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Comparing 30-day all-cause readmission rates between tibiotalar fusion and total ankle replacement

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ABSTRACT

Background: End-stage ankle arthritis is a debilitating condition that negatively impacts patient quality of life. Tibiotalar fusion and total ankle replacement are treatment options for managing ankle arthritis. Few studies have examined short term readmission rates of these two procedures. The objective of this study was compare all-cause 30-day readmission rates between patients undergoing tibiotalar fusion vs. total ankle replacement.

Methods: This study queried the Nationwide Readmission Database (NRD) from 2013–2014 and used international classification of disease, 9th revision (ICD-9) procedure codes to identify all patients who underwent a tibiotalar fusion or a total ankle replacement. Comorbidities, insurance status, hospital characteristics, and readmission rates were statistically compared between the two cohorts. Risk factors were then identified for 30-day readmission.

Results: A total of 5660 patients were analyzed with 2667 in the tibiotalar fusion cohort and 2993 in the total ankle replacement cohort. Univariate analysis revealed that the readmission rate after tibiotalar fusion (4.4%) was statistically greater than after total ankle replacement (1.4%). Multivariable regression analysis indicated that deficiency anemia (OR 2.18), coagulopathy (OR 3.51), renal failure (OR 2.83), other insurance relative to private (OR 3.40), and tibiotalar fusion (OR 2.51) were all statistically significant independent risk factors for having a readmission within 30-days.

Conclusions: These findings suggest that during the short-term period following discharge from the hospital, patients who received a tibiotalar fusion are more likely to experience a 30-day readmission. These findings are important for decision making when a surgeon encounters a patient with end stage ankle arthritis.

Level of evidence: Level III, cohort study.

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1. Introduction

End-stage tibiotalar arthritis is a disabling condition associated with impaired functional status and decreased quality of life [1–4]. Several factors contribute to end-stage ankle arthritis, though the most common etiology is post-traumatic [5–7].

The long accepted gold standard for treating end-stage arthritis of the tibiotalar joint is tibiotalar fusion [8,9]. Patients generally experience excellent pain relief and a reduction in physical limitations following fusion, but a number of shortcomings such as motion restriction and nonunion are associated with the procedure [10–15].

As a means to avoid some of the drawbacks associated with ankle fusion, total ankle arthroplasty (TAA) was developed [16]. The advantage of preserved range of motion that comes with TAA also comes with the risk of eventual implant failure and need for subsequent reoperation. As implant survivorship has improved, though, TAA has become an increasingly popular alternative to ankle arthrodesis for treating end-stage arthritis [17,18].

Several studies have compared the intermediate and long-term results of ankle arthrodesis and total ankle replacement, with no current, clear consensus as to which treatment modality remains most effective [19]. While, reoperation rates following the two procedures has been studied at length, few studies have examined 30-day readmission rates following the two procedures, which has

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important implications for both short term patient safety as well as cost for each procedure [19].

The objective of this study was to therefore investigate the all-cause 30-day readmission rate following treatment with either tibiotalar fusion or total ankle replacement.

2. Methods

This study utilized the data from the 2013–2014 Nationwide Readmissions Database (NRD), Healthcare Cost and Utilization Project (HCUP), Agency for Healthcare Research and Quality. International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes were used to extract all total ankle replacements (81.56) and tibiotalar fusions (81.11) from the database.

Only adult (age ≥18), elective procedures were included. Patients who died during admission or who were transferred from another hospital for admission were excluded. As the study focus was to examine 30-day readmission rates, admissions from December 1, 2013 onward to December 31, 2013 were excluded to allow for adequate follow up time. Patients who received a tibiotalar fusion as well as subtalar fusion (81.13) were excluded. Using ICD-9-CM diagnosis codes, patients with an index admission diagnosis related to orthopedic implant failure or infection, fracture, nonunion, or malunion were excluded as a means to eliminate revision procedures. For readmissions, though, these diagnoses were included. The NRD has 6 levels for insurance status; Medicare, Medicaid, private insurance, self-pay, no charge, and other. The self-pay, no charge, and other insurance categories were combined into a single "other insurance" categorical variable.

