

Rehabilitation of Flexor Tendons in Zone II: What Aspects Should We Take into Account When Assisting These Patients? Literature Review.

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ABSTRACT

The treatment of flexor tendons is a topic of interest and creates a constant challenge for both surgeons and rehabilitators. Numerous surgical techniques and treatments have been described in order to improve functional results, although nowadays there is no ideal protocol. The objective of this article is to analyze the relevant information in order to plan the rehabilitation of patients with flexor tendon injuries in zone II. Among other aspects, we will take into account the strenght of the suture, the edema, the scar, the type of immobilization and the tendon gliding. Good teamwork is required between the surgeon, the hand therapist, and the patient in order to plan the most appropriate rehabilitation for each case.

Keywords: Flexor tendons; rehabilitation; hand therapist; protocols; early active motion.

Level of Evidence: V

Rehabilitación de los tendones flexores en la zona II ¿Qué aspectos debemos tener en cuenta a la hora de abordar a los pacientes? Revisión bibliográfica

RESUMEN

El tratamiento de los tendones flexores es un tema de interés y genera un desafío constante tanto para los cirujanos como para los rehabilitadores. Se han descrito numerosas técnicas quirúrgicas y tratamientos con la finalidad de mejorar el resultado funcional, aunque hoy en día no existe un protocolo ideal. El objetivo de este artículo es analizar la información relevante a los efectos de planificar la rehabilitación de los pacientes con lesiones de tendones flexores en la zona II. Entre otros aspectos tendremos en cuenta la solidez de la sutura, el edema, la cicatriz, el tipo de inmovilización utilizada y el deslizamiento tendinoso. Es necesario contar con un buen equipo de trabajo formado por el cirujano, el terapeuta de mano y el paciente a fin de planificar la rehabilitación más adecuada para cada caso.

Palabras clave: Tendones flexores; rehabilitación; terapeuta de mano; protocolos; movilidad activa temprana.

Nivel de Evidencia: V

INTRODUCTION

In recent years, both flexor tendon surgery and its rehabilitation process have evolved significantly. The use of new surgical techniques and more resistant sutures has allowed the development of early active mobilization protocols that achieve very good outcomes.

Injuries to flexor tendons, mainly in zone II, pose a great challenge and we need to know how to address them for optimal outcomes.

The following literature review aims at discussing what aspects should be considered in the rehabilitation of patients who have suffered a lesion of the flexor tendons in zone II, beyond a standardized protocol. The relevant topics we will discuss are: communication between the surgeon, the hand therapist, and the patient; and the immobilization and mobilization of the tendon from the first days after surgery to the strengthening stage.

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THE IMPORTANCE OF COMMUNICATION AND TEAMWORK

Before starting treatment, we must have certain key information in order to be able to address the patient satisfactorily. It is of utmost importance to contact the treating surgeon to find out what type of injury the patient suffered, what type of suture was performed, whether the suture was tensioned or is optimal to start early active treatment, the condition of the pulleys, etc. It is also helpful to have access to the surgical protocol or a video or photo of the surgery. This information will allow us to estimate the strength of tendon repair and thus develop a rehabilitation program according to each patient, in a safe and effective manner.

On the other hand, communication with the patient is essential to ensure that they are compliant with treatment. They should be explained about the injury, the importance of their compliance with the treatment, and the fact that it is prolonged. In the same way, we need to be clear about contraindications and care, mainly in the first few weeks.

The initial objective after a tenorrhaphy of flexor tendons is to promote tendon gliding by avoiding adhesions, while taking care not to put the suture at risk.

The ultimate goal is to obtain a full range of motion and allow the patient to functionally involve his/her hand in all activities.

It should be borne in mind that, during the first weeks, gliding is hindered by edema, the lump of sutures, and the formation of adhesions.¹

We must find a balance between poor mobilization aimed at avoiding adhesions and excess mobilization, for if we force rehabilitation, there is a greater effort placed on the suture, which can cause a tendon rupture or elongation.

