Incidence Estimates and Demographics of Scaphoid Fracture
in the United States Population

A Thesis submitted to the
University of Arizona College of Medicine - Phoenix
in partial fulfillment of the requirements for the degree of
Doctor of Medicine

Dane Carlisle Van Tassel
Class of 2012

Mentor: Jennifer Moriatis Wolf, MD
Acknowledgments

I would like to thank Dr. Jennifer Wolf for all of her help and encouragement throughout this project and my career in medicine. Additional thanks to Dr. Brett Owens for his expert contributions to the paper and Lauren Pointer, PhD, Colorado REAP to Improve Care Coordination for Veterans, Denver, for her help with statistical analysis.
Abstract

Purpose: The epidemiology of scaphoid fracture occurrence is based mostly on retrospective analyses of small population centers. Analysis of a large injury database was performed with the hypothesis that previous studies have underestimated the incidence of scaphoid fracture.

Methods: The National Electronic Injury Surveillance System (NEISS) is a probability sample of injuries in the United States presenting to emergency rooms. The NEISS model was queried for injuries classified as wrist fractures, and narrative data evaluated specifically for scaphoid fracture, over the 5-year period 2002-2006. Descriptive characteristics were analyzed with respect to patient demographics, location, mechanism, and sports/recreation participation.

Results: A total of 507 injuries coded as fractures of the scaphoid comprised the dataset from 2002-2006, with weighted sampling estimating 21,481 scaphoid fractures nationwide during this time period. This results in an incidence rate for the US population of 1.47 fractures per 100,000 person-years (95% confidence intervals (CI), 1.31 to 1.63).
Conclusions: The NEISS dataset utilized in this study represents the largest single sample population for scaphoid fracture epidemiology in the medical literature. The estimated incidence of scaphoid fracture is higher in the U.S. than those reported for other countries.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Figures and Tables</td>
<td>Pg. 6</td>
</tr>
<tr>
<td>Introduction</td>
<td>Pg. 7</td>
</tr>
<tr>
<td>Materials and Methods</td>
<td>Pg. 11</td>
</tr>
<tr>
<td>Results</td>
<td>Pg. 13</td>
</tr>
<tr>
<td>Discussion</td>
<td>Pg. 20</td>
</tr>
<tr>
<td>Limitations and Possible Future Directions</td>
<td>Pg. 23</td>
</tr>
<tr>
<td>Conclusions</td>
<td>Pg. 25</td>
</tr>
<tr>
<td>References</td>
<td>Pg. 26</td>
</tr>
</tbody>
</table>
Figures and Tables

Figure 1: Scaphoid fracture incidence by gender.

Figure 2: Scaphoid fracture incidence by age decade.

Figure 3: Racial differences in scaphoid fractures.

Figure 4: Scaphoid fractures by sport.
Introduction

Scaphoid injury is one of the most commonly diagnosed carpal fractures; however, the incidence of such fractures has not been examined on a large scale.[1] There is extensive literature addressing the epidemiology of distal radius fractures in the literature including Brogren et al and Court-Brown et al who both noted an incidence rate of 260/100,000 and 1292/100,000 for distal radius fractures in a Swedish region and British region respectively[2, 3]. Thompson et al noted an incidence of 100 fractures per 100,000 persons in premenopausal women[4]. With respect to the diagnosis and treatment of scaphoid fracture; however, there are limited data about the epidemiology of scaphoid fracture. Prior incidence studies have been limited to small defined populations, or populations that do not accurately represent the general population demographic. One retrospective study from Odense, Denmark indicated an incidence of 2.6/10,000 people with a population size of 1,225,000 person years,[1] while other literature describes a scaphoid fracture incidence of 3.9/10,000 person-years in males in Reykjavik, Iceland.[5] A recent study showed an incidence of 1.21/1,000 person-years in a large
military population.\cite{6} Our calculated incidence is comparable to the lower values seen in the literature.

