



The Use of “Extended Flexor Tendon Graft” in the Repair of Delayed Flexor Tendon Injury Instead of the Traditional Technique; A Comparative Study

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ABSTRACT:

BACKGROUND:

Flexor tendons repair outcome depends on meticulous surgery built upon a thorough knowledge of the anatomy and biomechanics of the flexor tendon system. Direct tendon repair is the standard method with most rewarding outcome. Still at times where direct repair is impossible because of large defect or sever adhesions, extra synovial tendon graft is considered. Attachment of the distal end of the graft at the insertion of the flexor digitorum profundus into the distal phalanx has been a matter of controversy.

OBJECTIVE:

Compare between the traditional way of attaching the distal end of the graft to the stump of the flexor digitorum profundus tendon, with an alternative “extended graft” technique that involves attaching the distal end to the distal phalanx through a pull-out suture.

PATIENTS AND METHODS:

Twenty-six patients included in this study, 21 case of injury to the flexor digitorum profundus and 5 involving the flexor pollicis longus. A mean age of patients of 29 years. All injuries presented late (more than 3 months). All cases reconstructed in Two-stage procedure of Hunter-Salisbury using silicone rod in the first stage, followed by replacement by Palmaris longus tendon graft in the second stage. Patients are divided into 2 groups ; first which included 15 case where the traditional methods used ; that is attaching the distal end of the graft to the stump of the ruptured flexor tendon, and in the second group the technique of “ Extended graft “, where the graft is attached by a pull-out suture to the distal phalangeal bone.

RESULTS:

Two groups of patients studied, fifteen case in the first group where the traditional method of repair used, and the “extended technique” used in eleven case, the second group. In the first, more than 50% of DIP flexion lost, whereas in the second group, more than 90% of DIP flexion preserved.

CONCLUSION:

We concluded that using the “extended graft” technique can markedly reduce the stiffness in the distal interphalangeal joint and thereby the loss of flexion that result from the traditional method.

KEYWORDS: Flexor digitorum profundus, Palmaris longus, silicon rod, two-stage tendon repair.

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INTRODUCTION:

Flexor tendon injury is one of the most common traumas of the hand ⁽¹⁾. Tendon defect reconstruction is amongst the most technically challenging areas in hand surgery. Direct repair of the injured tendon is the standard method in clinical practice⁽²⁾. Complete flexor tendon lacerations should be repaired early (preferably within 7 days of injury)⁽³⁾. Nevertheless, flexor tendon reconstruction is often necessary if direct repair is not possible because of either large tendon defect, or the repair fail due to sever adhesions with or without rupture^(4,5).

Reconstructive techniques for flexor tendon deficiency or loss include; lengthening (advancement), grafting and tendon transfer. Each technique is associated with unique challenges ⁽⁶⁾. Hunter and Salisbury described in 1971 a two-stage flexor tendon reconstruction using silicon rod (flexible silicone-Dacron reinforced gliding implant) in the first stage, and a free extra synovial tendon graft through the pseudo-sheath formed around the silicone in the second stage ⁽⁷⁾. The most commonly used grafts are; the Palmaris Longus (PL) as the first choice, and the Plantaris as the second choice.

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Palmaris tendon may be absent unilaterally or bilaterally. Other alternative grafts include; flexor digitorum superficialis, extensor indicis proprius⁽⁸⁾. Samuel R. and Carolina M. described the use of abductor pollicis longus tendon as an alternative graft⁽⁹⁾.

Brunelli in 1982⁽¹⁰⁾, has described the technique of ‘pull-out’ suture, and has long been the standard method of attaching the distal end of the tendon to the bone of the distal phalanx. Though this method carried the risk of violating the nail, Alexandru V.G and colleagues described a modification on Brunelli technique to overcome this drawback, in that they put the pull-out suture on the volar surface of the finger tip, thereby moving the tension from the level of the tendon disruption to the finger pulp over the tendon insertion⁽¹¹⁾.