WHEN SHOULD REHABILITATION TREATMENT START?

Most authors suggest that rehabilitation should be delayed to avoid the period of increased resistance to mobilization of the injured tendons and may not begin until the fourth or fifth day after repair.

Adhesions do not form before the seventh or ninth day, and movement in the first days would only increase the patients' pain. Chang and Tang argued that starting too soon can increase the inflammatory response. Likewise, Amadio recommended waiting until the completion of the inflammatory phase and advised three to five days of rest.² From a biomechanical point of view, the immobilized tendon loses tensile strength during the first two weeks and glide function in the first 10 days after repair; therefore, it would be ideal to start treatment on the third and fifth postoperative days.³ This will allow the inflammation to decrease and will help reduce work of flexion and movement friction.⁴

When the patient begins rehabilitation, we must conduct an initial evaluation to gather the necessary information to develop an optimal treatment program. The following data should be taken into account: age, occupation, dominant hand, type and date of injury, and date of surgery. Initially, the following parameters are evaluated: pain, with the Visual Analog Scale (VAS) of 0-10; scar type; and edema.

Factors such as pulleys, edema, joint stiffness, and shortening of extensors contribute to tendon glide resistance and should be considered when choosing an early active mobilization protocol. Concomitant conditions and patient habits, such as tobacco use, should also be considered since they influence scarring.⁵

TREATMENT OF EDEMA

One of the main objectives of treatment is to reduce edema, which causes fibrosis, joint contractures, and tendon shortening, thus restricting mobility. Its persistence causes stiffness and pain, so prevention and management are essential. One way to approach it is by positioning the hand above the elbow and the elbow above the shoulder. Retrograde massages and the Manual Edema Mobilization (MEM) technique can be applied, as well as a cohesive bandage with self-adherent Coban wrap, placed from distal to proximal.

SCAR TREATMENT

Its management begins at an early stage even when the wound has stitches. The massage should be gentle, avoiding trauma that could prolong or exacerbate the inflammatory response. The treatment aims to prevent scar adhesions between superficial and deep tissues.

If the skin does not glide over the underlying tissue, movement may be very limited. When performing massage it is important to avoid slipping over the skin; firm contact must be maintained to move the deeper tissue below the scar line.

Deep massage can be horizontal, transverse and circumferential to mobilize all planes. It is also effective in decreasing height, vascularization, pain and itching.⁶

When the scar has no stitches or scabs, silicone gel sheets can be used to apply pressotherapy. This technique provides pressure in order to reshape collagen fibers and improve skin hydration.

WHAT IS THE MOST SUITABLE IMMOBILIZATION FOR THIS TYPE OF INJURY?

Along with the implementation of early active mobilization protocols, changes have been made in terms of immobilization splints.

The first splints developed for flexor tenorrhaphy protocols placed the wrist, metacarpophalangeal joints, and interphalangeal joints in flexion to reduce the tension of the repaired tendons.

As the first early active mobilization protocols evolved, this position ceased to be the most appropriate, since significant flexion of the metacarpophalangeal joint establishes an intrinsic plus pattern of flexion of the fingers. Starting flexion from this position is very difficult for the patient, since the repaired flexors are at a mechanical disadvantage.^{7,8}

Active mobilization should be started from the distal interphalangeal joint, this is achieved by placing the wrist at 10-30° extension and the metacarpophalangeal joints at 30° flexion.⁹

Savage studied how wrist position influences the forces required to move interphalangeal joints. He concluded that a wrist extension of 45° is the optimal position to minimize work of flexion when using an early active mobilization regimen.¹⁰

Shorter dorsal blocks have also been developed, such as the one on the Manchester splint. By allowing controlled wrist extension, this splint potentially reduces work of flexion, promotes greater tendon excursion and facilitates movement of the distal interphalangeal joint.¹¹

However, in a 2019 systematic review, Woythal et al. concluded that there were no differences between a long and a short splint.¹²

According to Tang, if the tendon repair is strong, it is not necessary to place the wrist in a specific position. It may be kept in a neutral position, or in slight flexion or extension, provided that the patient is comfortable.⁵ Therefore, most active flexor tendon protocols currently recommend a position with less flexion of the wrist and the metacarpophalangeal joints, leaving interphalangeal joints in extension (Figure 1).

