

# Practice Patterns in Operative Flexor Tendon Laceration Repair: A 15-Year Analysis of Continuous Certification Data from the American Board of Plastic Surgery

Joshua P. Weissman, BBA\*  
 Daniel C. Sasson, BA\*  
 Ava G. Chappell, MD\*  
 Steven L. Moran, MD†  
 Arun K. Gosain, MD\*

**Background:** The American Board of Plastic Surgery has been collecting practice data on operative repair of flexor tendon lacerations since 2006, as part of its Continuous Certification program.

**Methods:** Data on operative repair of flexor tendon lacerations from 2006 to 2014 were reviewed and compared with those from 2015 to 2020. National practice trends observed in these data were evaluated and reviewed alongside published literature and evidence-based medicine.

**Results:** In total, 780 patients with flexor tendon laceration injuries were included. Mean patient age was 38 years; mean time between tendon injury and first evaluation was 4 days, and the mean time from injury to operative repair was 12 days. Four-strand sutures remain the most common technique of tendon repair (57%). In the recent cohort, there were significant decreases in tourniquet use (94% versus 89%), general anesthesia (88% versus 74%), and monofilament sutures (44% versus 35%), with a significant increase reported in preserving the A1 pulley (20% versus 29%). Postoperative movement was described as “almost full range of motion” or “good” in 70% of cases, and 74% of patients were satisfied with their results. Postoperative adverse events were reported in 26% of cases, with the most common complications being tendon adhesions (14%) and rupture (3%).

**Conclusions:** Review of The American Board of Plastic Surgery tracer data for operative repair of flexor tendon lacerations establishes a framework by which surgeons can evaluate how their current practice aligns with that of their peers, and whether their practice patterns remain current relative to recommendations from evidence-based medicine. (*Plast Reconstr Surg Glob Open* 2022;10:e4558; doi: 10.1097/GOX.0000000000004558; Published online 7 October 2022.)

## INTRODUCTION

The American Board of Plastic Surgery (ABPS) Continuous Certification Program, formerly known as Maintenance of Certification-Plastic Surgery, allows plastic surgeons to engage in continuous learning and self-assessment as a component of Continuous Certification. Participation in Continuous Certification has been mandatory for all diplomates who were certified by the ABPS

from 1995 onwards, as directed by the American Board of Medical Specialties. The Continuous Certification requirements are aligned with three primary components: professionalism, lifelong learning/self-assessment, and improvement in medical practice. Collected data are divided into four modules (Comprehensive, Cosmetic, Craniomaxillofacial, and Hand). Surgeons choose among the tracer procedures created by the ABPS and report on patient presentation, operative techniques, and short/long-term surgical outcomes. Evaluation of this longitudinal dataset allows for gaining additional insight into current practice patterns and changes in best practice over time. Surgeons can also compare their current operative techniques with national trends. Cumulative tracer data are an invaluable resource to compare surgical trends with the current literature on evidence-based practices.

Cumulative tracer data have been collected on flexor tendon laceration repair since January 2006. The present

From the \*Division of Plastic Surgery, Ann and Robert H. Lurie Children's Hospital, Chicago, Ill.; and †Division of Plastic Surgery, Mayo Clinic, Rochester, Minn.

Received for publication July 17, 2022; accepted August 9, 2022.

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DOI: 10.1097/GOX.0000000000004558

**Disclosure:** The authors have no financial interest to disclose.

study analyzes evolving trends in operative repair of flexor tendon lacerations based on the hand tracer data collected by the ABPS, and compares changes in practice patterns over the past 15 years to recommendations based on evidence-based medicine (EBM).

### METHODS

Cumulative tracer data collected by the ABPS for hand flexor tendon laceration were reviewed from January 25, 2006 (inception of tracer data collection) to March 7, 2020. Data extraction categories included: clinical patient characteristics, preoperative assessment, anesthesia, operation location and time, surgical treatment plan, postoperative complications, and overall outcome. The 15-year collection period was divided into a “past cohort” from January 25, 2006, to December 31, 2014, and a “recent cohort” from January 1, 2015, to March 7, 2020. Data extraction categories were evaluated between the two timeframes. Time intervals were decided to account for relatively equal cohort size for meaningful statistical comparison. Data from the recent cohort were compared with EBM and Maintenance of Certification (MOC) articles published over the same period. Fisher’s exact test and two-sample *t*-test were used to compare patient demographics, common techniques, and complication rates between tracer data from 2006 to 2014 and

### Takeaways

**Question:** Do plastic surgeons increasingly adhere to evidence-based practices in flexor tendon laceration repair?

**Findings:** Repairs from 2006 to 2014 were compared with those from 2015 to 2020. Significant changes in practice overtime indicate declines in tourniquet usage and general anesthesia with increases in usage of the four strand technique and braided sutures.

