RESEARCH ARTICLE

Anesthesia Type and Short-Term Outcomes in Open Treatment of Hand Fractures

Robert L. Dalcortivo, BBA; Benjamin A. Yarbrough, MD; Dominick V. Congiusta, MD; Irfan H. Ahmed, MD; Michael M. Vosbikian, MD

Research performed at Rutgers New Jersey Medical School, Newark, NJ, USA

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Abstract

Objectives: The hand is one of the most commonly fractured parts of the body. Many of these injuries are treated operatively. This study compares short-term outcomes between general anesthesia and other forms of anesthesia in the open treatment of hand fractures.

Methods: Procedures related to the open treatment of carpal, metacarpal, and phalangeal fractures from the years 2005-2017 were queried from the National Surgical Quality Improvement Program (NSQIP) database. Outcome measures included 30-day reoperation rate, length of stay (LOS), minor complications, and major complications. Chi-squared tests were used to identify significant demographics and comorbidities. Significant variables were included in a logistic regression model.

Results: A total of 5,907 patients were included, of which 4,547 (77%) received general anesthesia, and 1,360 (23%) received local anesthesia, regional anesthesia, sedation, or monitored anesthesia care. Patients treated with general anesthesia were younger and more likely to be male. Operative time was longer with general anesthesia (65.0 vs. 59.8minutes, P<0.01). Anesthesia technique had no statistically significant association with thirty-day rate of reoperation, minor complications, or major complications (P=0.32, 0.91, and 0.07, respectively). General anesthesia had greater odds for LOS exceeding the 75th percentile (OR 2.05, P<0.01).

Conclusion: In the open treatment of hand fractures, short-term complication rates are similar between general anesthesia and other forms of anesthesia, but extended LOS is more likely with general anesthesia. When practical, surgeons can consider local anesthesia, regional anesthesia, sedation, and monitored anesthesia as reasonably safe alternatives to general anesthesia.

Level of evidence: III

Keywords: Anesthesia, Finger, Fracture, Hand, NSQIP, Wrist

Introduction

Fractures of the carpal, metacarpal, and phalangeal bones are common. Together, they account for an estimated annual incidence in the United States of 24.4 per 10,000 person years.[1] These injuries are more common in males and have an average age of injury in the fourth decade of life.[1,2]

Upper extremity fractures treated with internal fixation are increasing, and general anesthesia is the predominant anesthesia technique used in these procedures.[3] In the realm of hand fractures, many physicians are proponents of less invasive forms of anesthesia, with some advocating for wide-awake local or regional anesthesia often with no tourniquet (WALANT).[4-7] However, intravenous (IV) sedation or monitored anesthesia care (MAC) may be more practical alternatives to WALANT for better patient comfort, anxiolysis, and amnesia.[8] When compared to general anesthesia, these techniques have shown benefits in operative time, post-anesthesia care unit (PACU) stay, unplanned admission, postoperative analgesia requirements, nausea, and vomiting.[9-12]

To the authors' knowledge, no study has used a large national database to compare short-term outcomes with

Corresponding Author: Robert L. DalCortivo, Rutgers New Jersey Medical School Department of Orthopaedics, Newark, USA

Email: dalcort@njms.rutgers.edu

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different anesthesia techniques in the setting of hand fractures. This study uses the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database to compare 30-day minor complications, major complications, length of stay, and reoperation rates between general and other forms of anesthesia in carpal, metacarpal, and phalangeal fractures. We hypothesize that outcomes will not be significantly different by anesthesia technique.

Materials and Methods

Representing over 700 hospitals throughout the United States and 11 countries, the National Surgical Quality Improvement Program (NSQIP) database is a large, national, surgical database.[13] Hospitals that participate employ a trained reviewer who collects data in the perioperative period and in the 30 days following surgery on randomly assigned patients.[14] The database is validated, outcome-based, peer-controlled, and risk-adjusted with strong inter-rater reliability.[15-17]

This study analyzed the NSQIP database in years 2005-2017. Records with primary Current Procedure Terminology (CPT) code indicating open fixation of a carpal, metacarpal, or phalangeal fracture (CPT 25628, 25645, 25670, 25685, 25695, 26615, 26665, 26685, 26686, 26715, 26735, 26746, 26765, and 26785) were included. Data collected included outcome data, demographics, and comorbidities. Exclusion criteria were missing information and patients with multiple procedures performed.

