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A Fourteen-year Review of Practice Patterns and Evidence-based Medicine in Operative Metacarpal Fracture Repair

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Background: The American Board of Plastic Surgery has been collecting practice data on metacarpal fracture operative repair since 2006 as part of its Continuous Certification process. These data allow plastic surgeons to compare their surgical experience to national trends. Additionally, these data present the opportunity to analyze those trends in relation to evidence-based medicine.

Methods: Data on metacarpal fracture operative repair from May 2006 to December 2014 were reviewed and compared with those from January 2015 to March 2020. National practice trends observed in these data were evaluated and reviewed alongside published literature and evidence-based medicine.

Results: In total, 1160 metacarpal fracture repair cases were included. Outpatient (as opposed to inpatient) operative repairs have been trending upward, from 50% to 61% ($P < 0.001$). Most repairs were performed under general anesthesia (68%), and there was a decrease in the use of regional anesthesia between our two cohorts (14%–9%; $P = 0.01$). An open reduction with internal fixation was the most popular technique (51%), and a decrease in the use of closed reduction with splinting was observed (16%–10%; $P = 0.001$). Stiffness was the most commonly reported adverse event. Topics addressed in evidence-based medicine articles but not tracer data included interosseous wiring, which has shown success in spiral shaft fracture treatment with minimal complications, and nonoperative management.

Conclusion: As evidence-based recommendations continue to change with additional research inquiry, tracer data can provide an excellent overview of the current practice of metacarpal fracture repair and how effectively physicians adapt to remain aligned with best practices. *(Plast Reconstr Surg Glob Open 2022;10:e4065; doi: 10.1097/GOX.0000000000004065; Published online 25 January 2022.)*

INTRODUCTION

The American Board of Plastic Surgery (ABPS) diplomates submit procedure logs twice every 10 years to maintain Continuous Certification. The ABPS has identified 24 tracer procedures, subdivided into four modules (Comprehensive, Cosmetic, Craniomaxillofacial, and Hand). Plastic surgeons report 10 consecutive cases of one of the tracer procedures of their choice. Data collected include patient medical history, preoperative physical examination, operative details, and surgical outcomes (herein referred to as "tracer" data).

The ABPS has collected tracer data on metacarpal fracture operative repair since 2006. These data allow plastic surgeons to compare their surgical experience with national trends. Additionally, these data present the opportunity to analyze those trends in relation to evidence-based medicine. Here, we will compare tracer data for metacarpal fracture operative repair and its concurrence or discordance with evidence-based recommendations on the topic. This analysis will be split into three categories: "Pearls," or topics covered by evidence-based medicine and the ABPS tracer, research topics not covered by the ABPS tracer, and tracer elements collected that have not yet been assessed in the literature (suggested future research directions).

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METHODS

ABPS tracer data for metacarpal fracture operative repair were reviewed from May 2006 to March 2020. The data were divided into two groups: May 2006–December 2014 and January 2015–March 2020, to evaluate national trends. Comparisons between time points were performed using the chi-square test.

Clinical "pearls" were selected after a comparative review of tracer data with published plastic surgery literature, with particular respect to maintenance of certification reviews.[1–3] Evidence-based data present in the literature but not collected by the ABPS, and the converse, were examined for future research direction, focusing on improving patient outcomes.

Takeaways

Question: Do plastic surgeons increasingly adhere to evidence-based practices in metacarpal fracture operative repair?

Findings: Repairs from 2006 to 2014 were reviewed/compared with those from 2015 to 2020. Most were performed under general anesthesia (68%), and there was a decrease in the use of regional anesthesia (14%–9%; $P = 0.01$). A decrease in the use of closed reduction with splinting was observed (16%–10%; $P = 0.001$).

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

RESULTS

The ABPS Continuous Certification database contained information on 1160 metacarpal fracture operative repair cases from May 2006 to March 2020. An estimated 510 cases were reported from May 2006 to December 2014 and 650 from January 2015 to March 2020. The average patient age was 29 years, and 78% identified as men (Table 1). Thirty-three surgeons participated from 2006 to 2014, and 30 surgeons participated from 2015 to 2020. In total, 76% of surgeons were employed privately. On physical examination, 87% of fractures were closed. Most fractures (48%) presented on the bone shaft, followed by the neck (24%). Fractures of the fifth metacarpal and fourth metacarpals were most common (52% and 32%, respectively). In terms of fracture pattern, 43% were transverse, 38% oblique, and 33% comminuted. Rotational deformity (scissoring) was reported in 34% of patients. An estimated 95% of patients had no additional soft-tissue injury. An estimated 20% of patients experienced more than one metacarpal fracture.

