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Original Research

Operative Versus Nonoperative Management of Pyogenic Flexor Tenosynovitis: An Analysis of the National Readmissions Database

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Purpose: The purpose of this study was to use a national database to determine if either surgical or nonsurgical management of pyogenic flexor tenosynovitis (PFT) led to specific superior outcomes.
Methods: International Classification of Diseases, Tenth Revision codes were used to identify patients admitted with PFT from the National Readmissions Database for the years 2016–2019. All patients had been admitted initially and treated with either surgical or nonsurgical management. Baseline characteristics were determined, and in those who were readmitted, the top 10 diagnoses of 90-day readmissions were identified. Risk factors for readmission were identified using a regression analysis. Ninety-day readmission rates, amputation rates, and length of stay between the groups were compared, as these are outcomes that can be reviewed from the database.
Results: The overall 90-day readmission rate was 13.25%. Infectious complications from the original diagnosis of PFT were the leading causes of readmission. Variables associated with 90-day readmission were higher Charlson comorbidity index, hypertension, Medicaid insurance, longer initial length of hospital stay, tobacco use, and nonsurgical management. Ninety-day readmission rates and amputation rates were higher in the nonsurgical group.
Conclusions: In patients with PFT, surgical intervention may prevent hospital readmissions and reduce the likelihood of amputation. Readmission is more likely in patients with more medical comorbidities, tobacco users, and lower socioeconomic status.
Type of study/level of evidence: Prognosis IIC.

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Pyogenic flexor tenosynovitis (PFT) is an infection of the flexor tendon sheath, which accounts for 2.5% to 9.5% of hand infections.[1] This usually occurs as a result of direct traumatic inoculation of the flexor tendon sheath, hematogenous spread, or adjacent spread from tissue infection.[2] Kanavel[3] described four signs to assist in the diagnosis of PFT including fusiform swelling, pain with passive extension, flexion posturing, and tenderness to palpation of the flexor tendon sheath.

The mainstay treatment of PFT is urgent open surgical drainage and flexor sheath irrigation. Other treatment strategies include closed tendon sheath irrigation and nonsurgical management with intravenous antibiotics.[4,5] With the advent of modern antibiotics, there are advocates for conservative management, such as intravenous antibiotics without any procedure or even outpatient oral antibiotics, of early PFT which may be successful in select cases.[6]

Indications for conservative management with antibiotics are extrapolated from the successful treatment of other closed deep space infections; this form of management may be considered in those with early presentation and lack of systemic signs of infection.[7] Regardless of modality, early treatment is paramount in successful treatment as the sequelae of PFT can be devastating including stiffness, boutonniere deformity, tendon necrosis, and amputation.[8,9]

Despite its prevalence, our ability to predict which patients should receive surgical or nonsurgical management is lacking. There is not a study that compares outcomes between surgical and

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Table 1
ICD-10 Diagnosis Codes for the Identification of PFT Patients*

M65.041 - Abscess of tendon sheath, right hand
M65.042 - Abscess of tendon sheath, left hand
M65.049 - Abscess of tendon sheath, unspecified hand
M65.14 - Other infective (teno)synovitis, hand
M65.141 - Other infective (teno)synovitis, right hand
M65.142 - Other infective (teno)synovitis, left hand
M65.149 - Other infective (teno)synovitis, unspecified hand

* ICD-10 diagnosis codes used for identifying all patients with PFT in the NRD database.

Table 2
ICD10 Procedure Codes Used to Identify Patients who Underwent Surgical Management*

Code	Description
0L9700Z	Drainage of right hand tendon with drainage device, open approach
0L970ZX	Drainage of right hand tendon, open approach, diagnostic
0L970ZZ	Drainage of right hand tendon, open approach
0L9730Z	Drainage of right hand tendon with drainage device, percutaneous approach
0L973ZX	Drainage of right hand tendon, percutaneous approach, diagnostic
0L973ZZ	Drainage of right hand tendon, percutaneous approach
0L9740Z	Drainage of right hand tendon with drainage device, percutaneous endoscopic approach
0L974ZX	Drainage of right hand tendon, percutaneous endoscopic approach, diagnostic
0L974ZZ	Drainage of right hand tendon, percutaneous endoscopic approach
0L9800Z	Drainage of left hand tendon with drainage device, open approach
0L980ZX	Drainage of left hand tendon, open approach, diagnostic
0L980ZZ	Drainage of left hand tendon, open approach
0L9830Z	Drainage of left hand tendon with drainage device, percutaneous approach
0L983ZX	Drainage of left hand tendon, percutaneous approach, diagnostic
0L983ZZ	Drainage of left hand tendon, percutaneous approach
0L9840Z	Drainage of left hand tendon with drainage device, percutaneous endoscopic approach
0L984ZX	Drainage of left hand tendon, percutaneous endoscopic approach, diagnostic
0L984ZZ	Drainage of left hand tendon, percutaneous endoscopic approach

* ICD-10 procedure codes used to identify the patients who underwent surgical management of PFT.

nonsurgical management of this issue. There is thus a need to identify risk factors for complications in patients with PFT to help hand surgeons determine patients at higher risk for complications and thus those who may benefit more from definitive immediate surgical management. To address this question, we used the National Readmissions Database and Healthcare Cost and Utilization Project to characterize the readmission patterns of patients diagnosed with PFT.

