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THE MOST COMMON OVERUSE INJURIES OF THE FINGERS IN SPORT CLIMBERS – CURRENT DIAGNOSTIC AND TREATMENT STRATEGIES

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ABSTRACT

In recent years, we have observed a rapid increase in the popularity of sport climbing, which is associated with an increased number of finger injuries, particularly among beginners and intermediate climbers. The aim of our study was to present the most common finger injuries in climbers, the mechanisms by which they occur, diagnostic methods, and treatment approaches based on available scientific research.

We focused on three main finger injuries: finger flexor tendon pulleys , inflammation of tendons and synovial sheaths, and phalangeal epiphyseal fractures. We highlighted the mechanisms of injury, particularly in the context of using the "full crimp" grip, which significantly increases the load on the fingers.

Indications for conservative and surgical treatment, characteristic clinical symptoms, and the diagnostic significance of ultrasound and magnetic resonance imaging in pulley injuries were presented. In the case of tendonitis, we highlighted the role of training overload and the effectiveness of conservative treatment. In the context of phalangeal injuries, we highlighted their frequent occurrence in young athletes, appropriate diagnosis, and long-term rehabilitation.

Finger injuries in climbers are a serious problem, the incidence of which is increasing along with the popularity of this sport. Early diagnosis and proper identification are key to a quick return to sport climbing.

Methodology: This study provides an overview of the available scientific research describing the most common finger injuries among sport climbers. In our review, we focused on the mechanisms underlying these injuries, their diagnosis, and possible treatment options.

In our search for available scientific studies, we useed the following databases: PubMed, Scopus and Google Scholar, covering the period 1989–2021. When searching for available clinical studies, we focused on:

- types of injuries (ligament damage, tendinitis and tenosynovitis, phalangeal head fractures)
- mechanisms of injury, with particular emphasis on the 'full crimp' grip
- diagnostic methods (ultrasound, magnetic resonance imaging, X-ray)
- treatment strategies (conservative and surgical)

KEYWORDS

Finger Flexor Tendon Pulleys, Climbing, Tenosynovitis, Epiphyseal Fractures of the Finger Middle Joints

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Introduction

The growing popularity of climbing among the general public (1), especially following its debut in Tokyo in 2020, has led to more and more amateur climbers attempting advanced training methods in order to achieve faster progress and elevate their skills to a higher level. Their bodies specifically the fingers of the upper limbs are very often not yet ready for such stress. Due to the specific nature of climbing movements and the specific stress placed on individual structures, injuries occur that were previously unknown to physicians. (2)

In this study, we have focused on injuries to the annular ligaments and finger tendons, flexor tendons, and synovial membranes, as well as damage to the phalangeal epiphyses associated with excessive loading. The paper is based on available clinical studies that addressed the aforementioned injuries.

Due to the significant growth in the popularity of this sport, diagnostic and therapeutic methods (3) require regular updates, as the same injuries that occurred 20 years ago may present differently and may be treated with different therapeutic methods.

2. Finger flexor tendon pulleys injuries

Finger flexor tendon pulleys of the fingers perform a key biomechanical function; they keep the flexor tendons very close to the bony surfaces, enabling the force generated by the muscles in the forearms to be transferred into flexion movement at the finger joints [4].

The flexor finger tendon pulleys II–V consists of five annular ligaments (A1–A5) and three cruciate ligaments (C1–C3) (Fig. 1). These structures are responsible for stabilizing the tendons to the bone and ensuring proper tendon gliding during finger loading. When climbing, climbers very often use a "full crimp" grip; the proximal interphalangeal (PIP) joint is maximally flexed, and the distal joint is hyperextended. In this situation, the angle at which the tendon runs over the retinaculum decreases, causing greater forces to act on the retinaculum, which, when repeated many times, can lead to damage to these structures.

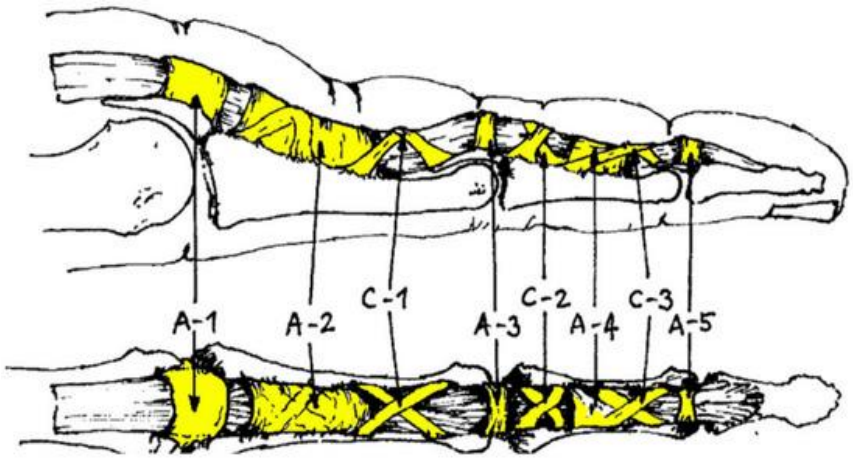

Fig.1 (15)

