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Outcomes of flexor carpi radialis tendon transfer surgery for patients with radial nerve injury: a comparison of the wide-awake method and general anesthesia

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Abstract

Advanced intraoperative anesthesia techniques have improved patient cooperation, stabilized hemodynamic status, and reduced postoperative pain and disability, especially in reconstructive limb surgeries. The Wide-Awake Local Anesthetic No Tourniquet (WALANT) technique has recently been adopted due to its peculiar advantages, but comparative studies of its benefits and limitations against general anesthesia are not well explored in FCR tendon transfer surgery. This study investigates outcomes of Flexor Carpi Radialis (FCR) tendon transfer surgery in patients with radial nerve injuries using either the Wide-Awake approach or general anesthesia. In this cross-sectional study, we included patients with confirmed radial nerve injuries who underwent FCR tendon transfer from 2019 to 2024. Participants were then divided into two groups; one received the WALANT anesthesia (200 ml epinephrine 1:400000 and 0.25% lidocaine buffered with sodium bicarbonate), while the other received general anesthesia. Data was collected from the medical records and the Hospital Information System (HIS). The intensity of pain, postoperative opioid consumption, wrist and finger function, and levels of patient satisfaction were measured both before and one month after surgery. There was no statistical difference between the groups regarding pain intensity, postoperative opioid dosage, and symptom severity. However, the WALANT group exhibited significantly less motor dysfunction in the postoperative period, which resulted in a much higher level of patient satisfaction compared to general anesthesia. WALANT provides quicker recovery of motor function and results in higher patient satisfaction when compared to general anesthesia for FCR tendon transfer surgeries. This approach thus leads to an earlier return to daily activities and occupational duties, which in turn helps improve overall patient satisfaction post-surgery.

Key Words: wide-awake local anesthetic no tourniquet, general anesthesia, tendon transfer.

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The flexor Carpi Radialis (FCR) tendon is a surgical procedure frequently employed to restore functionality to the hand or wrist, particularly in cases of nerve injury, tendon rupture, or conditions such as cerebral palsy and brachial plexus palsy.[1] This technique involves using the FCR tendon, which is a powerful wrist flexor, to replace or augment the function of a damaged tendon or muscle.[2] Primary indications for FCR tendon transfer include radial nerve palsy aimed at restoring the wrist and finger extension; tendon ruptures, mainly associated with injuries of other wrist extensors, rheumatoid arthritis; and cerebral palsy primarily to improve the function of the hand and also

to correct brachial plexus deformity and injury when paralysis or significant weakness in specific muscles are present.[3-5]

The preoperative assessment is imperative and must include an evaluation of the donor FCR, the recipient tendon or muscle, and a thorough examination of muscular strength and range of motion.[3] Among the most significant advantages of FCR tendon transfer is that it may restore important hand functions such as grasping, wrist flexion, and finger extension, improving quality of life and independence in daily activities.[5] However, the potential complications of this procedure include reduced wrist flexion strength from sacrificing the FCR tendon, infection, wound complications, or failure of the tendon transfer, and the potential for imbalance if other muscles are weak.[6]

The Wide-Awake Local Anesthetic No Tourniquet (WALANT) technique is a surgical intervention applied in hand and wrist operations.[7,8] It uses very localized anesthesia, specifically a combination of lidocaine and epinephrine, in which there is no requirement to include a tourniquet, allowing patients to remain awake and participate during surgery if necessary.[7,8] Therefore, to minimize discomfort with the injection, a buffered solution is often used, like lidocaine with bicarbonate. Some advantages of the technique are improved patient comfort when tourniquet pains are avoided, good surgical outcomes resulting from a possible adjustment of tendon suturing, patient active participation in intraoperative movements, and enhanced cost-effectiveness due to reduction of operating room time and human resources.[7-15] WALANT is particularly suited for outpatient settings, facilitating quicker patient recovery and discharge due to the absence of systemic anesthesia.[12,13] However, it may not be suitable for all patients, especially those with severe anxiety, allergies to local anesthetics or epinephrine, poor vascular health, or circulatory conditions that contraindicate the use of epinephrine.[16,17] Patient selection is very important in ensuring tolerance and cooperation during injections. Pain-minimizing strategies by surgeons include the use of smaller gauge-needles, slow injection, and buffering of local anesthetics with bicarbonate.[18]

