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Patient outcomes and costs after isolated flexor tendon repairs of the hand

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ABSTRACT

Background: Acute flexor tendon injuries are challenging injuries for patients, surgeons, and therapists alike. There is ongoing debate about the optimal timing and amount of therapy after these injuries.
Purpose: We sought to investigate the relationship between hand therapy utilization and reoperation rates after flexor tendon repair and quantify reoperation rates and costs associated with flexor tendon repair. We hypothesize there will be an inverse relationship between the number of hand therapy visits and later reoperation rates and a positive correlation between reoperation rates and total cost of care.
Study Design: A retrospective cohort study of patients undergoing primary flexor tendon repair was pursued.
Methods: A commercially available database was utilized to access insurance claims data for 20.9 million patients in the US from 2007 to 2015. Patients undergoing primary flexor tendon repair were included and followed for one year. Patients with fractures, vascular injuries, or digit replantation were excluded. We studied post-operative rehabilitation utilization, reoperation rates, and costs. Chi-Square tests and multivariable logistic regressions were used to assess the relationship between therapy utilization and reoperation rates and costs.
Results: The one-year reoperation rate was 11.4 percent at a median time of 100.0 days amongst 1,129 patients undergoing primary tendon repair. In multivariable analysis, age between 30 and 59, male sex, and utilization of over 21 therapy sessions were associated with increased odds of reoperation. Mean insurance reimbursement one year following primary flexor repair was $14,533 per patient but $27,870 if patients went on to reoperation.
Conclusion: Continued therapy utilization after primary flexor tendon repair is an independent predictor of reoperation need. These findings may help surgeons counsel patients who require a large number of visits after flexor tendon repair on when to revisit surgical options.

Introduction

Acute flexor tendon injuries are well-known to be debilitating for patients and challenging injuries for surgeons to treat. While advances have been made in the past 50 years in surgical technique[1] and rehabilitation protocols,[2] the overall trajectory of treatment often leads to unpredictable outcomes.[3]

While complication and reoperation rates after flexor tendon repair have been described, prior studies have been limited by small sample size and variation in post-operative rehabilitation usage. A nonsystematic review by *Tang et al* of literature from 1989 to 1999 estimated a rupture rate from 0 to 9% and a 10% rate of restrictive adhesions requiring re-operation.[4] When Dy et al performed a meta-analysis of 29 studies in 2012, they described rates of re-operation of six percent, rupture of four percent, and adhesions of four percent.[5] However, these studies

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included patients treated in major hand surgery centers, so their results may lack external validity when generalizing to community practice.

One of the main goals of hand therapy following flexor tendon repair is the prevention of tendon adhesions without disruption of the surgical attachment. In regards to rehabilitation, there has been little consensus on optimal therapy outside of support for early active motion protocols; recent evidence suggests long-term benefits in terms of low reoperation rates and better range of motion for patients undergoing these protocols.[6,7] While there are multiple surgical and patient factors known to affect rupture rate, adhesions, and overall reoperation rates,[8] there is ongoing debate about the timing and duration of therapy with respect to both cost and reoperation rate.[9] To our knowledge, there are no studies to date on the relationship between post-operative rehabilitation utilization and reoperation rates.

With regards to cost after flexor tendon repair, Rosberg et al studied the costs of tendon repair, rehabilitation, and reoperation following zone II flexor tendon injuries in Sweden,[10] but this analysis has not been replicated in the US to our knowledge. In a recent financial model, Mehrzad et al. estimated the total direct cost of flexor tendon repair in the US to be $13,725 per patient, with a total annual cost (both indirect and direct) of up to $409.1 million.[11] As US health care shifts more towards value-based care, it is increasingly important to understand the cost effectiveness of health care interventions.

Thus, our primary aims were to determine reoperation rates after primary flexor tendon repair, assess the relationship between utilization of post-operative rehabilitation following primary repair and reoperation rates, and describe the economic costs of flexor tendon repair surgery. We hypothesize there will be an inverse relationship between number of hand therapy visits and later reoperation rates and a positive correlation between reoperation rates and total cost of care.