Between May 2006 and 2014, the average duration from initial injury to repair was reported to be 9 days (Table 1). Outpatient (as opposed to inpatient) operative repairs have been trending upward, from 50% to 61% ($P < 0.001$) (Table 2). The most popular operative technique was an open reduction with internal fixation (51%), and most patients experienced no postoperative adverse events (85%) (Tables 2, 3). Metacarpal stiffness was the most commonly reported adverse event; however, the tracer did not inquire how many degrees of range of motion were lost. Patients (85%) and their physicians (84%) were overall satisfied with procedural outcomes (Table 3).

DISCUSSION

Pearls

Anesthesia

EBM

No experimental evidence has been described in the literature to support a specific anesthetic modality in metacarpal fracture repair. Therefore, practice patterns are likely due to surgeon and anesthesiologist training, patient preference, and the extent of the injury.

Tracer

Reported data indicate an increase in general anesthesia from 62% to 73% ($P < 0.001$), as well as a decrease in brachial plexus block specifically (regional anesthesia) from 14% to 9% ($P = 0.01$) (Table 4). However, the high proportion of general anesthesia is likely confounded by the larger proportion of complex (multiple fingers, comminuted, etc.) injuries in the dataset relative to the fractured population, which nearly always require surgical intervention.

Surgical Treatment Plan

EBM (Nonfirst Metacarpal Fracture)

The majority of metacarpal fractures can be treated nonoperatively (described as closed reduction, splinting).[4–9] This is the case for most fifth metacarpal neck and other minimally displaced shaft fractures when rotational deformity is not a concern. In their review, Wong and Higgins report that nonoperative reduction is generally not attempted in their practice due to the difficulty maintaining a nonfixed reduction and the good functional outcomes without doing so.[3]

When excessive displacement is present and necessitates open operative treatment, intermetacarpal pinning or intramedullary fixation (utilizing nail or Kirschner wire) is preferred to provide stability without disrupting extensor tendon function.[3] Superiority has not been established between anterograde and retrograde intramedullary fixation techniques.[10–15] Intramedullary fixation is additionally favored for significantly angulated metacarpal neck fractures lacking rotational deformity. In contrast, plate fixation or interfragmentary (lag) screw fixation is preferred in significantly angulated shaft fractures.[16–18] Low-profile plates have been utilized to minimize obstruction to surrounding soft tissues; however, no significant difference in outcome from plate thickness has been ascertained. The use of absorbable plates has been described as well; however, metal plates remain the gold standard.[19]

In open fractures, Kirschner wire fixation is the preferred operating modality where soft-tissue healing is of

