HHS Public Access
Author manuscript
J Hand Surg Eur Vol. Author manuscript; available in PMC 2016 March 23.

Published in final edited form as:
J Hand Surg Eur Vol. 2015 September ; 40(7): 720–728. doi:10.1177/1753193415570248.

Management of acute pyogenic flexor tenosynovitis: Literature review and current trends

Aviram M. Giladi, MD[1] **[Resident]**, **Sunitha Malay, MPH**[2] **[Clinical Research Coordinator]**, and **Kevin C. Chung, MD, MS**[3] **[Professor of Surgery]**

[1] Resident, Section of Plastic Surgery, Department of Surgery, The University of Michigan Health System

[2] Clinical Research Coordinator, Section of Plastic Surgery, Department of Surgery, The University of Michigan Health System

[3] Professor of Surgery, Section of Plastic Surgery, Department of Surgery, The University of Michigan Health System

Abstract

Pyogenic flexor tenosynovitis (PFT) is an aggressive closed-space infection that can result in severe morbidity. Although surgical treatment of PFT has been widely described, the role of antibiotic therapy is inadequately understood. We conducted a literature review of studies reporting on acute PFT management. Twenty-eight case series articles were obtained, all of which used surgical intervention with varied use of antibiotics. Inconsistencies amongst the studies limited summative statistical analysis. Our results showed that use of antibiotics as a component of therapy resulted in improved range of motion outcomes (54% excellent vs. 14% excellent), as did using catheter irrigation rather than open washout (71% excellent vs. 26% excellent). These studies showed benefits of early treatment of PFT and of systemic antibiotic use. As broad-spectrum antibiotics have changed the management of other infectious conditions, we must more closely evaluate consistent antibiotic use in PFT management.

Keywords

Acute flexor tenosynovitis; antibiotic usage; bacterial; pyogenic; surgical drainage; treatment

---

Pyogenic flexor tenosynovitis (PFT) is an aggressive closed space infection of the flexor tendon synovial sheath that can cause substantial morbidity if not treated effectively. (Boles and Schmidt, 1998; Pang et al., 2007; Weinzweig and Gonzalez, 2002) PFT comprises 2.5% - 9.4% of all hand infections, (Pang et al., 2007; Weinzweig and Gonzalez, 2002) and is diagnosed primarily using four criteria described by Kanavel in the 1930s (Table 1). (Bauman et al., 2005; Draeger and Bynum, 2012) During Kanavel's time, antibiotics were not available. The dictum that surgical drainage is the only option for treatment of PFT has

Corresponding Author: Kevin C. Chung, MD, MS, 1500 E. Medical Center Dr., 2130 Taubman Center, SPC 5340, The University of Michigan Health System, Ann Arbor, MI 48109-0340, Phone: 734-936-5885, Fax: 734-763-5354, kecchung@med.umich.edu.

Disclosures: None

been propagated since that pre-antibiotic era, when surgery was the only way to prevent devastating complications. (Kanavel, 1933)

The current literature on PFT only presents cases confirmed by surgical intervention. Most hand surgeons are acquainted with the surgical treatment options for PFT; however, the role of antibiotics and non-surgical management is not clearly established, even in the current era of broad-spectrum intravenous (IV) antibiotics. There remains little consistency in antibiotic use or timing, especially in treating mild or moderate cases of PFT where IV antibiotics might be effective in reducing severity, and potentially even avoiding need for surgery.

There is no classification system that clearly delineates pre-operative PFT severity. However, cases that present early, do not yet show a rise in WBC count, and do not have any systemic symptoms may warrant a different treatment approach from the fulminant cases. Modern antibiotics have successfully treated other infectious conditions, such as infectious nephritis and periprosthetic infections, (Ho and Su, 1981; Sakiniene, 1996; Spear, 2004) and have a role in treating PFT as well. The aim of this systematic review is to evaluate the role of antibiotics in treating PFT. Our goal was to appraise the literature on trends in PFT management, and evaluate persistent gaps in evidence guiding the care of these patients.

METHODS

We performed a literature review using MEDLINE, SCOPUS, EMBASE, and CINAHL databases to find primary articles reporting on treatment of acute bacterial flexor tenosynovitis (Figure 1). An experienced, masters of public health research coordinator performed the search, with support from university medical librarians. We used the key words “acute flexor tenosynovitis,” “treatment,” “pyogenic,” and “bacterial.” We used a database filter to exclude non-human studies, as we anticipated methodological differences that would limit any direct clinical application and outcomes information. We did not restrict the search to any specific time periods. We included non-English articles in our search. After deleting duplicate studies, we performed an abstract and title search of all articles to exclude surgical or imaging technique papers, case reports, and reviews. Manual search included reviewing additional articles and books cited in the articles identified through the database search.

We collected data on study sample size, study design, treatment, severity of condition (disease stage classification), mean patient age, digits involved, IV antibiotic use, intramuscular (IM) antibiotic use, oral antibiotic use, antibiotics in local wound care, irrigation technique and duration, antibiotics in irrigation fluid, duration of symptoms, time to treatment, follow-up period, range of motion, patient satisfaction, length of hospital stay, complications, comorbidities, and bacterial culture results. We also evaluated articles for hand function assessments and patient reported outcomes questionnaires. Table 2 presents the data collected.

