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The Rising Incidence of Operative Treatment of Mid-shaft Clavicle Fractures

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Abstract

Introduction: To evaluate whether the incidence of operative fixation of mid-shaft clavicle fractures has increased.

Methods: State Emergency Department Databases (SEDD) and State Ambulatory Surgery Databases (SASD) were used to identify patients presenting with mid-shaft clavicle fractures from 2005 to 2010 in California and New York State. Patients were identified by International Classification of Disease, Ninth Edition (ICD-9) and Current Procedural Terminology (CPT) codes. Multivariable logistic regression analysis was conducted to illustrate any demographic trends regarding patients undergoing operative fixation.

Results: Operative fixation of mid-shaft clavicle fractures increased by 368% and by 349% in California and New York, respectively, while the number of patients with clavicle fractures presenting to emergency departments remained stable.

Conclusion: The incidence of operative fixation of mid-shaft clavicle fractures has increased substantially at a similar rate in two states over a short period of time.

Keywords: Clavicle fracture; Incidence; Operative treatment; Mid-shaft; Epidemiology: database analysis

Introduction

Clavicle fractures account for 2.6% of all fractures and 40% of fractures around the shoulder girdle [1-3]. The reported incidence of mid-shaft clavicle fractures in adults is 64 per 100,000 with mid-shaft fractures accounting for approximately 69% to 81% of all clavicle fractures [4-6]. Traditional indications for open reduction and internal fixation of mid-shaft clavicle fractures are: skin tenting, open fracture, floating shoulder, or neurovascular compromise [7]. Earlier studies reported that operative treatment of these injuries often led to complications including symptomatic nonunion and infection [2,8]. This led most surgeons to prefer non-operative treatment for the majority of mid-shaft clavicle fractures, despite scarce Level I and II evidence supporting nonoperative treatment [9].

In 2007, the Canadian Orthopaedic Trauma Society provided level I support for expanding the indications for operative fixation of mid-shaft clavicle fractures with 100% displacement or shortening of more than 2 centimeters [10]. Reported nonunion rates of up to 15% for displaced mid-shaft clavicle fractures treated without surgery has been used as support for operative treatment of these injuries [10-13]. Lower nonunion rates and fewer deficits in shoulder motion and strength have been demonstrated with operative treatment of displaced mid-shaft clavicle fractures [10-14]. Additionally, operative fixation may be more cost effective in selected patients because of the increased function achieved with surgical treatment [15]. Despite the reported advantages of operative treatment of displaced mid-shaft clavicle fractures, controversy still exists regarding the optimal treatment of these injuries [1,16,17]. The purpose of this observational study was to determine whether the frequency of operative treatment of all mid-shaft clavicle fractures has changed over a recent span of time. Secondary variables included demographic factors that may have affected the rate of operative fixation.

Materials and Methods

Healthcare Cost and Utilization Project (HCUP) databases maintained and sponsored through the Agency for Healthcare Research and Quality (AHRQ) were utilized for this study. The HCUP is a family of healthcare databases which bring together the data collection efforts of state data organizations, hospital associations, private data organizations, and the federal government to create a national information resource of patient-level healthcare data [18]. New York and California Public Health Law mandate collection of patient data from all licensed emergency departments and licensed ambulatory surgery centers [19,20]. The de-identified records include information relating to the patient's age, sex, race, payer status, primary and secondary diagnoses, and primary and secondary procedures. Information from these databases in California and New York State has been used for numerous studies investigating procedure volume, incidence rates, epidemiologic trends, and surgical outcomes for various orthopaedic procedures [21-29]. The study protocol was reviewed by the institutional review board and was deemed to be exempt from requiring consent.

This study was conducted in two separate parts, A and B, utilizing data from two states – California and New York. In Part A, the HCUP

State Ambulatory Surgery Database (SASD) was used to conduct a search of all licensed ambulatory surgery centers in the states of California and New York. Patients diagnosed with a mid-shaft clavicle fracture who subsequently underwent operative fixation were identified by International Classification of Disease, Ninth Edition (ICD-9) and Current Procedural Terminology (CPT) codes. In Part B, the HCUP State Emergency Department Database (SEDD) was used to conduct a search of all licensed emergency departments in the states of California and New York. Patients presenting to the emergency department with a mid-shaft clavicle fractures were identified. Demographic data including sex, race, and insurance status were collected on patients identified in each database.

