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Original Article

Geographic variation in fasciotomy during operative management of tibia fractures

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ABSTRACT

Background: Diagnosis and treatment of acute or impending compartment syndrome (ACS) remains a clinical challenge. ACS is a clinical diagnosis, and may be associated with variation in its definition, as well as individual threshold for fasciotomy. We examined regional and state variation in rates of lower extremity fasciotomy associated with operatively managed tibia fractures.
Methods: A total of 313,344 surgically treated tibia fractures were identified via Current Procedural Terminology (CPT) codes using PearlDiver, a private-payer medical record database. Data from the PearlDiver database was compared to the National Trauma Data Bank trauma registry data to corroborate calculated fasciotomy rates.
Results: The aggregate United States fasciotomy rate derived from PearlDiver was 2.57%. State fasciotomy rates were wide-ranging (0.03%–11.86%) with an average state rate of 2.22% (n = 47, SD = 2.27).
Conclusions: There was significant state-to-state variation in the use of fasciotomy during operative management of tibial fractures. Various factors may have contributed to the observed difference of state fasciotomy rates.
Level of evidence: This is a Level III epidemiological study retrospectively comparing geographic rates of fasciotomy during operative management of tibia fractures.

1. Introduction

Diagnosis and treatment of acute or impending compartment syndrome (ACS) continues to be a debated topic among orthopedic surgeons. Tibia fractures are one of the most common long-bone injuries, with 492,000 reported per year in the United States.[1] Compartment syndrome has been cited in the literature as occurring in 1–10% of all tibia fractures.[2] Consensus for treatment of ACS is emergent fasciotomy, but there is still discordance regarding diagnosis of this condition. Diagnosis can be complex due to widely varying injury patterns and confounding comorbidities, and is often made using a combination of clinical symptoms and/or intra-compartmental pressure monitoring[3,4]. A missed or delayed diagnosis potentially results in deleterious consequences such as ischemic contracture, neurological sequelae, infection and ultimately amputation.[5] Alternatively, unnecessary fasciotomy carries noted morbidity. Patients who have undergone an open fasciotomy can develop complications of residual pain, altered sensation, wound morbidity and long-term functional deficit.[5] Diagnosis and management of ACS remains challenging for orthopedic surgeons, who must avoid a missed diagnosis, but also minimize the risk of an unnecessary surgical procedure with significant morbidity.

Variation in the diagnosis rate of ACS among individual surgeons has been noted and highlights the difficulty of diagnosing compartment syndrome in clinical practice[3]. The concept that procedure rates vary more widely than what can be explained by regional differences in prevalence of injury or disease has long been recognized, but to our knowledge, there is a paucity in the literature regarding the geographic variation of fasciotomy. The purpose of this study was to examine the geographical variation of fasciotomy during operative management of tibia fractures. Our hypothesis was that we would find substantial geographic variation in fasciotomy rates, suggesting that there may be underlying confounders that influence the decision to perform fasciotomy during surgical treatment of tibia fractures.

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2. Methods

This study utilized publicly available, aggregated data from two separate databases to identify surgically treated tibia fractures by means of Current Procedural Terminology (CPT) codes. Fasciotomy rates were calculated by dividing the total number of patients recorded as undergoing a lower extremity fasciotomy and surgery for a tibia fracture by the total of operatively managed tibia fractures. Patients recorded as having an operatively managed tibia fracture – open reduction internal fixation (ORIF) or intramedullary nailing of both proximal and distal tibia shaft fractures – were identified by CPT codes 27535, 27536, 27756, 27758, and 27759 (Appendix Table 1). Fasciotomy for a primary diagnosis of tibial compartment syndrome among patients that also underwent surgery for a tibia fracture were obtained by identifying fasciotomy procedures on any lower extremity compartment, multiple compartments, with or without debridement (CPT codes 27600, 27601, 27602, 27892, and 27894) in conjunction with the above codes.

The primary database utilized, PearlDiver (PearlDiver Technologies Inc. Warsaw, IN, USA; www.pearldiverinc.com) is a commercially available and Health Insurance Portability and Accountability Act (HIPAA) compliant national insurance database containing information from more than two billion de-identified Medicare and private payer patient records. A multitude of incidence and demographic studies of orthopedic injury have been used the PearlDiver database since 2010.[6–17] PearlDiver provided state totals of operatively managed tibia fractures and state totals of patients who have had both a lower extremity fasciotomy and an operatively managed tibia fracture from 2007 to 2011. State procedure volumes less than eleven were censored by PearlDiver to protect patient privacy. States with missing values were imputed with a weighted average of the difference in total volumes for the respective states.