A variety of techniques for draining tendon sheath infections are described in the literature. We broadly categorized types of treatment as “open surgical drainage” or “catheter irrigation." Open surgical drainage consists of open drainage, incision and drainage, and limited sheath incision and drainage. Catheter irrigation describes any approach with minimal violation of the flexor sheath, with an incision to permit egress of irrigation fluid introduced from a small catheter. This includes continuous or intermittent post-operative irrigation, or intraoperative-only irrigation. For the treatment modalities and outcomes we were able to compare, we assessed group differences using chi-square analysis. In preparing this manuscript, the authors adhered to Preferred Reporting Items for Systematic reviews and Meta-Analyses guidelines.

RESULTS

We identified a total of 986 articles (Figure 1). After the exclusion of 391 duplicates, we excluded 577 articles as outlined in Figure 1. We then had 18 articles for review. Among these, 12 articles were studies conducted on PFT and its treatment, 3 articles involved other conditions as well as PFT but presented data separately, and 3 articles reported on PFT in languages other than English. The French article was bilingual with article content provided in English on the same pages. We utilized the University language translation service to obtain English translations for the two German articles. Manual search of references in the 18 identified papers yielded seven additional studies. Books cited in the 18 original articles yielded an additional three articles, for a final total of 28 (Figure 1). All included studies were retrospective case series.

There were a total of 763 involved fingers. Study samples ranged from 6 to 125 patients. The mean age of the participants in each study ranged from 27.7 to 49.8 years. Follow-up period varied from 1 week to a mean of 45 months, although many articles did not clearly report a follow-up period. Pooled mean age for the study subjects was 42 years, and pooled follow-up time was 20.7 months. Surgical interventions varied in description and extent of exposure, preventing any clear comparative assessment of specific intervention types and associated outcomes. Fingers were the most common location for PFT, but occasionally it extended into palm, (Grinnel, 1937; Harris and Nanchahal, 1999; Nemoto et al, 1993; Sokolow et al., 1987; Unonius, 1947) and Parona space. (Marsden, 1946) Of the study participants, 96 of them had reported comorbid conditions such as diabetes, renal failure, peripheral vascular disease, osteomyelitis, rheumatoid arthritis, chronic lymphocytic leukemia, bronchitis and thrombophlebitis, septic arthritis of the metacarpophalangeal joint, and unspecified chronic underlying conditions. (Bauman et al., 2005; Dailiana et al., 2008; Florey, 1944; Harris and Nanchahal, 1999; Pang et al., 2007) In these studies, diabetes (39% amputation rate, p=0.003), peripheral vascular disease (71% amputation rate, p=0.003), and renal failure (64% amputation rate, p=0.002) were significantly associated with higher risk of amputations in patients with PFT. (Mann and Peacock, 1977; Pang et al., 2007)

One study presented excellent range of motion outcomes in two patients with early tenosynovitis who were found to have finger edema and pain on passive extension. These two patients were treated with antibiotics alone. (Murray, 1951) Upon rapid subsidence of signs and symptoms in 24 hours, surgical management was deferred. Full functional recovery followed in four days in these two cases. However, a similar result was not achieved in one other conservatively managed case that was then managed surgically.

Additionally, multiple publications described patients who were treated with antibiotics alone and did not require further intervention, yet the authors did not report on any specific outcomes for these patients. (Clarkson, 1963; Gaston and Greenberg, 2009; Gordon, 1951) In one of the studies, conservative treatment at an early stage of the infection was chosen due to availability of penicillin, feasibility to see the cases on a daily basis as outpatients, and having experienced poor results with early surgical management. (Gordon, 1951)

In the 28 studies included in our review, surgical management was inconsistently accompanied by systemic antibiotic therapy. Oral antibiotics were used in two studies (7%), IV antibiotics in twelve studies (43%), both oral and IV antibiotics in four studies (14%), and IM antibiotics in three studies (11%). No systemic antibiotics were used in seven studies (25%). Of these seven studies, one study used a calcium-antibiotic paste as a dressing for wound care, and two studies used antibiotics in the irrigation fluid only. (Florey, 1944; Marsden, 1946; Unonius, 1947) Six studies that used systemic antibiotics also used antibiotics in the irrigation fluid. For each of these treatment modalities, follow-up timing for outcomes reported varied substantially. The most notable difference is between antibiotics in irrigation fluid (shortest follow-up 3 months) and other antibiotics therapies [Table 2].

Twenty-two studies presented range of motion outcomes. In these studies, outcomes were graded as excellent, good, fair, or poor hand function (Table 3); however, grading categories were inconsistently used, with some articles using 4 categories and others using only 3 (no "excellent" outcomes). Additionally, definitions of each category were often not clearly described. As a result, we elected to use the articles that clarified "excellent" outcomes for our analysis, as this was the best indication of complete or near-complete return of function.

