Research Article

# Lower Complication Rate Following Ankle Fracture Fixation by Orthopaedic Surgeons Versus Podiatrists

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## Abstract

**Introduction:** Increased overlap in the scope of practice between orthopaedic surgeons and podiatrists has led to increased podiatric treatment of foot and ankle injuries. However, a paucity of studies exists in the literature comparing orthopaedic and podiatric outcomes following ankle fracture fixation.

**Methods:** Using an insurance claims database, 11,745 patients who underwent ankle fracture fixation between 2007 and 2015 were retrospectively evaluated. Patient data were analyzed based on the provider type. Complications were identified by the *International Classification of Diseases, Ninth Revision*, codes, and revision surgeries were identified by the Current Procedural Terminology codes. Complications analyzed included malunion/nonunion, infection, deep vein thrombosis, and rates of irrigation and débridement. Risk factors for complications were compared using the Charlson Comorbidity Index.

**Results:** Overall, 11,115 patients were treated by orthopaedic surgeons and 630 patients were treated by podiatrists. From 2007 to 2015, the percentage of ankle fractures surgically treated by podiatrists had increased, whereas that treated by orthopaedic surgeons had decreased. Surgical treatment by podiatrists was associated with higher malunion/nonunion rates among all types of ankle fractures. No differences in complications were observed in patients with unimalleolar fractures. In patients with bimalleolar or trimalleolar fractures, treatment by a podiatrist was associated with higher malunion/nonunion rates. Patients treated by orthopaedic surgeons versus podiatrists had similar comorbidity profiles.

**Discussion:** Surgical treatment of ankle fractures by orthopaedic surgeons was associated with lower rates of malunion/nonunion when compared with that by podiatrists. The reasons for these differences are likely multifactorial but warrants further investigation. Our findings have important implications in patients who must choose a surgeon to surgically manage their ankle fracture, as well as policymakers who determine the scope of practice.

**Level of Evidence:** Level III—retrospective cohort study

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Surgical treatment of ankle fractures has increased as a result of the increasing incidence of these injuries, particularly in the elderly.[1,2] Among the Medicare patients, ankle fractures are the third most common

extremity fracture, costing more than half a billion dollars per year.[3,4] Although most ankle fracture care continues to be provided by orthopaedic surgeons, the growing presence and expanding scope of practice of podiatrists has resulted in changes in the management of foot and ankle injuries. For example, following the introduction of podiatric staff privileges at a level-I trauma center, the overall proportion of foot and ankle consults seen by podiatrists increased sixfold from 9% to 58% within 5 years.[5] Similarly, the proportion of foot and ankle injuries surgically treated by podiatrists increased from 8% to 41% in the same time frame.[5] Despite the greater involvement of podiatrists in the surgical management of foot and ankle injuries, currently, no studies exist in the literature that directly compare orthopaedic and podiatric outcomes following ankle fracture fixation. In addition, no published studies have compared longitudinal trends in the proportion of ankle fractures treated by orthopaedic surgeons versus podiatrists.

Therefore, this study evaluated short-term complication rates following ankle fracture fixation based on the provider type. We also sought to identify changes in the proportion of ankle fractures treated by orthopaedic surgeons versus podiatrists. Our hypotheses were that (1) podiatrists would have increasing involvement in surgically treated ankle fractures and (2) surgical treatment of ankle fractures by orthopaedic surgeons would be associated with similar complication rates as compared with podiatrists.

