Epidemiology of Total Ankle Arthroplasty: Trends in New York State

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Feature Article

Total ankle arthroplasty (TAA) is an increasingly used procedure for patients affected by ankle arthritis. The current gold standard for end-stage ankle arthritis is arthrodesis, despite evidence demonstrating that TAA allows better joint motion and overall function while achieving equivalent pain relief. Interest in TAA is increasing in the United States, within both the orthopedic community and patient population due to improved operative techniques and new implant designs.

Several studies evaluating short- and medium-term outcomes of TAA using data from national registries in Northern Europe, New Zealand, and Australia have reported failure rates ranging from 7.1% to 19% at 5 years and 24% to 31% at 10 years. A recent review of the Cochrane database revealed a 10-year survival rate of 89%, with a yearly failure rate of 1.2%. The experience in the United States with TAA, which is mainly reported by single institutions and a few multicenter studies, has shown implant survival rates to be as high as 90% at 10 years.

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A recent study by Terrell et al. examined trends in patient demographics and the incidence of ankle fusion and TAA surgery performed in the United States using a commercial national health care database. They found a 57% increase in the rate of TAsAs performed between 2004 and 2009, while the number of patients receiving ankle fusions remained the same. The database used was limited by its inability to provide patient and clinical data such as patient age, diagnosis before and after surgery, comorbidities, implant failure, and revision surgeries. Two other recent studies using the Nationwide Inpatient Sample and the Medicare Provider Analysis and Review data files showed similar results with increased rates of TAA. In general, no national arthroplasty database exists in the United States, thus population-based reports of TAA failure rates and evaluation of practice patterns across health care systems have not been published.

The purpose of this study was to use a statewide hospital discharge database to evaluate the current incidence, etiology, and failure rates associated with TAA in New York State.

### Materials and Methods

Patients who underwent primary TAA from 1997 to 2010 were identified in the Statewide Planning and Research Cooperative System (SPARCS) database established in 1979 and maintained by the New York State Department of Health. SPARCS is an all-payer census of inpatient hospital admissions and ambulatory operative procedures performed in the state of New York. Facilities are required to report claims data to SPARCS in a specified format file, which is detailed in the SPARCS Input Data Dictionary (http://www.health.ny.gov/statistics/sparcs/sysdoc/input5010.pdf). The database contains information on characteristics such as age, sex, race, state of residence, payor status, and International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis and procedure codes. In this study, ICD-9-CM codes were used to identify operative diagnosis group, comorbidities and complications, and procedures performed in TAA patients (Table 1).

The ICD-9-CM procedure code for total ankle replacement (81.56) was used to identify 443 admissions with primary TAA. Three admissions were excluded due to missing patient information, resulting in a cohort of 420 patients who underwent 444 primary TAA procedures during 440 admissions. The analysis included only 1 record per patient and used the patient’s age and comorbid status as of the first TAA procedure. Patients were categorized into 3 diagnosis groups using ICD-9-CM codes: traumatic arthritis (716.X7), rheumatoid arthritis (RA) (714.XX), and osteoarthritis (OA) (715.X7).
For patients having a diagnosis code from more than 1 category, a diagnosis group was assigned using the following ordering system: traumatic arthritis > RA > OA. Patients without a diagnosis code from any of these 3 categories were categorized as other. ICD-9-CM diagnosis codes also were used to calculate the Charlson-Deyo Comorbidity score for patients during the index primary TAA admission. This score was selected because it allows calculation of a score that summarizes risk based on age and the number and types of comorbid conditions of a patient. It can be used generally to stratify risk or as a mortality predictor.

Encrypted unique patient identifiers were used to identify subsequent inpatient admissions for the TAA cohort through 2012 to assess outcomes of TAA failure, 90-day all-cause readmission, complications, and additional surgery. Patients in this cohort had a median time from index TAA to the end of the study period of 2210 days (range, 745-5777 days), and all patients had a minimum follow-up of 2 years. Admissions including additional minor foot and ankle procedures were selected using the following codes: ostectomies (ICD-9-CM 77.80, 77.88, and 77.89), incision and excision of joint structures, ankle (ICD-9-CM 80.17-80.47, 80.87, and 80.97), and other fusion of the foot (ICD-9-CM 81.14-81.18). TAA implant failure was defined as subsequent TAA revision (ICD-9-CM 81.59), ankle arthrodesis (ICD-9-CM 81.11), ankle implant removal (ICD-9-CM 80.07), or amputation (ICD-9-CM 84.12-84.17).

