Journal of Clinical Orthopaedics and Trauma 13 (2021) 53–56

Contents lists available at ScienceDirect

Journal of Clinical Orthopaedics and Trauma

journal homepage: www.elsevier.com/locate/jcot

Clavicle fractures: Associated trauma and morbidity

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ARTICLE INFO

Article history:
Received 24 April 2020
Received in revised form
13 August 2020
Accepted 25 August 2020
Available online 26 August 2020

Keywords:
Fracture
Clavicle
Epidemiology
Associated trauma
Concomitant injury

ABSTRACT

Background: Clavicle fractures are frequently associated with trauma to regions beyond the immediate zone of injury. In order to provide surgeons with information on injury prevalence to prevent delays in diagnosis and management, we describe the epidemiology of concomitant injuries in patients with clavicle fractures and identify differences between those with open and closed fractures. Methods: The Nationwide Inpatient Sample (NIS) 2001–2013 database was queried for adult patients discharged with a diagnosis of a clavicle fracture using ICD-9 codes. A "common" injury was defined as prevalence ≥4.0% in our study population. We analyzed data for injury locations associated with open vs. closed clavicle fractures with chi square and independent samples t-tests.

Results: A total of 41,1612 patients were included in our study population. The majority of patients had closed clavicle fractures (98.2%). The most common concomitant fracture was that of the rib, followed by the spine. The most common non-vascular, non-nervous injury was a hemo/pneumothorax followed by a lung, bronchus, or diaphragm injury. Fractures of the humerus, rib, scapula, pelvis, tibia or fibula, and facial bones as well as concussion, pneumo/hemothorax, other pulmonary, and splenic injuries were more common in patients with open clavicle fractures. Patients with open clavicle fractures were, on average, 11.8 years younger than those with closed fractures.

Conclusion: There is a significant association between clavicle fractures and concussion, splenic, and thoracic injuries, as well as increased rate of complications with open fractures. Clinicians may use this information to perform risk assessments prevent delays in diagnosis.

1. Introduction

Clavicle fractures represent 44% of all shoulder girdle related fractures and 2.6[19]-3.3%[6] of all orthopedic fractures. This injury is common among most age groups and is a significant source of morbidity in patients of both orthopedic and general surgeons.[18,20] Traffic accidents and accidental falls comprise the most frequent causes of clavicle fractures, followed by sports activities.[6,11,14,18,19] With these types of trauma, it is possible that patients will have other associated injuries that may not be limited to fractures, sprains, or dislocations. When multiple organ systems are involved, the risks of complications and surgeries also increase.

Clavicle fractures have been associated with various injuries and complications, which are separated into skeletal and non-skeletal injuries. In particular, non-skeletal injuries may present with trauma to the lung, pleura, nearby vessels, and brachial plexus.[7] In a retrospective review of a level I trauma center, Gottschalk et al. determined that shoulder girdle injuries are strongly associated with great vessel, thoracic, and head injuries.[9] A study conducted by Nordqvist et al. found more than 75% of polytrauma patients with clavicle fractures had related thoracic injuries.[18] Other literature has shown that thoracic injuries are more prevalent in patients with clavicle fractures than those without.[11] Indeed, others have shown associated injuries involving concussions, cerebral hemorrhage, gastrointestinal/abdominal injury, vascular injury,[22,23] and long bone fractures. Clearly, clavicle fractures have a high prevalence of concomitant injury to regions beyond the immediate zone of injury.

Current epidemiological studies of clavicle fractures and associated injuries have been focused on a specific complication of trauma, like thoracic injury,[8,24,25] or damage to the brachial plexus[12,15] rather than "all complications." As one of the most common causes of clavicle fractures is a fall or accident, other

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https://doi.org/10.1016/j.jcot.2020.08.020
0976-5662/

injuries to the body would likely be found, warranting investigation of their prevalence.

The aim of this study is to describe the epidemiology of concomitant injuries in patients with clavicle fractures and to determine the differences between those experiencing open and closed fractures. Determining these associations would be helpful to surgeons by providing a foundation for injury intervention and prevention, as well as mitigating delays in diagnosis.