**Meaning:** It can be concluded that most board-certified plastic surgeons are practicing with EBM guidelines.

2015 to 2020. A *P* value less than 0.05 considered statistically significant. Statistical analyses were performed with GraphPad Prism 9.0 (GraphPad Software, Inc., San Diego, Calif.).

### RESULTS

The ABPS Continuous Certification database contained information on 780 flexor tendon laceration cases from 2006 to 2020. From 2006 to 2014, there were 460 cases, and from 2015 to 2020 there were 320 cases. The average patient age was 38 years, and 76% were men (Table 1). Ninety four percent of participating surgeons were in private practice, and the remaining 6% were in

**Table 1. Patient Demographics**

	2006–2014		2015–2020		Overall		<i>P</i>
	#	%/ Avg	#	%/ Avg	#	%/ Avg	
1. Age (y)		$\bar{x}$ = 37 n = 460 SD = 16		$\bar{x}$ = 40 n = 320 SD = 17		$\bar{x}$ = 38 n = 780 SD = 17	
1.1 Practice type							
Academic practice	2		2		2	6%	
Private practice	27		18		34	94%	
2. Gender							
Men	354	77%	240	75%	594	76%	
Women	106	23%	80	25%	186	24%	
3. Medical history							
a. Smoker							
Yes	137	30%	80	25%	217	28%	
No	298	65%	207	65%	505	65%	
b. Occupation							
Light	83	18%	74	23%	157	20%	
Medium	116	25%	84	26%	200	26%	
Heavy	119	26%	84	26%	203	26%	
c. Operated hand							
Right dominant	250	54%	150	47%	400	51%	
Right nondominant	8	2%	10	3%	18	2%	
Left dominant	12	3%	15	5%	27	3%	
Left nondominant	166	36%	132	41%	298	38%	
d. Associated injuries							
Skin loss	84	18%	93	29%	177	23%	
Tendon	313	68%	213	67%	526	67%	
Artery	135	29%	84	26%	219	28%	
Nerve	284	62%	174	54%	458	59%	
Bone	74	16%	69	22%	143	18%	
e. Days between injury and first evaluation	430	$\bar{x}$ = 4	319	$\bar{x}$ = 4	749	$\bar{x}$ = 4	
f. Worker’s compensation for this condition							
Yes	125	27%	67	21%	192	25%	<0.001*
No	299	65%	224	70%	523	67%	
g. Tendon laceration type							
Clean cut	269	58%	180	56%	449	58%	
Frayed	119	26%	99	31%	218	28%	
Avulsion	41	9%	25	8%	66	8%	
h. Time interval between injury and tendon repair	349	$\bar{x}$ = 7	312	$\bar{x}$ = 17	661	$\bar{x}$ = 12	<0.001*

\**P* values for statistically significant differences in comparisons between 2006 and 2014 and 2015 and 2020 are shown.

**Table 2. Location and Length of Surgery**

	2006–2014		2015–2020		Overall	
	#	%/ Avg	#	%/ Avg	#	%/ Avg
1. Location						
Hospital inpatient	123	27%	87	27%	210	27%
Hospital outpatient	286	62%	210	66%	496	64%
Accredited freestanding outpatient facility	46	10%	17	5%	63	8%
Accredited office operating room (AAAASF or JCAHO or CAAASF)	5	1%	6	2%	11	1%
2. Surgery incision to dressing time (min) for flexor tendon only	460	$\bar{x} = 76$ SEM = 2	320	$\bar{x} = 61$ SEM = 3	780	$\bar{x} = 70$ SEM = 2

No significant differences were noted between 2006 and 2014 and 2015 and 2020.