Records were categorized into two categories based on the primary anesthesia technique of the procedure: a general anesthesia cohort and a local, regional, sedation, or MAC group ("other"). The database defines general anesthesia as IV anesthesia with intubation or laryngeal mask airway (LMA). A comparison between these groups was performed for 30-day reoperation, length of stay (LOS), minor complications, and major complications. Deaths were excluded as there were zero deaths in the entire cohort. Length of stay is calculated in the database using date of admission and date of discharge. Length of stay was defined as either routine (less than or equal to the 75th percentile) or extended (greater than the 75th percentile). This threshold was chosen to be consistent with existing literature.[18-20] Minor complications were grouped together and included pneumonia, superficial surgical site infection, urinary tract infection, wound dehiscence, and renal insufficiency not requiring dialysis. Major complications were also grouped together and included deep vein thrombosis, pulmonary embolism, myocardial infarction, cerebrovascular accident, cardiac arrest, reintubation, sepsis, deep surgical site infection, and acute renal failure requiring dialysis. Patient were also grouped into three categories based on injury location for subgroup analysis: carpal (CPT 25628, 25645, 25670, 25685, and 25695), metacarpal (CPT 26615, 26665, 26685, 26686, and 26715), and phalangeal (CPT 26735, 26746, 26765, 26785).

Data was analyzed using R statistical software, version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria). Demographics and comorbidities were compared using Chi-squared tests. Those that were significantly associated with each outcome were included in a binomial multivariate logistic regression model alongside anesthesia technique. Statistical significance was defined as $P < 0.05$.

This study was retrospective and based on de-identified records and thus was exempt from Institutional Review Board approval.

Results

A total of 5,907 patients were included in the study. Of these, 4,547 (77%) were treated with general anesthesia, and 1,360 (23%) were treated with either local anesthesia, regional anesthesia, IV sedation, or MAC. General anesthesia patients were more often male (75% vs. 69%, $P < 0.01$) and were on average four years younger (35.4 years vs. 39.5 years, $P < 0.01$). Operative time was longer for the general cohort (65.0 minutes vs. 59.8 minutes, $P < 0.01$). There was no difference between the two groups in race ($P = 0.31$) [Table 1]. Subgroup analysis showed the lowest rate of general anesthesia was used in phalangeal injuries (69.7%), followed by carpal (79.2%) and metacarpal (81.6%) injuries ($P < 0.01$). Males were more common in carpal (83.2%) and metacarpal (76.0%) injuries compared to phalangeal (65.0%) injuries ($P < 0.01$).

Table 1. Descriptive Data of Hand Fractures

	Frequency (%)		
Variable	**Overall**	**Other**	**General**
Total	***5,907 (100.0%)***	***1,360 (100.0%)***	***4,547 (100.0%)***
	Anesthesia		
Other	1,360 (23.0%)	1,360 (100.0%)	0 (0.0%)
General	4,547 (77.0%)	0 (0.0%)	4,547 (100.0%)
	Age		
<=40	3,953 (66.9%)	805 (59.2%)	3,148 (69.2%)*
41-60	1,381 (23.4%)	364 (26.8%)	1,017 (22.4%)
61-80	507 (8.6%)	169 (12.4%)	338 (7.4%)
80+	66 (1.1%)	22 (1.6%)	44 (1.0%)
	Sex		
Female	1,585 (26.8%)	425 (31.3%)	1,160 (25.5%)*
Male	4,322 (73.2%)	935 (68.8%)	3,387 (74.5%)