HOW DO WE START MOBILIZING THE TENDON?

Protocols for early active mobilization were driven by the increased strength and resistance of the sutures in recent years. Early mobilization promotes tendon excursion, reducing adhesions and improving functional outcomes. On the other hand, early movement generates greater gliding and confers more resistance to the repair, resulting in a lower incidence of rupture.^{13,14}

The aim of rehabilitation is to provide controlled stress by promoting the differentiated gliding of both tendons, facilitating the strengthening of the repair site and preventing the formation of adhesions.

The work of flexion of a tendon is the minimum strength it needs to overcome any resistance, whether internal or external, to flex the finger.

The tendon must be mobilized within what Amadio calls “the safe zone”. The tendon must be strong enough to start movement, but not so much as to jeopardize repair.^{2,6}

In 1975, Duran and Houser studied that the minimum length that the tendon had to move so as not to adhere was 3 to 5 mm. To achieve 3 mm of excursion in zone II, an active tension of at least 300 g is required.³

Several factors influence the tensile force; in repaired tendons, passive mobilization generates a force of approximately 15 N whereas active mobilization generates a force of 38 N. Another aspect to consider is that, during the first three weeks, the repair force of the flexor tendons decreases between 10% and 50%.¹⁵

The most appropriate rehabilitation program should be decided based on the type of repair. A two-strand repair allows only passive mobilization protocols, whereas for an active mobilization protocol, a minimum of four strands is required.¹⁴



Figure 1. Thermoplastic dorsal block with the wrist in a neutral position, the metacarpophalangeal joints in 30° flexion, and the interphalangeal joints in extension.

The repair force is also affected by the flexion curvature created by the tendon. A repair under a curved load is weaker than under a linear load. The repair force decreases progressively as the curvature increases, the greater the curvature of the tendon, the less force it has. Therefore, when full flexion is performed, the tendon must withstand a greater demand and may rupture, tear, or elongate. For this reason, clenching the fist should be avoided in the first weeks after surgery. Therefore, in the early postoperative period, active mid-range motion (partial or incomplete fist) is preferable and safer, since it generates less resistance.⁵

Cao and Tang investigated how much resistance is generated by edema in tendon gliding. Mild edema generates an additional force of 1.8 N and severe edema, one of 9 N. Consequently, when there is moderate or severe edema (7-9 N), active motion should be delayed or the patient should remain in a passive mobilization program.⁶

After analyzing all this information, we can decide whether the patient is eligible for inclusion in an early active mobilization program.

Before starting with an active mobilization protocol, we will always perform a passive mobilization of the digits, as proposed in the Duran program, where each joint is mobilized first analytically and then together (Figure 2). It should be done slowly and each movement should be held for 10 seconds.

