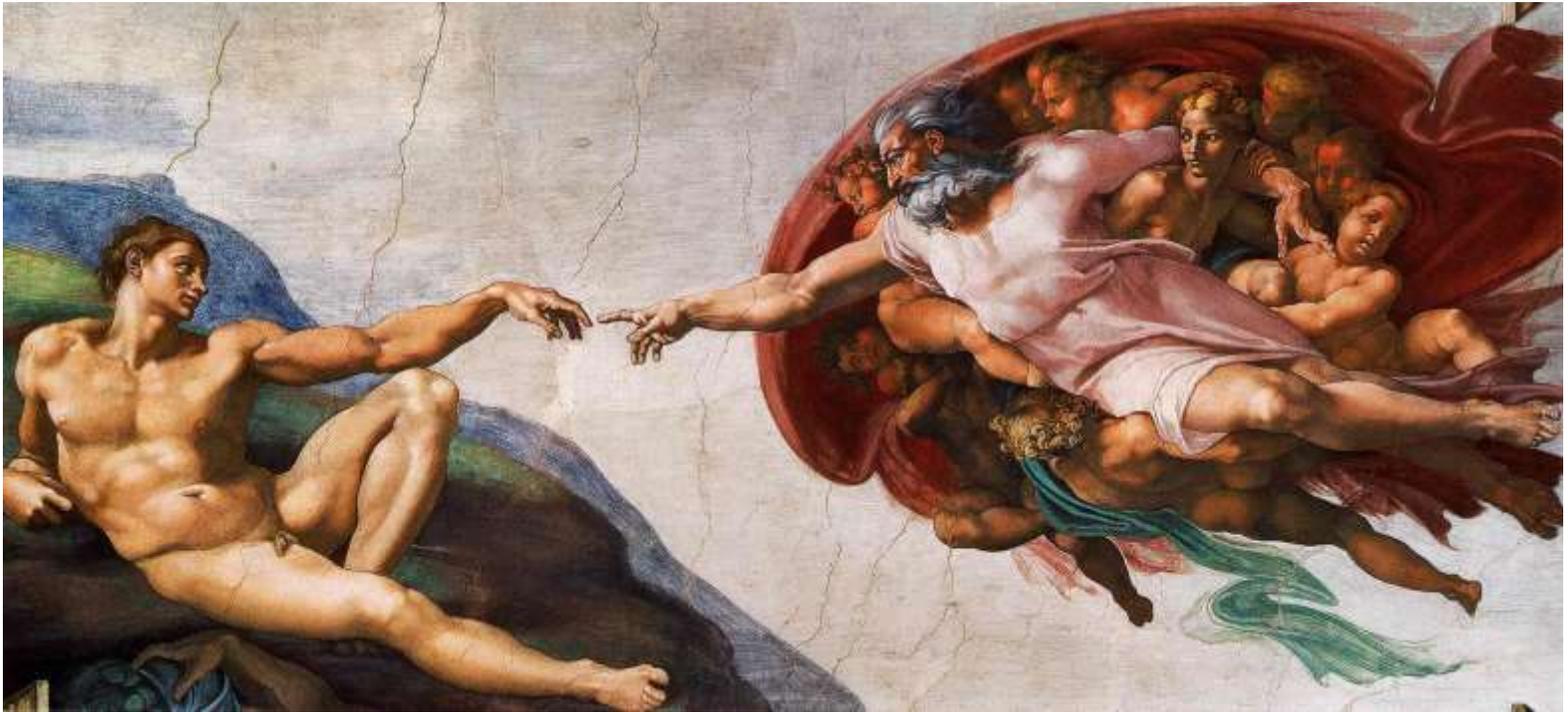


TENOSYNOVITIS (ACUTE BACTERIAL)



“The Creation of Adam”, fresco, c. 1512, Michelangelo Buonarroti, Sistine Chapel, Vatican palace, Vatican City

These four panels were the heart of the vault. Everything depended upon them. Unless he could create God as convincingly as God had created man, his ceiling would lack the focal core from whence sprang its reason for being. He had always loved God. In his darkest hours he cried out “God did not create us to abandon us”. His faith in God sustained him; and now he must make manifest to the world who God was, what He looked and felt like, wherein lay His divine power and grace. His God must not be special or peculiar or particular, but God the father to all men, one whom they could accept, honor, adore.

