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Research Articles

Demographic Characteristics and Factors Associated with Acute Scaphoid Fractures: An Analysis of 903 Patients

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Objectives

A comprehensive understanding of the epidemiology of scaphoid fractures is crucial to aid in diagnosing and treating patients with suspected injuries. The study aims to assess demographic characteristics and factors associated with acute scaphoid fractures in adults.

Methods

A retrospective review identified all patients with acute scaphoid fractures over four years at a single institution. Data collected included baseline demographics (age, biological sex, race, and ethnicity), body mass index, tobacco and alcohol use, pertinent medical history, and treatment modality. Laterality, location, and displacement of the fracture were confirmed on radiographic analysis.

Results

A total of 903 scaphoid fractures were included. The majority of fractures occurred in males (n=570, 63%) and were in the left hand (54%), unilateral (99%), nondisplaced (71%), and treated definitively with nonoperative management (71%). Nearly two-thirds (66%) of fractures occurred along the scaphoid waist, followed by the distal third of the scaphoid (25%). Proximal third fractures accounted for the smallest proportion of scaphoid fractures (8.6%) but had the highest displacement and surgical intervention rates compared to waist and distal third fractures. Younger age, male sex, fractures of the proximal third, and displaced fractures had higher odds of being treated surgically.

Conclusion

The scaphoid is one of the most frequently fractured carpal bones. Young adult males may be at an increased risk for injury. Patients with displaced fractures and those involving the proximal third require surgical intervention at higher rates.

INTRODUCTION

The scaphoid is one of the most frequently fractured bones of the carpus, with an estimated incidence of 1.47 fractures per 100,000 persons within the United States.[1] Scaphoid fractures are at risk for avascular necrosis, malunion, and nonunion compared to other carpal fractures due to their tenuous blood supply.[2,3] Delayed diagnosis and ineffective management can increase the risk of developing these complications.[2,3] Often, acute scaphoid fractures are challenging to diagnose as initial radiographic analysis may be inef-

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fective, and assessments during physical examinations have variable levels of sensitivity and specificity.[4,5]

To prevent improper management and to identify at-risk patients, it is crucial to have a clear understanding of the epidemiology and factors associated with acute scaphoid fractures. Previous studies consistently cite a higher incidence of scaphoid fractures amongst male sex and younger age.[1] However, limited studies assess independent factors associated with surgical utilization. Additionally, previous studies are outdated by nearly a decade or analyze patient-specific populations such as pediatric and military patients.[6-8] Populations incurring scaphoid fractures may have changed with time, especially as more women engage in contact sports and with increased active lifestyles later in life.[1,9]

Therefore, an up-to-date assessment of the epidemiology of acute scaphoid fractures across the adult population is useful to help diagnose and treat patients with scaphoid fractures. This study aims to characterize the demographic characteristics of patients with scaphoid fractures and identify independent factors associated with surgical intervention.

METHODS

Following Institutional Review Board approval and waiver of informed consent, all patients with scaphoid fractures who presented for treatment between January 2016 and December 2020 to one of 16 hand surgery fellowship-trained orthopaedic surgeons were retrospectively identified using International Classification of Diseases, 10th Revision (ICD-10) codes (Supplement 1). Patients over 18 years of age with either unilateral or bilateral acute scaphoid fractures were included in the study. Patients with subacute or chronic scaphoid fractures, defined as > 6 weeks in chronicity, and open fractures were excluded.

The electronic medical records for all patients meeting inclusion criteria were retrospectively reviewed. Baseline demographics (age, biological sex, race, and ethnicity), body mass index (BMI), tobacco use, alcohol use, patient-reported past medical history, and treatment modality were collected by patient chart review. ICD-10 codes were used to classify fractures based on location. For patients who underwent surgery, radiographs were reviewed to confirm treatment modality. Treatment modality was defined as surgical if surgery was used at any point in treatment and nonoperative if surgical intervention did not occur.

Statistical analyses were performed using Mann-Whitney U tests and Kruskal-Wallis tests for continuous data. Median values were obtained along with interquartile ranges for this data. Categorical data was analyzed using Chi-Square tests. Multivariate regression analyses were performed with dependent variables of displacement and surgical versus nonoperative management using odds ratios (OR) with 95% confidence intervals (CI). Statistical significance was defined as $P<0.05$.