**Table 3. Anesthetic Technique**

	2006–2014		2015–2020		Overall		P
	#	%/ Avg	#	%/ Avg	#	%/ Avg	
Local anesthetic only injected in affected area without sedation	20	4%	40	13%	60	8%	<0.001*
Local anesthetic only injected in affected area with sedation	31	7%	24	8%	55	7%	0.683
Regional anesthesia (brachial plexus block)	5	1%	10	3%	15	2%	0.041*
Regional anesthesia (Bier block)	1	0%	12	4%	13	2%	<0.001*
General anesthesia	403	88%	237	74%	640	82%	<0.001*
Use of epinephrine in finger and/or hand for hemostasis	1	0%	8	3%	9	1%	0.003*

\*P values for statistically significant differences in comparisons between 2006 and 2014 and 2015 and 2020 are shown.

academic practice. Only 26% of patients engaged in heavy work with their arms and hands daily. The mean duration between injury and tendon repair was 12 days. The most common associated injuries in addition to tendon laceration were nerve (59%), arterial (28%), and severe skin loss (23%). The most frequent tendon laceration type was clean cut (58%) followed by frayed (28%). Upon physical examination, the most affected digit was the index finger (24%), with zone II damage comprising most injuries across both cohorts (57%).

Seventy-two percent of procedures were performed in an outpatient setting (hospital or accredited freestanding), without significant shifts in practice patterns between cohorts (Table 2). The data show significant decreases in the use of general anesthesia (88% versus 74%,  $P < 0.001$ ) and significant increases in the use of local anesthesia without sedation, brachial plexus blocks, and Bier blocks (Table 3). A significant decrease was also seen in tourniquet usage (94% versus 89%,  $P = 0.007$ ).

When evaluating the surgical treatment plan, preservation of the A2 pulley remains the most common adjunct procedure (51%) among flexor tendon laceration repairs; however, significant increases were also seen in the preservation of the A1 pulley between the two time periods (20% versus 29%,  $P = 0.005$ ) (Table 4). Four strand tendon repair was the most frequently used technique (57%). Epitendinous repair occurred in 62% of cases. Suture material has seen substantial changes with increases in braided types and significant decreases in the use of smooth/monofilament sutures.

Most patients experienced no adverse outcomes (74%) (Table 5). Among those who had complications, the most frequent were tendon adhesions (14%) and tendon repair rupture (3%). Notably, 70% of patients had “good” or “almost full range” postoperative motion, with 78% satisfied with their results.

## DISCUSSION

### Evaluation of Cumulative Tracer Data Relative to Current Literature

Previous studies have evaluated the diagnosis and management of flexor tendon laceration repair based on evidence-based medicine.<sup>1–4</sup> The present study allows us to better understand the progression of practice patterns of ABPS diplomates in relation to recommendations made within recent articles.

### Relevant Medical History

A thorough medical history will uncover primary and subtle secondary concomitant injuries among patients who have experienced flexor tendon lacerations. Functional demands, such as hand dominance and occupational load, may influence a surgeon’s preoperative discussion with the patient.<sup>3,4</sup> Patient factors such as age, gender, history of smoking, obesity, occupation, previous history of hand or wrist trauma, and mechanism of injury are vital in the planning of and decisions made at the time of repair.<sup>2,3</sup> A randomized prospective trial on zone-II flexor tendon injuries reported that patients who currently smoked tobacco products had less active motion than their counterparts.<sup>5</sup> As smoking was reported among 28% of patients in the tracer data, there is a need for preventative strategies to improve overall health and outcomes, in which hand surgeons could potentially play a role through interactive dialogue with patients.<sup>6</sup>

### Preoperative Assessment

The ideal timing for flexor tendon repair has not been established with high-level evidence.<sup>1,4</sup> However, it is generally recommended that tendon repair be performed within 3 weeks after an injury as, over time, the tendon ends become distorted, the tendon sheath scars, the muscle-tendon unit shortens inhibiting primary repair, and