The inclusion criteria for Part A included all patients identified with the primary diagnosis of a mid-shaft clavicle fracture by ICD-9 code (810.02, closed fracture of shaft of clavicle) who underwent operative fixation at a licensed ambulatory surgery center (CPT 23515, open treatment of clavicular fracture, with or without internal or external fixation). The SASD are a set of databases that capture patient information on surgeries performed in which patients are admitted and released the same day. Patients in the California SASD were identified by diagnosis and procedure codes. A search of the California SASD was conducted from 2005 through 2010 identifying patients with the diagnosis of a mid-shaft clavicle fracture (ICD-9 810.02) who also underwent operative fixation (CPT 23515). Patients were included in the analysis under the condition that they both had a mid-shaft clavicle fracture (ICD-9 810.02) listed under a diagnosis code with operative fixation (CPT 23515) listed under the associated procedure code. Unlike California, the New York SASD identified patients only on ICD-9 diagnosis code. Each patient can only have one primary diagnosis code followed by several secondary diagnosis codes. A search of the New York SASD was conducted from 2005 through 2010 identifying patients with the primary diagnosis of a mid-shaft clavicle fracture (ICD-9 810.02) having surgery. Only primary ICD-9 diagnosis codes were used in the analysis as they represent the principal orthopaedic diagnosis and associated procedure performed, in contrast with secondary diagnosis codes, which may be unrelated to the procedures performed.

The inclusion criteria for Part B included all patients who presented to licensed emergency departments with a mid-shaft clavicle fracture not requiring admission. The SEDD captures discharge information on all emergency department visits that do not result in an admission. Each patient can only have one primary diagnosis code followed by several secondary diagnosis codes. Patients were identified by ICD-9 diagnosis code, and were included for analysis when a mid-shaft clavicle fracture was listed under any diagnosis code, in order to identify all patients presenting with mid-shaft clavicle fractures, regardless of primary diagnosis. A search of the California SEDD was conducted from 2005 through 2010 for the following ICD-9 code: 810.02 - closed fracture of shaft of clavicle. The same query was performed in the New York SEDD from 2006 through 2010, as information from 2005 was not available.

Statistical methods

For Parts A and B, descriptive statistics were reported on demographic variables and procedure volumes. Continuous measures were summarized with the use of means and standard deviations, whereas categorical measures were summarized with the use of counts and percentages. Using multivariable logistic regression models, we assessed the association of the incidence of operative treatment of mid-shaft clavicle fractures over the years controlling for age, sex, race and payer status. Odds Ratio (OR) and 95% Confidence Intervals (CI) were reported. Significance was defined as $p < 0.05$.

Results

Part A: Ambulatory surgery data

The rate of operative fixation of mid-shaft clavicle fractures increased in both California and New York during the study period (Figure 1).

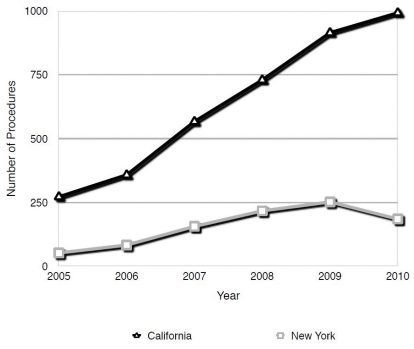

Figure 1: Line graphs showing the trend in absolute number of cases of operative fixation of clavicle fractures by year in California and New York State.

In California, there was a 0.036% absolute increase and a 368% relative increase as a proportion of all ambulatory surgery cases ($p < 0.0001$). In New York, there was a 0.106% absolute increase and a 349% relative increase as a proportion of all ambulatory surgery cases ($p < 0.0001$). With each subsequent year after 2005, a patient was 1.378 times (95% CI 1.351-1.407) more likely to undergo operative fixation of a mid-shaft clavicle fracture ($p < 0.0001$) in California, and a patient was 1.285 times (95% CI 1.233-1.341) more likely to undergo operative fixation of a mid-shaft clavicle fracture ($p < 0.0001$) in New York. When the data was adjusted for age, gender, race and insurance status, a patient was 1.424 times (95% CI 1.383-1.466) more likely to undergo operative fixation in California with each subsequent year ($p < 0.0001$), and a 1.337 times (95% CI 1.280-1.398) more likely to undergo operative fixation in New York with each subsequent year ($p < 0.0001$).