RESULTS

A total of 903 scaphoid fractures were included in this study.

DEMOGRAPHICS

Scaphoid fractures involving the left hand were more frequent than those of the right hand (54% vs. 45%).

Most were non-displaced (71%), unilateral (99%), and treated with nonoperative management (71%). Demographic analysis revealed a higher proportion of scaphoid fractures amongst non-Hispanic Caucasian males (n=700,78%). Scaphoid fractures frequently occurred in younger adults with an average age of 35 years (IQR: 32-38) and in patients with an average BMI of 26 kg/m^2 (IQR: 25-26). Approximately one-third (35%) of patients with scaphoid fractures were either former or current tobacco users, and 62% of patients reported some form of alcohol use. The most frequent patient-reported medical comorbidities included a prior history of fracture (n=660, 73%), hypertension (n=270, 18%), hyperlipidemia (n=160, 16%), asthma (n=140, 15%), and anxiety (n=130, 15%).

FRACTURE LOCATION

The majority of fractures occurred along the waist (n=600, 66%), followed by the distal third (n=230, 25%) and the proximal third (n=80, 8.6%) of the scaphoid. These groups significantly differed concerning the rates of fracture displacement, with the proximal third cohort having the highest rate of displacement (55%), followed by the waist (29%) and distal third (19%) ($P<0.001$). Surgical intervention was also significantly higher amongst proximal third scaphoid fractures (62%), with waist (34%) and distal third (4.9%) fractures more commonly being managed nonoperatively ($P<0.001$). Male sex was associated with a higher incidence of scaphoid fractures overall, irrespective of fracture location. Nevertheless, distal third (44%) and waist (37%) fractures accounted for the highest incidence of scaphoid fractures amongst females ($P=0.008$). Patients with these fractures were also older than those with proximal third scaphoid fractures (distal third: 45 yrs, waist: 35 yrs, proximal third: 24 yrs; $P<0.001$). Fracture location was not significantly associated with race and ethnicity. Tobacco and alcohol use also did not significantly differ regarding fracture location ($P=0.66$, $P=0.88$, respectively). When analyzing comorbidities, patients with self-reported thyroid disease (n=31, 14%), type II diabetes mellitus (n=150, 6.7%), history of Staphylococcus infections (n=140, 6.1%), and malignant hyperthermia (3, 1.5%) had a higher incidence of distal third scaphoid fractures ($P=0.036$, $P=0.017$, $P=0.010$, $P=0.035$, respectively).

FRACTURE DISPLACEMENT

Multivariate analysis demonstrated that fracture location was independently associated with fracture displacement.

Compared to proximal third fractures, waist (OR: 0.33, CI: 0.20-0.54) and distal third (OR: 0.19, CI: 0.11-0.33)

Table 1. Demographic Characteristics of Patients with Acute Scaphoid Fractures

Total Patients (N=903)	
Age (median [interquartile range])	35 [32;38]
BMI (median [interquartile range])	26 [25;26]
Sex (%)	
Male	63
Female	37
Laterality (%)	
Right	45
Left	54
Bilateral	1
Displacement (%)	
Yes	29
No	71
Treatment (%)	
Surgery	29
Non Operative	71

Table 2. Multivariate Analysis Assessing Independent Factors Associated with Fracture Displacement

	Displaced	**Non-Displaced**	**OR**	**P-Value**
	N = 259	N = 644		
Left Laterality (% [CI])	47 [40;53]	46 [42;50]	0.96 [0.72;1.3]	0.829
Bilateral Fractures (% [CI])	0.77 [0.09;2.8]	1.4 [0.64;2.6]	0.58 [0.08;2.3]	0.738
Fracture Location (% [CI])				**<0.001**
Proximal Third	17 [12;22]	5.4 [3.8;7.5]	Ref.	
Waist	67 [61;73]	66 [62;70]	0.33[0.20,0.54]	
Distal Third	17 [12;22]	29 [25;32]	0.19 [0.11,0.33]	
Male Sex (% [CI])	73 [68;79]	59 [55;62]	2.0 [1.4,2.7]	**<0.001**
Age at Injury (years) (% [CI])	30 [28;33]	38 [35;43]	1.0 [1.0;1.1]	**0.011**
Race (% [CI])				0.106
White	74 [68;79]	80 [76;83]	Ref.	
Black	9.1 [5.8;13]	8.3 [6.3;11]	1.2[0.7,2.0]	
Other	17 [13;23]	12 [9.7;15]	1.6[1.0,2.3]	
Hispanic Ethnicity (% [CI])	2.3 [0.85;5.0]	1.6 [0.75;2.8]	1.5[0.50,4.2]	0.414
BMI (kg/m^2) (% [CI])	26 [25;26]	26 [25;26]	1.0 [1.0;1.1]	0.529
Tobacco Use (% [CI])				0.348
No	61 [54;68]	67 [63;71]	Ref.	
Current	24 [18;30]	20 [17;24]	1.3[0.86,1.9]	
Former	15 [11;21]	13 [10;16]	1.3[0.79,2.0]	

