

Comparative Study in Primary Repair of Flexor Tendon Injuries Between Two Strands Tendon Repair and Four Strands Tendon Repair

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ABSTRACT

Introduction: In this study, we compared the functional outcome of repair of cut flexor tendons using modified Kessler technique versus the four strands technique.

Patients and Methods: Thirty Two adult patients with forty one severed flexor tendon underwent primary tendon repair. In group A, we used two strands repair technique and in group B we used four strand repair technique. We used early controlled physiotherapy rehabilitation protocols for both groups.

Results: Regarding total active range of motion and DASH score, there were no statistically significant differences between the outcomes of these two groups. Tendon rupture occurred in one case in group A.

Discussion: Primary tendon repair is the optimum treatment for cut flexor tendons. However, several repair techniques and rehabilitation protocols exist. In vitro tests concluded that the more the strands that cross the repair site, the stronger the repair but in vivo studies did not reflect such benefits except the four strands technique.

Conclusion: We were not able to identify any statistically significant differences in total active motion and DASH scores between two and four strands repair techniques. However, the results of four strands technique were more favorable.

Key Words: Flexor – Tendon – Kessler – Cruciate – DASH.

INTRODUCTION

Plastic and hand surgeons use different suture techniques to repair flexor tendon injuries and lacerations. Even when competent surgeons fix and reconstruct such injuries, post-operative complications, such as tendon ruptures, adhesions and gap formation still occur [1].

Galen first repaired injured flexor tendon in the second century [2]. In the Tenth Century, the Islamic scientist Avicenna described tendon repair in his book “Al-Qanun-fi-al-Tibb” [3]. In the twentieth century, Bunnell declared the concept of “no

man's land” as a result of poor outcomes following primary tendon repair [4]. Delayed tendon reconstruction and tendon grafts became popular by many surgeons [5,6].

In the fifties of the twentieth century, hand surgeons recognized the poor outcome following delayed tendon grafting especially in zone 2 tendon injuries and primary tendon repair regained its acceptance from many hand surgeons. Now, primary tendon repair is the treatment of choice for flexor tendon injuries. However, different suture techniques and variable postoperative rehabilitation protocols still rise the controversies about the universally accepted management of such injuries [7].

In this study, we compared the results of repair of the injured flexor tendons using two different techniques; the two strands tendon repair and the four strands tendon repair.

PATIENTS AND METHODS

We conducted this study at Plastic Surgery Department, Mansoura University, Egypt from 1/11/2017 to 31/10/2018 where thirty two patients were included and divided into two groups:

- *Group A (16 patients):* We performed tendon repair using two strands modified Kessler repair technique.
- *Group B (16 patients):* We performed tendon repair using four strands modified cruciate repair technique.

Inclusion criteria:

- Hand trauma complicated by flexor tendon injury.
- Age (15-60) years.

Exclusion criteria:

- Polytraumatized patients.
- Previous hand surgery or associated phalangeal fractures.
- Surgical unfit (comorbid conditions like DM, heart diseases.....).

We obtained local institutional review board approval. We obtained an informed consent from each patient participated in this study. Patients with flexor tendon injuries were managed in the same way as trauma cases. Each patient was subjected to the following:

- *Primary survey:* Life-threatening injuries are identified and we started resuscitation of injured patients.
- *Secondary survey:* After assurance of stabilized general conditions of each patient, history taking, detailed hand examination, laboratory investigations and imaging were conducted.

Surgical technique:

General anesthesia or supraclavicular nerve block were used. Applying of tourniquet to decrease blood loss from the skin incision. Using Zigzag incision to expose the injured tendon.

Group A: We used two strands (modified Kessler) technique by using non-absorbable monofilament (4/0 or 3/0) prolene sutures Fig. (1) followed by Strengthening of the repair by peripheral epitendinous suture (6-0 prolene).

Group B: We used four strands (modified cruciate core suture) using non-absorbable monofilament (4/0 or 3/0) prolene sutures Fig. (2) with Strengthening of the repair by doing peripheral epitendinous suture (6-0 prolene).