2. Materials and methods

2.1. Data set

A retrospective analysis was conducted on the Nationwide Inpatient Sample (NIS) 2001–2013 database. The NIS is a national database created by the Agency for Healthcare Research and Quality and maintained by the Healthcare Cost and Utilization Project (HCUP). It approximates a 20% stratified sample of all discharges from U.S. community hospitals, including specialty hospitals and academic medical centers while excluding rehabilitation centers, surgical centers, and long-term acute care hospitals.[1] The NIS is the largest publicly available all-payer inpatient database in the United States, and its utilization continues to increase due to its accessibility and validated methodology.[21]

Its unique design requires specific methodological considerations that are detailed in the available online tutorials and documentation prior to analysis.[17] In particular, a change in sampling strategy took place beginning with 2012 data, resulting in the need to apply trend weights for all subsequent years. Following these recommendations, data were weighted using HCUP provided trend and discharge weights for their appropriate years, and specific ICD-9 codes were used for data extraction.

The NIS 2001–2013 dataset was queried for adult patients discharged with a diagnosis of a clavicle fracture using *International Classification of Disease, 9*th *revision* (ICD-9) diagnosis codes (810.0x-810.1x). Other injuries were similarly identified by ICD-9 codes.

3. Outcomes and statistical analysis

The data obtained were primarily those of occurrence or non-occurrence of an injury. In order to assess epidemiology of injuries associated with clavicle fractures, the frequency of each injury was extracted. A "common" injury was defined as prevalence greater than the 50th percentile of concomitant injuries, which was ≥4.0% in our study population. We also analyzed our data for injury patterns associated with open vs. closed clavicle fractures, as open injuries often involve higher energy trauma and may be expected to have more severe injuries. Chi square analysis was used for categorical variables and an independent samples *t*-test was used for continuous variables. Significance was defined as $p < 0.05$.

4. Results

A total of 411,612 patients were included in our final study population (Table 1). The majority of patients had closed clavicle fractures (98.2%). The most common concomitant fracture was that of the rib, followed by the spine (Table 2). The most common non-vascular, non-nervous injury was a hemo/pneumothorax followed by a lung, bronchus, or diaphragm injury (Table 3). Concussions were also a common sequela.

Fractures of the humerus, rib, scapula, pelvis, tibia or fibula, and facial bones as well as concussion, pneumo/hemothorax, other pulmonary, and splenic injuries were significantly more common in patients with open clavicle fractures (Table 4). Patients with open clavicle fractures were, on average, 11.8 years younger than those with closed fractures. Sixty-seven percent ($n = 277,550$) of patients were evaluated in the emergency department, and 47.7% ($n = 196,222$) of patients had polytrauma, defined as having more than two injuries. A total of 2.9% ($n = 11,753$) died during hospitalization. There was a significant difference in mortality between patients with closed and open clavicle fractures (2.9% vs. 2.4%, respectively, $p < 0.01$). Additionally, there was a significant difference in overall length of stay between patients with closed and open clavicle fractures (6.2 days vs. 7.4 days, respectively, $p < 0.01$).

Table 1
Descriptive data.

Variable	Frequency (%)
Age	
19–34	55,794 (13.6%)
35–49	110,214 (26.8%)
50–64	60,075 (14.6%)
65–74	76,075 (18.5%)
≥75	63,200 (15.4%)
Female	155,577 (37.8%)
Race	
Caucasian	259,139 (63%)
African American	19,918 (4.8%)
Hispanic	33,135 (8.1%)
Other	18,826 (4.6%)
Emergency Services Used	277,550 (67.4%)
Mortality	11,753 (2.9%)

5. Discussion

Injuries to the clavicle in traumatic conditions represent at least 3% of all orthopedic fractures.[6] Though many of these fractures occur in isolation, there are frequently other associated injuries. The goal of our study was to determine the epidemiology of concomitant injuries in patients who have clavicle fractures. This may be used to guide assessment of such patients in primary and secondary traumatic surveys and explain injury patterns in cases of polytrauma. Our data show that the most predominant concomitant fracture was that of the rib, followed by the spine.