**Table 4. Surgical Techniques**

	2006–2014		2015–2020		Overall		P
	#	%/ Avg	#	%/ Avg	#	%/ Avg	
1. Tourniquet used							0.007*
No	17	4%	29	9%	46	6%	
Yes	432	94%	285	89%	717	92%	
2. Tourniquet time (min)	439	$\bar{x} = 71$ SEM= 2	295	$\bar{x} = 68$ SEM = 2	734	$\bar{x} = 69$ SEM = 1	
3. Pulley preserved							
A1	92	20%	92	29%	184	24%	0.005*
A2	244	53%	150	47%	394	51%	0.090
A3	81	18%	58	18%	139	18%	0.853
A4	188	41%	138	43%	326	42%	0.530
A5	90	20%	74	23%	164	21%	0.230
4. Type of tendon repaired							
2 strand	69	15%	41	13%	110	14%	
4 strand	257	56%	189	59%	446	57%	
6 strand	86	19%	44	14%	130	17%	
5. Type of suture material							
Braided	204	44%	157	49%	361	46%	0.194
Smooth	203	44%	112	35%	315	40%	0.011*
36586	145	32%	108	34%	253	32%	0.513
36617	181	39%	102	32%	283	36%	0.033*
6. Epatendinous repair							0.703
Yes	291	63%	193	60%	484	62%	
No	114	25%	85	27%	199	26%	
7. Patient compliant with follow-up							0.220
Yes	354	77%	255	80%	609	78%	
No	87	19%	47	15%	134	17%	
8. Therapy prescribed							
None	31	7%	25	8%	56	7%	0.568
Passive mobilization (Duran and Houser)	178	39%	103	32%	281	36%	0.063
Dynamic flexion/active extension (Kleinert)	137	30%	76	24%	213	27%	0.063
Tendon excursion by wrist movement (Indiana)	6	1%	19	6%	25	3%	<0.001*
Active movement protocol (Becker)	101	22%	87	27%	188	24%	0.093
Other	32	7%	30	9%	62	8%	0.219
9. Perioperative antibiotics							0.105
a. No. perioperative doses of antibiotics							
None	17	4%	18	6%	35	4%	
One	317	69%	214	67%	531	68%	
More than one	114	25%	86	27%	200	26%	
b. More than one day of antibiotics							0.139
No	131	28%	112	35%	243	31%	
Yes	310	67%	194	61%	504	65%	

\*P values for statistically significant differences in comparisons between 2006 and 2014 and 2015 and 2020 are shown.

**Table 5. Adverse Events and Outcomes**

	2006–2014		2015–2020		Overall		P
	#	%/ Avg	#	%/ Avg	#	%/ Avg	
1. No. nights in hospital	460	$\bar{x} = 1$ SEM = 0.12	320	$\bar{x} = 1$ SEM = 0.06	780	$\bar{x} = 1$ SEM = 0.07	
2. Time out of work (in weeks)	262	$\bar{x} = 8$ SEM = 0.4	219	$\bar{x} = 8$ SEM = 0.5	481	$\bar{x} = 8$ SEM = 0.3	
3. Postoperative adverse events							
None	334	73%	240	75%	574	74%	
Tendon repair rupture	12	3%	8	3%	20	3%	0.037*
Chronic regional pain syndrome	0	0%	3	1%	3	0%	
Tendon adhesions causing limited range of motion	68	15%	45	14%	113	14%	
Infection requiring oral antibiotics only	4	1%	0	0%	4	1%	
Infection requiring IV antibiotics	3	1%	1	0%	4	1%	
Dehiscence	1	0%	1	0%	2	0%	
Tendon suture exposure and removal	1	0%	4	1%	5	1%	
Other	50	11%	30	9%	80	10%	
4. Movement outcomes							
Almost full range of motion	175	38%	111	35%	286	37%	
Good range of motion	140	30%	120	38%	260	33%	0.040*
Poor range of motion	46	10%	35	11%	81	10%	
No movement	4	1%	3	1%	7	1%	
Tenolysis required	23	5%	7	2%	30	4%	0.045*
Don't know – patient did not return for follow-up	58	13%	35	11%	93	12%	
Other	36	8%	28	9%	64	8%	
5. Patient satisfaction with end results							
Satisfied	350	76%	256	80%	606	78%	
Dissatisfied	22	5%	12	4%	34	4%	
6. Physician satisfaction with end result							
Satisfied	333	72%	230	72%	563	72%	
Dissatisfied	56	12%	36	11%	92	12%	

\*P values for statistically significant differences in comparisons between 2006 and 2014 and 2015 and 2020 are shown.

adhesions may form.<sup>7-10</sup> The exception exists for zone V injuries, which should be treated urgently given the proximity of the nearby neurovascular structures and possible retraction of the tendons.<sup>2</sup> In the tracer data, the average time between injury and surgical repair was 12 days.

