Effect of Time to Hand Therapy following Zone II Flexor Tendon Repair

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Background: This population-based study aimed to define how time to hand therapy following isolated zone II flexor tendon repairs impacts complications and secondary procedures.
Methods: Insurance claims from the Truven MarketScan Databases were used to evaluate outcomes after isolated zone II flexor tendon repairs between January 2009 and October 2015. Cohorts differing in time to hand therapy were compared to evaluate the impact on complications, reoperation, and number of therapy sessions. Secondary outcomes analyzed how the number of therapy sessions affected rates of reoperation.
Results: Hand therapy was identified in 82% of patients (N = 2867) following tendon reconstruction. Therapy initiation occurred within 1 week, 1–4 weeks, and after 4 weeks in 56%, 35%, and 9% of patients, respectively. Univariate analysis showed no difference in non-tendinous complications (27%, 30%, 29%; $P = 0.29$) or tendon rupture rates (13%, 13%, 10%; $P = 0.42$) within 90 days between cohorts. Multivariable analysis showed no difference in rates of tenolysis (6.3%, 6%, 4.4%; $P > 0.01$). In the early initiation cohort, >23 hand therapy sessions were associated with the highest rates of tenolysis (19%).
Conclusions: Despite being a common fear of hand surgeons, early initiation of hand therapy was not associated with increased tendon rupture rates. Although delayed therapy is a concern for tendon scarring, it did not confer a higher risk of tenolysis. Complication rates do not appear to correlate with timing of hand therapy. Therefore, hand surgeons should promote early mobility following isolated flexor tendon injuries given the known functional outcome benefits. *(Plast Reconstr Surg Glob Open 2020;8:e3278; doi: 10.1097/GOX.0000000000003278; Published online 21 December 2020.)*

INTRODUCTION

Flexor tendon injury incidence is estimated at 30–42 per 100,000 person, with approximately a quarter of these occurring in work-related environments.[1] Annual total direct and indirect cost of tendinous injuries in the United States is estimated between $240 and $409 million.[2] Tendinous injuries may permanently impair hand function, thereby affecting long-term economic productivity and diminishing quality of life.[2–4] Therefore, maximizing restoration of hand function is critical. The extent of functional recovery after tendon injuries is dependent on several factors, including injury-related characteristics (eg, location, mechanism), surgical technique (eg, accurate coaptation, strength of repair), patient factors (eg, comorbidities, motivation), and post-operative care.[5–8] In regard to the latter, hand therapy after tendinous repairs is standard of care, but best practices are not uniformly agreed upon.[9,10]

Through biomechanical and clinical research advancements, there is a general understanding that early therapy-guided tendon excursion is more beneficial than strict immobilization to achieve maximal functional recovery.[10,11] Mobilization, through active or passive means, promotes

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intrinsic tendon healing, increases tensile strength, decreases adhesion formation, and improves tendon gliding.[5,12–14] These benefits translate into improved joint motion, less flexion contractures, and overall improved functional outcomes. Furthermore, these tenants of tendon healing may be most pertinent when treating zone II flexor tendon injuries.[4,15,16] Bunnell coined this region *no man's land* because of its anatomical complexity and propensity to form adhesion to the surrounding soft tissues.[17] Therefore, injuries in this zone must be subject to a meticulous rehabilitation regimen.

The optimal time for initiating hand therapy following flexor tendon repair is unknown, but early motion is advocated within the first week to minimize adhesions and improve functional outcome.[7] We used a national insurance database to investigate the hypotheses, and current dogma, that (1) early initiation of hand therapy would result in a higher rate of tendon ruptures, (2) delayed hand therapy would have a higher rate of revision surgeries, most notably tenolysis, and (3) a greater number of hand therapy sessions would result in less need for tenolysis. The current study design allows us to draw conclusions of effectiveness based on real life practices across the nation and will help surgeons make an educated decision on when to initiate hand therapy after zone II flexor tendon injuries.