Many scaphoid fractures initially present with tenderness in the anatomic snuffbox but negative radiographs, with a high clinical suspicion for scaphoid injury\cite{7}. Conventional radiographs are initially negative in 2-25\% of these fractures on first presentation.\cite{8} Additionally, some fractures may not be radiologically visible until several weeks after the original injury.\cite{9} Because the consequences of missed scaphoid injury can include nonunion and pan-carpal wrist arthritis, the initial treatment of suspected scaphoid fracture in the emergency room setting is initial stabilization, with planned later reevaluation of suspected fractures. Because of the risk in missed fractures, wrist injuries with scaphoid snuffbox tenderness presenting for acute care are treated as if they are true scaphoid injuries.

The NEISS (National Electronic Injury Surveillance System) database is a complex probability sample of all injuries presenting to U.S. emergency rooms. The NEISS sample includes 100 hospitals which were originally designated by stratified, randomized sampling of all United States hospitals with emergency rooms. Stratification is based on both geographic location and emergency room volume data.
Data are gathered on all injuries presenting to the 100 hospital probability sample, with each injury assigned a weighted estimate. In order to create sample weights, participating hospitals are classified into five categories: one representing children’s hospital emergency rooms and four representing hospital emergency rooms of varying sizes. A full description of the sample, design, and utilization is publicly available on the CPSC electronic webpage. The CPCS conducts yearly sampling of all active U.S. emergency rooms which include information regarding total emergency department visits (EDVs). Utilizing this data, adjustments are made to the sampling frame to ensure that hospitals conform to required specifications, and the sampling frame is utilized to ratio-adjust the statistical sample weights to account for changes in strata EDVs. Variables included in the standard NEISS case record are: treatment date, age, gender, race, diagnostic category, body part injured, patient disposition, location of injury, and two descriptive narrative fields. Data is updated on a daily basis and any missing information is obtained by phone interviews with patients within the first week of injury whenever possible. The NEISS therefore serves as a reliable and reproducible source for a wide range of epidemiological subjects. Information collected by the NEISS
sample for all records beginning January 1, 2002 is available in an
online database searchable by criteria-based queries.

The purpose of this study was to perform a descriptive
evaluation of the epidemiology of acute scaphoid fractures in the
United States population, with the hypothesis that incidence values
would be higher than previously shown in smaller or specialized
populations.
Materials and Methods

This cross-sectional descriptive epidemiological study utilized cases of wrist fracture in the Consumer Product Safety Commission’s (CPSC) National Electronic Injury Surveillance System (NEISS) database. Using the NEISS (National Electronic Information Surveillance System) database, a weighted database of injuries presenting for emergency care, we analyzed the incidence of scaphoid fractures in a large population over a 5-year period to provide data applicable to the U.S. population. Additionally, we used epidemiological statistical analysis to identify demographic risk factors associated with scaphoid fracture.

Based on the descriptive language in the NEISS database, a separate analysis of injuries coded as scaphoid fracture or possible scaphoid injury was performed. All injuries coded as wrist fractures were queried from the database and then analyzed using the narrative descriptions. This allowed for specific extraction of scaphoid fractures as well as suspected or possible scaphoid fractures. We then separated out the known fractures into one dataset and suspected or possible fractures into another and individually analyzed the data. NEISS data for 2002 to 2006 was used for weighted injury counts. United States
census data from 2001 through 2006 was used to estimate the population for calendar years 2002 through 2006. Because the US census data estimates are indexed from July 1 of each year, but the NEISS data is presented in calendar year form, half year US census data was used for incidence rate calculations for 2002 and 2006. Incidence rates with 95% confidence intervals were calculated by age group and gender. Incidence rate ratios were calculated using the lowest incidence rate as the reference group. Sampling standard errors provided in the NEISS documentation[11] were used to calculate 95% confidence intervals for incidence rates. Statistical analysis was performed using SAS version 9.2 (Cary, NC).
Results

A total of 507 injuries coded as fractures of the scaphoid presented for care over the 5 year period, with weighted sampling estimating these data represented 21,481 scaphoid fractures nationwide. This results in an incidence rate (IR) for the US population of 1.47 fractures per 100,000 person-years (95% confidence intervals (CI), 1.31 to 1.63). In comparison, 24,298 injuries coded as wrist fractures (which include scaphoid injury as well as distal radius fracture, ulnar styloid fracture, and other carpal injury) occurred during the same period, with a weighted sample estimate of 909,309 fractures. This translated to an incidence rate of 62.22 wrist fractures per 100,000 person-years (95% CI, 57.87 to 66.58).