## Methods

A retrospective cohort study was conducted using data from all patients between the ages of 20 and 80 years within the Humana subset of the PearlDiver Patient Record Database (Pearl-Diver Technologies) who underwent ankle fracture fixation between 2007 and 2015. The research and compliance office at our institution deemed the study exempt from human studies review because the data extracted for this study was from a publicly available source and all information received was de-identified. Patients who were diagnosed with an ankle fracture were identified using codes from the *International Classification of Diseases, Ninth Revision* (*ICD-9*), list for unimalleolar (824.0, 824.1, 824.2, 824.3), bimalleolar (824.4, 824.5), and trimalleolar (824.6, 824.7) fractures. Inclusion criteria for this study required patients to have undergone subsequent surgical treatment within 30 days of their primary ICD-9 code to limit the analysis to the treatment of acute ankle fractures alone. Surgical treatment was identified using the Current Procedural Terminology (CPT) codes for unimalleolar (27766, 27792), bimalleolar (27814), and trimalleolar (27822, 27823) fracture fixation with or without concomitant syndesmotic fixation (27829). Patients were then separated based on their provider type using the Healthcare Provider Taxonomy Code Set for orthopaedic surgeons (207X0004X, 207XX0801X) and podiatrists (213E00000X, 213EG0000X, 213ES0103X, 213ES0131X). A sample of our search algorithm for unimalleolar fractures is illustrated (Figure 1).

Among the identified patients who underwent ankle fracture fixation, subsequent complication rates were identified using a combination of *ICD-9* and CPT codes. Within 90 days of surgical treatment, the following complications were identified: new diagnoses of infection (*ICD-9* 996.67, 996.69, 998.51, 998.59), deep vein thrombosis (DVT) (*ICD-9* 453.40, 453.41 and 453.42), and revision surgery for irrigation and débridement (CPT 20000, 20005, 10140, 10180, 11042, 11043, 11044, 27603, 27607, 27610). These revision surgery codes were chosen as indicators of postoperative wound dehiscence or infection that could potentially be attributable to the treatment provider. Within 1 year of surgical treatment, the following complications were identified: new diagnoses of malunion or nonunion (*ICD-9* 733.81, 733.82). We did not analyze complications such as cardiac or respiratory events because of the likelihood of confounding factors that were not attributable to the surgical treatment directly.

Demographic data collected included sex, age, and Charlson Comorbidity Index (CCI). Statistical analyses to compare demographic data and complication rates were performed using chi-squared test for proportions and two-sample *t*-test

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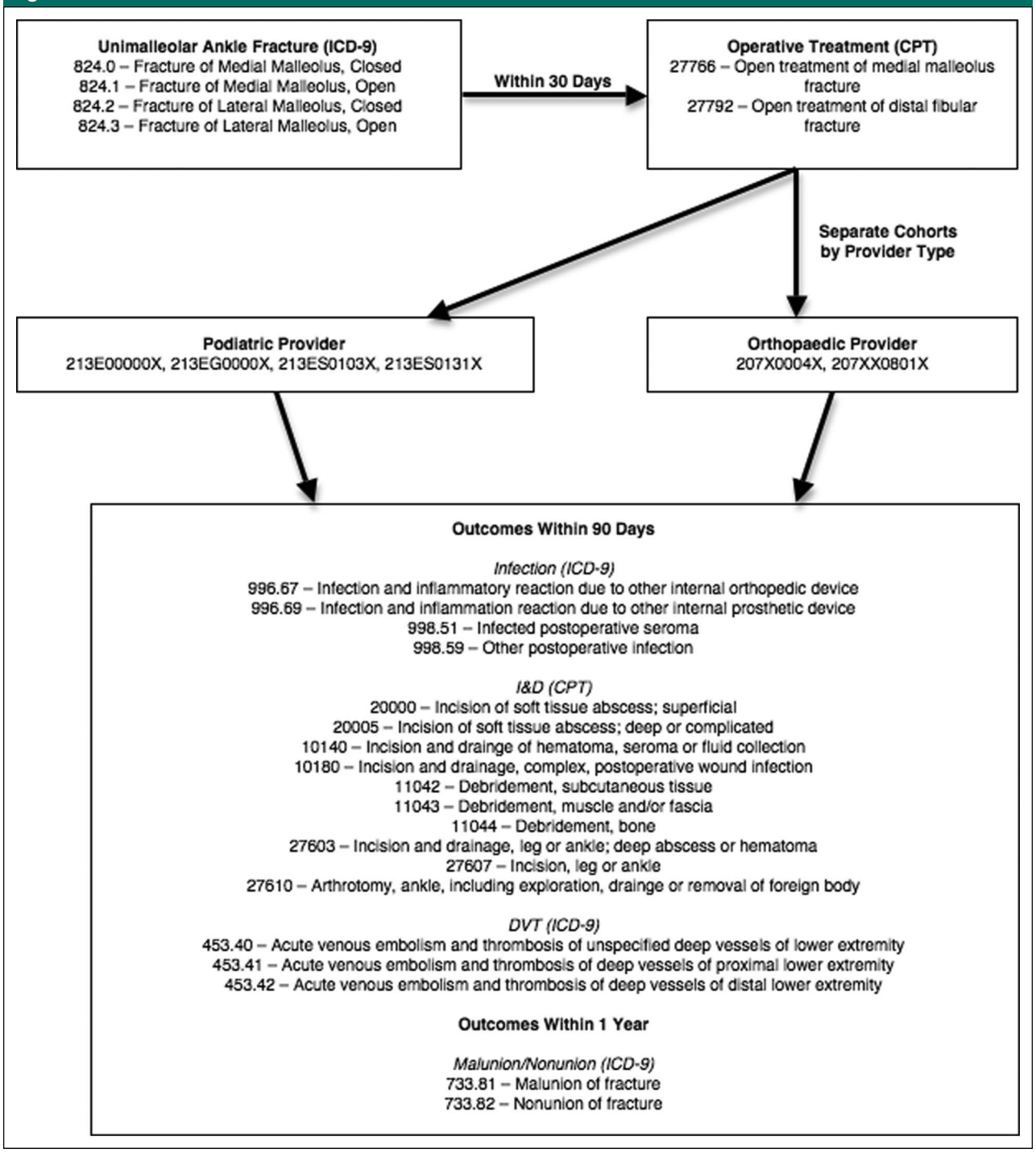
Figure 1