METHODS

Data Source

The MarketScan Commercial Claims national databases were used to perform this population-based study. The databases contain demographic and clinical information on more than 50 million employees and their dependents. Available information includes inpatient and outpatient encounters, ambulatory procedures, clinical visits, pharmaceutical purchases, and ancillary care services (eg, hand therapy). All patients enrolled in the database have employer-based insurance plans such as preferred provider organization, comprehensive, health maintenance organization, and point-of-service.[18] Data collection was de-identified, and the study was approved by the institutional review board. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement guidelines were followed for observational studies.[19]

Study Cohort

We identified patients aged 18 or older with a Current Procedural Terminology (CPT) code indicating they underwent an isolated zone II flexor tendon repair (CPT 26356) between January 1, 2009 and October 1, 2015. All patients had an associated International Classification of Diseases, ninth revision (ICD-9) diagnosis of tendon injury (ICD-9 88.22, 88.32) within 30 days before surgery. Patients were excluded if they did not have continuous enrollment in MarketScan from 1 month before 12 months after their elective surgery. If patients had no hand therapy after surgery, they were excluded. Patients were excluded if they had a concomitant hand fracture, hand dislocation, collateral ligament injury, or traumatic amputation in the perioperative period, defined as within 1 year before or 1 month following the tendon repair. (**See appendix, Supplemental Digital Content 1**, which displays inclusion and exclusion criteria, as defined by CPT and ICD-9 codes, for the study cohort. http://links.lww.com/PRSGO/B524.)

Patient Factors

Demographic and patient characteristics obtained included age, sex, regional median income, geographic region, type of insurance, Elixhauser Comorbidity Score, and diabetes mellitus status (yes or no). The Elixhauser Comorbidity Score, created by van Walraven, summarizes disease burden and accounts for 31 different medical conditions. Previous publications have used the scoring algorithm in observational database studies, and higher scores have been shown to correlate with increased health service utilization and mortality.[20,21] In addition, to control for confounding concurrent injuries, associated vessel, nerve, and soft-tissue injuries were identified if documented within 2 weeks before tendon reconstruction. (**See Appendix, Supplemental Digital Content 1**, http://links.lww.com/PRSGO/B524.)

Outcomes

The primary outcomes of interest were complications within 90 days following tendon reconstruction (including infection, pain, tendon rupture, contractures, and compartment syndrome) and secondary procedures performed within 1 year of surgery (including tendon rupture repair, tenolysis, tendon reconstruction, and pulley reconstructions). (**See Appendix, Supplemental Digital Content 1**, http://links.lww.com/PRSGO/B524.) Secondary outcomes of interest included the number of hand therapy sessions per patient, and how this number (1) differed based on the timing of initial hand therapy, and (2) affected the rate of tenolysis within 1 year of surgery. Hand therapy sessions were identified by clinical visits to an occupational therapist with an associated ICD-9 for tendon injury. Number of hand therapy sessions were calculated within 1 year or until time of a secondary surgery, which ever occurred first.

Analysis

The study population was subdivided into 3 cohorts based on time to hand therapy following tendon reconstruction: (1) within 1 week, (2) between 1 and 4 weeks, and (3) after 4 weeks. Demographic data and comorbidities between cohorts were compared using analysis of variance and *t*-tests for normally distributed covariates and Kruskal–Wallis test for non-normally distributed covariates. Multivariable logistic regression models accounting for demographics, therapy counts, and associated injuries were used to evaluate adjusted odds and risk-adjusted rates of undergoing secondary procedures and tenolysis. Goodness of fit was verified with chi-squared test. All analyses were performed using the statistical software package

R (version 2.14.1), and statistical significance was set with a $P < 0.01$.

RESULTS

In this population-based study, we identified 3501 patients who underwent repair of an isolated zone II flexor tendon injury and met the specified inclusion/exclusion criteria. Of these patients, 82% (N = 2867) received therapy within 1 year of surgery. Fifty-six percent of patients (N = 1612) initiated hand therapy within 1 week, 35% (N = 1008) between 1 and 4 weeks, and 9% (N = 247) after 4 weeks. There was no statistical difference in sex, income, insurance type, comorbidity score, diabetes mellitus, or presence of a current injury (Table 1). The cohort that initiated therapy after 4 weeks had an older population and a larger proportion of patients that lived in the northeast or north central part of the United States. In all cohorts, a majority (83%, 85%, and 86%, respectively) had a concurrent injury, with soft-tissue injuries being the most common.

