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Case Report

Extensor tendon injuries in zone VI – surgical repair and functional outcomes: a case report

Guillermo Tapia-Barragán[1]*, Paul A. Palacios-Zaragoza[2], Eduardo Balboa-Hernández[3], Andrea Alvarado-Herrera[4], Alejandro H. Oliva-Arvizu[5], José F. González-González[6]

[1]General Surgery Department, Hospital General 450 de Durango, México
[2]Universidad de Colima, México
[3]General Surgery Department, Complejo Científico Ortopédico Internacional Frank País, La Habana, Cuba
[4]General Surgery Department, Hospital General Regional 251, Metepec, México
[5]General Surgery Department, Hospital General Regional No. 1 IMSS, Querétaro, México
[6]General Surgery Department, UMAE Hospital de Especialidades "Dr. Bernardo Sepulveda" CMN Siglo XXI, IMSS, México

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***Correspondence:**
Dr. Guillermo Tapia-Barragán,
E-mail: medscienceeditorial@gmail.com

ABSTRACT

Extensor tendon injuries in Zone VI of the hand are common and generally offer favorable conditions for primary repair because of the larger tendon caliber and lower anatomical complexity. Optimal functional recovery depends on appropriate surgical technique, suture selection, and postoperative rehabilitation. We report the case of a 35-year-old man with complete laceration of the extensor digitorum communis tendons of the third, fourth, and fifth digits following a sharp traumatic injury. Primary repair was performed using a modified Kessler technique with a 3-0 nylon core suture and a continuous 4-0 nylon epitendinous suture. A review of the recent literature on Zone VI extensor tendon injuries, including technical and biomechanical considerations, was also conducted. This case supports current evidence that combining core and epitendinous sutures, together with a thorough understanding of tendon anatomy and biomechanics and the implementation of early rehabilitation protocols, provides reliable restoration of extensor function and favorable clinical outcomes in Zone VI tendon injuries.

Keywords: Extensor tendons, Juncturae tendinum, Injury

INTRODUCTION

The extensor tendons of the hand are fundamental anatomical structures for fine motor function, enabling finger extension and coordinating complex hand movements in conjunction with the flexor apparatus. Anatomically, these tendons are located on the dorsal aspect of the hand and are characterized by a superficial course with relatively thin soft-tissue coverage, making them particularly vulnerable to traumatic injury.

Unlike the flexor tendons, the extensor tendons become flatter distally and form complex expansions, such as the dorsal extensor apparatus, which includes the central slip, lateral bands, and intertendinous structures. On the dorsum of the hand, specifically within the so-called Zone VI, the tendons of the extensor digitorum communis (EDC) are relatively independent, with less contribution from the *juncturae tendinum* compared with more proximal zones. This anatomical arrangement results in distinct biomechanical behavior in the setting of tendon injury and repair.

The classification of extensor tendon injuries is primarily based on their anatomical location, with the most widely accepted system being the one proposed by Verdan, which divides the extensor mechanism into eight zones. Zone VI corresponds to the dorsum of the hand at the level of the metacarpals and is considered one of the regions most frequently affected by open traumatic injuries.

This zone presents favorable anatomical characteristics for surgical repair, as the tendons are of larger caliber, exhibit less structural complexity than those in more distal zones, and allow the application of more robust suture techniques. However, the presence of adjacent structures such as the intertendinous expansions and the differential mobility of the tendons may influence functional outcomes.

From a clinical standpoint, injuries in this zone typically manifest as loss of active extension of the affected digits, with relative preservation of passive extension.

Globally, the incidence of tendon injuries of the hand varies according to occupational and socioeconomic context, occurring more frequently among manual laborers, manufacturing industry workers, and individuals engaged in domestic activities. In developing countries such as Mexico, these injuries are of particular relevance due to the high proportion of the population employed in informal and manual labor, as well as the limited implementation of occupational safety measures.

