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Original Article

The Outcome of the WALANT Technique in Primary Hand Flexor Tendons Repair

Mohammed Adel Abd Elhameed[a], Khaled Mohamed Hassan[b], Ashraf Mohamed Ali Metawally[c], Mohamed Sabry[d,*]

[a] *Assistant Lecturer of plastic and reconstructive surgery, plastic, and reconstructive surgery department, Minia University Hospital, Minia, Egypt*
[b] *Professor of plastic and reconstructive surgery, plastic and reconstructive surgery department, Minia University Hospital, Minia, Egypt*
[c] *Lecturer of general surgery, general surgery department, Minia University Hospital, Minia, Egypt*
[d] *Lecturer of plastic and reconstructive surgery, plastic and reconstructive surgery department, Minia University Hospital, Minia, Egypt*

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ABSTRACT

Introduction: Wide-awake local anesthesia and no tourniquet (WALANT) represents a revolutionary technique for hand surgeons who dismiss tourniquets and sedation. In this study, we present our experience with the WALANT technique in primary flexor tendon injuries of the hand.

Patient and methods: This prospective research was carried out on 30 patients undergoing hand primary, flexor tendon repair surgery. Flexor tendon injury zones 2, 3, 4, and 5 were included. WALANT was prepared and injected. The tendons were surgically managed by a cruciate single cross-stitched locked 4-strand technique. The pain was assessed using a visual analog scale (VAS) score. The range of motion (ROM) of affected fingers was assessed according to the Strickland evaluation system.

Results: There was a highly significant relationship between the patient's compliance with physiotherapy and obtained ROM of the affected finger with a P value <0.001. During injection of WALANT solution, 4 cases (13.3%) had no pain, 25 cases (83.3%) had mild pain (score 1–4), and 1 case (3.3%) had moderate pain (score 5–7).

* Corresponding author: Mohamed Sabry, Minia, Egypt, Telephone: +201001233552
E-mail address: mohamed.sabri@minia.edu.eg (M. Sabry).

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Conclusion: WALANT provides an optimal bloodless and comfortable field with an opportunity to assess the strength of tendon repair, gapping or triggering and managing them intra-operatively.

Introduction

Injuries to the flexor tendon of the hand pose a dilemma for hand surgeons because these injuries cannot heal without surgery, and postoperative follow-up necessitates planned mobilization to prevent adhesions, despite the risk of rupture.[1]

Wide-awake local anesthesia and no tourniquet (WALANT) represents a revolutionary technique for hand surgeons who dismiss tourniquets and sedation. WALANT medications are composed of lidocaine and epinephrine, which are injected to induce both anesthesia and hemostasis.[2]

Numerous advantages of WALANT include avoiding the use of the complications of a tourniquet. In addition, pre-operative fasting may be waived, and the temporary cessation of medications is not guaranteed,[3,4] which is more suitable for diabetic, cardiac, or renal patients who need such surgical treatment.[5] Based on these findings, the healthcare resources could be minimized, the financial burdens could also decrease, and the anesthesia providers and their assistant staff would be eliminated.[6]

In addition, it allows for the patient's active intraoperative participation, which leads to the onsite assessment of the strength and function of repairs, resulting in lower rates of tendon ruptures and re-repairs and improved clinical outcomes.[7]

No cases of digital infarction have been reported in the literature for high-dose (1:1000) accidental epinephrine finger injection.[8] Subsequently, the use of epinephrine with a concentration of 1:100000 is unlikely to induce digital ischemia.[9]

In this study, we present our experience with the WALANT technique in primary flexor tendon injuries of the hand.

Patients and methods

This prospective research was carried out on 30 patients undergoing hand primary flexor tendon repair surgery. Patients aged between 12 and 60 years, flexor tendon injury zones 2, 3, 4, and 5 were included. The exclusion criteria included patient refusal, associated hand fractures, nerve injury, vascular insufficiency conditions, peripheral vascular disorders, bleeding tendency, associated traumatic tissue loss, patients who were allergic to local anesthetics, and psychological troubles.

The patients were admitted, and then clinical assessment was done, including history taking, local neurovascular assessment, and skin assessment. The integrity of the tendon was assessed by testing the movement of the involved fingers. Plain X-ray anteroposteriorly and oblique views were performed on the affected region. The only pre-operative laboratory tests performed were a bleeding profile and a complete blood count.

