

## TRAUMATIC LESIONS TO THE TENDONS OF THE HAND

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### SUMMARY

As regards traumatology in the 21<sup>st</sup> century, some precedence should be given to the treatment of lesions to the tendons of the hand. This is due to the high functional value of this extremity for the human body, both in terms of work and social life. The aim of this article is to analyse the surgical and rehabilitation treatment of traumatic lesions to the hand; specifically, with regard to the anatomical position of the lesions and the site of the interruption of the tendon. It will be evident that only an intervention which combines both surgery and physio-kinetic therapy can allow for the restoration of full functionality.

### Introduction

Among the various structures that make up the hand (muscular tissue, bone, nerves, vessels, tendons) which may be subject to diverse traumas, either individually or in combination, here the focus is placed on lesions to the tendons: structures that are crucial for a full range of grasping motions. In particular, the treatment of traumatic lesions to the tendons is considered, as opposed to atraumatic lesions which are a result of chronic inflammation or iatrogenic pathologies or are the consequence of metabolic disorders. Traumatic lesions of the hand may occur as a result of any of the following: cutting, crushing, laceration and contusion, and subcutaneous rupture; open or closed, partial or complete. Their surgical treatment, which presents various problems due to the complexity of the tendon apparatus anatomy and adjacent structures, must be combined with rehabilitation treatment aimed at complete functional recovery [1]. In terms of aetiology, traumatic lesions to the tendons are primarily caused by accidents (60%) compared to work related traumas (30%) and those related to road accidents (about 10%). However, statistics regarding the site of the trauma show that they most frequently involve the fingers (47.3%), followed by the hand (36.7%) and finally the wrist (16%). Moreover, the extensor tendons (63.1%) are more often involved than the flexors (36.9%). Often there are associated cutaneous or bone lesions or lesions of vascular-nervous formations. In this last case, it is rare for the vessels to be involved exclusively; most often a nervous lesion is confirmed, involving the median (6.5%) or ulnar nerve (3.9%). Lesions to the left hand (59.2%, of which 25.8% are isolated and 15.8% are associated) are those which are seen most often, compared to the right hand (40.8%, of which 25.8% are isolated and 15.8% are associated). With regards to patient age, the lesions that appear most frequently in the 14-20 age group are those related to physical activity and sport or road accidents. However, trauma as a result of work place accidents is more common among the 30-40 age group [2-3].

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### Anatomy

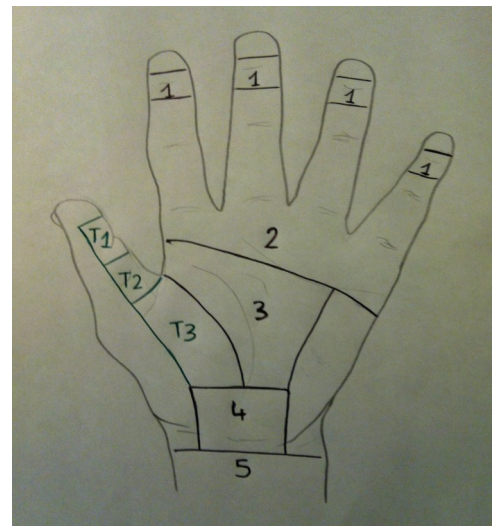
The tendons are chords of fibrous-elastic consistency which connect bones to muscles through the osteotendinous and musculotendinous junctions. They are flexible and are held in place by pulleys which prevent the tendons from moving out of their normal position. Tendons are covered in a synovial membrane which acts as a lubricant, and allows for the normal movement of the tendon. Despite the fact that the flexor tendons have a wider range of movement compared to the extensors, a lesion to the latter results in a more serious loss of mobility than a lesion to the former [4].

Knowledge of the tendon apparatus has allowed for the definition of different topographical areas for anatomy and biomechanics. Indeed, the lesion will have specific clinical and therapeutic requirements depending on its location. Currently, the classification system of the International Federation of Societies for Surgery of the hand (IFSSH) is being used. As regards the flexor tendons, this classification divides the fingers into five zones and the thumb into three (Figure 1). Instead, the extensor apparatus is subdivided into 8 topographical zones, and four for the thumb (Figure 2) [5].