Epidemiological studies conducted in Mexico have reported that injuries caused by sharp instruments—including metal sheets, glass, and tools—constitute a frequent cause of extensor tendon damage, predominantly affecting young men of working age.[1]

Management of extensor tendon injuries in Zone VI is predominantly surgical, particularly in cases of complete transection, with the primary objective of restoring tendon continuity and preserving extensor function. Primary repair through tenorrhaphy remains the treatment of choice, employing suture techniques that combine a central or "core" component—such as the modified Kessler technique—with a circumferential epitendinous suture, thereby increasing tensile strength and facilitating tendon gliding. The relatively broad tendon caliber in this zone allows placement of multiple suture strands, improving repair stability.[2]

Additionally, the advent of surgical techniques performed under wide-awake local anesthesia with no tourniquet (WALANT) has enabled improved intraoperative assessment of tendon function.

On the other hand, treatment success depends not only on the surgical technique but also on the implementation of an appropriate rehabilitation protocol. Current trends favor early controlled mobilization, which has demonstrated superior functional outcomes compared with prolonged immobilization by reducing adhesion formation and improving tendon excursion. Protocols such as relative motion extension splinting have shown particular benefits in injuries involving Zones V and VI.[3]

In this context, extensor tendon injuries in Zone VI represent a clinically relevant model that combines anatomical characteristics favorable for repair with important biomechanical and rehabilitation challenges. Their appropriate management requires a comprehensive understanding of anatomy, classification, epidemiology, and surgical principles in order to optimize functional outcomes and facilitate the patient's return to daily and occupational activities.

CASE REPORT

A 35-year-old male patient with no significant past medical history presented after sustaining a sharp traumatic injury to the right hand caused by contact with a metal sheet, subsequently developing partial inability to actively extend the third, fourth, and fifth digits.

Initial clinical examination demonstrated an extension deficit of the affected fingers, without evidence of distal vascular compromise. The patient was evaluated by the Plastic and Reconstructive Surgery service, and surgical management was indicated (Figure 1).

Figure 1: Preoperative image showing an 8×3 cm laceration on the dorsum of the right hand with exposure of the extensor digitorum communis tendon.

Figure 2: Intraoperative image showing transection of the extensor tendons of the third, fourth, and fifth digits.

The patient was taken to the operating room, where, under sterile conditions with appropriate aseptic and antiseptic measures, surgical exploration of the dorsal aspect of the right hand was performed. During the procedure, complete transection of the extensor tendons corresponding to the extensor digitorum communis of the third, fourth, and fifth digits was identified (Figure 2).

Figure 3: Intraoperative image showing repair of the common extensor tendons of the third, fourth, and fifth digits of the right hand.