Cases were divided into cohorts of those treated with either total ankle arthroplasty (TAA) or tibiotalar fusion (TTF). The NRD has data elements regarding common comorbidities. Demographics, comorbid conditions, hospital characteristics, and readmission rates were statistically compared between the two cohorts.

2.1. Statistical analysis

All data was extracted and analyzed using R Version 3.3.2 (R Foundation for Statistical Computing, Vienna, Austria). Given the large sample size, a Shapiro–Wilkes normality test was conducted for continuous variables to determine the normality of the distribution. The NRD has a discharge weight variable (DISCWT) that can extrapolate the data within the NRD to a national level in order to make data more generalizable. This discharge weight variable was applied to all statistical tests. The length of stay variable was recoded into a categorical variable with a length of stay greater than or equal to three days representing one group, and less than 3 days representing the other. All normally distributed continuous variables were compared between cohorts using an unpaired t-test. All non-normally distributed variables were compared with a Wilcoxon Rank Sum test. Categorical variables between groups were compared with a chi-square test.

Multi-variable logistic regression was performed using all-cause 30-day readmission as the outcome variable.

All statistical tests were considered significant with a $p < 0.05$.

3. Results

3.1. Patient characteristics

A total of 5660 cases were analyzed, with 2667 tibiotalar fusions and 2993 total ankle replacements. There were a total of 160 30-day readmissions, yielding a 2.8% 30-day readmission rate.

Table 1 summarizes the demographics, comorbid conditions, and hospital characteristics for patients treated with TTF or TAA. There was a statistically significant difference in the median age between the TTF and TAA groups (59 vs. 65 years), as well as statistically significant differences in the number of patients who had rheumatoid arthritis, congestive heart failure, depression, diabetes, obesity, and renal failure. Additionally, there was a significant difference in the type of insurance patients had, where they were discharged to, and how long they spent in the hospital

Table 1
Demographics, comorbid conditions, and hospital characteristics for patients treated with tibiotalar fusion or total ankle replacement.

Variable	Tibiotalar fusion (n = 2667)	Total ankle replacement (n = 2994)	P Value
Age (median (IQR))	59 (49–68)	65 (57–72)	<**0.001**
Female	1202 (45.1%)	1387 (46.3%)	0.577
Deficiency anemia	219 (8.2%)	95 (3.2%)	<**0.001**
Rheumatoid arthritis	133 (5.0%)	96 (3.2%)	**0.035**
Congestive heart failure	89 (3.4%)	19 (0.7%)	<**0.001**
Chronic lung disease	440 (16.5%)	402 (13.4%)	0.066
Coagulopathy	52 (2.0%)	32 (1.1%)	0.113
Depression	395 (14.8%)	325 (10.9%)	**0.011**
Complicated diabetes	203 (7.6%)	23 (0.8%)	<**0.001**
Hypertension	1507 (56.5%)	1656 (55.3%)	0.608
Obesity	656 (24.6%)	500 (16.7%)	<**0.001**
Renal failure	214 (8.0%)	85 (2.9%)	<**0.001**
Insurance			<**0.001**
Medicaid	248 (9.3%)	64 (2.1%)	
Medicare	1193 (44.8%)	1667 (55.7%)	
Other insurance	292 (10.9%)	156 (5.2%)	
Private insurance	933 (35.0%)	1106 (36.9%)	
Teaching hospital	1727 (64.8%)	1964 (65.6%)	0.699
Discharge location			<**0.001**
Facility	567 (21.3%)	370 (12.4%)	
With home health care	496 (18.6%)	387 (12.9%)	
Routine	1604 (60.1%)	2236 (74.7%)	
LOS ≥ 3 days	1130 (42.4%)	847 (28.3%)	<**0.001**
Readmissions	118 (4.4%)	42 (1.4%)	<**0.001**

Bolded numbers indicate statistical significance.
IQR = interquartile range.

(Table 1). Lastly, the readmission rate in patients who underwent tibiotalar fusion was 4.4%, which was statistically greater than the rate of 1.4% following total ankle arthroplasty ($p < 0.0001$).

3.2. Indications for index surgery and for 30-day readmissions

The top 5 most common admission diagnoses for all procedures were local ankle osteoarthritis (36.6%), traumatic ankle arthropathy (21.4%), ankle arthropathy not otherwise specified (8.3%), ankle osteoarthritis not otherwise specified (8.1%), and primary ankle osteoarthritis (5.3%) (Fig. 1).

