Advanced Medical Journal, Vol.8, No.2, P.105-115, 2023 https://doi.org/10.56056/amj.2023.224

A comparison between modified Kessler and modified Tsuge suture techniques in flexor tendon repair

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Abstract

Background and Objective: Severed digital flexor tendon needs to be repaired to restore flexion function of the finger. The aim is to evaluate tendon repair outcomes by using two different suturing techniques modified Kessler and modified Tsuge.

Patients and Methods: This is a comparative study performed in Rozhawa Emergency Hospital and Emergency Medical Center in Erbil city, Kurdistan region-Iraq between 1st of December 2019 to 1st of June 2021. The study included (33) patients of both genders who presented with acute flexor tendons laceration in fingers which their number were (44) fingers underwent digital flexor repair by using two different suture techniques modified Tsuge and modified Kessler.

Results: This study includes (30) males and (3) females, patients with digital flexor tendon cut the age ranged from 18 years to 58 years, mean age was 30.1 ± (10.5) years SD. The majority of the injuries (90.9%) were in zone 2, and the right hand was injured in 56.8% of the total injuries. The most common injured fingers were the ring (25%) and the little finger (25%). The Flexor digitorum profundus was the most common (79.5%) injured tendon. The proportion of the patients who were satisfied with the operation's outcome is 60.6%.

Conclusions: Tendon repair by using modified Tsuge 4 strands suture technique showed significant strength and less complication rate.

Key words: Flexor tendon cut; Modified Kessler; Modified Tsuge suture.

Introduction

One of the common hand injuries is flexor tendon lacerations in which both gender and different age groups are affected due to different types of injurious mechanisms, these injuries might be associated with bone fractures and/or other soft tissue injuries including nerve or vessel that result in functional deficit.[1] Postoperative complications have happened like rupture of a repaired tendon, joint stiffness, and adhesions despite the good diagnosis and perfect tendon repairing surgery.[2] An Injured flexor tendon is treated by repairing with various suturing methods composed of a core and epitendinous sutures. Through the years numerous repair techniques had been developed for repairing severed tendons, leading to non-unified techniques of suturing to achieve reliable repair strength.[3] Several kinds of research had been demonstrated that good strength needs at least 4 strands for core suturing in order to start early active movements. Adding epitendinous suture in tendon repair gives a significant improvement in strength and unruffled repaired surface.[4] The tensile strength of the repair increases by increasing the number of core strands.[5] In this study, two types of repair techniques have been utilized to compare modified Tsuge (4 strands) and modified Kessler (2 strands).

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In the healing process after tendon surgery, the fundamental tendency of injured tissue to adhere to surrounding tissue demands active flexion movement protocols postoperatively for sufficient tendon excursion and to prevent restrictive adhesions. The repaired tendon must move leisurely in flexion and extension with a much force to prevent cohesion to the enclosed tissue and stretching or rupturing the repair.[6] However, these multi-strand techniques are time-consuming and involve repetitive tendon handling with repeated passages of needle and suture material through the tendon. Some of these repairs have a knot on the surface of the tendon while the others are at the repair site.[7] The tensile strength of the repair is affected by different locking configurations in addition to multiple cores strands.[8] The aim of this study is to evaluate the functional outcomes and complications in repairing injured flexor tendons in zones II, and III by using two different suturing techniques modified Tsuge and modified Kessler.