Physical examination remains the gold standard of preoperative assessment.<sup>1,4</sup> Disruption of the physiological cascade upon extension of the injured digit is suggestive of flexor tendon injury. Assessment can be further supported with the loss of the tenodesis effect or an abnormal forearm compression test.<sup>2</sup> Additionally, several authors have noted the utility of high-frequency ultrasound and magnetic resonance imaging in confirming the preoperative assessment of disrupted tendons and pulleys.<sup>11-14</sup> Concomitant nerve damage is frequently reported in the tracer (59%) and thus would support a thorough neurologic examination of all patients with flexor tendon injuries. Ulnar and radial digit nerves should be tested using the examiner's method of choice, such as the ten test or two-point discrimination test.<sup>15</sup> Skin loss (23%) and bone fracture (18%) were also seen in a substantial proportion of patients. Bony fixation should always be performed before tendon repair; additionally, any non-viable soft tissue should be debrided and defects covered to avoid infection and potential adhesions.<sup>3</sup>

### Anesthesia

Increasing evidence has supported the switch from general anesthesia to wide-awake flexor tendon repair.<sup>16-18</sup> This WALANT (wide-awake, local anesthesia, no tourniquet) technique utilizes locally injected lidocaine and epinephrine for anesthesia and hemostasis without using a tourniquet. This allows patients to actively move the tendon while the surgeon examines and makes final adjustments before the skin is ultimately closed. The ability to prevent tendon bunching in the suture or at the pulley with active movement has been reported to lower the tendon rupture rate.<sup>19</sup> Although prospective studies do not directly compare wide-awake local anesthesia versus general anesthesia for flexor tendon repair, Leblanc et al demonstrated both safety and efficacy in performing hand surgery outside the operating room with local anesthetic with epinephrine alone.<sup>20</sup> The widespread adoption of local anesthesia for flexor tendon repair is reflected in the significant declines in general anesthesia usage reported in the tracer data (88% versus 74%,  $P < 0.001$ ). Although the rate of general anesthesia is still high in this dataset, we expect to see a decline in its use for flexor repair as more data continues to support local anesthetic measures. Concurrently, significant increases in the usage of local anesthesia without sedation, brachial plexus blocks, and Bier blocks were seen. It has been documented that regional nerve blocks may negatively impact outcomes, as paralysis of the nerves negates optimal patient cooperation with finger flexion and extension; however, additional studies will be needed to support or negate their efficacy.<sup>21</sup>

### Procedure Setting

Most flexor tendon laceration repairs occur in hospitals, with 64% in a hospital outpatient setting and 27%

hospital inpatient. A minority occurred in an accredited freestanding outpatient facility. No study has directly compared outcomes for inpatient versus outpatient repairs for flexor tendon laceration injuries. Outpatient settings are reported to be less of a financial burden on the patient than inpatient repairs.<sup>22,23</sup> Also, patients without Medicaid are noted to have a significantly harder time acquiring an outpatient appointment.<sup>22</sup>

### Hemostasis and Tourniquet Use

A tourniquet may be used for hemostasis during exploration and tendon repair and eventually released for vascular anastomosis.<sup>2,24</sup> Tourniquet use remains high among surgeons although decreasing in recent years (94% versus 89%,  $P = 0.003$ ). This decline is partially accounted for by the rising use of the WALANT technique in flexor tendon repairs. When used, a tourniquet requires careful monitoring due to the severity of associated, yet rare, complications, including digital ischemia, neurovascular damage, chemical burns, and deep venous thromboemboli.<sup>25,26</sup>

### Surgical Treatment

It is generally recommended that lacerations up to 60% of the width of the tendon do not require direct repair.<sup>4,27,28</sup> When opting for surgical intervention, the surgeon should aim to preserve the pulleys of the hand, particularly the A2 and A4 pulleys, given the biomechanical advantage they exude on finger flexion.<sup>29-32</sup> This is concurrent with tracer data, as the A2 and A4 pulleys are the most maintained. Interestingly, recent literature has shown that 100% of the A2 or A4 pulley does not need to be maintained, given that the other pulleys remain intact.<sup>10,29</sup> This may also explain the increase incidence of preservation of the A1 pulley amongst surgeons, which Cox and colleagues have shown to be a valuable preventer of bowstringing when the A2 is released.<sup>33</sup>