The top 5 diagnoses upon 30-day readmission were infection of orthopedic device (11.8%), other postoperative infection (11.7%), ankle sprain (5.4%), acute on chronic heart failure (3.3%), and acute posthemorrhagic anemia (2.8%).

The top reasons for readmission after tibiotalar fusion were infection of orthopedic device (16.1%), other postoperative infection (12.5%), ankle sprain (7.4%), acute posthemorrhagic anemia (3.8%), and acute kidney failure (3.4%), while the top reasons for readmission after a total ankle arthroplasty were acute on chronic heart failure (12.3%), other postoperative infection (9.4%), diverticulitis (8.7%), acute pulmonary embolism (7.3%), and calcifying tendonitis of the shoulder (6.8%), (Fig. 2).

3.3. Risk factors for 30-day readmission

A number of statistically significant independent risk factors for all cause 30-day readmission were identified. Deficiency anemia (OR = 2.18), coagulopathy (OR = 3.51), and renal failure (OR = 2.83) were the comorbidities that were found to be risk factors (Table 2). Having "other insurance" was a risk factor with an odds ratio of 3.40 relative to having private insurance. Lastly, getting a tibiotalar fusion was found to be an independent risk factor for 30-day readmission relative to total ankle replacement with an odds ratio of 2.51 (Table 2). The regression model had an overall F-test that was statistically significant ($p < 0.0001$).

4. Discussion

The aim of this retrospective review was to compare the 30-day readmission rates between patients who underwent either a tibiotalar ankle fusion or a total ankle arthroplasty. While total ankle replacements were originally developed to circumvent some of the drawbacks associated with fusion, many studies have found

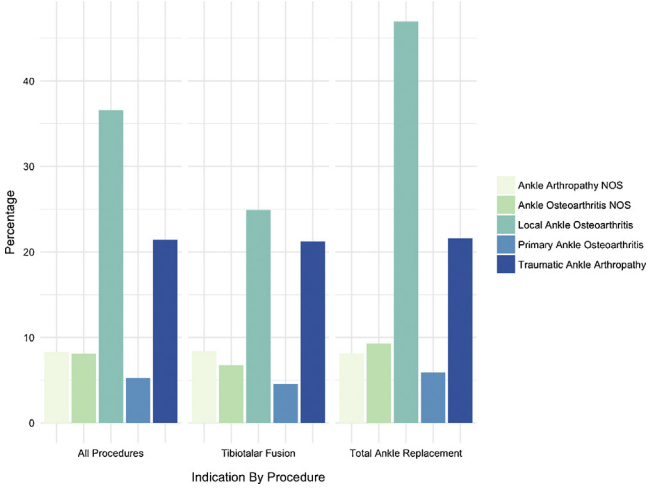

Fig. 1. Top 5 indications for surgery broken down by all procedures, tibiotalar fusions only, or total ankle replacements only.

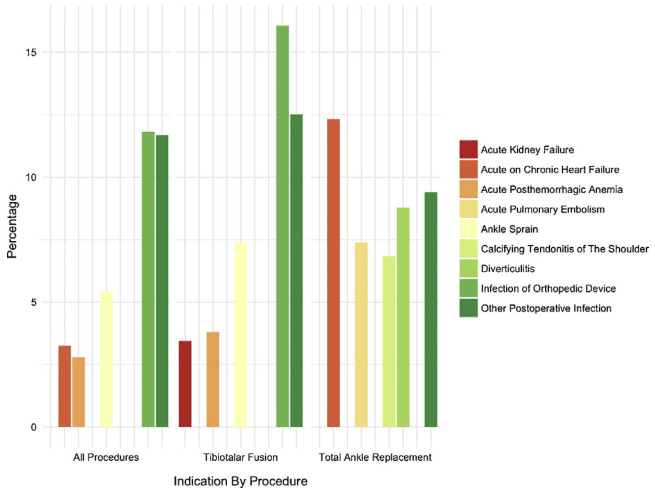

Fig. 2. Top 5 indications for 30-day readmission broken down by all procedures, tibiotalar fusions only, or total ankle replacements only.

Table 2
Results from multivariable logistic regression with readmission as the outcome variable.