Of the patients undergoing operative fixation in California and New York from 2005 to 2010, males outnumbered females 5.25:1 and 4.25:1, respectively. Female gender was an independent predictor for nonoperative treatment (Table 1).

	California			New York		
Variable	OR	95% CI	P value	OR	95% CI	P value
Gender						
Male	1			1		
Female	0.17	0.15, 0.19	<0.0001	0.2	0.17, 0.23	<0.0001

Insurance						
Private	1			1		
Medicaid	0.29	0.29, 0.35	<0.0001	0.25	0.18, 0.34	<0.0001
Medicare	0.14	0.11, 0.18	<0.0001	0.17	0.10, 0.26	<0.0001
Self-Pay	1.05	0.81, 1.35	0.689	1.25	0.90, 1.69	0.17
Other	0.2	0.12, 0.32	<0.0001	0.96	0.73, 1.24	0.77
Race						
White	1			1		
Hispanic	0.3	0.22, 0.39	<0.0001	0.36	0.25, 0.51	<0.0001
African American	0.32	0.27, 0.37	<0.0001	0.22	0.14, 0.33	<0.0001
Native American	0.17	0.10, 0.27	<0.0001	1.59	0.90, 2.57	0.08
Asian	0.25	0.002, 1.71	0.329	0.57	0.34, 0.90	0.02
Year						
2005	1			1		
2006	1.37	1.08, 1.74	0.008	1.5	1.02, 2.21	0.04
2007	1.98	1.60, 2.47	<0.0001	2.8	2.01, 3.99	<0.0001
2008	2.61	2.12, 3.23	<0.0001	3.29	2.40, 4.64	<0.0001
2009	4.32	3.55, 5.31	<0.0001	3.61	2.64, 5.06	<0.0001
2010	5.38	4.43, 6.59	<0.0001	4.29	2.10, 6.06	<0.0001

Table 1: Multivariate regression analyses of gender, insurance status, race, and year affecting rates of operative treatment of mid-shaft clavicle fractures.

Of the patients undergoing operative fixation in California from 2005 to 2010, 83% carried private insurance, 5.0% were covered under Medicaid, 3.9% were uninsured, and 2.3% were covered by Medicare. Of the patients undergoing operative fixation in New York from 2005 to 2010, 82% carried private insurance, 8.2% were covered under Medicaid, 4.5% were uninsured, and 2.0% were covered by Medicare. On multivariate analysis, Medicaid and Medicare coverage were found to be independent predictors for nonoperative treatment in both states.

Of the patients undergoing operative fixation in California from 2005 to 2010, 85% were White, 11% were Hispanic, 0.8% were African American, 2.4% were Asian or Pacific Islander, and 0.8% were not specified. Of the patients undergoing operative fixation in New York from 2005 to 2010, 86% were White, 3.7% were Hispanic, 2.5% were African American, 1.7% were Asian or Pacific Islander, and 5.6% were not specified. In the final multivariate analysis, African American and Hispanic minorities were independent determinants for nonoperative treatment in both states.

Part B: Emergency department data

Of the 8,560,741 patients presenting to emergency departments in 2005 in California, 5,408 were found to have a mid-shaft clavicle fracture, representing 0.0632% of all encounters. In 2010, there were 6,299 patients identified as having a mid-shaft clavicle fracture, which represented 0.0640% of all encounters that year (Figure 2).

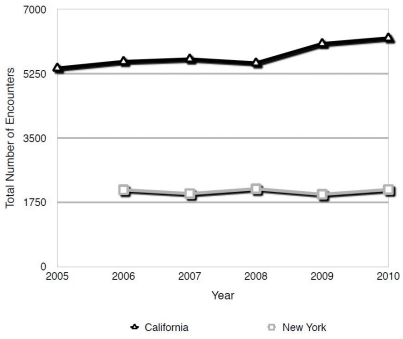

Figure 2: Line graphs showing the trend in absolute number of patients with mid-shaft clavicle fractures presenting to emergency departments by year in California and New York State.

