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Traumatic Lacerations of Flexor Tendons of the Hand: A Retrospective Epidemiological Study and Review of Current Therapeutic Concepts

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Abstract

Introduction

Flexor tendon lacerations of the hand are a frequent surgical emergency with major functional and socioeconomic implications. This retrospective study reports our recent experience at the Department of Trauma and Orthopedic Surgery A of Ibn Tofail University Hospital, Marrakech, over a six-month period, with a minimum follow-up of six months for each included patient.

Methods

Thirty consecutive patients presenting with flexor tendon lacerations of the hand, managed between January 2026 and June 2026, were included. Sixty-five tendon injuries were analyzed. Functional assessment was performed using the White and Boyes criteria.

Results

The mean age of the participants was 32 years (range: 17-58 years), with a clear male predominance (n=26, 86.7%). Stab wounds were the leading etiology (n=13, 43.3%). Zone II accounted for 27 (41.5%) lesions. Primary repair using the modified Masson-Kessler core suture was performed in 28 (93.3%) cases. At a six-month follow-up, 18 (72%) reviewed patients showed excellent or good functional outcomes.

Conclusion

Our findings confirm the local epidemiological profile and highlight the importance of high-quality primary repair combined with early rehabilitation. The integration of the Wide Awake Local Anesthesia No Tourniquet (WALANT) technique into our practice offers promising prospects for further improving outcomes.

Categories: Plastic Surgery, Trauma, Sports Medicine
Keywords: flexor tendon laceration, hand surgery, primary repair, walant technique, zone ii

Introduction

Hand injuries constitute one of the most frequent surgical emergencies encountered in trauma departments worldwide. Among these, flexor tendon lacerations occupy a particular place because of the anatomical complexity of the injured region, the technical demands of repair, and the potential severity of functional sequelae [1,2].

The hand - an organ of grasp, communication, and expression - is exposed daily to a wide variety of injuries. Zone II, historically termed the “no man's land” by Bunnell, concentrates the greatest anatomical and surgical difficulties: two tendons travel there within a common sheath closely related to the annular pulleys, in a precarious vascular environment [3]. Outcomes of repair in this zone remain a subject of intense ongoing research.

Since the previous thesis conducted in our department over the 2016-2021 period (212 patients, 488 tendon injuries) [4], flexor tendon surgery has undergone significant developments: the rise of the WALANT technique (Wide Awake Local Anesthesia No Tourniquet), the development of high-strength multi-strand core sutures, refinement of rehabilitation protocols with early active mobilization, and an improved understanding of tendon healing biology [5-7].

This retrospective study, covering 30 patients managed between January 2026 and June 2026, aims to: (1) analyze the current epidemiological profile of flexor tendon lacerations in our setting; (2) report functional

outcomes at three months of follow-up; and (3) discuss contemporary therapeutic developments in light of our own practice.

Materials And Methods

Study design and setting

This is a retrospective, descriptive study conducted at the Department of Trauma and Orthopedic Surgery A of Ibn Tofail Hospital, Mohammed VI University Hospital, Marrakech, the referral center for hand surgery for the Marrakech-Safi region. Two periods are distinguished. The management (inclusion) period ran from January 2026 to June 2026, and all eligible patients operated on during this period were included. Follow-up was set at 3 months from the date of surgery, and data were collected up to the cut-off date of 23 September 2026.

Study population

Inclusion Criteria: The inclusion criteria were: any patient older than 15 years presenting with a confirmed (complete or partial) laceration of one or more flexor tendons of the hand (long fingers or thumb), operated on in our department between January 2026 and June 2026, irrespective of whether the three-month review was subsequently attended.

Exclusion Criteria: The exclusion criteria were: digital amputations, isolated concomitant extensor tendon injury, and incomplete records (missing operative report or injury description).