The gender breakdown of scaphoid fractures, using the weighted data, showed a male predominance with 66.4% of fractures occurring in men with 33.6% in women (Figure 1). The calculated IR for males was 1.98 per 100,000 person years (95% CI, 1.73 to 2.24) and for females was 0.97 per 100,000 (95% CI, 0.85 to 1.11). The incidence rate ratio (IRR) for gender, using females as the referent group, showed a ratio of 2.04.
Figure 1:

Scaphoid Fracture Incidence by Gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Incidence Rate (per 100,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td>0.97</td>
</tr>
<tr>
<td>Males</td>
<td>1.98</td>
</tr>
</tbody>
</table>
Stratified by age group, scaphoid fracture occurrence showed a peak incidence in the second and third decades (Figure 2). The IR of scaphoid injury for those aged 10-19 years was 3.38 per 100,000, compared to 2.34 per 100,000 person-years in the 20-29 year age group, and these were significant when compared to other decade groups (p<0.05). The IRR for scaphoid injury in persons aged 10-19 was 35.3, compared to 25.1 in the 20-29 year group, using the 0-9 age group as the referent category.

Falls were reported as the mechanism of injury in 74.0% of patients. 26.5% percent of scaphoid fractures occurred in the home and 25.3% were noted to have occurred at an industrial place. Race data was reported for 374 of the 507 scaphoid fractures (74%). Stratification by race indicated that 52% of patients with scaphoid fractures were white, 10% were African-American, and 2% were Hispanic, while 26% did not have race reported (Figure 3).

A total of 507 scaphoid fractures, translating to a weighted total of 7335 injuries, were found to have taken place during sporting activities, making up 34.15% of all reported fractures. The highest number of injuries occurred in basketball (n=59, weighted total = 2086,
Figure 2:

Scaphoid Fracture Incidence

Incidence Rate (per 100,000 person years)

Age (years)
Figure 3:

Scaphoid Fractures By Race

<table>
<thead>
<tr>
<th>Race</th>
<th>Self-identified Race (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td>0.8</td>
</tr>
<tr>
<td>Asian</td>
<td>1.0</td>
</tr>
<tr>
<td>African American</td>
<td>10.8</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2.5</td>
</tr>
<tr>
<td>Other</td>
<td>0.1</td>
</tr>
<tr>
<td>White</td>
<td>52.3</td>
</tr>
<tr>
<td>Race not Reported</td>
<td>32.5</td>
</tr>
</tbody>
</table>
11.6%). Other common sports etiologies included bicycling (n=51, weighted total = 1890, 10%) and skateboarding (n=41, weighted total = 1931, 8.1%). In tracked sports-associated fractures, males consistently comprised the majority of injuries, with the exception of rollerblading and snowboarding (Figure 4).

Injuries specifically coded as suspected scaphoid injury made up a very small portion of fractures in the NEISS dataset. A total of 38 actual fractures were reported, with a weighted estimate of 2037 possible scaphoid fracture. The incidence rate was calculated as 0.14 suspected scaphoid fractures/100,000 person-years (95% CI, 0.11-0.17).
Figure 4:

Scaphoid Fractures by Sport

Percent of Total Sports-Associated Fractures

Sport

Baseball
Basketball
Biking
Football
Gymnastics
Hockey
Lacrosse
Rollerblade
Rugby
Skateboarding
Skiing
Snowboarding
Soccer
Volleyball
Wrestling
Discussion