Methods

This study was deemed non–human subjects research by the Committee for Research Involving Human Subjects. International Classification of Diseases, Tenth Revision (ICD-10) codes were used in the National Readmissions Database to identify patients admitted with PFT between years 2016 and 2019 (Table 1). Baseline comorbidities and socioeconomic characteristics of the cohort were collected using descriptive statistics and cross-tabulations. The top 10 diagnoses associated with readmission within 90 days were identified.

Table 3
Baseline Characteristics*

Patient Characteristics	Value
Mean age (y)	48.06
Mean Charlson index (mean, SEM)	0.97 (0.02)
Percent obese (BMI >30)	11.45
Percent with diabetes (uncomplicated)	7.17
Percent with diabetes (complicated)	35.45
Percent with hypertension	35.50
Percent with chronic lung disease	13.11
Percent with immune deficiency	1.02
Percent with tobacco use	1.02
Payer type (%)	
Medicaid (%)	24.97
Medicaid (%)	28.23
Private (%)	26.91
Other (%)	19.98
Teaching hospital (%)	71.26
Nonteaching hospital (%)	28.71
Rural status	17.70
Urban status	82.30
Mean length of stay (d)	4.74

BMI, body mass index.
* The baseline characteristics of all patients admitted with pyogenic flexor tenosynovitis.

Table 4
Leading Diagnoses Associated With 90-day Readmission*

Diagnosis Associated With Readmission
1. A419 (sepsis, unknown origin), N = 138
2. M65141 (other infective (teno)synovitis, right hand), N = 72
3. T814XXXA (infection following a procedure, initial encounter), N = 60
4. L03113 (cellulitis of right upper limb), N = 71
5. L03011 (cellulitis of right finger), N = 49
6. M65142 (other infective tenosynovitis, left hand), N = 47
7. M65841 (other synovitis and tenosynovitis, right hand), N = 40
8. M65842 (other synovitis and tenosynovitis, left hand), N = 44
9. M659 (synovitis and tenosynovitis, unspecified), N = 42
10. E1169 (Type 2 diabetes mellitus with other specified complication), N = 41

* The top 10 ICD-10 diagnoses associated with 90-day readmissions.

A multivariate logistic regression analysis was performed to identify variables independent of each other that were associated with 90-day hospital readmission. The patients were then separated into two matched cohorts: those who underwent surgical intervention of any kind during the first hospital admission and those treated nonoperatively with intravenous antibiotics only. All patients had been admitted to the hospital for treatment as a defined parameter of the database. Patients who underwent surgical management were identified using the ICD-10 procedure codes listed in Table 2. The 90-day readmission rate, rate of amputation, and initial length of stay were compared between the two groups. A statistically significant *P* value was determined to be less than .05.

Results

The total number of 16,596 PFT cases was identified. There were 5,470 patients in the surgical group and 11,126 patients in the nonsurgical group. The baseline characteristics of all patients included are listed in Table 3. Overall, 33% of patients underwent surgical intervention during the initial hospital stay. Nine of the top 10 readmission diagnoses were infection-related (Table 4).

On average, readmissions occurred at 33.15 days after discharge. Higher Charlson index (odds ratio [OR], 1.28; confidence interval [CI], 1.226–1.336), hypertension (OR, 1.38; CI, 1.149–1.580), Medicaid versus private insurance (OR: 0.614; CI: 0.486–0.777),

Table 5
Multivariate Regression Analysis of Predictors of Readmission for all Patients With Flexor Tenosynovitis*