It was a delicate task, yet he did not doubt that he could achieve such a God. He had only to set down in drawings the image he had carried with him since childhood. God as the most beautiful, powerful, intelligent, and loving force in the Universe. Since He had created man in His own image, He had the face and body of a man. The first human whom God created, Adam had surely been fashioned in His likeness. By setting forth Adam, the son, true creature of his Father; magnificent in body, noble in thought, tender in spirit, beautiful of face and limb, archetype of all that was the finest in heaven and on Earth, there would be reflected God, the Father, God, in clinging white robe which matched His virile white beard, had only to hold out His right arm to Adam, to reach one infinitesimal life-breath more, man and the world would begin.

While Michelangelo remained high in the heavens painting the smaller panel of God Dividing the Waters from the Earth, Julius reversed positions with his fresco painter,

plunging into the special inferno reserved for warriors who suffer a rout. He failed in his siege of Ferrara, failed in his efforts to break the alliance between the Holy Roman Empire and France; went down so badly with gout that he had to be carried to Ravenna in an oxcart. His Papal and Venetian forces were severely defeated by the rampaging Ferrarese, his funds so exhausted that he had to raise eighty thousand ducats by selling eight new cardinalates at ten thousand ducats each. The French and Ferrarese recaptured Bologna and reinstated the Bentivoglios. Julius lost his armies, artillery, baggage, the last of his resources. Crushed, making his way back to Rome, he found nailed to the cathedral door at Rimini a summons of all rebellious churchmen to a general council at Pisa to conduct an inquiry into the official behavior of Pope Julius II.

Julius' defeat was also a defeat for Michelangelo, his life had become inextricably interwoven with his pontiff's. The moment the Bentivoglios returned to power, the Bolognese had thronged into the piazza Maggiore, torn his bronze statue of Julius from its niche, and thrown it to the paving stones. The triumphant Duke of Ferrara had then melted it down and recast it into a cannon, which he named "Julius". Fifteen months of his time, energy, talent, and suffering now sat on the cobbles of the Piazza Maggiore in the form of a cannon that was the butt of coarse jokes from the Bolognese, and would surely be used against Pope Julius if he were rash enough to lead another army northward. Vincenzo had triumphed.

Here in Rome it seemed to Michelangelo, the same pattern of overthrow must continue. During the warm, light days of May and June he spent seventeen consecutive hours on the scaffold, taking food and a chamber pot up with him so that he would not have to descend, painting like a man possessed, the four glorious nude males in the corners of the panels, then the young Prophet Daniel with an enormous book in his lap; opposite, the old Persian Sibyl in her white and rose robes, then the single most powerful portrait on the ceiling, God in deeply dramatic action, creating the golden ball of the sun....hoping, praying, striving desperately to complete his Genesis before the collapse of its protector, before outraged successors came in, clerical or military and, wanting to wipe out all traces of Pope Julius II's reign, sent a crew into the Sistine to spread coats of white-wash over its ceiling.

It was a race against death. As a result of his internecine warfare, Julius had returned to Rome the most hated man in Italy, his resources so exhausted that he had to carry the Papal tiara to the banker Chigi's house under his robes, ostensibly going to dinner, but actually to borrow forty thousand ducats on the jewels. His enmities extended to all the city-states he had defeated and punished: Venice, Bologna, Modena, Perugia, Mirandola...Even the Roman nobles, some of whom had led his defeated armies, were now in league against him.

Bound to each other, understanding defeat, Michelangelo felt that he must call on his Pope, the only obligation that could take him off the scaffold.

"Holy father, I have come to pay my respects".