Including all patients in these studies, 341 of 763 cases returned to excellent range of motion (45%). Use of either oral, IV, or IM antibiotics resulted in excellent range of motion in 302 of 561 reported cases (54%). (Bauman et al., 2005; Carter et al., 1966; Dailiana et al., 2008; Florey, 1944; Gaston and Greenberg, 2009; Gordon, 1951; Juliano and Eglseder, 1991; Lille et al., 2000; Marsden, 1946; Monstrey et al., 1985; Murray, 1951; Neviaser, 1978; Pang et al., 2007; Pillukat et al., 2011; Pollen, 1974; Schnall et al., 1996; Sokolow et al., 1987; Unonius, 1947; Volinger and Partecke, 2003) Patients had excellent range of motion outcomes in 25 of 177 cases (15%) after surgical treatment without accompanying systemic antibiotics, significantly worse than those with antibiotics ($p<0.001$). (Delsignore et al., 1986; Florey, 1944; Grinnel, 1937; Harris and Nanchahal, 1999) Whether antibiotics were administered preoperatively or post-operatively varied between the studies and often was not clearly delineated.

Of the cases that used systemic antibiotics, when open surgical drainage was used, 57 of 218 cases (26%) resulted in excellent range of motion. (Gordon, 1951; Florey, 1944; Murray, 1951; Pang et al., 2007;) Using systemic antibiotics with a catheter irrigation technique resulted in excellent range of motion outcomes in 245 of 343 cases (74%), significantly better than with the open technique ($p<0.001$). (Bauman et al., 2005; Carter et al., 1966; Dailiana et al., 2008; Gaston and Greenberg, 2009; Juliano and Eglseder, 1991; Marsden, 1946; Murray, 1951; Neviaser, 1978; Pollen, 1974; Schnall et al., 1996; Sokolow et al., 1987; Unonius, 1947; Volinger and Partecke, 2003)

To evaluate patient-reported outcomes (PRO), four studies used the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, (Bauman et al., 2005; Dailiana et al., 2008; Pillukat et al., 2011; Volinger and Partecke, 2003) and one study used the Quick DASH questionnaire. (Nikkah et al;., 2012) (Table 4). The questionnaire was administered at final follow-up (7-53 months from infective episode), (Dailiana et al., 2008) 6-12 months after discharge, (Nikkah et al., 2012) and at an unspecified time in 3 studies. Two of the studies reporting DASH and one study reporting Quick DASH had results for less than half of the patients included in the study. (Bauman et al., 2005; Nikkah et al., 2012; Volinger and Partecke, 2003) In three of four studies that included antibiotic use, DASH score was below 10 (low disability). (Dailiana et al., 2008; Volinger and Partecke, 2003; Nikkah et al., 2012) This is in contrast to the one study without antibiotic use, where average DASH score was 16.8. (Pillukat et al., 2011)

Six studies classified PFT severity using Michon classification, all of which used antibiotics as a component of treatment. (Bauman et al., 2005; Dailiana et al., 2008; Juliano and Eglseder, 1991; Nikkah et al., 2012; Pang et al., 2007; Sokolow et al., 1987) According to this classification, stage I has serous fluid within the sheath, stage II has purulent fluid within the sheath, and stage III has necrosis of the tendon, pulleys, and sheath. (Michon, 1974) In each of these studies, patients with more severe PFT generally had worse outcomes. However, surgical treatment varied widely, preventing any comparative outcomes based on infection severity. Earlier studies in our review stratified based on disease severity, without any defined classification system, and also described worse outcomes with more severe PFT. (Florey, 1944; Gordon, 1951; Grinnel, 1937) Number of Kanaval signs in study participants was described in 3 studies but outcomes were not presented accordingly. (Dailiana et al., 2008; Gutowski et al., 2002; Nikkah et al., 2012)

Among the ten studies that used hand therapy, four studies began therapy after signs of infection subsided, (15,17,30,36) two studies started therapy during the catheter irrigation, (Harris and Nanchahal, 1999; Nemoto et al, 1993) and four studies initiated therapy in the postoperative period. (Gaston and Greenberg, 2009; Gosain et al., 1991; Nikkah et al., 2012; Schnall et al., 1996) However, outcomes based on the timing, duration, and therapy type were not reported, except that earlier initiation of therapy helped regain good finger range of motion.

Fourteen studies that reported range of motion outcomes also reported time from diagnosis to initiation of treatment (Table 5). Although these articles differed in route of antibiotic delivery, timing of antibiotic use, surgical approach, and other elements, the general trend indicated that as treatment was delayed to 3 days or beyond, substantially more fair/poor outcomes were seen as compared to results from treatment delivered early. This is supported by reports that patients with an average treatment delay of 3.5 days had excellent outcomes as compared to delays of 7.5 days – 24.5 days resulting in fair and poor outcomes. (Carter et al., 1966; Florey, 1944) Cases treated within 48 hours had over 80% excellent range of motion outcomes. (Bauman et al., 2005; Gordon, 1951; Monstrey et al., 1985; Nikkah et al., 2012)

Timing of antibiotic administration varied among studies. They were started before the samples were sent for bacterial cultures, (Dailiana et al., 2008; Glass, 1982; Gutowski et al., 2002; Harris and Nanchahal, 1991; Lille et al., 2000; Marsden, 1946; Pollen, 1974; Vollinger and Partecke, 2003;) after the samples were sent for cultures,(Bauman et al., 2005: Juliano and Eglseder, 1991; Schnall et al., 1996) and during the surgical procedure. (Carter et al., 1996, Unonius, 1947) Staphylococcus group was the most common identified causal organism in nineteen studies. Duration of hospitalization ranged from 2.8 days to 8.9 days in ten studies, with pooled mean hospital stay of 6.4 days. (Dailiana et al., 2008; Gaston and Greenberg, 2009; Gosain and Markison, 1991; Gutowski et al., 2002; Juliano and Eglseder, 1991; Lille et al., 2000; Neviaser, 1978; Pang et al., 2007; Pillukat et al., 2011; Schnall et al., 1996) No specific treatment method was associated with longer or shorter hospital stays.