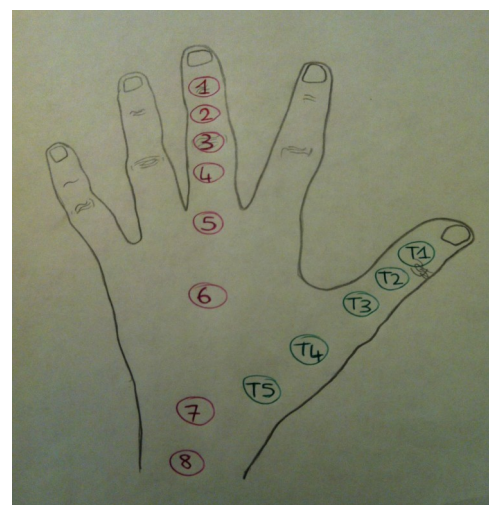
### Surgical treatment

Surgery aims to produce a tendon suture which provides for good traction and reduced encumbrance to allow the tendons to slide. As regards therapeutic options, there are essentially two: immediate or deferred emergency surgery. Cutaneous lesions or lesions with well-defined margins, which are neither modified nor infected, are most frequently sent for primary or immediate emergency surgery. In contrast, where the local conditions (cutaneous and tendinous) are unfavourable, tenorrhaphy is chosen in deferred emergency surgery. In the first instance, the wound is surgically cleansed and the cutaneous wound is sutured; after not more than 24-48 hours, as long as there is no evidence of inflammation, surgical tendon repair may be performed [6]. It is wise not to delay surgical intervention for too long because as soon as 4-5 days after the trauma,

the muscles will have retracted irreversibly and the edges of the clipped tendon start to degenerate progressively up to 3-4 cm from the point of the original lesion. In such a situation, proceeding to termino-terminal matching of the tendon is unlikely; instead, it is more probable that either tendon grafts or transpositions would be necessary [7]. As regards lesions of the flexor, tenorrhaphy may be achieved with a pull-out technique or with internal stitches (termino-terminal). The former, indicated for lesions near to the distal insertion of the deep flexor, requires the use of a wire which sticks out of the skin and is tied to a button on the fingertip which can be removed



**Figure 1:** IFSSH classification of the hand: flexor tendons (the letter T indicates the thumb zone)



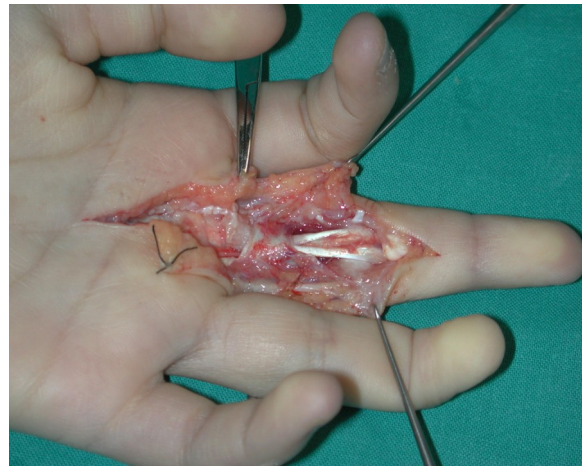
**Figure 2:** IFSSH classification of the hand: extensor tendons

once repair is complete (Figures 3 – 3a – 3b). Internal stitches instead are not removed; they involve a central suturing internal to the tendon, which guarantees the necessary hold and overseeing around the facing tendon stumps [8]. The aim of this overseeing is to reconstruct the anatomy of the tendon and isolate the internal from the peritendinous environment as in the former reparative scarring processes are occurring. This should help to avoid scarring problems and prevent the formation of adhesions. There are various different techniques for the execution of central sutures: the Kleinert suture (a running stitch crossed at the two extremities), the modified Kessler suture (square shaped) and the Tsuge suture (axial) [9]. The calibre of suture for the flexor tendons is usually 4-0 and 6-0 is used for peritendinous structures [10].

