

# Patient-Reported Outcomes of Primary Total Ankle Arthroplasty in Patients Aged <50 Years

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## Abstract

**Background:** Compared to more prevalent arthritic conditions, ankle arthritis is complicated by an earlier age of onset. Recently published data demonstrates excellent survivorship and complication rates in short-/midterm follow-up of younger patients who received a primary total ankle arthroplasty (TAA). Additionally, older TAA patients display comparable reported outcomes relative to hip/knee arthroplasty. However, there remains a paucity of literature surrounding the reported outcomes of younger patients undergoing TAA. Thus, our aim was to assess the reported outcomes of individuals aged <50 years receiving a primary TAA.

**Methods:** A retrospective cohort analysis of adult patients <50 years who received a primary total ankle replacement was conducted. Patient demographics, diagnosis, treatment, and outcome characteristics were recorded from a chart review of 41 patients with at least 1 year of postoperative clinical follow-up. Postoperative reported outcomes were obtained via telephone interviews. Primary outcomes that were measured included emotional and physical health, activity limitation, ambulation, and global health. Measures used included the 36-Item Short Form Health Survey (SF-36), Patient-Reported Outcomes Measurement Information System (PROMIS) Global Health, and Sickness Impact Profile Ambulation. The functional outcomes in our study sample were compared with age- and gender-matched norms from a general US population, and 95% CIs were calculated for each functional outcome mean. Student t test was used for continuous variables, and  $\chi^2$  analysis was used for categorical variables.

**Results:** Thirty-one of 41 eligible patients were reached for interview. The average age at surgery was 39.7 years. Clinical and radiographic follow-up was a mean of 51.6 months and 31.2 months following TAA, respectively. General health as measured with the SF-36 was not significantly different from age-/gender-matched norms. Eighty-seven percent of patients would choose to have a TAA again. Although 58% reported being limited in vigorous activities, 61% were able to ambulate frequently for long periods of time. On average, the patients did not report ongoing pain, and only 16% reported fatigue that hindered activities. Eighty-one percent reported returning to full employment and performing their duties without difficulty, and 84% reported they resumed all normal social activities. Primary implant survivorship was 93%.

**Conclusion:** Despite a younger age and potentially increased demands, patients aged <50 years undergoing primary TAA are generally satisfied with their index procedure at a mean follow-up of nearly 5 years. Our findings of positive outcomes on their health and well-being may improve surgeon insight for TAA as an alternative treatment for younger individuals with end-stage ankle arthritis.

**Level of Evidence:** Level IV, case series.

**Keywords:** ankle arthritis, total ankle replacement, total ankle arthroplasty, patient reported outcome measurement



## Introduction

With the advancement of ankle prostheses, total ankle arthroplasty (TAA) strengthens its trend as the procedure of choice for the older patient with end-stage ankle arthritis.<sup>1,4,20</sup> However, because of its posttraumatic nature, ankle arthritis remains a complex disease with onset in the third or fourth decade with dramatic quality of life effects similar to those found in older hip and knee arthrosis populations.<sup>13,24,29</sup> Current insight toward the physical and mental outcomes of patients receiving a TAA, along with componentry improvement, presents the question, Should younger patients be offered an ankle replacement?<sup>21,25</sup>

Recently, Consul et al<sup>8</sup> reported a cohort of patients aged <55 years who underwent TAA demonstrating a survivorship of 94% at short- to midterm follow-up. Additional studies have shown comparable complications, survivorship, gait, and clinical outcomes in patients around 50 years of age in comparison to more elderly populations.<sup>10,22,27,28</sup> Ankle arthroplasty revision componentry has recently been made available as well (Stryker Medical INVISION, Integra XT Revision systems), providing both patients and surgeons additional options for revision TAA if needed. This paradigm shift has been demonstrated before in knee arthroplasty, as revision systems became available and improved the outcomes of the total knee arthroplasty (TKA) revision, thus decreasing the mean age of a TKA patient over time.<sup>16,23</sup>

Currently, patient-reported outcomes are increasingly used to elucidate patient-perceived function, pain, and satisfaction following many orthopaedic procedures.<sup>9,19,21</sup> Ramaskandhan et al<sup>21</sup> showed that at 5 years, TAA patients demonstrate similar SF-36 mental and physical function scores in comparison to TKA patients. Although the TAA patients did not perform as well in other functional and activities of daily living categories, the results were encouraging and demonstrative of improved function and satisfaction achieved with TAA in comparison to arthrodesis.<sup>11,25,30</sup> Despite the ample literature on TAA, to our knowledge there is a paucity of literature as it relates to reported outcomes in young patients undergoing TAA.

