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Identifying Risk Factors for 30-Day Readmissions After Triple Arthrodesis Surgery

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ABSTRACT

Rigid flatfoot deformity is a debilitating condition that can be managed by triple arthrodesis surgery. Triple arthrodesis has the potential to restore health-related quality of life, but it is also associated with several complications. Few studies have examined the 30-day readmission rates after triple arthrodesis. The objective of this study was to investigate risk factors for 30-day all-cause readmissions after triple arthrodesis. The nationwide readmission database was queried from 2013. By using International Classification of Disease, Ninth Revision, procedure codes, all triple arthrodesis procedures were identified. Demographic factors, comorbidities, insurance status, and hospital characteristics were statistically compared between patients who experienced a 30-day readmission and those who did not. Multivariable logistic regression was used to identify independent risk factors for 30-day readmission. Overall, 1916 triple arthrodesis cases were identified. The overall 30-day readmission rate after triple arthrodesis was 4.6%. Univariate analysis revealed a statistically higher proportion of patients with electrolyte abnormalities (13.8% vs 4.6%; $p < .01$) in the patients who were readmitted within 30 days compared with those who were not. Multivariable analysis demonstrated Medicaid insurance, relative to private insurance, as the only statistically significant predictor of 30-day readmission with an odds ratio of 4.43 ($p < .05$). These results suggest that patients of lower socioeconomic status may be at a greater risk for development of a short-term readmission after triple arthrodesis surgery. These findings are important for surgeon and patient communication, counseling, and postoperative care when choosing to pursue triple arthrodesis surgery.

Adult-acquired flatfoot deformity is a painful and disabling condition that can lead a once–fully functional individual to become severely debilitated and impaired (1–3). Although the cause of adult-acquired flatfoot is multifactorial, the greatest contributing factor is generally insufficiency of the posterior tibial tendon (4,5).

Loss of posterior tibial tendon function leads to collapse of the transverse tarsal joint, destabilization of the midfoot, and abduction of the forefoot, resulting in a pes planovalgus position. Ligaments around the midfoot and ankle also deteriorate as the deformity progresses, further contributing to instability (6,7). The deformity leads to abnormal stress on the joints of the ankle, midfoot, and hindfoot, which can lead to severe arthritis and arthropathy of the foot and ankle and ultimately a rigid, irreducible foot deformity (5,8).

Treatment for the early and flexible stages of the disorder are nonoperative or joint-sparing surgical procedures (9–11). Rigid deformities require fusion of the mid and hindfoot joints to correct the deformity and achieve a stable, plantigrade foot with adequate physiological alignment (12–14). Although triple arthrodesis is indicated for progressive neurologic conditions as well, the most common indication is severe, rigid flatfoot deformity (15,16).

Although several modifications of the technique have been developed over the years, it was originally described as a fusion of the calcaneocuboid joint, talocalcaneal joint, and talonavicular joint (17). Triple arthrodesis is an extensive procedure that can successfully restore a patient's quality of life, but it is also associated with complications such as nonunion, wound breakdown, and accelerated arthritis of surrounding joints (18,19).

Although the incidence of these complications has been documented in several studies, few studies have examined readmission rates after triple arthrodesis. Readmission rates have become an important metric for evaluating hospitals on quality of care and resource use (20). Hospitals may be subject to penalties when readmissions occur for certain

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procedures (21). Additionally, readmissions increase costs and re-expose patients to the hospital environment, which may increase risk of infection or adverse events.

Understanding risk factors for readmissions after surgical procedures is therefore paramount for improving quality of care. The objective of this study was to investigate risk factors for all-cause 30-day readmission after arthrodesis surgery. We hypothesize that comorbidities and demographic factors known to be risk factors for complications after foot and ankle surgery, such as diabetes, obesity, and Medicaid insurance, will also be risk factors for 30-day readmissions after triple arthrodesis.

Methods

This study used 2013 data from the Nationwide Readmissions Database (NRD), Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality. International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure codes were used to query the database for all triple arthrodesis (81.12) procedures.