Laceration injuries are not common in the general population, but they occur very frequently among people training in sport climbing. Among competitive climbers, the incidence of injury to these structures ranges from 19% to 26%[5]. The most commonly injured pulley is A2, followed by A4, and the forces acting on them are 287 N and 226 N, respectively, for a 70-kg climber[6]. Repeated stress on the ligaments can lead to numerous overloads and, in the final stage, to damage to these structures

Classification of finger pulley injuries[7]

- Grade 1 – Tension in the tendons without bone or tendon separation (<2 mm on MRI/ultrasound). Very good prognosis; return to climbing within 4–6 weeks.
- Grade 2: Partial rupture of the A2/A3 ligament or rupture of the A4 ligament,
- Grade 3: Complete rupture of the A2/A3 pulley, leading to a prolonged recovery period.
- Grade 4: Complex injuries involving multiple pulley ruptures or pulley rupture combined with damage to the gluteal muscles or collateral ligaments

Grade 1–3 injuries are treated conservatively, while Grade 4 injuries are treated surgically-Table 1. The preferred surgical technique is the Widstrom loop-and-a-half technique, in which a free palmaris longus graft is harvested, wrapped around the phalanx, and sutured to serve as a substitute for the damaged ligament. If injury in this area is suspected, the diagnostic procedure should be conducted according to the algorithm shown in diagram 1.

Table 1. [7]

	Grade 1	*Grade 2*	*Grade 3*	*Grade 4*
Injury	Pulley strain	Complete rupture of A4 or partial rupture of A2 or A3	Complete rupture A2 or A3	Multiple ruptures, as A2/A3, A2/A3/A4 or single rupture (A2 or A3) combined with lumbricalis muscle or ligament damage
Therapy	Conservative	Conservative	Conservative	Surgical repair
Immobilisation	None	10 days	10–14 days	Postoperative 14 days
Functional therapy	2–4 wk	2–4 wk	4 wk	4 wk
Pulley protection	Tape	Tape	Thermoplastic or soft-cast ring	Thermoplastic or soft-cast ring
Easy sport-specific activities	After 4 wk	After 4 wk	After 6–8 wk	4 mo
Full sport-specific activities	6 wk	6–8 wk	3 mo	6 mo
Taping through climbing	3 mo	3 mo	6 mo	>12 mo

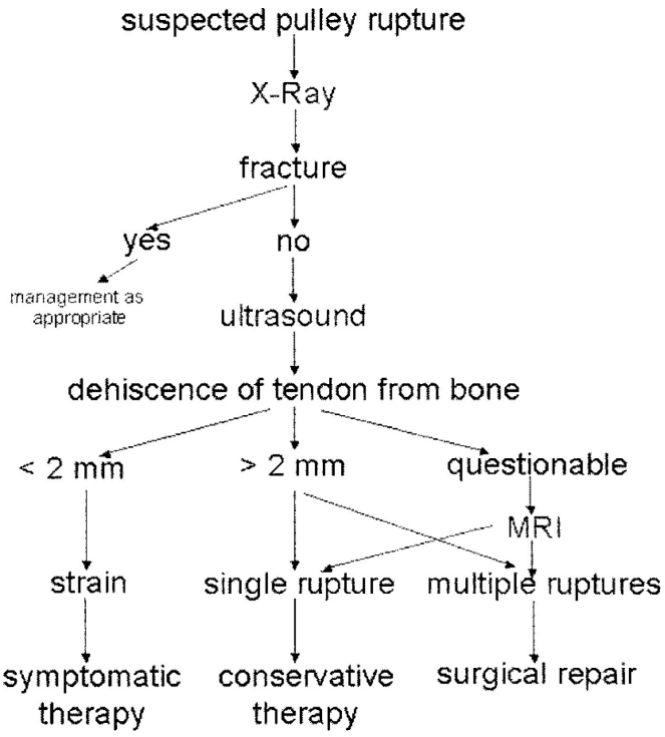

Diagram 1[7]

Diagnosis:

In climbers, injuries to the flexor tendons of the fingers are usually preceded by other symptoms: pain, swelling, and limited range of motion in the affected finger may occur [8]. However, there are cases where damage occurs, or even a complete rupture of the pulley, without prior symptoms. A characteristic snapping sound, resembling a branch breaking, is heard at the time of injury. People who have suffered such an injury often describe increasing pain, a burning sensation, difficulty bending the finger, and a decline in its function [9]. The so-called "bowstring sign" may also occur, but it is not characteristic, as it requires multiple consecutive ruptures of the pulley.