Univariate analysis on the rate of any complication, tendon rupture, and non-tendinous complications within 30 days was lower in patients that initiated therapy after 4 weeks, but within 90 days there was no significant difference (Table 2). Within 90 days of surgery, the complication rate was 36%, 37%, and 37%, and tendon rupture rate was 13%, 13%, and 10%, respectively. Secondary procedures (14%, 12%, 9%) and tenolysis surgery (11%, 10%, 7%) within a year of surgery were not statistically different when comparing cohorts. Tendon reconstructions and tendon pulley reconstruction surgeries were infrequently performed in all cohorts. After adjusting for demographics, therapy sessions, and concurrent injuries, there was no difference in the rate of secondary surgeries or tenolysis surgery (Table 3).

Table 1. Patient Demographic and Characteristics by the Initiation Time of Therapy (N = 2867)

	Therapy Initiated <1 Week	Therapy Initiated 1–4 Weeks	Therapy Initiated >4 Weeks
Total	1612	1008	247
Mean age	40	40	41
Age ($P = 0.004$)			
18–34	645 (40%)	409 (41%)	90 (36%)
35–49	533 (33%)	298 (30%)	83 (34%)
50–65	381 (24%)	253 (25%)	53 (21%)
Older than 65	53 (3%)	48 (5%)	21 (9%)
Sex ($P = 0.545$)			
Male	946 (59%)	606 (60%)	153 (62%)
Female	666 (41%)	402 (40%)	94 (38%)
Quartile of median house income ($P = 0.292$)			
Quartile 1 (<=$46,910)	266 (17%)	181 (18%)	38 (15%)
Quartile 2 ($46,910–$51,920)	288 (18%)	147 (15%)	48 (19%)
Quartile 3 ($51,920–$58,900)	374 (23%)	266 (26%)	64 (26%)
Quartile 4 (>$58,900)	440 (27%)	267 (26%)	62 (25%)
Missing	244 (15%)	147 (15%)	35 (14%)
Insurance type ($P = 0.083$)			
PPO	1035 (64%)	625 (62%)	143 (58%)
Comprehensive	45 (3%)	37 (4%)	7 (3%)
HMO	149 (9%)	113 (11%)	40 (16%)
POS	127 (8%)	83 (8%)	17 (7%)
Other	169 (10%)	94 (9%)	22 (9%)
Missing	87 (5%)	56 (6%)	18 (7%)
Comorbidity score ($P = 0.014$)			
0	1177 (73%)	690 (68%)	166 (67%)
1–3	83 (5%)	68 (7%)	13 (5%)
4–8	236 (15%)	174 (17%)	37 (15%)
>8	116 (7%)	76 (8%)	31 (13%)
Region ($P < 0.001$)			
Northeast	335 (21%)	237 (24%)	77 (31%)
North Central	376 (23%)	174 (17%)	53 (21%)
South	583 (36%)	375 (37%)	71 (29%)
West	277 (17%)	204 (20%)	45 (18%)
Missing	41 (3%)	18 (2%)	1 (0%)
Diabetes ($P = 0.402$)			
No	1542 (96%)	970 (96%)	233 (94%)
Yes	70 (4%)	38 (4%)	14 (6%)
Concurrent injury within 14 days before tendon repair ($P = 0.302$)			
No	269 (17%)	146 (14%)	37 (15%)
Yes	1343 (83%)	862 (86%)	210 (85%)
Concurrent vessel injury within 14 days before tendon repair ($P = 0.732$)			
No	1500 (93%)	930 (92%)	230 (93%)
Yes	112 (7%)	78 (8%)	17 (7%)
Concurrent nerve injury within 14 days before tendon repair ($P = 0.187$)			
No	880 (55%)	515 (51%)	136 (55%)
Yes	732 (45%)	493 (49%)	111 (45%)
Concurrent soft-tissue injury within 14 days before tendon repair ($P = 0.46$)			
No	421 (26%)	244 (24%)	67 (27%)
Yes	1191 (74%)	764 (76%)	180 (73%)