Descriptive statistics were calculated for the variables of interest. Means and standard deviations were reported for continuous variables, and frequencies and percentages were presented for categorical variables. The Wilcoxon rank sum test and Fisher exact test were used to evaluate associations between patient characteristics and the outcomes of interest for continuous and categorical variables, respectively. Multivariable logistic regression models were developed for each outcome using selected variables based on clinical relevance and statistical significance in univariate analyses and adjusting for age, sex, year of surgery, and New York State residence, as it was more likely in-state residents would return to a New York hospital for subsequent treatment. Survival estimates were generated using the Kaplan-Meier method.

RESULTS

During the 14-year study period from 1997 to 2010, there was a large increase in the number of TAAs performed per year, from 4 primary TAAs performed in 1997 to 87 TAAs in 2010 (Figure 1). Beginning in 2008, the number of replacements increased considerably, with a more than 3-fold change from 2007 to 2010.

The mean age of TAA patients was 61 years (range, 24-91 years), 248 (59%) patients were women, and 329 (78.3%) identified as white. The majority of patients were residents of New York State (361, 86%). Payor status had the following breakdown: Medicare, 45.9%; private insurance, 41%; workers’ compensation, 6%; Medicaid, 5.7%; and other (eg, self-pay), 1.4%. The patients in this cohort were generally healthy, with most having a Charlson-Deyo Comorbidity score of zero (289, 68.8%). Of the remaining 130 patients, 97 (23.1%) had a score of 1 and 34 (8.1%) had a score of 2 or greater. All patients who underwent subsequent procedures had a Charlson-Deyo Comorbidity score of 2 or lower (Table 2).

Of the 3 major diagnosis groups, ankle OA was the most common (37.4%), followed by traumatic arthropathy (34.3%) and RA (15.5%) (Figure 2). Of the 54 TAA patients who were classified as other, 36 (66.7%) had a code specifying OA of the pelvis, hip, or leg. Of those, the 2 most prevalent diagnoses were localized osteoarthritis of the lower leg (ICD-9-CM 715.36) in 15 patients and osteoarthritis of the lower leg, unspecified (ICD-9-CM 715.96) in 13 patients. Patients with a diagnosis of RA were younger (58.2 vs 62 years, P<.05) and more often women (83.3% vs 54%, P<.05). Patients with RA also were more likely to undergo bilateral ankle replacements (12.9% vs 4.3%,
Of those patients who underwent bilateral TAA, 91.7% (27 of 30) had the second TAA performed by the same surgeon who performed the initial replacement, with 4 of the 27 being simultaneous TAAs performed on the same day.

Many patients had concomitant procedures in addition to undergoing TAA. The most common was ankle fusion, which was performed in 12.1% of patients. The general code did not further specify where the fusion was located within the ankle. The second most common procedure was a subtalar fusion in 5.5% of patients. Other procedures performed concomitantly with TAA on at least 5 patients included other fusion of the foot (1.9%), triple arthrodesis (1.2%), and ankle synovectomy (1.2%).

Within 90 days of the index procedure, the all-cause readmission rate was 9.5% (40 of 420) with Charlson-Deyo comorbidity score being the factor most associated with readmission in the multivariable logistic regression model. Patients with scores of 2 or higher were over 4 times more likely to be readmitted than patients with a comorbidity score of zero (odds ratio [OR], 4.32; 95% confidence interval [CI], 1.66-11.24) (Table 3). The most common reasons for readmission were postoperative infection in 12 patients (30%), mechanical complications in 4 patients (10%), fracture below the knee joint and pulmonary embolism in 3 patients each (7.5%), and nonhealing operative wound in 2 additional patients (5%). One patient (2.5%) was admitted for each of acute myocardial infarction, sepsis, and other joint disorder.

The rate of subsequent failure procedures after TAA was 13.8% (58 of 420). The most common diagnosis at the time of TAA failure was mechanical complication (ICD-9-CM 996.4X), which occurred in 30 of 58 patients (62.5%). The exact mechanical complication was not able to be determined from the database further than the general code specified. The operative procedure performed most commonly for TAA failure was a revision in 22 patients (45.8%). A conversion to ankle fusion occurred in 19 patients (39.6%), implant removal in 5 patients (10.4%), and amputation in 2 patients (4.2%). For patients who had a failure procedure performed,