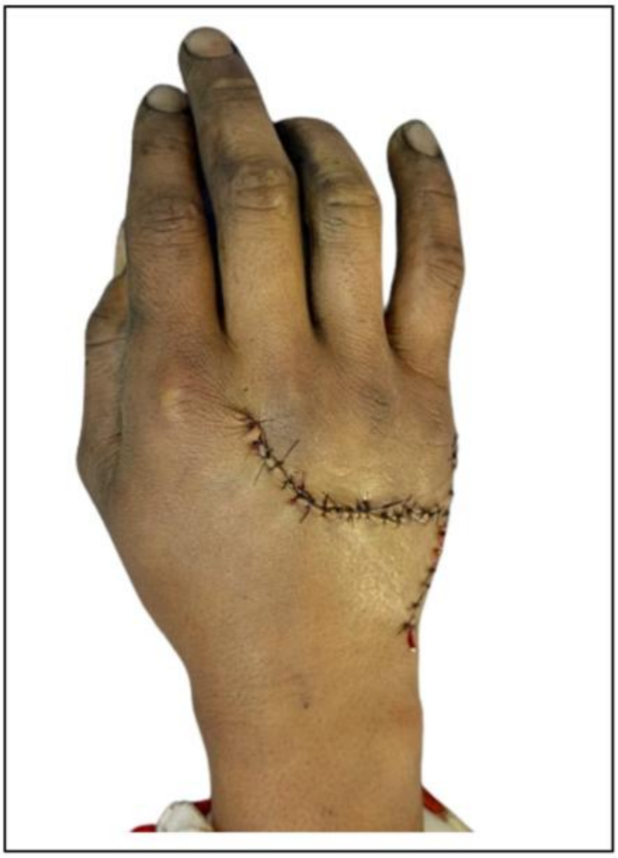

Figure 4: Postoperative image showing the wound closed with simple interrupted 3-0 nylon sutures.

Primary repair was then performed using a modified Kessler tenorrhaphy technique with 3-0 nylon for the core suture, complemented by a continuous epitendinous suture using 4-0 nylon, achieving adequate coaptation of the tendon ends (Figures 3 and 4).

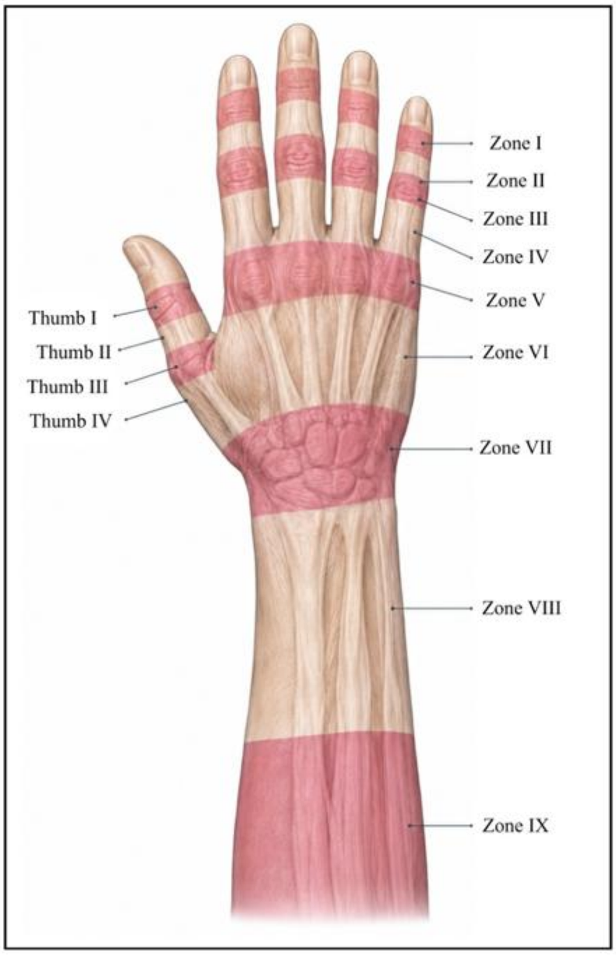

Figure 5: Extensor tendon zones according to Claude Verdan.

Tendon repair in Zone VI achieved adequate coaptation of the tendon ends, providing sufficient stability to allow the implementation of early mobilization protocols. Current literature reports that modified Kessler-type sutures provide an approximate tensile strength ranging from 40 to 60 N, which is significantly increased with the addition of an epitendinous suture, reaching values close to 60–80 N. This additional reinforcement reduces the risk of repair dehiscence and promotes improved tendon gliding. Furthermore, combined repair techniques have been shown to improve functional outcomes and decrease adhesion formation when compared with simple tendon repairs.

DISCUSSION

Zone VI of the extensor system corresponds to the dorsal metacarpal region and represents a particularly important area for primary repair because, unlike more distal zones, the tendons are thicker, better accommodate core sutures, and allow for protected early mobilization strategies. At the same time, the presence of the juncturae tendinum may mask extension deficits and delay diagnosis if clinical examination is not performed meticulously.

