

## Statement of Purpose

A total ankle replacement (TAR) provides an alternative treatment option to arthrodesis for those suffering from an arthritic ankle. Initial attempts at TARs were fraught with high failure rates; however, recent studies have demonstrated improved outcomes attributed to advances in implant design and surgical technique. The purpose of this review was to evaluate the short-term outcomes in TARs and to assess if there was a correlation between patient factors or surgical technique with the incidence of post-operative complications.

## Methodology & Hypothesis

A retrospective chart review over a 3-year duration revealed 31 TARs in 30 patients with an average follow-up of 12 months. Fixed-bearing modern total ankle prostheses were implanted from an anterior approach in 30 procedures and posteriorly in 1. The Fisher's exact test was used to determine if there was an association between patient factors as well as intra-operative techniques and the development of post-operative complications. The following information was collected from each patient: age, BMI, duration of procedure, tobacco use, history of ipsilateral ankle surgery, pre and post operative pain level, pre and post operative ankle range of motion as determined with goniometer, closure technique, complications. In a small portion of patients both American Orthopedic Foot and Ankle Scores (AOFAS) Hindfoot/Ankle and Lower Extremity Functional Scale (LEFS) scores were obtained.

## Procedure

An anterior ankle incision was placed at the interval between the extensor hallucis longus and the tibialis anterior tendon in 30 of 31 procedures. In one patient a posterior approach was utilized due to poor anterior ankle soft tissue quality. A fixed-bearing modern total ankle prosthesis was implanted in all cases. Over the previous year we have adopted two techniques to help reduce complications with TAR, laser-assisted indocyanine green fluorescent dye angiography (LA-ICGA) and a unique non-invasive skin closure device. After intravenous injection of plasma bound indocyanine green dye, an external camera is placed over the site of interest which ascertains the dye frequency representing skin perfusion. Software then quantifies the frequencies, in percentage form, allowing objective comparison of perfusion. The non-invasive surgical skin closure device is a sterile single-use system with two self-adhesive hydrocolloid strips linked by adjustable self-locking fasteners. Post-operative care was identical for all patients. Descriptive summaries were frequencies and percentages for categorical variables, medians, and quartiles for continuous variables. Demographic and baseline characteristic differences between groups (with complication versus without complication) were assessed using the Pearson Chi-squared test or Fisher's Exact test for categorical data, and the non-parametric Wilcoxon Rank-Sum test for continuous not paired data. Paired data, such as pre-post measurements were compared using the non-parametric Wilcoxon signed rank test. The level of significance was set at 5%. All analyses were done in SAS® for Windows Version 9.4.

## Literature Review

Unlike arthritis of the hip or knee, which is typically of primary origin, end-stage ankle arthritis is more commonly posttraumatic in 65% to 80% of cases. TAR has become a viable option to address end-stage ankle arthritis and this is reflected by the nearly 4-fold increase in the number of US hospitals performing this procedure, from 3.1% in 1991 to 12.6% in 2010. In regards to the modern TAR designs, short to mid-term results have been promising with survival rates up to 90%. Haddad et al performed a systematic literature review comparing outcomes of TAR and ankle arthrodesis and found mid-term outcomes to be similar. Gougoulis et al performed a systematic literature review reporting on the outcomes of modern TARs. Their study included 1105 total ankle arthroplasties and found the overall failure rate to be 9.8% at 5.2 years. Complications were examined and revealed superficial wounds occurring in 0% to 14.7%, deep infections in 0% to 4.6%, and residual pain in 27% to 60%. Ankle range of motion was also reviewed and revealed mean postoperative range of motion was equal to the preoperative level or improved by approximately 4 to 14 degrees. Outcomes and complications associated with TARs have been thoroughly detailed in the literature. The reported complication rates for TARs have been variable, ranging from 7% to 54%, with delayed wound healing seen in up to 40% and rates of infection ranging from 2% to 8.5%. The wide variations indicate a lack of consistency in either technique or in the reporting of complications. Whalen et al found the expense for treating patients who had wound necrosis and deep soft tissue loss was five times greater than the cost of a total ankle arthroplasty that healed without complication. Glazebrook et al noted that deep infection, albeit a least likely complication to occur at 1.7% was associated with a high implant failure rate of 80.6%. Thus to minimize our risk of complication, we have supplemented our TARs with both LA-ICGA exam and a noninvasive skin closure device. Moyer et al utilized LA-ICGA to predict mastectomy skin flap necrosis and found that a value of 33% had an 88% positive predictive value of removing nonviable skin and a 16% negative predictive value of removing healthy skin. As for noninvasive surgical skin closure, Mitwalli et al compared this type of closure with conventional suturing. They found comparable aesthetic outcomes and also noted that both wound reapproximation and device removal took less time when compared to suturing.

## Results



Figure 1: DOS: 12-31-15: Patient suffered a wound dehiscence with localized signs of infection. Patient would return to the operating room 2m s/p total ankle replacement for debridement & irrigation with wound graft application. Patient would subsequently heal with no evidence of chronic infection.

At final follow-up we found a statistically significant improvement in the visual analogue scale, median average 8.0 pre-op to 2.0 post-op, as well as with ankle dorsiflexion, 0 degrees pre-op to 7 degrees post-op. In a small subset, 11 of 31 procedures, there were AOFAS and LEFS scores available. AOFAS improved from 32.0 pre-op to 75.0 post-op and LEFS scores improved from 43.75% pre-op to 75.0% post-op. An adverse event was documented in 6 (19%) of the 31 procedures. In regards to the complications associated with a total ankle replacement procedure: 6 (19.3%) suffered wound dehiscence with one (3.2%) subsequently resulting in a below knee amputation. No increased complication incidence was found to be associated with the following factors: age, BMI, procedure duration, tobacco use, previous ipsilateral ankle surgery. Overall, of the 10 patients who received intra-operative tissue perfusion imaging, one suffered a complication (p = 0.63). Of the 13 patients who received a non-invasive closure device, two suffered a complication (p = 0.99). Of the nine patients who received both intra-operative tissue perfusion imaging as well as a non-invasive closure device, zero complications were encountered.

## Analysis & Discussion

**Table I: Patient Baseline Characteristics**

Variable	Overall (n=30, 100%)	No Complication (n=24, 80%)	Complication (n=6, 20%)	P Value
Age, in years	53.0 (46.0, 61.0)	52.5 (46.0, 60.5)	53.0 (51.0, 61.0)	0.678 <sup>a</sup>
Gender, female	17 (57)	13 (54)	4 (67)	0.673 <sup>b</sup>
Body Mass Index	29.2 (26.6, 35.3)	30.3 (27.1, 36.3)	26.6 (20.2, 33.9)	0.162 <sup>a</sup>
Never Smoker	16 (53%)	15 (63%)	1 (17%)	0.073 <sup>b</sup>

Note: Data are count (percentage), unless otherwise specified; \* median (1<sup>st</sup> quartile, 3<sup>rd</sup> quartile)  
<sup>a</sup>Wilcoxon rank-sum test; <sup>b</sup>Fisher's exact test;

**Table II: Procedures Characteristics**

Variable	Overall (n=31, 100%)	No Complication (n=25, 81%)	Complication (n=6, 19%)	P Value
Follow-up, in months	6.0 (4.0, 12.0)	5.0 (4.0, 12.0)	8.5 (5.0, 13.0)	0.246 <sup>a</sup>
Duration of Procedure, in minutes	183.0 (162.0, 227.0)	183.0 (169.0, 227.0)	182.5 (155.0, 202.0)	0.516 <sup>a</sup>
History of Previous Ankle Surgery	24 (77%)	20 (80%)	4 (67%)	0.596 <sup>b</sup>
Duration of Hospital Stay, in days	2.0 (2.0, 5.0)	2.0 (2.0, 4.0)	2.5 (1.0, 6.0)	0.516 <sup>a</sup>
Pleasant with Outcome	28 (90%)	24 (96%)	4 (67%)	0.088 <sup>b</sup>

Note: Data are count (percentage), unless otherwise specified; \* median (1<sup>st</sup> quartile, 3<sup>rd</sup> quartile)  
<sup>a</sup>Wilcoxon rank-sum test; <sup>b</sup>Fisher's exact test; <sup>c</sup>Pearson's Chi-square test;

Our objective was to determine if any of the aforementioned factors would influence the post-operative complication incidence. Interestingly, there was no increased incidence of complications when considering age, BMI, procedure duration, tobacco use, or previous ipsilateral ankle surgery. Of the six procedures where a complication was encountered; three subsequently healed with local wound care and oral antibiotics, two subsequently healed with return to the operating room for debridement and irrigation followed by local wound care with parenteral/oral antibiotics, and one procedure would ultimately result in a below knee amputation. Thus, our successful limb salvage without operative intervention and implant salvage for those with complications was 83.3%. In those requiring operative intervention, our successful limb salvage and implant salvage was 67%. Similarly, Patton et al in a retrospective review found that with operative intervention of an infected total ankle arthroplasty they were able to achieve limb salvage in 79% of cases and implant salvage in 66% of cases. Additionally, we have highlighted the benefits of two novel techniques that have reduced our complication incidence. Although we believe these two novel techniques will help to reduce post-operative complications, it obviously goes without saying that meticulous planning, the delicate handling of soft tissues, and proper patient selection are critical to successful outcomes. The hope is that when combining this with innovative techniques one may be able to further minimize postoperative complications.

## References

- Bolton-maggs BG, Sudlow RA, Freeman MA. Total ankle arthroplasty: A long-term review of the London Hospital experience. *J Bone Joint Surg Br.* 1985;67(5):785-90.
- Daniels TR, Younger AS, Penner M, et al. Intermediate-term results of total ankle replacement and ankle arthrodesis: a COFAS multicenter study. *J Bone Joint Surg Am.* 2014;96(2):135-42.
- Glazebrook MA, Arsenault K, Dunbar M. Evidence-based classification of complications in total ankle arthroplasty. *Foot Ankle Int.* 2009;30(10):945-9.
- Gougoulis N, Khanna A, Maffulli N. How successful are current ankle replacements?: a systematic review of the literature. *Clin Orthop Relat Res.* 2010;468(1):199-208.
- Gross CE, Hamid KS, Green C, Easley ME, Deorio JK, Nunley JA. Operative Wound Complications Following Total Ankle Arthroplasty. *Foot Ankle Int.* 2015;36(6):626-34.
- Patton D, Kiewiet N, Brage M. Infected total ankle arthroplasty: risk factors and treatment options. *Foot Ankle Int.* 2015;36(6):626-34.
- Pugely AJ, Lu X, Amendola A, Callaghan JJ, Martin CT, Crum P. Trends in the use of total ankle replacement and ankle arthrodesis in the United States Medicare population. *Foot Ankle Int.* 2014;35(3):207-15.
- Haddad SL, Coetzee JC, Estok R, Fahrback K, Banell L, Nalysnyk L. Intermediate and long-term outcomes of total ankle arthroplasty and ankle arthrodesis. A systematic review of the literature. *J Bone Joint Surg Am.* 2007;89(9):1899-905.
- Krause FG, Windolf M, Bora B, Penner MJ, Wing KJ, Younger AS. Impact of complications in total ankle replacement and ankle arthrodesis analyzed with a validated outcome measurement. *J Bone Joint Surg Am.* 2011;93(9):830-9.
- Mitwalli H, Dolan C, Bacigalupi R, Khorasani H. A randomized, controlled, prospective clinical study comparing a novel skin closure device to conventional suturing. *J Am Acad Dermatol.* 2016;74(1):173-4.
- Moyer HR, Losken A. Predicting mastectomy skin flap necrosis with indocyanine green angiography: the gray area defined. *Plast Reconstr Surg.* 2012;129(5):1043-8.
- Pevich MT, Salzman CL, Callaghan JJ, Alvine JG. Total ankle arthroplasty: a unique design. Two to twelve-year follow-up. *J Bone Joint Surg Am.* 1998;80(10):1410-20.
- Salzman CL, Salamon ML, Blanchard GM, et al. Epidemiology of ankle arthritis: report of a consecutive series of 639 patients from a tertiary orthopedic center. *Iowa Orthop J.* 2005;25:44-6.
- Schuberth JM, Patel S, Zarutsky E. Perioperative complications of the Agility total ankle replacement in 50 initial, consecutive cases. *J Foot Ankle Surg.* 2006;45(3):139-46.
- Spirt AA, Assal M, Hansen ST. Complications and failure after total ankle arthroplasty. *J Bone Joint Surg Am.* 2004;86-A(6):1172-8.
- Whalen JL, Speilberg SC, Murray P. Wound breakdown after total ankle arthroplasty. *Foot Ankle Int.* 2010;31(4):301-5.