Julius' face was ravaged by frustration and illness. Their last face to face encounter had been a stormy one, yet instinctively Julius had sensed that Michelangelo had not come seeking revenge. Julius' voice was friendly, intimate; they felt strongly drawn to each other.

"Your ceiling, it moves along?"

"Holiness, I think you will be gratified".

"If I am you will be the first to bring me gratification for a long time".

"It is no simpler in Art than in war, Holiness", said Michelangelo firmly.

"I will come to the Sistine with you. This very moment".

He could hardly make it up the ladder. Michelangelo had to haul him the last few rungs. He stood panting at the top; and then he saw God above him, about to impart the gift of life to Adam. A smile came to his cracked lips.

"Do you truly believe that God is that benign?"

"Yes holy father".

"I most ardently hope so, since I am going to be standing before Him before very long. If He is as you have painted Him, then I shall be forgiven my sins". He turned his face towards Michelangelo, his expression now radiant. "I am pleased with you my son".

Irving Stone, The Agony and the Ecstasy, 1961.

The great warrior Pope, Julius II, was tired and weary of life. Much of his military conquests in Italy had been reversed. His health was failing rapidly, and he feared he would soon have to answer to his God. Whilst he anguished over the fate of his soul, he gained great comfort in the companionship of his master Artist, Michelangelo Buonarroti. Although the relationship of the two men had been tempestuous in the extreme, their volatile temperaments were all too similar, both now sat silently together, alone on the scaffolding within the vast chapel. Though each had fought violently with the other, both men retained a great mutual respect. They were at last at peace with each other, both recognizing that at least they had produced a most magnificent legacy that would reach out to humanity to the centuries that would come after them. In the magnificent vision before him Julius perhaps even felt some comfort in the thought of his own rapidly approaching death - he survived the completion of the Sistine vault by only a few months.

Some have argued that perhaps the greatest work of Western Art, is Raphael's "The School of Athens". Those of a more spiritual ilk argue that this honour belongs to Michelangelo's vision of the creation of humanity. For those of a more secular mind, then at least the cultural symbolism is powerful indeed for those who gaze up at the truly monumental work. One cannot help but to silently ponder one's own mortality when looking up at it in the real. The anthropomorphic vision of humanity made in the very image of its creator does give spiritual comfort - the creator is like me - so he will understand me when my time comes for judgement - and he will forgive me. Michelangelo took the Biblical teaching of humanity made in God's image and firmly established it in the cultural visual lexicon of the West. In the secular world of the Twenty First century, we understand the wondrous machinations of evolution. Of profound interest is the eternal question of just what it is that separates us from the rest of creation - if anything at all!. If not an immortal soul then perhaps simply our unparalleled adaptations to the environment we find ourselves in, adaptations that include the ability to think symbolically, an efficient bipedal gait, the incredible ability of speech, but there is one other that sets us apart, the fantastic degree to which the primate opposable thumb has evolved in Homo Sapiens. An adaption that gives us the technical capability to create visions such as the vault of the Sistine Chapel. The Creation of Adam is the central feature of the vault, and the central feature of this work is the hand - the hand of God reaching out to the hand of man in the act of the creation of life. It is a fitting symbol for both a religious and a secular age.

Acute pyogenic flexor tenosynovitis is a vitally important condition to recognize - a grave threat to one of our most important evolutionary adaptations!

TENOSYNOVITIS (ACUTE BACTERIAL)

Introduction

Acute bacterial Tenosynovitis is a surgical emergency.

The term tenosynovitis simply refers to inflammation of a tendon and its synovial sheath.

This condition occurs most frequently in the **hands** and **wrist**.