Methods

This analysis utilized the PearlDiver Patient Records Database (Colorado Springs, CO), a retrospective nationwide insurance billing database of over 25 million patients. The records in the PearlDiver Patient Records Database are acquired from Humana's (Louisville, KY) claims database, de-identified, and released commercially for research purposes. Humana is a private insurance company that offers both commercial and Medicare advantage plans. Claims in the PearlDiver database are from patients enrolled in either of Humana's commercial or Medicare advantage plans between 2007 and 2015.

Patients undergoing primary flexor tendon repairs who were insured for at least one year after their index surgery and were identified by Current Procedural Terminology (CPT) codes (26350, 26356, 26370). Patients with a CPT code for a fracture, arterial repair, or replantation on the day of flexor tendon repair were excluded (Appendix 1) given the potential impact on post-operative therapy protocols. Reoperation type and timing within one year was determined via CPT codes, as were number of post-operative therapy visits within one year of index surgery (Appendix 1).

Demographic data recorded included age and sex. Number of post-operative therapy visits were also determined. In order to preserve patient confidentiality, the PearlDiver database does not allow analyses to be performed on procedures occurring in groups of 10 or fewer patients. The overall one-year reoperation rate was calculated, and the time between index surgery and reoperation was determined for patients who went on to receive reoperation. The relative frequency and median timing of each type of secondary surgery (revision repair with and without graft, tenolysis, capsulectomy, arthrodesis, and amputation) from the index operation were also determined. Total payer costs within one year of the index surgery were tabulated.

Table 1
CPT Codes associated with Reoperations Due to Presumed Rupture and Stiffness.

	Type of Reoperation	CPT Codes
Presumed Rupture	Revision Repair (no graft)	CPT-26357, CPT-26373
	Revision Repair with Graft	CPT-26352, CPT-26358, CPT-26390, CPT-26392
	Tendon Transfer	CPT-26485, CPT-26489
Presumed Stiffness	Tenolysis of Flexor Tendon	CPT-26440, CPT-26442
	Tenotomy of Flexor Tendon	CPT-26450, CPT-26455
	Capsulectomy	CPT-26520, CPT-26525

Note. CPT, Current Procedural Terminology

Statistical Analysis

The relationship of age, sex, and number of post-operative therapy visit were tested against the presence of revision flexor tendon surgery using Pearson chi-square tests. Number of reoperations were also separated into reoperation for stiffness (including tenolysis, tenotomy, and capsulectomy) and reoperation for rupture (including revision repair, grafting, and tendon transfer) by CPT code (Table 1). A chi-square test was used to evaluate the incidence of rupture- and stiffness-associated reoperations by number of therapy sessions. A *P*-value less than 0.05 was considered significant for all comparisons.

A multivariable logistic regression model was performed to assess the relationship between number of therapy sessions and odds of reoperation, after adjusting for patient demographics. Female patients aged 20-29 years old who attended no therapy sessions were used as the reference for the multivariable analysis (defined as having odds of 1.0).

Differences in one-year costs after surgery between primary and reoperation groups were analyzed. Data management was performed using Microsoft Excel (Microsoft, Redmond, WA). All statistical analyses were performed using R (R Foundation, Vienna, Austria). Graphs were generated using Microsoft Excel.

Results

We identified 1129 patients who underwent primary flexor tendon repair from 2008 to 2015 in the US. Within one year of primary flexor tendon repair, 125 patients (11.4 percent) underwent reoperation. Revision surgery occurred at a median time of 100.0 days and a mean time of 124.1 days (standard deviation 87.5 days) after primary repair. The most common type of reoperation was tenolysis (77 patients), which occurred at a median time of 134 days after the index procedure (Table 2).

There was an association identified between reoperation rate and age ($P = 0.008$), with the highest reoperation rates in patients aged 30 to 59. However, there was no association between reoperation rate and sex ($P = 0.799$) (Table 3).

In the first year following flexor tendon repair, there was an association identified between number of therapy visits and reoperation rates ($P = 0.003$, Table 4). Patients with 21-30 and more than 31 therapy visits in the first year had reoperation rates of 24.31 percent and 40.91 percent respectively. The rate of reoperation in patients who had no post-operative therapy was 5.2%, which was significantly lower than the reoperation rate of patients who received therapy, 12.2% ($P = 0.005$).