In zone 1 and in T1 the pull-out technique is usually employed; however in the remaining zones a termino-terminal suture is performed using one of the methods described above. The specific conditions of zone 2 mean that tendon repair can be problematic due to the simultaneous presence of the deep and surface flexors. When possible it is preferable to repair both tendons. If excessive suture encumbrance occurs at the level of the intersection of the surface tendon or the A2 pulley, then only the deep tendon is repaired and the surface flexor is resected. This

causes a modest loss of strength; however, the risk of adhesions with consequent articular stiffness and limitation of movement is reduced. In the surgical opening of the digital canal the A2 and A4 pulleys should remain in place, if these are also damaged, however, they must be reconstructed in order to prevent the onset of “bow-tendon” of the flexors during grasping [11].

Just as the flexor tendons are treated with termino-terminal tenorrhaphy, so are the sections of the extensor tendons next to the metacarpals, the first phalanges and the distal interphalangeal joint. Use of the pull-out technique is very rare and limited to zone 1 and T1. Tenorrhaphy of an extensor tendon does not need to be as resistant as that of a flexor (Figures 4 – 4a – 4b).



**Figure 3:** Lesion of the long flexor of the third finger



**Figure 3a:** Before surgery: the patient cannot flex the finger



**Figure 3b:** After surgery

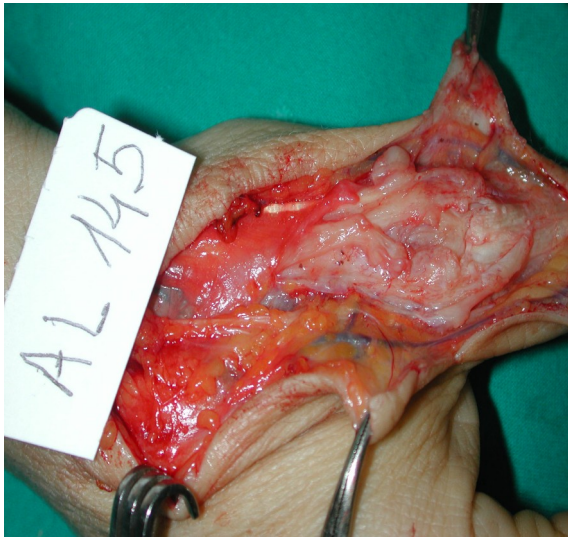
Usually loose stitches in the shape of a U are sufficient, using 4-0 or 5-0 calibre wire. When there is a lesion of the tendon apparatus at the level of the second interphalangeal joint, which makes a termino-terminal suture impossible, it is best to opt for a tendon transplant. A useful technique in this situation is that of Fawler, where the tendon of the long palmar muscle is taken from the same side of the body as the lesion. When presented with lesions of the long extensor tendon of the thumb with loss of substance or excessive tissue degeneration or degeneration of the tendon itself, usual practice is to opt for tendon transposition, using the extensor of the index finger, transferred to the distal portion of the

long extensor of the thumb [12].

#### Rehabilitation treatment

The type of rehabilitation treatment chosen depends on a number of factors: the timing of the repair, the location of the lesion and the patient adhering to their particular programme i.e. early mobilisation for autosufficient patients and delayed mobilisation for non-autosufficient patients and for children under 7 years old [13].

