Determining Frequency and Defining the Patient Profile of Sacral Insufficiency Fractures

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Abstract

Background: Insufficiency fractures at the sacrum represent a considerable cause of low back pain and disability within the geriatric population. However, there has never been a large-scale study examining the epidemiologic trends associated with the disease, and thus this condition has been largely under recognized.

Methods: This study analyzed a Nationwide Inpatient Sample (NIS) database to trend frequency and burden of sacral insufficiency fractures (SIF). All inpatient stays from 1998 to 2010 noted on the NIS were included if the case maintained at least one or more diagnostic code. A total of 257,697 unique admissions (63% women, 37% men) met our criteria.

Results: In 1998, there were 14,629 occurrences of SIF in the NIS population; this number steadily increased to 35,434 by 2010. This is a 142% increase in SIF frequency in a 12-year span. Congruently, there was an exponential increase in the total financial burden of SIF on the NIS healthcare institutions. In 1998, the total financial burden of SIF within the NIS database was $581 million; this number increased to $3.18 billion in 2010, which represents a 514% increase.

Conclusions: Overall, the frequency of SIF may be increasing as our population ages. Limited understanding of the disease characteristics has created a disproportionate burden on the healthcare system.

Introduction

Stress fractures of the sacrum are typically classified into two categories: fatigue fractures and insufficiency fractures.[1] Fatigue fractures occur in normal bone owing to abnormally high stresses or loads. These fractures are more commonly seen in young athletes, military recruits and third trimester pregnancies.[2-4] Insufficiency fractures, on the other hand, occur under normal physiologic stresses in weakened bone and are an often-overlooked source of low back pain. Previously identified risk factors for sacral insufficiency fractures (SIF) include older age, osteoporosis, chronic systemic inflammatory disease, long-term corticosteroid use, and a history of pelvic radiotherapy.[5-11]

Patients with SIF typically present without a history of significant trauma but with acute, intractable low back and buttock pain which is worse with ambulation. These patients are often plagued by an acute and severe decline in mobility and ability to perform activities of daily living. No specific classification scheme has been developed to categorize SIF. However, using the Denis classification for stratifying risk of neurological comprise, most SIF fall into zone 1 and run a vertical course parallel to the sacroiliac joint.[2] Long-standing neurologic deficits are exceptionally rare with this fracture pattern, although patients may have an acute exacerbation of underlying lumbar stenosis or radiculopathy owing to altered body mechanics. Further complicating this presentation is a high association with pubic rami fractures, occurring in as many as 78% of patients,[12] causing poorly localized parasymphseal pain.

Findings of initial radiographs are often inconclusive, but the presence of an isolated pubic rami fracture on radiograph may be suggestive of an occult sacral injury. Advanced imaging is often required to confirm the diagnosis. Computed tomography, magnetic resonance imaging, and technetium 99m bone scintigraphy have all been used successfully.

Treatment options focus on conservative management of SIF, with liberal use of analgesics and early mobilization. Various biophysical adjunct therapies have been successful, including pulsed electromagnetic fields, low-intensity pulsed ultrasound, and extracorporeal shockwave therapy. Unfortunately, these biophysical adjuncts are significantly limited by availability in most geographic areas. Interventional sacroplasty has been used successfully to rapidly improve pain scores and time to mobilization.[13] Similar procedures used for vertebral insufficiency fractures have a well-established safety profile and track record, but use in treating SIF is limited owing to lack of long-term studies and concerns of polymethylmethacrylate damage to nearby nerves and vessels.[1] Surgical treatment has been reserved for patients with instability or neurologic deficits, and includes osteosynthesis with trans-sacral positioning bar, iliolumbar plate fixation, and screw fixation often supplemented by cement due to underlying osteoporosis.

SIF represent an important subset of sacral stress fractures, and a significant cause of low back pain and disability within the geriatric population. As the older-aged population continues to increase, a similar rise in incidence is expected. Despite improved awareness of the condition, very little information exists regarding annual frequency and the magnitude of impact that accompanies this underdiagnosed condition.[13] Therefore, our specific aims were to answer the following questions. First, what is the incidence of SIF nationally? Second, what patient characteristics are associated with SIF? Finally, what is the associated financial burden of managing SIF? We hypothesized that incidence of SIF would increase during the time frame examined, to mirror that of an aging population.