Seven studies reported on a total of 37 amputations out of the 763 infected fingers in our review (4.5%). (Dailiana et al., 2008; Delsignore et a;., 1986; Florey, 1944; Gordon, 1951; Grinnell, 1937; Juliano and Eglseder, 1991; Pang et al., 2007) Four studies described use of systemic antibiotics in 18 patients that required amputations;(Dailiana et al., 2008; Gordon, 1951; Juliano and Eglseder, 1991; Pang et al., 2007) however, at least 15 of these cases occurred in patients that had treatment delay (no antibiotics or surgery) greater than three days. (Dailiana et al., 2008 and Pang et al., 2007) Other collective analyses were limited as there was no standardization of results reported across the studies.

DISCUSSION

PFT causes substantial morbidity despite aggressive surgical treatment. (Draeger et al., 2012) Prospective clinical studies evaluating different treatment modalities for this acute infection are lacking, and the existing studies are of low-level evidence. (Draeger et al., 2010) We were unable to perform a typical systematic review or meta-analysis because necessary comparative measures were not consistently reported. However, we did identify trends worthy of further investigation.

Our findings support the use of systemic antibiotics in the treatment of PFT, as these cases showed better PROs and arc of motion outcomes with fewer complications for patients with varying severity of disease. Some reported on initial surgical debridement followed by intravenous (IV) antibiotic use postoperatively, (Bauman et al., 2005) whereas others suggested that antibiotic therapy should be initiated as soon as the diagnosis is made. (Clark, 2003; Dailiana, 2008; Henry, 2011) We could not differentiate outcomes between these approaches. Of note, most of these studies predate the availability of modern broad-spectrum IV antibiotics. Additionally, no study reported measurable outcomes for PFT patients treated with IV antibiotics alone, although success with non-surgical treatment of PFT was described. (Clark, 2003; Clarkson 1963; Gaston and Greenberg, 2009; Gordon, 1951; Henry, 2011, Murray, 1951)

This review supports the results from smaller comparative technique studies(Delsignore et al., 1986; Monstrey et al., 1985; Murray 1951; Sokolow et al., 1987) in finding that limited entry into the flexor sheath, utilizing catheter irrigation for treatment, results in better overall range of motion outcomes without increased risk of infectious complications. Use of antibiotics in the irrigation fluid had no clear benefit.

Prompt diagnosis of PFT can be challenging, but early recognition and initiation of treatment is essential to avoid complications and preserve hand function. (Boles and Scmidt, 1998) Misdiagnosis owing to deep infection, initial presentation to a primary care facility, or referral after receiving initial treatment elsewhere can lead to delays in diagnosis and treatment. (Dailiana et al., 2008; and Stern et al., 1983) Our results support the importance of initiating treatment early, whether with antibiotics or surgery. We were unable to thoroughly investigate the benefit of antibiotics without surgery; however, our review supported the benefits of antibiotics alongside surgery.

Complication rates as high as 38% have been reported for PFT. (Langer, 2009; Lee, 2010; Stern et al., 1983) Finger stiffness, boutonniere deformity, deep space infection, tendon necrosis, adhesions, persistent infection, and need for amputation can all occur. (Evgeniou and Iyer, 2012; and Clarkson, 1963) Some of the complications of PFT, including finger stiffness and tendon adhesions, are potentially caused by surgical violation of the flexor sheath, especially in cases with more aggressive open exploration. (Boles and Scmidt, 1998) This is evident in comparing outcomes of aggressive surgical intervention (26% excellent) to catheter irrigation (74% excellent). Considering that collective overall arc of motion outcomes were only 45% “excellent” for all studies, perhaps the surgical intervention itself, even with limited catheter irrigation techniques, caused some of the poor outcomes.

Early use of antibiotics for treatment of PFT may decrease complications by supporting more limited surgical techniques, or potentially avoiding surgery entirely as has been reported in some of the articles reviewed here (Clarkson, 1963; Gaston and Greenberg, 2009; Gordon, 1951, Murray 1951). The pathogenesis and resultant morbidity of PFT is similar to other closed space infections, such as septic arthritis, septic nephritis, and bacterial meningitis. (HO and Su, 1981, Sakiniene wt al., 1996; Spear et al., 2004; Wysenbeek et al., 1998) Antibiotics have improved treatment of all of these conditions. With such advances in the treatment of other challenging bacterial infections, PFT treatment with antibiotics warrants more thorough investigation.