Definition of cases, cohorts and units of analysis

Unit of Analysis

The patient (n=30) is the unit of analysis for demographic, etiological, management and rehabilitation variables. The injured finger (n=39 fingers) and the injured tendon (n=65: 35 flexor digitorum superficialis, 20 flexor digitorum profundus and 10 flexor pollicis longus) are the units of analysis for lesion topography, associated injuries, and suture techniques are also listed. Complications and functional outcome are reported per patient (n=30 and n=22).

Study Cohorts

All 30 patients operated on between January and June 2026 form the management cohort, used for all descriptive analyses. The functional cohort comprises the 22 patients (73.3%) who were evaluated at three months. The remaining eight patients (26.7%) had no three-month evaluation at the cut-off date (September 23, 2026): four were lost to follow-up and four had been operated on too recently to have reached three months. They were not excluded from the study: they are described in the management cohort but are not part of the functional analysis.

Injured and Repaired Tendons

All 65 injured tendons were repaired. When both the superficialis and profundus tendons were lacerated, both were repaired (26 fingers); when a single tendon was lacerated, it was repaired (13 fingers). The denominator is stated in each table (injured tendons, repaired tendons, fingers or patients).

Data collection protocol

Data were collected retrospectively from medical records, operative reports, and follow-up consultations, using a standardized form including: sociodemographic data (age, sex, occupation, hand dominance), circumstances and injuring agent, time to management, tendon and associated lesion assessment (nerve, vascular, osteoarticular), surgical modalities (anesthesia, approach, suture technique, material), rehabilitation protocol, and functional outcomes at the three-month follow-up.

Topographic classification

Lesions were classified according to the International Federation of Societies for Surgery of the Hand (IFSSH) classification, distinguishing five zones for the long fingers (I to V) and three zones for the thumb (T1 to T3).

Functional assessment

Functional outcomes were assessed with the White and Boyes criteria, classifying results as excellent, good, fair or poor from the pulp-to-distal-palmar-crease distance in active flexion and the total active extension deficit. Patients were scheduled for review at six weeks, three months and six months postoperatively; the functional result analyzed in this study is the score recorded at the three-month review, available for all 22 evaluated patients. The assessment was performed by members of the department team (the first author, senior surgeons of the department and a physiotherapist/hand therapist), without a single standardized

assessor, without blinding. Inter-observer reliability could not be calculated; this is acknowledged as a limitation.

Statistical analysis

Data were analyzed descriptively using SPSS software, version 26.0 (IBM Corp, Armonk, NY, USA). Quantitative variables are expressed as means±standard deviation and qualitative variables as counts and percentages. Because this is a descriptive study with a small sample, no inferential tests were performed and no p-values are reported.

Results

Epidemiological data

Frequency and Temporal Distribution

Our series comprises 30 consecutive patients managed over six months, corresponding to an average frequency of five cases per month. The monthly distribution is shown in Figure *1*.

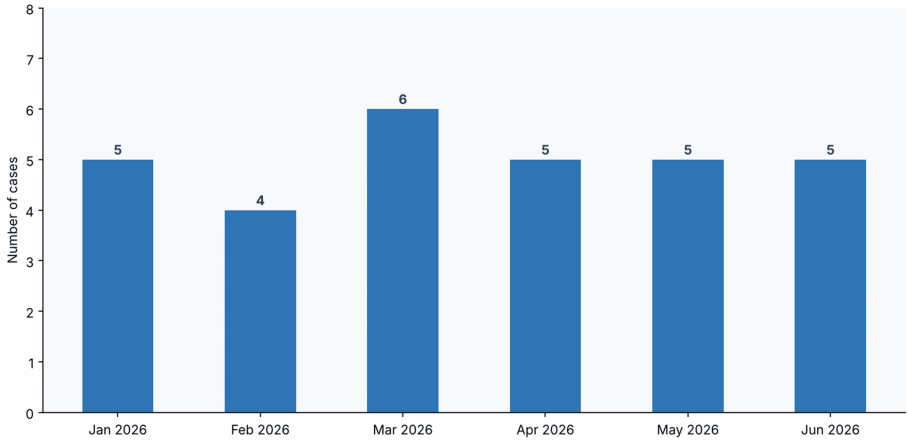


FIGURE 1: Monthly distribution of the 30 cases of flexor tendon lacerations (January 2026 – June 2026)

Age

The mean patient age was 32 years (±10.4 years), ranging from 17 to 58 years. The 21-40 year age group predominated, accounting for 66.7% of the cases (Figure *2*).