Patients and Methods

This is a comparative study performed in Rozhawa Emergency Hospital and Emergency Medical Center in Erbil city, Kurdistan region-Iraq between 1st of December 2019 to 1st of June 2021. The study included 33 patients (44 fingers) of both genders who presented with acute flexor tendons laceration in fingers, which fulfilled the study inclusion criteria. Cases who are non-compliant patients, patients who are unfit for surgery, with psychological disease, fractures, extensor tendon injury, joint injury, skin defects, and children were excluded. Patients included in the study their ages ranged from 18 to 58 years. Patients who had injured flexor tendons underwent tendon repair by using four strands modified Tsuge suture or two strands modified Kessler suture technique comparing both techniques in the same hand while multiple fingers were involved in the trauma. In the tendon suturing the 4.0 polypropylene round suture material had been used for core suturing while 6.0 polypropylene round suture material was used for circumferential running epitendinous suturing. Forty-four of the injured fingers had flexor tendon lacerations in zone II Figure (6), and three were injured in zone III Figure (5). Among the patients (31case) were caused by sharp cuts, (two cases) were caused by saws injuries. In the emergency department, all cases had been evaluated clinically and photographically as shown in Figure (1) in which the injured fingers will be out of cascade due to cut in the flexor tendons. Patients had been operated on under general anesthesia. The injured finger was explored through extending existing wounds by using Bruner incisions. Modified Tsuge suturing technique was applied in 25 injured digits while in 19 injured digits a modified Kessler was applied for repairing severed flexor tendons in consecutive manner.

Figure (1): Left index finger out of cascade due to cut of flexor digitorum profundus and flexor digitorum superficialis in zone 2.

The modified Tsuge technique was designed for and used in three steps in which a 4.0 polypropylene's needle was inserted into the proximal part of the injured tendon end at the volar surface, 1 cm away from the injured end. The needle run longitudinally across the repair site and was taken out 1 cm away from the repair site (injured end) at the distal tendon end. With the needle passed transversely in the distal part, by making a double loop at the lateral part and the suture reinserted into the distal tendon end, crossing the repair site at the dorsal surface as a dotted line and existing from the proximal end dorsally so that it could be reintroduced transversely to make a single loop. A knot made on the surface of the tendon by this will be the final part of the first step as shown in Figure (2).

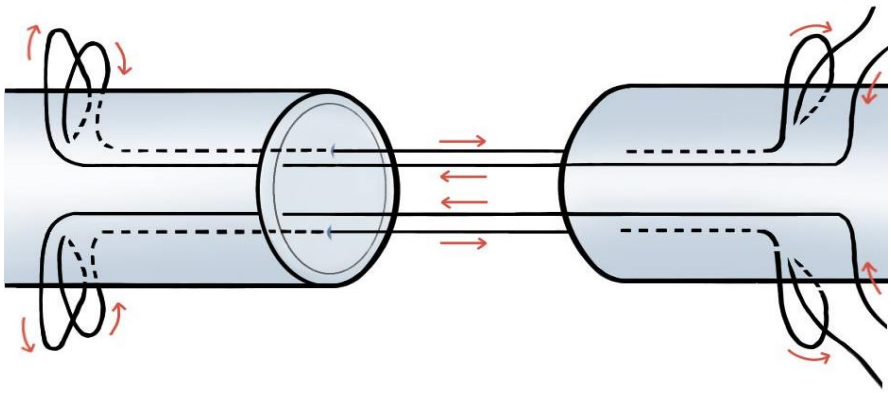

Figure (2): The modified Tsuge suturing technique is designed in a way that the suture is inserted into the proximal part of the injured tendon's end at the volar surface which is run longitudinally across the repair site. In the distal part, the needle passed transversely where a double loop was created then the suture was reinserted to leave the distal tendon end, crossing the repair site at the dorsal surface which showed as a dotted line and existing from the proximal end dorsally so that it could be reintroduced transversely to make a loop and final tying.