There was also an association between the number of therapy visits within the first four weeks following flexor tendon repair and reoperation rates ($P < 0.0001$, Table 4). Patients utilizing 11

Table 2
Types of Reoperation after Flexor Tendon Repair.

Reoperation Type	Timing (days)			
	Number	Median	Mean	SD
Revision Repair or Advancement without Graft *CPT: 26357, 26373*	27	45	69	66.8
Revision Flexor Repair with Graft *CPT: 26352, 26358, 26390, 26392, 26500, 26502*	34	99	107	80.4
Tenolysis of Flexor Tendon *CPT: 26440, 26442*	77	134	155	79.1
Capsulectomy *CPT: 26520, 26525*	13	164	176	70.7
Arthrodesis *CPT 26850, 26852, 26860, 26861*	15	101	136	110.1
Amputation *CPT 26910, 26951, 26952*	17	36	126	160.8

Table 3
Demographics of patients undergoing primary flexor tendon repair and incidence of reoperation.

Variable	Total (%)	Reoperations (% of total)	*P* value
Age			
20 to 29	102 (9.0)	11 (10.8)	0.0078
30 to 39	105 (9.3)	21 (20.0)	
40 to 49	139 (12.3)	19 (13.7)	
50 to 59	157 (13.9)	25 (15.9)	
60 to 69	248 (22.0)	24 (9.7)	
70 to 79	201 (17.8)	16 (8.0)	
Gender			
Female	359 (31.8)	41 (11.4)	0.799
Male	770 (68.2)	84 (10.0)	

Table 4
Incidence of reoperation by number of therapy visits within 1 year and 4 weeks.

Therapy Visits	Total (%)	Reoperations (% of total)	*P* value
In one year			
No therapy	190 (16.8)	10 (5.3)	0.003
1-10 visits	396 (35.0)	25 (6.3)	
11-20 visits	327 (28.0)	27 (8.3)	
21-30 visits	144 (12.8)	35 (24.3)	
31+ visits	66 (5.8)	27 (40.9)	
In four weeks			
No therapy	321 (29.0)	18 (5.6)	< 0.0001
1-10 visits	765 (69.0)	99 (12.9)	
11+ visits	20 (1.8)	8 (40.0)	

or more therapy visits in the first four weeks had a 40 percent reoperation rate, compared to 5.61 percent of patients who did not undergo therapy.

Of patients who attended more therapy sessions and had reoperation, a greater proportion of reoperations were tenolyses, tenotomies, or capsulectomies than revision repairs, staged revision repairs with grafts, or tendon transfers. Amongst patients who visited hand therapy between 21 and 30 times in the year after surgery, 21.5% of patients underwent a tenolysis- or capsulectomy-related reoperation while only 7.6% underwent a revision repair-related reoperation (Figure 1).

In multivariate analysis to predict odds of reoperation, male sex (OR 1.61, 95% CI 1.24-2.12), age groupings between 30 and 59, and having greater than 21 therapy sessions were associated with increased odds of reoperation ($X^2 = 361.5$, df = 11, $P < 0.0001$) (Table 5). Patients older than 60 had a similar rate of reoperation when compared to patients aged 20 to 29, as determined by 95% confidence intervals overlapping 1.0. Patients who attended one to 20 therapy sessions in the first year did not have a higher odds of reoperation compared to patients who did not attend therapy. Patients undergoing greater than 21 therapy sessions in the first year had higher odds of reoperation than patients undergoing no therapy (21-30 sessions: OR 5.27, 95% CI 3.4-8.41; 31+ sessions: OR 13.86, 95% CI 8.52-23.16).

Table 5
Odds of reoperation by gender, age, and number of therapy sessions in one year after surgery.