Surgeries under WALANT are becoming increasingly popular, mainly for tendon transfers in the hand and distal forearm. This applies to current practices, indicating that tendon repairs and transfer surgery can effectively be done using the WALANT technique, allowing for real-time assessment of tendon functionality during the surgery.[19-21] However, even today, many surgeons assume that general anesthesia is the best way to maintain the hemodynamic stability of a patient, as it gives full control over the patient during the surgery and achieves more satisfaction after surgery. Hence, this study aims to compare the surgical outcome of FCR tendon transfer in patients with radial nerve injuries using WALANT and general anesthesia as stronger methods for determining the best surgical technique.

Materials and Methods

Study design

In the present study, a retrospective cohort study was conducted on patients with a known history of radial nerve injury who were candidates for FCR tendon transfer surgery. The surgeries took place between 2019 and 2024 at Baqiyatallah Hospital.

Eligible participants were those aged 18 years or older who provided informed consent for their inclusion in the study and were deemed to be suitable candidates for FCR tendon transfer surgery. Specific exclusions included: active injuries of other areas of the extremities, hypersensitivity to local anesthetics (such as epinephrine or lidocaine), opioid addiction, and a history of prior interventions on the upper extremity.

According to the study conducted by Davison *et al.*[22], the percentage of narcotic use following surgery was 35% for the Wide-Awake technique and 66% for general anesthesia. The estimated sample size required in each arm was 40, with a confidence level of 0.05 and a study power of 80%.

$$n_1 = n_2 = \frac{(p_1(1-p_1)+p_2(1-p_2))(Z_{1-\frac{\alpha}{2}}+Z_{1-\beta})^2}{(p_1-p_2)^2}$$

P1=0.35, P2=0.66
α=0.05, β=0.20
N1=N2=40

Implementation

Patients were divided into two groups according to the type of surgical approach. The first group underwent surgery under the WALANT technique, which consisted of the administration of 200 milliliters of epinephrine at a dilution of 1:400,000 combined with 0.25% lidocaine buffered with sodium bicarbonate. The second group received general anesthesia. All patient information, including background characteristics, was collected through a comprehensive review of archived patient records and the Hospital Information System (HIS). Pain intensity was measured using the Visual Analogue Scale (VAS), both before the procedure and one month after the surgery. The opioid dosage prescribed within the first 24 hours after surgery was also recorded for both groups. In addition, functional results of the wrist and fingers were measured by physical examination and the Carpal Tunnel Questionnaire (CTQ) in both groups. Patient satisfaction after the procedure was also measured in both groups.

Statistical analysis

Quantitative variables are presented as mean±SD, while categorical qualitative variables are presented as percentages. For comparing quantitative variables, the t-test was used, while chi-square tests were applied for comparing qualitative variables. The level of significance was considered at $p < 0.05$. All analyses were done using SPSS version 23.

Results

Background characteristics of the study patients

The current study analyzed 80 patients, divided into two groups: one undergoing surgery via the WALANT technique and the other under general anesthesia, each consist-

ing of 40 patients. The background characteristics of the study population are summarized in Table 1. Regarding gender distribution, 50% of the patients in the Wide-Awake group and 45% in the general anesthesia group were male, while the remaining 50% and 55%, respectively, were female; there was no statistically significant difference in terms of gender distribution between the two groups (P=0.654). Educational level distribution is found to be as follows: both groups exhibited similar patterns, with 5% being illiterate, 35% and 32.5% having primary and secondary education, 42.5% and 37.5% holding a high school diploma, and 17.5% and 25% having higher education; no significant difference was observed between groups' educational level (P=0.875).