In the second step, the previous design is applied to the opposite side of the same injured tendon and the last step of the repair was by using a 6.0 polypropylene running circumferential suture for epitendinous part. The other technique (modified Kessler) is shown in Figure (3). The suturing design started by inserting the needle longitudinally through the repair site of the injured tendon at the proximal end and taking out 1cm away from the repair site then making a loop at the lateral part of the tendon and transversely crossing the proximal tendon part by making another loop, crossing repair site and existing in distal tendon end also making a loop at the lateral part of the tendon and transversely crossing the distal tendon part by making another loop lastly strand exist to repair site for tying. The final step in this technique also was using 6.0 polypropylene for running suture for epitendinous part. Intraoperative injured hand had been put in back slab customized in a way that 20° to 30° wrist flexion, MP joint 70° to 80° and interphalangeal joints straight Patients were putting the back slab for 1 month. For postoperative rehabilitation, early controlled active flexion started on the 3rd postoperative day, Patients followed up every 3 days for 1st week, weekly for 1 month, every 2 weeks for 3 months, then at 6 months, and 1 year. The patients were asked to perform active mobilization of their fingers under the supervision of slowly and gently moving within the splint for 1month postoperatively. The physiotherapy period continued for another 2 months after the splint removal by increasing the range of flexion movements before permitting the patient to return to daily activities.

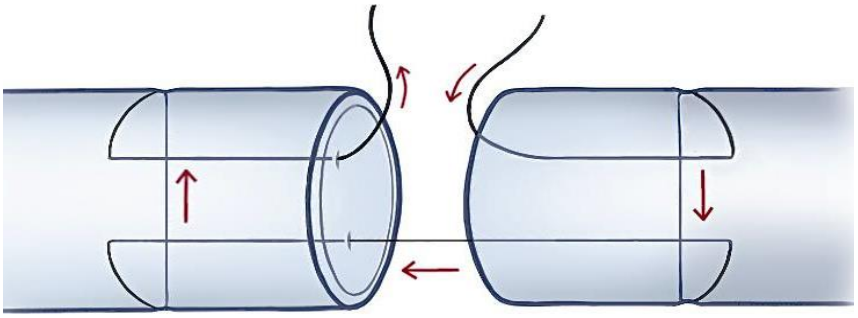

Figure (3): The modified Kessler technique suturing design started by inserting the suture material longitudinally through the repair site of the injured tendon at the proximal end to make two loops in bilateral parts of the proximal tendon end, then it is crossing the repair site to repeat same steps in distal tendon end and lastly, suture tied at the repair site.

The study protocol was approved by the Medical Ethics Committee of the KHCMS. Data were analyzed using the Statistical Package for Social Sciences (SPSS, version 26). Fisher's exact test was used (instead of the Chi-square test) when the expected frequency (value) was less than 5 of more than 20% of the cells of the table. A p-value of ≤ 0.05 was considered statistically significant.

Results

Thirty-three patients (44 injured fingers) were included in the study. Their mean age was 30.1± (10.5) years (SD), ranging from 18 – 58 years. The median was 28 years. It is evident in Table (1) that two-thirds of the patients were young adults (20-39 years old), and the majority (90%) were males Table (1).

Table (1): Age and gender distribution of patients

	No.	(%)
Age (years)		
< 20	6	(18.2)
20-29	11	(33.3)
30-39	11	(33.3)
≥ 40	5	(15.2)
Gender		
Male	30	(90.9)
Female	3	(9.1)
Total	33	(100.0)

The majority of the injuries (90.9%) were in zone 2, and the right hand was injured in 56.8% of the total injuries. The most common injured fingers were the ring (25%) and the little finger (25%). The Flexor digitorum profundus was the most common (79.5%) injured tendon Table (2).

Table (2): Characteristics of the injured fingers

	No.	(%)
Zone		
Zone 2	40	(90.9)
Zone 3	4	(9.1)
Injured hand		
Right	19	(43.2)
Left	25	(56.8)
Injured finger		
Thumb	8	(18.2)
Index	5	(11.4)
Middle	9	(20.5)
Ring	11	(25.0)
Little	11	(25.0)
Injured Flexor tendons		
Flexor pollicis longus	8	(18.2)
Flexor digitorum profundus	35	(79.5)
Flexor digitorum superficialis	1	(2.3)
Total	44	(100.0)

The rate of complications like rapture was significantly lower when using the modified Tsuge suture, (8%) compared with 47.4% of modified Kessler. While the rate of adhesion in using modified Kessler 5.2% is less than modified Tsuge (16%) Table (3).