Adult patients (age ≥18) who underwent elective procedures were included. Patients who died during initial admission or who were transferred from another hospital to undergo surgery were excluded. Considering the study investigated 30-day readmissions, all patients who underwent surgery on December 1, 2013, or onward were excluded to allow sufficient follow-up time. ICD-9-CM diagnosis codes were used to exclude any patients with admission diagnoses related to orthopedic implant failure or infection, fracture, nonunion, or malunion to minimize revision procedures (733.81, 733.82, 99640-996.49, 996.66, 996.67, 996.69, 996.77-996.79). 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" category because the population size of each category was very small. All-cause 30-day readmissions were examined for the remaining patients who underwent triple arthrodesis.

Statistical Analysis

All data were analyzed with 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 that can extrapolate the data within the NRD to a national level to make it more generalizable. This discharge weight variable was applied to all statistical tests. All normally distributed, continuous variables were compared between cohorts by use of an unpaired t test. All non-normally distributed continuous variables were compared by use of a Wilcoxon rank sum test. Categorical variables between groups were compared by use of a χ^2 test.

Multivariable logistic regression was performed to identify risk factors, using all-cause 30-day readmission as the outcome variable. The independent variables investigated as independent risk factors included age, sex, deficiency anemia, congestive heart failure, chronic lung disease, depression, complicated diabetes, hypertension, electrolyte disorders, neurologic disorders, obesity, valvular heart disease, insurance status, and length of stay. These comorbidities have been found as risk factors for various orthopedic procedures (22,23). Age and length of stay were continuous variables; all other variables were binary, with the exception of insurance status, which had the factorial levels explained earlier. For insurance status, the reference level was private insurance. The rational for this is that Medicaid insurance has been shown to be a risk factor for poor outcomes after other orthopedic procedures, and we hypothesize that Medicaid will be a risk factor for 30-day readmissions (24,25). Medicare patients are typically older and have more comorbid conditions than the privately insured, which was an additional reason the private insurance group was the reference group. Therefore, the odds ratio in our results will demonstrate the risk of Medicaid and Medicare relative to private insurance. All statistical tests were considered significant with a $p < .05$.

Results

Patient Characteristics

A total of 2395 adult (>18 years), elective triple arthrodesis procedures were identified. Zero patients were excluded as a result of death; 38 were excluded for transfer from another facility on day of surgery; 147 were excluded who had a procedure done in December; and 294 were excluded who presented with an admission diagnosis related to orthopedic implant failure or infection, fracture, nonunion, or malunion. Therefore, a total of 1916 triple arthrodesis cases were included in the final analysis, with 89 (4.6%) all-cause 30-day readmissions. A Shapiro-Wilk test demonstrated that age and length of stay were both non-normally distributed variables ($p < .001$ for both). There was a statistically significant difference in the proportion of patients who had electrolyte disorders between those who were readmitted within 30 days and those who were not (13.8% vs 4.6%; $p = .01$; Table 1).

Indications for Surgery and for 30-Day Readmissions

The top 5 diagnoses for index procedures were local osteoarthritis not otherwise specified (14.2%), flatfoot (13.3%), acquired ankle/foot deformity (9.4%), ankle arthropathy (7.0%), and ankle osteoarthritis (6.0%) (Fig. 1). The top 5 reasons for 30-day readmission were postoperative infection (14.6%), implant infection (10.3%), wound disruption (9.3%), hematoma (5.8%), and influenza (3.3%) (Fig. 2).

Multivariable Logistic Regression

Only 1 statistically significant independent risk factor for all-cause 30-day readmission was identified. Relative to private insurance, Medicaid had an odds ratio of 4.43 for being readmitted within 30 days (Table 2). Despite not being statistically significant risk factors for 30-day readmission, patients with congestive heart failure or electrolyte disturbance and those insured by Medicare were all 2-fold more likely to be readmitted within 30 days after undergoing triple arthrodesis surgery (Table 2).

Discussion

Triple arthrodesis is an extensive procedure used for managing severe end-stage arthritis, as well as for correction of adult-acquired flatfoot deformity. Some of the more common complications of triple arthrodesis include wound breakdown, nonunion, and degeneration of the surrounding joints (18,19). Beyond the complications, few studies have examined readmission rates after triple arthrodesis. This study sought to examine the 30-day readmission rate and identify risk factors for 30-day readmission after triple arthrodesis.