Table 2. Univariate Analysis on the Rate of Complications and Secondary Surgeries by Initiation Time of Therapy (N = 2867)

	Therapy Initiated <1 week	Therapy Initiated 1–4 weeks	Therapy Initiated >4 weeks
Any complications within 30 days after repair (*P* < 0.001)			
No	1291 (80%)	794 (79%)	236 (96%)
Yes	321 (20%)	214 (21%)	11 (4%)
Tendon rupture within 30 days after repair (*P* < 0.001)			
No	1481 (92%)	926 (92%)	244 (99%)
Yes	131 (8%)	82 (8%)	3 (1%)
Non-tendinous complications within 30 days after repair (*P* < 0.001)			
No	1407 (87%)	864 (86%)	239 (97%)
Yes	205 (13%)	144 (14%)	8 (3%)
Any complications within 90 days after repair (*P* = 0.62)			
No	1039 (64%)	631 (63%)	156 (63%)
Yes	573 (36%)	377 (37%)	91 (37%)
Tendon rupture within 90 days after repair (*P* = 0.424)			
No	1401 (87%)	878 (87%)	222 (90%)
Yes	211 (13%)	130 (13%)	25 (10%)
Non-tendinous complications within 90 days after repair (*P* = 0.292)			
No	1178 (73%)	709 (70%)	175 (71%)
Yes	434 (27%)	299 (30%)	72 (29%)
Any secondary procedures within 365 days after repair (*P* = 0.017)			
No	1380 (86%)	891 (88%)	225 (91%)
Yes	232 (14%)	117 (12%)	22 (9%)
Tenolysis within 365 days after repair (*P* = 0.078)			
No	1428 (89%)	907 (90%)	230 (93%)
Yes	184 (11%)	101 (10%)	17 (7%)
Repeat tendon repair within 365 days after repair (*P* = 0.067)			
No	1550 (96%)	982 (97%)	243 (98%)
Yes	62 (4%)	26 (3%)	4 (2%)
Tendon reconstruction surgery within 365 days after repair (*P* = 0.498)			
No	1584 (98%)	989 (98%)	240 (97%)
Yes	28 (2%)	19 (2%)	7 (3%)
Tendon pulley reconstruction within 365 days after repair (*P* = 0.655)			
No	1563 (97%)	983 (98%)	241 (98%)
Yes	49 (3%)	25 (2%)	6 (2%)

There was a significant difference in number of therapy sessions within 1 year of surgery among the cohorts. Early initiation of therapy corresponded with a greater number of therapy sessions. The mean count of therapy sessions for patients who initiated therapy within 1 week was 16 [standard deviation (SD) 11.8], between 1 and 4 weeks was 14.1 (SD 10.6), and greater than 4 weeks was 10.6 (SD 9.9). Figure 1 shows the distribution of number of therapy sessions per cohort.

Table 4 demonstrates how the rate of secondary surgery and tenolysis surgery varied within cohorts depending on the number of hand therapy sessions. In the cohorts of patients who received therapy within 1 week, rate of secondary surgeries (19%, *P* = 0.052) and tenolysis (19%, *P* < 0.001) was greatest in patients who received the most therapy (>23 sessions). In contrast, within the other 2 cohorts, there was no statistical difference in secondary surgeries or tenolysis based on the number of therapy session. When observing crude rates across cohorts, the patients with the lowest rate of secondary surgeries and tenolysis initiated therapy after 4 weeks and had <7 therapy sessions.