Table (3): Complications by type of suturing.

	Modified Tsuge	Modified Kessler	Total	p*
Complications	No. (%)	No. (%)	No. (%)	
None	19 (76.0)	9 (47.4)	28 (63.6)	
Rupture	2 (8.0)	9 (47.4)	11 (25.0)	
Adhesion	4 (16.0)	1 (5.2)	5 (11.4)	0.010
Total	25 (100.0)	19 (100.0)	44 (100.0)	

By Fisher's exact test.

A considerable proportion of the patients (60.6%) were satisfied with the operation's outcome Figure (4).

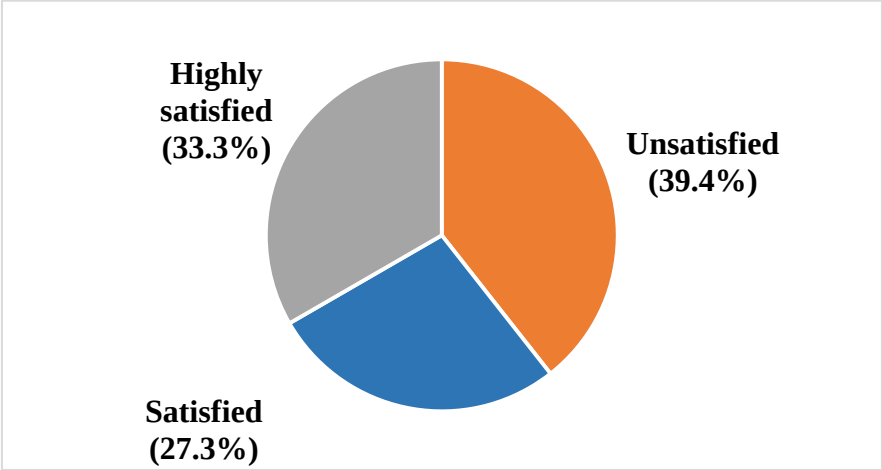

Figure (4): Patients' satisfaction with the outcome of the tendon repair.

No significant association was detected between the incidence of complications and type of finger, whether using the modified Tsuge suture (p = 0.888), or using the modified Kessler suture (p = 0.088) as presented in Table (4).

Table (4): Incidence of complications by type of finger and suture type

	Complications				
	None	Rupture	Adhesion	Total	
	No. (%)	No. (%)	No. (%)	No. (%)	
Modified Tsuge					
Thumb	3 (60.0)	1 (20.0)	1 (20.0)	5 (100.0)	
Index	2 (100.0)	0 (0.0)	0 (0.0)	2 (100.0)	
Middle	4 (66.7)	0 (0.0)	2 (33.3)	6 (100.0)	
Ring	5 (100.0)	0 (0.0)	0 (0.0)	5 (100.0)	
Little	5 (71.4)	1 (14.3)	1 (14.3)	7 (100.0)	0.888*
Total	19 (76.0)	2 (8.0)	4 (16.0)	25 (100.0)	
Modified Kessler					
Thumb	1 (33.3)	1 (33.3)	1 (33.3)	3 (100.0)	
Index	0 (0.0)	3 (100.0)	0 (0.0)	3 (100.0)	
Middle	1 (33.3)	2 (66.7)	0 (0.0)	3 (100.0)	
Ring	3 (50.0)	3 (50.0)	0 (0.0)	6 (100.0)	
Little	4 (100.0)	0 (0.0)	0 (0.0)	4 (100.0)	0.088*
Total	9 (47.4)	9 (47.4)	1 (5.3)	19 (100.0)	

*By Fisher's exact test.