	Odds ratio (95% CI)	P-Value
Age	0.996 (0.9725–1.02)	0.7414
Female gender	1.2699 (0.7067–2.2817)	0.4244
Deficiency anemia	2.1788 (1.0344–4.5889)	**0.0406**
Rheumatoid arthritis	1.079 (0.3541–3.2878)	0.8936
Congestive heart failure	0.8157 (0.217–3.0662)	0.763
Chronic lung disease	1.0496 (0.5212–2.1137)	0.8922
Coagulopathy	3.5148 (1.0751–11.4913)	**0.0377**
Depression	1.3348 (0.5285–3.3712)	0.5413
Complicated diabetes	0.6508 (0.2365–1.7907)	0.4056
Hypertension	1.3224 (0.7261–2.4083)	0.361
Obesity	0.474 (0.2447–0.9179)	**0.0269**
Renal failure	2.8272 (1.0975–7.2828)	**0.0314**
Medicare	1.3709 (0.6784–2.7705)	0.3796
Medicaid	1.5445 (0.5494–4.342)	0.4098
Other insurance	3.3987 (1.0965–10.5349)	**0.0341**
Teaching hospital	0.9887 (0.5863–1.6676)	0.9662
Discharge to facility	1.8544 (0.9153–3.757)	0.0866
Discharge w/home health care	1.0224 (0.4604–2.2706)	0.9566
LOS 3 days or more	1.3724 (0.7185–2.6216)	0.3378
Tibiotalar fusion	2.5109 (1.3715–4.5968)	**0.0029**

Bolded numbers indicate statistical significance.

the outcomes and efficacy of each procedure to be comparable [10,11,19,20].

In general, patients in the TTF group had more comorbidities, with a statistically significant larger proportion of patients who had deficiency anemias, rheumatoid arthritis, congestive heart failure, depression, complicated diabetes, obesity, and renal failure. Patients who received a TAA were statistically older by over 6 years compared to those who received a TTF. Age, however, was not found to be an independent risk factor for 30-day readmission on multivariable analysis. The 6-year difference in age seen between the two groups is likely explained by the shorter survivorship total ankle replacements [21,22]. Koivu et al. recently published long term results of the Scandinavian Total Ankle Replacement and found that survivorship decreased from 93.3% at 5 years to 63.6% at 15 years follow-up [22]. Of the 34 ankles replaced in the study, 15 (44%) required revision, with 5 being revised for marked osteolysis. The authors detected radiologic osteolysis in 50% of ankles, with a median time to detection of 7 years. Several other studies of the same prosthesis found comparable survivorship rates, with survivorship at 14 years dropping as low as 45% in one study

[11,21–23]. These findings underscore the importance of considering patient age, lifestyle, and implant survivorship when choosing between total ankle arthroplasty or ankle fusion to treat a particular patient.

This notion is supported by the comparison in complication and reoperation rates between total ankle replacements and ankle fusions. A multicenter study using patients from the Canadian Orthopedic Foot and Ankle Society (COFAS) found that at the mean follow-up of 5.5 years, patients treated with arthrodesis saw an average improvement in ankle osteoarthritis scale (AOS) of 25.5 points, while patients treated with ankle arthroplasty only experienced an improvement in AOS scores of 19.8 points [11]. When baseline characteristics were taken into consideration, though, the improvement in scores became much more similar between the two groups. The study also demonstrated the increased rate of reoperation and major complications in patients treated with total ankle arthroplasty. Of the 281 ankles replaced, 19% experienced a major complication and 17% were revised, whereas only 7% of the 107 fused ankles experienced a major complication and 7% were revised. Though these numbers are striking, the authors did not perform any statistical comparisons in their analysis of revision and complication rates between the groups. A meta-analysis by Kim et al. demonstrated similar results, with a relative risk of reoperation of 1.81 after receiving a total ankle replacement [19] Additionally, total ankle replacement carried a relative risk of developing a complication of 2.25. These findings demonstrate that while outcomes following ankle fusion and total ankle arthroplasty may be comparable, the risk of reoperation or developing a major complication are higher after receiving a total ankle replacement.