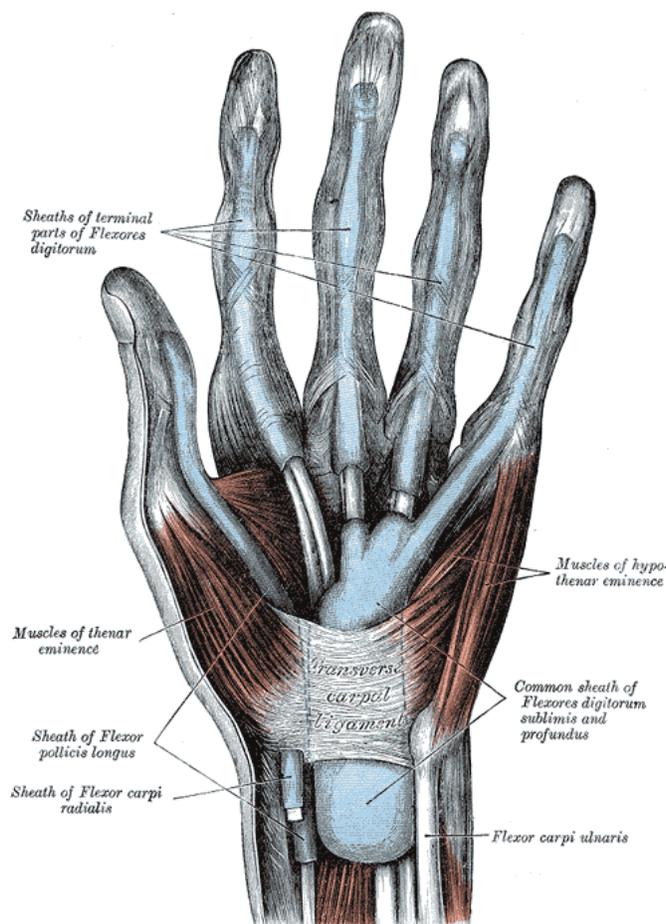
The causes of tenosynovitis can be infectious or non-infectious, (such as de Quervain's tenosynovitis).

This document refers to the condition of **acute bacterial** tenosynovitis, a true surgical emergency.

Most commonly infection involves the **flexor** tendon sheath of one of the **fingers**, i.e **acute pyogenic flexor tenosynovitis**

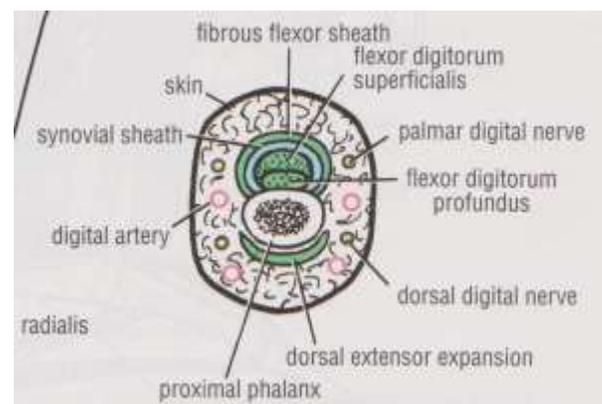
Management involves urgent IV antibiotics and timely surgical drainage.

Anatomy



Left: the flexor sheaths of the palmar aspect of the left hand, (Gray's Anatomy 1918).

Below: Transverse section through a digit.



Extensor and flexor tendon sheaths have two surfaces: an inner visceral layer adherent to the tendon and an outer parietal layer abutting adjacent structures such as bursae and muscles.

In their normal states, the visceral and parietal layers abut one another; in the setting of tenosynovitis the space between the two layers may fill with inflammatory or purulent fluid.

The ends of *flexor* tendons are overlaid by retinacular structures that act as pulleys to facilitate movement (particularly in the hands, feet, ankle, and wrist). In contrast, most *extensor* tendons lack retinacular structures, so infections of extensor tendons rarely result in loculated or well-localized infections. Thus, extensor tenosynovitis may be difficult to distinguish from a simple soft tissue infection.

Acute pyogenic tenosynovitis, therefore is seen more commonly in flexor tendons, than in extensor tendons.

The eight tendons of the flexor digitorum superficialis and profundus invaginate a common synovial sheath from the **lateral** side. This common sheath extends proximally into the forearm for a distal of about a fingerbreadth proximal to the flexor retinaculum. Distally, the medial part of the sheath continues downward without interruption on the tendons of the little finger as far as the base of the distal phalanx. The remainder of the sheath ends blindly approximately at the level proximal transverse skin crease of the palm.