Discussion

The hand undergoes multiple types of trauma one of them is flexor tendon injury by different injurious mechanisms like sharp /clean cut or crushed that are led to the loss of flexion of the fingers and disturbance in hand's function.[21] In this study digital flexor tendon cut result in most injuries in zone two (90.9%) in 40 cases, probably because this is the longest zone and the tendons are confined to unprotected narrow area. Our results of zone involvements are consistent with the finding of Çalışkan et al (in which injuries were 58.2% in zone 2 and 7.7% in zone 3 in 821 cases) [18] and Chang et al (35.7% of the patients' injuries were in zone 2 and 9.4% zone 3 in 308 cases).[22] Multiple fingers might be involved in flexor tendon

injury depending on the position of the hand and mechanism of the injury while in this study the result demonstrated the same rate for involving the ring and little fingers in the trauma which was 25% for each of them. Our study is inconsistent with De Jong et al who found that the little finger is the most involved in the trauma.[9] In this study, There was a significant association between a lower rate of complications like a rupture with using four core strand modified Tsuge technique that showed superior results for good repair strength during the cyclic loading and less rate of repair ruptures which was 8% (two cases) who were noncompliant to use the splint, one of these two patients did not follow instructions and started to use his hand in daily activities at week 2. Using two strands modified Kessler's chance of rupture increased by 47.4% this occurred in three patients who didn't stick to the program of splint wearing and in the other six cases the repair rupture happened during active mobilization. The ideal tendon suturing technique should be simply performed and strong enough to allow active motion. Restoring near-complete flexion function is demanding tendon repair in a way that prevents complications like repair rupture, adhesion, and joint contracture in which the need for further treatment lead to longer follow-up compared with the successful cases. Previous investigations determined that an increase in the number of the suture strands across the repair site proportionally increases the tensile strength and resistance to gap formation.[10]