We observed a 4.6% 30-day all-cause readmission rate after triple arthrodesis. The most common reasons for readmission were related to infection or wound problems. Few studies have investigated the 30-day

Table 1
Demographic characteristics, comorbid conditions, and hospital information for patients who were readmitted within 30 days of discharge

Variable	No readmission (n=1827)	30-day Readmission (n=89)	P Value
Age (median [IQR])	60 [51.0,69.0]	59 [50.9,71.1]	0.82
Female (%)	1160 (63.5)	45 (50.6)	0.16
Deficiency Anemia (%)	147 (8.0)	*	0.65
Congestive Heart Failure (%)	46 (2.5)	*	0.05
Chronic Lung Disease (%)	300 (16.4)	15 (16.8)	0.95
Depression (%)	244 (13.4)	*	0.31
Complicated Diabetes (%)	125 (6.8)	*	0.23
Hypertension (%)	1056 (57.8)	61 (68.5)	0.26
Electrolyte Disorder (%)	85 (4.6)	12 (13.8)	0.01
Neurologic Disorder (%)	87 (4.8)	*	0.67
Obesity (%)	462 (25.3)	34 (38.5)	0.11
Valvular Heart Disease (%)	57 (3.1)	*	0.18
Insurance			0.08
Medicaid (%)	125 (6.8)	15.4 (17.4)	
Medicare (%)	835 (45.7)	46 (52.2)	
Other Insurance (%)	102 (5.6)	*	
Private Insurance (%)	765 (41.9)	24 (27.4)	
Length of stay (median [IQR])	2 [2.0,3.0]	3 [2.0,3.7]	0.27

Abbreviation: IQR, interquartile range.
*Smaller than the recommended number to be published by the Healthcare Cost and Utilization Project (HCUP)

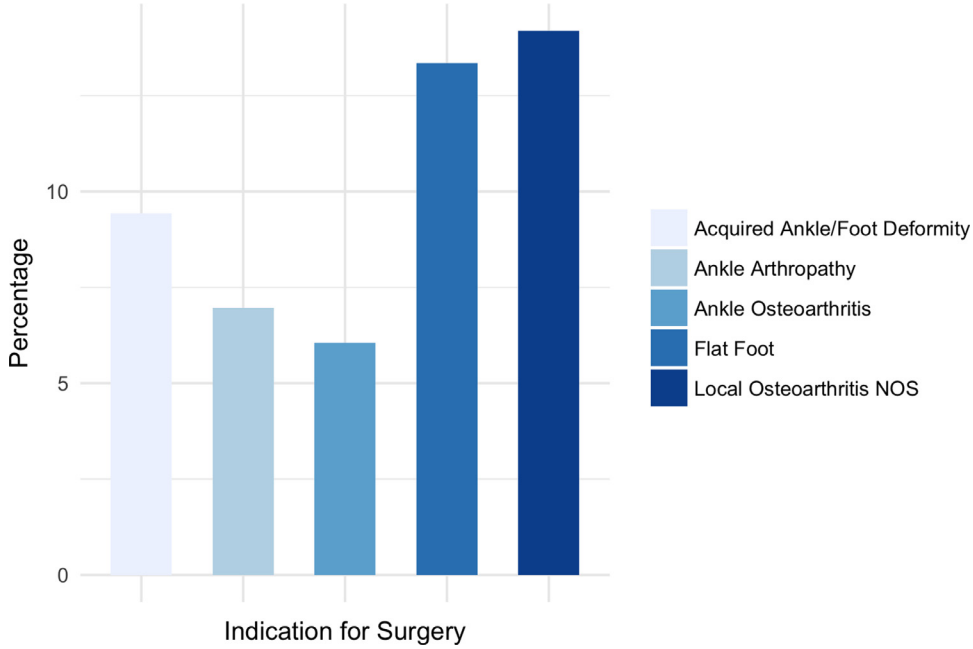

Fig. 1. Top 5 indications for triple arthrodesis surgery (N = 1916).

readmission rates after foot and ankle procedures, making it difficult to contrast the results of this study for triple arthrodesis to other procedures. Some other common orthopedic surgery procedures, such as total knee arthroplasty and transforaminal lumbar interbody fusion, carry rehospitalization rates of 3.7% and 5.5%, respectively (26,27). Based on the literature, the 30-day readmission rate of 4.6% that we observed after triple arthrodesis seems similar to other orthopedic surgery procedures. One of the major complications after triple arthrodesis is wound breakdown (16,19). Although wound breakdown could not be specifically investigated, wound disruption, hematoma, and postoperative infection were among the top 5 reasons for readmissions in the patients we analyzed. A number of studies demonstrate that performing the procedure entirely through a medial approach, or using a medial approach and performing a double-arthrodesis only, leads to a reduction in wound-healing problems (16,28,29). Care must be taken when planning triple arthrodesis procedures to minimize risk of such wound complications after the procedure.