On examination, localized tenderness and swelling are observed within the injured finger, along with tenderness on palpation and a hematoma in the area of the injured pulley. Pain and weakness often occur during pincer and power grips as well. The phenomenon known as "bowstringing" reduces tendon shortening during active flexion, leading to a decrease in finger strength and function.

To confirm rotator cuff injuries, we perform detailed imaging studies to be absolutely certain and select the appropriate treatment.

Ultrasound—the test of choice. If the tendon is detached by less than 2 mm from the bone, we use symptomatic treatment, when by more than 2 mm but there is a single injury, we use conservative treatment and if the tendon is detached by 2 mm but there are multiple injuries, we use surgical treatment.

MRI—if the ultrasound image is inconclusive, or if swelling or other abnormalities prevent us from accurately assessing the damaged pullet structures, we use ultra-high-field magnetic resonance imaging [10].

X-ray examination—we often use it to rule out a fracture or to identify nonspecific swelling; therefore, it is not a recommended test [11].

Tendonitis and Synovitis

Tendon and synovial membrane inflammation is one of the most common injuries among climbers. It involves fluid accumulation around the tendon [13], caused by repeated, very intense training sessions, resulting in numerous microtraumas around the ligaments and tendons of individual fingers. Athletes affected by this injury describe discomfort on the palmar side of the finger in a location comparable to the A2 and A4 ligaments; therefore, differential diagnosis with damage to these structures is mandatory [14].

Diagnosis:

The initial diagnosis involves a clinical examination, which consists of palpation of the injured finger, typically in the area of the A2 and A4 ligaments. The patient then experiences significant pain, which may also extend to the forearm, and swelling of the finger may occur. On ultrasound, a characteristic halo around the tendon is observed.- Fig.2 and Fig.3. In a 2015 study, 31 men with this condition were examined, in whom the thickness of the tendons, A2 and A4 pulley, and the volume of synovial fluid in this area in individuals with symptoms of tendon and synovial membrane inflammation was significantly increased[15], confirming that ultrasound is the gold standard for diagnosing this condition[16]

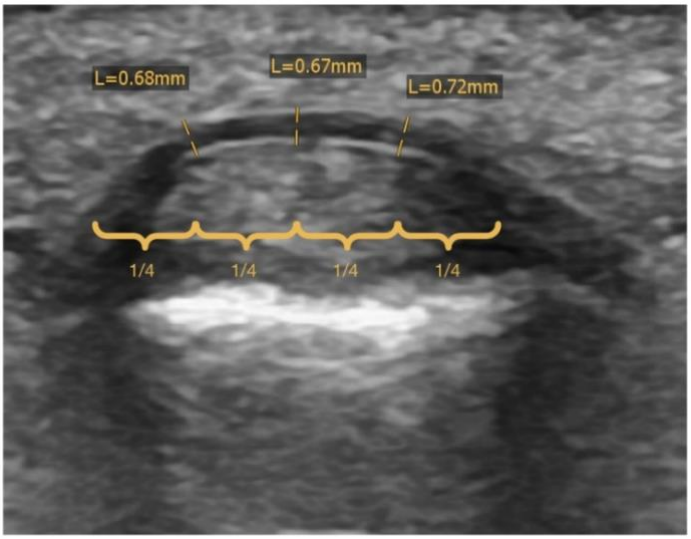

Fig. 2 [15]

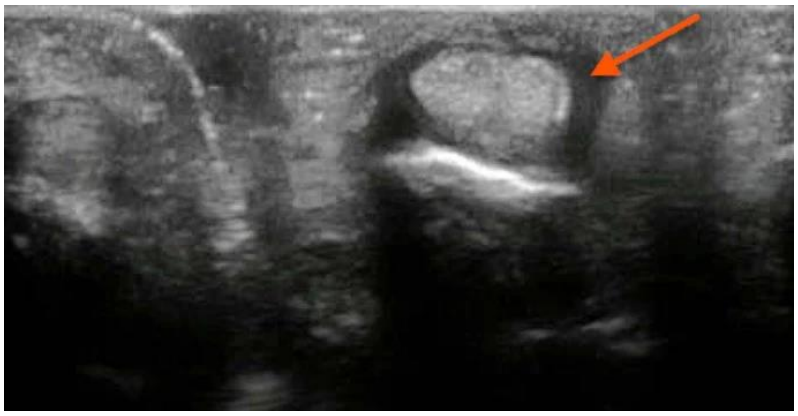

Fig. 3 [15]

Treatment:

In their study, Schoffl et al. described 42 patients with tendon and sheath inflammation lasting more than 6 weeks. They used two corticosteroid injection regimens on these patients. They observed a complete reduction in pain in 57.5% of the patients after 2 injections, and 84.2% reported a relative reduction in pain symptoms [13]. Corticosteroid injections are indicated if conservative treatment—such as transverse massage, NSAID ointments, a finger massage ring, and rest—fails after 4 weeks or if symptoms persist for more than 6 weeks. However, one must be aware of complications that may occur during such procedures, such as tendon damage or infection at the injection site [17].