The increased reoperation and complication rates after total ankle arthroplasty seen in the literature are likely related to the survivorship of the technique. The results of the present study provide a temporal contrast by examining very short term events following either ankle fusion or total ankle arthroplasty. All-cause 30-day readmission rates following ankle fusion and total ankle replacement were 4.4% and 1.4%, respectively, and this difference was statistically significant. Multivariable logistic regression demonstrated that ankle fusion patients were 2.51 times more likely to experience a 30-day readmission, independent of comorbidities, insurance status, discharge location, or length of hospital stay. This finding is important because when confronted with a sicker patient, surgeon's may opt for a more definitive fixation with ankle fusion over arthroplasty. Our results, however, suggest that independent of comorbidities, ankle fusion is a risk factor for postoperative readmission. The other independent risk factors for readmission were deficiency anemia (OR 2.18), coagulopathy (OR 3.51), renal failure (2.83), and having other insurance relative to private (OR 3.40). Aside from similar comorbid conditions reported as risk factors in the literature, private insurance has consistently been associated with better outcomes throughout the orthopedic literature, which reflects the impact of socioeconomic disparities within the healthcare system in the United States [24,25].

It is also clear from the results that the reasons for readmission after each procedure were different. The causes for readmission after ankle fusion were more directly related to the procedure, with implant infection, postoperative infection, ankle sprain, and hemorrhagic anemia being among the top 5 indications for readmission. In contrast, the reasons for readmission after TAA were more medical in nature and unrelated to surgery, with acute on chronic heart failure, diverticulitis, and frozen shoulder among the top 5 reasons for readmission. This demonstrates that the strategy for minimizing readmissions after each procedure may be different. Patients undergoing TAA may benefit from more aggressive risk stratification and medical optimization prior to surgery. Such results support that each procedure may be chosen in a tailored way based on the patient's presentation.

Another important factor that may influence the efficacy of each of these treatment modalities is the range of motion a patient has following each operation. Pedowitz et al. conducted a study of patients who either underwent isolated tibiotalar fusion or total ankle arthroplasty, and examined overall arc of movement and talonavicular movement using weight-bearing lateral maximum dorsiflexion and plantarflexion radiographs [16]. The authors also collected short form-12 (SF-12), visual analog pain scores, and the foot and ankle ability measure (FAAM). The mean arc of motion in the fusion group was 24.3° compared to 34.2° observed in the arthroplasty group ($p < 0.0001$). Additionally, the authors found that almost the entirety of motion in the arthrodesis patients came from the talonavicular joint (22.8°), whereas a more physiologic range of motion at the talonavicular joint was seen in the arthroplasty group (10.5°). The authors observed statistically significant better postoperative visual analog pain scores and FAAM scores in the total ankle arthroplasty group. The decreased overall range of motion and increased range of motion at the midfoot seen in the arthrodesis group may contribute to the worse pain and FAAM scores experienced by these patients, and may also predispose the patients to further degenerative changes over time [16]. Additional studies suggest that restriction of motion in ankle fusion patients may lead to degeneration of adjacent joints, which would play an integral role in a patient's definitive outcome [26,27]. Future investigations into the impact of adjacent joint degeneration on patient outcome would help to clarify the long-term efficacy of ankle arthrodesis.

5. Limitations

This study is limited by only one year of data collection by the database that was used. The trends of readmissions for each procedure may be changing over time, and investigating such trends was therefore not possible with the present study. Additionally, the database only collects certain comorbidities, and does not have information that may be more relevant to the orthopedic population. There is also no information in the database regarding outcome scores, radiologic status, or range of motion, and it is therefore difficult to determine if the observed readmission rates had any negative clinical impact. Cost data was also not collected which prevents the calculation of any costs incurred by a readmission.

6. Conclusions

In sum, the results of the present study demonstrate that ankle fusion is an independent risk factor for 30-day readmission with an odds ratio of 2.51. These results have implications for short term patient outcomes as well as costs of treatment. The literature suggests that both ankle arthrodesis and total ankle replacement are both effective procedures in the mid to long-term, with ankle replacement patients developing more major complications and experiencing more reoperations, but sustaining more physiologic range of motion postoperatively. Surgeons must use a patient specific, tailored approach when deciding whether to manage a patient with tibiotalar fusion or total ankle arthroplasty.

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Conflicts of interests

The authors have no conflicts of interest relevant to the study presented in this manuscript.

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