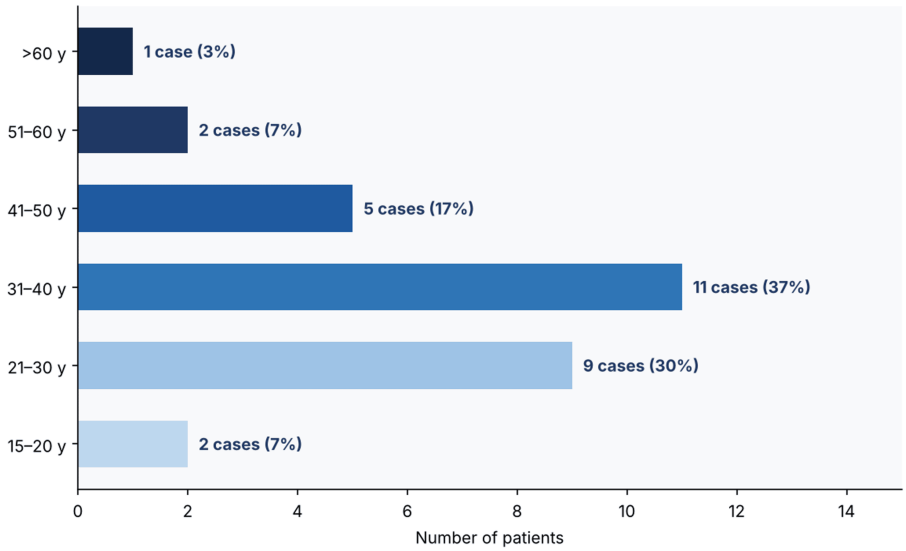


FIGURE 2: Distribution of the 30 patients by age group

Sex

A clear male predominance was noted, with 26 men (86.7%) versus four women (13.3%), a sex ratio of 6.5:1 (Figure 3).

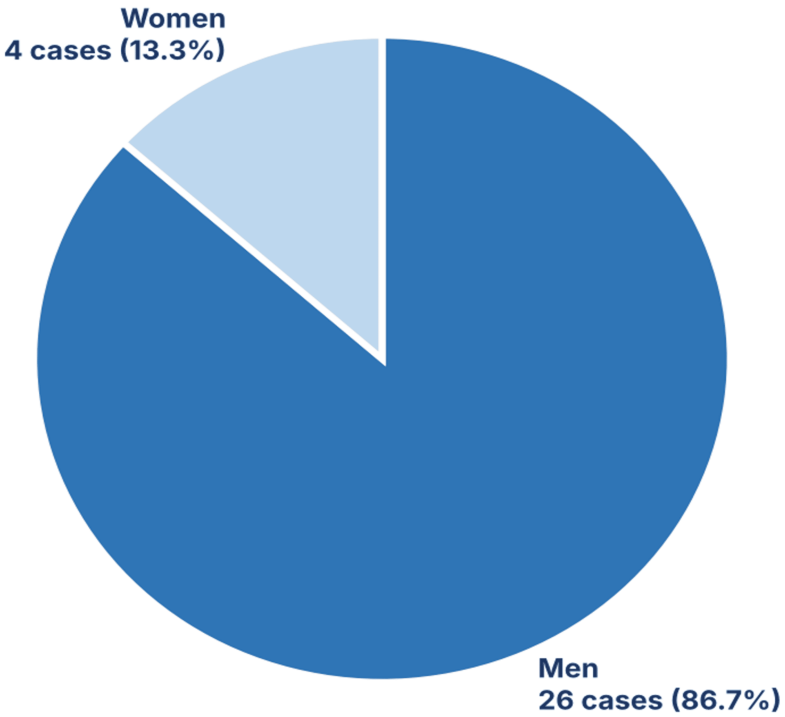


FIGURE 3: Distribution by sex (n = 30)

Occupation

Manual workers accounted for the majority of injured patients (60% of cases): nine heavy manual laborers (masons, construction workers) and nine craftsmen/precision workers (carpenters, mechanics). Six patients had no stated occupation and six were students or unemployed.