To corroborate that PearlDiver data represented generally accurate procedure counts, this study also utilized data from the National Trauma Data Bank (NTDB). The NTDB is the current largest aggregation of U.S trauma registry data. The NTDB research dataset used in this study is based on the 2012 admission year and consists of 773,299 records from 747 facilities.[18] The NTDB identified individuals by CPT code from participating trauma registries. State rates were unable to be calculated using this database, but US region of the hospital where procedures were performed was provided, allowing for the calculation of a total US fasciotomy rate as well as a regional rate to substantiate the general accuracy of PearlDiver data (refer to Appendix Table 2 for states included in each US region).

Comparison of fasciotomy rates between data sources for each region was done using Pearson's Chi-square test. Comparisons of median fasciotomy rates of states within each region were done using the Kruskal–Wallace test. Change in aggregated fasciotomy rates over the study time period was done using the Cochran-Armitage trend test. To describe the central tendency of the fasciotomy rates, descriptive statistics including mean, standard deviation, and skewness were computed. Spearman correlation was used to assess the association between total volume of operatively managed tibia fractures and fasciotomy rates as well as the association between fasciotomy rates and population. All tests were performed using a significance level of 0.05. There was no external funding source for this study.

3. Results

3.1. Results found using PearlDiver database data

A total of 47 US states were included in the analysis. Due to missing data, North Dakota, Alaska, and Delaware were excluded.

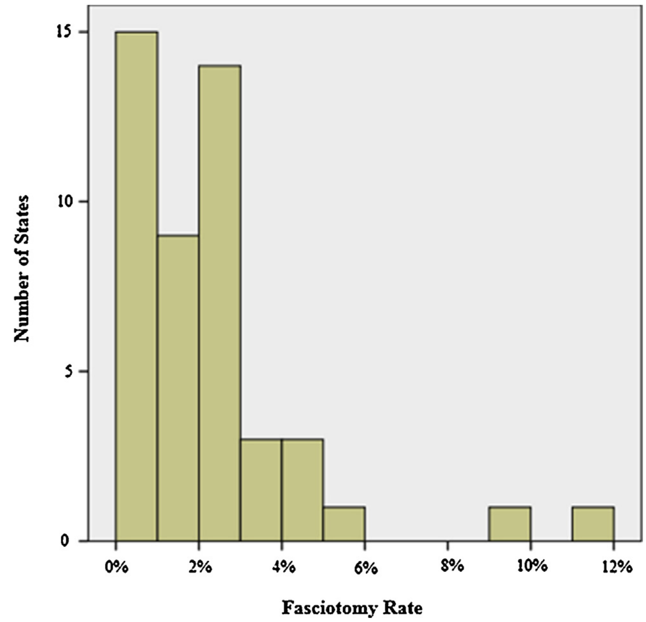

Fig. 1. Histogram for state fasciotomy rate. Data are displayed for 47 US states.

Considerable variation in state fasciotomy rates were noted (0.03%–11.86%) with an average rate of 2.22% (n = 47, SD = 2.27). Sizable variance and skewness values indicate the distribution of the data is clustered between 0.03% and 3.00%. A majority of the state rates (n = 20, 42.6%) were less than 1.5% with two outliers at 11.90% and 9.52% (Fig. 1).

Fig. 2 illustrates the geographic distribution of fasciotomy rates in the U.S (averaged from 2007 to 2011).

There was a significant trend of US fasciotomy rates increasing over the study time period ($p < 0.0001$) (Fig. 3).

The states with the five highest fasciotomy rates were Vermont (11.90%), Idaho (9.53%), Maryland (5.05%), Washington (4.83%), and Massachusetts (4.69%). Alternatively, the states with the five lowest fasciotomy rates (all less than 1%) were West Virginia, Kansas, Nebraska, Montana, and Wyoming (Table 1). The Spearman's rho revealed a statistically significant negative relationship between state fasciotomy rates and the total volume of operatively managed tibia fractures in each state ($rs[47] = -0.499$, $p < 0.0001$). States with higher the volumes of operatively managed tibia fractures were associated with lower fasciotomy rates. There was also a statistically significant negative relationship between state fasciotomy rates and the total population of each state ($rs[47] = -0.429$, $p = 0.003$). States with larger populations were associated with lower fasciotomy rates.

3.2. Results using National Trauma Data Bank data

Dividing the contiguous US states into four broad regions: North Eastern, Southern, West, and Mid-Western, there was no statistically significant variation of fasciotomy rates among operatively managed tibia fractures between regions ($p = 0.170$) (Appendix Table 2 identifies the states included in each region). There was no significant difference between the two datasets when comparing fasciotomy rates by region (Table 2), although the US PearlDiver rate overall was 2.57% (N = 313,344) was different than the US rate of 3.44% (N = 16,896) derived from the National Trauma Data Bank data ($p < 0.0001$).

Distribution of state fasciotomy rates (grouped by region) is right skewed with two outlier states in the North Eastern and in the Western region of the US respectively (Fig. 4).