DISCUSSION

In this study of isolated zone II flexor tendon repairs, early therapy was favored in a majority of the cohort, with 56% of patients starting within 1 week of their tendon repair. This practice appears justified because there was no difference in rate of complications, tendon rupture, or secondary surgeries based on timing of hand therapy initiation. Although need for revision surgery is a theoretical

Table 3. Multivariable Logistic Regression Analysis on Secondary Procedure and Tenolysis based on Timing of Therapy Initiation

	Secondary Procedures		
Timing of Therapy Initiation	Adjusted Odds Ratios	*P*	Adjusted Rate (%)
<1 week	1	—	11.8
1–4 weeks	0.8 (0.6, 1)	0.112	9.9
>4 weeks	0.6 (0.4, 1)	0.055	7.8
Tenolysis within 365 days			
Timing of Therapy Initiation	Adjusted Odds Ratios	*P*	Adjusted Rate (%)
<1 week	1	—	6.3
1–4 weeks	0.9 (0.7, 1.2)	0.66	6
>4 weeks	0.7 (0.4, 1.1)	0.143	4.4

Analysis adjusted to account for demographics, number of therapy sessions, and concurrent injuries (N = 2867).
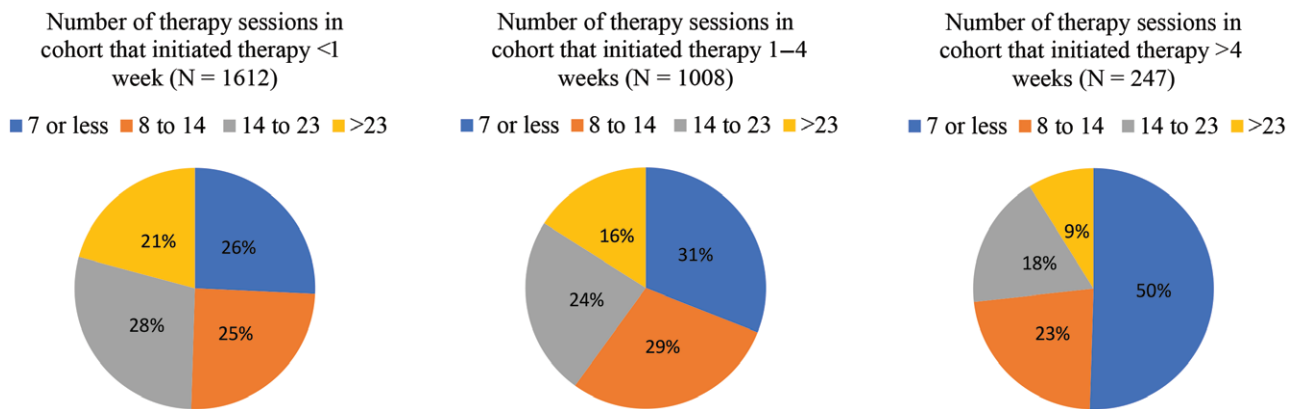
Fig. 1. Distribution of number of therapy sessions per cohort (N = 2867).

concern for patients immobilized after tendon repair, patients who initiated hand therapy 4 weeks after their repair did not have a higher rate of tenolysis. Given the known clinical benefits of early hand therapy in regard to functional outcomes, the findings in this study supports initiation of therapy within 1 week following isolated zone II tendon repairs.

Since Kleinert introduced early flexor tendon mobilization protocols, evidence has mounted to support the superiority of early protocols over immobilization in regard to mobility outcomes.[10,22] Regardless, a paucity of clinical data exists regarding the best time to initiate hand therapy after repair or the effects of timing on patient outcomes. Early active, passive, and combined active-passive therapy protocols are commonly initiated within a 4- to 7-day window after surgery. Although some protocols initiate therapy within 48 hours, experimental studies indicate that the work of flexion and gliding resistance are increased in the first 3 days due to soft-tissue edema and joint stiffness related to trauma and surgery.[6,23–25] Alternatively, delaying therapy past the 7-day mark introduces a greater risk of early fibrosis and adhesion formations. In the present study, 44% of patients started therapy outside the 1-week window, which suggest that surgeons

may be more conservative with therapy than the literature recommends.