Circumstances of injury: context, agent, place and mode

Regarding the mode of injury, assaults with a bladed weapon were the leading circumstance (13 cases, 43.3%), followed by accidents (15 cases, 50.0%: domestic accidents, eight cases (26.7%); work-related accidents, five cases (16.7%); sports accident one case (3.3%); accidental glass injury, one case, 3.3%) and self-inflicted injuries (two cases, 6.7%: punching a glass surface). The place of injury was the workplace (nine patients, 30.0%), the home (9 patients, 30.0%) or a public place (12 patients, 40.0%).

Regarding the injuring agent, a knife was the most frequent (15 cases, 50%), followed by glass shards (10 cases, 33.3%) and sharp metal objects (5 cases, 16.7%) (Figure *4*).

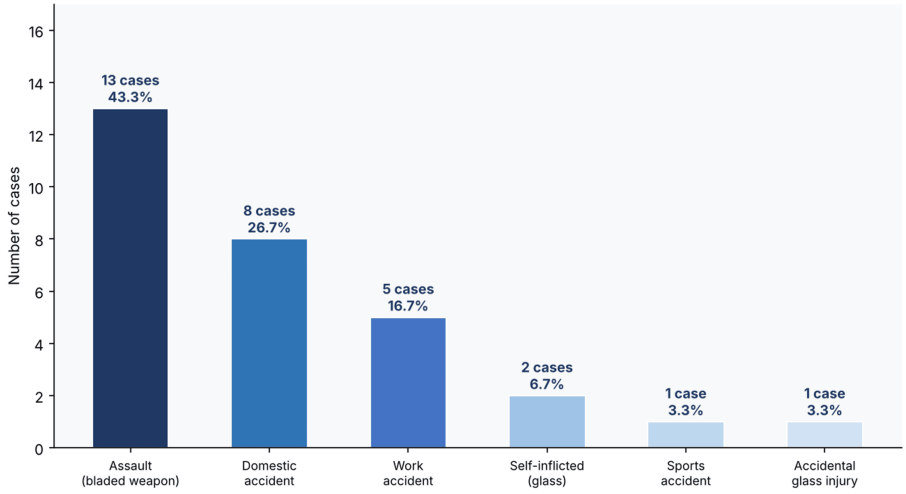


FIGURE 4: Distribution of the 30 cases by mode of injury

Lesion assessment

Topographic Zones

The IFSSH classification of flexor tendon zones is summarized in Figures *5*, *6*. A total of 65 tendon injuries were identified among our 30 patients (mean of 2.17 lesions per patient) (Table *1*).

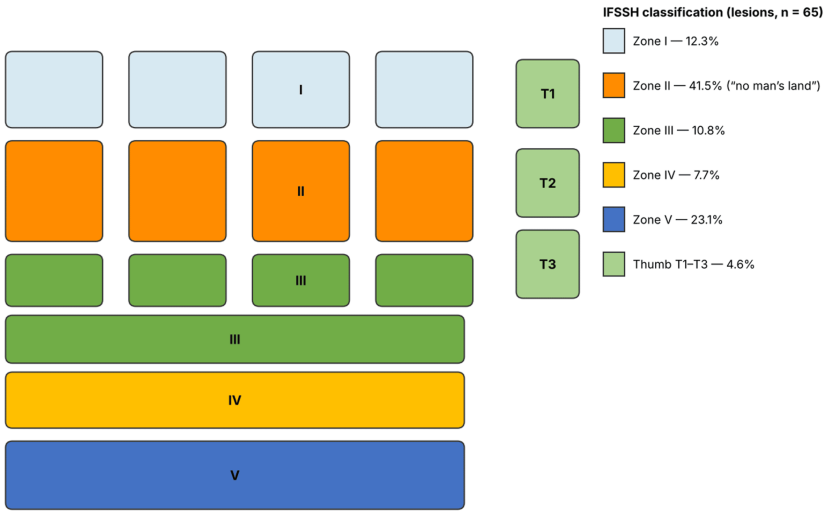


FIGURE 5: IFSSH classification of flexor tendon zones: anatomical diagram with distribution in our series