Insurance status proved to be the only statistically significant risk factor for 30-day readmission based on multivariable regression analysis. Specifically, Medicaid status carried an odds ratio of 4.43 for 30-day

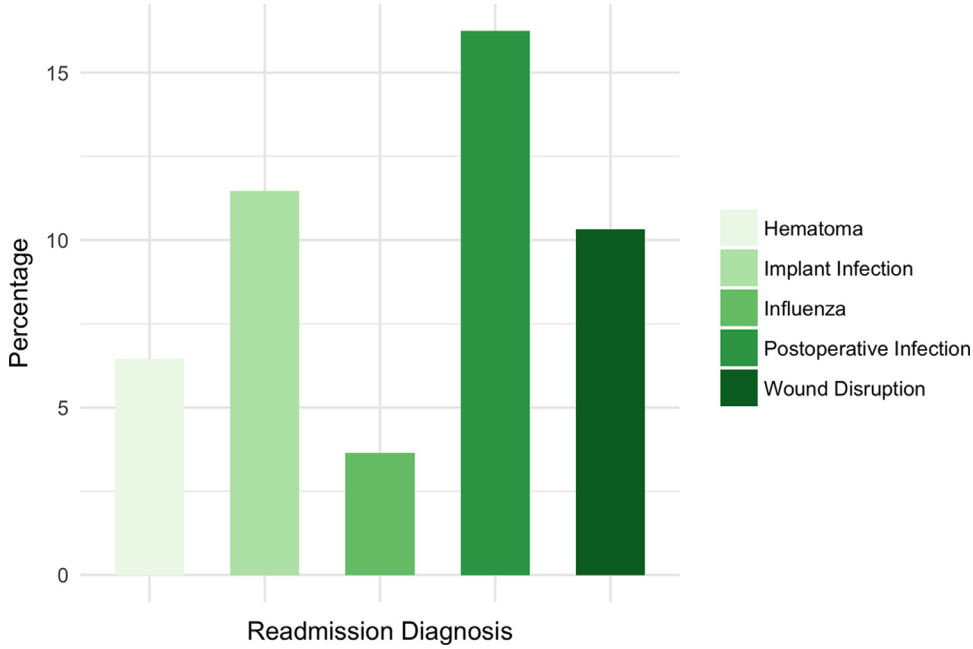

Fig. 2. Top 5 indications for 30-day readmission (N = 89).

Table 2
Multivariable logistic regression results with all-cause 30-day readmission as the outcome variable (n = 89)

	Odds Ratio (95% CI)	*p* Value
Age	0.9922 (0.9525 to 1.0336)	.71
Female sex	0.6132 (0.2604 to 1.444)	.26
Deficiency anemia	0.4172 (0.0988 to 1.7621)	.23
Congestive heart failure	2.6637 (0.6497 to 10.9202)	.17
Chronic lung disease	0.9596 (0.3333 to 2.7626)	.94
Depression	0.3909 (0.0723 to 2.1139)	.28
Complicated diabetes	0.905 (0.3167 to 2.5861)	.85
Hypertension	1.2383 (0.4645 to 3.3011)	.67
Electrolyte disturbance	2.6067 (0.8049 to 8.4415)	.11
Neurologic disorder	0.6026 (0.0583 to 6.233)	.67
Obesity	1.8875 (0.8624 to 4.1309)	.11
Valvular heart disease	2.2455 (0.6144 to 8.2071)	.22
Medicare*	2.0371 (0.7978 to 5.2016)	.14
Medicaid*	4.4268 (1.1729 to 16.7077)	.03
Other insurance*	0.9475 (0.0971 to 9.2449)	.96
Length of stay	1.0789 (0.9606 to 1.2117)	.20

Abbreviation: CI, confidence interval.
*Medicare, Medicaid, and other insurance are relative to private insurance.