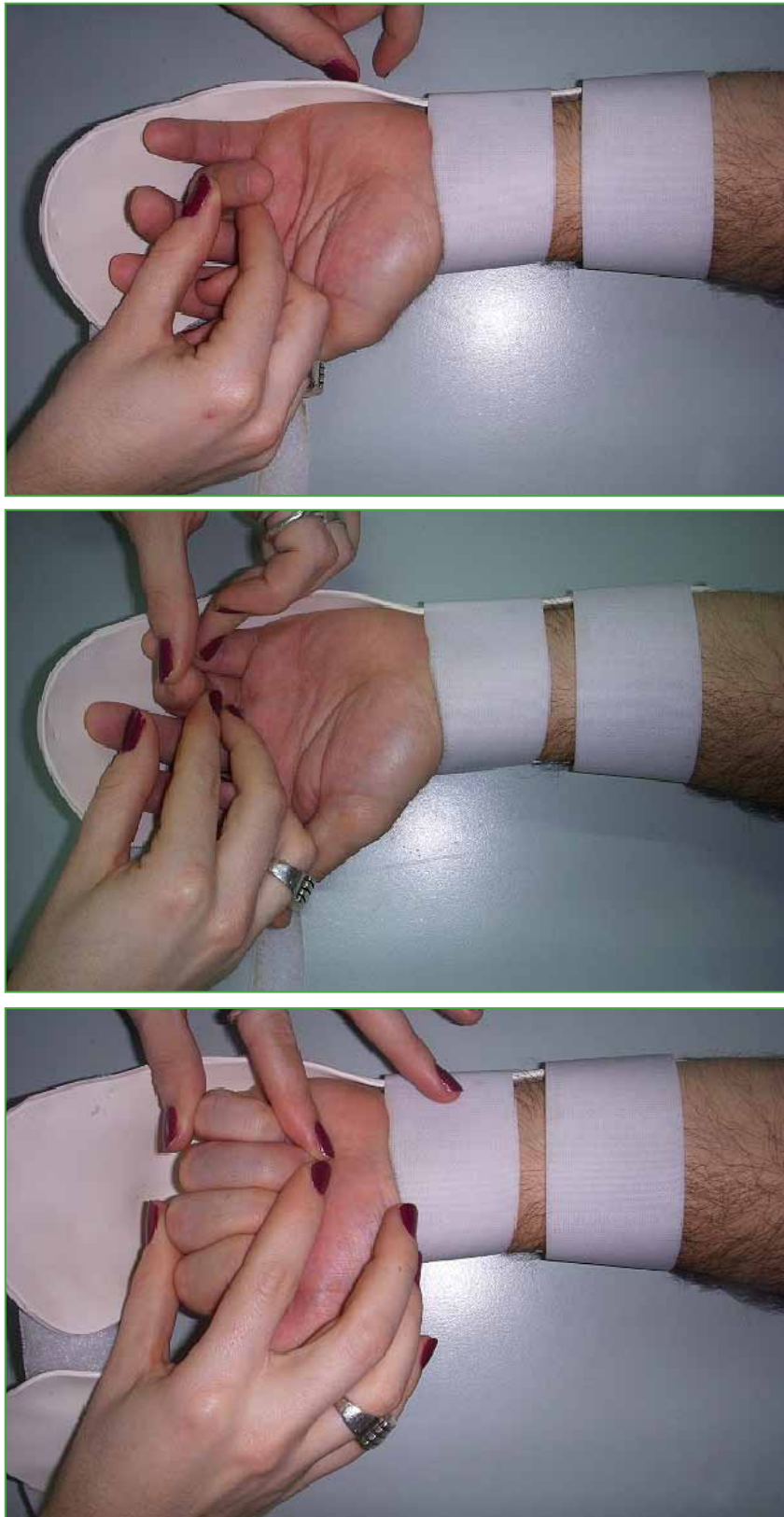


Figure 2. Passive mobilization and flexion of the distal and proximal interphalangeal joints.

Passive motion helps reduce joint edema and stiffness, minimizing peritendinous adhesions, facilitating tendon healing, improving vascularization and tensile strength.¹⁶

To achieve greater gliding of the proximal tendon through the pulleys, passive exercises should be supplemented (whenever possible) with wrist tenodesis exercises or active digit flexion exercises in middle ranges.