In contemporary practice, the best available evidence supports three fundamental principles: anatomical repair with atraumatic tissue handling, construction of a tenorrhaphy that is sufficiently strong yet low in bulk, and early protected rehabilitation—ideally through early active motion protocols such as relative motion extension splinting (RME/ICAM) or controlled active motion (CAM) when the repair is robust and patient adherence is reliable.[4] Merritt et al, Tang et al and Arvind et al concur that the objective is not merely to “reconnect” the tendon, but rather to restore tendon gliding, prevent gap formation, and minimize adhesions without increasing the risk of rupture.[2,5,6]

From a technical perspective, the modified Kessler technique remains a valid and highly reproducible option in Zone VI, particularly in clean lacerations involving one or multiple extensor digitorum communis tendons, especially when combined with a continuous epitendinous suture that improves edge coaptation and surface smoothness.[6] However, biomechanical literature demonstrates that alternative configurations, such as the modified Becker technique or the running interlocking horizontal mattress (RIHM) suture, may provide greater stiffness or initial tensile strength in certain experimental models.[7]

Zone VI is located over the metacarpals on the dorsum of the hand. In the traditional Verdan classification, it corresponds to the “metacarpal zone” of the extensor apparatus; Tang et al and the subsequent international consensus by Tang et al have emphasized the need to clarify these anatomical boundaries in order to standardize indications and outcome reporting.[8,9] In this region course the tendons of the extensor digitorum communis, frequently accompanied by the extensor indicis proprius and extensor digiti minimi. Unlike more distal zones, the tendons in Zone VI possess sufficient bulk to accommodate core suture techniques. However, clinical assessment must take into account the presence of the juncturae tendinum, oblique intertendinous connections between the extensor tendons that redistribute force and may preserve a degree of extension despite isolated complete tendon transection. For this reason, selective extension testing with adjacent digits flexed and individual examination of each digital ray are recommended during clinical evaluation (Figure 5).

The favorable anatomy of Zone VI explains why it is considered an ideal region for primary repair, provided that viable tendon ends are present and tension-free coaptation can be achieved. Classical indications include complete lacerations and significant partial lacerations associated with weakness or clinically evident extensor lag. The so-called “50% rule” remains widely cited; however, the systematic review by Dickson et al demonstrated that the supporting evidence for this threshold is weak, while the national practice survey by Reed et al confirmed persistent uncertainty among surgeons regarding its application.[10,11] In other words, rather than relying solely on an isolated percentage of tendon involvement, greater importance should be placed on functional deficit, laceration pattern, tissue quality, wound contamination, and the feasibility of reliable postoperative rehabilitation.

Absolute contraindications to immediate primary repair are relatively few; however, several important relative contraindications must be considered, including grossly contaminated or bite wounds that have not yet undergone adequate debridement, active infection, segmental tendon loss requiring repair under excessive tension, associated cutaneous or articular destruction preventing safe coverage or mobilization, and a clinical context in which adherence to rehabilitation protocols is unlikely. When significant tendon loss is present or direct coaptation compromises subsequent flexion, the strategy should shift toward tendon grafting, lengthening, or tendon transfer rather than forcing a “heroic” end-to-end repair. Interestingly, Dalton et al did not identify major clinical differences between repairs performed before or after 14 days in their retrospective series; nevertheless, this does not invalidate the practical principle that early repair is generally technically cleaner and less prone to fibrosis.[12]

Preoperative preparation begins with verification of the mechanism of injury, laterality, involved digits, sensory and vascular status, as well as the presence of associated osseous or articular injury. If the wound is clean and the patient cooperative, the WALANT (wide-awake local anesthesia no tourniquet) technique is particularly useful in Zone VI because it allows real-time assessment of tendon mechanics during surgery. The most commonly used formulations include 1% lidocaine with epinephrine 1:100,000, with or without bicarbonate. Several reviews recommend waiting approximately 20–30 minutes to maximize vasoconstriction, although some groups have reported successful use with shorter waiting intervals. When WALANT is not employed, regional block anesthesia or general anesthesia with pneumatic tourniquet ischemia remain valid alternatives.[13]