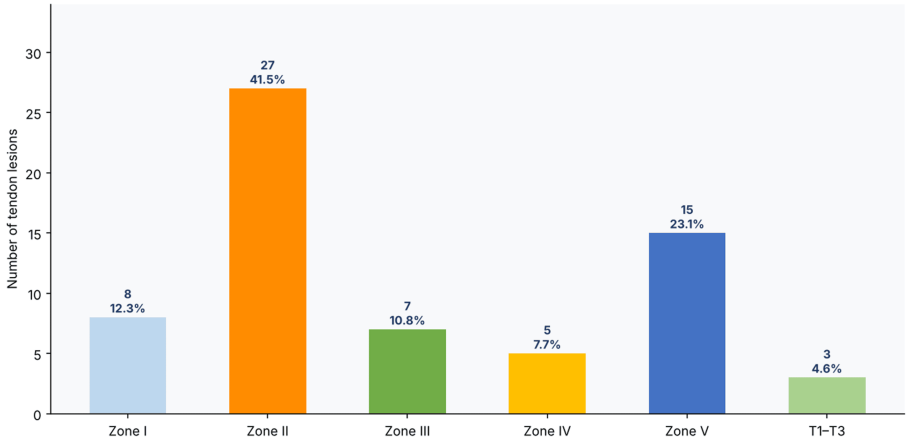


FIGURE 6: Distribution of the 65 tendon injuries by IFSSH topographic zone

Zone	I	II	III	IV	V	T1-T3	Total
Number of lesions	8	27	7	5	15	3	65
% of total	12.3%	41.5%	10.8%	7.7%	23.1%	4.6%	100%

TABLE 1: Distribution of the 65 tendon injuries by topographic zone

Type of Tendon Injury

Among the 65 tendon injuries, 52 were complete lacerations (80.0%) and 13 were partial lacerations (20.0%). Concomitant lacerations of the flexor digitorum superficialis (FDS) and flexor digitorum profundus (FDP) were the most frequent pattern in the long fingers (27 cases).

Associated Injuries

Some patients had more than one type of associated injury; 17 patients (56.7%) had at least one associated injury (Table 2).

Type of associated injury	Number of patients	Percentage (%)	Number of fingers (n=39)	Fingers (%)
Nerve injuries	9	30.0	11	28.2
Vascular injuries	5	16.7	6	15.4
Osteoarticular injuries	4	13.3	6	15.4
Soft-tissue / skin loss	2	6.7	4	10.3

TABLE 2: Injuries associated with tendon lacerations (n=30 patients; 39 injured fingers)

Therapeutic management

Time to Management

Twenty-seven patients (90%) underwent primary repair within the first 24 hours after injury. Two patients were operated on at 48-72 hours because the operating room was unavailable. One patient presented with a neglected laceration dating back three weeks.

Anesthesia

Thirty patients received 34 anesthetic techniques because four patients underwent two techniques successively. Regional anesthesia (plexus or truncal block) was performed in 24 patients (80%); it was sufficient in 20 patients (66.7%) and was converted to general anesthesia in four patients because they felt pain during the procedure. General anesthesia was used in six patients (20%): the four conversions and two patients planned from the outset for complex multi-digit injuries or vascular repair. WALANT (epinephrine-containing local anesthesia without tourniquet) was used in four patients (13.3%) with isolated distal lesions, allowing active intraoperative control of the repaired tendon. Counted by final technique, the three groups (regional alone 20, general six, WALANT four) are mutually exclusive and total 30 patients.

Surgical Approach

A Bruner zig-zag incision was used in 25 cases (83.3%). A mid-lateral incision was performed in four cases, and simple extension of the wound in one case.