Strickland et al. developed the Indiana method that uses two splint models. A dorsal block and a hinged splint to allow for tenodesis movement. With the tenodesis splint, the patient performs the place and hold exercise, in which they flex the fingers passively, bring the wrist to extension, and hold a closed fist for 5 seconds. After 5 seconds, the patient relaxes muscle contraction, flexes the wrist, and synergistically extends the fingers.¹⁷

If the patient only has a dorsal block, this exercise can be performed out of the splint. It is advisable to first teach the patient how to do it with the healthy hand to experience and feel the movement and, once they understand it, repeat it with the injured hand (Figure 3).

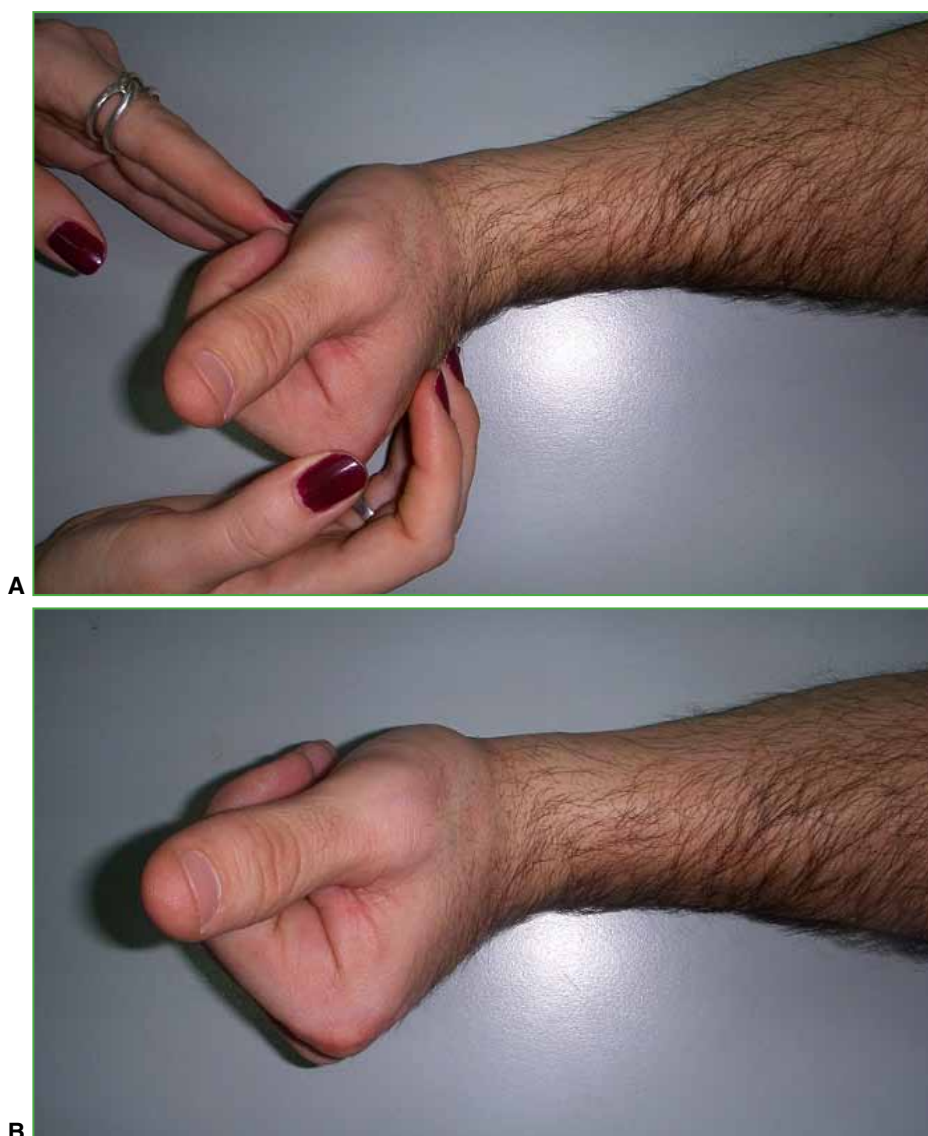


Figure 3. **A.** The fingers are passively closed and the wrist is brought to extension. **B.** Then the patient holds the closed fist for 5 seconds.