The limitations of this review include availability of moderate number of studies (N=28), with varying follow-up timing across the studies and between the different treatment types. Additionally, making comparisons between treatment techniques and results reported in these studies risks selection bias from the data presented in the original studies, as well as bias in pooling these varied results to make summative conclusions (eg. inability to evaluate success of antibiotic therapy stratified by disease severity). Publication bias may also have been introduced as a result of only having access to cases that have been reported (eg. no measured results presented for patients treated with antibiotics alone). Our results were further limited by heterogeneity in the outcomes, no clearly outlined or consistent treatment protocol, and lack of prospective studies.

Early treatment of PFT is of paramount importance. Aggressive open surgical debridement should be avoided, because it is associated with worse outcomes and no additional benefit. The trend towards using limited catheter irrigation techniques has resulted in improved overall outcomes. The treatment of PFT has evolved since the introduction of antibiotics. Although this review highlights the benefits of antibiotic therapy in PFT management, they are still not consistently used in practice. Certainly more advanced cases and those refractory to conservative treatment warrant urgent surgical intervention, but the mild and non-fulminant cases might yield better outcomes with antibiotic-only therapy. The most effective strategy to treat these cases of PFT is not clearly delineated. In this era of powerful antibiotics, a randomized clinical trial is required to evaluate treatment of mild cases of PFT with IV antibiotics and close observation as initial stand-alone therapy. This will help identify a treatment method that provides better functional outcomes, reduces complications, and is cost effective. This will also inform us about patient characteristics, clinical conditions, and other elements that yield better outcomes when IV antibiotics are used before committing a patient to surgery. Although surgical intervention is the mainstay of treatment for persistent and severe PFT, it may not be the most appropriate first-step intervention for all PFT patients.

Acknowledgement

Support for this work was provided (in part) by the Plastic Surgery Foundation® (to AMG). Additional support was provided by the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health under Award Number K24 AR053120 (to KCC) and the National Institute on Aging and National Institute of Arthritis and Musculoskeletal and Skin Diseases R01 AR062066 (to KCC). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

REFERENCES

1. Bauman JT, Millon SJ, Tanner SL. The outpatient treatment of pyogenic flexor tenosynovitis. J Surg Orthop Adv. 2005; 14:92–5. [PubMed: 16115435]
2. Boles SD, Schmidt CC. Pyogenic flexor tenosynovitis. Hand Clin. 1998; 14:567–78. [PubMed: 9884895]
3. Carter SJ, Burman SO, Mersheimer WL. Treatment of digital tenosynovitis by irrigation with peroxide and oxytetracycline: review of nine cases. Ann Surg. 1966; 163:645–50. [PubMed: 5934641]
4. Clark DC. Common acute hand infections. Am Fam Physician. 2003; 68:2167–76. [PubMed: 14677662]
5. Clarkson, PPA. General and Plastic Surgery of the hand. Blackwell scientific publication; Oxford: 1963.
6. Dailiana ZH, Rigopoulos N, Varitimidis S, et al. Purulent flexor tenosynovitis: factors influencing the functional outcome. J Hand Surg Eur Vol. 2008; 33:280–85. [PubMed: 18562357]
7. Delsignore JL, Ritland D, Becker DR, et al. Continuous catheter irrigation for the treatment of suppurative flexor tenosynovitis. Conn Med. 1986; 50:503–06. [PubMed: 3757503]
8. Draeger RW, Singh B, Bynum DK, et al. Corticosteroids as an adjunct to antibiotics and surgical drainage for the treatment of pyogenic flexor tenosynovitis. J Bone Joint Surg Am. 2010; 92:2653–62. [PubMed: 20952605]
9. Draeger RW, Bynum DK Jr. Flexor tendon sheath infections of the hand. J Am Acad Orthop Surg. 2012; 20:373–382. [PubMed: 22661567]
10. Evgeniou E, Iyer S. Pyogenic flexor tenosynovitis leading to an amputation. BMJ. Case Rep. 2012 2012.