Table 1. Continued			
Race			
Caucasian	3,669 (62.1%)	827 (60.8%)	2,842 (62.5%)
African American	670 (11.3%)	169 (12.4%)	501 (11.0%)
Other/Not Reported	1,568 (26.5%)	364 (26.8%)	1,204 (26.5%)
Mean (SD[a])			
Variable	**Overall**	**Other**	**General**
Age (years)	36.4 (15.7)	39.5 (17.0)	35.4 (15.2)*
Operative Time (minutes)	63.8 (37.8)	59.8 (38.2)	65.0 (37.6)*

[a] Standard deviation
*Indicates significance, defined as P < 0.05

The general cohort had a higher proportion of smokers (32% vs. 25%, $P < 0.01$), but a lower proportion of patients with diabetes (4% vs. 6%, < 0.01), morbid obesity (3% vs 4%, $P = 0.03$), and hypertension requiring medication (12% vs 15%, $P < 0.01$). Other comorbidities, including corticosteroid use, open wound status, chronic obstructive pulmonary disease, coagulopathy, and non-morbid obesity were similar among the two cohorts ($P \geq 0.05$) [Table 2].

Table 2. Comorbidities of Hand Fractures			
Frequency (%)			
Comorbidity	**Overall**	**Other**	**General**
Smoker	1,799 (30.5%)	344 (25.3%)	1,455 (32.0%)*
Corticosteroid user	38 (0.6%)	14 (1.0%)	24 (0.5%)
Open Wound	145 (2.5%)	36 (2.6%)	109 (2.4%)
COPD	57 (1.0%)	15 (1.1%)	42 (0.9%)
Coagulopathy	37 (0.6%)	11 (0.8%)	26 (0.6%)
Diabetes	253 (4.3%)	81 (6.0%)	172 (3.8%)*
Non-morbid Obesity	1,240 (21.0%)	286 (21.0%)	954 (21.0%)
Morbid Obesity	202 (3.4%)	60 (4.4%)	142 (3.1%)*
Hypertension	738 (12.5%)	210 (15.4%)	528 (11.6%)*

*Indicates significance, defined as P < 0.05

The overall 30-day reoperation rate was 1.0%. The overall minor complication rate was 1.0%, and the overall major complication rate was 0.3% [Table 3]. The most common minor complication was superficial surgical site infection (0.7%), and the most common major complication was deep surgical site infection (0.2%). On a univariate basis, LOS was more likely to be extended in the general cohort (8% vs. 5%, $P < 0.01$). Rates of 30-day reoperation, minor complications, and major complications were similar between the two groups [Table 3]. A breakdown of frequencies of minor and major complications is provided in [Table 4].

In the multivariate logistic regression model, general anesthesia was independently associated with extended LOS (odds ratio (OR) 2.05, 95% confidence interval (CI) 1.56-2.71, $P < 0.01$). Rates of reoperation (OR 1.39, CI 0.73-2.64, $P = 0.32$), minor complications (OR 0.96, CI 0.52-1.77, $P = 0.91$), and major complications (OR 6.33, CI 0.84-47.86, $P = 0.07$) were not significantly associated with anesthesia technique [Table 5].

Table 3. Outcomes of Hand Fractures			
Frequency (%)			
Outcome	**Overall**	**Other**	**General**
Extended LOS[a]	449 (7.6%)	65 (4.8%)	384 (8.4%)*
Reoperation	59 (1.0%)	12 (0.9%)	47 (1.0%)
Minor Complication	57 (1.0%)	14 (1.0%)	43 (0.9%)
Major Complication	18 (0.3%)	1 (0.1%)	17 (0.4%)

[a] Length of stay greater than the 75th percentile
*Indicates significance, defined as P < 0.05