WALANT consist of 100 ml of lidocaine 1%, 1 ml of epinephrine (1:1000), and 10 ml of 8.4% sodium bicarbonate (total of 111 ml). The patients rest in a supine position. Two milliliters of the previous mixture were injected into the proximal injection point. As a start, a few millimeters were injected beneath the skin, the remainder of the mixture was injected underneath the superficial palmar fascia, and then 3 ml was injected at each finger base.

Two milliliters were injected into the subcutaneous tissue between the two digital nerves in each proximal and middle phalanges. If further dissection was required, 1 ml was injected into the subcutaneous tissue of the middle of the distal phalanx, just distal to the crease.

The integrity of the Flexor Digitorum Profundus (FDP) and Flexor Digitorum Superficialis (FDS) was confirmed intra-operatively. After the injection, we waited between 25 and 35 minutes for an

optimally bloodless field. A deflated cuff of the pneumatic tourniquet was utilized on the same upper arm as a precaution just in case WALANT anesthesia was insufficient.

Z-shaped incisions were made to extend the wound by approximately 1.5–2 cm proximally and distally. Wash and debridement of necrotic edges were done following a delicate dissection. It was considered to preserve the pulley system as much as possible during dissection to avoid bowstringing.

In this study, the tendons were surgically managed by a cruciate single cross-stitched locked 4-strand technique by 3/0 polypropylene (proline TM) strand as a core suture accompanied by simple continuous running epitendinous sutures using 5/0 proline strand. All injured FDPs were repaired, while FDS tendons were occasionally repaired.

The patient was tested to actively perform full flexion and extension of the injured finger to detect any gapping of sutures or obstructions in gliding to predict the likelihood of postoperative rupture, dehiscence, or triggering.

The suture gapping was handled by immediately recurring the core suture, whereas the gliding difficulties (triggering) were handled by trimming the edges of the repair and partial venting of the neighbor pulley.

The skin was then sutured with 3/0 or 4/0 proline strand sutures, and then a dorsal static splint was utilized to stabilize the wrist joint at balanced posture, the metacarpophalangeal joints at 60° flexion, and inter-phalangeal joints in full extension posture.

After 7 weeks, the range of motion (ROM) of affected fingers was assessed according to the Strickland evaluation system.

The analysis of the data was performed using the IBM SPSS version 25 statistical package software.

Results

This study included 30 hand trauma patients with affected 41 digits. The distribution of the digits was: 11 little fingers (26.8%), 11 ring fingers (26.8%), 9 middle fingers (22%), 7 index fingers (17.1%), and 3 thumbs (17.3%). All cases were right-handed. In 10 cases, the trauma was at the right hand (33.3%), whereas in 20 cases, the trauma was at the left hand (66.7%). In addition, 21 cases (70%) had only 1 affected finger, while 9 cases (30%) had multiple affected fingers.

The ages of the patients ranged from 12 to 60 years, with a mean $\pm$ *SD* $=$ 33.4 $\pm$ 14 years. Additionally, 22 of the patients were males (73.3%) and 8 were females (26.7%). None of the included patients had comorbidities.

The majority of fingers were injured at zone 2 30 (73.3%), 3 (7.3%) were at zone 3, 3 (7.3%) were at zone 4, and 5 (12.2%) were at zone 5. The distribution of the injured tendons was 3 digits (7.3%) were FPL, 36 digits (87.8%) were both FDP & FDS, while only 2 digits (4.9%) were FDP only.

In zone 2 injury cases, there were a total of 30 fingers, 28 of which were cut in both FDP and FDS, while only 2 were cut in FDP only.

In zones 3, 4, and 5 injuries, all the cut tendons were repaired, whereas in zone 2, we repaired both FDP& FDS in some cases, but only FDP in others, and compared the outcomes.

The duration until reaching full action of the WALANT effect was 25–35 minutes with *mean* $\pm$ *SD* $=$ 31.7 $\pm$ 3.3.

From skin incision to skin closure, the duration of surgeries ranged from 45 to 180 minutes, with *mean* $\pm$ *SD* $=$84 $\pm$ 36 minutes. During this duration, there was no pain or blood loss.