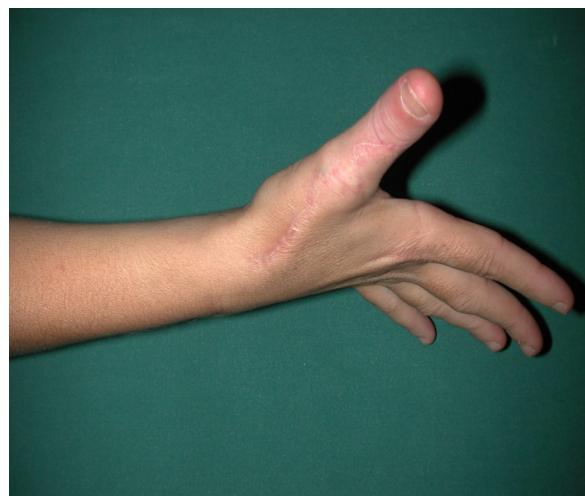
In the case of repair to a lesion of the flexor tendon in zones 1, 2 and 3, it is possible to remove the strong compression medication during the first 3 days, substituting it with light compression medication. A splint is applied with a dorsal block at the wrist and the fingers, with the following positions: wrist 20° of flexion, metacarpalphalangeal joints (MCF) 50° of flexion, distal interphalangeal joints (DIP) and proximal interphalangeal joints (PIP) fully extended. For the following 4 weeks passive mobilisation exercises are performed, along with flexion and extension exercises for the DIP and PIP, finger by finger. Active extension exercises have to be performed in the splint. Up to the fourth week, active range of motion (ROM) exercise for flexion of the fingers and the wrist are continued. This allows for active extension of the pulse, only up to the neutral position or 0° of extension. The patient has to perform exercises every hour after the splint has been removed. These exercises include: making



**Figure 4 :** Lesion of the long extensor of the thumb



**Figure 4a:** Before surgery: the patient cannot extend the thumb



**Figure 4b:** After surgery

a fist, flexion and extension of the wrist up to neutral position and combined flexion of the immobilised fingers and wrist. At the fifth week, electrotherapy may begin in order to improve tendon excursion. As well as guiding the restoration of motor schemas, electrotherapy helps to reinstate muscle tropism and tone. Before proceeding with electro-therapy, however, it is important to consider the quality of the repair, the nature of the lesion and the patient's medical history. At the sixth week, use of the splint may be suspended and the aim is to achieve ROM in complete flexion [14]. A resting splint may be applied with maximum extension if there is significant stiffness of the extrinsic flexor tendons. Often, it is only necessary to wear a gutter extension splint during the night. At the eighth week resistance exercises with sponges or a Nerf ball begin, to be followed by floating handgrip exercises until the hand can be used for light activities, but not to lift weights or for heavy work. From the tenth to twelfth week, the hand may be used freely for all daily tasks together with a programme aimed at further strengthening the hand. The greatest improvement in total mobility is obtained between twelve and fourteen weeks after the operation [15].

As regards flexor tendon lesions in zones 4 and 5, during the first 7-10 days, strong compression medication is substituted with light compression medication and a splint with a dorsal block to the wrist and to the fingers (wrist 30° of flexion, MCF 50° of flexion, PIP and DIP incomplete extension) is applied. Passive ROM exercises in flexion and extension (in the splint) start and are performed hourly. At the third week a programme of active exercises for the ROM start for 10-15 minutes every hour and it is also possible to begin electrotherapy and scar massage using scar tissue e remodelling techniques to reduce as far as possible subcutaneous adhesions. At the sixth week the splint is removed and passive ROM exercises of the wrist and the fingers begin. Light strengthening exercises may also start using a Nerf ball or plasticine. It is possible to go on with the strengthening exercises into

the seventh week, adding the use of a floating hand-grip. Between the tenth and the twelfth week unlimited use of the injured hand is allowed [16].

In the case of lesions to the long flexor of the thumb, strong compression medication is replaced by light compression medication in the first 3 days following surgery. A splint is applied with a dorsal block at the wrist and with the fingers in the following positions: wrist 20° of palmar flexion, MCF and IP of the thumb at 15° of flexion for each articulation, carpometacarpal joint (CMC) of the thumb in palmar abduction. A programme of passive controlled mobilisation in the splint starts with combined passive flexion and extension of the MCF and IP. At the fourth week the splint is removed every four hours to allow for active flexion and extension exercises of the wrist and the thumb maintaining, however, the passive exercises for the ROM. At the fifth week it is possible to start to use electrotherapy and around the sixth week the splint is removed and active flexion and extension exercises of the thumb and IP of the thumb combined begin. From the sixth week passive exercises for the ROM of the wrist and thumb in extension are performed. At the eighth week progressive strengthening exercises begin with the Nerf ball, progressing to the use of the hand-grip avoiding; however, lifting heavy weights and strenuous activity. Between the tenth and twelfth weeks full use of the hand is allowed for most daily activities, including sports [17].