Variable	OR of Reoperation	95% CI
Gender		
Female	1	Reference
Male	1.61	1.24-2.12
Age		
20-29	1	Reference
30-39	3.29	2.17-5.02
40-49	1.84	1.20-2.82
50-59	2.64	1.75-4.00
60-69	1.31	0.87-1.98
70-79	1.36	0.87-2.11
80-89	0.48	0.17-1.14
Therapy sessions in one year		
None	1	Reference
1-10	0.87	0.54-1.42
11-20	1.14	0.72-1.84
21-30	5.27	3.4-8.41
31+	13.86	8.52-23.16

OR, odds ratio.

The mean insurance reimbursements over the first year following primary flexor repair were $14,533 per patient not undergoing reoperation and $27,870 per patient undergoing reoperation.

Discussion

The one-year reoperation rate after primary flexor tendon repair in this population was 11 percent, in line with previous reports in the literature. The largest sample studied to date was by Dy et al, estimating a six percent reoperation rate.[5] While this meta-analysis by Dy et al did include a large number of patients (3852 patients across 39 studies), most of the individual studies were small samples of surgeries performed by specialists at academic centers. The reoperation rate in these academic settings may be an underestimate of the true reoperation rate nationwide. Another study by Toker et al. reported a 14.4% rate of tenolysis and 5.6% rate of rupture in patients treated at a trauma center.[12] The present study includes a more diverse cohort of Humana-insured patients who seek care at academic centers and community hospitals alike, providing a more representative sample of flexor tendon repairs in the United States.

Regarding timing of reoperation, tenolysis was the most common type of reoperation, which occurred at a median time of 134 days (Table 2). This information can prove useful for surgeons when counseling patients on when to consider further surgery for stiffness.

While there was no association identified between sex and reoperation rates in chi-square analysis, men had a 60 percent higher odds than women of having a reoperation in the multivariable model, which also included age and number of therapy sessions (OR 1.61, 95% CI 1.23-2.12). While previous literature reports similar rates of reoperations following flexor tendon repair between men and women,[13] male sex was associated with a threefold higher odds of reoperation following flexor pulley reconstruction.[14] The fact that sex was significantly associated with reoperation rate in multivariable analysis could indicate a suppression effect by either age or number of therapy session. A

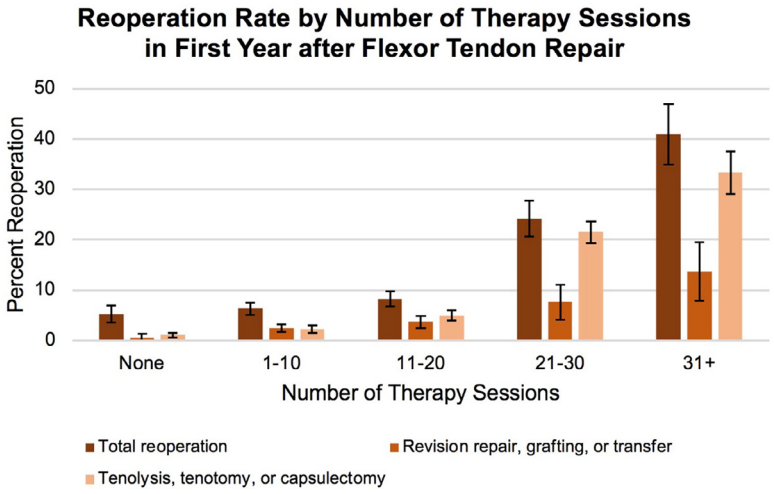

Figure 1. Patients undergoing reoperation by number of therapy sessions.

possible explanation could involve patient occupation, particularly if more men in the reoperation cohort participated in manual labor type jobs and had higher functional demands.

Regarding the impact of age on reoperation rate, the age 30 to 59 group had a higher odds of reoperation. This may be due to patient selection by surgeons. For example, while older patients have been shown to have reduced range of motion following flexor tendon repair, patients and surgeons alike may be more likely to accept a suboptimal outcome in an elderly patient in order to avoid revision surgery.[15] Meanwhile, younger patients are often better able to regain motion and strength in rehabilitation than their older counterparts, and surgeons may be less aggressive when pursuing secondary surgery when treating these patients.