Intentionally delaying early therapy past 1 week may be misguided if the motivation is to allow strengthening of the repair. Tendons that are mobilized early are stronger than immobile, unstressed tendons when measured at 2 weeks after repair.[26] Furthermore, studies have shown that biological healing strength is either maintained or modestly decreased in the 4 weeks following surgery (followed by rapid strengthening).[27–29] Therefore, a surgeon would need to adhere to a full 4–6 week immobilization period if allowing their repair to gain meaningful strength. The present study found no difference in rupture rates based on timing of therapy; therefore, early hand therapy protocols should continue to be advocated for their functional benefits. Presumably, more important than the temporal relationships of hand therapy on tendon rupture is the quality of repair. Frail tendon repairs due to technical failures, such as poor tissue handling or gapping, allow scar tissue to infiltrate during healing and introduce a greater risk of tendon rupture.[15,30]

A small minority of patients receiving therapy did not start until post-operative week 4 or more (9%). Potential causes could be socioeconomic, physician-related, or patient non-compliance. Literature has clearly

Table 4. Receipt of Secondary Surgery and Tenolysis by Number of Therapy Session, Stratified by Time to Therapy Initiation

No. Therapy Sessions		7 or less	8–14	15–23	>23	P
Therapy initiated <1 week	Secondary surgery					
	No	359 (86%)	343 (87%)	406 (88%)	272 (81%)	0.052
	Yes	57 (14%)	53 (13%)	58 (12%)	64 (19%)	
	Tenolysis					
	No	385 (93%)	357 (90%)	413 (89%)	273 (81%)	<0.001
	Yes	31 (7%)	39 (10%)	51 (11%)	63 (19%)	
Therapy initiated 1–4 weeks	Secondary surgery					
	No	281 (89%)	260 (90%)	206 (86%)	144 (88%)	0.478
	Yes	34 (11%)	29 (10%)	34 (14%)	20 (12%)	
	Tenolysis					
	No	291 (92%)	264 (91%)	208 (87%)	144 (88%)	0.094
	Yes	24 (8%)	25 (9%)	32 (13%)	20 (12%)	
Therapy initiated >4 weeks	Secondary surgery					
	No	119 (94%)	48 (86%)	39 (89%)	19 (90%)	0.253
	Yes	7 (6%)	8 (14%)	5 (11%)	2 (10%)	
	Tenolysis					
	No	120 (95%)	50 (89%)	40 (91%)	20 (95%)	0.449
	Yes	6 (5%)	6 (11%)	4 (9%)	1 (5%)	

demonstrated that functional outcomes after surgery are improved with directed hand therapy, and therefore, the absence of post-operative care could be related to non-medical influences, notably economic. Toker et al., in a study of therapy adherence, found that patients who failed to attend therapy cited lack of finances (for co-payments or costs not covered by insurance), lack of transportation, and the inability to take time off of work.[31] The delayed therapy cohort had a slightly higher proportion of patients older than 65 years, which may indicate surgeons have guarded enthusiasm about early therapy in this population. But there is currently no evidence to support delaying flexor tendon therapy in older patients. In contrast, immobilizing older patients for prolonged durations likely carries a greater risk for long-term joint stiffness.[32]

Surprisingly, in this study of insured patients, 18% of patients undergoing a repair received no therapy in the post-operative period. This subset of patients was intentionally omitted from the study design because the primary outcome of interest was determining how timing of therapy affected complications (and hand therapy is uniformly agreed upon as beneficial). This *no therapy cohort* likely consisted of patients who were lost to follow-up, had self-directed therapy, had self-pay therapy, or truly had no therapy. Therefore, meaningful conclusions comparing time to hand therapy could not be made when including this group.

There was no difference in rupture rates based on time to therapy, but the rates of 13%, 13%, and 10% per cohort were higher than commonly quoted. Dy et al performed a meta-analysis on complications rates, which included 39 studies (mostly observational and of low quality), and pooled data showed a rupture rate of 4% [confidence interval, (CI) 3%–5%].[33] Notably, the authors discussed their reliance on lower quality studies in the absence of national, population-based studies. Other commonly quoted rupture rates range from 2% to 11%, but most studies have a short follow-up.[10,15] Thirty-day rupture rate in this study was 8%, indicating approximately 5% of ruptures occurred during post-operative months 2 and 3. Importantly, we did not control for surgeon training or the type of therapist, which may influence complication rates. Furthermore, our cohort consisted of zone II injuries, which notoriously have poorer outcomes, including rupture rate.[8,34]