The distal ends of the flexor tendons of the index, middle, and ring fingers have **digital synovial sheaths** that commence at the level of the distal transverse crease of the palm and end at the bases of the distal phalanges. Thus for a short length the tendons for these fingers are devoid of a synovial covering.

The synovial sheaths of the flexor pollicis longus (sometimes referred to as the **radial bursa**) communicates with the common synovial sheath of the superficialis and profundus tendons (sometimes referred to as the **ulnar bursa**) at the level of the wrist in about 50 % of subjects.

The **vincula longa** and **brevia** are small vascular folds of synovial membrane that connect the tendons to the anterior surface of the phalanges. They resemble a mesentery and convey blood vessels to the tendons.

The function of these sheaths is to allow the long tendons to move smoothly with the minimum of friction, beneath the flexor retinaculum and the fibrous flexor sheaths.

Anatomically the digital sheath of the index finger is related to the thenar space, while that of the ring finger is related to the midpalmar space. The sheath for the middle finger is related to both the thenar and midpalmar spaces. These relationships explain how infection can extend from the digital synovial sheaths and involve the palmar fascial spaces.

In the case of infection of the distal sheaths of the little finger and thumb, the ulnar and radial bursae are quickly involved. Should such an infection be neglected, pus may burst through the proximal ends of these bursae and enter the fascial space of the forearm between the flexor digitorum profundus anteriorly and the pronator quadratus and the

interosseous membrane posteriorly. This fascial space in the forearm is commonly referred to clinically as the **space of Parona**.

History

Allen B. Kanavel (1874 - 1938) was an American World War I army surgeon, who described the four cardinal signs of acute pyogenic flexor sheath tendon infection of the fingers.

Pathology

Organisms:

- Staphylococcus aureus
- Streptococcus species
- Pasteurella species may be seen with animal bites.
- Infections may also be **polymicrobial**, (including gram-negative organisms), especially in diabetics.
- Occasionally Neisseria gonococcus.

Causes

Tenosynovitis may occur as a result of:

- Penetrating injury:
 - ♥ This may include a retained foreign body
- Contiguous spread from infected adjacent soft tissues such as an untreated **paronychia/ felon**

Less commonly:

- Hematogenous spread (e.g. gonococcal infection).

Many cases however will in fact have **no obvious precipitating cause**.

Complications

- **Untreated cases ultimately lead to compartment syndrome and tissue necrosis with loss of the finger.**
- Osteomyelitis
- Tendon rupture

- Scarring - Deformity / stiffness/ loss of function.
- Generalized bacteria/ septicaemia
- Proximal spread into the forearm.

Severity grading:

Michon classified severity of infections involving flexor tendons according to three stages, as follows: ⁴

STAGE	FEATURES
Stage I	Distention of the inflamed tendon sheath with exudative fluid.
Stage II	Distention of the inflamed tendon sheath with purulent fluid
Stage III	Septic necrosis and destruction of the tendon sheath and surrounding retinacular structures.

Clinical Features

The diagnosis of infectious tenosynovitis is usually made on clinical grounds and then confirmed by microbiological and histopathological evaluation.

Important points of history

- Pain is usually very significant
- History of Penetrating injury including animal bites
 - ♥ Though a history of penetrating injury may not be recalled
- Comorbidities - diabetes
- Tetanus immunization status

Important points of examination:

Clinical features of an **acute bacterial flexor tenosynovitis** include:

Systemic signs

- Fever, (not always present)

- Rigors

Local signs:

These include the four classic signs of **Kanavel:**

- Finger in slight fixed flexion (i.e the position of rest and greatest comfort)
- Maximal tenderness along the line of the tendon sheath
- Marked pain on passive extension
- Fusiform swelling

Additionally there may be:

- The other usual *non-specific* signs of inflammation warmth/ erythema
- Hemorrhagic ecchymosis
- Frank tissue gangrene/ necrosis (in late presentations).