Our study retrospectively reviews prosthesis survivorship/revisions and postoperative reported outcomes of patients aged <50 years undergoing primary TAA with at least 1 year of clinical follow-up.

## Materials and Methods

### Clinical Data Review

This study was an institutional review board–approved retrospective chart review of patients who underwent a primary TAA (CPT 27702) at a single academic center from November 2003 to October 2019. Patients were all aged >18 years and <50 years at the time of index procedure, skeletally mature, and maintained at least 12 months of clinical follow-up. Forty-one patients met the inclusion criteria with a mean clinical follow-up of 51.6 (range, 13–207 months) and radiographic follow-up of 31.2 months (range, 1.5–182 months). Patients were excluded if undergoing revision surgery, aged >49 years at the time of primary arthroplasty, <12 months of clinical follow-up, or had incomplete radiographic or chart data. Chart review was performed for sex, age, body mass index, diabetes mellitus, and tobacco use. Preoperative coronal plane alignment was also recorded as neutral (<5 degrees of varus or valgus), varus (>5 degrees), or valgus (>5 degrees). Primary outcomes analyzed for survivorship included revision surgery of metallic componentry, explantation, arthrodesis, and amputation along with the etiology of failure.

### Operative Protocol

All patients underwent a primary TAA by one of 4 fellowship-trained orthopaedic surgeons at an academic medical center. Those included underwent a standard direct anterior approach to the ankle, unless a local or free flap prevented this access, in which a fellowship-trained plastic surgeon gained access for the orthopaedic surgeon. A tourniquet was used. Arthroplasty was performed first, and depending on the date of index procedure and deformity/bone loss related to the case, several different implants were used (Table 1). Associated procedures to balance the ankle or foot were performed when deemed necessary by the attending surgeon followed (Table 2). Patients were closed in standard fashion without a drain, placed into a trilaminar/AO-type splint, and were discharged on an outpatient basis or postoperative day 1 depending on case length/difficulty and patient comorbidities. Patients were made nonweightbearing. The splint was removed at 2 weeks, then the patient was placed into a boot to begin range of motion exercises and physical therapy, as long as there were no issues with

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**Table 1.** Implant Types and Frequency of Use.

Prosthesis	Number of Cases (41)	Percentage of Cases
INBONE II (Wright Medical)	17	41
INFINITY (Wright Medical)	13	32
STAR (Stryker)	6	15
INVISION (Wright Medical)	3	7
AGILITY II (DePuy)	2	5

**Table 2.** Associated Procedures Performed Concurrent to Total Ankle Arthroplasty.

Associated Procedure	Number Performed	Percentage of Cases
Tendo-Achilles lengthening	16	39
Lateral ankle ligament reconstruction	5	12
Gastrocnemius recession	3	7
Syndesmotic arthrodesis	2	5
First metatarsal dorsiflexion osteotomy	2	5
Subtalar joint arthrodesis	1	2
Medial displacement calcaneal osteotomy	1	2
Medial cuneiform opening wedge osteotomy	1	2

the anterior incision. Weightbearing was initiated anywhere from 2 to 6 weeks in a boot depending on incision healing, bone quality, and associated procedures.

### Patient-Reported Outcomes

Postoperative reported outcomes scores were obtained via telephone interviews. Primary outcomes measured included emotional and physical health, activity limitation, ambulation, and global health. Measures used included the 36-Item Short Form Health Survey (SF-36), Patient-Reported Outcomes Measurement Information System (PROMIS) Global Health v1.2, and Sickness Impact Profile Ambulation. The Medical Outcomes Study SF-36 measures physical function, pain, vitality, physical disability, social function, health perceptions, emotional disability, and mental health.<sup>12</sup> Functional outcomes in our study sample were compared with age- and gender-matched norms via the SF 36 from a general US population. Participants also completed the ambulation subscale of the Sickness Impact Profile. The profile describes limitations such as walking more slowly, being able to walk for only short distances, needing the assistance of another person to walk, and not being able to walk at all.<sup>3</sup> PROMIS Global Health v1.2 measures physical, mental, and social health in generic

rather than disease-specific terms.<sup>15</sup> Patients were also asked whether they had received revision surgery elsewhere, and whether they would undergo a TAA again.

