

Treatment of Delayed Flexor Tendon injury in Zone II by Single Stage Tendon Graft

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Abstract

Objectives: To evaluate the functional outcome after tendon reconstruction by single-stage tendon grafting in neglected cases of zone II flexor tendon injuries in which primary repair was not considered because of delay in treatment or of inappropriate circumstances on the part of the wound and the patient. **Patients and methods:** A total of 9 patients (8 male and 1 female) aged between (1.5-57) year and mean \pm SD (19.4 ± 9.4) who (present with delayed flexor tendon injury 3 weeks to 1year post injury), in zone II, were operated as single stage flexor tendon grafting. **Results:** Functional outcome was excellent in 5 fingers (55.55%), good in 2 fingers (22.22%) and fair in 2 fingers (22.22%). Active movement ranged from $135^\circ - \geq 180^\circ$. **Conclusion:** Single-stage flexor tendon grafting seems to be an appropriate choice of treatment for flexor tendon injuries where good local wound conditions, mobile joint and no associated nerve injury.

Keywords: zone II flexor tendon injuries, single-stage flexor tendon grafting, neglected flexor tendon injury

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Introduction

Flexor tendon injuries account for <1% of all hand injuries (1). The management of delayed zone II flexor tendon injuries, is a highly debatable topic (3). Overall, the flexor tendoplasty previously described by Carroll in 1963 by using silicone rod for use in two stage flexor tendon surgery (4).The indications for secondary tendon reconstruction are: failed primary repair, neglected injuries, segmental tendon loss and complicated injuries (5).It has to be decided whether to do single stage tendon reconstruction or to proceed for two stage tendon reconstruction. There are certain prerequisites that have to be fulfilled before undertaking single stage reconstruction; these include: supple joints, wounds healed without contracture or much scarring, intact neurovascular structure, willingness and understanding to participate in rehabilitation programmes. It is important to adhere to the strict surgical technique of minimal tendon handling with preservation of the existing pulley system and tendon sheath. If excessive scarring is found in the tendon bed or pulleys are contracted leading to constriction

of the graft; then procedure should be converted for two stage tendon reconstruction as the single stage (6).

In the last 30 years there has been a steady improvement in the reported results of flexor tendon surgery and recovery of good or excellent function can now be expected in 80% or more of most strong tendon repair followed by early post-repair motion protocols(7).

Neglected cases and Lack of necessary materials such as (silicone rod) which use in two stage flexor tendon reconstruction motivated us to using Single-stage flexor tendoplasty.

Patients and methods

A total of 9 patients (8 male and 1 female) aged between (1.5-57) year and mean \pm SD (19.4 \pm 9.4) who (present with delayed flexor tendon injury 3 weeks to 1 year post injury), in zone II, were operated as single stage flexor tendon grafting. The study was conducted in Basrah General Hospital. The ethics committees of participating universities (College of Medicine, University of Basrah) and Basrah General Hospital approved the study, and informed consent was obtained from all patients, as well as the approval of patients who were under 16 year was taken from their parents. The cause of the injury was sharp materials like glass, knife etc. in 6 cases, while work accidents in 3 cases. All the cases were evaluated preoperatively by clinical and radiological assessment.

Inclusion criteria are: delayed flexor tendon injury (more than 3 weeks since injury), in zone II, flexible joints proximal and distal to the injury site, not infected and no associated nerve injury (explained clinically by paresthesia).

Exclusion criteria are infected site of injury, injury in other zones rather than zone II, stiff joint and associated nerve injury.

Tourniquet was used between pneumatic and the classical Esmarch, the standard Brunner's zigzag incisions were used to dissect tendons (8) as shown in (Figure 1).



Figure 1: pre and intra operative photos of patient with flexor tendon injury(zone II) for tendon graft.

Flexor tendon sheath were minimally resected and preserved if not already injured. Deep flexor tendon, nearly one cm length, was protected distally, and the rest of the flexor tendon was excised until the origin of the lumbrical muscles.

Superficial or deep flexor tendons were used as a motor power as well as, if deep flexor tendons were used as motor tendon, superficial flexor tendons are pulled distally and cut. Distal superficial flexor tendon was cut out, but 1-2 cm of tendon was preserved to avoid hyperextension deformity in PIP joint. It's worth mentioning that the palmarislongus muscle was presented in all our cases, and used as free tendon graft (for 8 fingers). In 1 case, flexor digitorum superficialis tendon was used.

The tendon grafts are transferred through the flexor tendon sheath using sutures. Generally, distal tendon repair was performed first, otherwise the proximal tenorrhaphy was performed with deep flexor tendon at the level of the origin of lumbrical muscle (Zone III).

Entire tendon grafts were interposed between zone I and III; distal insertions were performed by such techniques: distal phalanx perforation (Bunnell), transposing the graft through pulp (Pulvertaft), end to end tenorrhaphy to the distal end of the flexor tendon (tendon-tendon); and proximal insertions were performed by: Kessler and Pulvertaft methods (9, 10). Insertions were performed by tendon-tendon type distally and Pulvertaft type proximally in cases, tendon-tendon distally and Kessler type proximally in cases, Tension (length) of the tendon graft is important.

Early passive movement program was used as passive flexion and extension exercises were performed at the ward for the patient education and then instructed them to do so at home. The splint holds the wrist joint at 30° flexion, metacarpophalangeal joint at 70° flexion and DIP/PIP joint at 0° extension.

Active movement was started at 4th week, also the splint was used until 6th week. Isolated active joint movement started at 6th week. Consequently, at 8th week the hand was allowed for daily activities as shown in (Figure 2).