Prognostic features:

For early presentations in patients without immunosuppression or significant comorbidities, a good outcome is expected.

Pang et al ³ found that the following risk factors were associated with poorer outcomes:

- Age over 45 years
- Presence of diabetes mellitus, renal failure, or peripheral vascular disease
- Ischemic changes at the time of presentation
- Subcutaneous purulence
- Polymicrobial infection at the time of surgery

Investigations

Blood tests:

1. FBE
2. CRP
3. U&Es / glucose

4. Blood cultures if the patient is particularly systemically unwell with fever/ rigors/ hypotension

Microbiology:

Swabs should be taken for microscopy and culture when pus is able to be sampled or at surgery.

Plain Radiography:

Plain radiography is not generally helpful, unless a radio-opaque foreign body is being sought.

Subcutaneous or subfascial gas formation, if present may be seen.

Evidence of osteomyelitis may be seen

Ultrasound:

This is useful to confirm the diagnosis in early cases, as well as locating possible foreign bodies.

MRI:

This cannot distinguish infectious flexor tenosynovitis from non-infectious inflammatory tenosynovitis, but may confirm the diagnosis in milder cases and help determine the extent of the pathological process.

It is most useful when associated osteomyelitis or bone infarction is suspected.

It can assist in preoperative evaluation to localize the exact extent of infection.

Note however that imaging should not delay timely surgical drainage.

Management

Management steps will include:

1. Splint and elevate
2. Analgesia as clinically indicated
 - A **digital nerve block** will give temporary relief in cases where patients are in severe distress - the need for this should however be weighed against the possible risk of aggravating a compartment type syndrome by introducing an added volume of anaesthetic.
3. IV antibiotics:

Empiric options include:

- Flucloxacillin
- Cephalexin
- Clindamycin, (if penicillin allergic).

See latest Antibiotic Therapeutic Guidelines for full prescribing details.

4. Tetanus Immunoprophylaxis as indicated.
5. Surgery:

Milder infections may resolve with IV antibiotics, though if there is no dramatic improvement within 24 surgical drainage and washout will be required.

Moderate to severe infections will require urgent surgical drainage and washout

Disposition:

There should be urgent referral to a plastic / hand surgeon.

Appendix 1



Above left:

A twenty-five-year-old patient with mild acute infective flexor tenosynovitis who presented with Kanavel signs of a semiflexed posture of the little finger, fusiform swelling, and pain on passive extension.

The patient had none of the identified risk factors and recovered well, with IV antibiotics with 100% recovery of total active motion of the little finger.³

Above right:

A forty-year-old man with moderate acute infective flexor tenosynovitis who had sustained a penetrating injury from a wooden splinter to the volar aspect of the middle phalanx of the right middle finger.