In both groups, we put the affected hand and forearm in dorsal splint extending from beyond the fingertips to below the elbow with light volar dressing with 80-90° MCP joints in flexion and 20° wrist in flexion and proximal and distal interphalangeal joints (PIP/DIP) is fully extended.

Post-operative care:

- 1- The patient was discharged to the ward. Systemic antibiotics and proper analgesia were given to the patient.
- 2- At the first post-operative day: Removal of the drains, change of the dressings and patient's discharge from the hospital were done.
- 3- The physiotherapy protocol (early active mobilization protocol).

In cases with zone 3 injuries, early exercises were initiated 24 hours after repair while for cases with zone 2 injuries, exercises were initiated 48 hours after repair. During first 4 weeks, patients were instructed to do 2 repetitions 4 hourly apart of passive finger flexion Fig. (3) and active hold exercises. Full active PIP extension was started from 1st week. At 4 weeks, splint was discontinued. 3 weeks later, protected passive interphalangeal extension exercises were started. Full function was started by 12 weeks.

Outcome measure:

At the 6th post-operative month all patients were assessed for the outcome of the surgery by:

- Measuring of the active ranges of movement of all joints (MCP, PIP & DIP) of repaired injured fingers using a goniometer.
- Calculating of Total Active Motion (TAM) of affected fingers (by adding of the active flexion range of motion of metacarpophalangeal joint, proximal interphalangeal joint and distal interphalangeal joint minus extension lag of each joint).
- The Arabic version of the questionnaire of Disabilities of the arm, shoulder and hand score (DASH score) was given to all. Thirty questions were asked to each patient. Score ranged from 30-150. The following formula $[(score-30)/1.2]$ was used to give the final score from 0 to 100.

Data analysis:

We used the Statistical Package for the Social Sciences (SPSS) version 20 (SPSS Inc., Chicago, IL, USA) for the analysis of our results. We compared the mean values between the two groups regarding DIP, PIP, MCP joints active flexion, TAM and DASH score using parametric independent samples Student's *t*-test. We considered that the probability value (*p*-value) was significant when it was less than 0.05.

RESULTS

In this study, we operated upon 41 tendons in 32 patients. The causes of cut tendons were injuries due to sharp instruments (22 patients), crush injuries (8 cases) and glass injuries (2 cases). Dominant hands were injured in 15 patients and in non-dominant hands were injured in 17 patients. Patients' demographic data were shown in (Table 1).

Early post-operative complication included rupture of one tendon in only one case in group A. Then re-exploration and re-suturing was done after

3 weeks from the first surgery. The complications rate was 6.3% in group A. the overall success rate of all cases was 96.9%.

Regarding late post-operative follow-up and outcome assessment:

There was no statistically significant differences between the two groups. Table (2) shows the post-

Table (1): Patients' demographic data.

Characteristic	Group A	Group B
Age (mean ± SD)	29.6±12.11	30.25±12.17
Sex (male/female)	15/1	14/2
Right/left hand	9/7	5/11
Zone of injury (two/three)	15/1	14/2
<i>Affected fingers:</i>		
Index	5	4
Middle	4	5
Little	3	3
Thumb	3	3
Ring	4	7



Fig. (1): Two strand tendon repair (modified Kessler) in little finger.

operative range of motion of DIP, PIP joints flexion range of motion and Total Active Movement (TAM) of the injured fingers.

The DASH score for patients in group A ranges between 10-30. In group B, it ranges between 2-26. There was no statistically significant differences between the results of these two groups.

Table (2): Post-operative outcome measures of patients in both groups.

