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Novel Technique

The tendon graft wrap repair in flexor zone 5 injuries

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ABSTRACT

Tendon lacerations are commonly presented in hand injuries. Within flexor tendons, zone 5 has not been a spotlight topic in the literature although it encompasses important tendons involved in wrist stability. The aim of the study was to highlight the importance of tendon repair in flexor zone 5 introducing a novel technique. In this article we described our new surgical technique use at the plastic and reconstructive surgery unit of the General Hospital of Mexico with 4 different flexor tendon zone 5 injuries. All cases included a HBRT laceration in this zone. We also describe its variances for reconstruction based on our proposed tendon territory classification. Our tendon injury classification is based on anatomical features and may be useful for repair planning. Our technique is based on a 'like with like' tendon supply to achieve a strong biomechanical reinforcement. TGW technique was a reliable reinforcement on primary tendon repair after using a conventional tenorrhaphy. Tendon reconstruction still has a field of research and improvements. Our work stands out some specific tendon requirements and relevant territories. We propose a simple management with a novel technique.

Keywords: Tendon injuries, Tendon repair, Tendon graft, Flexor zone 5

INTRODUCTION

Background

Tendon lacerations are commonly presented in hand injuries.[1] In 1981 the committee of tendon injuries established an anatomic nomenclature that is still used worldwide to guide primary repair.[2]

Within flexor tendons, zone 5 has not been a spotlight topic in the literature, although it encompasses important tendons involved in wrist stability. There are few statistics concerning this zone. The aim of the study was to highlight the importance of tendon repair in flexor zone 5 introducing a novel technique.

Recent data

In the period between April 2021 and September 2022, we operate 125 flexor zone 5 injuries at our unit.

Gender shows 93 males (74.4%) and 32 females (25.6%). Age group was predominantly the third decade of life (53%). The most common cause was glass injuries (53%).

Reported complications were repair rupture, peritendinous adhesion, digital joint contracture, wrist, and digital deformity.[3-5] Our data matches with limited world literature.

We focus on special tendons repair in this zone.

Biomechanical requirements in tendons

Flexor zone 5 tendons varies on length, caliber, and strength, according to their biomechanical requirement. We notice 3 groups arising in this zone (Table 1). High biomechanical requirement tendons (HBRT) are located at the superficial flexor tendon plane in the forearm playing an important role in wrist stabilization. The analogous HBRT in the dorsal compartment is extensor zone 8, including extensor carpi radialis longus and brevis, and extensor carpi ulnaris.

Table 1: Biomechanical requirement of tendons in flexor zone 5.

Biomechanical requirement	Tendon
Low	PL
Intermediate	FDS, FDP, FPL
High	FCR, FCU

*Note: PL: Palmaris longus; FDS: flexor digitorium superficiali; FDP: FD. Profundus; FPL: flexor policis longus; FCR: flexor carpi radialis; and FCU: flexor carpi ulnaris.

Tendon territories

One tendon pathway presents a remarkable difference in strength properties, elongation range, collagen fibbers and surrounding tissue that leads us to propose an anatomical division. We landmark 3 relevant tendon territories (Figure 1). <2 cm close to osteotendinous junction (territory 1: t1), along the tendon body (territory 2: t2) and < 2 cm close to musculotendinous junction (territory 3: t3). This outcomes on a tendon injury classification depending on the tendon territory affected (t1, t2, t3).[6]

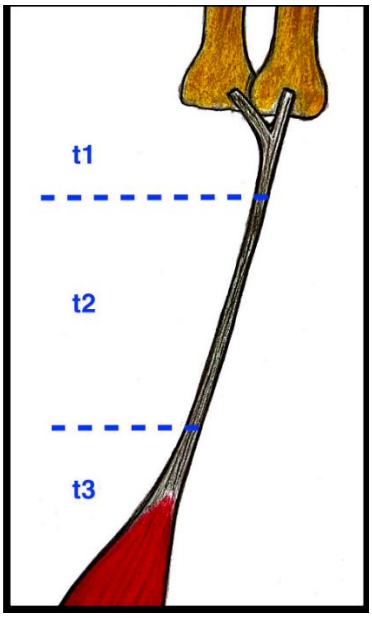

Figure 1: Tendon territories- FCR illustration with 3 relevant tendon territories: (t1) <2 cm close to osteotendinous junction, (t2) along the tendon body, and (t3) <2 cm close to musculo-tendinous junction.