Phalangeal base fractures

As sport climbing has grown in popularity, an increasing number of younger climbers are attempting more intense training and using training methods that are more likely to cause injuries, which in turn puts greater strain on their finger joints. Repetitive injuries, such as those resulting from intense athletic activity, can cause intra-articular ossification disorders by damaging the blood vessels at the bone epiphysis[19]. It has also been noted that the use of high-impact training methods, such as campus boards, at an early age increases the risk of developing osteoarthritis of the hand joints later in life[18].

Diagnosis:

The main symptom reported by patients is pain and swelling in the affected joint; passive flexion in this joint is often limited as well. It has been observed that a thickening is palpable on the dorsal side [20] and axial deviation of the finger may occur—Figure 4.

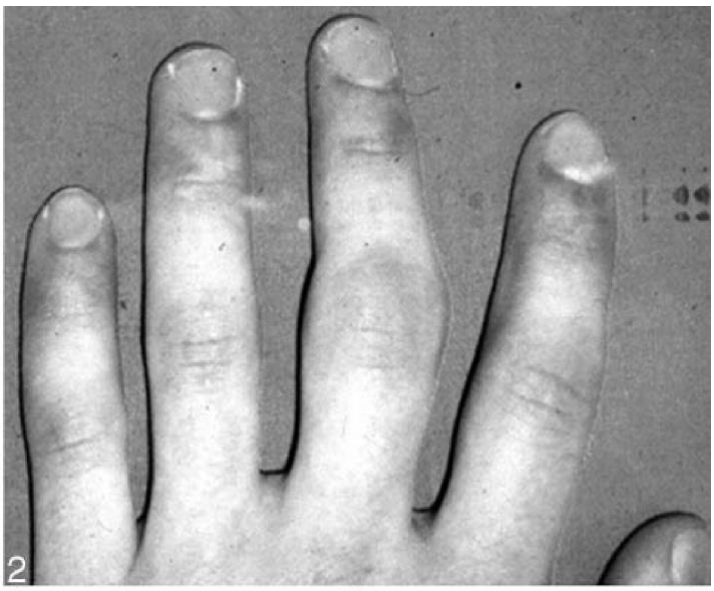

Fig. 4 [20]

X-ray—X-ray examination is crucial for confirming a fracture, but it sometimes happens that a fracture will only become visible on a standard X-ray 3 months after the injury—Figure 5

Fig. 5 [20]

MRI—due to an inconclusive X-ray, Schloef et al.in a 2005 study of a patient with pain and a normal X-ray, they performed an MRI of the affected joint. The T1 sequence clearly shows a decreased signal at the bone base in the proximal interphalangeal joint compared to the metacarpophalangeal, while the T2 image shows intra-articular effusion in the proximal interphalangeal joint. [21] - Figure 6.

Fig. 6 [21]

Treatment:

For individuals with symptoms lasting up to 4 weeks, finger immobilization with a splint for 3 weeks is recommended, along with cessation of climbing; return to sports is permitted only after radiographic confirmation of fracture healing, typically after approximately 4–6 months. Patients who reported symptoms lasting more than 4 weeks received treatment consisting of ceasing climbing for 4 to 6 months, finger exercises using the TheraBand Hand Exerciser, vibration massage, ice therapy, and anti-inflammatory medications[21].

Conclusions

Finger injuries are the most common injuries encountered among climbers.In recent years, we have observed an increase in their frequency, which is directly linked to the growing popularity of the sport, particularly after 2020 when it became an Olympic discipline for the first time at the Tokyo Games. The most common injuries include ligament tears, tendon and bursa inflammations, and phalangeal epiphysial fractures. Each of these injuries has a different mechanism of injury, but the common cause remains chronic overuse of the finger structures, particularly during the use of the "full crimp" grip.

Early diagnosis and proper assessment, based on medical history, physical examination, and precise imaging, are crucial for a rapid return to sport climbing.

In many cases, conservative treatment, rest, training modifications, and rehabilitation are sufficient, and surgical treatment is reserved for severe injuries.

The role of prevention including proper training planning, avoiding excessive strain, and educating climbers, especially at early stages of proficiency also deserves emphasis.

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