readmission relative to private insurance. This result suggests that socioeconomic status may play an important role in a patient's outcome after triple arthrodesis, which is supported by several studies in the literature examining other orthopedic procedures (24,25,30,31). Tanenbaum et al (24) used the Nationwide Inpatient Sample to investigate the impact of insurance status on adverse health care quality events, and determined that after controlling patient and hospital characteristics, Medicaid and Self-Pay insurance together had an odds ratio of 1.16 relative to private insurance. Similar results have also been found for cervical spine fusion procedures, with Medicaid patients being 1.51 times more likely to have a hospital-acquired condition develop and 1.52 times more likely to experience an adverse event classified as a patient safety indicator (25). Vani et al (31) investigated the effect of insurance status on patients undergoing treatment for proximal humerus fractures. The authors found that Medicaid status had odds ratios of 2.00, 1.69, and 1.34 for developing a postoperative infection, wound complication, and acute respiratory distress syndrome, respectively.

In addition to an increased risk of adverse events based on insurance status, the prevalence of smoking among Medicaid patients is more than double that of patients with private insurance (32,33). Smoking has been documented as a risk factor for both poor wound and bone healing in foot and ankle surgery and is a predictor of negative outcome after upper and lower extremity open fracture repair (34–36). The increased incidence of smoking in Medicaid patients may be a contributing factor to 30-day readmissions, but the authors cannot conclude this from this study. The discussed literature demonstrates how Medicaid, and indirectly lower socioeconomic status, may negatively impact patient outcomes after different types of orthopedic surgery. Additionally, Medicaid patients generally have limited access and delayed access to care, leading to poorer outcomes. These findings are important for surgeons working in and treating patients in low-income areas. Patient education may play an important role in preventing readmissions in such vulnerable populations.

The notion that lower socioeconomic status negatively affects outcomes, beyond just Medicaid status, is also supported throughout the literature. Schairer et al (37) conducted a cross-sectional study of patients with clavicle fractures. Between the study period of 2005 to 2010, the authors observed an increase in the rate of operative clavicle fracture fixation of 7.4%. This increase in rates of operative fixation varied depending on patient demographics. The group that experienced the slowest increase in rate of fixation were minorities with lower-income levels who had nonprivate insurance. The authors also examined timing of surgery and found that females and those with low-income status were more likely to have delayed ($\geq$3 weeks) fixation. These findings support that low socioeconomic status beyond just insurance type may influence a patient's care. Surgeons must be cognizant of the patient population receiving treatment and take steps to educate those potentially at higher risk of adverse outcomes.

The literature and present findings underscore the importance of considering socioeconomics as a patient variable for those undergoing orthopedic surgery. Our results suggest specifically that patients on Medicaid are significantly more at risk of a 30-day readmission after triple arthrodesis than those with private insurance.

Limitations

Only 1 year of data was collected using the NRD, providing only a snapshot of 1 year's time. Readmission trends may change over time, and we were therefore unable to investigate this using only 1 year of data. One year of data also led to a relatively small number of patients who were readmitted (n = 89), which may have skewed results. Additionally, comorbidities that may be more pertinent to an orthopedic surgery population, such as smoking status, are not collected within the database. It is difficult to determine the clinical impact of our findings, given there is no correlation available to clinical outcome scores or radiographic findings. Cost data are also not reported in the database, making it difficult to extrapolate the cost burden incurred by the readmissions. Regarding comorbid conditions, large administrative databases have limited comorbidity data and do not provide sufficient data to evaluate cases based on an established, validated comorbidity index. Perhaps the most significant limitation is that we use Medicaid insurance as a proxy variable for socioeconomic status. Although in certain cases it may be an accurate representation for low socioeconomic status, it is not a direct depiction of socioeconomic status, thus limiting our conclusions. Future studies should seek to find a more precise variable for expressing health disparity and socioeconomic status, or to combine multiple databases that may allow further detail on the relationship between insurance status and socioeconomic status.

In conclusion, the literature demonstrates that insurance type and socioeconomic status have an impact on patient outcomes after different types of orthopedic operations. The results of this study support these findings by using a large database to examine 30-day readmission rates after triple arthrodesis. Medicaid insurance status was found to be an independent risk factor for experiencing a 30-day readmission compared with private insurance (odds ratio 4.43). These findings have important implications for surgeons treating patients in low socioeconomic areas who may be vulnerable to adverse events.

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