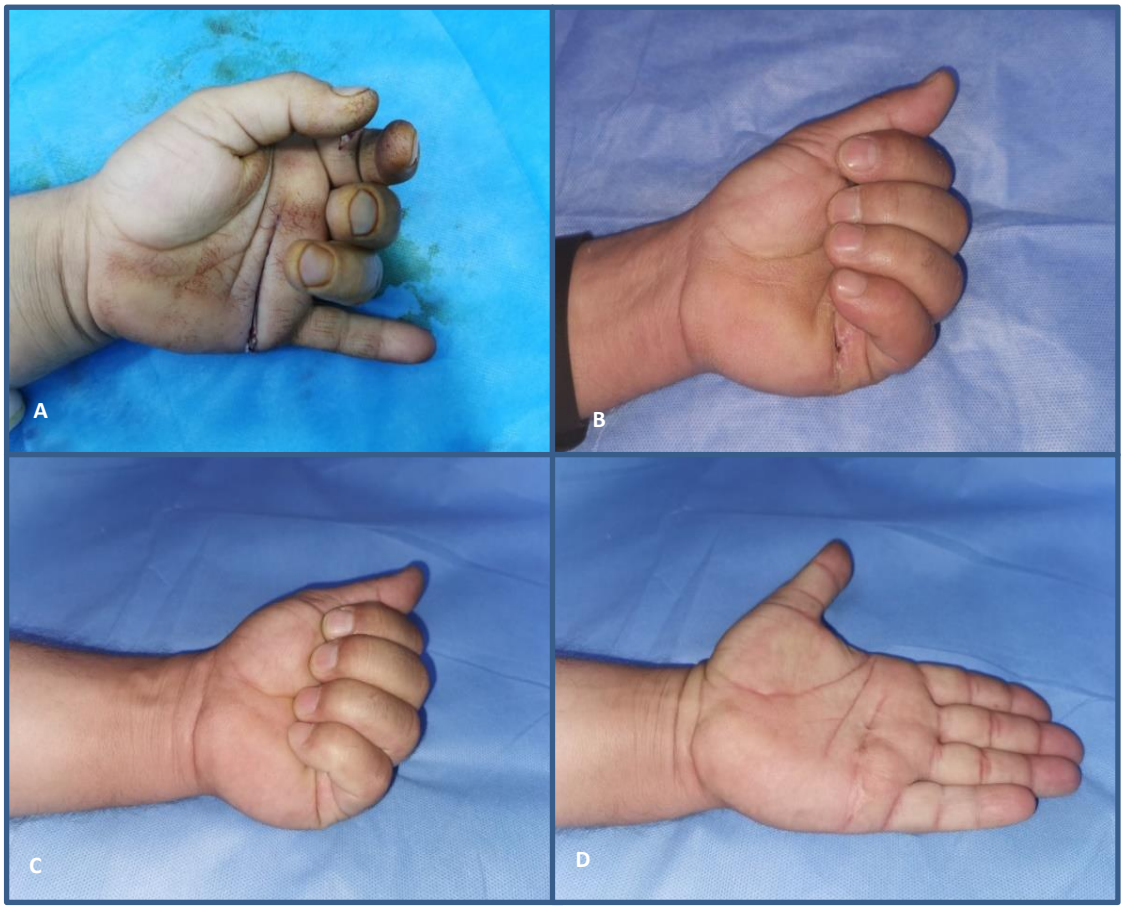

Figure (5): Illustrates the cut of flexor tendons of the left little finger in zone 3, (A) intraoperative the Lt little finger is out of cascade, (B) after 1 month shows little finger follows cascade with other fingers, (C, D) after 3 months shows full flexion and extension of the finger.