Table 4. Summary of Minor and Major Complications

	Frequency (%)		
Outcome	**Overall**	**Other**	**General**
	Minor Complications		
Renal Insufficiency	0 (0.0%)	0 (0.0%)	0 (0.0%)
Pneumonia	2 (0.0%)	1 (0.1%)	1 (0.0%)
Wound Dehiscence	4 (0.1%)	1 (0.1%)	3 (0.1%)
Superficial SSI	44 (0.7%)	9 (0.7%)	35 (0.8%)
UTI	8 (0.1%)	3 (0.2%)	5 (0.1%)
	Major Complications		
Myocardial Infarction	1 (0.0%)	0 (0.0%)	1 (0.0%)
Deep Vein Thrombosis	0 (0.0%)	0 (0.0%)	0 (0.0%)
Pulmonary Embolism	0 (0.0%)	0 (0.0%)	0 (0.0%)
Cerebrovascular Event	1 (0.0%)	0 (0.0%)	1 (0.0%)
Sepsis	2 (0.0%)	0 (0.0%)	2 (0.0%)
Cardiac Arrest	0 (0.0%)	0 (0.0%)	0 (0.0%)
Deep SSI	14 (0.2%)	1 (0.1%)	13 (0.3%)
Intubation	1 (0.0%)	0 (0.0%)	1 (0.0%)
Acute Renal Failure	0 (0.0%)	0 (0.0%)	0 (0.0%)

Table 5. Predictors of Outcomes of Hand Fractures

	Extended LOS[a]	**Reoperation**	**Minor Complications**	**Major Complications**
	OR[b] (95% CI[c])	**OR[b] (95% CI[c])**	**OR[b] (95% CI[c])**	**OR[b] (95% CI[c])**
		Age		
<=40	Ref[d]	Ref[d]	-	Ref[d]
41-60	1.56 (1.23, 1.98)*	2.61 (1.43, 4.74)*	-	3.06 (0.98, 9.51)
61-80	1.78 (1.26, 2.52)*	4.43 (2.21, 8.87)*	-	7.57 (2.29, 24.97)*
>80	3.13 (1.58, 6.22)*	5.06 (1.16, 22.14)*	-	11.71 (1.38, 99.19)*
		General Anesthesia		
	2.05 (1.56, 2.71)*	1.39 (0.73, 2.64)	0.96 (0.52, 1.77)	6.33 (0.84, 47.86)
		Comorbidities		
Open Wound	6.39 (4.43, 9.22)*	2.88 (1.12, 7.41)*	4.95 (2.08, 11.78)*	-
Coagulopathy	1.54 (0.63, 3.75)	-	-	-
Morbid Obesity	-	-	4.14 (1.85, 9.30)*	-
Hypertension	1.14 (0.85, 1.54)	-	-	-

[a] Length of stay greater than the 75th percentile
[b] Odds ratio
[c] Confidence interval
[d] Reference

Discussion

Hand fractures treated operatively are done so primarily under general anesthesia, but alternative forms of anesthesia are also utilized. The aim of our study was to assess whether there was any difference in short-term outcomes between general anesthesia and other forms of anesthesia. In agreement with our hypothesis, our data show similar rates of reoperation, minor complications, and major complications by anesthesia technique. However, we also found greater odds for extended length of stay with general anesthesia.

In the field of hand surgery, literature comparing postoperative outcomes by anesthesia technique is limited. One study by Hustedt *et al.* used the NSQIP database to analyze anesthetic choice for a broad range of hand procedures.[21] they found a 59% increased odds of sustaining a postoperative complication with general anesthesia compared to wide awake anesthesia. Their study included over 200 CPT codes with a fair amount of heterogeneity in complexity and anesthesia technique. Our study differs in that the scope is limited to carpal and hand fractures. To further investigate the data, we also included

four additional years of data, excluded records with multiple procedures, grouped wide awake anesthesia together with sedation, and split complications into minor and major complications. These differences may explain the difference between their results and our study.

Another study by Lee *et al.* used the same database to analyze anesthetic choice in distal radius fractures.[22] although they excluded sedation and MAC in their patient population, they found no difference in major complications, minor complications, or unplanned reoperations between general and regional anesthesia. Our findings are in agreement with this study.