The success of repair is dependent on its ability to withstand the forces generated during controlled passive motion thus preventing excessive ‘gap formation’, suture rupture or suture pullout from the tendon⁽¹²⁾.

Anatomical background

Flexion of the medial four fingers is powered by flexor digitorum superficialis (FDS) muscle which flexes the proximal interphalangeal joint (PIPJ), and flexor digitorum profundus (FDP) muscle, which flexes the distal interphalangeal joint (DIPJ). In the thumb, flexion of the ‘only one’ interphalangeal joint is accomplished by the action of the flexor pollicis longus muscle⁽¹³⁾. These tendons lie within a tendon sheath which is a synovial-lined channel that allows smooth gliding of the tendons during movement⁽¹⁴⁾. The flexor tendons are held close to the phalanges at all positions of flexion by ‘Pully’ system. There are five *annular* (A) and three *cruciate* (C) pulleys. A1, A3 and A5 pulleys occur at the joint levels. A2 is over the mid of the proximal phalanx, A4 is over the mid of the middle phalanx. A2, and A4 are the most important pulleys for proper flexion function, injury to these 2 pulleys results in ‘bowstringing’ deformity. The thumb has unique pulley system in that it has A1 and A2 pulleys with intervening ‘oblique’ pulley. Flexor tendons are classified as intrasynovial tendons because they are located within a synovial environment⁽¹⁴⁾.

PATIENTS AND METHODS:

This study included 26 patients presented with injuries of the deep flexor of the fingers (Flexor digitorum profundus 21 cases, Flexor pollicis longus 5 cases). Nineteen were males, seven were females. Ages ranged between 15 and 43 years. All the cases were presented late (after 3 months), where reconstruction by delayed direct repair was not possible. Therefore all cases were treated by two-stage reconstruction, Hunter-Salisbury technique; in the first stage a silicon rod was inserted to create a pseudo-sheath through which the tendon graft can glide freely when inserted in the second stage. In all cases Palmaris longus tendon was used as a graft. The type of Anesthesia used was regional (Bier’s block) using pneumatic tourniquet. Exploration of the area done through Brunner Zig-Zag incision.

Postoperatively, the dressing included dorsal blocking Plaster of Paris (POP) splint is applied to maintain the wrist flexion at 20° to 30°, the metacarpophalangeal (MCP) joint flexion at 50° to 70° and PIP and DIP joints in resting position, aided by the application of Kleinert stitch, and commencing motion at 7 days postoperatively. Passive PIP and DIP joints motion within the splint encouraged 4 times / day. At the week 4, active flexion and extension exercises outside the splint. At the fifth week the splint is discontinued. Blocking exercises initiated at 6th week. At the 8th week, gentle strengthening exercises started. Resisted exercised at the week 10.

RESULTS:

The cases were divided into 2 groups; the *first group* (Table 1), included **Fifteen cases**, in these cases the distal end of the grafts were attached ‘traditionally’ to the remnant (stump) of the flexor tendon performing Kessler’s technique of suture. The *second group* (Table 2), included **eleven cases**, here we used an ‘extended graft’ technique, in which the distal end of the grafts were attached directly to the base of the distal phalanx by a ‘Pull-out’ suture tied over a button on the nail dorsally ‘Brunelli’ technique⁽¹⁰⁾, used in eight cases, and in 3 cases the modified technique used as described by Alexandru⁽¹¹⁾ performed tying the pull-out suture anteriorly at the digital pulp.

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Table 1: Traditional method of attachment of the distal end of the graft to the stump of the FDP

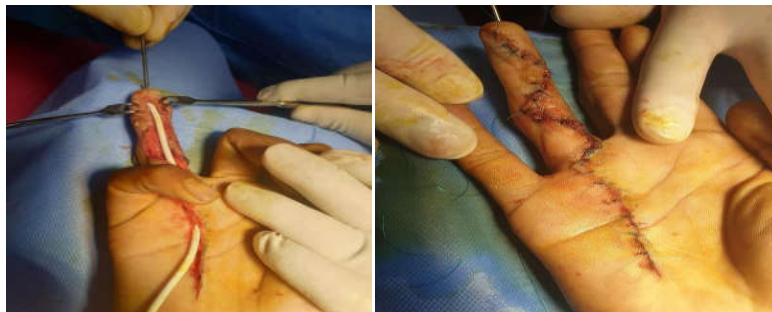
1 st GROUP		
No. of cases (Total 15)	DIP J flexion	PIP J flexion
12	50% loss	Good
2	Partial loss	Good
1	Infection(rod emoved)	

Table 2: Extended technique; attaching the graft end to the base of the distal phalanx.