Table 1. Patient Demographics and Preoperative Evaluation

	2006–2014		2015–2020		Overall		
	#	% / Avg	#	% / Avg	#	% / Avg	*P*
1. Age (y)		$\bar{x}$ = 28 n = 510 SD = 15		$\bar{x}$ = 30 n = 650 SD = 18		$\bar{x}$ = 29 n = 1160 SD = 17	
1.1 Practice type (surgeons)							0.612
Academic practice	7		8		15	24%	
Private practice	26		22		48	76%	
2. Gender							
Men	403	79%	496	76%	899	78%	
Women	107	21%	154	24%	261	23%	
3. Medical history							
a. Smoker							
Yes	111	22%	134	21%	245	21%	
No	339	66%	486	75%	825	71%	
b. Occupation							
Light	104	20%	136	21%	240	21%	
Medium	99	19%	140	22%	239	21%	
Heavy	46	9%	76	12%	122	11%	
c. Operated hand							
Right dominant	316	62%	440	68%	756	65%	
Right nondominant	12	2%	10	2%	22	2%	
Left dominant	36	7%	29	4%	65	6%	
Left nondominant	122	24%	153	24%	275	24%	
d. Associated injuries							
Skin loss	32	6%	41	6%	73	6%	
Tendon	18	4%	34	5%	52	4%	
Artery	5	1%	7	1%	12	1%	
Nerve	10	2%	25	4%	35	3%	
Bone	135	26%	185	28%	320	28%	
e. Days between injury and first evaluation		Average = 6					
f. No. days between injury and surgery		Average= 9					
g. Worker's compensation for this injury							
Yes	33	6%	38	6%	71	6%	
No	384	75%	511	79%	895	77%	
4. Physical examination							
a. Fracture type							0.422
Open	47	9%	75	12%	122	11%	
Closed	453	89%	561	86%	1014	87%	
b. Location							
Head: intraarticular	20	4%	24	4%	44	4%	0.839
Head: extraarticular	21	4%	21	3%	42	4%	0.422
Neck	115	23%	168	26%	283	24%	0.194
Shaft	257	50%	302	46%	559	48%	0.141
Base: intraarticular	72	14%	83	13%	155	13%	0.503
Base: extraarticular	57	11%	81	12%	138	12%	0.502
c. Digit							
Thumb	62	12%	75	12%	137	12%	0.746
Index	55	11%	69	11%	124	11%	0.926
Middle	74	15%	97	15%	171	15%	0.844
Ring	153	30%	215	33%	368	32%	0.041*
Small	269	53%	334	51%	603	52%	0.645
d. Fracture pattern							
Transverse	243	48%	252	39%	495	43%	0.002*
Oblique	193	38%	245	38%	438	38%	0.958
Spiral	54	11%	67	10%	121	10%	0.877
e. Comminution							0.030*
Yes	150	29%	228	35%	378	33%	
No	329	65%	370	57%	699	60%	
f. Rotational deformity (scissoring)							0.009*
Yes	152	30%	247	38%	399	34%	
No	309	61%	338	52%	647	56%	
g. More than one metacarpal fractured							0.871
Yes	97	19%	131	20%	228	20%	
No	402	79%	504	78%	906	78%	

*$P < 0.05$; *P* values indicate comparisons between 2006 and 2014, and between 2015 and 2020 groups.

concern.[11] When bone loss is present, locking plate fixation is favored to maintain alignment and length.[16,20,21] In the most severe cases where bone loss or soft-tissue compromise is present, external fixation techniques may be used.[22,23] Additional operative approaches with nonspecific indications include closed reduction and percutaneous pinning with Kirschner wires, as well as open reduction and internal fixation with miniplates.[24]

EBM (First Metacarpal Fracture)

Consensus exists among the literature that first metacarpal fractures be treated operatively in almost all cases to avoid trapeziometacarpal joint displacement and ultimately, adduction contractures. Bennett fractures with fragments of significant size should be treated openly with interfragmentary (lag) screw fixation.[17] In cases where the fragment size is insufficient to allow for screw fixation,

Table 2. Surgical Treatment Plan

	2006–2014		2015–2020		Overall		
	#	% / Avg	#	% / Avg	#	% / Avg	*P*
I. Operation location and time							
1. Location							<0.001*
Hospital inpatient	95	19%	107	16%	202	17%	
Hospital outpatient	253	50%	399	61%	652	56%	<0.001*
Accredited freestanding outpatient facility	120	24%	68	10%	188	16%	
Accredited office operating room (AAAASF or JCAHO or CAAASF)	16	3%	26	4%	42	4%	
2. Incision to dressing surgery time (min) for metacarpal fracture surgery		$\bar{x}$ = 51		$\bar{x}$ = 51		$\bar{x}$ = 51	
3. Tourniquet used							0.379
No	160	31%	180	28%	340	29%	
Yes	316	62%	427	66%	743	64%	
4. Tourniquet time (min)		$\bar{x}$ = 38		$\bar{x}$ = 41		$\bar{x}$ = 40	
II. Surgical treatment plan							
1. Reduction							
Closed reduction, splinting	83	16%	63	10%	146	13%	0.001*
Closed reduction, percutaneous pinning	121	24%	182	28%	303	26%	0.100
Closed reduction percutaneous lag screw	1	0%	1	0%	2	0%	0.863
External fixator	2	0%	6	1%	8	1%	0.278
Open reduction and internal fixation†	259	51%	336	52%	595	51%	0.759
†Plate fixation	57	11%	58	9%	115	10%	0.202
†Lag screw(s)	35	7%	43	7%	78	7%	0.867
Other	59	12%	86	13%	145	13%	0.396
2. Perioperative Antibiotics							
a. No. perioperative doses of antibiotics							0.402
None	110	22%	115	18%	225	19%	
One	319	63%	421	65%	740	64%	
More than one	53	10%	76	12%	129	11%	
b. More than one day of antibiotics							0.508
No	284	56%	376	58%	660	57%	
Yes	174	34%	220	34%	394	34%	