Concerning employment status, 20% of the Wide-Awake group and 15% of the general anesthesia group were employed, 27.5% and 47.5% were homemakers, 27.5% and 17.5% were self-employed, and 25% and 20% were unemployed or retired; there were no significant differences concerning employment status between the two groups (P=0.375). Regarding the side of involvement, 47.5% of patients in both groups had a problem on the left side and 52.5% on the right side, with no significant difference (P=0.001). The age range for the WALANT group was 44.58±3.94 years, and that for the general anesthesia group was 44.70±4.77 years. No significant difference in the mean age of patients in both groups (P=0.899).

Clinical characteristics and treatment outcomes

Clinical characteristics and treatment outcomes are summarized in Table 2. In both patient groups, preoperative pain scores were documented as 8.18±1.03 for the Wide-Awake group and 8.30±0.93 for the general anesthesia group. No significant difference was found in terms of preoperative pain scores between the two groups (P=0.573). At one-month post-surgery, the pain scores were 3.08±0.88 and 2.98±0.92, respectively, without any statistical difference between them (P=0.622). The opioid consumption after surgery was 7.62±2.99 mg in the Wide-Awake group and 7.88±3.18 mg in the general anesthesia group, without a significant difference between groups (P=0.718).

Preoperative symptom severity was 51.42±5.22 for the WALANT group versus 51.15±5.31 for the general anesthesia group, with no significant difference between the groups (P=0.816). One month postoperatively, the mean

Table 1. *Baseline characteristics of study population.*

Characteristics	Wide-Awake (n=40)	General anesthesia (n=40)	P value
Gender distribution			0.654
Male (%)	50	45	
Female (%)	50	55	
Education level			0.875
Illiterate (%)	5	5	
Elementary and high school education (%)	35	32.5	
Diploma (%)	42.5	37.5	
Academic education (%)	17.5	25	
Employment status			0.375
Employee (%)	20	15	
Housewife (%)	27.5	47.5	
Self-employed (%)	27.5	17.5	
Unemployed or retired (%)	25	20	
Side of conflict			1.000
Left side (%)	47.5	47.5	
Right side (%)	52.5	52.5	
Mean age (year)	44.58±3.94	44.70±4.77	0.899

Table 2. *Patient characteristics and outcomes.*

Characteristics	Wide-Awake (n=40)	General anesthesia (n=40)	P value
Pain score			
Before surgery	8.18±1.03	8.30±0.93	0.573
One month after surgery	3.08±0.88	2.98±0.92	0.622
Symptom severity score			
Before surgery	51.42±5.22	51.15±5.31	0.816
One month after surgery	20.08±6.99	22.82±7.21	0.087
Functional impairment severity score			
Before surgery	37.40±3.79	36.40±4.03	0.257
One month after surgery	20.60±7.66	24.00±7.47	0.048
Mean opioid dose (mg)	7.62±2.99	7.88±3.18	0.718
Satisfaction level (%)			0.016
Very satisfied (%)	65	35	
Somewhat satisfied (%)	30	37.5	
Somewhat dissatisfied (%)	5	2.5	
Very dissatisfied (%)	0	2.5	

severity score was 20.08±6.99 and 22.82±7.21, respectively, with no significant difference, as indicated by P=0.087. Regarding functional impairment, the mean preoperative scores were 37.40±3.79 for the WALANT group and 36.40±4.03 for the general anesthesia group. There was no significant difference regarding functional impairment in both groups (P=0.257). However, at one-month post-surgery, the mean impairment scores were significantly lower in the Wide-Awake group, 20.60±7.66, compared to 24.47±7.47 in the general anesthesia group (P=0.048).
Regarding patient satisfaction, 65% of the patients in the WALANT group reported being completely satisfied, as compared to 35% in the general anesthesia group, while 30% and 37.5% reported being somewhat satisfied; 5% and 25% were somewhat dissatisfied, and none in the WALANT group were completely dissatisfied, compared to 2.5% in the general anesthesia group. This suggests a higher level of satisfaction in the Wide-Awake group (P=0.016; Figure 1).