A majority of both minor and major complications in our study were related to infections. A systematic review by Cheng *et al.* analyzed infection risk across several surgical specialties. Within orthopedic surgery, they included total knee and hip arthroplasty, tumor, acetabular fracture, and tibial plateau fracture cases in their analysis. For orthopedic patients, they found a 20% increase in mean operative time was associated with an 84% increased likelihood of surgical site infection.[23] In our study, operative time with general anesthesia was, on average, only 5.2minutes (8.7%) longer than non-general forms of anesthesia. This small increase in operative time was likely not long enough to lead to any significant increase in infection rate.

Patients in our study had a 105% increased odds of extended LOS with general anesthesia. This is consistent with existing literature which has shown longer PACU stay, time-to-home readiness, discharge times, and hospital stay with general anesthesia.[9,11,12] This result is likely due to patients with general anesthesia needing inpatient pain control and treatment of the side effects of general anesthesia, such as nausea, vomiting, inability to void, and oversedation.[12]

In addition to the decreased LOS demonstrated in this study, alternatives to general anesthesia provide a range of other advantages. First, wide-awake hand surgery enables the patient to interact with the surgeon, allowing the surgeon to make dynamic adjustments to the procedure prior to skin closure. It reduces preoperative testing, patient travel time and visits, rates of nausea and vomiting, and it allows the patient to care for themselves following their surgery.[24,25] Whether it be wide-awake anesthesia or sedation, alternatives to general anesthesia reduce operative time, length of post-anesthesia care unit stay, unplanned admission, postoperative analgesia requirements, nausea, and vomiting.[9-12] General anesthesia carries greater cost than its alternatives, with local anesthesia being the least costly.[26-29] In addition to its increased operative time, general anesthesia also increases nonsurgical time, which can impact facility efficiency.[30] Lastly, in the setting of distal radius fractures, alternatives to general anesthesia have shown benefits in pain control and functional outcomes as far out as 6 months post-surgery.[31]

This study is limited. Participation in the NSQIP database is costly, and therefore it represents mostly large teaching hospitals with more financial resources.[32] As such, ambulatory surgery centers, where general anesthesia is less likely to be utilized, are likely underrepresented. This study is retrospective in design and therefore lacks randomization. We have no information about indications for anesthesia choice, which is another flaw inherent in retrospective studies. Data entry into the database may be error prone. Outcomes are only tracked for 30 days, so we are unable to assess complications outside of that time frame. Similarly, post-operative functional outcomes from open treatment of hand fractures such as range of motion, return to work times, and continued pain were not able to be evaluated in this study. Lastly, the database lacks information about patient and surgeon satisfaction with the procedures, which could influence the appeal of a particular type of anesthesia. Additional studies in the form of prospective randomized-controlled studies are needed to strengthen our findings.

Conclusion

This study has shown that in the open treatment of hand fractures, short-term complication rates are similar between general anesthesia and other forms of anesthesia, but LOS is greater for general anesthesia. Although the circumstances around each individual case may dictate anesthesia choice, surgeons and patients are sometimes offered a choice. In these situations, local or regional anesthesia with or without sedation may be considered as reasonably safe alternatives to general anesthesia.

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Authors Contribution:

Robert DalCortivo contributed to research design, the acquisition, analysis, and interpretation of data, and drafting the paper.

Benjamin Yarbrough and Dominick Congiusta contributed to research design, interpretation of data, and drafting the paper.

Irfan Ahmed and Michael Vosbikian were responsible for the critical analysis and writing of the manuscript and approval of the submitted and final versions.

All authors have read and approved the final submitted manuscript.

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Robert L. Dalcortivo BBA [1]
Benjamin A. Yarbrough MD [1]
Dominick V. Congiusta MD [1]

Irfan H. Ahmed MD [1]
Michael M. Vosbikian MD [1]

1 Rutgers New Jersey Medical School Department of Orthopaedics, Newark, USA

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