Total Ankle Arthroplasty: Clinical and Radiographic Outcomes of a Case Series with 10-Year Follow-up

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ABSTRACT

Introduction: End-stage ankle osteoarthritis is a major cause of pain and disability. Total ankle arthroplasty (TAA) has emerged as an alternative to arthrodesis, aiming to preserve joint mobility and improve quality of life. However, long-term evidence remains limited. The objective of this study was to evaluate the clinical and radiographic outcomes of a series of patients who underwent TAA with a minimum follow-up of 10 years. **Materials and Methods:** A retrospective series of patients who underwent TAA between 2007 and 2015 was analyzed. Demographic data, pain assessed using the Visual Analog Scale (VAS), function assessed using the American Orthopaedic Foot & Ankle Society (AOFAS) score, quality of life assessed using the Short Form-36 (SF-36), radiographic findings, and implant survivorship were evaluated. **Results:** Out of 40 patients, 17 completed the 10-year follow-up. The median VAS score improved from 8 to 3 ($p < 0.001$). The AOFAS score increased from 36 to 79 points, reaching a maximum of 80 points at 5 years ($p < 0.001$). The SF-36 demonstrated good to very good results across most domains. Implant survivorship at 10 years was 82%. **Conclusion:** Total ankle arthroplasty provides sustained pain relief and improves function and quality of life at 10 years, supporting its role as a valid alternative to arthrodesis in patients with end-stage ankle osteoarthritis.

Keywords: Total ankle arthroplasty; survivorship; revision; quality of life.

Level of Evidence: IV

Artroplastia de tobillo: evaluación clínica y radiológica de una serie de casos con un seguimiento de 10 años

RESUMEN

Introducción: La artrosis de tobillo en estadios avanzados es una causa importante de dolor y discapacidad. La artroplastia total de tobillo ha surgido como una alternativa a la artrodesis, con el objetivo de preservar la movilidad y mejorar la calidad de vida. La evidencia a largo plazo es limitada. El objetivo de este estudio fue evaluar los resultados clínicos y radiológicos de una serie de pacientes sometidos a una artroplastia total de tobillo con un seguimiento mínimo de 10 años. **Materiales y Métodos:** Se estudió a una serie de pacientes operados entre 2007 y 2015. Se evaluaron los datos demográficos, el dolor mediante la escala analógica visual (EVA), la función con el puntaje de la AOFAS, la calidad de vida con el SF-36, los hallazgos radiológicos y la supervivencia de la prótesis. **Resultados:** Diecisiete pacientes completaron el seguimiento de 10 años. El dolor mejoró de una mediana de 8 a 3 ($p <0,001$). El puntaje de la AOFAS aumentó de 36 a 79, con un máximo de 80 a los 5 años ($p <0,001$). El SF-36 arrojó resultados buenos a muy buenos en la mayoría de los dominios. La supervivencia de la prótesis a los 10 años fue del 82%. **Conclusión:** La artroplastia total de tobillo alivia el dolor y mejora la función y la calidad de vida a 10 años, esto la consolida como una alternativa válida frente a la artrodesis en pacientes con artrosis avanzada de tobillo.

Palabras clave: Artroplastia total de tobillo; supervivencia; revisión; calidad de vida.

Nivel de Evidencia: IV

INTRODUCTION

Advanced ankle osteoarthritis is a disabling condition that causes pain, loss of motion, and functional impairment, significantly affecting patients' quality of life.[1-3]

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Unlike hip and knee osteoarthritis, which is primary in origin and affects older individuals, ankle osteoarthritis is most commonly post-traumatic and usually affects young, active adults.[4]

For many years, ankle arthrodesis was considered the standard treatment for end-stage ankle osteoarthritis.[5,6] However, although it effectively relieves pain, it is associated in the medium and long term with the development of degenerative changes in adjacent joints, accompanied by relatively low levels of patient satisfaction and quality of life.[7]

Total ankle arthroplasty (TAA) emerged as a therapeutic alternative aimed at preserving joint motion, improving function, and reducing overload of adjacent joints.[8,9] Early TAA results in the 1970s were unsatisfactory, with high complication and revision rates.[5] Third-generation implants, such as the STAR® prosthesis in Europe and the Buechel-Pappas prosthesis in the United States, incorporate a three-component anatomic design with reduced constraint and minimal bone resection, allowing expansion of the surgical indications and improving short- and mid-term clinical outcomes.[10]

Implant designs continue to evolve, and long-term outcomes have become increasingly consistent, although they remain inferior to those reported for total hip and knee arthroplasty. This underscores the need for long-term follow-up studies evaluating not only implant survivorship but also patient-reported function and quality of life.