Where a patient has no mobility at all, or when the lesion is a result of crushing, which can cause serious oedema or problems regarding treatment of the wound, immobilisation lasts no more than three weeks. From the third week strong compression medication is substituted with a lighter compression medication. A splint with a dorsal block is applied to the wrist and the fingers; furthermore, active and passive exercises for the ROM are performed in the splint. Active ROM exercises can be started before those of the other regimes because the area will have been immobilised for longer. From this point on however, the programme is as ex-

plained above [18].

As regards lesions of the extensor tendons in zones 4, 5 and 6, passive exercises of the PIP with the MCF fully extended and the wrist at 40° of flexion, start in the first two weeks post-operation. At the second week, after the suture has been removed, a removable splint is applied with the MCF fully extended and the wrist in neutral position. The passive exercises of the PIP continue. The splint is only removed for scar massage and for reasons of hygiene. Between the fourth and the sixth week, active flexion exercises of the MCF and the wrist begin with orthosis in the breaks between exercises and at night the wrist is placed in neutral position. During the following two weeks passive flexion exercises and active assisted exercises begin. At the sixth week the splint is removed, as long as no extensor deficit of the MCF occurs, passive flexion exercises of the wrist are performed as required [19].

Where lesions of the extensor tendons in zones 7 and 8 are concerned, a post-operative splint which maintains the wrist at 30-40° of flexion is necessary for the first two weeks. This encourages an elevated position and the full movement of the PIP and DIP which reduces tumefaction and oedema. If any significant tumefaction occurs it is treated by loosening the bandage and raising the limb. At the second week, the suture is removed and a volar splint is applied holding the wrists at 20° of extension and the MCF of the affected finger in complete extension. Exercises for the full movement of the PIP and DIP continue for the following 2 weeks, scar massage also begins in order to improve blood flow between the skin and the tendon. Between the fourth and the sixth week, hourly exercises of the wrist and MCF begin; the splint is replaced at rest and during the night. From the fifth to sixth week, the wrist is held in extension during the flexion exercises of the MCF and the MCF is extended during flexion exercises of the wrist. Also from the fifth week combined flexion exercises of the wrist and the fingers are performed. At the sixth week the splint is removed and a programme of

passive ROM exercises and extension exercises with resistance begin [20].

Where there is a lesion to the long extensor of the thumb, regardless of its location, a splint is placed with the wrist at 30° of extension and the thumb at 40° of radial abduction and in complete extension. In the first 2 weeks, it is only permitted to perform the activities that are possible while wearing the post-operative splint. Measures taken to control oedema include the elevation of the limb and exercises for the undamaged fingers. Two weeks after repair, the post-operative splint and the suture are removed, and a new splint with the wrist and thumb positioned as detailed above is applied. This is done in order to reduce tension to the repair site as much as possible. Between the fourth and the sixth week a removable splint is applied, this allows for it to be taken off every hour so that flexion and extension exercises of the IP, MCF and CMC of the thumb may be performed, with the wrist in extension. It may be necessary to continue measures to control oedema for 8 weeks and possibly longer [21-22].

In conclusion, in cases of lesions to the tendons of the hand, if possible, immediate emergency tenorrhaphy is the first treatment option. However, this is not recommended for patients with serious multiple tissue lesions of the fingers or the palm, infected wounds or significant loss of skin to the area above the tendons. In these situations, tenorrhaphy is deferred until the problems have been resolved. It is widely acknowledged, however, that surgically repaired tendons, either with pull-out technique or with termino-terminal suture, which then undergo early and appropriate motor simulation, increase in strength more rapidly and develop fewer adhesions than those tendons that undergo immobilisation repairs.

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