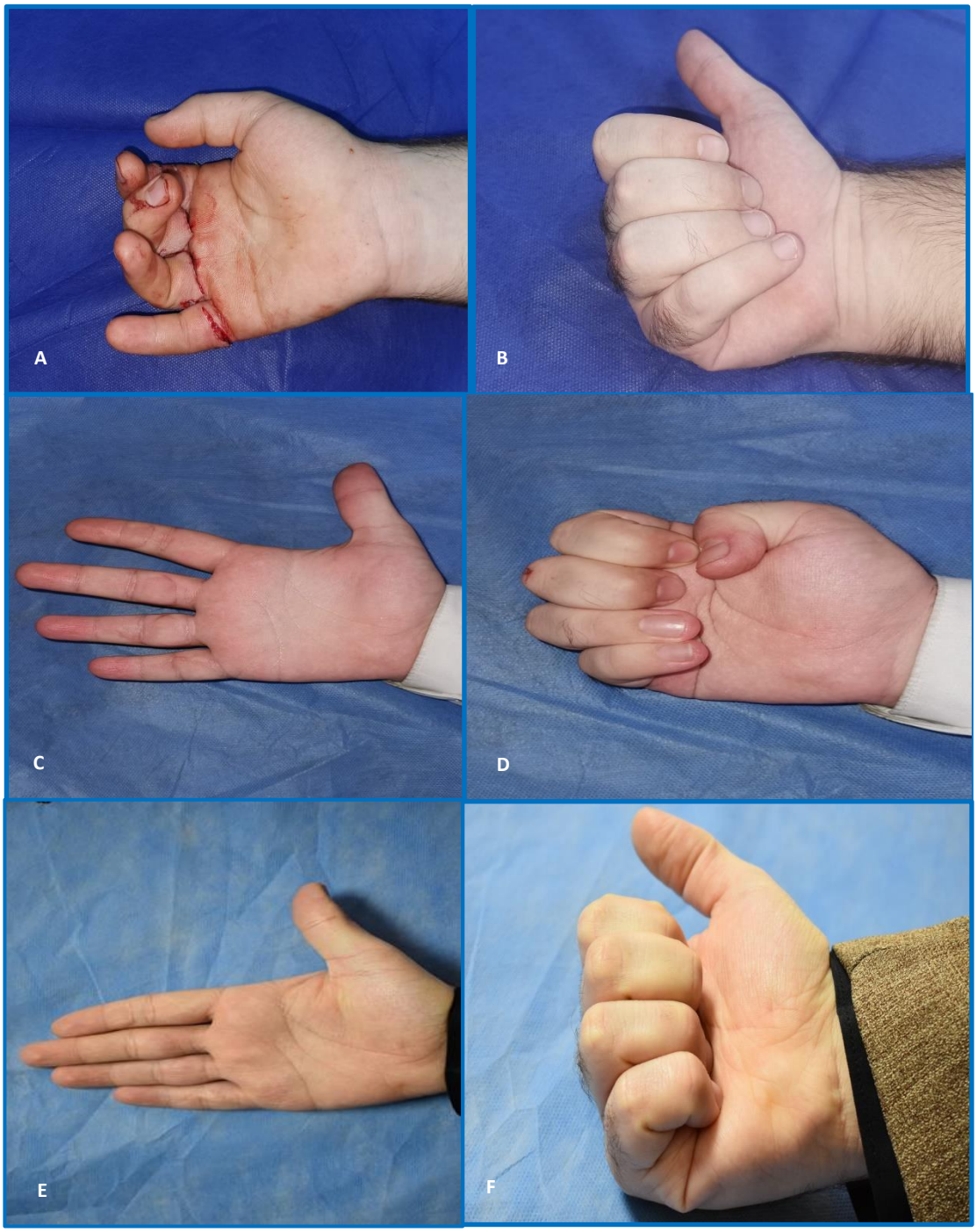

Figure (6): Flexor tendons injury and repair of Rt. Ring and little fingers. (A) intraoperative, both fingers are out of cascade, (B) 1 month postoperative which shows both ring and little fingers follow the cascade with other fingers, (C, D) 3 months post-op. shows both fingers maximum flexion and extension, (E, F) after 1 year of operation shows full flexion and extension of the ring and little fingers.

Figure (7): Inability of the patient to extend her right middle finger which indicates adhesion of the flexor tendons post repair.

Minimization of adhesion formation and preventing joint stiffness can be done efficiently by starting after flexor tendon repair, which also strengthens the tensile strength of the tendon when compared with continuous immobilization. Active participation of the patient in rehabilitation is mandatory for proper function and minimization of complications rate and this is consistent with other studies (Using the Strickland criteria, 'good' function was obtained in 95 (30%) out of 322 fingers at 8 weeks),[11] (5% of 39 units used the 4-Strand Cruciate in repair injured tendons and early mobilization protocol showed a result of no adhesion and rupture) and (63% of 118 cases achieved good function which they started early active mobilization after tendon repair).[13] In this study, patients who started rehabilitation of early active movement post-operatively had a better result with a low rate of tendon adhesion. In cases who were noncompliant and uncooperative to do physiotherapy; The result showed that 16% (four cases) have tendon adhesion in modified Tsuge Figure (7) and 5.2% (one case) in modified Kessler these findings are consistent with a study done by Lee HI et al (25.7 % of 25 cases developed adhesion in which their tendons repaired by Four-strand locking cruciate).[20] Most of the patients who underwent flexor tendon repair were male patients (90.9%). They have a higher incidence of trauma involved with different occupational demands. They are most likely to have more physical labor and intensive occupations which may place them at increased risk for the injury which is consistent with a study done by Fattah et al[14] (70.2% of 121 cases were male patients) and Naudé et al[15] (74.1% of 31 cases were male patients). In the current study patients' satisfaction remain considerable due to functional results in which 60.6% (29 cases) were satisfied, and 39.4% (15 patients) were unsatisfied with the operation's outcomes in whom complications happened after the repair and it is consistent with a study done by Koehler et al (93% of 29 patients were very satisfied with the outcome of the tendon repair) [16] and Saleh et al (a satisfactory result with a mean of 79.59 ± 4.84 of 20 patients with a maximum score of 100%).[17] Other complications like wound infection and finger ischemia did not happen.

Conclusions

Suturing by modified Tsuge led to good results with less complication rate and early return to routine daily activities since it allows early active physiotherapy. We recommend that further studies need to be done on a larger number of patients.

Conflicts of interest

The author reports no conflicts of interest.

Acknowledgment

The authors like to thank Dr. Zhilya Burhan for her contribution to the creation of suture technique sketches.

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