Methods

By virtue of the de-identified nature of the dataset, this study was awarded an exemption from our ivestigative review board. We used the Agency for Healthcare Research and Quality (AHRQ) Healthcare Cost and Utilization Project (HCUP) National Inpatient Sample (NIS) database to estimate annual incidence, patient characteristics, and financial burden associated with SIF.[1] The NIS is the largest inpatient all-payer database in the US, representing more than 8 million inpatient stays per year in 1000 hospitals. This approximates a 20% stratified sample of US community hospitals. The sample has grown from 24 states in 1999 to 45 states in 2011. The NIS represents a stratified probability sample of hospitals, with sampling probabilities proportional to the number of US community hospitals in each stratum. Discharge data can be implemented to create national estimates. Despite changes in numbers of states sampled, the sampling method has remained constant since 1998 to reflect the cross-sectional population of hospitals. Notably, the NIS contains discharge-level records, not patient-level records. Names and identifying information have been removed to protect privacy.

The NIS database provides information regarding the index hospital admission and includes patient demographic data; primary and secondary diagnoses (including the diagnoses for 27 types of patient comorbidities); primary and secondary procedures; hospital characteristics; and discharge information. The International Classification of Diseases, Ninth Revision (ICD-9) codes can be used to identify adult patients (aged ≥ 18 years) with a diagnosis of SIF. We analyzed the prevalence and trends since 1998 and the healthcare cost of SIF. For each year of the AHRQ HCUP NIS beginning in 1998 and ending in 2010, all inpatient stays were included if the case maintained at least one or more diagnostic ICD-9-CM code shown in Table 1. A total of 257,697 unique admissions (63% women, 37% men) met our criteria for SIF from 1998-2010.

Table 1. ICD-9 code used as inclusion criteria in the current study

Code	Description
805.6	Sacrum and coccyx, closed
805.7	Sacrum and coccyx, open
806.6	Sacrum and coccyx, closed
806.60	With unspecified spinal cord injury
806.61	With complete cauda equina lesion
806.62	With other cauda equina injury
806.69	With other spinal cord injury
806.7	Sacrum and coccyx, open
806.70	With unspecified spinal cord injury
806.71	With complete cauda equina lesion
806.72	With other cauda equina injury
806.79	With other spinal cord injury
806.8	Unspecified, closed
806.9	Unspecified, open

ICD-9, the International Classification of Diseases, Ninth Revision.

Results

Overall, a 3% hospital mortality rate was associated with SIF. The 27 selected comorbidities were ranked according to their relative frequency (Table 2).

The frequency of SIF increased steadily, ranging from 14,629 in 1998 to 35,434 in 2010 (Figure 1). This represents a 142% increase in 12 years, averaging an 11.8% increase in the frequency per year.

A 21.3% increase was found in the mean age of patients who experienced SIF from 1998 to 2010 ($P < 0.001$). In 1998, the mean age was 47 years; this number increased to 57 years in 2010 and maximized in 2008 with a mean age of 60 years (Figure 2). On average, there was a 10-month increase in the mean age per year followed by this study.

No significant fluctuation was noted in length of hospital stay for patients with SIF during the 12-year period. Patients stayed a median of 6 days from 1998 to 2006 and 5 days from 2006 to 2010. Mean length of stay was greater than the median by an average of 3 days. However, the mean measure of central tendency was skewed by an unacceptable amount because of the outliers in the database. For this reason, we believed that the median is a more clinically relevant measure of central tendency.

There was a steady increase in the adjusted mean total hospital charges incurred by patients diagnosed with SIF from 1998 to 2010 (Figure 3). In 1998, the adjusted mean hospital charge was $40,424. This number increased to $90,688 in 2010 and represented a 124% increase in charges during a 12-year span ($P < 0.001$), averaging a 10.3% increase in the charges per year. The most dramatic increase occurred between 2009 and 2010, during which the mean charge grew 19.2% ($76,065 to $90,688; $P < 0.001$). All reported cost values had been converted to 2010 dollars and were listed as the adjusted value.

The adjusted total financial burden of SIF on the NIS healthcare institutions and their patients increased by 514% (Figure 4). The adjusted total financial burden of SIF increased from $581 million in 1998 to $3.18 billion in 2010 ($P < 0.001$). The largest increase occurred between 2009 and 2010 ($2.23 billion to $3.18 billion; $P < 0.001$).