The primary objective of this study was to evaluate the clinical and radiographic outcomes of patients who underwent TAA with a minimum follow-up of 10 years. The secondary objective was to analyze long-term implant survivorship.

MATERIALS AND METHODS

An observational, descriptive study was conducted on a series of patients who underwent TAA with a cementless, unconstrained prosthesis (Hintegra®, Integra LifeSciences, Plainsboro, NJ, USA) between January 2007 and December 2015, with a minimum follow-up of 10 years.

The inclusion criteria were age >18 years, TAA, and a minimum clinical and radiographic follow-up of 10 years. The exclusion criteria were incomplete medical records and inability to complete the quality-of-life questionnaires (e.g., cognitive impairment).

For the clinical, functional, and quality-of-life assessments, only patients with available follow-up and a retained implant at the time of the final evaluation were included. Patients who required revision surgery were included in the survivorship analysis as events but were excluded from the functional and quality-of-life analyses.

Of the initial 40 patients, only 17 underwent clinical evaluation at 10 years and constituted the study cohort selected from the original population.

Data collection was performed by two foot and ankle fellows who were not involved in the preoperative decision-making process.

Surgical Technique

The procedure was performed on an inpatient basis. Through a standard anterior approach, the cementless tibial and talar components were implanted according to the manufacturer's cutting guides.

The postoperative protocol consisted of immobilization in a short-leg cast for 3 weeks, followed by a removable walking boot, with progressive weight-bearing and functional rehabilitation.

Patients were followed monthly during the first 3 months. Thereafter, follow-up visits were scheduled at 6, 9, and 12 months after surgery and annually thereafter.

Clinical and Surgical Evaluation

Demographic data, preoperative diagnosis, the need for concomitant procedures during TAA, intraoperative complications, reoperations, and revision surgeries were recorded.

Function was assessed using the *American Orthopaedic Foot and Ankle Society* (AOFAS) Ankle-Hindfoot Score, administered preoperatively and at 5 and 10 years postoperatively.[11] In addition, preoperative pain and pain at the 10-year follow-up were assessed using a visual analog scale (VAS; range, 0-10).

Quality of life was evaluated using the Spanish-validated version of the Short Form-36 (SF-36) questionnaire, administered only at the 10-year follow-up.[12]

Definitions of Reoperation and Revision

Reoperation was defined as any surgical procedure intended to prolong implant survivorship without replacement of the metallic components (e.g., cyst curettage and grafting, polyethylene insert exchange, osteophyte excision, or osteotomies), whereas revision was defined as any procedure involving removal of the metallic components and implantation of a new TAA or conversion to arthrodesis.[13,14]

Radiological Evaluation

Ankle CT scans and weight-bearing anteroposterior and lateral ankle radiographs obtained at the 10-year follow-up were analyzed. The presence of cysts, heterotopic ossification, and radiolucent lines was recorded.

Statistical Analysis

Continuous variables were expressed as mean and standard deviation or median and interquartile range, as appropriate. Data normality was assessed using the Shapiro-Wilk test. Categorical variables were presented as absolute frequencies and percentages. Within-group comparisons were performed using the paired Student's *t* test or, in the case of non-normal distribution, the Wilcoxon signed-rank test. The χ^2 test or Fisher›s exact test was used for categorical variables, as appropriate.

TAA survivorship was analyzed using a cumulative incidence function, considering revision as the event of interest and death as a competing event, up to 120 months (10 years), with a 95% confidence interval.

Descriptive and inferential statistical analyses were performed using JASP software, version 0.95.3 (JASP Team, Amsterdam, the Netherlands). Statistical significance was set at $p < 0.05$.

RESULTS

Demographic Data

Between January 2007 and December 2015, 40 patients underwent TAA. Twenty-three were excluded from the clinical and functional analysis at 10 years: 6 died from causes unrelated to the procedure, 7 underwent revision surgery, 1 had dementia, and 9 were lost to follow-up. It should be noted that patients who underwent revision surgery, either before or after the 10-year follow-up, were excluded from the clinical and quality-of-life assessments but were counted as events in the implant survivorship analysis. The demographic characteristics of the series are summarized in Table 1.