### Statistical Analysis

Ninety-five percent CIs and ranges were calculated for each functional outcome mean. Statistical analysis was performed using Student *t* test for continuous variables, and  $\chi^2$  analysis for categorical variables.

### Results

Out of the 41 patients included in the survivorship arm of the study, there were 21 females and 20 males. The mean age was 39.7 years (range, 20-49 years) with an average body mass index of 31.2 (range, 17.4-51.5). More than a quarter (26.8%, 11/41) of patients were using tobacco at the time of surgery, and 9.8% (4/41) had been diagnosed with diabetes mellitus.

Overall primary prosthesis survival was 93% (38/41) at 51 months. Preoperatively, 26 ankles had neutral coronal plane alignment, 9 had varus alignment (mean 12, range 5-20 degrees), and 6 had valgus alignment (mean 14, range 5-40 degrees). There was 1 revision TAA performed, 1 explantation with cement spacer placement, and 1 below-knee amputation (Table 3).

Thirty-one of the 41 patients (75.6%) in the study were reached for participation in the postoperative reported outcomes analysis at an average of 59.7 months following surgery (range, 14-207 months). General health as measured with the SF-36 was not significantly different from age-/gender-matched norms (40-year-old male/female, respectively  $p = 0.64/0.42$ ). Eighty-seven percent of patients (27/31) would choose to have a TAA again, and none of the patients had undergone further surgery via another institution. Of the 4 patients who stated that they would not have a TAA again, 3 reported still being able to walk long distances frequently and had a good or very good quality of life. Although 58% reported being limited in vigorous activities, 61% were able to ambulate frequently for long periods of time. Twenty-five of the respondents (81%) reported a good, very good, or excellent quality of life. On average, the patients did not report ongoing pain, and only 16% reported fatigue that hindered activities. Eighty-one percent reported returning to full employment and performing their duties without difficulty, whereas 84% reported they resumed all normal social activities.

### Discussion

Owing to the traumatic nature of ankle arthrosis, the younger and often more active population demands solutions that maintain motion and stave off further hindfoot/

**Table 3. Primary TAA Failures.**

Patient	Age (y)	BMI	Tobacco Use	Diabetes Mellitus	Diagnosis	Clinical Follow-up (mo)	Alignment	Associated Procedures	Implant	Etiology	Outcome	SIP Ambulation	TAR Again?
TAA7	39	28.7	Yes	No	Posttraumatic arthritis	90	Varus, 5 degrees	none	STAR	Aseptic loosening	Revision TAA at 55 mo	Short distances without difficulty	Yes
TAA15	32	29.8	Yes	No	Posttraumatic arthritis	56	Varus, 20 degrees	Ankle arthrodesis takedown	INBONE II	Septic loosening	BKA at 48 mo	Long distances without difficulty	Yes
TAA16	42	40	Yes	No	Primary osteoarthritis	19	Varus, 20 degrees	TAL, lateral ligament reconstruction	INVISION tibia, INBONE talus	Septic loosening after stopping HIV medication	Explant with antibiotic spacer insertion at 16 mo	No response	No response

Abbreviations: BKA, below-knee amputation; BMI, body mass index; SIP, Sickness Impact Profile; TAA, total ankle arthroplasty; TAR, total ankle replacement.