The odds of a patient presenting to the emergency department with a mid-shaft clavicle fracture each subsequent year did not change significantly (OR=0.995, 95% CI 0.989- 1.001; p=0.13). Of the 5,620,109 emergency department patient encounters in 2006 in New York, 2,089 were found to have a mid-shaft clavicle fracture, representing 0.037% of all visits. Of the 6,335,866 patient encounters in 2010, there were 2,098 patients who presented to New York emergency departments with a mid-shaft clavicle fracture, representing 0.033% of all encounters that year. The odds of a patient presenting to the emergency department with a mid-shaft clavicle fracture each subsequent year was 3.8% less likely (OR=0.962, 95% CI 0.949-0.976; p < 0.0001). In the final multivariate analysis, the odds of a patient presenting to the emergency department with a mid-shaft clavicle fracture did not change significantly with each subsequent year (Table 2).

	California			**New York**		
Variable	OR	95% CI	P value	OR	95% CI	P value
Gender						
Male	1			1		
Female	0.28	0.27, 0.29	<0.0001	0.36	0.35, 0.37	<0.0001
Insurance						
Private	1			1		
Medicaid	0.42	0.40, 0.43	<0.0001	0.43	0.40, 0.45	<0.0001

Medicare	0.45	0.42, 0.48	<0.0001	0.7	0.64, 0.76	<0.0001
Self-Pay	0.65	0.63, 0.68	<0.0001	0.69	0.66, 0.73	<0.0001
Other	0.57	0.55, 0.60	<0.0001	0.49	0.45, 0.54	<0.0001
Race						
White	1			1		
Hispanic	0.6	0.59, 0.62	<0.0001	0.23	0.22, 0.25	<0.0001
African American	0.18	0.16, 0.19	<0.0001	0.1	0.09, 0.11	<0.0001
Native American	0.54	0.40, 0.73	<0.0001	0.6	0.50, 0.72	<0.0001
Asian	0.6	0.56, 0.64	<0.0001	0.32	0.28, 0.35	0.02
Year						
2005	1			n/a		
2006	1.04	0.99, 1.08	0.055	1		
2007	1.02	0.98, 1.06	0.34	0.96	0.90, 1.02	0.82
2008	0.97	0.94, 1.01	0.14	0.95	0.89, 1.00	0.78
2009	0.97	0.94, 1.01	0.16	0.82	0.77, 0.87	0.32
2010	1.01	0.98, 1.05	0.5	0.89	0.84, 0.95	0.55

Table 2: Multivariate regression analyses of gender, insurance status, race, and year affecting rates of presentation of patients with mid-shaft clavicle fractures to emergency departments. n/a: Data not available.

Of the patients presenting to emergency departments with mid-shaft clavicle fractures in California and New York, males outnumbered females 3.35:1 and 2.68:1, respectively. In the multivariate analysis, females were significantly less likely to present to emergency departments with mid-shaft clavicle fractures in both states.

Of the patients presenting to emergency departments in California from 2005 to 2010, 57% carried private insurance, 17% were covered under Medicaid, 16% were uninsured, 3.8% were covered by Medicare, and 6.2% were not specified. Of the patients presenting to emergency departments in New York from 2006 to 2010, 73% carried private insurance, 7.5% were covered under Medicaid, 13% were uninsured, 3.9% were covered by Medicare, and 2.6% were not specified. In the multivariate analysis, patients who did not carry private insurance were significantly less likely to present to emergency departments with mid-shaft clavicle fractures in both states.

Of the patients presenting to emergency departments in California from 2005 to 2010, 60% were White, 34% were Hispanic, 2.2% were African American, and 3.8% were Asian or Pacific Islander. Of the patients presenting to emergency departments in New York from 2006 to 2010, 81% were White, 8.3% were Hispanic, 4.6% were African American, 1.7% were Asian or Pacific Islander, and 3.7% were not specified. In the multivariate analysis, all races were significantly less likely than Whites to present to emergency departments with mid-shaft clavicle fractures in both states.