Table 2. The 27 selected comorbidities associated with sacral insufficiency fractures, ranked in order of frequency, within the National Inpatient Sample database from 1998-2010

Associated Diagnosis	Sum	Percentage (%)
Hypertension	68,480	29
Fluid and electrolyte abnormalities	39,159	17
Iron deficient anemia	25,619	11
Chronic pulmonary disease	25,482	11
Hypothyroidism	19,941	9
Diabetes	21,519	10
Uncomplicated	3657	8
Complicated	17,861	2
Depression	16,816	7
Alcohol abuse	14,612	6
Neurologic disorder	14,435	6
Congestive heart failure	12,541	5
Coagulopathy	9349	4
Recent weight loss	8578	4
Renal failure	8244	4
Drug abuse	7856	3
Psychosis	7172	3
Valvular disease	7251	3
Peripheral vascular disease	6216	3
Rheumatoid arthritis/ Collagen vascular disease	5306	2
Obesity	4434	2
Paralysis	3460	1
Chronic blood loss anemia	3339	1
Pulmonary circulatory disease	2714	1
Solid tumor with metastasis	2385	1
Liver disease	2857	1
Metastatic disease	1299	1
Lymphoma	828	< 1
Acquired immune deficiency	190	< 1

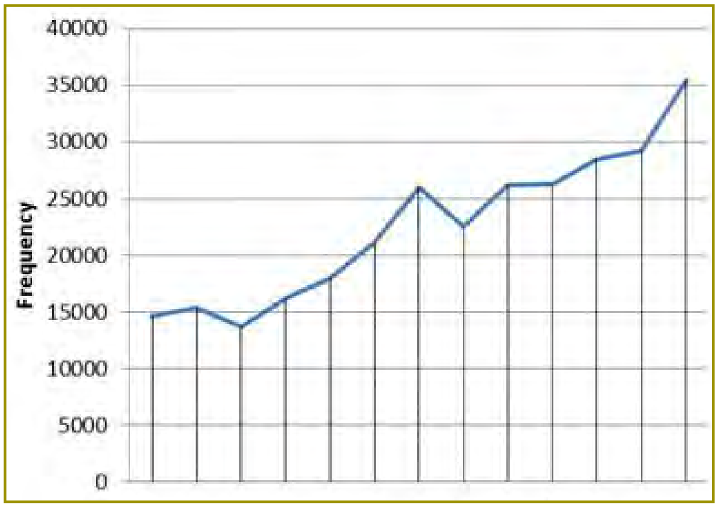

Figure 1. Yearly incidence of sacral insufficiency fractures within the National Inpatient Sample, plotted over the 12-year period.

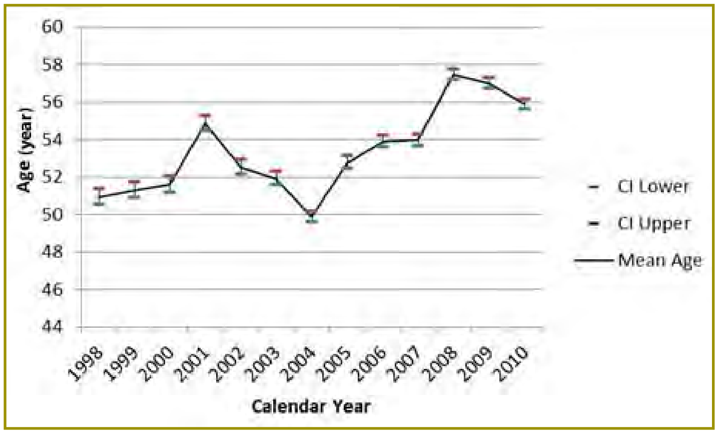

Figure 2. Mean age of patients with sacral insufficiency fractures, plotted over the 12-year period.

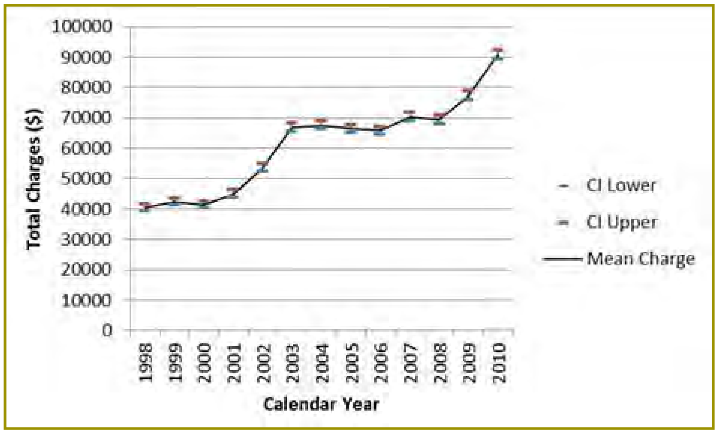

Figure 3. Inflation adjusted mean charges per year for patients with sacral insufficiency, plotted over the 12-year period.