Tendon Suture Technique

Repairs used a core suture, most often a modified Masson-Kessler stitch in 4/0 polypropylene, reinforced in most cases by a peripheral epitendinous running suture in 6/0 polypropylene (Table 3) [5,8].

Suture technique	Number of lesions	%
Modified Masson-Kessler core suture	51	90.2
Pull-out suture (zone I)	4	7.1
Kleinert	1	1.8
Not specified	1	1.8
Total with documented technique	57	100
Not documented	8	-
Total repaired tendons	65	-

TABLE 3: Tendon suture techniques (percentages calculated on the 57 tendons with a documented core suture; 65 tendons repaired in total)

All 65 injured tendons were repaired. The core suture technique was documented in the operative report for 57 of them and not documented for eight. A peripheral epitendinous running suture in 6/0 polypropylene reinforced 58 of the 65 repaired tendons (89.2%). The core suture material was 4/0 polypropylene.

Treatment of Associated Injuries

Nerve injuries (nine cases) were repaired using epiperineural sutures in 8/0 polypropylene. Vascular injuries (five cases) underwent end-to-end anastomosis in 8/0 polypropylene after tourniquet release.

Postoperative Rehabilitation

All patients received initial immobilization in a dorsal plaster splint in the intrinsic-plus position (wrist at 30° flexion, metacarpophalangeal joint (MCP) at 70°, IP in extension). Fourteen patients (46.7%) followed an early active mobilization protocol [9,10] starting on day 7 under physiotherapy supervision. Eight patients (26.7%) followed the Duran-controlled passive mobilization protocol [11]. The remaining eight patients were treated with plaster immobilization alone, for reasons related to follow-up access or compliance.

Complications

Complications are reported per patient (n=30), because adhesions with stiffness, rupture and infection were recorded as clinical events of the patient or the finger rather than of an individual tendon, and the records do not allow reliable attribution to a single tendon. This is acknowledged as a limitation (Table 4).

Complication	Number (n=30)	%
Adhesions with digital stiffness	4	13.3
Tendon rupture	2	6.7
Superficial infection	1	3.3
No complication	23	76.7

TABLE 4: Postoperative complications at last follow-up (per patient, n=30)

Both tendon ruptures were successfully repaired surgically within 10 days. Adhesions were managed with intensive rehabilitation; tenolysis was required in one patient.

Functional outcomes

Functional assessment at three months was performed for 22 of the 30 patients (73.3%). The remaining eight patients (26.7%) had no three-month evaluation at the cut-off date: four were lost to follow-up and four had been operated on too recently; they are not part of the functional analysis (Table 5).

Rating (White and Boyes)	Excellent	Good	Fair	Poor	Total
Number	8	6	6	2	22
Percentage (%)	36.4	27.3	27.3	9.1	100

TABLE 5: Functional outcomes according to the White and Boyes criteria at three months (only 22 patients evaluated)

The overall rate of excellent and good results was 63.6% (14 of 22 patients). By dominant zone of injury, the results were: zone I 0/1, zone II 6/11 (54.5%), zone III 4/5 (80%), zone IV 1/2 (50%), zone V 3/3 (100%).

Discussion

Epidemiological profile: comparison with the local reference series

Our retrospective series of 30 cases (January-June 2026) broadly confirms the epidemiological profile established by the department's previous series covering 212 cases (2016-2021) [4] and is in line with recent series from other settings [12,13]. The male predominance remains very marked (86.7% vs. 87.7%), reflecting the differential exposure of men to domestic and occupational trauma and to assaults. The mean age is slightly younger in our series (32 years vs. 35 years), which constitutes a favorable prognostic factor (Table 6).