Table 1. Demographic data of the series.

Variable	Measures of central tendency and dispersion
Age (years), mean (SD)	68.25 (14.33)
Female	10 (58.8%)
Right side	9 (52.9%)
Preoperative alignment	
Neutral	7 (41.2%)
Valgus	4 (23.5%)
Varus	6 (35.3%)
Preoperative diagnosis	
Post-traumatic osteoarthritis	11 (64.7%)
Rheumatoid arthritis	4 (23.5%)
Primary osteoarthritis	2 (11.8%)

Several of the 17 patients with a retained TAA and complete clinical, functional, and radiographic follow-up underwent concomitant procedures at the time of the index surgery: 5 underwent subtalar arthrodesis, 1 underwent double arthrodesis, 1 underwent an isolated valgus-producing calcaneal osteotomy, and 2 underwent valgus-producing calcaneal osteotomies combined with lateral ligament reconstruction. Of these latter two patients, one also required peroneal retinaculum repair, whereas the other underwent percutaneous Achilles tendon lengthening.

Clinical Outcomes

The median pain score on the visual analog scale (VAS) was 8 (interquartile range [IQR] 7-8) preoperatively and 3 (IQR 2-3) at 10 years after surgery.

Functional assessment using the AOFAS Ankle-Hindfoot Score yielded a preoperative median of 36 points, reflecting marked functional impairment. At the 5-year follow-up, the median increased to 80 points, and at the 10-year evaluation, the scores remained stable, with a median of 79 points. Although a slight decrease was observed between the 5- and 10-year assessments, this difference did not reach statistical significance. In contrast, both the 5-year and 10-year scores were significantly higher than the preoperative values (Table 2).

Table 2. Results of the AOFAS scale.

Variable	Preoperative	5 years	10 years
AOFAS, median (IQR)	36 (32-37)	80 (79-84)	79 (72-80)
Preoperative AOFAS vs. 5 years	p <0.001		
Preoperative AOFAS vs. 10 years	p <0.001		
AOFAS 5-year vs. 10-year	p >0.05		

IQR = interquartile range; AOFAS = *American Orthopaedic Foot and Ankle Society*.

Quality of life at 10 years, as assessed with the SF-36 questionnaire, showed favorable results across all domains of the instrument (Table 3).

Table 3. Results of the Short Form-36 questionnaire.

Variable	Median (IQR)
Role limitations due to physical health	75 (50-100)
Physical functioning	70 (45-85)
General health	65 (35-75)
Bodily pain	77 (65-80)
Vitality	70 (50-70)
Role limitations due to emotional problems	100 (66-100)
Social functioning	87 (62-100)
Mental health	76 (64-80)
Health transition	50 (50-50)

IQR = interquartile range.

These functional outcomes (AOFAS and SF-36) correspond only to patients with available follow-up and a retained implant at the final evaluation and therefore reflect the outcomes of a selected subpopulation from the original cohort.

Radiographic Outcomes

The most frequent periprosthetic findings on the 10-year CT scans were radiolucent lines in 8 ankles (47.1%), predominantly around the tibial component; periprosthetic cysts in 9 cases (52.9%); and heterotopic ossification in 16 cases (94.1%). No apparent clinical correlation was identified in this series.

Implant Survivorship

For the survivorship analysis, revision was considered the event of interest and death a competing event up to 120 months (10 years). The cumulative incidence of revision at 10 years was 18% (95% confidence interval, 7%-34%) (Figure).