Flow chart showing the data search algorithm used to identify complication and revision surgery rates following unimalleolar ankle fractures from the PearlDiver claims database.

for means (Med Calc Software Version 15.1). With both of these tests, $P$ values less than or equal to 0.05 were considered statistically significant.

## Results

We identified a total of 11,115 ankle fracture patients who were surgically treated by orthopaedic surgeons and 630 ankle fracture patients who were treated by podiatrists. When comparing the overall demographics of the two patient cohorts, no difference

**Table 1**

**Patient Demographics**

| Factor | Ortho | Podiatry | *P* Value |
|---|---|---|---|
| Patients | 11115 | 630 | |
| Age (%) | | | |
| <60 yr | 34.5 | 36.1 | 0.41 |
| >60 yr | 65.5 | 63.9 | |
| Sex (%) | | | |
| Male | 32.5 | 35.6 | 0.11 |
| Female | 67.5 | 64.4 | |
| CCI (mean ± SD) | 2.7 ± 3.4 | 2.8 ± 3.3 | 0.47 |

CCI = Charlson Comorbidity Index

was found in sex or the proportion of patients who were younger than or older than 60 years (Table 1). In addition, the mean CCI score was comparable between the orthopaedic cohort (mean, 2.7 ± 3.4) and the podiatric cohort (mean, 2.8 ± 3.3).

From 2007 to 2015, the proportion of ankle fractures treated by podiatrists doubled from 3.5% to 7.0%. The proportion of ankle fractures treated by orthopaedic surgeons decreased over the period from 96.5% to 93.0%. Across all types of ankle fractures, a statistically significantly higher rate of malunion/nonunion was found in the patient cohort treated by podiatrists compared with the cohort treated by orthopaedic surgeons (7.3% versus 4.6%). The relative risk for malunion/nonunion across all ankle fractures was 1.6 (95% confidence interval, 1.2 to 2.1; $P = 0.002$) when treated by podiatrists as compared with orthopaedic surgeons. No significant differences were reported in the observed rate of infection, DVT, or irrigation and débridement (Table 2).