Parameter	2016-2021 series [4] (n=212)	Our 2026 series (n=30)	International literature
Male sex (%)	87.7	86.7	76-92
Mean age (years)	35	32	28-39
Zone II predominance (%)	41.6	41.5	36-58
Primary repair (%)	96.7	93.3	85-99
Excellent+Good results (%)	72.4 (two-year follow-up)	63.6 (three-month follow-up)	65-85

TABLE 6: Comparison of epidemiological data with the department's reference series and the international literature

The predominance of stab wounds/assaults with a bladed weapon (43.3%) as the leading etiology is a constant feature of our setting, contrasting with Western and Asian series in which occupational accidents predominate. This local epidemiological specificity should guide prevention strategies toward targeted interventions.

Zone II: anatomical considerations and contemporary surgical challenges

Zone II, accounting for 41.5% of our lesions, remains the most challenging territory in tendon surgery. Its particular anatomical environment - two tendons within a common sheath, constrained by five annular and cruciate pulleys - explains the difficulty of repair and the frequency of postoperative adhesions [3,14].

Contemporary work by Tang et al. [15] has profoundly renewed the approach to zone II, showing that partial release of the A2 pulley (distal third) combined with complete release of A3 significantly reduces tendon friction without compromising digital biomechanics. This strategy, combined with high-strength multi-strand core sutures, allows for more aggressive early active mobilization, reducing the risk of adhesions.

Current developments in tendon surgery

The WALANT Technique: A Practice-changing Innovation

The WALANT technique, introduced by Lalonde et al. [16,17], uses a local infiltration of 1% lidocaine with epinephrine (1:100,000), allowing surgery without a tourniquet in an awake, cooperative patient. In our series, we began applying this technique in four patients with isolated distal lesions, with satisfactory active

intraoperative control of tendon tension.

Its advantages are numerous: it allows the surgeon to verify in real time the resistance of the repair to active traction, to confirm smooth tendon gliding beneath the pulleys, and to immediately correct any catching or insufficient tension [16,17]. Higgins et al. [17] demonstrated that this intraoperative verification significantly reduces the rate of postoperative ruptures. It is now our goal to systematically integrate this technique for lesions in zones I, II, and distal III.

WALANT also has limitations. The patient remains awake, which can generate anxiety, and the local anesthetic injection is painful for some patients. A waiting time of about 25 minutes after infiltration is needed to obtain adequate vasoconstriction [18], and the absence of a tourniquet may compromise the operative field if bleeding occurs. The technique is less suited to prolonged or complex multi-digit procedures and to uncooperative patients, which is why complex injuries in our series were operated on under general anesthesia. Concern about epinephrine-related digital ischemia has not been confirmed in large series, including a multicenter prospective study of 3110 consecutive cases with no digital necrosis [19], although phentolamine should be available as a rescue treatment.

Multi-Strand Sutures: Toward Greater Repair Strength

The modified Masson-Kessler two-strand core suture, which dominates our practice (90.2% of the repairs with a documented technique), provides a biomechanical strength of 30 to 45 N, insufficient to allow aggressive early active mobilization [8,20]. Four-strand repairs (double Kessler, Savage, Adelaide) reach 60 to 90 N, and six-strand repairs exceed 100 N, allowing active mobilization without an increased risk of rupture.

Tang et al. [15] and Wu and Tang [8] have shown that moving to a minimum of four-strand core sutures, combined with a 6/0 epitendinous running suture (adding 10%-50% additional strength), represents the contemporary standard for zones II and III, as supported by clinical series combining multi-strand repair, pulley division and early active motion [21]. Progressive adoption of these techniques in our department is planned, contingent on surgeon training and the availability of appropriate suture materials.

For the eight tendons whose core suture technique was not documented in the operative reports, the literature indicates what should have been done and recorded: a core suture with at least four strands, combined with a 6/0 epitendinous running suture, which provides the strength needed for early active mobilization in zones II and III [8,15,20]; and a complete operative report stating the number of strands, the suture material and the pulley management, so that repairs can be audited. The absence of this information in eight repairs reflects incomplete operative reporting, a recognized limitation of retrospective studies, and is acknowledged in the Limitations.