11. Florey MEW R.E.O. Hand infections treated with penicillin. Lancet. 1944:73–81.
12. Gaston RG, Greenberg JA. Use of continuous marcaine irrigation in the management of suppurative flexor tenosynovitis. Tech Hand Up Extrem Surg. 2009; 13:182–86. [PubMed: 19956043]
13. Glass KD. Factors related to the resolution of treated hand infections. J Hand Surg Am. 1982; 7:388–94. [PubMed: 7119400]
14. Gordon I. Expectant treatment of pyogenic infections of the hand, with special reference to infection of the flexor aspect of the fingers. Br J Surg. 1951; 38:331–9. [PubMed: 14812108]
15. Gosain AK, Markison RE. Catheter irrigation for treatment of pyogenic closed space infections of the hand. Br J Plast Surg. 1991; 44:270–3. [PubMed: 1647830]
16. Grinnell RS. Acute Suppurative Tenosynovitis of the Flexor Tendon Sheaths of the Hand: A Review of One Hundred and Twenty-Five Cases. Ann Surg. 1937; 105:97–119. [PubMed: 17856913]
17. Gutowski KA, Ochoa O, Adams WP, et al. Closed-catheter irrigation is as effective as open drainage for treatment of pyogenic flexor tenosynovitis. Ann Plast Surg. 2002; 49:350–4. [PubMed: 12370638]
18. Nemoto K, Yanagida M, Nemoto T. Closed continuous irrigation as a treatment for infection in the hand. J Hand Surg Br. 1993; 18:783–9. [PubMed: 8308444]
19. Harris PA, Nanchahal J. Closed continuous irrigation in the treatment of hand infections. J Hand Surg Br. 1999; 24:328–33. [PubMed: 10433448]
20. Henry M. Septic flexor tenosynovitis. J Hand Surg Am. 2011; 36:322–3. [PubMed: 21276896]
21. Ho G Jr. Su EY. Antibiotic therapy of septic bursitis. Its implication in the treatment of septic arthritis. Arthritis Rheum. 1981; 24:905–11. [PubMed: 7259803]
22. Juliano PJ, Eglseder WA. Limited open-tendon-sheath irrigation in the treatment of pyogenic flexor tenosynovitis. Orthop Rev. 1991; 20:1065–9. [PubMed: 1771103]
23. Kanavel, A. The symptoms, signs and diagnosis of tenosynovitis and major facial space absceses. 6 ed. Lea & Febiger; 1933.
24. Langer MF. [Pyogenic flexor tendon sheath infection: a comprehensive review]. Handchir Mikrochir Plast Chir. 2009; 41:256–70. [PubMed: 19790018]
25. Lee DH. Commentary on an article by R.W. Draeger, MD, et al.: “Corticosteroids as an adjunct to antibiotics and surgical drainage for the treatment of pyogenic flexor tenosynovitis”. J Bone Joint Surg Am. 2010; 92:e30. [PubMed: 20952604]
26. Lille S, Hayakawa T, Neumeister MW, et al. Continuous postoperative catheter irrigation is not necessary for the treatment of suppurative flexor tenosynovitis. J Hand Surg Br. 2000; 25:304–7. [PubMed: 10961561]
27. Mann RJ, Peacock JM. Hand infections in patients with diabetes mellitus. J Trauma. 1977; 17:376–80. [PubMed: 870701]
28. Marsden JA. Penicillin therapy for tendon sheath infections of the hand. Med J Aust. 1946; 1:435. [PubMed: 21024057]
29. Michon J. [Phlegmon of the tendon sheaths]. Ann Chir. 1974; 28:277–80. [PubMed: 4839194]
30. Monstrey SJ, van der Werken C, Kauer JM, et al. Tendon sheath infections of the hand. Neth J Surg. 1985; 37:174–8. [PubMed: 4088521]
31. Murray AR. The management of the infected hand: based on a clinical investigation of 513 cases. Med J Aust. 1951; 1:619–22. [PubMed: 14852152]
32. Neviaser RJ. Closed tendon sheath irrigation for pyogenic flexor tenosynovitis. J Hand Surg Am. 1978; 3:462–6. [PubMed: 556478]
33. Nikkhah D, Rodrigues J, Osman K, et al. Pyogenic flexor tenosynovitis: one year's experience at a UK hand unit and a review of the current literature. Hand Surg. 2012; 17:199–203. [PubMed: 22745083]
34. Pang HN, Teoh LC, Yam AK, et al. Factors affecting the prognosis of pyogenic flexor tenosynovitis. J Bone Joint Surg Am. 2007; 89:1742–8. [PubMed: 17671013]
35. Pillukat T, Schadel-Hopfner M, Prommersberger KJ, et al. [Closed irrigation system for pyogenic flexor tenosynovitis of the hand]. Oper Orthop Traumatol. 2011; 23:184–91. [PubMed: 21725664]

36. Pollen AG. Acute infection of the tendon sheaths. Hand. 1974; 6:21–5. [PubMed: 4494182]
37. Sakiniene E, Bremell T, Tarkowski A. Addition of corticosteroids to antibiotic treatment ameliorates the course of experimental Staphylococcus aureus arthritis. Arthritis Rheum. 1996; 39:1596–1605. [PubMed: 8814072]
38. Schnall SB, Vu-Rose T, Holtom PD, et al. Tissue pressures in pyogenic flexor tenosynovitis of the finger. Compartment syndrome and its management. J Bone Joint Surg Br. 1996; 78:793–5. [PubMed: 8836073]
39. Sokolow C, Dabos N, Lemerle JP, et al. Bacterial flexor tenosynovitis in the hand. A series of 68 cases. Ann Chir Main. 1987; 6:181–8. [PubMed: 3426324]
40. Spear SL, Howard MA, Boehmler JH, et al. The infected or exposed breast implant: management and treatment strategies. Plast Reconstr Surg. 2004; 113:1634–44. [PubMed: 15114123]
41. Stern PJ, Staneck JL, McDonough JJ, et al. Established hand infections: a controlled, prospective study. J Hand Surg Am. 1983; 8:553–9. [PubMed: 6355263]
42. Unonius E. Local penicillin treatment of suppurative infection in the tendon sheath. Acta Chir Scand. 1947; 95:532–40. [PubMed: 20256687]
43. Vollinger M, Partecke BD. [Infections of flexor tendon sheath - treatment and results]. Handchir Mikrochir Plast Chir. 2003; 35:392–8. [PubMed: 14681772]
44. Weinzweig N, Gonzalez M. Surgical infections of the hand and upper extremity: a county hospital experience. Ann Plast Surg. 2002; 49:621–7. [PubMed: 12461446]
45. Wysenbeek AJ, Volchek J, Amit M, et al. Treatment of staphylococcal septic arthritis in rabbits by systemic antibiotics and intra-articular corticosteroids. Ann Rheum Dis. 1998; 57:687–90. [PubMed: 9924212]