The results show that the *Range of blood loss was* (40–105) with *mean* $\pm$ *SD* $=$ 64.2 $\pm$ 15.5. No necrosis occurred due to epinephrine use in any case.

Gapping intra-operatively occurred in 3 (7.3%) of fingers and was re-repaired immediately by recurring the core suture while triggering occurred in 5 (12.2%). This triggering was handled by trimming the edges of the tendon repair and partial venting of the neighbor pulley. Furthermore, an intraoperative rupture occurred in 2 (4.9%) of the fingers, which was re-repaired immediately. No postoperative rupture occurred.

The pain was assessed using a visual analog scale (VAS) score[10] during injection of WALANT solution intra-operatively and every hour for 6 hours postoperatively.

Table 1
Shows the relationship between the compliance of the patient to physiotherapy and the obtained range of motion of the affected finger.

	Range of motion	
	R	P value
Compliance to physiotherapy	***0.911***	***<0.001****

Significant level at P value <0.05.

Table 2
Shows the correlation between the repaired tendons and the obtained range of motion of the affected digit.

		Repaired tendons			P value			
		FPL (I) N=3	FDP (II) N=18	FDP and FDS (III) N=20	Among 3 groups	I vs II	I vs III	II vs III
Range of motion	*Poor*	0 (0%)	0 (0%)	2 (10%)	**0.008***	0.115	**0.002***	**0.012***
	Fair	0 (0%)	0 (0%)	5 (25%)				
	Good	1 (33.3%)	14 (77.8%)	13 (65%)				
	Excellent	2 (67.7%)	4 (22.2%)	0 (0%)				

Significant level at P value <0.05.

During injection of WALANT solution, 4 cases (13.3%) had no pain, 25 cases (83.3%) had mild pain (score 1–4), and 1 case (3.3%) had moderate pain (score 5–7) with median = 2 and IQR = *(1.8–3)*. All cases experienced no pain intra-operatively and for 1 hour postoperatively.

Three hours postoperatively, 4 cases (13.3%) had no pain, 25 cases (83.3%) had mild pain (score 1–4), and 1 case (3.3%) had moderate pain (score5–7) with median = 2 and IQR = *(1.8–3)*.

At 6 hours postoperatively, 16 cases (53.3%) had mild pain (score 1–4), and 14 cases (46.7%) had moderate pain (score 5–7) with median = 4 and IQR = *(4–5)*. No cases complained of severe pain.

There was a significant difference in VAS score value and VAS grades during WALANT injection, at 3 and 6 hours postoperative, compared with during operation and 1 hour postoperative with a P value *<0.001.*

The patient's hospitalization lasted between 8 and 16 hours with *mean* ± *SD* = 9 ± 1.8 hours.

After 7 weeks, the ROM of the affected fingers was evaluated using the Strickland evaluation system. Six fingers (14.6%) had excellent results, 28 fingers (68.3%) had good results, 5 fingers (12.2%) had fair results, and 2 fingers (4.9%) had poor results. There was a weak correlation between age, ROM, and compliance, as well as between sexes.

There was an insignificant correlation between the ROM and the zone of injury. This result may be attributable to the low number of cases in zones other than zone 2.

There was a highly significant relationship between the patient's compliance with physiotherapy and obtained ROM of the affected fingers with a P value <0.001. This demonstrates the significance of physiotherapy, and early active motion protocols (our used protocol), in achieving better results of ROM (Table 1).

A statistically significant difference (P < 0.01) was found between the cases in which we repaired only the FDP tendon and those in which we repaired both the FDP and FDS tendons in terms of ROM (Tables 2 and 3)

The patient's satisfaction with surgery and outcome was highly significant when evaluating the functional outcome and cosmesis, with a considerable statistical difference (P < 0.01). (Table 4).

Discussion

Despite actual advancements in recent decades, the primary repair of flexor tendon injuries remains challenging to manage.[1]

Table 3
Shows the range of motion of when we repaired FDP only in comparison to repairing both FDS and FDP tendons in zone 2 flexor injuries.

		Repaired tendons		P value
		FDP N=18	FDP and FDS N=10	
Range of motion	*Poor*	0 (0%)	2 (20%)	**0.008***
	Fair	0 (0%)	3 (30%)	
	Good	14 (77.8%)	5 (50%)	
	Excellent	4 (22.2%)	0 (0%)	

Table 4
Shows patient satisfaction with surgery and with outcome.