*$P < 0.05$; *P* values indicate comparisons between 2006 and 2014, and between 2015 and 2020 groups.
†Operative technique is a subset of open reduction and internal fixation.

Table 3. Outcomes and Adverse Events

	2006–2014		2015–2020		Overall		
	#	% / Avg	#	% / Avg	#	% / Avg	*P*
1. No. nights in hospital		$\bar{x}$ = 1		$\bar{x}$ = 1		$\bar{x}$ = 1	
2. Time out of work (wk)		$\bar{x}$ = 4		$\bar{x}$ = 5		$\bar{x}$ = 4	
3. Postoperative adverse events							
None	425	83%	558	86%	983	85%	0.237
Wound separation treated conservatively	3	1%	2	0%	5	0%	0.469
Infection requiring oral antibiotics only	7	1%	8	1%	15	1%	0.832
Infection requiring IV antibiotics	2	0%	3	0%	5	0%	0.858
Injury to tendon	0	0%	3	0%	3	0%	0.124
Injury to nerve	0	0%	0	0%	0	0%	
Injury to artery	0	0%	0	0%	0	0%	
Nonunion	3	1%	7	1%	10	1%	0.372
Malunion	9	2%	3	0%	12	1%	0.029*
Decreased range of motion of MCP joint	28	5%	35	5%	63	5%	0.937
Complex regional pain syndrome	2	0%	2	0%	4	0%	0.808
Readmission to the hospital	3	1%	2	0%	5	0%	0.469
Plate/screw removal†	10	2%	14	2%	24	2%	0.819
Tenolysis†	3	1%	5	1%	8	1%	0.712
Capsulotomy†	3	1%	5	1%	8	1%	0.712
Other	33	6%	31	5%	64	6%	0.208
4. Movement outcomes							
Almost full range of motion	316	62%	402	62%	718	62%	0.968
Good range of motion	83	16%	151	23%	234	20%	0.003*
Poor range of motion	20	4%	16	2%	36	3%	0.155
No movement	1	0%	0	0%	1	0%	0.259
Tenolysis required	2	0%	3	0%	5	0%	0.858
Don't know—patient did not return for follow up	67	13%	65	10%	132	11%	0.095
Other	29	6%	31	5%	60	5%	0.484
5. Patient satisfaction with end results							0.091
Satisfied	418	82%	563	87%	981	85%	
Dissatisfied	6	1%	5	1%	11	1%	
6. Physician satisfaction with end result							0.007*
Satisfied	410	80%	565	87%	975	84%	
Dissatisfied	29	6%	20	3%	49	4%	

*$P < 0.05$; *P* values indicate comparisons between 2006 and 2014 and between 2015 and 2020 groups.
†Reoperation required.

Table 4. Anesthesia Plan

	2015–2020		2015–2020		Overall		
	#	% / Avg	#	% / Avg	#	% / Avg	*P*
1. Anesthetic type							
Local anesthetic only injected in affected area without sedation	41	8%	42	6%	83	7%	0.301
Local anesthetic only injected in affected area with sedation	15	3%	29	4%	44	4%	0.178
Regional anesthesia (brachial plexus block)	69	14%	58	9%	127	11%	0.013*
Regional anesthesia (Bier block)	8	2%	7	1%	15	1%	0.462
General anesthesia	316	62%	473	73%	789	68%	<0.001*
Use of epinephrine in hand for hemostasis	11	2%	29	4%	40	3%	0.033*

*$P < 0.05$; *P* indicate comparisons between 2006 and 2014, and between 2015 and 2020 groups.