Most clavicle injuries involve trauma due to vehicle crashes, falls, or sports accidents in younger patients.[5,14] Our study shows that younger patients have a higher incidence of open fractures compared to those with closed fractures by nearly a decade. This may reflect the predilection of younger patients to be involved in more high energy trauma compared to the elderly population.[4,13] As younger people comprise a significant portion of patients with clavicle fractures, public health initiatives may be directed to decrease the incidence of high-risk behaviors or increasing their safety, though this was not assessed in our study. Indeed, patients and physicians alike recognize a need for effective public health efforts through decreasing alcohol consumption, smoking, and sports injury prevention.[5,16]

Current epidemiological studies of clavicle fractures and associated injuries are focused on a specific complication of trauma, with thoracic injury being the most common.[2,8,24,25] The clavicle is described as the gateway to the thorax.[3] Our study is consistent with others describing the majority of concomitant injuries associated with clavicle fractures are those within the thorax, as 23.5% of injuries were a hemo/pneumothorax and 17.7% involved a lung, bronchus, or diaphragm injury. Open clavicle fractures are a relatively rare injury, but their presence has been associated with serious concomitant injury.[10] We show fractures of the humerus, rib, scapula, pelvis, tibia or fibula, and facial bones as well as concussion, pneumo/hemothorax, other pulmonary, and splenic

Table 2
Fractures, dislocations, and sprains in patients with clavicle fractures.

Injury	Frequency (No Emergency Services Used, Emergency Services Used)	Percent
Fractures		
Closed Clavicle	404,193 (108,927, 272,509)	98.2
Open Clavicle	7419 (1908, 5079)	1.8
Forearm Fracture	22,871 (5560, 16,043)	5.6
Humerus Fracture	16,492 (4407, 11,191)	4.0
Spine Fracture	63,063 (16,635, 43,710)	15.3
Sacrum or Coccyx Fracture	170 (42, 109)	<1%
Rib Fracture	170,143 (42,029, 119,236)	41.3
Scapula Fracture	46,051 (11,703, 31,976)	11.2
Trunk Fracture	281 (161, 115)	<1%
Pelvis Fracture	38,490 (9815, 26,268)	9.4
Femur Fracture	25,009 (5789, 17,727)	6.1
Patella Fracture	3049 (746, 2163)	<1%
Tibia or Fibula Fracture	20,034 (4976, 13,737)	4.9
Carpal Fracture	2506 (737, 1611)	<1%
Metacarpal Fracture	6793 (1648, 4675)	1.7
Phalanx Fracture	5288 (1404, 3541)	1.3
Multiple or Ill-Defined Fracture	780 (261, 465)	<1%
Foot or Ankle Fracture	8401 (2026, 5875)	2.0
Skull Fracture	36,344 (9520, 24,861)	8.8
Facial Fracture	28,535 (7298, 19,750)	6.9
Skull or Face With Other Fracture	4001 (1121, 2585)	1.0
Larynx or Trachea Fracture	184 (58, 117)	<1%

Table 3
Non-vascular, non-nervous soft tissue injuries.

Injury	Frequency (No Emergency Services Used, Emergency Services Used)	Percent
Concussion	34,352 (8293, 23,885)	8.3
Brain Laceration or Contusion	14,276 (3559, 9667)	3.5
Subarachnoid Hemorrhage	14,464 (3749, 10,107)	3.5
Subdural Hemorrhage	11,756 (3037, 8232)	2.9
Epidural Hemorrhage	1145 (307, 743)	<1%
Unspecified Brain Injury	11,406 (3356, 7473)	2.8
Pneumo/Hemothorax	96,567 (22,922, 68,397)	23.5
Heart Injury (laceration, contusion)	2094 (504, 1495)	<1%
Lung, Bronchi, or Diaphragm Injury	72,724 (17,847, 51,208)	17.7
Esophagus Injury	47 (9, 38)	<1%
Stomach Injury	156 (57, 94)	<1%
Intestine Injury	1643 (374, 1108)	<1%
Pancreas Injury	611 (136, 427)	<1%
Other Gastrointestinal Injury	1276 (349, 836)	<1%
Liver Injury	13,181 (3100, 9223)	3.2
Spleen Injury	17,442 (4189, 12,263)	4.2
Kidney Injury	5831 (1389, 4162)	1.4
Genitourinary Tract Injury	2105 (505, 1441)	<1%
Other Pelvic Organ Injury	404 (83, 308)	<1%
Other Abdominal Organ Injury	7447 (1875, 5185)	1.8

injuries to be significantly more common in patients with open clavicle fractures. We hypothesize that this may be due to more severe trauma at the time of injury compared to those with closed fractures.[10] Overall, concomitant injuries of the head and thorax are more common in clavicle fractures compared to patients with other types of shoulder girdle injury.[3]

These data may be used to inform surgeons on the prevalence of this level of injury and examine risk of soft-tissue injury that occurs along with clavicle fractures. They can serve as a foundation for potential risk stratification for trauma patients with clavicle fractures and prevent delays in diagnosis of concomitant injury.