	Patient satisfaction		P value
	Not satisfied	Satisfied	
About surgery	5 (16.7%)	25 (83.8%)	***<0.001****
About outcome	6 (20%)	24 (80%)	***0.001****

Comparing the results of previous studies remains a dilemma because the outcome of flexor tendon repair is influenced by a multitude of variables, including age, mechanism of injury, inclusion criteria, time of repair, method of repair, postoperative rehabilitation protocol, and patient preference.[2]

In this research, patients presented with acute flexor tendon traumas were managed by primary tendon repair utilizing the WALANT procedure. The rehabilitation protocol was performed according to an early active motion protocol. Its outcomes were recorded using the Strickland evaluation system, which is comparable to numerous other studies, including references from[11] to.[18] However, these studies utilize different types of anesthesia. They utilized either a brachial block or general anesthesia. Therefore, other studies done by Higgins et al., 2010[7] and Khaled et al., 2018[13] were implicated, regardless of being partly distinct from the studies mentioned earlier, to match our outcomes in the newly presented wide-awake procedure with the literature.

The sample size in this research is relatively comparable to those reported by Braga-Silva and Kuyven, 2005[14] (82 patients with injured 82 digits), Duru et al., 2022[15] (61 patients with injured 67 digits) (43 male and 9 female), with a mean age of 36.8. In addition, it is comparable to Kadhum et al., 2022[16] (63 patient, 41 of whom were males and remaining patients were females) with a mean age of 38.5 $\pm$ 14.4 years. In our study, the sample size was larger than that reported by Khaled et al., 2018[13] (22 patients presented with 32 injured digits), more than that registered by Starnes et al., 2012[17] (21 patients presented with 24 injured digits) and more than that mentioned by Al-Qattan 2011[18] (5 patients with 20 affected digits).

As evidenced by the observation of the mean age and gender distribution, the more active a person is, the higher their risk of injury. In our study, the young male denomination pre-dominated, which is consistent with research published by Starnes et al., 2012[17] and Duru et al., 2022.[15]

We achieved a very good hemostasis without using the tourniquet. The volume of blood loss *ranged from* 40 to 105 ml, whereas Abdelshaheed 2022[19] registered that the range of blood loss was between 17 and 28 milliliters. We hypothesized that this difference in blood loss was because the majority of his cases were elective cases, whereas ours were acute.

The procedure was almost painless, which is promising evidence, directing the hand surgeons to continue utilizing WALANT. This finding aligns with the results of Khaled et al., 2018[13] and Abdelshaheed, 2022.[19]

Also, supported by the outcomes of Lee et al.,[20] who compared the WALANT procedure vs. conscious sedation in hand surgeries, utilizing the VAS score, the WALANT group registered that the 1st 24 hours showed remarkable significance in favor of the WALANT group, with no other differences. The highest difference occurred 6 hours post-operatively. Additionally, the WALANT group was prescribed fewer analgesics for the subsequent 24 hours. Furthermore, Okamura et al.[21] noted that regarding the

VAS, there were remarkable differences among the groups during the intraoperative time and 2, 4, 6, and 8 hours post-operatively.

Local injection of epinephrine presented an efficient bloodless field throughout the operation without utilizing diathermy or applying a tourniquet. In addition, no epinephrine-related complications were registered, which aligns with Khaled et al., 2018.[13]

WALANT enabled the surgeon to evaluate the repair intra-operatively and detect any gapping or triggering. It was reflected in the postoperative outcomes by reducing the rate of rupture and improving the gained ROM. This finding is consistent with the findings reported by Barrie et al., 2001[22] while testing the effect of suture locking and suture caliber on fatigue strength of flexor tendon repairs. They discovered that a 4-strand cross-stitch locked repair with a 3/0 suture had significantly improved fatigue strength and holding capacity compared to the other types of repairs examined (2- and 4-strand repairs that were either nonlocked or locked with 3/0 or 4/0 sutures). In addition, this result is comparable to those of Khaled et al., 2018[13] and Kadhum et al., 2022.[16]