midfoot degeneration.<sup>24,26</sup> Flavin et al<sup>11</sup> used gait analysis to show that patients who received an ankle arthroplasty produced a more symmetrical ground reaction force curve closer to normal gait controls when compared to arthrodesis patients. Further functional results compared 41 TAA patients with 27 ankle arthrodesis patients, revealing that TAA shows statistically significant improvement in sagittal plane range of motion, pain relief, and patient-perceived function than ankle arthrodesis.<sup>18</sup> In a meta-analysis performed in 2007 on intermediate/long-term outcome and survivorship comparisons of TAA vs arthrodesis, TAA had an overall 2% lower revision rate, a higher mean American Orthopaedic Foot & Ankle Society (AOFAS) hindfoot score, lower below knee amputation rates, along with similar percentages of excellent/good outcomes.<sup>14</sup> A more recent and comprehensive meta-analysis published by Zaidi et al<sup>21</sup> reviewed 58 manuscripts on nearly 8000 TAAs, finding a 10-year survival rate of 89% with a 1.2% annual failure rate concluding that the 10-year benefits include improvements in pain, function, gait, and range of motion. It is also important to note that these meta-analyses were performed on data published from 1986 to 2012, which includes many outdated second-generation total ankle implant designs that are no longer in routine use today or have undergone significant design updates. Current designs offer ultrahigh-molecular-weight polyethylene with improved wear properties, patient-specific instrumentation to improve implantation along the mechanical axis, and minimal resection implants that improve osseous preservation.<sup>5,6,17</sup>

With these considerations and the advent of revision prostheses, there is a paradigm shift for many orthopaedic foot and ankle surgeons that mirrors observations seen 2 decades prior in total knee arthroplasty. On improvement in revision prosthesis componentry, orthopaedic surgeons gained confidence in providing younger patients with tricompartmental knee arthrosis and arthroplasty knowing there were revision options for these patients as they aged.<sup>16,23</sup> Losina et al<sup>16</sup> demonstrated an increase of 134% from 1999 to 2008 in the number of TKAs performed in the United States, with the greatest increase found in the 45-64-year age group. Authors pointed to the fact that the spike in the number of arthroplasties was not related to increasing obesity or population, suggesting an improvement in implant survivability confidence. A prior meta-analysis demonstrated revision total knee arthroplasty to be a safe and effective procedure with rerevision rates of only 12.9%. The advancement of revision TKA systems in the early 2000s allowed for relaxed indications for primary implantation into younger patients and those with more complex deformities.<sup>23</sup> The TAA paradigm shift is on a smaller scale due to prevalence but is backed by several prior studies on younger patients.

Before the introduction of the fourth-generation and revision componentry, Rodrigues-Pinto and colleagues<sup>22</sup> compared 31 patients aged <50 years (mean 43) with 72

patients aged >50 years (mean 61) that underwent primary TAA with average follow-ups of 39 months and 42, respectively. There were no differences in survivorship rates (both 93%), complications, or range of motion (both significantly improved) between the groups. Although both groups also showed significant improvement in AOFAS score, the <50-year age group displayed significantly greater improvement, scoring 93.5 vs 89.8.<sup>22</sup> Tenenbaum et al<sup>27</sup> compared 21 patients aged >70 years with 21 patients aged 50-60 years who underwent TAA and analyzed both clinical (visual analog scale for pain, SF-36, AOFAS score) and gait analysis at 2 weeks prior to TAA and then again at a minimum of 2 years postoperatively. There were no significant differences in clinical or gait analysis values between the 2 groups, both of which enjoyed significant improvements over preoperative numbers.<sup>27</sup> At an average follow-up of 3 years, Demetracopoulos et al<sup>10</sup> identified 3 groups of TAA patients, <55 years, 55-70 years, and >70 years. They found the <55-year age group displayed the greatest improvement in AOFAS and SF-36 scores without differences in wound complications, revisions, and need for reoperation between the groups.<sup>10</sup> Recently, Consul and colleagues<sup>8</sup> reported their outcomes on patients aged <55 years (51 patients) undergoing primary TAA with a mean follow-up of 31 months. Overall implant survivorship was 94%, with 7 patients needing a return trip to the operating room. Only 3 patients required explantation and revision arthroplasty or conversion to arthrodesis.<sup>8</sup> These outcome scores and survivorship results were echoed by Uselli et al, who found greater improvement in AOFAS score and survivorship at 2 years in their younger cohort (aged ≤50 years) using a mobile-bearing prosthesis.<sup>28</sup>

Overall, our survivorship was comparable to previous studies at 93%; a detailed outline of our 3 failures can be found in Table 3. Patient selection also included a large number of tobacco users (26.8%), along with several patients diagnosed with diabetes mellitus (9.8%). To our knowledge, our data are the first to reflect reported outcomes scores in patients with a mean age <40 years who underwent a TAA. Despite their young age and often increased demands, patient responders displayed improved well-being, with 81% reporting a good/very good/excellent quality of life, 81% reporting return to full employment and performing their duties without difficulty, and 84% stating they resumed all normal social activities. Few were hindered by fatigue (5/31), and the majority could ambulate frequently for long periods of time (61%). Finally, 87% stated that they would have a TAA again, and of the 4 respondents who would have chosen other means of care, 3 still maintained the ability to ambulate frequently for long distances and stated they enjoyed a good or very good quality of life.