Discussion

This study was performed to assess post-operative results after FCR tendon transfer surgery in patients with radial nerve injury, using two approaches: the WALANT technique and general anesthesia. The main purpose of the study was to evaluate the changes in the intensity of pain, severity of clinical symptoms, and extent of functional impairment in patients after surgery, as well as the degree of satisfaction with surgical interventions performed with both of these techniques. For this reason, all of these parameters were measured both before and one month following the surgery. The results of the current study indicated no statistical significance in pain intensity, postoperative opioid consumption, or severity of clinical symptoms in the two groups. We surely did not find in the current study any significant differences between the two techniques on the level of pain control and symptom alleviation. However, in the WALANT group, there was significantly lower motor dysfunction as compared to the patients with general anesthesia. In addition, there was a notable improvement in motor function among patients in the WALANT group, occurring significantly more rapidly within one-month post-surgery. Consequently, the level of patient satisfaction following the procedure was significantly higher for the WALANT group compared with the group that underwent surgery under general anesthesia. In other words, the quicker return to daily activities and the resumption of occupational functions likely contributed to a higher level of patient satisfaction.
Our findings were similar to those of the previously conducted studies, hence showing a trend in the same direction in patients' perspectives about WALANT and presenting

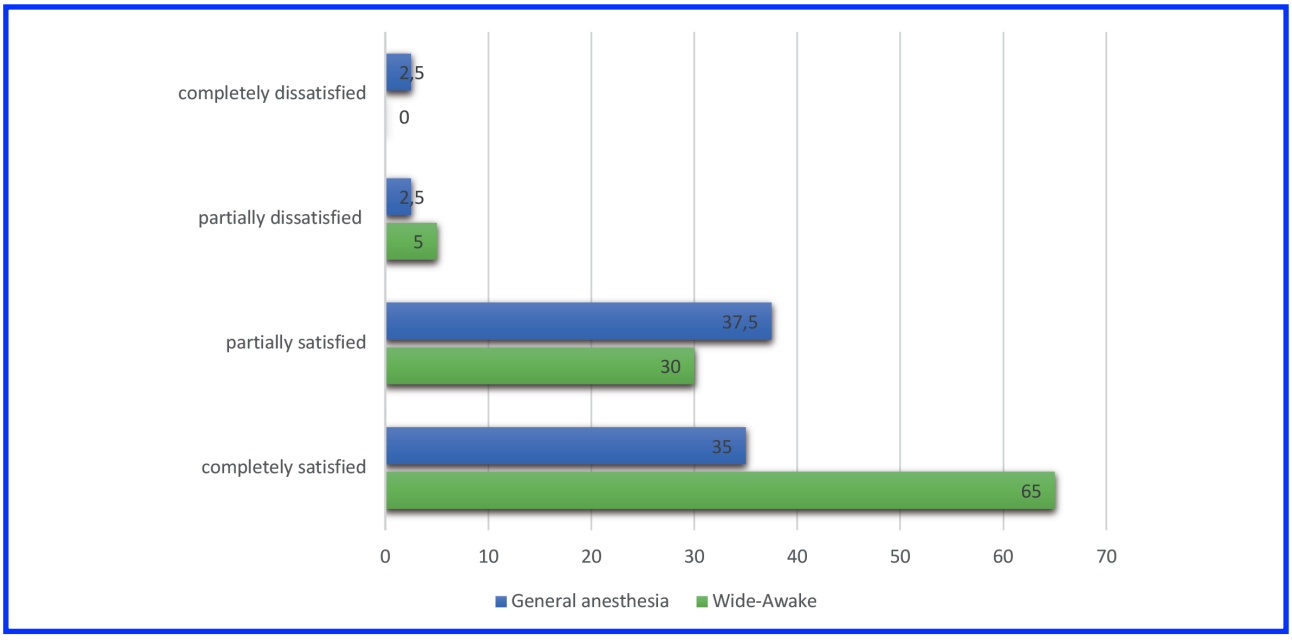

Figure 1. Patient satisfaction levels after surgery.

good experiences of the patients. Several studies were conducted regarding the advantages and benefits of the WALANT technique, which proved its effectiveness and safety during the procedures. However, the number of studies regarding the application of this method in tendon transfer as a reconstructive surgery is limited. A study by Abdullah *et al.* (2020) showed that the WALANT technique allows patients to instantly employ the flexor muscles to perform extension movements following the surgery.[21]