CI: Confidence Interval, OR: Odds Ratio, BMI: Body Mass Index

scaphoid fractures were less likely to be displaced (*P<0.001*). Displaced fractures also had a higher odds of undergoing surgical intervention (OR: 3.6, CI: 2.6-4.9, *P<0.001*). Race, ethnicity, BMI, tobacco use, and alcohol use were not independently associated with fracture displacement. Among the patient-reported medical comorbidities, only thyroid disease was independently associated with displacement, occurring in 12% of nondisplaced fractures (OR: 0.47, CI: 0.85-0.24, *P=0.019*).

Table 3. Multivariate Analysis Assessing Independent Factors Associated with Treatment Modality

	Operative Treatment	Nonoperative Treatment	OR [95% CI]	P-Value
	N = 263	N = 640		
Left Laterality (% [CI])	51 [45;56]	44 [40;48]	0.73 [0.55;0.98]	**0.041**
Bilateral Fractures (% [CI])	1.5 [0.42;3.9]	1.1 [0.44;2.2]	1.4 [0.36;4.9]	0.739
Fracture Location (% [CI])				**<0.001**
Proximal Third	18 [14;24]	4.7 [3.2;6.6]	Ref.	
Waist	78 [72;83]	62 [58;65]	0.32 [0.20,0.53]	
Distal Third	4.2 [2.1;7.4	34 [30;38]	0.032[0.015,0.068]	
Displaced Fractures (% [CI])	48 [42;55]	21 [18;24]	3.6 [2.6;4.9]	**<0.001**
Male Sex (% [CI])	75 [70;80]	58 [54;62]	2.2[1.6,3.1]	**<0.001**
Age at Injury (years) (% [CI])	28 [26;30]	42 [38;47]	1.1[0.96,0.98]	**<0.001**
Race (% [CI])				**0.013**
White	72 [66;77]	80 [77;83]	Ref.	
Black	9.8 [6.5;14]	8.0 [6.0;10]	1.4[0.82,2.3]	
Other	19 [14;24]	12 [9.3;14]	1.8[1.2,2.6]	
Hispanic Ethnicity (% [CI])	3.4 [1.6;6.4]	1.1 [0.44;2.2]	3.2 [1.2,9.1]	**0.024**
BMI (kg/m^2) (% [CI])	26 [25;26]	26 [25;26]	0.99 [0.97;1.0]	0.947
Tobacco Use (% [CI])				0.622
No	66 [59;72]	65 [60;69]	Ref.	
Current	22 [17;29]	21 [17;25]	1.1 [0.71,1.6]	
Former	12 [7.9;17]	15 [12;18]	0.81 [0.49,1.3]	

CI: Confidence Interval, OR: Odds Ratio

FRACTURE MANAGEMENT

Multivariate regression analysis also revealed that fracture location was independently associated with treatment modality.