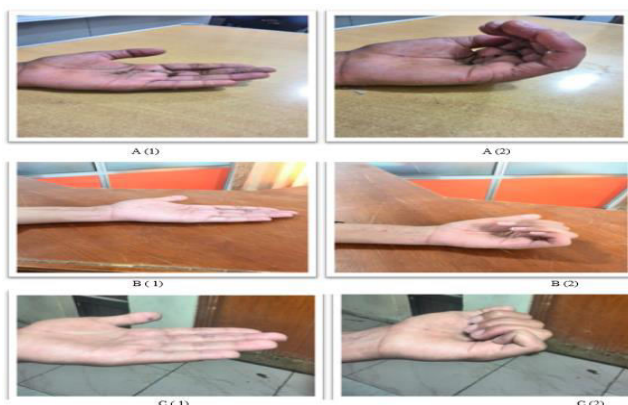


Figure 2: The same patient A(1 month), B (2 months) and C (4 months).

Moreover, the flexion movement was evaluated by Buck-Gramcko method (11) (Table 1).

Repair of flexor pollicislongus tendon injury was also evaluated by Buck-Gramcko method. Results were assessed by comparing the tendon graft choice (FDS/PL). Follow-up time was range from 3-7 months.

Table 1: Buck-Gramcko criteria for post-operative assessment of flexor tendon repair

Buck-Gramcko criteria	Degree	Points
PTP* distance TAF **	0-2.5 cm $\geq 200^\circ$	6
	2.5-4 cm $\geq 180^\circ$	4
	4-6 cm $\geq 150^\circ$ >6 cm	2
	<150	0
Extension deficit	$0^\circ-30^\circ$	3
	$31^\circ-50^\circ$	2
	$51^\circ-70^\circ$	1
	$>70^\circ$	0
Total active movement (TAM)	$\geq 160^\circ$	6
	$\geq 140^\circ$	4
	$\geq 120^\circ$	2
	$< 120^\circ$	0
Classification	-	
Excellent	-	14-15
Good	-	11-13
Fair	-	7-10
Poor	-	0-6

*PTP, palm-to-pulp distance in centimeters; TAF**, composite flexion of MCP, PIP and DIP joints; TAM, total active motion (TAM = TAF - TAED); TAED, total active extension deficit (12).

Results and Discussion

Primary repair becomes the preferred treatment for zone II flexor tendon injuries due to the developments in tendon repair techniques, indeed utilization of better suture materials and the increase in number of the surgeons dealing with hand surgery. It's worth to mention that delayed cases of zone II flexor tendon injuries, secondary repair is usually associated with poor outcome due to narrow pulley system, significant gapping of tendon ends due to tendon retraction, adhesions and fibrosis of muscle fibers. In such cases especially those cases which are not associated with fracture, vessel or nerve injury, good soft tissue cover, single stage tendon graft would be a reasonable option.

Functional results (according to Buck-Gramcko score excellent) were excellent in 5 fingers (55.55%), good in 2 fingers (22.22%) and fair in 2 fingers (22.22%) were achieved. Active movement was ranged from 135° - $\geq 180^\circ$.

Study performed by Aydin *et al.* included 37 patients (involving 41 fingers) showed 12 fingers (29.26%) perfect results, 13 fingers (31.7) good results, in 14 fingers (34.14%) average results, in 2 fingers (4.87) bad results were achieved (13).

On the other hand, Bunnell presented the results of 138 flexor tendon repairs at 118 patients, quarter of the patients had the excellent results as the pulp of the patients could touch distal palmar crease, half of the patients had good results as they could barely touch the palmar surface (14).

Chow *et al.* displayed the results of 78 flexor tendon repairs at 66 patients: %94 of all cases had excellent or good results by the formulation of Strickland (12).

In our study we found that the most common causes for the result below the excellence score are either uncooperative patient (like 2 of 3 children cases) or lack of programmed rehabilitation by the patient or the family.

No case of post-operative infection had been found in our cases, but Aydinet *al.* reported infection at the incision site has been occurred in 3 cases and regressed with antibiotic (13).

Palmaris Longus was used as free tendon graft in 6 fingers. In 3 cases, flexor digitorum superficialis tendon was used. Tendoplasty with FDS tendon sounds to be worse because of the thickness of the tendon comparing PL tendon; but we found no significant difference between the results of these two repairs. As a result, the use of flexor digitorum superficialis tendon which can easily be dissected at the operation area does not affect negatively to the results, this is also represented by Aydinet *al.* in his study (13).

Bunnell believed that the graft is shortened by time and he used to insert the tendon graft under minimal tension, on the contrary Pulvertaft believed that the tendon graft is elongated by time and inserted the graft under maximal tension (15, 16). In our series we put the tendon graft under maximum tension in all cases.

In our series we used combined Duran protocol (passive flexion of the DIP and PIP joints followed by active extension), followed by controlled active movement after 14 days while Aydinet *al.* used early passive movement (13).

There is study was performed by Silfverskiöldet *al.* stated that a large part of the variance in all the outcomes was probably related to the psychological and biologic characteristics of the patient (17).

Conclusion

We conclude that, when the local wound conditions are not suitable for primary tendon repair and tendons are too short to be repaired primarily, if the flexor pulley system is sufficient, we think that single stage tendoplasty with tendon graft is a good option, whereas in case which is re-operated or the pulley system was injured badly, two stage tendoplasty by tendon prostheses is advisable.

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