All FDPs were injured and repaired. With respect to FDSs, 5.3% were intact, whereas 94.7% were injured. We repaired both FDP & FDS tendons in all cases of zone 3, 4, and 5 injuries, but in the 28 cases of zone 2, we repaired both tendons in 10 cases (35.7%) and FDP only in 18 cases (64.3%). The repair of injured FDS tendons was not performed in the current study to preclude the adhesion with the repaired FDPs, particularly under the narrow tube of the A2 pulley, to prevent its complete venting, besides the obstacles of repairing FDS tendon near its insertion. This result agrees with the research registered by Khaled et al., 2018.[13] However, he recommended that repairing FDS tendons should be only performed if the injury happened proximal to the A2 pulley where FDSs are softly repaired and existing under the A1 pulley, which could be vented completely presenting a wide compartment with lower hazards of adhesion with repaired FDP.

This finding is consistent with the research performed by Al-Qattan, 2011,[18] who only repaired FDP tendons. Tang, 1994[23] supported repairing FDP tendons only in zone 2. In contrast, Klein, 2003,[12] Braga-Silva and Kuyven, 2005,[14] Caulfield et al., 2008,[11] Sandow and McMahon 2011,[24] and Starnes et al., 2012[17] recommended repairing all injured FDS tendons.

Regarding ROM in zone 2 cases, when we compared the repair of both FDS & FDP tendon with the repair of FDP only, the ROM was much better when we repaired FDP only. There was a highly significant increase in ROM when repairing FDP only in comparison with repairing both FDP & FDS with a P value 0.008. This is supported by Tang, 1994,[23] Al-Qattan, 2011[18] and Khaled et al., 2018.[13]

Gapping of the repair, intra-operatively, occurred in 3 (7.3%) of fingers and was re-repaired immediately. Triggering occurred in 5 (12.2%) and was immediately solved by trimming the edges of the repair and performing partial venting of the nearby pulley. Also, intraoperative rupture after repair occurred in 2 (4.9%) of the fingers and was re-repaired immediately.

Duru et al., 2022[15] reported that 1 repair (from 67 fingers), and Higgins et al.[7] registered 7 repairs (from 68 patients) were repeated due to intraoperative gapping. The WALANT gives the operator the power to check the repair and manage any obstacles intra-operatively. Consequently, the expected poor results could be prohibited. Moreover, Khaled et al., 2018[13] documented 2 fingers (6.3%) with intraoperative gapping and 5 fingers (15.6%) suffered from triggering and were also handled immediately.

No postoperative rupture occurred. This result is close to those of Duru et al., 2022,[15] who registered a rupture rate of (1.5%). Higgins et al.[7] documented a rupture rate of (3.3%), while Khaled et al.[13] documented a rupture rate of (6.3%).

The systematic review of Chesney et al., 2011[25] on the flexor tendon rehabilitation protocols in zone 2 documented that the early active motion protocol had better outcomes than Kleinert or combined Kleinert and Duran protocols in research that applied the Strickland evaluation system to assess the ROM.

The ROM was assessed according to the Strickland evaluation system. Our results revealed that 14.6% were excellent, 68.3% were good, 12.2% were fair, and 4.9% were poor. The sum of excellent and good results was 82.9%. This result is close to Duru et al.[15] who reported that excellent and good results were 88%, 10 % were fair, and 2% were poor and Khaled et al., 2018[13] who reported that 25.8% were excellent, 35.5% were good, 25.8% were fair, and 12.9% were poor. The sums of excellent and good results were 61.3%.

The ROM was dramatically increased in patients who followed a strict physiotherapy regimen. There was a significant positive correlation between the patient's compliance with physiotherapy, especially early active motion protocols and the resulting ROM with a P value *<0.001, which is highly* significant. This result comes in agreement with Chesney et al., 2011[25] and Khaled et al., 2018.[13]

Conclusion

WALANT provides an optimal bloodless and comfortable field with an opportunity to assess the strength of tendon repair, gapping or triggering, and managing them intra-operatively, thereby urging surgeons to initiate an early active motion protocol with reduced risks of postoperative rupture.

Declaration of competing interest

All Authors declare that they have no conflict of interest.

Informed consent

Informed consent was obtained from the patients and/or their guardians.

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None.

Ethical approval

This study was approved by the local Ethics Committee, Faculty of Medicine, Minia University REC no. (350:2022). This work was carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

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