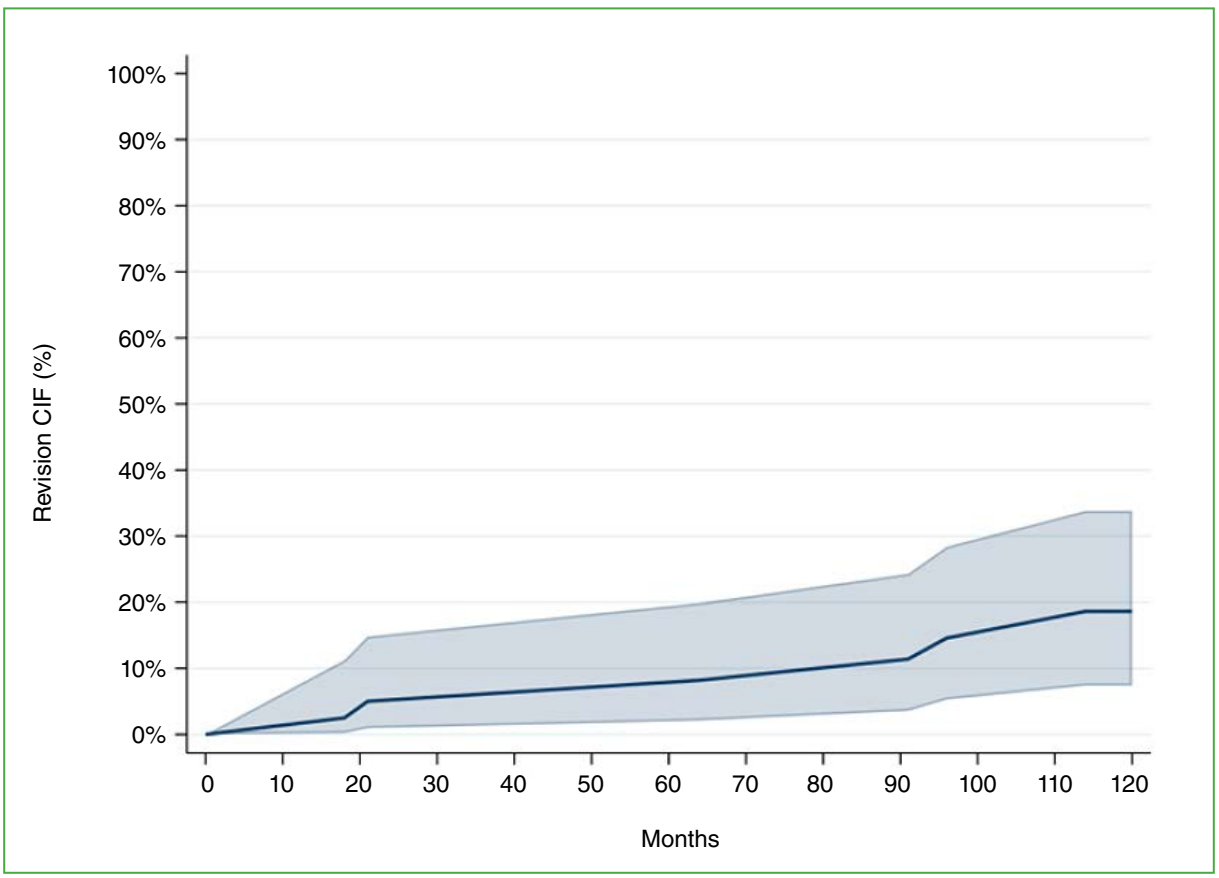

Figure. Cumulative incidence of revisions.

Complications, Reoperations, and Revision Surgeries

Two intraoperative complications occurred: a fibular fracture and a medial malleolar fracture, both of which were treated with internal fixation during the same surgical procedure.

In addition, among the 17 patients included in the analysis, three required reoperation. One underwent excision of osteophytes and heterotopic ossification, another required liner exchange because of wear, and a third developed large bone cysts that required bone grafting.

In addition to the cases described above, Table 4 summarizes the 7 patients who underwent revision surgery during follow-up and were excluded from the final study cohort.

Table 4. Total ankle arthroplasty revisions.

Patient	Reason for revision	Revision surgery
1	Medial malleolar fracture and liner dislocation	Tibio-talar arthrodesis
2	Liner breakage plus anterior bone impingement	Arthroplasty
3	Aseptic prosthetic loosening plus liner dislocation	Arthroplasty plus calcaneal valgus osteotomy
4	Prosthesis infection	1st stage: cement spacer 2nd stage: tibiotalar arthrodesis
5	Tibial fracture	Osteosynthesis plus arthroplasty
6	Aseptic prosthetic loosening plus liner wear	Arthroplasty
7	Aseptic prosthetic loosening plus liner dislocation	Arthroplasty plus Evans and calcaneal valgus osteotomies

DISCUSSION

Tibiotalar arthrodesis remains the procedure of choice for treating patients with end-stage ankle osteoarthritis in many centers. However, over the past few decades, TAA has gained increasing prominence.[14] This trend is likely attributable to advances in implant design, the growing experience of surgeons, and, most importantly, the goal of reducing overload of adjacent joints.[15,16]

Our study yielded satisfactory results at 10 years after TAA for the treatment of ankle osteoarthritis. Functional scores improved significantly compared with preoperative values, and the cumulative incidence of revision at 10 years was 18% (95% confidence interval, 7%-34%).