2 nd GROUP (Palmaris tendon graft)		
No. of cases (Total 11)	DIP J flexion	PIP J flexion
9	90% flexion	Good
2	Lost(un compliant patient)	

Twelve cases from the *first group* experienced loss of nearly 50% of distal IP joint DIPJ flexion, with preservation of good PIPJ flexion. In two cases there was minimal DIPJ flexion lag. One case developed infection, and the rod was removed (Table 1). In the *second group*, with the use of extended graft technique;

attaching the distal graft directly into the base of the phalanx, nine cases showed well preservation of more than 90% of DIPJ flexion besides good flexion of PIPJ. Unfortunately, two cases lost due to lost follow-up (uncompliant patients), (Table2).



A case from the 2nd group; the silastic rod inserted in the distal phalanx in a pull-out suture technique.

DISCUSSION:

Dealing with flexor tendon injuries presenting late after one month, has long been a challenge to the hand surgeon, since these cases are mostly associated with either; laceration and loss of part of the tendon; adhesion of the tendon with the surrounding tissues; destruction and collapse of the synovial sheath; or damage to the pulley system. Small number of cases may present late and still there is a possibility of repair by delayed direct suturing, aided by advancement of the tendon, but not more than 1 cm., or using a Z-plasty technique at the musculotendinous junction to elongate the tendon for direct repair as described by Le Viet⁽¹⁵⁾. The two-staged procedure of flexor tendon reconstruction using a tendon graft,

has been widely applied since introduced by Hunter and Salisbury in 1971. In this procedure, attachment of the distal end of the graft to the site of flexor tendon insertion at the base of the distal phalanx has been done either by; attachment to a remnant of the flexor tendon, or in cases of near total rupture of the flexor tendon or avulsion with or without a piece of the base of the distal phalanx, attaching the graft to a “ Pull-out “ suture through 2 holes created in the bone and held to a button on the dorsal surface over the nail as described by Brunelli in 1992. In this study, we treated fifteen case by the traditional method, attaching the grafted tendon to a remnant of the injured flexor tendon, and found that it was associated with

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increasing stiffness of the distal interphalangeal joint (DIPJ) causing marked loss of flexion at this joint of nearly 50% in 12 cases out of 15, (table 1). This complication has largely been overcome by using the "extended graft" technique, whereby we attached the graft to the bone of the distal phalanx directly using 2 burr holes and a pull-out suture, ignoring the remnant of the flexor tendon insertion. This was markedly noticed in 9 cases out of 11 (2 lost due to lost follow-up), whereby flexion of more than 90% achieved, i.e; less than 10% flexion deficit (table 2). Compared with results by Zhang J.P. et al, where they gained 90% of flexion at the DIP joint in 4 cases out of 15 case of repair in zone I, and 69 case out of 111 case of repair in zone II, studied from 2014-2017⁽¹⁶⁾.

Postoperative physiotherapy using the passive motion of Kleinert, attaching the nail plate to an elastic band held at the wrist, passively draw the finger into flexion, against a dorsal blocking splint, for 4 weeks, followed by active flexion and extension exercises outside the splint for one week. At the fifth week the splint is discontinued, and gentle exercises initiated. At the eight week increasing strength exercises stated, resisted exercises at the week 10.

CONCLUSION :

The "Extended technique" of pull-out suture, markedly superior to the traditional method of attachment into the flexor tendon stump, in terms of improving the distal interphalangeal joint movement and thereby largely preventing stiffness.

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