Among the subgroup of patients with unimalleolar ankle fractures, a trend toward a higher rate of malunion/nonunion in ankle fractures was observed in those treated by podiatrists compared with those treated by orthopaedic surgeons (6.2% versus 4.0%), although this was not statistically significant. Among the subgroup of patients with bimalleolar or trimalleolar ankle fractures, surgical treatment by podiatrists was associated with a significantly higher rate of malunion/nonunion compared with surgical treatment by orthopaedic surgeons (8.2% versus 4.9%). The calculated relative risk for malunion/nonunion in patients with a bimalleolar or trimalleolar ankle fracture was 1.7 (95% confidence interval, 1.2 to 2.4; $P = 0.006$) when surgical treatment was performed by a podiatrist.

## Discussion

Although the amount of overlap in the scope of practice between podiatrists and orthopaedic surgeons varies from state to state, surgical treatment of unstable ankle fractures is a common procedure performed by both provider types. However, currently no studies exist in the literature that directly compare patient outcomes following ankle fracture treatment by orthopaedic surgeons and podiatrists. Our study evaluated short-term complication rates following ankle fracture fixation by orthopaedic surgeons and podiatrists, and revealed higher rates of malunion or nonunion following podiatric surgery among all types of ankle fractures. This difference in malunion and nonunion rate was driven primarily by higher complexity bimalleolar and trimalleolar ankle fractures. No significant differences were found in the rates of postoperative infection, DVT, or irrigation and débridement. In addition, our study demonstrated a longitudinal trend toward increasing involvement

**Table 2**

**Complication Rates by Provider Type Following Ankle Fracture Fixation**

| | All Ankle Fractures | | | | | Single Malleolar Fractures | | | | | Bimalleolar or Trimalleolar Fractures | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Factor | Orthopaedic | Rate | Podiatry | Rate | *P* Value | Orthopaedic | Rate | Podiatry | Rate | *P* Value | Orthopaedic | Rate | Podiatry | Rate | *P* Value |
| Total patients | 11,115 | | 630 | | | 3,638 | | 275 | | | 7,477 | | 355 | | |
| Malunion or nonunion | 512 | 4.6% | 46 | 7.3% | 0.002 | 144 | 4.0% | 17 | 6.2% | 0.07 | 368 | 4.9% | 29 | 8.2% | 0.006 |
| Infection | 476 | 4.3% | 21 | 3.3% | 0.23 | 149 | 4.1% | 8 | 2.9% | 0.33 | 327 | 4.4% | 13 | 3.7% | 0.53 |
| Irrigation and débridement | 347 | 3.1% | 20 | 3.2% | 0.89 | 110 | 3.0% | 9 | 3.3% | 0.78 | 237 | 3.2% | 11 | 3.1% | 0.92 |
| Deep vein thrombosis | 190 | 1.7% | 14 | 2.2% | 0.35 | 53 | 1.5% | 7 | 2.5% | 0.20 | 137 | 1.8% | 7 | 2.0% | 0.78 |

of podiatry in the surgical treatment of ankle fractures.

The disparity in malunion and nonunion rates between podiatrists and orthopaedic surgeons is important because these complications have the potential to impact patient outcome. Fibular and medial malleolar malunion resulting in tibiotalar malalignment has been shown to significantly alter tibiotalar contact pressures.[6-10] Moreover, complications such as delayed union or nonunion following ankle fracture fixation has been associated with increased rates and decreased latency time to the development of posttraumatic ankle osteoarthritis.[11]

The underlying cause for the difference in malunion and nonunion rate remains unclear but is likely multifactorial. Risk factors for postoperative complication rates following ankle fracture fixation can generally be categorized into patient-specific factors and surgeon-related variables. In regard to patient-specific factors, no observed differences was observed in the age and sex proportions between the two cohorts that would account for the difference in malunion or nonunion. Patient comorbidities, such as diabetes and peripheral vascular disease, have previously been demonstrated to be a risk factor for short-term complications following ankle fracture fixation.[12-14] However, similar CCI scores were reported in our podiatric and orthopaedic cohorts, suggesting a comparable level of comorbidities. Our study did not specifically exclude patients with multiple injuries or open fractures, which could potentially affect the observed complication rates. These surgeries are typically performed by orthopaedic surgeons on an inpatient basis though, which would be more likely to bias complications toward the orthopaedic cohort.