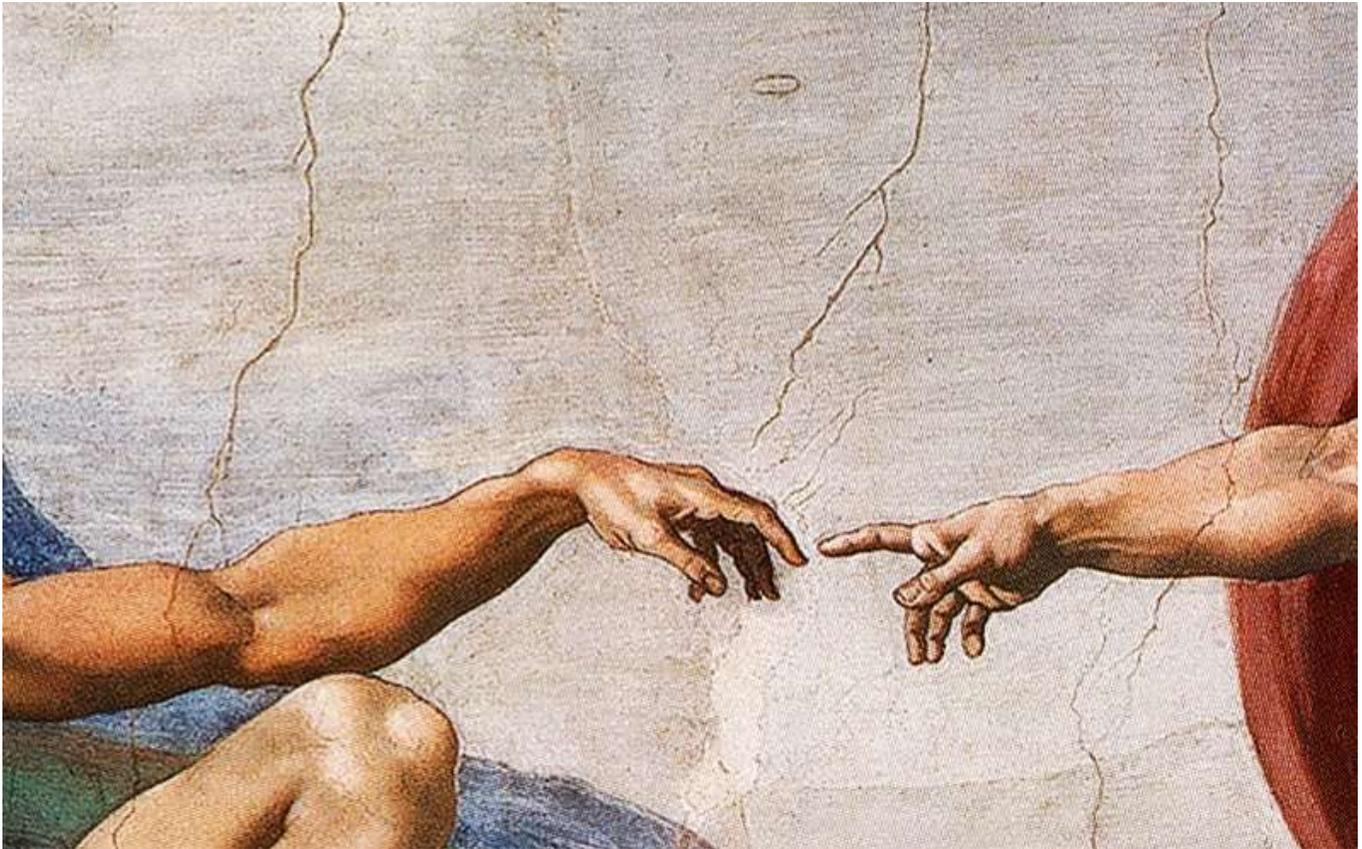
He presented with all four Kanavel signs and subcutaneous purulence, with purulent drainage from the puncture wound. At the time of surgery, there was pus in both the subcutaneous tissue and the tendon sheath.

The patient received surgical and antibiotic treatment and had 65% recovery of the total active motion at the time of the one-year follow-up.³



A fifty-year-old patient with severe acute infective flexor tenosynovitis who had a long-standing history of diabetes mellitus and peripheral vascular disease presented with signs of ischemia and skin necrosis.

The infection failed to respond to multiple surgical débridements, and the patient eventually required an amputation.



“The Creation of Adam”, (Detail) fresco, c. 1512, Michelangelo Buonarroti, Sistine Chapel, Vatican palace, Vatican City

References

1. Snell R.S. Clinical Anatomy for Medical Students 5th ed, 1995.
2. Daniel J Sexton, Infectious tenosynovitis in Up to Date Website, March 2014.
3. Hee-Nee Pang et al. Factors Affecting the Prognosis of Pyogenic Flexor Tenosynovitis. J Bone Joint Surg Am. 2007; 89:1742 - 8
doi:10.2106/JBJS.F.01356
4. Michon J. Phlegmon of the tendon sheaths. Ann Chir 1974; 28:277.

Dr J. Hayes
Reviewed August 2015.