Most surgeons believe that both the flexor digitorum superficialis and flexor digitorum profundus tendons should be repaired in zone II injuries, the most frequent injury zone reported in the tracer (57%).<sup>3,34-36</sup> However, there is debate in the field about the efficacy of repairing the profundus alone, both tendons, or just one slip of the superficialis.<sup>37-40</sup> Substantial evidence supports the need to repair the profundus, but best-practice superficialis management is not conclusive. As profundus ± superficialis injuries comprise at least 75% of flexor tendon lacerations in the tracer data, additional research on long-term outcomes should be conducted.

Another important consideration in the management of flexor tendons is the type and quantity of suture strands utilized. Various suture materials have been used for tendon repair, with FiberWire and stainless steel being the most biomechanically suitable.<sup>41-44</sup> Studies report that both absorbable and nonabsorbable sutures have similar efficacy.<sup>45</sup> It is crucial to minimize friction during flexor tendon repair.<sup>46,47</sup> Despite available evidence favoring smooth/monofilament sutures, tracer data indicate a significant decline in smooth suture usage with increased braided sutures for flexor tendon lacerations.<sup>48,49</sup> It has also been shown in cadaver tendons that increasing suture

caliber can lead to better outcomes.<sup>50</sup> Specifically, strength was decreased by over 50% from 2-0 to 3-0 to 4-0 to 5-0 sutures. Likewise, core suture purchases should be at least 7–10 mm.<sup>51</sup> However, recent evidence explains that the repair strength is related most directly to the number of strands of suture material crossing the repair site and that quantity of suture material should be prioritized over suture caliber or length.<sup>52–55</sup> Four strand repairs remain the most popular (57%) among diplomates of the ABPS. Substantial experimental work shows that tendon rupture may decrease by adding two or more additional strands to a two-strand repair.<sup>52–54,56,57</sup> Good outcomes have also been achieved with six- and eight-strand repairs.<sup>56,58</sup> The utility of additional strands remains strong in literature but still is debated among surgeons in the field.<sup>59,60</sup>

In addition to the four-strand core suture technique, several different techniques involving grasping, cross-stitch, mattress, cruciate, and locking configurations have been used in flexor tendon repair, although not reported in our tracer data.<sup>30,61</sup>

### Antibiotic Use

Rates of infection following flexor tendon injuries are low, and perioperative antibiotics tend to be ineffective.<sup>62,63</sup> Despite their low efficacy, 94% of patients receive one or more perioperative doses of antibiotics, and 65% receive antibiotics for more than 1 day after surgery. Given that these are traumatic injuries, it is crucial to consider the state of the wound and the patient's health status. Patients who smoke, have diabetes, or are immunocompromised may require altered antibiotic regimens. Overall, antibiotics may be an unnecessary adjunct for some patient populations provided meticulous surgical debridement is taken. Future tracer data may show a decline in the usage of antibiotics.<sup>64</sup> Clear guidelines remain to be established.

### Therapy Prescribed

There are three basic types of postoperative early movement regimens after flexor tendon repair: dynamic flexion/active extension started by Kleinert et al, passive flexion and extension founded by Duran and Houser, and early active movement pioneered by Becker et al.<sup>65–67</sup> Currently, there is only one Cochrane review on rehabilitation after flexor tendon injuries, which concluded insufficient evidence to define the best mobilization strategy.<sup>68</sup> However, there is a strong trend toward increasing early active movement protocols in EBM, although this has not been reflected in the tracer data.<sup>34,69–72</sup> Becker's active protocol accounts for 24% of therapy prescribed behind Duran's (36%) and Kleinert's (27%) techniques.

### Outcome and Patient Satisfaction

In the literature, flexor tendon laceration repairs over the past 15 years yielded "excellent" to "good" total active motion assessment results as follows: zone I, 79%; zone II, 77%; zone III, 81%; zone IV, 81%; and zone V, 90%.<sup>73</sup> Good results demonstrate total active motion of greater than 75%, whereas excellent results demonstrate total active motion synonymous to a non-injured digit.<sup>3</sup> In the present study, 78% of patients and 72% of physicians were

satisfied with the outcome. It is interesting that the percentage of physician satisfaction has been unchanged over this time period. Additional qualitative studies may seek to better understand why hand surgeons have felt relatively unchanged regarding flexor tendon repair. Given that zone II represents the most common zone injury site (57%) yet has the lowest reported outcomes in the literature, efforts should be continually made to ensure optimal surgical care for these flexor tendon lacerations.