Contrary to our hypothesis, patients who required reoperation showed an association with attending a higher number of post-operative therapy visits in the year after primary-repair surgery. In multivariable analysis, having 21 to 30 therapy sessions within the first year was associated with a 5.27 higher odds of reoperation compared to attending no therapy (95% CI 3.4-8.41). Having greater than 31 therapy sessions was associated with an even higher odds of reoperation (OR 13.86, 95% CI 8.52-23.16). This association between therapy visits and reoperation rate was observed for both the number of therapy visits in the first year and the number of therapy visits in the first four weeks.

This relationship between number of therapy sessions and re-operation rates may highlight the importance of stiffness after surgery and access to care as important drivers of reoperation after flexor tendon repair. Patients with higher numbers of therapy sessions were more likely to have a tenolysis or capsulectomy (for presumed stiffness) than revision repair (for presumed rupture). This may suggest a lack of functional motion due to adhesions was a more common cause for reoperation than tendon rupture. Thus, this correlation between post-operative therapy and reoperation is likely not due to early failure from forceful active motion. An alternate explanation may be that patients requiring multiple therapy visits were dissatisfied with their outcome and were more apt to pursue further surgery. Additionally, it is possible that access to education from therapists on further improvement potential helps encourage patients to seek more care – either through additional therapy and/or reoperation to improve their functional motion. Finally, the higher reoperation rate amongst patients with greater than 31 visits may implicate a potential "plateau effect," after which patients who need reoperation fail to improve on therapy alone and eventually seek reoperation. These findings may help hand therapists counsel patients who require a large number of visits in the first year after surgery. Hand therapists can cite these data to suggest to patients in this category that they may strongly consider revisiting surgical options with their hand surgeon, particularly if they have plateaued with functional motion.

There are several contributing factors to the observation that patients who did not attend therapy had a lower odds of reoperation compared to those who attended greater than 21 sessions. Our study did not allow for evaluation of functional outcomes, and so we are unable to assess the clinical results. While some patients who were satisfied with their results may have foregone substantial therapy or reoperation, other patients who lacked access to therapy may have also been less likely to attend follow up with their surgeon. It has previously been shown that patients responsible to pay for their own postoperative care were less adherent to postoperative therapy and less likely to seek additional treatment including tenolysis.[12] Thus, the correlation in our study between increased therapy utilization and increased re-operation rates may also reflect patient access and insurance coverage. Our study attempted to control for loss to follow-up by including only patients who were documented to be actively insured for at least one year after the tendon repair, however being insured is not necessarily synonymous with adequate access to hand surgery care and rehabilitation. Efforts should be made to educate patients on the importance of postoperative therapy in flexor tendon repair and to encourage appropriate follow-up with their surgeons.

With regards to cost, one-year insurance reimbursement for patients in this analysis were $14,533 and $27,870 for patients who underwent primary surgery only and who underwent primary surgery followed by reoperation, respectively. These costs greatly exceed the costs for other common hand surgeries such as open carpal tunnel release ($2,602)[16] and are approximately $750 greater than Mehrzad et al.'s previous estimate of $13,725.[11] A recent study reported costs for comprehensive care of flexor tendon repairs over a similar time period in Australia. Their cost estimates ranged from $4,673 to $6,541,[17] significantly lower than noted in our work. Australia employs a different health care model than the US which likely explains this discrepancy. Due to the high financial burden of flexor tendon repair surgery and subsequent therapy, more research is indicated to determine the most cost effective surgical and rehabilitation protocols.

While this correlation between post-operative therapy visits and reoperation after flexor tendon repair is significant, there are limitations to the types of conclusions that can be drawn from any

database analysis. First of all, databases such as PearlDiver do not allow analysis of individual patient records, and we thus could not control for specific surgical factors such as repair type, patient factors such hand dominance, occupation, or number of injured digits, or for therapy-related factors such as rehabilitation protocols that affect reoperation rates. Additionally, we could not study specific functional outcomes of individual patients. While patients who did not visit a therapist post-operatively had a significantly lower reoperation rate than those who had greater than 21 visits, this potentially reflects a lack of access to therapy and reoperation surgery.

