Flexor Tenosynovitis

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KEYWORDS

• Pyogenic • Flexor tenosynovitis • Hand infection • Flexor sheath • Kanavel

KEY POINTS

- Physical examination, including evaluation of Kanavel's four cardinal signs, is the primary mode of diagnosis for flexor tenosynovitis (FTS).
- The mainstay treatment of FTS is the same as any other abscess: surgical debridement and irrigation, followed by IV antibiotics; occasionally early identified cases may be treated with IV antibiotics alone.
- Multiple approaches have been described for debridement and irrigation (eg, closed sheath irrigation, open midaxial incision); the surgeon must use judgment to balance adequate debridement and the size, location, and morbidity of incisions.
- Postoperative irrigation on the ward is not supported by evidence and the benefits rarely merit the increased burden for nurses and discomfort to patients.
- Diabetes mellitus and peripheral vascular disease place patients at higher risk of poor outcomes including stiffness and amputation; early administration of antibiotics is the intervention that most correlates with good outcomes.

INTRODUCTION

The potential diagnosis of flexor tenosynovitis (FTS) tends to provoke anxiety in primary evaluators and surgeons given the difficulty of diagnosis and treatment. The unique anatomy and function of the hand make prompt and appropriate surgical or nonsurgical treatment imperative.[1] The surgical treatment of FTS is considered an essential skill for graduating orthopedic surgery residents.[2] Postoperative rehabilitation must not be overlooked as a key component of functional recovery. This article demystifies FTS and provides the latest evidence available for diagnosis and treatment.

HISTORICAL PERSPECTIVE

The seminal work of Kanavel[3,4] describing the aggressive surgical treatment of pyogenic FTS dramatically improved the natural history of this infection, including the sequelae of finger stiffness, tendon necrosis and rupture, hand dysfunction, systemic infection, and even death. The introduction of antibiotics further revolutionized management such that the mainstay of FTS treatment today is intravenous (IV) antibiotics coupled with surgical debridement and irrigation; occasionally, cases identified early may even be treated by IV antibiotics alone. More recent advances include efforts to decrease the morbidity of surgical access while adequately debriding the closed space of the flexor sheaths.

ANATOMY

The flexor tendon sheath provides nutrition and an optimal gliding and restraining interface to the extrinsic tendons to the digits. The sheath is formed of two layers, as a "double-walled 'tube'"[5]: the visceral layer, which is synonymous with the epitenon, and the parietal layer, which is confluent with the fibrous pulley system.[6] In the normal hand, these two layers coalesce to form a sealed synovial space. In the index, middle, and ring fingers, the sheath extends 1 to 3 mm proximal to the palmar aponeurosis pulley at the level of the metacarpal necks.[6] The small

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finger sheath is confluent with the ulnar bursa in a significant portion of hands (80% in earlier texts[7] and 30% in more recent studies[8]) and Parona space in the forearm. The sheaths of the fingers end proximal to the distal interphalangeal joint.[6] The thumb sheath extends from 2 cm proximal to the radial styloid to just distal to the interphalangeal joint.[9]

Multiple communicating patterns between the flexor sheaths, the ulnar and radial bursae, and Parona space have been identified[10]; furthermore, septic sheaths may develop abnormal connections given increased synovial pressure and tissue degradation.[5] During the initial evaluation and serial examinations, the surgeon must keep in mind that an infection starting in one digit may spread to the hand, forearm, and other digits. An infection involving the radial and ulnar flexor sheaths is thus termed a "horseshoe" abscess.

Once bacteria are inoculated into the space between the visceral and parietal layers, the synovial fluid that normally provides nutrition to the tendon becomes a medium for bacterial growth. Sheath interconnections in the palm and with Parona space in the forearm allow for spread, and the closed nature of the sheath limits the host's ability to combat the infection.[5]

The confined space within the dermis of the digits has been compared with the fascia of muscle compartments,[11–13] where increased pressure within the digit (or compartment) can limit perfusion and delivery of antibiotics and the host's innate immune system. In 14 digits taken to surgery for FTS, Schnall and colleagues[14] found all patients had increased subcutaneous pressures compared with contralateral control digits, with an average pressure of 33 mm Hg (range, 20–73). Eight of the patients had pressures greater than 30 mm Hg,[14] fitting an older definition of compartment syndrome.[15]

If surgery is required, an understanding of pertinent hand anatomy is paramount. Extra care must be taken because the edematous hand and digits may have displaced neurovascular structures that are under greater tension than usual. With Kaplan cardinal line drawn from "the apex of the interdigital fold between the thumb and the index finger to the hook of the hamate,"[16] the superficial palmar arch is found 18 $\pm$ 4 mm distal to the intersection of Kaplan cardinal line and a line extending from the ulnar border of the middle finger.

Common digital arteries branch from the superficial arch and course distally until branching into proper digital arteries. At the level of finger web spaces, the proper digital arteries and veins flank the flexor tendons sheath. The arterial supply to the thumb is typically via the princeps pollicis (80%), a branch of the radial artery or deep palmar arch, or a branch of the superficial palmar arch (20%).[17]

Branches of the median and ulnar nerves typically pass between the superficial and deep transverse metacarpal ligaments, after which the nerve courses on the palmar aspect of the digital artery.[18] In the thumb, the radial digital nerve crosses over the flexor pollicis longus tendon 0.9 $\pm$ 2.3 mm proximal to a line extending along the radial border of the index finger.[19]

The pulley systems of the fingers and thumb have been extensively studied[8–10,20–22] and should be understood to perform safe and adequate debridement and irrigation. In addition to five annular pulleys, the index, middle, ring, and small fingers also have three cruciate pulleys; the palmar aponeurosis also has some pulley function (Table 1).[6] The thumb has 4 well-described variations of pulleys (Table 2).[9,21,23]

MICROBIOLOGY

Most cultures from FTS identify skin flora, specifically *Staphylococcus* and *Streptococcus*. In a recent large series with 71 consecutive patients, *Staphylococcus* and *Streptococcus* accounted for 70% of FTS infections, including 13% methicillin-resistant *Staphylococcus aureus* (MRSA). No growth was found in 18%, and the remaining 11% were caused by gram-negative organisms, *Mycobacterium*, and *Cryptococcus*.[24] Table 3 shows the culture results from representative studies from 1975 to 2012.

Atypical organisms should also be considered, especially for patients with diabetes

Table 1
Pulleys of the index-small fingers

Pulley Name	Pulley Location
PA	Metacarpal neck
A1	MP joint
A2	Proximal half of proximal phalanx
C1	Distal half of distal proximal phalanx
A3	PIP joint
C2	Proximal quarter of middle phalanx
A4	Middle quarter of middle phalanx
C3	Distal quarter of middle phalanx
A5	Distal most aspect of middle phalanx

Abbreviations: MP, metacarpophalangeal joint; PA, palmar aponeurosis; PIP, proximal interphalangeal joint.