The incision should be centered over the laceration but extended longitudinally when visualization is inadequate. On the dorsum of the hand, longitudinal extensions are considered safe and provide improved exposure with lower risk of compromising narrow cutaneous flaps. Following copious irrigation and conservative debridement—limited only to devitalized or clearly frayed tissue—each tendon end should be identified while preserving the paratenon as much as possible. In Zone VI, proximal tendon retraction may be limited by the juncturae tendinum; however, these same connections can mask multiple tendon injuries. Therefore, adjacent tendons must be systematically explored, and it should never be assumed that the wound involves only a single tendon. Hemostasis should be precise but not excessive: the goal is adequate visualization rather than tissue carbonization, as excessive cautery and manipulation increase adhesion formation.

Once the tendon ends have been identified, the margins are minimally trimmed, any longitudinal markings are aligned when present, and the repair is assessed to ensure anatomical coaptation without significant shortening. In a standard Zone VI tenorrhaphy, a reasonable sequence consists of: core suture placement, verification of symmetry, epitendinous/circumferential suture, excursion testing, skin closure, and splint application. When WALANT is used, an important advantage is the ability to ask the patient to perform gentle flexion and extension of the fingers after repair in order to detect gapping, tendon entrapment, or overtightening. This intraoperative physiological assessment represents one of the most compelling strengths of the tourniquet-free approach.

In Zone VI, the modified Kessler technique is commonly performed as a two-strand core suture with the knot buried within the repair site. In practical terms, the needle is inserted several millimeters proximal to the lacerated edge, exits through the tendon surface, crosses into the distal tendon stump, re-enters at the transected edge, and exits distally. The same pathway is then mirrored on the opposite hemicylinder, allowing two strands to cross the repair site and compress the tendon ends when tied. Its appeal is evident: speed, reproducibility, and low repair bulk. In thicker tendons, or when greater tolerance for early mobilization is desired, the same principle may be expanded to a four-strand construct by repeating the pattern or using looped or related variants. The limitation of the modified Kessler technique is not conceptual but biomechanical: compared with more complex configurations, it provides adequate—but not maximal—strength. Arvind et al and contemporary technical reviews continue to consider it an appropriate option in Zones V–VII.[14] Biomechanically, Woo et al demonstrated in an extensor tendon model that the double modified Kessler configuration achieved 48.6±12.6 N at 2 mm gap formation and an ultimate load of 56.8±14.8 N.[15]

The continuous epitendinous suture should not be regarded as merely decorative, but rather as a functional component of the repair. Its purpose is to improve peripheral coaptation, reduce surface irregularity, decrease force dispersion at the laceration edge, and provide additional resistance against gap formation. In extensor tendons on the dorsum of the hand, it is typically performed using fine monofilament material, most commonly 4-0 to 6-0 nylon or polypropylene, with short, regular passes that capture only the tendon periphery in order to avoid excessive repair bulk. Henderson et al experimentally demonstrated that, as an isolated peripheral repair, the interlocking horizontal mattress variant achieved an ultimate tensile strength of 43 N, exceeding that of other peripheral repair techniques, which ranged between 27 and 31 N. Although that experiment did not directly quantify a combined "Kessler + epitendinous" repair in Zone VI, it nevertheless supports the mechanical value of a well-constructed peripheral repair.[16]

Regarding alternative techniques, the modified Becker repair has demonstrated greater strength in classic extensor tendon studies, although it is more technically demanding and bulkier.[17] The running interlocking horizontal mattress (RIHM) technique demonstrated, in a cadaveric Zone VI model, an ultimate load comparable to Becker repair but with greater stiffness and significantly less shortening. The modified Bunnell technique is well known but is generally less attractive when rigidity and minimization of shortening are prioritized. Techniques such as Savage, cruciate, or interlocking repairs have sound biomechanical rationale—more strands, more locking configurations, greater strength—but direct quantitative data specifically addressing Zone VI extensor tendons remain limited. For this reason, this review does not extrapolate Newton values derived from flexor tendon models as though they were anatomically equivalent, except to acknowledge that the general direction of evidence favors increased strand number and locking constructs when tendon caliber can accommodate the added bulk.