closed (fluoroscopic) reduction with percutaneous pinning between the larger metacarpal base segment and trapezium can be utilized.[24]

Given fracture fragments of sufficient size, locking miniplate fixation can be utilized for comminuted first metacarpal base fractures.[25] If the fragment area is insufficient, external fixation between the distal metacarpal and trapezium should be used.[26] Additional operative approaches with nonspecific indications include open reduction and internal fixation, and intermetacarpal pinning.[27]

Tracer

Open reduction and internal fixation was reported as the most commonly utilized operative modality (51%) (Table 2). This is in concurrence with EBM recommendations for its use as a primary surgical technique. As reported, these data encompass intermetacarpal pinning, intramedullary fixation, and open Kirschner wire fixation. Plate fixation and interfragmentary (lag) screws were far less commonly used in open reduction at 10% and 7%, respectively. Closed reduction with percutaneous pinning, the standard for first metacarpal fractures was reported as the second most common technique, although these fractures ranked low in prevalence in the present data (12%).[28] External fixation was reported to be a highly uncommon procedure in practice (1% of repairs) and is not a suggested repair method for any metacarpal by the literature (Table 2).

Nonoperative treatment (described as closed reduction, splinting) was reported in relatively low proportion and has been trending downward from 16% to 10% ($P < 0.001$) (Table 2). This is likely because tracer data focus on patients that are categorized to have undergone a surgical procedure.

Perioperative Antibiotics

EBM

Meta-analyses have demonstrated no significant difference in infection rates following single-dose versus multiple-dose prophylactic antibiotic administration. A cost-effectiveness approach may be more constructive in developing an optimal antibiotic strategy.[29]

Tracer

Surgeons tended to prescribe one perioperative dose of antibiotics (64%) or none at all (19%) (Table 2). However, a significant proportion (34%) of patients received multiple days of antibiotics in the postoperative period, likely related to the injury's severity. Without further information, these data remain discordant with evidence-based practices.

Infection

EBM

Surgical wound infections of closed fractures are relatively rare.[29] Percutaneous and external methods have the highest risk of infection due to the continued exposure to epidermal bacterial flora.[30]

Tracer

Infection was an uncommon complication (~1%), with no trend (Table 3).

In Literature but not in Tracer. The literature commonly differentiates between first and nonfirst surgical techniques and recommendations for metacarpal fractures. However, the tracer data do not provide the same differentiation. In addition, nonoperative management of metacarpal fractures may be underreported in the tracer data since data entry focuses on operative cases done during the ABPS Continuous Certification process. Several operative techniques have been grouped in the tracer and relegated to "other" (Table 2). These include interosseous wiring, which has shown success in spiral shaft fracture treatment with minimal complications.[31] Lastly, perceived pain is often reported in the literature but is not specifically collected in the tracer.[30,32,33]

Future Research Directions. Detailed tourniquet use is missing from the literature but is reported to be used in over 64% of procedures (Table 2).[34] Additionally, no specific evidence-based studies have been identified that compare different rehabilitation methods following metacarpal fracture treatment. In total, 23% of patients reported an incomplete range of motion following surgery; thus, studies to determine a specific rehabilitation protocol would be largely beneficial (Table 3). Most authors currently recommend early active motion.[17,18,35,36] Successful petitioning for workers' compensation is reported in the tracer, but no actionable conclusions can be found in the literature beyond its effect on recovery profile (Table 1).[37]

The ABPS did not collect information regarding nonsurgical treatments. Including this information in

a future tracer database would add significant value to analyses of trends and adherence to best practices. Lastly, per-patient tracer information would allow for analysis more specific to patient and treatment variables, allowing for comparison between components such as practice outcomes specific to practice type, antibiotic usage outcomes, and comorbidity effects on patient prognosis.

CONCLUSIONS

The metacarpal fracture operative repair tracer data allow practicing plastic surgeons to compare their surgical inclinations and techniques with national trends from board-certified plastic surgeons and EBM. Additionally, it can be concluded that most board-certified plastic surgeons are practicing within EBM guidelines. As these recommendations continue to change with additional research inquiry, tracer data can provide an excellent overview of the current practice of metacarpal fracture repair and how effectively physicians adapt to remain aligned with best practices.

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