When compared to proximal third fractures, both waist (OR: 0.32, CI: 0.20-0.53) and distal third (OR: 0.03, CI: 0.02-0.03) fractures were less likely to be treated operatively (*P<0.001*). Scaphoid fractures occurring bilaterally were not associated with the use of surgical management. However, unilateral scaphoid fractures involving the right hand did have a higher odds of being treated surgically (OR: 1.4, CI: 1.0-1.8, *P=0.041*). Males had higher odds of undergoing surgical management (OR: 2.2, CI: 1.6-3.1, *P<0.001*). Conversely, increasing age was associated with a higher likelihood of being treated nonoperatively (OR: 1.1, CI: 0.96-0.98, *P<0.001*). Patients who identified their race as black (OR: 1.4, CI: 0.82-2.3) or other (OR: 1.8, CI: 1.2-2.6) and those of Hispanic ethnicity (OR: 3.2, CI: 1.2-9.1) were more likely to be treated surgically compared to whites and non-Hispanics, respectively (*P=0.013*, *P=0.024*, respectively). The following medical comorbidities had a significantly lower odds of surgical intervention: anemia (OR: 0.10, CI: 0.02-0.36; *P<0.001),* bleeding abnormalities (OR: 0.12 CI: 0.01-0.64, *P=0.023*), osteoarthritis (OR: 0.39, CI: 0.19-0.73, *P=0.005*), heart disease (OR: 0.30, CI: 0.09-0.80, *P=0.029*), hypertension (OR: 0.56, CI: 0.36-0.86, *P=0.010*), cardiac dysrhythmia (OR: 0.33, CI: 0.14-0.71 *P=0.008*), hyperlipidemia (OR: 0.62, CI: 0.39-0.96, *P=0.045*), rheumatoid arthritis (OR: 0.38, CI: 0.15-0.88, *P=0.040*), scoliosis (OR: 0.36, CI: 0.12-0.89, *P=0.046*), and complications with anesthesia (OR: 0.27, CI: 0.08-0.71, *P=0.014*).

DISCUSSION

Studies investigating the epidemiology and demographic factors associated with scaphoid fractures are inconsistent or frequently isolated to populations outside the United States.[10,11] Nevertheless, a comprehensive understanding of factors associated with acute scaphoid fractures is useful in diagnosing and treating patients presenting with suspected injuries. This study demonstrates that scaphoid fractures occur predominantly along the scaphoid waist and in young adult males. Younger age, male sex, proximal third fractures, and fracture displacement were independently associated with surgical intervention.

Almost two-thirds of scaphoid fractures within this study occurred at the waist, similar to previous studies.[6, 12] Proximal third scaphoid fractures constituted the smallest proportion of scaphoid fractures but had the highest rates of displacement and surgical intervention. Fractures involving the proximal pole pose a higher risk of avascular necrosis and nonunion due to its retrograde blood supply.[3] They also tend to have a prolonged healing period, as they rely mainly on the intraosseous blood supply of the scaphoid.[13] Consequently, these are often treated surgically, especially when displaced.[13,14]

Scaphoid fractures occurred predominantly in males, accounting for 63% of scaphoid fractures within this study. This is less than previous studies in which 66% to 70% of scaphoid fractures were observed in males.[1,10,12] A relative increase in females within this study may be attributed to greater engagement in organized sports.[1,15] In this study, scaphoid fractures occurred in young adults with an average age of 35 years. This supports the notion that scaphoid fractures occur in the younger population, which is likely due to an increased risk of wrist trauma through falls and contact sports.[1,12] However, prior studies cite an even younger cohort of men, typically less than 29 years of age, that have the highest incidence of scaphoid fractures.[1,6] Children and skeletally immature individuals were excluded from this study, which may have contributed to its higher average age.

Younger age and male sex were also significant predictors of surgical intervention. This coincides with Zhang *et al.,* who found that males had higher odds of surgical treatment.[16] However, their analysis was limited to nondisplaced and minimally displaced scaphoid waist fractures. Increased rates of surgical intervention within our study may not be inherent to the male sex. Instead, fracture displacement may have been a contributing factor. Fracture displacement was higher amongst males and younger patients and associated with higher surgical utilization rates. This is not unexpected, considering that males tend to have higher severity and season-ending injuries than females.[15]

The difference in incidence of scaphoid fractures in regards to race and ethnicity has been previously noted in the military population, with whites having higher rates of scaphoid fractures compared to blacks.[7] In this study, nearly all patients identified as non-Hispanics, and over three-fourths of patients with scaphoid fractures were white. However, blacks, non-whites, and Hispanics were more likely to undergo surgical intervention compared to white and Hispanic patients. The interplay between race/ethnicity and scaphoid fractures is likely multifactorial and is relatively unknown. Therefore, comparisons must be made outside the domain of scaphoid fractures. Previous studies demonstrate that black patients have lower odds of undergoing surgical intervention for distal radius fractures.[17] And within the lower extremity, both black and Hispanic patients have lower rates of utilization of total hip arthroplasty.[18] This is in contrast to our study, which demonstrated higher odds of resource utilization involving surgical intervention amongst blacks and Hispanics.