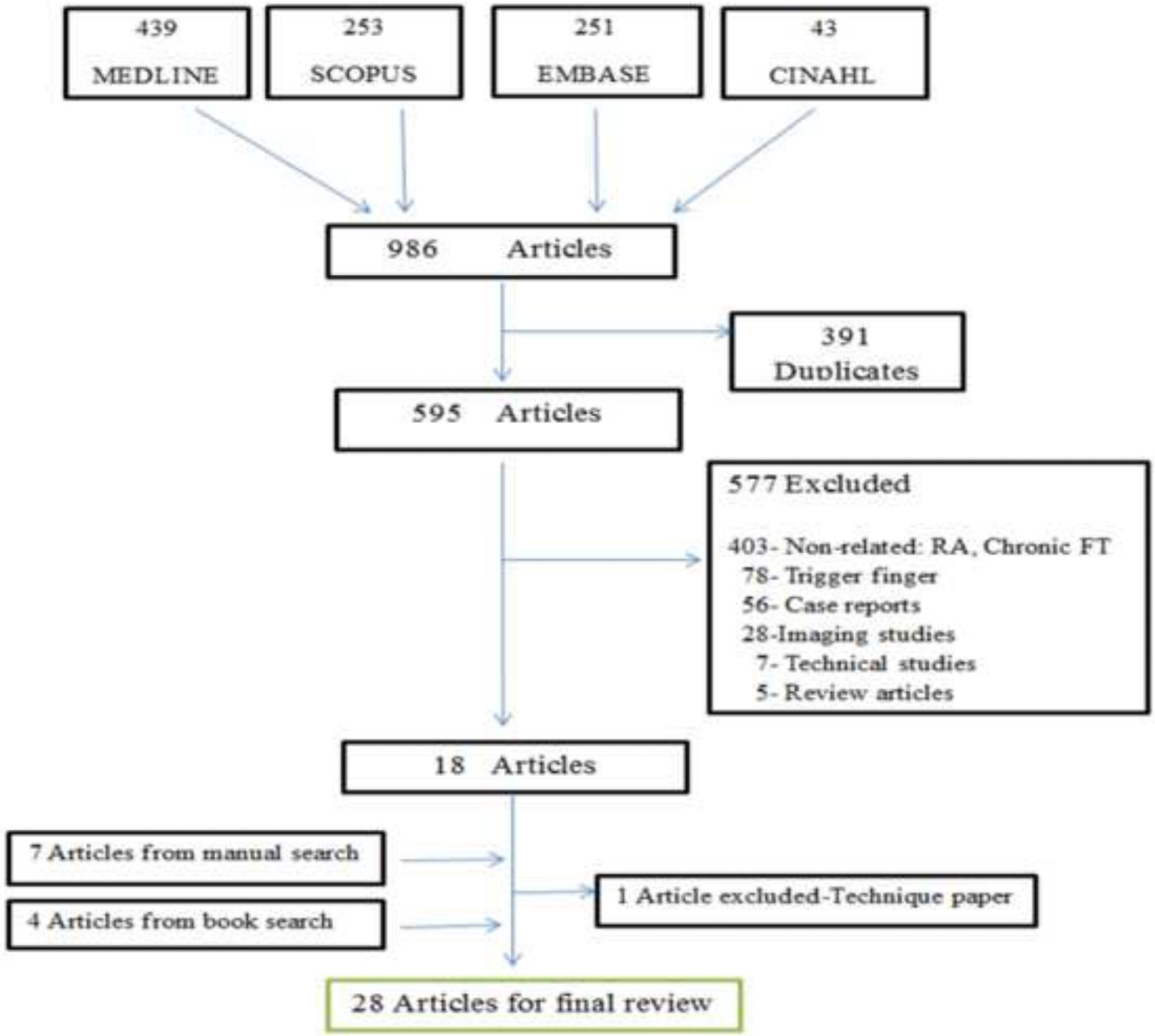

Figure 1.
Flow chart of database search for treatment of acute flexor tenosynovitis

Table 1

Kanavel signs used to diagnose acute flexor tenosynovitis

	Sign
1.	Fusiform swelling of the affected finger
2.	Tenderness along the course of the tendon sheath
3.	Digit held in semi-flexed posture
4.	Pain on passive extension of the affected digit

Adapted from:

1. Kanavel A. The symptoms, signs and diagnosis of tenosynovitis and major fascial space abscesses. 6 ed: Lea & Febiger; 1933.