As a subset of wrist fractures, scaphoid injuries present with a similar mechanism of injury. However, scaphoid fractures as a group are more difficult to diagnose radiographically, and a missed injury carries significant consequences of nonunion and post-traumatic arthritis. Although there is a great deal of data focusing on the diagnosis and treatment of scaphoid fractures, there is limited data pertaining to the epidemiology of such fractures in large population samples. Data from recent studies evaluating small cities or populations showed incidence rates ranging from 1.5-3.8 per 10,000 person years, with population denominators of 50,000-5,550,000.[1, 5, 6, 12] A large recent study focused on the United States military population, with a large population of 12,117,749 person-years. This study showed an overall incidence rate of 1.21 scaphoid fractures per 1000 person-years. [6] Using a publicly available database of acute injuries in the US general population, we showed an incidence rate of 1.47/100,000 person-years (95% CI, 1.31 to 1.63). To our knowledge, this is the largest population sample of patients examined in the literature. Our study utilized the National Electronic Injury Surveillance System (NEISS) database, which is a stratified,
randomized sampling of all United States hospitals with emergency rooms used to query data on all scaphoid fractures presenting for treatment over a 5 year period.

The occurrence of scaphoid fractures has previously been noted to be highest in younger age groups, as seen in Bohler’s early study, with the highest incidence seen in the 20–29-year-old age group. [13] Our study also showed similar results, with stratification by age indicating that the groups with persons aged 10-19 years and those aged 20–29 years had the highest incidence of scaphoid fracture. In Hove’s series, 225 of 330 total scaphoid fractures occurred in males, a predominance of 82%. [12] Our study also demonstrated a male predominance at 66.4% of injuries, but nearly one-third of scaphoid injuries occurred in females in the US population. This may reflect greater participation by women in organized sports, a phenomenon that has been attributed to the passage of Title IX legislation mandating equal gender access to sports. [14, 15]

In patients who self-identified race, this study also showed a higher rate of fractures in whites when compared to other racial groups, with 52% of patients with scaphoid fractures identified as white, 10% African-American, and 2% Hispanic. Other studies have
examined differences in fracture incidence between races with similar findings. The rate of distal radius fractures in white individuals (136 per 10,000) was more than twice that in non-white individuals (59 per 10,000) according to a recent study[16]. Recent studies have noted that African-American subjects have a higher bone mineral density than non-Hispanic whites, possibly explaining the differences in fracture rates.[17, 18]
Limitations and Possible Future Directions

The primary limitation of this study is the use of data gathered by a variety of input personnel. The NEISS database only includes patients who present to the emergency department, and therefore excludes patients who may present to other facets of the health-care system. The data does not include radiographic information, healthcare provider level, or involvement of consultants. Thus, these results may overestimate the incidence of scaphoid fracture because of the inability to identify whether the diagnosis was determined by a radiologist, orthopedic surgeon or an emergency room physician.

The definition of acute scaphoid fracture is generally clinical, because early imaging is often unrevealing. Conventional X-rays and imaging techniques have been shown to miss up to 25% of scaphoid fractures.[19] However, Pillai et al noted that the incidence of true fractures of the scaphoid diagnosed after having a clinically suspected scaphoid injury or negative radiograph was 6.66%.[20] Similarly low numbers from Jenkins in 2008 reveal that suspected scaphoid fractures translate to a true incidence of confirmed fractures of 16%.[21] In order to minimize this potential limitation, our analysis specifically separated data entered as possible or suspected fractures
in the descriptive narrative. Our evaluation is based on the assumption that data entry included only scaphoid fractures seen on plain radiography. However, the NEISS database does not specify whether the fracture was confirmed by X-ray, so this is a potential weakness with suspected scaphoid fractures entered as definitive injuries.
Conclusions

Despite these potential limitations, the use of the general United States population from census data makes this the largest population denominator reported for a study of scaphoid fracture epidemiology. We noted a scaphoid fracture incidence of 1.47 fractures per 100,000 person-years. Consistent with previous literature, younger age and male gender showed a higher incidence of scaphoid fracture. An improved understanding of the epidemiology of scaphoid fractures may increase the index of suspicion for this injury in individuals at risk.
References:


