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Additional Procedures at the Time of Total Ankle Replacement Do Not Increase Risk of Short-term Complications: A Matched Cohort Analysis

Maria I. Peri, BS[1], Sarah Whitaker, BA[1], Sarah Cole, BA[1], Albert Anastasio, MD[2], James R. Satalich, MD[3], Conor N. O'Neill, MD[2], Tejas T. Patel, MD[3], James A. Nunley, MD[2], Mark E. Easley, MD[2], and Karl M. Schweitzer, MD[2]

Abstract

Background: This retrospective cohort study compared short-term complication rates following total ankle arthroplasty (TAA), alone or with concomitant procedures. Secondary independent risk factors were also examined as they related to postoperative outcomes.

Methods: The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database was queried using *Current Procedural Terminology* (*CPT*) codes to identify patients who underwent TAA (27702) between 2010 to 2021. Patients were divided into cohorts based on the presence or absence of ancillary procedures. Propensity score matching was employed to account for demographic differences, and statistical analyses were performed to compare short-term complication rates between matched cohorts.

Results: A total of 2225 patients were identified, with 1432 (64.4%) receiving TAA alone and 793 (35.6%) with ancillary procedure(s). After matching, 793 patients were included in each cohort. The ancillary cohort had longer operative times ($P < .001$) and length of hospital stay (LOS) ($P < 0.001$). Rates for extended LOS were significantly higher in the ancillary cohort than in the simple cohort ($P = .01$). No other complications varied significantly between cohorts, including the incidence of any adverse event (AAE). American Society of Anesthesiologists classification of 4 was found to be an independent risk factor for development of AAE (odds ratio [OR] = 1.091, $P = .04$). Matched subgroup analysis excluding tendon lengthening as a concomitant procedure found that the ancillary cohort still had longer operative time ($P < .001$) and LOS ($P < .05$) than patients undergoing simple TAA.

Conclusion: Without significant difference in rates of AAE other than extended LOS, the relative safety of ancillary TAA appears similar to that of TAA alone. Such knowledge can help inform surgical decision-making and assuage safety concerns for patients requiring additional corrective procedures at the time of TAA.

Level of Evidence: Level III, retrospective comparative study.

Keywords: ankle osteoarthritis, total ankle arthroplasty, postoperative complications, NSQIP

Introduction

Total ankle arthroplasty (TAA) is an increasingly common treatment for end-stage ankle arthritis.[6,10,13] The majority of cases of ankle arthritis arise after trauma to the joint but can also be due to primary or inflammatory arthritis.[15] Progression to end-stage ankle arthritis conveys significant morbidity to patients.[15] Such patients can lose substantial quality of life and productive work years, leading many individuals to pursue TAA for restoration of joint function and pain reduction.[15] Arthrodesis of the

ankle is another solution for end-stage arthritis and has historically been considered the treatment of choice over TAA, given high failure rates of early-generation TAA.[10,15] However, TAA allows for preservation of gait and ankle range of motion (ROM), and newer-generation TAA designs demonstrate significantly improved early- to midterm survivorship rates compared to earlier-design implants.[15] Consistent with these improvements, recent trends show the rate of TAA procedures performed annually has been increasing.[10,15] For example, Law et al (2018) looked at patients insured by Medicare and observed a compound annual growth rate of approximately 16% for TAA incidence between 2005 and 2012.[14] Additionally, between 2009 and 2019, annual incidences and case volumes of primary TAA both increased by more than 120% in the general United States.[10]

Patients undergoing TAA for end-stage arthritis often have additional ankle or foot pathologies that may require concomitant procedures.[3] For example, we know from previous literature that correction of coronal plane deformity during TAA with osteotomy is important to create a stable base with appropriate mechanical alignment.[7,21] Examples of other concomitant operations include tendon lengthening (for ankle equinus contracture), ligament reconstruction (for varus/valgus and joint instability), and hindfoot/subtalar arthrodesis (for optimal joint alignment and symptom relief).[3,15,22] Several studies examine clinical and functional outcomes in TAA with and without ancillary procedures. Togher et al[25] investigated the effect of concomitant procedures on joint congruence after TAA. They included multiple ancillary procedure types representing a variety of bony and soft tissue operations (osteotomy, ligament stabilization, fusion, tendon lengthening, etc). They did not find a significant association between ancillary procedure(s) and implant alignment, concluding that receiving concomitant procedures did not increase risk of postoperative joint incongruity.[25] Kim et al[12] examined outcomes of TAA with and without various hindfoot fusion procedures. Postoperative clinical outcomes were similar between the two groups, and there was no significant difference in complication or failure rates. Overall, Kim et al concluded that hindfoot arthrodesis should be performed together with TAA if indicated. Based on the existing literature, it appears that performing additional procedures simultaneously with TAA does not negatively affect postoperative function and may be necessary to restore alignment of the foot and ankle or address degenerative changes to adjacent joints.

It is currently unclear in the available literature whether performing these adjunctive procedures simultaneously or separately impacts early complications. Togher et al[25] evaluated the influence of concomitant procedures on joint alignment after TAA; however, they did not investigate differences in safety outcomes based on the presence or absence of ancillary operations. Other studies have examined postoperative function for specific concomitant procedures, such as TAA alone vs TAA with either gastrocnemius recession or tendo-Achilles lengthening.[9,22] Kim et al reported equal complication rates between simple TAA and TAA with hindfoot fusion procedures but did not include data on other operations for ankle pathology often associated with TAA.[12]

Thus, there is a lack of studies comparing outcomes based on our categorization of whether TAA was performed alone or with concurrent procedure(s). The present study seeks to address this gap in existing knowledge. We will analyze adverse postoperative complications following TAA, both alone and including various concomitant procedure types. We aim to evaluate short-term complications following TAA to examine if the overall safety of this procedure changes when performed on its own versus simultaneously with other procedures. We will also investigate secondary independent risk factors for postoperative adverse events.

Materials and Methods

This study used the American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) database to retrospectively review short-term outcomes of patients undergoing TAA operations with or without concomitant procedures. The NSQIP database collects data from nearly 700 participating hospitals on surgical procedures and 30-day postoperative outcomes via a trained clinical nurse review.[1] This employee gathers prospective information on surgical procedure(s), patient demographics, laboratory results, concomitant conditions and risk factors, and 30-day complication rates.[1,11] The participating sites are subject to routine audits for quality assurance, and prior studies have demonstrated interrater disagreement rates of less than 2%.[5,26] Other studies have shown the NSQIP database to be a reliable resource for orthopaedic research.[1,11,13,18,19]

To form the cohorts, the database was filtered using *Current Procedural Terminology* (*CPT*) codes to identify patients who had undergone a TAA (27702) between 2010

[1]Virginia Commonwealth University School of Medicine, Richmond, VA, USA
[2]Department of Orthopaedic Surgery, Duke University Health System, Durham, NC, USA
[3]Department of Orthopaedic Surgery, Virginia Commonwealth University Health System, Richmond, VA, USA

Corresponding Author:
Maria I. Peri, BS, Virginia Commonwealth University School of Medicine, 1201 E Marshall Street, Richmond, VA 23298, USA.
Email: perimi@vcu.edu

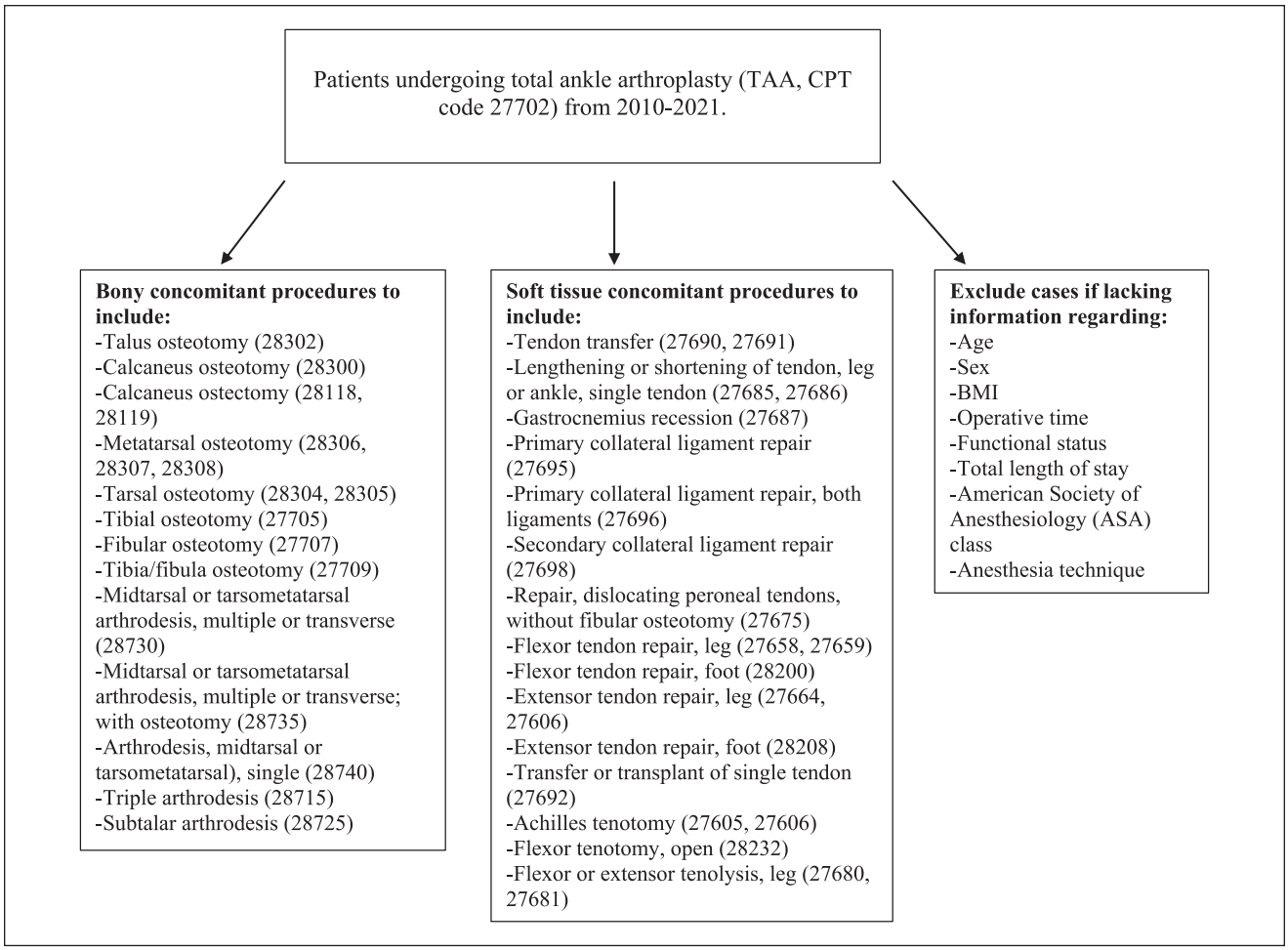

Figure 1. Inclusion and exclusion criteria, with an index of *Current Procedural Terminology* (*CPT*) codes for concomitant procedures.

and 2021. The two cohorts were then formed by creating a group for patients undergoing an isolated TAA and a group for patients undergoing a TAA with a concomitant bony or soft tissue procedure. Ancillary procedures are outlined in Figure 1. Cases were then excluded from both cohorts if they lacked known or had no values for sex, body mass index (BMI), operative time, functional status, age, total length of stay (LOS), American Society of Anesthesiologists (ASA) classification, or anesthesia technique. Exclusions were made to ensure optimal matching.

Once the isolated TAA and ancillary TAA cohorts were formed, we performed a 1:1 propensity match to eliminate bias from confounding variables and enhance the study's power by imitating randomization. The matched cohorts were formed on the basis of age, sex, race, BMI, ASA classification, history of diabetes, smoking status, steroid use, hypertension controlled by medication, history of congestive heart failure, history of chronic obstructive pulmonary disease, functional status, and history of bleeding disorder. Thirty-day postoperative outcomes were then compared between the matched cohorts and included death, wound dehiscence, surgical site infection, pneumonia, unplanned intubation, postoperative transfusion, acute renal failure, sepsis, urinary tract infection, reoperation, deep vein thrombosis (DVT), cardiac arrest, myocardial infarction, cerebrovascular accident, pulmonary embolism, extended LOS, and any adverse event (AAE). We defined extended LOS as any LOS more than 1 SD above the prematched mean LOS. AAE included surgical site infection, wound dehiscence, extended LOS, pneumonia, unplanned intubation, postoperative transfusion, acute renal failure, sepsis, urinary tract infection, reoperation, deep vein thrombosis, cardiac arrest, myocardial infarction, cerebrovascular accident, death, and pulmonary embolism.

Patients who underwent gastrocnemius recession (27687), lengthening or shortening of a single tendon (27685, 27686), or Achilles tenotomy (27605, 27606) with no other ancillary procedures were then excluded for further subgroup analysis in consideration of ongoing debates about whether these procedures are concomitant operations

or part of the index of procedures for TAA.[4,27] The new simple TAA and TAA with concomitant procedure cohorts then underwent the same matched and unmatched comparative analyses as described above.

To assess for statistically significant differences in postoperative short-term outcomes between the cohorts, we used RStudio software version 2023.06.1+524 (R Foundation for Statistical Computing, Vienna, Austria) and employed a variety of statistical strategies including multivariate and bivariate analysis and propensity score matching. For continuous variables in the matched and unmatched cohorts, demographics, risk factors, and complications were analyzed using Student 2-tailed *t* tests. For categorical variables in the matched and unmatched cohorts, demographics, risk factors, and complications were analyzed using χ^2 tests. Multivariable logistic regression analysis was then used to find any preoperative characteristics associated with higher risks of AAE. We defined statistical significance as a *P* value of less than .05 for all statistical analyses.

A post hoc power analysis was done to assess the probability that our study correctly identified a true difference between groups. The incidence of AAE in the simple TAA cohort was 2.9%, and we compared this parameter to a hypothetical incidence of 5% in the ancillary procedures cohort. This proposed rate was selected based on what we would consider a clinically significant increase in AAE associated with ancillary procedures. Using these parameters, the size of each matched cohort (n = 793), and a *P* value of .05, we calculated 57.4% power.

Results

Demographics

A total of 2225 patients who met inclusion/exclusion criteria were identified. Of these, 1432 patients (64.4%) underwent TAA without additional bony or soft tissue procedures, and 793 patients (35.6%) underwent TAA with an ancillary procedure. Prior to matching, patients undergoing TAA with an ancillary procedure had significantly longer operative times and total length of hospital stay. No baseline demographic characteristics varied significantly between unmatched cohorts.

After propensity score matching, 793 patients were included in each cohort for a total of 1586 patients in the final analysis. The ancillary procedure cohort had longer operative times (172.8 vs 144.1 minutes, $P < .001$) and total length of hospital stay (1.76 vs 1.52 days, $P < .001$). The average ages for the simple TAA and ancillary procedure cohorts were 63.8 and 64.0 years, respectively. In addition, 56.5% of the simple TAA cohort and 57.1% of the ancillary procedure cohort were males. No demographic differences varied significantly between matched cohorts. Complete demographic data are outlined in Table 1.

Outcomes

Prior to matching, the only complication rate that varied significantly between cohorts was rate of extended LOS (Table 2). Patients undergoing TAA with an ancillary procedure had higher rates of extended LOS than patients undergoing TAA only (21.2% vs 16.8%, $P = .01$). After matching, the rate of extended LOS remained significantly higher in the ancillary procedure cohort when compared to the simple TAA cohort (21.2% vs 16.3%, $P = .01$). No other complications varied significantly between cohorts, including the incidence of return to the OR or any adverse event (AAE). Detailed outcome data can be found in Table 2.

When controlling for all other variables, ASA classification of 4 was found to be an independent risk factor for development of any adverse event (odds ratio [OR] = 1.091, $P = .04$). Increasing age and operative time, male sex, diabetes, chronic obstructive pulmonary disease, bleeding disorder, and steroid use were not found to significantly increase the risk of developing AAE postoperatively (Table 3).

Subgroup Analysis

An additional subgroup analysis was performed excluding all patients who had undergone an isolated tendon lengthening (Achilles) procedure in addition to TAA. A total of 438 patients from the ancillary procedure cohort in the primary analysis had undergone an isolated tendon lengthening procedure and were thus excluded from the subgroup analysis. There were 1787 patients included in the subgroup analysis, with 1432 (80.1%) undergoing TAA only and 355 (19.9%) undergoing TAA with an ancillary procedure. Prior to matching, the ancillary procedure cohort had significantly longer operative times and hospital stays, higher average morbidity probability, and higher percentage of males than the simple TAA cohort. After matching, patients undergoing TAA with an ancillary procedure had longer operative times and longer length of hospital stays than patients undergoing TAA only. No demographic characteristics varied significantly between groups. Complete demographic data for this subgroup is outlined in Table 1. No complication rates, including return to the OR or AAE, varied significantly between cohorts before or after propensity score matching (Table 4).

Discussion

In both unmatched and matched data analysis for the entire group, extended LOS was the only statistically significant adverse event that differed between the isolated TAA and ancillary procedure cohorts. In the subgroup analysis excluding tendon lengthening as an ancillary procedure, LOS persisted in being significantly different, as longer LOS was associated with undergoing additional procedures.

Table 1. Demographic and Comorbidity Characteristics for Patients Undergoing TAA Only vs Patients Undergoing TAA With Additional Bony or Soft Tissue Procedures.[a]

	Whole Group Analysis			Subgroup Analysis		
	TAA Only, Matched	Additional Procedures, Matched	*P* Value	TAA Only, Matched	Additional Procedures, Matched	*P* Value
Patients	793 (50.0)	793 (50.0)		355 (50)	355 (50)	
Age, y, mean ± SD	63.8 ± 10.5	64.0 ± 9.94	.689	65.1 ± 10.0	64.8 ± 9.24	.724
BMI, mean ± SD	31.0 ± 5.78	31.3 ± 5.88	.368	30.7 ± 5.77	31.1 ± 6.15	.451
Male sex	448 (56.5)	453 (57.1)	.839	228 (64.2)	222 (62.5)	.697
Operative time, min, mean ± SD	144.1 ± 52.1	172.8 ± 62.2	**<.001**	142.5 ± 51.7	187.6 ± 67.5	**<.001**
Length of stay, mean ± SD	1.52 ± 1.16	1.76 ± 1.32	**<.001**	1.59 ± 1.28	1.83 ± 1.28	**.0132**
Outpatient status	194 (24.5)	171 (21.6)	.189	73 (20.6)	74 (20.8)	>.999
ASA class	2.38 ± 0.60	2.39 ± 0.57	.831	2.34 ± 0.57	2.41 ± 0.59	.137
1 (no disturbance)	36 (4.54)	28 (3.53)	–	14 (3.94)	13 (3.66)	–
2 (mild disturbance)	430 (54.2)	436 (55.0)	–	210 (59.2)	190 (53.5)	–
3 (severe disturbance)	314 (39.6)	321 (40.5)	–	127 (35.8)	147 (41.4)	–
4 (life-threatening disturbance)	13 (1.64)	8 (1.00)	–	4 (1.13)	5 (1.41)	–
5 (moribund)	0	0	–	0	0	–
Race						
White	658 (83.0)	639 (80.6)	–	280 (78.9)	278 (78.3)	–
Black	21 (2.65)	27 (3.40)	–	8 (2.25)	9 (2.54)	–
Asian	8 (1.00)	6 (0.76)	–	1 (0.28)	4 (1.13)	–
Other	0	1 (0.13)	–	0	1 (0.28)	–
Unknown	106 (13.4)	120 (15.1)	–	66 (18.6)	63 (17.7)	–
Morbidity probability, mean ± SD	.0203 ± .0092	.0213 ± .0103	.0576	.0202 ± .0087	.0220 ± .0105	**.0147**
Mortality probability, mean ± SD	.0017 ± .0028	.0016 ± .0020	.477	.0018 ± .0026	.0016 ± .0021	.410
Dependent functional status (partial or total)	8 (1.00)	8 (1.00)	>.999	0	2 (0.56)	.479
Current smoker	58 (7.31)	55 (6.93)	.845	21 (5.92)	20 (5.63)	>.999
Comorbidities						
Congestive heart failure	1 (0.13)	2 (0.25)	>.999	2 (0.56)	2 (0.56)	>.999
Dialysis[b]	1 (0.13)	2 (0.25)	>.999	0	1 (0.28)	>.999
Steroid use	40 (5.04)	42 (5.30)	.910	22 (6.20)	23 (6.48)	>.999
Bleeding disorder	24 (3.03)	24 (3.03)	>.999	11 (3.10)	11 (3.10)	>.999
Ascites	0	0		0	0	–
Preoperative transfusion	0	0		0	0	–
Diabetes	85 (10.7)	85 (10.7)	>.999	30 (8.45)	34 (9.58)	.694
IDDM	17 (2.14)	18 (2.27)	–	3 (0.85)	5 (1.41)	–
NIDDM	68 (8.58)	67 (8.45)	–	27 (7.61)	29 (8.17)	–
COPD	21 (2.65)	20 (2.52)	>.999	7 (1.97)	8 (2.25)	>.999

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; COPD: chronic obstructive pulmonary disease; IDDM, insulin-dependent diabetes mellitus; NIDDM, non–insulin-dependent diabetes mellitus; TAA, total ankle arthroplasty.

[a]Subgroup analysis excluded patients undergoing an Achilles tendon lengthening procedure as their sole ancillary operation. Unless otherwise noted, values are n (%). Boldface indicates statistical significance ($P < .05$).

[b]Dialysis: acute or chronic renal failure requiring dialysis within 2 weeks of indexed procedure.

This consistency in our data suggests that receiving procedures in addition to TAA lengthens hospital stay and increases risk of extended LOS. Subgroup analysis also showed that patients undergoing ancillary procedures had significantly longer operative time. There were no significantly different rates of AAE in the matched subgroup cohorts. In summary, with extended LOS being the only significantly different adverse event, concomitant procedures do not appear to increase risk for major short-term complications following TAA.

We did find incidence of extended LOS (defined as greater than 1 SD above the mean) to be higher in the additional procedures cohort within the entire group analysis. However, there was no significant difference in extended

Table 2. Incidence of Adverse Events for Patients Undergoing TAA Only or TAA With Additional Procedures.

	TAA Only, Unmatched		Additional Procedures, Unmatched			TAA Only, Matched		Additional Procedures, Matched			Overall, Matched	
	No.	Rate (%)	No.	Rate	*P* Value[a]	No.	Rate	No.	Rate	*P* Value[a]	No.	Rate (%)
Any adverse event[b]	45	3.14	21	2.65	.501	23	2.90	21	2.65	.760	44	2.77
Death	2	0.14	1	0.13	.933	1	0.13	1	0.13	>.999	2	0.13
Wound dehiscence	3	0.21	3	0.38	.499	0		3	0.38	.0833	3	0.19
Sepsis	1	0.070	1	0.13	.696	0		1	0.13	.318	1	0.063
Pulmonary embolism	3	0.21	1	0.13	.633	2	0.25	1	0.13	.564	3	0.19
Acute renal failure	0		0			0		0			0	
Myocardial infarction	1	0.070	1	0.13	.696	1	0.13	1	0.13	>.999	2	0.13
Cardiac arrest	0		0			0		0			0	
Stroke	2	0.14	0		.157	2	0.25	0		.157	2	0.13
Transfusion	2	0.14	3	0.38	.319	1	0.13	3	0.38	.317	4	0.25
DVT	4	0.28	2	0.25	.905	1	0.13	2	0.25	.564	3	0.19
UTI	7	0.49	2	0.25	.356	1	0.13	2	0.25	.564	3	0.19
Pneumonia	2	0.14	1	0.13	.933	1	0.13	1	0.13	>.999	2	0.13
Intubation issues[c]	1	0.070	0		.318	0		0			0	
SSI	19	1.33	9	1.13	.691	8	1.00	9	1.13	.808	17	1.07
Return to the OR	10	0.70	4	0.50	.562	6	0.76	4	0.50	.526	10	0.63
Extended LOS	241	16.8	168	21.2	**.0133**	129	16.3	168	21.2	**.0121**	297	18.7

Abbreviations: DVT, deep vein thrombosis; LOS, length of stay (extended: greater than 1 SD above the mean); OR, operating room; SSI, surgical site infection; TAA, total ankle arthroplasty; UTI, urinary tract infection.

[a]Boldface indicates statistical significance ($P < .05$).

[b]Any adverse event: superficial and deep surgical site infection, organ space infection, wound dehiscence, acute renal failure, intubation (fail to wean or reintubation), postoperative transfusion, pneumonia, DVT, pulmonary embolism, UTI, stroke, cardiac arrest, myocardial infarction, return to the OR, or death.

[c]Intubation issues: reintubation or failure to wean from intubation.

LOS rates in the subgroup analysis excluding tendon lengthening as a concomitant procedure. In our whole group analysis, the mean length of stay was 1.52 days for the isolated TAA cohort and 1.76 days for the additional procedures cohort. Subgroup analysis showed similar results, with a mean of 1.59 days for isolated TAA and 1.83 days for additional procedures. Our post-TAA LOS averages are consistent with the existing literature. Sambandam et al[23] observed an LOS of 1.7 days, and Peairs et al[20] found an LOS of 1.5 days for patients aged 55-70 years, a range that encompasses the average patient age (63.8-65.1 years) in the present study. Although these results did show statistical significance, the clinical significance of an additional 5.8 hours of LOS is debatable.

Aside from extended LOS, no adverse events exhibited significantly different incidences between cohorts in subgroup or whole group analysis. This trend was consistent with Kim et al's[12] findings of similar complication rates (including intra-articular infection and wound healing issues) in patients receiving TAA and TAA with concomitant hindfoot arthrodesis. We did not find other studies examining the influence of ancillary procedures on rates of AAE following TAA. For this reason, the present analysis of nationally representative data confirming similar complication rates in TAA performed either with or without ancillary procedures contributes substantially to the literature and the general understanding of TAA, relevant to both patients and foot and ankle surgeons. In general, TAA is considered to be safe, with very low reported rates of postoperative pulmonary embolism, DVT, myocardial infarction, and other AAE.[8]

Our multivariable analysis results showed that the only risk factor independently associated with AAE—irrespective of cohort—was designation of ASA class 4. None of the other ASA classes or patient characteristics included in our analysis were significantly associated with risk of AAE. Kwon et al[13] did not find age, sex, or steroid use to be associated with risk of reoperation or wound infection, and our results were consistent with this conclusion. However, both Kwon et al[13] and Del Balso et al[6] reported diabetes mellitus (DM) to be a risk factor for 30-day readmission. Del Balso et al also observed higher rates of reoperation and major complications (like death, pulmonary embolism, or pneumonia) in patients with DM.[6] This is in contrast with our results, as we did not find a significant association between diabetes and risk for readmission or any other postoperative

Table 3. Odds of Developing Any Adverse Event During Surgery as Related to Patient Demographics, Comorbidities, and Procedure.

	Multivariable Analysis[a]		
	OR Coeff.	95% CI	*P* Value[b]
Overall			
Age (1-y intervals)	1.00	0.999-1.001	.538
Operative time (1-min intervals)	1.00	1.000-1.000	.243
Sex			
Female	Ref	—	—
Male	1.005	0.988-1.022	.559
ASA class			
1	Ref	—	—
2	1.021	0.979-1.065	.328
3	1.032	0.988-1.078	.151
4	1.091	1.005-1.186	**.0383**
Diabetes mellitus			
IDDM	Ref	—	—
NIDDM	0.984	0.925-1.046	.604
None	0.979	0.926-1.036	.466
COPD			
No	Ref	—	—
Yes	1.012	0.961-1.066	.648
Bleeding disorder			
No	Ref	—	—
Yes	0.987	0.941-1.035	.578
Steroid use			
No	Ref	—	—
Yes	0.982	0.946-1.019	.342

Abbreviations: ASA, American Society of Anesthesiology; Coeff, coefficient; COPD, chronic obstructive pulmonary disease; IDDM, insulin-dependent diabetes mellitus; NIDDM, non–insulin-dependent diabetes mellitus; OR, odds ratio; Ref, referent.
[a]Variables are adjusted for all baseline characteristics; referent procedure: total ankle arthroplasty only.
[b]Boldface indicates statistical significance ($P < .05$).

complication, regardless of insulin dependence status. Tarricone et al[24] conducted a systematic review of studies comparing rates of adverse events after TAA and arthrodesis in patients with and without diabetes. They concluded that diabetes was not associated with increased major adverse events following TAA. Another study examined postoperative complications in patients with controlled DM compared to patients without DM and did not find a significant difference in the number of total complications for each group.[16] Tarricone et al noted that not all studies included in their review classified or quantified (via HbA_{1c}) the severity of patients' diabetes.[24] A limitation of the present study would similarly be that we were unable to obtain more accurate and specific measures for diabetes control; we were able to classify patients with DM further into insulin-dependent or non–insulin-dependent, but could not examine HbA_{1c} scores or glucose levels. Neither Del Balso et al nor Kwon et al included details classifying patients with diabetes; both only reported the number of patients with or without DM in their respective cohorts and analyses.[6,13] Overall, the unknown but possible variation in diabetes control may be able to account for the differences between this study and other previous NSQIP studies examining TAA postoperative risks. Our conclusion on the influence of DM on TAA complications maintains the assertion in existing literature that TAA remains safe for both diabetic and nondiabetic patients alike. However, additional research is needed to more optimally understand the impact of DM on complications and outcomes following TAA.

Additional limitations of this study include lack of functional outcomes data. NSQIP does not provide ROM data, an important preoperative and long-term postoperative outcome to consider for joint arthroplasty with or without concomitant procedures.[9,15,18,22] Therefore, our study focused on complication rates that could be obtained in the database. Additionally, we could not track preoperative diagnosis or indication for TAA (ie, type of arthritis). TAA is performed for advanced ankle arthritis, and although most ankle arthritis is posttraumatic, the condition can also be due to inflammatory arthritis or primary osteoarthritis (OA).[15] Lee et al[17] and Bai et al[2] compared outcomes after TAA based on etiology of ankle arthritis. Lee et al did not find a significant difference in complication rates between primary OA and posttraumatic OA groups. Interestingly, both studies observed that the number of ancillary procedures performed was increased in the posttraumatic group compared with primary OA.[2,17] We could not explore these relationships within our own data set because of the constraints of available data, as NSQIP only provides postoperative diagnosis codes rather than surgical indications. Despite these limitations, we were able to include a wide variety of concomitant procedures in our analysis in an effort to encompass patients with diverse pathologies requiring TAA. Additionally, by using the NSQIP database, we were able to focus on severe potential complications following simple and complex TAA. This was made the primary focus in order to augment existing literature already assessing functional outcomes in isolated and ancillary TAA.