Flexor tendon repair using the WALANT technique is safe and offers operative and functional results comparable to traditional anesthesia techniques. There is no significant difference in rupture, infection, and re-operation rates among WALANT, regional, and general anesthesia. Moreover, the advantages of intraoperative repair assessment, enhanced patient education, and increased operating room efficiency may contribute to a growing interest in adopting WALANT for flexor tendon repair.[23]

The WALANT technique for flexor tendon repair has a few substantial advantages over traditional anesthetic methods. It allows intraoperative assessment of repair strength and glide, facilitating exact management of the surgical site and early postoperative movement. Furthermore, the technique enhances patient communication and education, which is crucial for managing expectations and encouraging adherence to postoperative protocols.[24-28] The support for these benefits in recent literature underlines the fact that WALANT has become increasingly recognized as an important approach in flexor tendon repair, which should be pursued further and used more extensively in clinical practice.

As noted in the current study, the literature suggests that WALANT has a higher satisfaction rate among patients than conventional anesthesia methods.[23,28-30] For instance, one study presented the results of six patients who underwent transfer of the FDS by using WALANT for repair of a closed rupture of the FDP tendon in the ring finger. Accordingly, the results were as follows: excellent in two, good in three, and poor in one patient. Importantly, none of the patients had complaints about the ring finger. The WALANT technique helps check for tension during the operation, and early active motion exercises after surgery are also a contributing factor to the satisfactory result obtained.[29]

In addition, a retrospective review of 100 patients who underwent surgery by the technique of WAHS demonstrated that sixty-five per cent of patients responded to a mailed questionnaire, where the majority were satisfied highly, 86% preferred to be fully awake if repeat hand surgery was needed and 90% would recommend WAHS to a friend.[30] Furthermore, in another retrospective chart review, it was noticed that awake in-office A1 pulley release gives better patient satisfaction along with more cost-effective results for patients and offers increased physician reimbursement than when performed in the operating theatre under conscious sedation.[31]

The WALANT technique was capable of enhancing operational efficiency by optimizing theatre time and minimizing the need for anesthetic personnel, equipment, and human resources, as well as reducing healthcare costs, leading to reduced healthcare costs and increased patient satisfaction. Patients appreciate the decreased waiting times, avoidance of preoperative fasting, and shorter recovery and discharge times without systemic anesthesia.[12,13,28,30,32] WALANT also avoids the discomfort of tourniquet pain and is thus a very attractive option for both patients and healthcare providers.[32]

Although the present study sheds light on the comparative outcomes of WALANT versus regional and general anesthesia, further multicenter studies in a randomized trial de-

sign are warranted to fully explain the benefits and risks of each anesthesia technique. Future studies in these areas would further help develop not only the efficacy and safety profiles of such approaches but also help clinicians in decision-making regarding the particular needs of every individual patient.

Conclusions

The WALANT approach is associated with quicker recovery of motor function postoperatively compared to general anesthesia, leading to higher levels of patient satisfaction. This facilitated recovery enables the patients to return to their daily activities and occupational functions more quickly. However, it should be noted that no significant difference was observed between the two techniques in terms of pain intensity or improvement in symptom severity.

List of abbreviations

WALANT, Wide-Awake Local Anesthetic No Tourniquet
FCR, Flexor Carpi Radialis
HIS, Hospital Information System
VAS, Visual Analogue Scale
CTQ, Carpal Tunnel Questionnaire

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Informed consent

All patients participating in this study signed a written informed consent form for participating in this study.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Author contributions

All authors participated the search and collection data, drafting of the manuscript; proposed the concept and designed the study, performed statistical analysis, wrote the first draft of the manuscript and revised the manuscript. All authors read and approved the final manuscript.

Conflict of interest

The authors declare no potential conflict of interest, and all authors confirm accuracy.

Ethics approval

The study was approved by the local ethics committee of the Baqiyatallah University of Medical Sciences (Ethical Code Number: IR.BMSU.BAQ.REC.1404.017). All experiments were performed in accordance with relevant guidelines and regulations such as the Declaration of Helsinki.

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