Discussion

Historically, the majority of mid-shaft clavicle fractures have been treated nonoperatively. The current study found that while the incidence of clavicle fractures presenting to emergency departments remained stable, there was a three-fold relative increase in the proportion of operative treatment of clavicle fractures at all ambulatory surgery centers during the period of the study in both regions surveyed. This represents either a dramatic shift towards increased surgical management of mid-shaft clavicle fractures or a shift towards outpatient management of these fractures.

As this study is observational by design, no conclusions can be made with respect to surgeon decision making or the reason for the observed increase in operative management of these fractures. There are, however, several possible explanations for findings of this study. In 2007, the Canadian Orthopaedic Trauma Society provided level I support for expanding the indications for operative fixation. Several other studies in recent years have supported operative fixation of displaced, shortened mid-shaft clavicle fractures [1,10-12,14,30]. Another reason is that several manuscripts published during the years studied demonstrated a nonunion rate of 15% for displaced clavicle fractures treated nonoperatively [1,10,13,17]. This nonunion rate may be unacceptable for some surgeons and patients leading to the preference of operative treatment for this type of fracture. Additionally, with the introduction of clavicle-specific fracture plates over the past 20 years that are intended for use with these injuries, the technical demands of internal fixation may have been reduced [31].

Disproportionately more males underwent operative fixation in both California and New York. It is possible that males sustain higher energy injuries than females, resulting in more severe fracture patterns potentially leading to operative management. The reasons for this observation is unclear as there is no published evidence to suggest one gender benefits more from operative treatment of these injuries than the other. Robinson et al. [17] demonstrated that female gender is a risk factor for nonunion. Alternatively, Leroux et al. [32] found that females have significantly higher rates of reoperation for implant removal than males potentially leading surgeons to preferentially treat some females non-operatively.

Insurance status influenced whether or not patients underwent operative treatment and whether or not patients presented to emergency departments. Patients undergoing operative treatment in this series were largely covered by private insurance. The databases utilized did not allow for us to determine why this occurred, but the reason for this observation is likely multifactorial. There may be a difference in treatment expectations between insured and uninsured patients. The reason may be financially driven as patients who are uninsured or underinsured are more often treated at tertiary care centers or do not have access to the same level of care as insured patients [33,34]. Lastly, patients covered under Medicare were less likely to undergo operative treatment presumably due to the advanced age and increasing co-morbidities of that patient population where operative fixation has not been conclusively shown to improve outcomes.

All races were less likely than Caucasians to present to emergency departments with mid-shaft clavicle fractures, however only African Americans and Hispanics were less likely to undergo operative fixation at ambulatory surgery centers. It is unlikely that this is secondary to surgeon bias as there is data to suggest that surgical decision making is not affected by race [35]. African Americans and Hispanics are, however, the two most impoverished and underinsured races in this country [36]. As previously stated, these patients are preferentially treated at tertiary care centers or do not have access to the same level of care as insured patients [33,34].

The current investigation had several limitations. As this is an observational study, we cannot conclusively determine why the rate of operative fixation has increased or explain the gender and racial disparities of patients undergoing operative treatment. Furthermore, the study was limited to all licensed ambulatory surgery centers, and not the inpatient hospital setting. While it is possible that some patients with mid-shaft clavicle fractures managed operatively were transitioned from inpatient to outpatient surgical setting during the study period, this effect alone is unlikely to account for the three-fold increase in operative treatment of these injuries which occurred in the years examined in the current study. It also remains possible that there were small coding inaccuracies, as inaccuracies in ICD-9 coding in general practice have been previously documented [37]. Due to limitations in CPT and ICD-9 codes, it is unclear whether patients were undergoing operative treatment for acute fractures versus symptomatic nonunions. A final limitation of the current investigation is that one must use caution extrapolating the results from two states to the actual practice patterns of all orthopaedic surgeons on a national level. The case mix of surgeons in New York and California may differ from that of surgeons practicing in other states. Several other studies have used these New York and California to identify national trends in practice patterns as they are the two most populous states in the country representing approximately 19% of the national population [21-29,36].

Conclusions

The present data document a substantial increase in the overall rate of operative fixation of mid-shaft clavicle fractures in the ambulatory setting while the fracture incidence has remained stable. This represents a dramatic change in clinical practice which has occurred in two distinct geographic regions of the United States. This reason for this change is likely multifactorial.

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