### Postoperative Adverse Events

In total, 74% of patients experienced no adverse events following flexor tendon repair. Tension adhesions giving suboptimal results (14%) and tendon repair rupture (3%) were among the most common complications. Recent analyses have noted comparable complication rates, with rupture rates often being due to unfortunate postoperative accidents.<sup>73–76</sup>

### Workers' Compensation

Workers' compensation for flexor tendon laceration injuries has significantly decreased over the last 15 years (27% versus 21%,  $P < 0.001$ ). Total direct costs per injury are estimated to be \$13,725, whereas indirect costs can range from \$60,786 to \$112,888.<sup>23</sup> Based on tracer data, the average reported time out of work after repair is 8 weeks, thus placing a significant burden on affected patients.<sup>22,23,77</sup>

### In Literature But Not in Tracer Data

#### Postoperative Topical Agents

Various agents have been used to reduce adhesions of the flexor tendon that may result after repair, including glycosaminoglycan gels, topical 5-fluorouracil, hyaluronic acid, platelet-rich plasma with fibrin matrix, mannose-6-phosphate, nonsteroidal anti-inflammatory drugs, amnion, and periosteum.<sup>78–84</sup> Botulinum toxin has also been used as an adjunct form of protection for tendon repair.<sup>85,86</sup> The current scope of evidence does not fully support the use of any particular agent; however, further research into their efficacy may help diminish tendon adhesion complications following flexor tendon repair.

### Limitations

As with other analyses of national databases, this study has limitations. Given the 15 years of tracer data in this report, many surgeons who entered data may not have been aware of the most current evidence cited in this study. We acknowledge that trends of evidence-based medicine adoption are relatively slow. In addition, the questions which ABPS diplomates answered when entering their tracer data may not effectively cull information related to recent changes in treatment recommendations from evidence-based medicine. Another limitation is that because the data are collected from diplomates of the ABPS who chose the flexor tendon laceration tracer as part of the recertification process, it does not reflect those who selected another tracer or those who hold a lifetime certificate by the ABPS. Third, the data in this tracer are self-reported by ABPS diplomates and are vulnerable to

reporting bias. This concern is minimized, as surgeons must report 10 consecutive cases to ensure that their best outcomes are not selectively recorded. Despite these limitations, this dataset has several distinct advantages that make it worth reporting. The dataset was designed by members of the ABPS Board of Directors who maintain sub-specialty certification in surgery of the hand, and it therefore includes many relevant variables that more generic databases would not contain. Additionally, similar databases like the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) have 30-day follow-up data, whereas the follow-up provided in this dataset may be up to three years. Future studies may aim to compare this tracer database with ACS NSQIP and/or international surgeon databases.

## CONCLUSIONS

Significant changes in practice over this time were noted by decline in tourniquet use and the use of general anesthesia, increase in the four-strand technique for flexor tendon repair, and increase in the use of braided sutures. Despite substantial evidence supporting the efficacy of active movement postoperative therapy, tracer data indicate that it still lags behind passive mobilization and dynamic extension postoperative rehabilitation regimens. With an adverse event rate incidence of 26%, overall outcomes appear good following traumatic flexor tendon repairs. These data provide insight into national practice patterns and the evolution of presentation, diagnosis, and surgical techniques to manage flexor tendon lacerations. It is important to utilize this data among other EBM to create national clinical guidelines for the care of our patients. Plastic surgeons may use these results to reflect on their current surgical practices in the context of national statistics.

Joshua P. Weissman, BBA

Division of Plastic Surgery

Northwestern University Feinberg School of Medicine

420 East Ohio St, Apt 16F

Chicago, IL 60611

E-mail: joshpw@northwestern.edu

## ACKNOWLEDGEMENTS

We wish to acknowledge Keith Brandt, Executive Director of the American Board of Plastic Surgery (ABPS), and the Executive Committee of the ABPS for their careful review of this article to ensure its accuracy in summarizing the tracer data collected by the ABPS.

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