Variable	OR	Interpretation	*P* Value
Charlson index	1.29 (1.233–1.355)	Higher Charlson score more likely to be readmitted	< .0001
Obesity	0.88 (0.704–1.103)	NS	.16
Diabetes (uncomplicated)	0.788 (0.599–1.037)	NS	.07
Diabetes (complicated)	1.041 (0.767–1.413)	NS	.75
Hypertension	1.336 (1.139–1.567)	Hypertension cases more likely to be readmitted	.0003
Chronic lung disease	0.899 (0.725–1.09)	NS	.46
Immunodeficiency	0.796 (0.444–1.428)		.54
Tobacco	1.338 (1.144–1.566)	Tobacco use more likely to be readmitted	.0003
Age (y) group	0.998 (0.992–1.003)	NS	.18
Medicaid vs private	0.691 (0.558–0.857)	Private less likely to be readmitted	.0062
Length of stay	1.041 (1.027–1.054)	Longer length of stay more likely to be readmitted	< .0001
Open drainage of flexor tendon	0.834 (0.717–0.972)	Drainage procedure less likely to be readmitted	.0185
Would include anyone with any of the below highlighted procedure codes			

NS, not statistically significant.
* The results of the multivariate regression analysis performed to determine factors independently associated with 90-day readmission.

Table 6
Post Hoc Analysis of Risk Factors and Their Relationship to Surgical Versus Nonsurgical Management*

Risk Factor	Surgical (#)	Nonsurgical	*P* Value
Medicaid vs private pay %	32.3% vs 34.2%	67.7% vs 65.8%	.1876
Hypertension vs none %	31.6% vs 33.7%	68.4 vs. 66.3%	.06
Charlson score	1.03 (SD = 2.34)	0.84 (SD = 2.04)	< .0001
Tobacco vs no	32.47% vs 33.29%	67.53% vs 66.71%	.2694

* Post hoc analysis to see if there are differences between the discovered risk factors and surgical versus nonsurgical management.

Table 7
Outcomes Based on Surgical Versus Nonsurgical Management*

Outcome	Surgical Patients No., N = 5,470 (%)	Nonsurgical Patients No., N = 11,126 (%)	*P* Value
90-day readmission rate	616 (11.26%)	1,589 (14.28%)	.0002
Amputation rate	186 (3.40%)	615 (5.52%)	< .0001
Length of stay in days (mean)	4.41	4.90	< .0001

* 90-day readmission rates, amputation rates, and length of stay in the surgical and nonsurgical groups.

tobacco usage (OR, 1.338; CI, 1.144–1.566), and longer length of initial hospital stay (OR, 1.041; CI, 1.028–1.055) were significantly associated with risk of 90-day readmission. Patients who underwent surgical intervention were significantly less likely to be readmitted within 90 days (OR, 0.833; CI, 0.716–0.970; Table 5). We looked at the above risk factors to see if there were differences in the groups in terms of whether they received surgical versus nonsurgical management (Table 6). There were no differences in management in Medicaid versus private pay patients, those with hypertension versus not, or those who were tobacco users or not. Charlson index score was slightly increased in the surgical group compared with the nonsurgical group indicating that patients with a greater number of comorbidities are more likely to have had surgery during their initial hospitalization; however, the differences in the score may not be clinically significant. Ninety-day readmission rate (3.71% vs 9.58%, $P = .0002$) and amputation rate (1.12% vs 3.71%, $P < .0001$) were also higher in the nonsurgical group (Table 7). Length of stay was statistically lower in the surgical group (4.41 days vs 4.90 days, $P < .0001$).

Discussion

Our results demonstrate that higher Charlson comorbidity index, hypertension, Medicaid insurance, longer initial hospital stay, and nonsurgical management are all risk factors for readmission in patients with PFT. Most readmission diagnoses were related to persistent or progressive infection from the initial PFT diagnosis. Patients who were treated nonoperatively were more likely to be readmitted to the hospital and undergo subsequent amputation within 90 days. They were also more likely to require surgical intervention for their infection during their readmission. Because of the lack of evidence as to when nonsurgical treatment is appropriate in the setting of PFT, our results may suggest that surgical treatment is superior even in individuals with less severe infection, especially in the setting of the above risk factors.

The Charlson comorbidity index was originally developed as a tool to predict mortality within 1 year of hospital admission in patients without trauma. A higher score generally indicates a higher number and severity of comorbidities in patients and has been associated with increased morbidity and mortality after orthopedic procedures.[10,11] With this in mind, we feel that surgical intervention should be considered in patients with a high Charlson score early after the diagnosis of PFT. This is supported by several studies that have found an increased risk of readmission, prolonged length of stay, and postoperative complications for high-risk patients with hand surgery or hand infections.[12,13]

We also identified hypertension as an independent risk factor for 90-day readmission in patients with PFT. Hypertension has been identified as a risk factor for infection in other diagnoses including open tibial fractures and lower-extremity tendon repairs.[14–16] Hypertension has been found to be a risk factor for postoperative complications including infection in distal radius fractures as well.[17,18] This risk factor makes less intuitive sense compared with others but may be related to immune susceptibility in hypertensive patients as noted in other types of infection.[19]