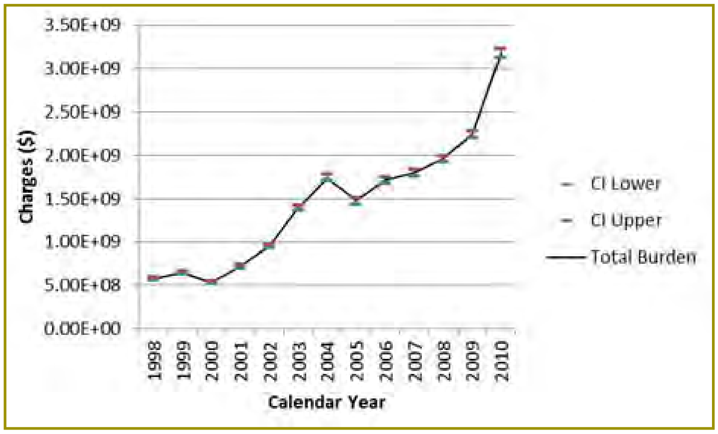

Figure 4. Total healthcare burden (incidence x median charges) for patients with sacral insufficiency fractures over the 12-year period.

Discussion

To our knowledge, this is the largest study available that has evaluated the epidemiologic trends associated with SIF. There is a strong trend showing increasing frequency of SIF, by an average of 11.8% per year, and an increase in mean patient age at admission, by 21.3% per year. This may be because of the aging baby-boomer generation that is living longer. Women outnumbered men 2:1 in our study of SIF, which is consistent with previous reports showing an increasing age and female gender are main risk factors for SIF.[5,7,8,10,11]

Chronic systemic inflammatory disease and long-term corticosteroid use have been reported as independent risk factors for SIF.[10,11,16] This was also found in our study. Reports have indicated a baseline prevalence of 0.5% to 1% concerning rheumatoid arthritis,[17] although we found 2.3% of patients affected in our study. Chronic obstructive pulmonary disease (COPD) is also strongly associated with osteoporosis owing to systemic inflammation, smoking, and long-term corticosteroid use.[18] COPD has a baseline prevalence of 6.2% in some reports,[18] although we found an 11% prevalence in our study. Interestingly, the baseline prevalence of 1% to 4.6% has been described for hypothyroidism[17]; however, we found it present in 8.7% of our study population. There is a well-known association between hyperthyroidism and increased rates of bone resorption, making this finding somewhat counterintuitive. This finding probably reflects exogenous or iatrogenic hyperthyroidism, in which patients are over-treated with thyroid hormone replacement.[19] Comorbidities such as hypertension, iron-deficient anemia, diabetes, and depression were similar to national trends.

Total hospital-related costs increased by an average of 10.3% per year after adjusting for inflation. This trend is probably multifactorial but may be explained by the changing age demographic. Because the average age of patients with SIF has increased, more medical comorbidities are likely and require additional diagnostics, consultations, and therapies.

These results should be evaluated with some caution, as they represent a wide spectrum of patients, with a myriad of reasons for admission. It is impossible to know whether the coded SIF was the primary reason for admission or a secondary condition that complicated treatment. Furthermore, the cost of admission represents charges for all care related to the patient stay, not just SIF. Additionally, the nature of the current ICD-9 coding system makes it impossible to differentiate traumatic, isolated sacral fractures in patients with normal bone density from insufficiency fractures because they code identically. As a result, these non-insufficiency fractures may skew the results and artificially lower the prevalence of the comorbidities noted in Table 2. Finally, this catchment of patients represents only the cases severe enough for inpatient admission. It is reasonable to assume that most patients who sustained an SIF did not require admission and were able to undergo conservative treatment as an outpatient; these fractures are not captured in the current study.

In summary, SIF represent an under-recognized but notable cause of low back pain and disability within the geriatric population. Furthermore, SIF imparts a disproportionate burden on our current healthcare system. As our population continues to age, the frequency and cost associated with these injuries will continue to increase. Improved understanding of the disease and prevention of osteoporosis will be key to reducing morbidity and costs associated with SIF.

Funding

The authors received no financial support for the research, authorship, and publication of this article.

Conflict of Interest

The authors report no conflicts of interest.

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