The Indiana method favors tendon gliding and a greater differentiated tendon excursion, resulting in reduced adhesions and encouraging finger movement without compromising the sutures.

Higgins and Lalonde use an active short arc flexion protocol called the Saint John Protocol.¹⁸ Tang and Evans also use the same principle that allows the patient to perform an initial active flexion of a quarter, a third, or half of the fist, within the dorsal block. The patient should be explained that they can move their fingers (in a protected way), but not use their hand.

In the first weeks, extreme active finger flexion is contraindicated, since it overloads the repaired tendons, with the risk of breaking the suture. Starting from the fourth week, the goal is to achieve full active flexion.^{5,19}

Harris proposed an alternative for graduating flexion. The patient should place the four fingers of the healthy hand on the palm of the injured hand, supporting the little finger on the distal palmar crease and the fingers perpendicular to the palm. In the first week, the patient flexes their fingers until touching the index finger and then advances one finger a week until touching the palm in the fourth week.^{20,21}

To make the movement begin with the flexion of the distal interphalangeal joint, Van Strien introduced a small, but very important modification to the previous technique. He suggested that when the fingers are flexed, the patient has to scratch the back of the finger of the healthy hand; this makes it possible to observe progress week by week and favors the gliding of both flexors.^{6,20,22}

At four weeks, the patient can remove the splint and start tendon glide exercises.²³

Beyond emphasizing gradual digital flexion, we must not forget about the extension. One way to exercise it is by positioning the metacarpophalangeal joints in flexion; however, Colditz assured that full active extension can be trained safely with the wrist in a neutral position, thanks to the protective action of lumbricals. Lumbricals contribute to the extension of the interphalangeal joints by decreasing the tension of the deep flexor; therefore, there is no tension put on suture of the repaired flexor tendon.²⁴

The number of suggested repetitions for each exercise varies among different authors. Approximately, there should be 10 to 30 repetitions of passive movements and 20 to 30 repetitions of active movements four to five times a day,

HOW DO WE PROCEED IN THE EVENT OF ADHESION FORMATION?

To assess the effectiveness of treatment or make some kind of modification, we must take into account edema and range of motion, session by session. Clinically, the formation of adhesions can be detected based on the discrepancy between the active and passive range of motion, where the passive is greater than the active. Groth devised a model to identify the optimal application of force and to regulate the load with progressive exercises, evaluating the severity of adhesions and the response to treatment. He proposed a pyramid of eight exercises, where those involving less tensile strength are located at the base. After identifying a delay in active flexion, we can progress to the next step of the pyramid.²⁵

Between the fourth and fifth weeks of the postoperative period, there is a noticeable increase in tendon repair force, which is why tendon glide exercises are initiated. When making the hook fist, a greater excursion is generated between both flexors.

Between the fifth and sixth week, analytical mobility or finger blocking exercises may be included.

Flexion contractures starting at six weeks can be treated with night splints as well as passive and elongation exercises.

The dorsal block is generally discontinued between the fifth and sixth week after surgery, although strength activities are contraindicated.

After six weeks, gradual strengthening exercises begin.^{7,11,23}

FINAL CONSIDERATIONS

The current trend following a flexor tendon suture is to use an early active mobilization protocol, but several aspects need to be taken into account at the time of rehabilitation. Early active movement can take place provided that the repair is solid and the patient complies with the rehabilitation program. We need to evaluate the patient session by session to design a protocol tailored to their needs.

A successful final outcome will be reached by the successful combination of teamwork, correct surgical technique, optimal rehabilitation protocol, and patient cooperation and compliance. There is no ideal protocol; there is good teamwork and that should be our aim.

Conflict of interest: The author declares she does not have any conflict of interest.

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