Medicaid insurance, which may be thought of as a proxy for lower socioeconomic status, was identified as an additional risk factor for 90-day readmission. This may be related to delayed presentation, lack of access to health care, or that surgical management may be less likely to be performed in patients with public insurance.[20] In our group of patients, there was no difference in the percentage of patients who underwent surgical versus nonsurgical management based on insurance, which leads less credence to this last thought. Another contributing factor for higher readmission among the Medicaid population may be decreased follow-up after

Table 8
Comparison of Secondary Procedures Between Initial Surgical Versus Nonsurgical Groups*

Procedure Patterns for Readmitted Patients		
	Procedure on First Admission?	
Procedure on Second Admission	Yes	No
Yes	560	198
No	858	590
OR	1.94	(1.60–2.36)

* Patients who were initially nonoperatively had around twice the odds of requiring an surgical procedure during their readmission than those who were treated operatively initially.

initial discharge or follow-up in the emergency department instead.[21,22] Emergency department follow-up may lead to admission in cases where complications could typically be followed outpatient.

Tobacco usage of any kind was found to increase the risk of readmission in our cohort of patients. In this group of patients, there was no difference in the type of treatment obtained if one was a tobacco user (Table 5), but a significantly increased risk of readmission whether they received surgery or not ($P = .0003$). Tobacco use is a well-established risk factor for infection in upper-extremity surgery.[23,24] Tobacco usage has also been implicated as a risk factor for readmission in elective surgery in other studies. Smoking has a well-established link with wound healing and impairment of immune defenses, and this finding in our study agrees well with that of current literature.[25,26]

Length of stay during initial hospitalization was also identified as a risk factor for readmission in patients with PFT. Although traditionally used as an outcome measure, length of stay has been implicated previously as a risk factor for readmission after surgery in hip fractures.[27] Patients who require longer length of stay may inherently be more frail and have worse long-term health outcomes. Increased severity of infections likely contributes to prolonged initial length of stay. Furthermore, in our study, patients who were treated without surgery had a longer length of hospital stay, reinforcing the outcome disparity in nonsurgical versus surgical treatment.

The most significant finding in this study is that surgical intervention led to fewer 90-day readmissions, fewer amputations, and shorter length of stay. There are no currently published studies comparing nonsurgical versus surgical drainage of PFT. Previous studies have suggested that patients without frank purulence, sepsis, or cellulitis could be managed nonoperatively. Infections with frank purulence or infection outside the tendon sheath should be managed with surgical intervention.[6,28] However, even with these criteria available in the literature, we found in our data analysis that patients who were treated initially nonoperatively had an OR almost double that of the surgical cohort of later requiring surgical procedure for drainage of the hand (Table 8) and increased rate of readmission. Although one could say that the assessment of the severity of the infections may have been incorrect initially, it suggests that the criteria for nonsurgical management are still persistently lacking. The benefits of nonsurgical management initially are clear and include less scarring or functional impairment in less severe infections, but the delay in surgery by days to weeks during a readmission can be devastating to functional outcomes.

Although we find this study to contain useful conclusions in the management of PFT, there are several limitations. One limitation of our study is the inability to delineate the type of surgical treatment based on Current Procedural Terminology codes to compare different surgical options with nonsurgical management; therefore, no conclusions can be made regarding the superiority of percutaneous, open, or continuous irrigation individually to nonsurgical management. However, these have been compared previously and noted to have similar outcomes to each other.[29,30] Certain demographic information such as race and education level of patients cannot be captured by this database study and was thus not included in this analysis. These demographic factors could potentially affect outcomes in PFT patients. Infection culture results and organisms were also unable to be obtained as the database does not contain this information. Another limitation is the inability to define other outcomes of PFT for comparison, such as range of motion and stiffness, or any other outpatient parameters, such as follow-up, as this information is not within the database but would be useful to evaluate. An additional limitation of this study is the inability to define the severity of PFT or if multiple digits are involved, as no single ICD-10 accounts for multiple affected digits in the database. Finally, there is a subset of patients with PFT treated in the outpatient setting. This is likely a minor, although significant, group of patients that would be missed in this data set. At our institution, PFT patients are usually admitted, but this may not be the case everywhere. In the absence of rigorous clinical studies, however, this large database analysis does favor surgical intervention for patients with PFT. This will serve to guide hand surgeons in choosing the proper treatment options for patients based on risk factors and consider that current data used to help decide nonsurgical management may not be sufficient. This will also help with providing evidence while discussing the risks and benefits of patients opting for nonsurgical management in less severe infections. Future directions of study would delineate those clinical parameters of patients who would have acceptable outcomes with nonsurgical management.

Conflicts of Interest

No benefits in any form have been received or will be received related directly to this article.

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