Another limitation of a database analysis is the dependence on the accuracy of patient coding. While miscoding has been reported as not uncommon, this in theory should only represent a minority of our cohort.[18] Finally, when studying costs, we did not control for the type of anesthesia that was utilized for both primary and revision surgeries. Many advocates of wide-awake local anesthesia no tourniquet (WALANT) surgery advocate for use of that technique since it has been associated with lower costs and lower reoperation rates.[19-21] The main strength of this study is the utilization of a large patient population to study factors that contribute to reoperation after flexor tendon repair.

Conclusion

The findings of this study demonstrate an 11 percent overall reoperation rate after flexor tendon repair. Continued therapy utilization is an independent predictor of reoperation need, indicating that hand therapy remains an important part of care for patients following primary flexor tendon repair. As expected, there was a higher cost of care when patients had secondary procedures after flexor tendon repair.

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Appendix

Appendix 1
Inclusion and exclusion CPT codes used in analysis.

Primary Flexor Tendon RepairCPT codes	Reoperation CPT codes	Hand therapy CPT codes	Exclusion CPT codes (artery, fracture, replant)
26350	20690	95852	20802
26356	26352	95853	20805
26370	26357	97001	20808
	26358	97002	20816
	26373	97003	20822
	26390	97004	20824
	26392	97010	20827
	26440	97012	26720
	26442	97014	26725
	26450	97016	26727
	26455	97018	26735
	26479	97022	26740
	26485	97024	26742
	26489	97026	26746
	26500	97028	26750
	26502	97032	26755
	26520	97033	26756
	26525	97034	26765
	26850	97035	35206
	26852	97036	35207
	26860	97039	35236
	26861	97110	35266
	26910	97112	
	26951	97113	
	26952	97124	
	20690	97140	
	26352	97150	
		97530	
		97535	
		97537	
		97545	
		97546	
		97750	
		97755	
		97760	
		97762	

