using WALANT in osteotomy was the ability to test the stability of the reduction during active voluntary wrist movements and monitor tendon movements for possible entrapment.[3,16] However, some disadvantages were observed during the operation. The potential challenge when reduction under WALANT is the muscle contraction that can make the reduction harder.

In the WALANT technique, patients in the risk group can perform radial osteotomy without using a tourniquet, and it has also been seen to eliminate the risk of paralysis that can develop after the use of a tourniquet. Another advantage of this approach is that it shortens the hospital stay and allows early discharge. The waiting time

for surgery has decreased.[17] It is more difficult for patients to tolerate the technique of WALANT psychologically.[12,18] Patients have excellent compliance when informed about the benefits of this approach. As only regional anesthesia is applied, there is a chance to communicate with the patient during the operation.

In this study, intra- and postoperative neurovascular examinations of patients undergoing surgery with the WALANT technique could be evaluated. Patients who were operated with the WALANT technique were observed to benefit from the vasoconstriction effect of the mixture.[10,11,19] However, the amount of intraoperative bleeding in these techniques is relatively high.[10,20,21]

In the study of Huang et al.[8] using the WALANT technique in distal radius fractures, it was shown that the patients did not have postoperative tourniquet pain and, therefore, the patients were more comfortable. In this study, tourniquet pain in the block group was compared with the WALANT group, and the patients in the WALANT group were more comfortable. Huang et al.[8] observed active hand wrist movements and movement clearance during the operation, as the aforementioned study did not receive patient sedation. In this study, the patient's hand, wrist and tendons movements could be observed after osteotomy.

Arik et al.[18] showed that waiting time for the start of surgery could be sped up in case of emergency hand surgery with the WALANT technique. This study found that elective hand surgery cases could reduce the beginning surgery times without waiting for the anesthesia period. In the case report of Rafiqi et al.,[12] the patient's neurovascular exam could be checked in a healthy way during the operation. This study also showed that more patients who did not have sedation could undergo osteotomy using the WALANT technique. Ki Lee et al.[19] reported that patients' postoperative pain scores were scaled, and the WALANT group had significantly less pain. In the current study, the patients' need for analgesics was less than the block group.

In another study, Abitbol et al.[11] evaluated the postoperative range of motion of patients operated with a volar plate in distal radius fractures using the WALANT technique. Our study showed that the functional scores of the patients who underwent distal radius osteotomy with the WALANT technique were good. Nolan et al.[22] showed that, under the WALANT technique, flexor tendon movements could be evaluated in communication with the patient, and

finger movements could be seen. In this study, finger movements after osteotomy could not be evaluated in the block group, while finger movements were evaluated during surgery in the WALANT group.

The main limitations of this study are as follows: the patients who were operated in a single center by a single surgical team were evaluated; the number of patients in the control group was low; and the postoperative follow-up period was relatively short. In addition, the difference in the amount of bleeding between the two techniques could not be calculated precisely.

In conclusion, Kienbock's disease treatment can be managed without the need for upper extremity block applications. In this study, the WALANT technique seems to be safe and applicable. According to these findings, WALANT is applicable for a distal radius shortening osteotomy. The WALANT is an effective technique with advantages such as evaluating tendon movements and neurovascular examination during the operation, decreasing postoperative pain, patient preparation time, and costs while increasing patient satisfaction.

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