### Table 2

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (range), y</td>
<td>61.4 (24-91)</td>
</tr>
<tr>
<td>Sex, No. (%)</td>
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<tr>
<td>Female</td>
<td>247 (59.2)</td>
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<tr>
<td>Male</td>
<td>170 (40.8)</td>
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<tr>
<td>Race, No. (%)</td>
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<tr>
<td>White</td>
<td>327 (78.4)</td>
</tr>
<tr>
<td>African American</td>
<td>23 (5.5)</td>
</tr>
<tr>
<td>Asian</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Other</td>
<td>28 (6.7)</td>
</tr>
<tr>
<td>Unknown</td>
<td>38 (9.1)</td>
</tr>
<tr>
<td>Resident of New York State, No. (%)</td>
<td>359 (86.1)</td>
</tr>
<tr>
<td>Primary payor, No. (%)</td>
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<tr>
<td>Medicare</td>
<td>191 (45.8)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>23 (5.5)</td>
</tr>
<tr>
<td>Private</td>
<td>172 (41.3)</td>
</tr>
<tr>
<td>Workers’ compensation</td>
<td>25 (6.0)</td>
</tr>
<tr>
<td>Other (eg, self-pay)</td>
<td>6 (1.4)</td>
</tr>
<tr>
<td>Index Charlson-Deyo score, No. (%)</td>
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<tr>
<td>0</td>
<td>287 (68.8)</td>
</tr>
<tr>
<td>1</td>
<td>97 (23.3)</td>
</tr>
<tr>
<td>2+</td>
<td>33 (7.9)</td>
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<tr>
<td>Diagnosis group, No. (%)</td>
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<tr>
<td>Ankle osteoarthritis</td>
<td>157 (37.7)</td>
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<tr>
<td>Rheumatoid arthritis</td>
<td>63 (15.1)</td>
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<tr>
<td>Traumatic arthritis</td>
<td>143 (34.3)</td>
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<tr>
<td>Other</td>
<td>54 (13.0)</td>
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<tr>
<td>Surgery type, No. (%)</td>
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<tr>
<td>Unilateral</td>
<td>393 (94.2)</td>
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<tr>
<td>Bilateral, 2 admissions</td>
<td>20 (4.8)</td>
</tr>
<tr>
<td>Bilateral, same day</td>
<td>4 (1.0)</td>
</tr>
<tr>
<td>Concomitant foot/ankle procedures, No. (%)</td>
<td></td>
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<tr>
<td>Ankle fusion</td>
<td>51 (12.2)</td>
</tr>
<tr>
<td>Subtalar fusion</td>
<td>23 (5.5)</td>
</tr>
<tr>
<td>Other fusion of foot</td>
<td>8 (1.9)</td>
</tr>
<tr>
<td>Triple arthrodesis</td>
<td>5 (1.2)</td>
</tr>
<tr>
<td>Ankle synovectomy</td>
<td>5 (1.2)</td>
</tr>
</tbody>
</table>

Abbreviation: TAA, total ankle arthroplasty.
the median time to failure was 649 days (range, 55-4369 days). Two patients having a failed TAA within 90 days of their arthroplasty had a diagnosis of mechanical complication (ICD-9-CM 996.4). One patient underwent an ankle fusion, and the other patient had the ankle implant removed without undergoing any subsequent ankle procedure.

Age at index procedure was lower in patients whose TAA failed (56.5 vs 62 years, respectively), and failure was 3% less likely for each additional year of patient age at the time of surgery (OR: 0.97; 95% CI: 0.94-0.99). No other patient-related factors including payor, diagnosis, and comorbidity score were found to be associated with subsequent failure (Table 4). The overall survival rates were 97.4% at 1 year, 90.1% at 3 years, and 87.1% at 5 years (Figure 3).

**DISCUSSION**

This study represents the first to use a statewide database (SPARCS) to assess TAs in New York State and demonstrates the number of cases performed has been steadily increasing, particularly beginning in 2008. The TAA failure and revision rates appear similar to those reported in other national registries. Published registry survival rates for TAA are not yet comparable to those of hip and knee arthroplasty at 5 years compared to the national registries for hip and knee arthroplasty. Within Northern Europe, New Zealand, and Australian registries, total hip replacements have a 5-year revision rate of 6.45% and total knee replacements were revised 6.3% of the time. The TAA 5-year failure rate of 12.9% did perform better than total elbow replacements, which were revised in up to 25.4% at the same time point.

The SPARCS database offers advantages over previous population-based studies in that it provides information regarding comorbidities, readmission, and revision surgery allowing the calculation of survival rates. The current study is believed to be the first published database review of in-hospital peri- and postoperative medical complications following TAA. It also includes data across all insurance payors and institutions within the state of New York.