This study identified a higher reoperation rate within 1 year of surgery (14%, 12%, 9% per cohort, respectively) compared with the meta-analysis by Dy et al, which was 6% (CI 4.2%–7.5%). Tendon repair (4%) and tendon reconstruction (2%) were quite low, indicating that a fair proportion of patients did not undergo additional surgeries for rupture. Tenolysis to release adhesions was a common secondary surgery (11%, 10%, 7%, respectively). Zone II harbors both flexor digitorum superficialis and profundus in a narrow fibro-osseous tunnel, and therefore, adhesions are often problematic for tendon excursion. Reported rates of tenolysis after flexor tendon repairs vary among single-institutional reported experiences, often on the order of 2%–6%.[35,36] This population-based study may reveal a truer incidence, given the longevity of follow-up and a more heterogenous cohort with patients of all injury severities, surgeon practice differences, and therapy protocols.

The hypothesis that tenolysis would be more common in the immobilization cohort was not true. Without early mobilization, adhesion formation and joint stiffness inevitably leads to diminished range of motion, but this did not translate to a higher rate of tenolysis. The group with the highest crude rate of undergoing tenolysis were patients who initiated therapy within 1 week and attended the most therapy sessions (18%). This likely reflects the notion that patients demonstrating less functional improvement continue to receive more direct hand therapy (versus home-directed therapy), and ultimately require secondary surgeries when a functional plateau had been met. Additionally, patients may have been excellent candidates for tenolysis but declined treatment to avoid added cost, recovery time, and morbidity. Lastly, tenolysis does not explicitly imply that a patient had a poor range of motion after repair. For example, in a retrospective study of digital flexor tenolysis, Moriya et al. reported that indications for tenolysis in their practice were to achieve a full range of motion in patients with "good" digit motion or improvement of range of motion in patients with "fair" digit motion. Therefore, pursuing tenolysis is an individualized decision made by the patient and the surgeon.[35]

Explaining the observation that the early hand therapy cohort received more hand therapy sessions is speculative without direct clinical correlation, but it remains noteworthy that patients initiating therapy within 1 week averaged 6 more sessions than those immobilized for 4 or more weeks. We know from previous literature that non-adherence to therapy following tendinous injuries is a poor prognostic indicator.[37,38] Therefore, there is a potential benefit in engaging patients early in the recovery process, which can motivate them to be more invested in their clinical outcomes. Lastly, there is clear evidence that partial or self-pay patients are less likely to participate in therapy and therefore have worse outcomes.[31] This population was insured, but their out-of-pocket expenses were not explored and may have influence the frequency of attending therapy (or not receiving therapy at all).

Limitations of the study are mostly related to the observational design using an insurance claims database and the absence of clinical data. Specifically, pre-morbid condition of the patient, the mechanism and severity of injury, technical details (eg, suture type, repair technique, number of core-strands, and use of an epitendinous suture), and patient adherence to aftercare are all important influences on outcomes after a tendon reconstruction. Furthermore, the outcomes of interest were documented claims rather than direct clinical information such as patient-reported outcomes measures of quality of life and global hand function. Similarly, there is no information on the rigorousness of post-operative hand therapy, whether therapy was passive or active, or if patients participated in self-directed hand therapy outside the clinical setting. Furthermore, there may have been patient factors (eg, non-compliance) that dictated the need to delay therapy start time. As with other database studies, documentation related to diagnosis coding is subject to inaccuracies. Lastly, channeling

bias is unavoidable in this study design, given that factors that lead patients to be in later and less-frequent hand therapy protocols (eg, more severe injuries) may inadvertently lead to confounders.

Literature surrounding rehabilitation after flexor tendon repairs has advocated early involvement of hand therapist to minimize tendinous adhesions and maximize functional range of motion. Although tendon rupture is a feared complication in early mobilization, this study did not identify a difference in rupture rates based on time to hand therapy after surgery. Early protocols are theoretically desirable because they may decrease the need for future tenolysis, but rates of tenolysis did not differ based on time to hand therapy after surgery, either. In contrast, the sub-cohort of patients who started therapy early and attended the most hand therapy sessions were most likely to undergo tenolysis. This likely reflects a pattern of dedicated treatment by the treating surgeon and therapist to achieve maximal functional outcomes.

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