References

1. Luo J., Mass D.P., Phillips C.S., He T.C. The future of flexor tendon surgery. 2005;21:267–273. doi:10.1016/j.hcl.2005.01.001.
2. Neiduski RL, Powell RK. Flexor tendon rehabilitation in the 21st century: A systematic review. *J Hand Ther*. 2019;32:165–174 Apr-JunEpub 2018 Dec 10. PMID: 30545730. doi:10.1016/j.jht.2018.06.001.
3. Asmus A, Kim S, Millrose M, Jodkowski J, Ekkernkamp A, Eisenschenk A. [Rehabilitation after flexor tendon injuries of the hand]. *Orthopade*. 2015;44:786–802. doi:10.1007/s00132-015-3160-6.
4. Tang JB. Clinical outcomes associated with flexor tendon repair. *Hand Clin*. 2005;21:199–210. doi:10.1016/j.hcl.2004.11.005.
5. Dy CJ, Hernandez-Soria A, Ma Y, Roberts TR, Daluiski A. Complications after flexor tendon repair: A systematic review and meta-analysis. *J Hand Surg Am*. 2012;37:543–552. doi:10.1016/j.jhsa.2011.11.006.
6. Chesney A, Chauhan A, Kattan A, Farrokhyar F, Thoma A. Systematic review of flexor tendon rehabilitation protocols in zone II of the hand. *Plast Reconstr Surg*. 2011;127:1583–1592. doi:10.1097/PRS.0b013e318208d28e.
7. Starr HM, Snoddy M, Hammond KE, Seiler JG. Flexor tendon repair rehabilitation protocols: A systematic review. *J Hand Surg Am*. 2013;38:1712–1717 .e14. doi:10.1016/j.jhsa.2013.06.025.
8. Singh R, Rymer B, Theobald P, Thomas PBM. A review of current concepts in flexor tendon repair: physiology, biomechanics, surgical technique and rehabilitation. *Orthop Rev (Pavia)*. 2015;7:6125. doi:10.4081/or.2015.6125.
9. Khor WS, Langer MF, Wong R, Zhou R, Peck F, Wong JKF. Improving outcomes in tendon repair. *Plast Reconstr Surg*. 2016;138 1045e-1058e. doi:10.1097/PRS.0000000000002769.
10. Rosberg HE, Carlsson KS, Höjgård S, Lindgren B, Lundborg G, Dahlin LB. What determines the costs of repair and rehabilitation of flexor tendon injuries in zone II? A multiple regression analysis of data from southern Sweden. *J Hand Surg Am*. 2003;28 B:106–112. doi:10.1016/S0266-7681(02)00352-2.
11. Mehrzad R, Mookerjee V, Schmidt S, Jehle CC, Kiwanuka E, Liu PY. The economic impact of flexor tendon lacerations of the hand in the United States. *Ann Plast Surg*. 2019. doi:10.1097/SAP.0000000000001950.
12. Toker S, Oak N, Williams A, Ipaktchi K, Ozer K. Adherence to therapy after flexor tendon surgery at a level 1 trauma center. *Hand*. 2014;9:175–178. doi:10.1007/s11552-014-9612-3.
13. Dy CJ, Daluiski A, Do HT, Hernandez-Soria A, Marx R, Lyman S. The epidemiology of reoperation after flexor tendon repair. *J Hand Surg Am*. 2012;37:919–924. doi:10.1016/j.jhsa.2012.02.003.
14. Dy CJ, Lyman S, Schreiber JJ, Do HT, Daluiski A. The epidemiology of reoperation after flexor pulley reconstruction. *J Hand Surg Am*. 2013;38:1705–1711. doi:10.1016/j.jhsa.2013.05.015.
15. Rigo IZ, Røkkum M. Predictors of outcome after primary flexor tendon repair in zone 1, 2 and 3. *J Hand Surg Eur Vol*.. 2016;41:793–801. doi:10.1177/1753193416657758.
16. Zhang S, Vora M, Harris AHS, Baker L, Curtin C, Kamal RN. Cost-minimization analysis of open and endoscopic carpal tunnel release. *J Bone Joint Surg Am*. 2016;98:1970–1977. doi:10.2106/JBJS.16.00121.
17. Robinson LS, Brown T, O'Brien L. Cost, profile, and postoperative resourceuse for surgically managed acute hand and wrist injuries with emergencydepartment presentation. *J Hand Ther*. 2021;34:29–36 Jan-MarEpub 2020 Apr 30. PMID: 32360062. doi:10.1016/j.jht.2019.12.007.
18. Gologorsky Y, Knightly JJ, Lu Y, Chi JH, Groff MW. Improving discharge data fidelity for use in large administrative databases. *Neurosurg Focus*. 2014;36:E2. doi:10.3171/2014.3.FOCUS1459.
19. Higgins A, Lalonde DH, Bell M, McKee D, Lalonde JF. Avoiding flexor tendon repair rupture with intraoperative total active movement examination. *Plast Reconstr Surg*. 2010;126:941–945. doi:10.1097/PRS.0b013e3181e60489.
20. Lalonde D, Bell M, Benoit P, Sparkes G, Denkler K, Chang P. A multicenter prospective study of 3,110 consecutive cases of elective epinephrine use in the fingers and hand: the Dalhousie project clinical phase. *J Hand Surg Am*. 2005;30:1061–1067. doi:10.1016/j.jhsa.2005.05.006.
21. Lalchandani GR, Halvorson RT, Rahgozar P, Immerman I. Wide-awake local anesthesia for minor hand surgery associated with lower opioid prescriptions, morbidity, and costs: a nationwide database study. *J Hand Surg Glob Online*. 2020;2:7–12. doi:10.1016/j.jhsg.2019.09.011.

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1. The study design is
   a. RCTs
   b. case series
   c. retrospective cohort
   d. prospective cohort

2. The reoperation rate was approximately
   a. 10%
   b. 5%
   c. 15%
   d. 50%

3. The authors investigated
   a. costs
   b. reoperation rates
   c. therapy utilization
   d. all of the above

4. The most common reoperation procedure was
   a. delayed secondary repair
   b. re-repair
   c. tenolysis
   d. Hunter rod and tendon graft

5. Higher rates of reoperation were associated with higher number of therapy sessions
   a. false
   b. true

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