Kofoed and Lundberg-Jensen reported that TAA is a safe and reliable treatment across different age groups after evaluating 52 ankles treated with this type of joint replacement and a mean follow-up of 9 years.[17]

TAA survivorship remains inferior to that observed after hip and knee arthroplasty, in which 10-year revision rates rarely exceed 6%[18,19]

With regard to implant survivorship and reintervention rates, the results should be interpreted with caution, as comparisons among studies depend on the definitions of reoperation and revision adopted in each case.[13,14]

This issue explains why survivorship rates reported in the literature range from 94.4% at 10 years, as described by Jastifer and Coughlin, to 66% in other publications.[20–22] Studies reporting lower survivorship rates excluded liner exchanges and reoperations for heterotopic ossification from the category of favorable surgical outcomes. It is noteworthy that a meta-analysis of 58 studies including 7,942 TAAs reported a 10-year survivorship of 89%; the most commonly used implants were the STAR® and Hintegra® prostheses.[23] In our series, implant survivorship at 10 years was 80%, consistent with the findings reported by Koivu et al. (78.5%) and Clough et al. (82.7%).[5] On the other hand, our reoperation rate was 7.5%, comparable to that reported by Lawton et al. (9.5%).[24]

In our cohort, AOFAS scores showed sustained improvement compared with preoperative values, with a non-significant trend toward deterioration between the 5- and 10-year follow-up evaluations. The median AOFAS score improved from 36 preoperatively to 79 at 10 years. These findings are consistent with those of Clough et al., who, in a series of 200 patients treated with STAR® prostheses, observed an increase in the mean AOFAS score from 28 to 61 points after nearly 16 years of follow-up.[5] Similarly, Bagheri et al., in a systematic review of more than 3,700 ankles with a minimum follow-up of 10 years, reported a mean improvement of 40 points in the AOFAS score, confirming the sustained long-term benefits of this intervention.[25]

Quality of life at 10 years, as assessed with the validated SF-36 questionnaire, also supports TAA as a valuable treatment alternative. These findings are consistent with those reported in other studies and further support the positive impact of TAA on functional outcomes and patients' overall perception of their health.[15,25]

On the other hand, the radiographic findings analyzed (radiolucencies, heterotopic ossification, and periprosthetic cysts) indicate that these are very common findings during the follow-up of this type of joint replacement. It is noteworthy that, in our series, they were not associated with a significant clinical or functional impact, nor did they affect patients' quality of life. Nevertheless, their clinical relevance remains a matter of debate in the literature. While some studies have associated these findings with an increased risk of failure, others have found no direct correlation with functional outcomes or the need for revision surgery.[21] This heterogeneity highlights the need for further investigation into these radiographic findings and their relationship with clinical and functional outcomes.

In 42.82% of the patients who underwent revision surgery, the indication was aseptic loosening, which is consistent with the literature identifying aseptic loosening as the leading cause of revision.[16,19]

The limitations of our study are those inherent to its retrospective design, its moderate sample size, and its single-site nature. Another limitation is the considerable rate of loss to follow-up, which we attribute primarily to the advanced age of the patients who underwent total ankle replacement during our early years of experience with this procedure. On the other hand, the strengths of this study include a series of patients treated with the same implant, in a relatively challenging setting for performing this type of procedure, and the limited local literature reporting clinical, functional, and radiographic outcomes of TAA with a minimum follow-up of 10 years.

Finally, future research should focus on multicenter studies with larger sample sizes and prospective designs that reduce selection bias and loss to follow-up.

CONCLUSIONS

Total ankle arthroplasty is a valid therapeutic alternative to arthrodesis and provides sustained clinical and functional benefits over time. However, implant survivorship remains the main long-term challenge and should continue to be evaluated as newer prosthesis designs reach longer follow-up periods, surgical experience increases, and the population of candidates for this procedure expands.

Conflicts of interest: The authors declare no conflicts of interest.

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