The tendon graft wrap

After a tendon repair is performed; load force provokes a reverse proportion change in elongation.[7-9] High load decrease elongation and future loading risks repair rupture. When increasing substance, the tissue may be reinforced, and elongation may tolerate higher loading.[10] Based on a 'like with like' principle, the ideal substance supply is an autologous tissue. A tendon graft is a metabolically active structure that maintains viability by diffusion of tissue fluid. Therefore, we design a tendon graft supply to wrap a primary tendon repair that may reinforce it while increasing substance.

METHODS

In this article we described our new surgical technique use in 4 cases at the plastic and reconstructive surgery unit of the General Hospital of Mexico. We presented 4 different flexor tendon zone 5 injuries operated from April 2022 to September 2022. All cases included a HBRT laceration in this zone.

Surgical technique

We performed all procedures at the plastic and reconstructive emergency room. Preoperative preparation includes nerve block anaesthesia, and we applied a forearm tourniquet. The cleaning was made with povidone-iodine solution and debriding if necessary with a scalp blade. All procedures were performed with 3.5X magnification. We focus the surgical description in tendon repair using the tendon graft wrap (TGW) technique. We describe and illustrate the TGW technique with an example of a tendon body laceration (Figure 2).

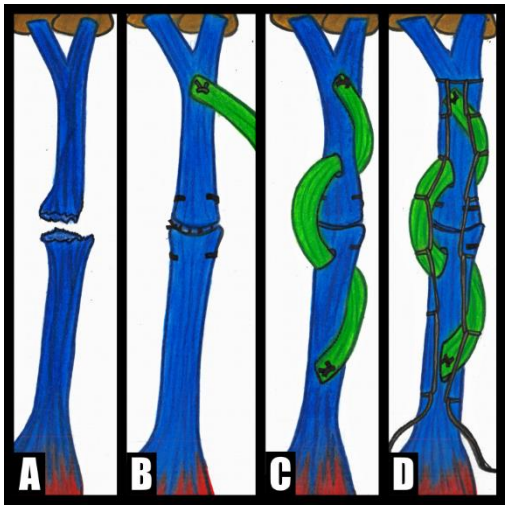

Figure 2: TGW technique (illustration)- Tendon injury (t2) of a FCR (blue) using a PL graft (green) for TGW reconstruction (A) FCR rupture; (B) FCR repair with central core suture technique and PL graft harvested; (C) FCR primary repair reinforced with PL graft weave; and (D) TGW final fixation with a continuous locking loop suture.

TGW can be performed in all tendon territories (t1- t3) (Figure 3) with different graft patterns (Figure 4). The source of tendon graft might be palmaris longus (if present) or flexor digitorium superficialis (if available).[11] The tenorrhaphy is performed with a double loop central core (Bunnell or modified Kessler) with internal Knott. The suture material used is 4-0 non-absorbable suture. Tendon graft can be wrapped on a free style design (Figure 5), performing a 2-5 weave repair *(*pulvertaft*)*. Final fixing is made with a continuous locking loop suture (Krackow).[12] Intra-operative total active movement was tested after every final repair.

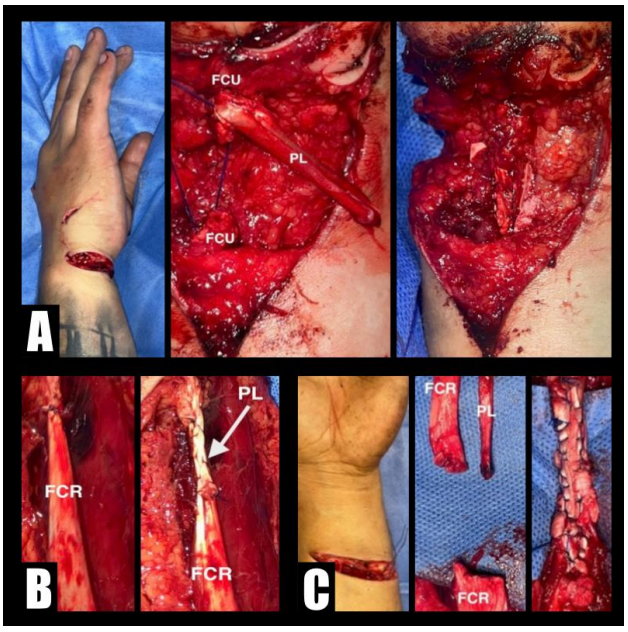

Figure 3: TGW use in different tendon territories. In every case a PL graft design is use, and TGW technique is performed after primary tendon repair. A: FCU (t1); B: FCR (t2); and C: FCR (t3).

