Smoking as an Independent Modifiable Risk Factor for Reoperation for Upper Extremity Tendon Transfers

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INTRODUCTION:

Tendon transfer procedures follow general principles to maximize functional outcomes for patients; however, risk factors affecting outcomes are seldom studied. A National Surgical Quality Improvement Program (NSQIP) study found smoking can potentially contribute to delayed wound healing and surgical site infections in elective hand surgeries, but it was not investigated in tendon transfers. Our investigation studied whether smoking is associated with higher rates of medical complications, surgical complications, or re-operation in patients undergoing upper extremity tendon transfer.

METHODS:

The NSQIP database was queried for patients who underwent upper extremity tendon transfers from 1/2012 –12/2019. A total of 1736 upper exptremity tendon transfer patients were identified; of which, 323 (18.6%) were smokers (defined as smoking within one-year of surgery). Our primary outcome was the rate and cause of 30-day readmission among smokers vs. non-smokers after upper extremity tendon transfer. Secondary outcomes focused on relative incidence of wound complications. Univariate and descriptive analyses were implemented to characterize difference in baseline characteristics and outcomes between smokers and non-smokers. Multivariable regression accounted for age, race, and sex and compared preoperative comorbidities through American Society of Anesthesiology scores.

RESULTS:

Incidence of 30-Day Adverse Outcomes in Smokers vs. Non-Smokers

There was no significant difference in the incidence of non-home discharge (p=0.518), or 30-day readmission (p= 0.79; **Table 1**). However, 30-day reoperation was significantly higher among smokers compared to non-smokers (7 (2.17%) vs. 8 (0.56%) p=0.011).

None of the included cases experienced transfusion-requiring intraoperative hemorrhage or postoperative neurological deficits. Wound complications were recorded in 14 patients total, 11 (0.8%) in non-smokers and 3 (0.9%) in smokers with no significant differences (p=0.785). Infection rate and complications (including one report of sepsis) were found in 9 non-smokers and 3 smokers with no significant differences in population (p=0.569). More specifically, rates of superficial infection (p=0.673) and deep infection (p=0.333) demonstrated no significant differences in populations either. Dehiscence (two non-smokers) and sepsis (one non-smoker) occurrences were seldom seen within 30 days post-operatively. Due to the low number of complications, analysis was performed in joint groups (combining superficial site infections, deep site infections, dehiscence, and sepsis outcomes) and demonstrated non-significant differences between non-smokers and smokers (Table 2).

Multivariable Regression for 30-day Reoperation

Multivariable regression accounting for patient determinants, including age, race and sex, as well as the preoperative comorbidity burden using the American Society of Anesthesiologist (ASA) scores demonstrated that smoking was independently associated with higher odds of 30-day reoperation (Odds ratio: 4.6, 95% Confidence Interval [1.5-13.7]; p=0.007).

Reoperation Details

Mean age of the reoperated cohort was 54.3±17.2 years. 14 of the reoperations involved the distal upper extremity with one focused on the proximal upper extremity. Of those in the distal upper extremity, eight reoperations directly focused on tendons of the hand and six were related to the forearm and or the wrist (Table 3). 46.7% of the total reoperations were performed in smokers, which was significantly different compared to nonsmokers, as previously reported (p=0.011; Table 1).

DISCUSSION AND CONCLUSION:

Smoking status significantly increased the risk of reoperation within 30 days. This pattern suggest an early tendinous failures with smoking requiring additional surgical repair. Clinicians can consider patients' smoking status for effects on clinical outcomes. Patients should be counselled to refrain from smoking preoperatively and throughout the healing and rehabilitation phases. Future prospective studies with follow up intervals >30 day recommended to assess long-term effects of smoking on tendon transfers.

Table 1. *Demographic data from all 1763 subjects regarding age, race, sex, BMI, and comorbid diagnoses, stratified according to smoking status within one year of surgery including discharge destination and absence of post-operative readmission. Significant data demonstrated by p-value <0.05.*

Demographic Data		Non-Smoker	Smoker	Overall	p-Value
		N=1440	N=323	N=1763	
Age, mean (SD)		57.3 (16.5)	49.2 (14.5)	55.8 (16.4)	**<0.001**
Race, n (%)	American Indian or Alaska Native	12 (0.8)	5 (1.5)	17 (1.0)	**0.007**
	Asian	29 (2.0)	8 (2.5)	37 (2.1)	
	Black or African American	112 (7.8)	43 (13.3)	155 (8.8)	
	Native Hawaiian or Pacific Islander	4 (0.3)	2 (0.6)	6 (0.3)	
	Unknown	299 (20.8)	75 (23.2)	374 (21.2)	
	White	984 (68.3)	190 (58.8)	1174 (66.6)	
Sex, n (%)	Female	829 (57.6)	168 (52.0)	997 (56.6)	0.079
	Male	611 (42.4)	155 (48.0)	766 (43.4)	
BMI, mean (SD)		28.5 (7.4)	27.0 (7.5)	28.2 (7.4)	**0.002**
COPD, n (%)	Yes	48 (3.3)	24 (7.4)	72 (4.1)	**0.001**
Diabetes Mellitus, n (%)	Insulin	74 (5.1)	9 (2.8)	83 (4.7)	0.105
	Non-insulin	93 (6.5)	16 (5.0)	109 (6.2)	
Discharge Destination, n (%)	Home	1424 (98.9)	320 (99.3)	1744 (99.0)	0.892
	Other	16	2	18	
Non-readmission, n (%)		259 (98.1)	1222 (98.4)	1481 (98.3)	0.79
Reoperation, n (%)		8 (0.56%)	7 (2.17%)	15 (0.86%)	**0.011**

Table 2. *Wound infections and or complications reported within 30 days post-operatively in tendon transfer procedures, stratified by smoking status. Percentages are relative to total demographic. Significant data demonstrated by p-values <0.05.*

Complications (n, (%))	Non-Smoker	Smoker	p-value
Superficial Incisional SSI	7 (0.5)	2 (0.6)	0.673
Deep Incisional SSI	1 (0.1)	1 (0.3)	0.333
Dehiscence	2 (0.1)	0 (0.0)	
Sepsis	1 (0.1)	0 (0.0)	
Total	11 (0.8%)	3 (0.9%)	0.762

Table 3. *Description of the fifteen reported tendon transfer reoperation procedures and the CPT coding associated with each.*

Repeat Tendon Transfer: Description and CPT Codes	Quantity
Repair, Revision and/or Recon on Humerus/Elbow (24301)	1
Tendon transplant/transfer of Flexor or Extensor in Forearm and/or Wrist (single) (25310)	4
Tendon transplant/transfer of Flexor or Extensor in Forearm or Wrist, with tendon graft (single) (25312)	2
Tendon transplant/transfer of tendon, carpometacarpal area/dorsum of hand (26480)	2
Tendon transplant/transfer of tendon, carpometacarpal area/dorsum of hand, with free tendon graft (26483)	3
Tendon transplant/transfer of tendon to palm (26485)	1
Tendon transfer to restore intrinsic function, all four fingers (26498)	1
Cross intrinsic transfer (26510)	1
Total	15