Surgeon-related variables, such as surgical technique, case volume, and training, may also contribute to the observed difference in malunion and nonunion rates. In our study, a large discrepancy was observed in the number of ankle fractures treated by orthopaedic surgeons versus podiatrists. Previous studies have implicated surgical case volume as a factor that can affect patient outcomes. In lumbar spine surgery, surgeons and hospitals with surgical volume in the top 25% of the National Inpatient Sample were found to have significantly lower rates of mortality and perioperative complications.[15] In total hip arthroplasty, patients treated by surgeons who performed less than 35 cases per year were found to have higher rates of dislocations as well as revision surgeries.[16] Similarly, in total ankle arthroplasty, surgeons with case volume greater than the 90th percentile were found to have decreased rates of complications and intraoperative fractures.[17] However, the association between case volume and complications has not been demonstrated in studies on ankle fractures to date.[13,14] Although the claims database that our data were extracted from precluded an analysis of the average volume of ankle fractures treated by individual surgeons, more than 90% of all surgically treated ankle fractures identified were treated by an orthopaedic surgeon. Notably, the ratio of ankle fractures treated by orthopaedic surgeons compared with those treated by podiatrists was even higher in the bimalleolar and trimalleolar subgroup than in the unimalleolar subgroup. The lower volume of bimalleolar and trimalleolar ankle fractures treated by podiatrists could certainly be a contributing factor to the increased rates of malunion and nonunion observed with these higher complexity patterns.

Finally, significant differences exist in the training that orthopaedic surgeons and podiatrists receive, which could potentially affect outcomes following ankle fracture fixation. Orthopaedic surgeons are required to complete 4 years of medical school, 5 years of residency, and often another year of subspecialized fellowship training. In contrast, podiatry training was recently standardized in 2011 to 4 years of podiatry school followed by a 3-year residency. Over the course of residency, orthopaedic surgeons are afforded a longer surgical training time and extensive exposure to fracture care in all areas of the body. This increased exposure likely improves competency and may help to optimize patient outcome.[18,19] Furthermore, a previous study revealed shortcomings in general musculoskeletal knowledge among podiatric residents compared with orthopaedic residents,[20] which may be relevant to patient outcomes following ankle fracture surgery. The only other studies that have been published, which have directly compared surgical outcomes based on surgeon specialty, are from the spine literature. These studies used patients from the National Surgical Quality Improvement Program database and found no difference in postoperative complication rates following certain procedures between neurosurgeons and orthopaedic surgeons.[21-23] However, the intensity and length of training between neurosurgery and orthopaedic surgery are more comparable, which may minimize any observed differences in outcomes.

Limitations of the present study include those associated with the use of an administrative claims data set such as PearlDiver. Patients who relocated or changed insurance providers postoperatively would not be captured by this study. Similarly, the rate of complications such as infection, malunion, and nonunion is reliant on accurate coding and diagnosis by the treatment providers. We did not have objective radiographic measures to corroborate the diagnoses of malunion or nonunion. In addition, we did not have access to patient-reported outcomes to assess

the clinical importance of the observed complication rates. Furthermore, we intentionally limited our analysis to short-term complications in an attempt to only capture complications that could be directly related to the treatment provider. As such, we were unable to assess long-term complications such as the development of posttraumatic ankle arthritis or subsequent conversion to ankle arthrodesis or arthroplasty. Finally, our study was designed only to identify the rates of complication and revision surgery based on provider type rather than the underlying cause for these differences. Further studies will need to be performed to address the reasons behind the observed difference in complication rates.

In conclusion, our study found that surgical treatment of ankle fractures by podiatrists was associated with higher rates of malunion and nonunion compared with treatment provided by orthopaedic surgeons. This observation is particularly relevant given that our study also identified an increasing involvement of podiatrists in the surgical management of ankle fractures. Although the specific reasons for the difference in malunion and nonunion rate is likely multifactorial, our findings have important implications in patients who must choose a surgeon to surgically manage their ankle fracture, as well as policymakers who determine the scope of practice.

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