The strengths of our data set include the youngest mean age found among prior studies (39.7 years with all patients aged <50 years) along with the longest reported average



clinical follow-up of 51.6 months for all 41 patients and nearly 5 years (59.7 months) for outcomes respondents. The patient-reported outcomes related to ambulation, satisfaction, pain, employment, social, and emotional well-being give orthopaedic surgeons insight as to how a younger patient perceives function with a TAA despite often increased demands and expectations compared to older patients. This is strengthened by the lack of difference found between age/gender-matched norms in the general population when compared to our cohort.

Although a prior study of 538 TAAs failed to find age as correlating demographic to early failure, many orthopaedic surgeons are hesitant with consideration of placing a TAA into a younger, demanding patient.<sup>7</sup> We certainly concede that this continues to be a valid concern as our hip and knee colleagues have found the opposite. Bayliss and colleagues used a large online registry to identify 63 158 total hip arthroplasty (THA) and 54 276 TKA patients followed for a maximum of 20 years, finding a 5% risk of revision for those aged >70 years, yet a dramatic increase to 35% risk of revision for men in their 50s.<sup>2</sup> This is coupled with the fact that TAA patient-reported outcomes still lag slightly behind hip and knee patients. Five-year PROMS of THA, TKA, TAA in patients with mean ages >60 years showed that TAA displayed similar improvements when compared to hip and knee in terms of pain relief, satisfaction with the procedure, return to activities of daily living, and mental health. However, they performed worse in terms of stiffness, function, and return to recreational activities.<sup>21</sup> Our findings mirror this, with 58% of patients stating that they were limited in vigorous activities. Furthermore, our data lack a comparison group of older patients found in other studies along with a preoperative reported outcomes questionnaire.

Our study does contain several notable limitations. The study was performed at one of the busiest trauma centers in North America, as a result, the population is transient to a degree, making complete follow-up challenging. This is reflected in several patients lacking a full year of radiographic follow-up and is again highlighted in our patient-reported outcome arm, missing 25% of the patients found in the survivorship portion of the study. This population is also heterogenous in etiology of ankle arthritis (eg, ankle fractures, talus fractures, tibial plafond fractures, arthrodesis takedown, rheumatoid arthritis, and hemophilia). Additionally, it contains a modest number of patients making it difficult to weigh complete practice management changes from the data set. Our method of telephone interviews is not as effective in controlling bias in comparison to computer reported versions. The “yes” or “no” nature of the questions fails to enlighten certain patient responses, such as why the 3 patients who reported they would not have a TAA again stated they still had a good quality of life and could ambulate to long distances.

In conclusion, we uphold that TAA is a viable option for the younger demographic provided that a shared decision-making process occurs between the orthopaedic surgeon

and patient regarding expectations, abilities, limitations, and need for eventual revision. Further studies with larger numbers, computer reporting, and control groups would better illuminate the capabilities of TAA in the younger patient. The capacity to maintain motion in the setting of prior hindfoot arthrodesis due to trauma, improve gait, and dramatically reduce or eliminate pain to provide for a higher quality of life for someone with many years yet to live should be the foremost goal in the carefully selected patient.<sup>11,24,26</sup> As componentry evolves and more orthopaedic surgeons look to TAA in a younger patient, larger studies will help answer the question, Should younger patients be offered an ankle replacement?

### Ethical Approval

Ethical approval for this study was obtained from University of Texas Health Science Center Houston McGovern College of Medicine IRB (HSC-MS-21-0131).

### Author's Note

Michael Greaser and William C. McGarvey is now affiliated to McGovern College of Medicine, University of Texas Health Science Center–Houston, Houston, TX, USA.

### Declaration of Conflicting Interests

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