The choice of suture material should be pragmatic. In Zone VI, the core repair is commonly constructed with 3-0 or 4-0 nonabsorbable suture. Nylon and Prolene are frequent monofilament choices, whereas some surgeons prefer braided polyester because of its handling characteristics and knot security. A 3-0 caliber is often reserved for thicker tendons and repairs expected to tolerate protected mobilization, while 4-0 may be sufficient for smaller tendons or when minimizing repair bulk is desirable. PDS represents a reasonable absorbable alternative when concern exists regarding knot prominence beneath thin dorsal skin, although its use remains more heterogeneous and Zone VI–specific evidence is limited. Ultimately, the rationale for material selection depends less on the commercial name and more on four essential properties: knot security, tissue drag, suture memory, and the final bulk of the repair.[18]

From an epidemiological perspective, hand injuries predominantly affect young men of working age. On a global scale, the global burden of disease analysis for 2017 reported an age-standardized incidence of 179 per 100,000 population for hand and wrist fractures, 24 per 100,000 for thumb amputations, and 56 per 100,000 for non-thumb digital amputations, with a relative increase in disease burden observed in middle-income countries.[19] In Mexico, an emergency department series from a referral center found that hand and wrist injuries accounted for 8.9% of all emergency consultations. The majority of affected patients were men between 21 and 30 years of age, and extensor tendon injuries of the hand represented approximately 1.55% of the specific recorded diagnoses.

This epidemiological context is important because it highlights why reliable tendon repair and efficient rehabilitation have not only functional implications but also significant social and occupational impact (Table 1).

Table 1: Biomechanical evaluation of classical and contemporary extensor tendon repair techniques.

Technique	Typical Material	Reported Strength	Advantages	Disadvantages
Kessler modified	Core 3-0/4-0 nylon or polypropylene	48.6 N at 2 mm gap; 56.8 N ultimate load	Reproducible, fast, low bulk	Lower strength than Becker in classic studies
RIHM	3-0 nylon in clinical practice; nonabsorbable variants in laboratory studies	51 N ultimate load; stiffness 8.506 N/m; shortening 1.7 mm	High stiffness, less shortening, rapid execution	Less widely used
Becker augmented	Nonabsorbable	53 N ultimate load; stiffness 5.971 N/m	Strong construct	Greater shortening than RIHM
Bunnell modified	Nonabsorbable	48 N ultimate load; stiffness 6.719 N/m	Well-known technique	Greater shortening, lower stiffness than RIHM
Horizontal interlocking mattress epitendinous	4-0/5-0/6-0 monofilament	43 N ultimate load	Improves peripheral edge apposition and strength	Adds operative time and some bulk
Simple continuous epitendinous / Halsted / Silfverskiöld	4-0 to 6-0 monofilament	27–31 N ultimate load	Smooths surface and improves edge coaptation	Lower peripheral strength than IHM

Note. Values in Newtons are derived from biomechanical studies not explicitly included in the original priority list: Woo et al, Lee et al and Henderson et al.[7,15,29]

The principal complications associated with extensor tendon repair include tendon rupture, adhesions, stiffness, infection, and extensor lag. Tendon rupture is commonly related to inadequate suture purchase, poor tissue quality, excessive tension, inappropriate repair configuration, or a rehabilitation protocol whose intensity exceeds the initial strength of the repair. Adhesions and stiffness, in contrast, are often the consequence of the surgical trauma–immobilization interplay. For this reason, prevention begins even before splint application: minimal debridement, preservation of the paratenon, meticulous hemostasis, avoidance of tendon shortening, addition of a continuous peripheral suture whenever possible, and selection of a postoperative rehabilitation protocol that corresponds to the actual biomechanical strength of the repair rather than the surgeon's optimism. In contaminated or bite wounds, septic control must take precedence over the "elegance" of immediate repair. In the present case, meticulous surgical technique, atraumatic tissue handling, precise tendon approximation, and appropriate postoperative management resulted in an uneventful recovery. The patient developed no postoperative complications, including tendon rerupture, infection, adhesions, stiffness, or extensor lag. Wound healing progressed satisfactorily, tendon continuity was maintained, and full functional recovery of the affected digits was achieved. These findings underscore the importance of adherence to sound surgical principles and evidence-based rehabilitation in minimizing complications and optimizing functional outcomes following Zone VI extensor tendon repair.