	Group A	Group B	p-value
<i>PIP flexion ROM:</i>			
Mean ± SD	96.88±3.59	98.68±2.26	0.079
Range	90-100	95-100	
<i>DIP flexion ROM:</i>			
Mean ± SD	71.58±2.91	72.73±2.98	0.221
Range	65-75	70-80	
<i>TAM of fingers ex. thumb:</i>			
Mean ± SD	259±4.9	261.8±3.8	0.068
Range	250-265	255-270	

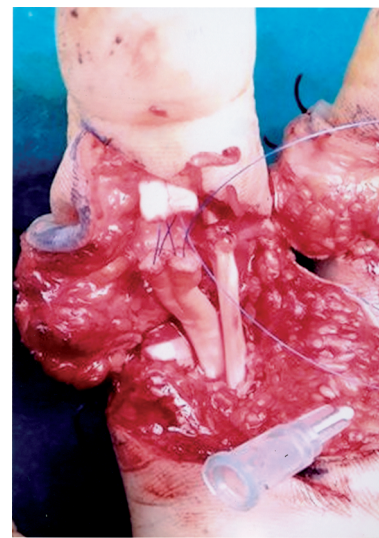


Fig. (2): Modified cruciate four strands sutures (intraoperative photo).



Fig. (3): Post -operative physiotherapy (passive flexion exercises).

DISCUSSION

Since the sixties of the twentieth century, the concept of primary flexor tendon repair started to gain popularity among surgeons [8]. Advances in understanding of flexor tendon anatomy, response to injury, healing mechanisms together with improvements in suture materials, suture repair designs, use of magnification and advanced rehabilitation protocols resulted in improved outcome of primary flexor tendon repair over delayed tendon grafting [9].

However, the goals of surgery for treatment of flexor tendon injuries are still constant. They include achieving precise coaptation of the ends of the lacerated tendon in order to permit successful rehabilitation protocol that improve tendon gliding and prevent adhesions formations and eventually results in restoration of normal ranges of motion of the affected finger [10].

Tendon suture techniques were assessed with concern to their materials, repair technique and usage of the epitendinous sutures. The optimal suture must be reliable, easy to achieve, result in identical coadaptation of the severed edges of injured tendon, produce a minor gap, provide minimal interference with vascularity of tendon and provide adequate power to permit quick rehabilitation [11].

The more the number of threads that transverse the tendon repair area, the stronger the power of the repair. Two, four, six [12] or even eight [13] strands tendon repair suture techniques have been described. Obviously, it could be shown that the biomechanical stability increases with number of core suture. However, surgeons aim to make tendon sutures easier and to preserve the suture power without increasing the technical difficulties [14].

The double-strand technique had considerably greater formation of gap than found in the four-strand technique [15]. However, the *in vitro* benefits of multi-strands tendon repair techniques are not necessarily reflected on results *in vivo* [16]. In addition, the usage of epitendinous suture is important to augments the confrontation of the repaired tendon by 10% to 50% and decreases the incidence of gap formation [17].

Kleinert passive motion rehabilitation protocol is a widely used protocol [18]. Frueh et al., in terms of Total Active Motion (TAM), did not observe any difference between early mobilization and controlled active motion [19]. In addition, very early active post-operative exercises can achieve minimal complication rate [20].

Interestingly, in an meta-analysis, there were no any statistically significant differences between double and multiple strands suture repair [21]. This why there is no universally accepted protocol for management of flexor tendon injuries.

The debate extends to the assessment tool for the outcome of surgery. Only a single joint ROM assessment in one finger using goniometer was shown to be reliable. Measuring of the sum of the ROM of two or three joints is less reliable [22].

However it is only a rough measure to assess the outcome of surgery. Assessment using (TAM/ROM) is difficult (needs multiple measuring) and debatable (depends on hand dominance and affected finger) [23]. Questionnaire DASH score needs cooperative and well informed patient and the questionnaire is not specific to flexor tendon injuries. It is an oral questionnaire that depends on the patients answers that may be incorrect or misleading [24]. Regarding hand grip strength, several studies did not prefer hand grip and pinch as a tool for assessment of outcome for tendon repair surgery (depends on intrinsic muscles plus flexor tendon, differs from dominant and nondominant hands and affected by age and sex) [25].

Conclusion:

In this study, we noticed that Cruciate (four-strand) suture procedures are easy to accomplish, offer less interfering with tendon gliding and are adequately strong for an early post-operative rehabilitation program. Regarding total active range of motion and DASH score, there were no statistically significant differences between the four strands or two strands groups.

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