2. Boles SD, Schmidt CC. Pyogenic flexor tenosynovitis. Hand Clin 1998;14:567-578.

3. Draeger RW, Bynum DK, Jr. Flexor tendon sheath infections of the hand. J Am Acad Orthop Surg 2012;20:373-382.

Table 2

Data collected from studies obtained through literature search

	Intravenous antibiotics (IV)	Oral antibiotics	Antibiotics in Irrigation fluid	Local and intramuscular antibiotic use	No antibiotic use
Number of patients	581	180	92	71	204
Pooled Mean age (y)	44.4	34.4	38.0	-	37.2
Time range in diagnosis to surgery (days)	0-14	< 1-14	1-10	3-10	4-6 days
Follow-up period	2 weeks - 45 months	1 week- 32 months	3 months-unspecified time	54 days - 3 months	16 months

Table 3

Range of motion achieved after surgery for acute flexor tenosynovitis

Treatment protocol	Antibiotic use IV/Oral/IM/None	Range of motion				
		Total number of digits	Excellent	Good	Fair	Poor
Open Drainage	Yes	218	57	106	17	38
	No	177	25	38	38	76
Catheter Irrigation	Yes	343	245	43	35	20
	No	25	14	9	1	1

Table 4

Patient reported outcomes after surgical management of acute pyogenic flexor tenosynovitis

Author (Year)	Number of patients evaluated with DASH*	Antibiotic use (IV/Oral/Both /None)	DASH* score
Vollinger & Partecke (2003)	23	IV	9
Bauman et al. (2005)	5	Post-op IV(average 3.5 days) Oral (average 9.5 days)	47.43 (Mean normative function score)^ 45.88 (Mean normative work score)^
Dailiana et al. (2008)	41	IV (pre-op and 2 days post-op) Oral (5 days)	8.1
Pillukat et al. (2011)	33	None	16.8
Nikkhah et al. (2012)	7	IV (post-op) Oral (post-op for 7 days)	7.14 (Quick DASH)**

*Disabilities of the Arm, Shoulder and Hand questionnaire: The DASH consists of 30 questions. Final scores range 0-100, with 0 indicating no disability.

**Quick DASH is a condensed version of DASH. It consists of 11 items, with an optional additional 4 items. Quick DASH final scores also range 0-100, with 0 indicating no disability.

^Normative scores are adjusted and compared to population norms for uninjured people. As a result, the numerical result is higher than other reported outcomes; however, as presented by Bauman, these adjusted DASH scores indicate low overall disability

Table 5

Outcomes of pyogenic flexor tenosynovitis treatment as related to timing of initial intervention

Year	Author	No. of patients with outcomes results reported	Time between diagnosis and surgery	Antibiotics before surgery	Antibiotics after surgery	Excellent/Good results		Fair/Poor results
1937	Grinnell	125	Average 6.2 days	No	No	21 patients – average delay 3.4 days		31 patients – average delay 5.0 days
						29 patients – average delay 4.6 days		44 patients – average delay 9.3 days
1951	Gordon	64	<24 hours to surgery in 12 patients; Early antibiotics and delayed surgery in 52 patients	Yes	Yes	Early surgery group (12 patients)	9% (6 patients)	9% (6 patients)
						Early antibiotics and delayed surgery group (52 patients)	73% (47 patients)	8% (5 patients)
1974	Pollen et al.	27	3-10 days	Yes	Yes	81% (22 patients)		19% (5 patients)
1985	Monstrey et al.	48	9 hours to 7+ days	Yes for some (not specified)	Yes in 39/48 patients	100% when treated within 2 days; 70% when delayed > 2 days		30% when treatment provided >2 days after diagnosis [6 with tendon necrosis or amputation]
1986[%]	Delsignore et al.	17	4-5 days	No	No	53%		47% [5 amputations]
1987	Sokolow et al.	52	Up to 9 days	Inconsistent use	Inconsistent use	Yes		Of those operated > 36 hours after diagnosis: 65%
1993	Nemoto et al	10	4 days- 4 months	No	No	60% excellent results – average delay 2.3 weeks		-
						20% good results - average delay 3 weeks		20% poor results – average delay 6 weeks
1996	Schnall et al.	16	Average 3.5 days	No	Yes	56%		44%
2003	Vollinger & Parteck	49	Varied from 1 to 40 days	No	Yes	64% excellent results – average delay 3.6 days		9.5% fair results – average delay 7.5 days
						22% good results – average delay 4.8 days		4.5% poor results – average delay 24.5 days
2005	Bauman et al.	15	<24 hours	Yes	Yes	93%		7%

Year	Author	No. of patients with outcomes results reported	Time between diagnosis and surgery	Antibiotics before surgery	Antibiotics after surgery	Excellent/Good results	Fair/Poor results
2007	Pang et al.	75	Average 3 days to antibiotics, average 6 days to surgery	Yes	No	~75%	~25% (13 amputations –17%)
2008	Dailiana et al.	41	"Delayed" = 10 or more days (in 16 patients)	Yes	Yes	No numbers given, but those treated with small incisions/irrigation did well regardless of surgical timing	Of patients with an open irrigation, the "delayed" patients had an additional loss of average ~15° range of motion
2011	Pillukat et al.	33	Average 7 days to surgery (varied from 0 to 42)	No	Yes	87%	13%
2012	Nikkhah et al.	7	<48 hours	Yes	Yes	100%	0%