Patient-reported medical comorbidities did not contribute to higher rates of surgical intervention. Instead, they were often associated with higher odds of nonoperative management. Of those who did report medical comorbidities, scaphoid fractures were most frequent amongst patients with prior fractures, cardiac disease, and pulmonary disease. Patients with thyroid disease had a higher incidence of distal third scaphoid fractures and were more likely to have nondisplaced fractures. Pre-injury factors associated with acute scaphoid fractures are relatively unknown. Most studies assess smoking and failure rates in the setting of scaphoid nonunions.[19,20]

This study has several strengths and weaknesses. It provides an up-to-date comprehensive analysis of demographic characteristics in patients who sustained acute scaphoid fractures over 4 years in a large patient population. It also assesses independent factors associated with fracture displacement and surgical intervention, which can aid orthopaedic surgeons in their management. However, the study has several limitations, mainly inherent to its retrospective design. First, given that we used ICD-10 codes to identify patients, some fractures may have been miscoded and thus may have occurred in the opposite extremity and/or different locations along the scaphoid axis. We sought to limit this by confirming fracture laterality, displacement, and location on radiographs. Second, we captured all medical comorbidities using a chart review. At our institution, patients are prompted about changes in their past medical history at every evaluation. However, it is possible that not all medical histories were documented for each patient. Third, we did not report patient-reported outcomes or complications, as this is beyond the scope of our study. Lastly, we only included skeletally mature individuals within our analysis. Therefore, our results may not be generalizable to children and adolescents.

CONCLUSION

The current study collaborated on the supporting notation that scaphoid fractures are most prevalent in young adult men, with a predilection for the waist of the scaphoid bone. Independent factors associated with surgical intervention include fracture displacement and fractures of the proximal third located in the proximal third, despite most fractures being managed non-operatively. These findings offer valuable information about the epidemiology of scaphoid fractures, shedding further light on their occurrence and identifying individuals at high risk.

DECLARATION OF CONFLICT OF INTEREST

the authors have NO relevant disclosures to report

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DECLARATION OF ETHICAL APPROVAL FOR STUDY

IRB #14D.432 was obtained prior to study initiation.

DECLARATION OF INFORMED CONSENT

There is no information (names, initials, hospital identification numbers, or photographs) in the submitted manuscript that can be used to identify patients or participants.

ICD-10 Codes Included

S62.011A	**Displaced fracture of distal pole of navicular [scaphoid] bone of right wrist, initial encounter for closed fracture**
S62.012A	Displaced fracture of distal pole of navicular [scaphoid] bone of left wrist, initial encounter for closed fracture
S62.014A	Nondisplaced fracture of distal pole of navicular [scaphoid] bone of right wrist, initial encounter for closed fracture
S62.015A	Nondisplaced fracture of distal pole of navicular [scaphoid] bone of left wrist, initial encounter for closed fracture
S62.021A	Displaced fracture of middle third of navicular [scaphoid] bone of right wrist, initial encounter for closed fracture
S62.022A	Displaced fracture of middle third of navicular [scaphoid] bone of left wrist, initial encounter for closed fracture
S62.024A	Nondisplaced fracture of middle third of navicular [scaphoid] bone of right wrist, initial encounter for closed fracture
S62.025A	Nondisplaced fracture of middle third of navicular [scaphoid] bone of left wrist, initial encounter for closed fracture
S62.031A	Displaced fracture of proximal third of navicular [scaphoid] bone of right wrist, initial encounter for closed fracture
S62.032A	Displaced fracture of proximal third of navicular [scaphoid] bone of left wrist, initial encounter for closed fracture
S62.034A	Nondisplaced fracture of proximal third of navicular [scaphoid] bone of right wrist, initial encounter for closed fracture
S62.035A	Nondisplaced fracture of proximal third of navicular [scaphoid] bone of left wrist, initial encounter for closed fracture

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SUPPLEMENTAL

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