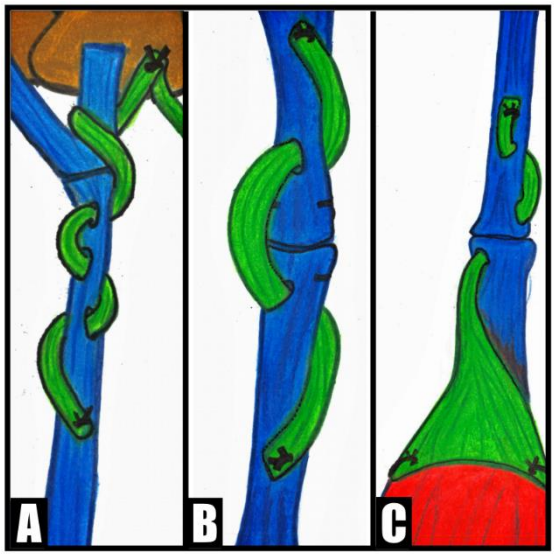

Figure 4: Grafting patterns in different tendon territories (A) 'V' shape (t1); (B) single strip shape (t2); and (C) hand-fan shape (t3).

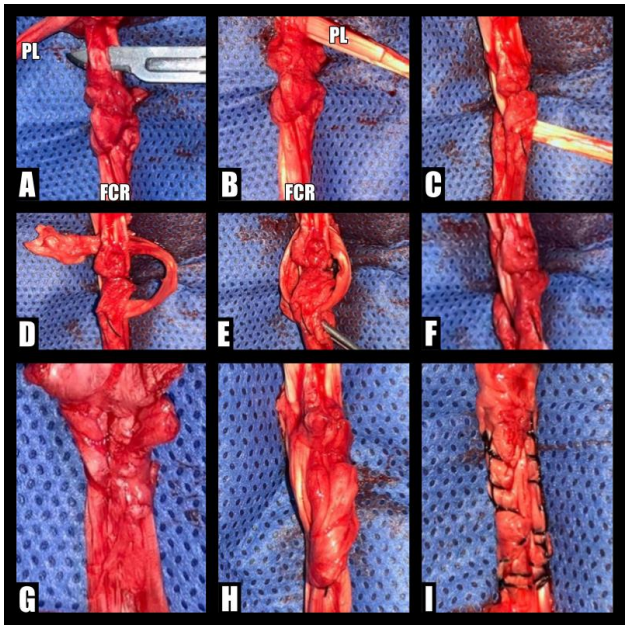

Figure 5: TGW technique (case). Critical points after a FCR t2 primary repair, reinforced with a PL graft. (A) FCR distal window made with scalp; (B) PL graft going through the distal window; (C) second weave of PL graft (after this point, the third weave would normally pass through a proximal window, but a back loop reinforcement was performed); (D) back loop of PL graft; (E) PL graft loop surrounding 360° of the tendon injury; (F) PL graft squeezing the tendon injury site to reduce the tendon gap; (G) FCR central core suture; (H) FCR 5 weave repair (after G); and (I) FCR continuous locking loop suture (after H).

RESULTS

Our proposed tendon injury classification helped us for repair planning and guided the surgical performance. In 't1' laceration the graft tenodesis stabilized wrist motion, permitting a primary tendon repair extremely close to the osteotendinous junction. In 't2' laceration it showed a safe tendon repair with a normal wrist angulation at the end of the procedure. In 't3' laceration it reinforced the complex musculotendinous junction with a strong and anatomical reconstruction. All tendon reconstructions presented a successful intraoperative active motion test. TGW technique was a reliable reinforcement on primary tendon repair after using a conventional tenorrhaphy.

DISCUSSION

Current literature encompasses different surgical techniques for primary tendon repair and update surgical management based on biomechanical properties.[13-15]An important outcome is that primary repair of tendon lacerations is considered the gold standard if available. Flexor zone 5 has not been a spotlight topic in the literature despite these injuries needs special attention considering wrist stabilization and earlier tendon recovery. This article lies in tendon reconstruction, pointing out that scenarios

where arterial or nervous damage is present, microvascular repair is priority. We first proposed a tendon injury classification based on anatomical features to clarify repair planning. Our technique is versatile while using free style graft patterns, leaving the hand surgeon an enormous range of possibilities after a primary tendon repair. It is based on a 'like with like' tendon supply to achieve a strong biomechanical reinforcement that may be a useful tool in tendon reconstruction.

CONCLUSION

Tendon reconstruction still have a field of research and improvements. Our work stands out some specific tendon requirements and relevant territories. We propose a simple management with a novel technique. Future research is needed around our technique and might include extensor tendons, secondary tendon repair and tendon transfer.

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