There are several important limitations to our study. Due to the nature of the NIS database, there is a notable lack of detailed, granular information. Important information about polytrauma, such as the mechanism, extent of injury, and environmental circumstances were not investigated in this study. These variables may be useful in determining the clinical significance and extent of treatment indicated for these injuries. There is a lack of information about the mechanism of injuries leading to the clavicle fractures, therefore it is difficult to apply any prevention techniques in particular. Additionally, the NIS reports inpatient data without long-discharge information or term follow up. Therefore, conditions occurring as outpatients or across multiple healthcare settings may be underrepresented. Because only inpatient samples were used for interpretation, which are likely to be associated with significant polytrauma, there could be an overestimation of the true incidence of associated pathology for clavicle fractures. The conclusions from this data must therefore be made cautiously with the potential overestimation in mind. However, the purpose of this study was not to evaluate outcomes, but to report the epidemiology of injuries associated with clavicle fractures. Our findings corroborate and add new information to the pattern of trauma surrounding these injuries.

Table 4
Analysis of selected associated injuries.

	Frequency (% Clavicle Fractures)		P value
	Closed (n = 404,193)	Open (n = 7419)	
Demographics			
Age (mean years)	49.8	38.1	<0.001*
Female	154,076 (38.3%)	1501 (20.3%)	<0.001*
African American (vs. Caucasian)	18,738 (4.6%)	1179 (15.9%)	<0.001*
Hispanic (vs. Caucasian)	32,282 (8.0%)	854 (11.5%)	<0.001*
Length of Stay (mean, days)	6.2	7.4	<0.001*
Associated Injury			
Fracture			
Forearm	22,446 (5.6%)	424 (5.7%)	0.549
Humerus	15,954 (3.9%)	538 (7.3%)	<0.001*
Spine	61,961 (15.3%)	1103 (14.9%)	0.271
Rib	167,712 (41.5%)	2431 (32.8%)	<0.001*
Scapula	44,682 (11.1%)	1370 (18.5%)	<0.001*
Pelvis	38,152 (9.4%)	338 (4.6%)	<0.001*
Tibia or fibula	19,740 (4.9%)	294 (4.0%)	<0.001*
Skull	35,701 (8.8%)	643 (8.7%)	0.615
Facial bones	27,869 (6.9%)	666 (9.0%)	<0.001*
Concussion	33,904 (8.4%)	447 (6.0%)	<0.001*
Pneumo/hemothorax	94,483 (23.4%)	2085 (28.1%)	<0.001*
Other Pulmonary (Lung, Bronchi, or Diaphragm) Injury	70,889 (17.5%)	1835 (24.7%)	<0.001*
Spleen	17,212 (4.3%)	231 (3.1%)	<0.001*
Mortality	11,577 (2.9%)	176 (2.4%)	0.012

6. Conclusion

Acknowledging the associations of concomitant injury in patients with clavicle fractures can better inform surgeons about the distribution of disease and forms the basis for disease prevention. It may also provide evidence for the development and evaluation of public health policy and clinical interventions. Our data show a significant association of clavicle fractures with concussion, splenic injury, and thoracic injury. Clinicians may use this information to perform risk assessments and increase awareness of common injury patterns. Future studies may investigate the risk of complications in patients of polytrauma and evaluate the effectiveness of public health interventions and delays in diagnosis in this population.

Author contributions

Kamil Amer, Dominick Congiusta, Pooja Suri, Katie Otero, and Arsalaan Choudhry contributed to research design, the acquisition, analysis, and interpretation of data, and drafting the paper. Mark Adams were responsible for the critical revision of the manuscript and approval of the submitted and final versions. All authors have read and approved the final submitted manuscript.

Declaration of competing interest

None.

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