Rehabilitation Protocols: A Decisive Impact

In our series, 11 of the 14 patients (78.6%) mobilized early and actively had excellent or good results, versus three of the eight evaluated patients (37.5%) treated with Duran passive mobilization or immobilization alone. These figures are descriptive only: the numbers are small, the protocol was not allocated by a standardized criterion (it depended on follow-up access and compliance), and no statistical comparison was performed, so no conclusion about the relative effectiveness of the protocols can be drawn from our data. They are nevertheless consistent with the literature favoring early mobilization [22,23].

Early active mobilization - started between postoperative days three and seven, depending on the protocol - prevents adhesions by stimulating intrinsic tendon healing (via the synovial pathway), promotes remodeling of scar tissue, and preserves sheath gliding [10,22]. The Duran protocol (early passive mobilization) [11] is a validated alternative for two-strand repairs or in less compliant patients.

The main obstacle in our setting remains limited access to hand-therapy-trained physiotherapy. Patient and family education, initiated as early as the preoperative consultation, is an essential lever for improving compliance.

Functional outcomes and prognostic factors

At three months, 63.6% of the evaluated patients had excellent or good results, compared with 72.4% in the department's reference series at two years [4]. This comparison must be interpreted with caution because follow-up durations differ: tendon recovery may continue up to nine to 12 months postoperatively, so our three-month results probably underestimate the final outcome. In addition, eight patients were not evaluated, which may introduce selection bias.

The factors reported in the literature as unfavorable include zone II injury, associated nerve injury, poor compliance with rehabilitation and delayed management, whereas young age, a clean wound, repair within 24 hours and regular hand therapy are associated with better outcomes [22-24]. Our series was too small,

and no inferential analysis was performed, to test these associations.

Study limitations

The main limitations of this study are: its retrospective, single-center design and the limited sample size (30 patients, 65 tendons), which preclude inferential analysis; a short follow-up of three months, which is insufficient for definitive conclusions since tendon recovery may continue up to nine to 12 months, and which was even shorter for the patients operated on most recently; the fact that eight patients (26.7%) were not evaluated, reflecting the socioeconomic constraints of our setting, which exposes the functional results to selection bias; incomplete operative reports (core suture technique not documented for eight tendons); functional assessment by several non-standardized assessors, without blinding and without measurement of inter-observer reliability; complications reported per patient rather than per tendon; and the use of the patient as the unit of analysis for several variables although several patients had multiple injured fingers. These limitations justify a longer-term, ideally multicenter, prospective study.

Conclusions

This retrospective study of 30 consecutive patients (65 tendon injuries) managed between January and June 2026 confirms the persistence of a stable epidemiological profile of flexor tendon lacerations of the hand in Marrakesh: male predominance, young adults, an etiology dominated by assaults with bladed weapons, and zone II as the most frequently affected territory.

Among the 22 patients evaluated at three months, 63.6% had excellent or good results, which is encouraging and comparable to recent series in the literature, although the short follow-up calls for confirmation at a later stage. These findings support the reliability of primary repair using the modified Masson-Kessler core suture and underline the importance of postoperative rehabilitation, although our data do not allow a comparison of rehabilitation protocols.

Contemporary developments in tendon surgery - the WALANT technique enabling active intraoperative control, high-strength multi-strand sutures allowing early active mobilization, and judicious management of the annular pulleys in zone II - represent a promising therapeutic horizon whose progressive integration into our practice is under way.

Prevention of hand injuries, particularly through strengthened workplace safety measures and efforts to reduce violence involving bladed weapons, remains a public health priority in our region.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Younes Fakir, Mohamed Habab, abdessalam Achkoun, Chafik Rachid

Acquisition, analysis, or interpretation of data: Younes Fakir, Mohamed Habab, abdessalam Achkoun, Chafik Rachid

Drafting of the manuscript: Younes Fakir, Mohamed Habab, abdessalam Achkoun, Chafik Rachid

Critical review of the manuscript for important intellectual content: Younes Fakir, Mohamed Habab, abdessalam Achkoun, Chafik Rachid

Supervision: Younes Fakir, Mohamed Habab, abdessalam Achkoun, Chafik Rachid

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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