Conclusion

The primary objective of this study was to examine risk factors for postoperative complications following TAA. Of paramount interest, we sought to evaluate whether receiving TAA alone or with ancillary bony and/or soft tissue procedures influences risk of early postoperative complications. Extended LOS was the only variable found to be statistically significantly different between cohorts, with a greater rate of extended LOS observed in the ancillary group.

Table 4. Incidence of Adverse Events for Patients Undergoing TAA Only or TAA With Additional Procedures, Excluding Tendon Lengthening Procedures.

	TAA Only, Unmatched		Additional Procedures, Unmatched			TAA Only, Matched		Additional Procedures, Matched			Overall, Matched	
	No.	Rate (%)	No.	Rate	*P* Value	No.	Rate	No.	Rate	*P* Value	No.	Rate (%)
Any adverse event[a]	45	3.14	11	3.10	.966	15	4.22	11	3.10	.425	26	3.66
Death	2	0.14	0		.157	1	0.28	0		.318	1	0.14
Wound dehiscence	3	0.21	2	0.56	.395	2	0.56	2	0.56	>.999	4	0.56
Sepsis	1	0.070	0		.318	0		0			0	-
Pulmonary embolism	3	0.21	1	0.28	.814	0		1	0.28	.318	1	0.14
Acute renal failure	0		0			0		0			0	-
Myocardial infarction	1	0.070	1	0.28	.466	0		1	0.28	.318	1	0.14
Cardiac arrest	0		0			0		0			0	-
Stroke	2	0.14	0		.157	2	0.56	0		.158	2	0.28
Transfusion	2	0.14	2	0.56	.302	1	0.28	2	0.56	.564	3	0.42
DVT	4	0.28	2	0.56	.501	0		2	0.56	.158	2	0.28
UTI	7	0.49	1	0.28	.539	0		1	0.28	.318	1	0.14
Pneumonia	2	0.14	1	0.28	.634	0		1	0.28	.318	1	0.14
Intubation issues[b]	1	0.070	0		.318	0		0			0	-
SSI	19	1.33	3	0.85	.401	8	2.25	3	0.85	.129	11	1.55
Return to the OR	10	0.70	2	0.56	.767	5	1.41	2	0.56	.255	7	0.99
Extended LOS	241	16.8	74	20.8	.092	55	15.5	74	20.8	.065	129	18.2

Abbreviations: DVT, deep vein thrombosis; LOS, length of stay (extended: greater than 1 SD above the mean); OR, operating room; SSI, surgical site infection; TAA, total ankle arthroplasty; UTI, urinary tract infection.

[a]Any adverse event: superficial and deep surgical site infection, organ space infection, wound dehiscence, acute renal failure, intubation (fail to wean or reintubation), postoperative transfusion, pneumonia, DVT, pulmonary embolism, UTI, stroke, cardiac arrest, myocardial infarction, return to the OR, or death.

[b]Intubation issues: reintubation or failure to wean from intubation.

However, the clinical significance of this difference remains debatable. Additionally, the only risk factor for complications independent of cohort was ASA class 4 status. Without significant difference in rates of other AAE, we conclude that undergoing TAA with concurrent procedures is as safe as undergoing TAA alone. We believe these findings can help inform surgical decision-making and assuage safety concerns for patients requiring additional procedures at the time of TAA.

Ethical Approval

Ethical approval was not sought for the present study because data were obtained from a nationally used, de-identified database.

Declaration of Conflicting Interests

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ORCID iDs

Maria I. Peri, BS, https://orcid.org/0009-0008-0878-1653
Sarah Cole, BA, https://orcid.org/0009-0006-9049-7525
Albert Anastasio, MD, https://orcid.org/0000-0001-5817-3826
Conor N. O'Neill, MD, https://orcid.org/0000-0003-4456-9445
James A. Nunley, MD, https://orcid.org/0000-0002-3825-7536

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