The demographic data are consistent with other studies, which suggests that TAA is performed more commonly in women than men and in patients age 60 years or older. Although it is well known that the majority of ankle arthritis occurs after trauma, the percentage of patients undergoing TAA with a diagnosis of osteoarthritis was higher than expected; this is most likely due to inaccuracies in coding. Finally, the comorbidity data suggest TAA generally is performed in healthy patients; when performed in patients who are not generally healthy, TAA...
has a greater likelihood of leading to complications.

The overall 5-year rate of TAA failure procedures in the SPARCS database was 12.9%. Several studies have been published that examined the failure rate of TAA in other countries with the use of their national joint arthroplasty registries. The failure rate of ankle replacements at 5 years in other national joint registries ranged from 11% to 19% and then increased to 24% to 31% at 10 years. The data from the United States, which show failures at the lower end of previously published data, may be due to a larger percentage of the database having a shorter follow-up as most implantations occurred during the later years of the study. It also should be noted that the published data from registries outside the United States contain ankle replacement implants not available to surgeons for use in the United States, which also may have led to differences in failure rates between countries. It therefore becomes important to examine the experience with implant options in the United States.

Limitations of this study include those common to database studies in general, such as potential inaccuracies in coding by hospital administrators as well as a lack of patient-reported comorbidities and outcomes. New York State has strict requirements on the submission of data and attempts to limit inaccuracies in the database by periodically performing audits to verify data validity and consistency. All hospitals in New York State are required to submit 100% of admission data to the SPARCS database within 180 days of the end of the fiscal year in which the admission took place, which would ensure the data ending in 2010 are complete. Because of this, SPARCS has been used previously in similar studies to report on total shoulder arthroplasty, total elbow arthroplasty, anterior cruciate ligament reconstruction, and rotator cuff repair.

The SPARCS database cannot account for those patients who had a revision of the TAA performed in another state and those who had implant failure but were not admitted to a hospital or did not undergo further surgery. This will underestimate the true failure rate.

Future goals include reanalysis of TAA in the SPARCS database in the next 5 to 10 years to evaluate long-term survival rates in patients with modern TAA prosthetic designs. The number of TAAs assessed also could be expanded by using the State Inpatient Databases (SID), which are part of the Healthcare Cost and

### Table 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR</th>
<th>95% Lower CL</th>
<th>95% Upper CL</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>0.97</td>
<td>0.94</td>
<td>0.99</td>
<td>.01</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male†</td>
<td></td>
<td></td>
<td></td>
<td>.10</td>
</tr>
<tr>
<td>Female</td>
<td>0.78</td>
<td>0.40</td>
<td>1.51</td>
<td>.46</td>
</tr>
<tr>
<td>New York State resident</td>
<td>0.57</td>
<td>0.24</td>
<td>1.35</td>
<td>.20</td>
</tr>
<tr>
<td>Year of surgery</td>
<td>0.83</td>
<td>0.76</td>
<td>0.90</td>
<td>&lt;.001</td>
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<tr>
<td>Charlson-Deyo score</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0†</td>
<td></td>
<td></td>
<td></td>
<td>.14</td>
</tr>
<tr>
<td>1</td>
<td>0.21</td>
<td>0.03</td>
<td>1.72</td>
<td></td>
</tr>
<tr>
<td>2+</td>
<td>1.56</td>
<td>0.74</td>
<td>3.27</td>
<td></td>
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<tr>
<td>Readmission within 90 days of index TAA</td>
<td>3.04</td>
<td>1.27</td>
<td>7.27</td>
<td>.01</td>
</tr>
</tbody>
</table>

Abbreviations: CL, confidence limit; OR, odds ratio; TAA, total ankle arthroplasty.

*Reference.*

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**Figure 3:** Survival curve showing Kaplan-Meier survivorship for total ankle arthroplasty (TAA) from time of implantation.
Utilization Project (HCUP) and contain similar administrative discharge information for many other states.\(^{28}\) Implementation of a national TAA joint registry in the United States to evaluate a large number of procedures as well as individual surgeons, institutions, and prosthesis survival rates will become more important as TAA popularity grows.

**Conclusion**

The analysis of a single state database provides the first published data regarding the survival rate of TAA across a large number of institutions and insurance payers. During the period data were collected, the incidence of TAA increased greatly, particularly in the past several years. The overall revision rate compared favorably to other national joint registries. However, the overall failure rate at 5 years is still not comparable to those of hip and knee replacements. Therefore, surgeons who regularly perform ankle replacements should be aware and counsel their patients accordingly regarding the possibility of the need for revision and other subsequent procedures.

**References**