With regard to rehabilitation, contemporary evidence favors protected early mobilization over rigid immobilization when the repair is sufficiently robust. Collocott et al concluded that early active mobilization protocols in Zones V–VI provide superior outcomes compared with immobilization, although no single program has proven universally superior.[20] The randomized trial by Collocott et al demonstrated that a relative motion extension (RME) program enabled earlier return of hand function and greater patient satisfaction with the orthosis compared with a controlled active motion (CAM) protocol.[21] Subsequently, Hirth et al showed that the RME approach, with or without an additional nighttime orthosis, produced clinically similar outcomes without tendon rupture.[22] Bűhler et al further supported that the RME-plus protocol was not inferior and was more cost-effective than dynamic extension orthosis, while Bojnec et al found that the RME concept in Zones IV–VI accelerated early functional recovery compared with dynamic extension orthosis (DEO), with no major differences between isolated RME and RME-plus protocols.[23,24] In clinical practice, RME/ICAM protocols are generally indicated for stable repairs in compliant patients, whereas CAM remains a highly reasonable option when a more conventional controlled orthotic strategy is preferred. Immobilization is best reserved for fragile repairs, complex injuries, noncompliant patients, or unfavorable pediatric or social circumstances.

Expected functional outcomes in proximal extensor tendon zones are generally superior to those observed in distal zones. Dalton et al reported poorer final flexion in Zones 1–4 compared with Zones 5–8, with a final total active motion of 141.4° versus 195.3°, respectively, while no significant differences were observed in final extension. In the WALANT series by Lim et al, the mean Patient-Rated Wrist/Hand Evaluation (PRWHE) score was 8.2/50, grip strength approached normative values, and complication rates were low, including two superficial infections (0.82%) and one rerupture (0.41%).[25] Favorable outcomes were associated with meticulous repair, limited tissue complexity, and structured rehabilitation, whereas poorer results were linked to more complex proximal injuries, crush or avulsion mechanisms, contamination, and associated lesions. In the present case, the patient demonstrated a favorable postoperative recovery, achieving full active extension of the affected digits and near-complete flexion without extensor lag or functional limitation. At follow-up, tendon continuity was preserved, wound healing was uneventful, and no complications such as rerupture, infection, or adhesion-related restriction were observed. The patient successfully returned to daily activities with satisfactory hand function, consistent with the favorable outcomes reported for appropriately managed Zone VI extensor tendon injuries.

CONCLUSION

This case reinforces the current evidence that successful management of Zone VI extensor tendon injuries relies on the integration of meticulous surgical technique, sound biomechanical principles, and structured early rehabilitation rather than on tendon repair alone. The favorable functional outcome achieved following primary tenorrhaphy with a modified Kessler core suture and continuous epitendinous reinforcement highlights the effectiveness of this approach in restoring extensor function while minimizing complications. Beyond its clinical relevance, this report contributes to the growing body of evidence supporting standardized, evidence-based treatment strategies for Zone VI injuries by correlating anatomical characteristics, repair biomechanics, and postoperative rehabilitation with functional recovery. These findings further strengthen the understanding of optimal surgical management in this anatomically favorable region and may serve as a practical reference for hand and reconstructive surgeons seeking to optimize patient outcomes and facilitate an earlier return to daily and occupational activities.

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