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Total Ankle Arthroplasty in Rheumatoid Arthritis: Clinical Outcomes and Prosthesis Survivorship with Mean 8-Year Follow-up

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Purpose: Total ankle arthroplasty (TAA) is a surgical option for end-stage ankle arthritis, including that caused by rheumatoid arthritis (RA). However, concerns persist regarding postoperative complications associated with inflammatory responses and immunosuppression in patients with RA. This study evaluated clinical outcomes and prosthesis survivorship in RA patients who underwent TAA for painful ankle arthritis.

Materials and Methods: Thirty-four consecutive TAAs performed in RA patients with a minimum follow-up of 2 years were included and reviewed retrospectively. The visual analog scale for pain, ankle osteoarthritis scale pain and disability subscores, and ankle range of motion were used to assess clinical outcomes. Prosthesis survivorship, reoperations, complications, and risk factors were also analyzed.

Results: The mean follow-up duration was 95.5 months (range, 26–221 months). All clinical scores significantly improved from preoperative values to the final follow-up. Revision surgery was performed on 6 ankles (17.6%), and 1 ankle (2.9%) failed due to deep infection. No minor wound complications were observed. Kaplan–Meier survival analysis demonstrated prosthesis survivorship rates of 97.4% at both 5 and 10 years postoperatively, and revision-free survivorship rates of 81.5% at 5 years and 74.7% at 10 years. No individual factor was significantly associated with revision.

Conclusion: Mobile-bearing TAA resulted in favorable clinical outcomes and high prosthesis survivorship in RA patients. No disease-specific factor was associated with revision surgery. These findings support TAA as a viable surgical option for RA patients with painful end-stage ankle arthritis.

Key Words: Ankle, total ankle arthroplasty, total ankle replacement, rheumatoid arthritis

INTRODUCTION

Rheumatoid arthritis (RA) is a systemic autoimmune connective tissue disease that causes inflammatory arthritis by affecting the synovial membranes.[1] The ankle joint is involved in approximately 52% of RA patients.[1,2] Patients with rheumatoid ankle arthritis often present with a compromised soft tissue envelope and poor bone quality, largely due to prolonged treatment with immunosuppressive medications. Additionally, they display a relatively high prevalence of concurrent arthritis in adjacent hindfoot and midfoot joints.

In recent decades, total ankle arthroplasty (TAA) has emerged as a viable alternative to ankle arthrodesis, which has historically been considered the standard surgical treatment for painful end-stage ankle arthritis. Advances in implant design and

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surgical techniques have led to improved prosthesis survivorship and functional outcomes that are comparable to, or better than, those of ankle arthrodesis.[3,4] Considering the frequent multi-joint involvement in RA, performing TAA specifically in patients with ankle arthritis caused by RA may offer advantages over arthrodesis by preserving ankle range of motion (ROM), thereby reducing stress on adjacent joints and promoting more natural gait kinematics.[2,5] However, the immunosuppressive status of RA patients may increase the risk of wound complications and deep infection.[6,7] Additionally, hindfoot fusion—which may be more common in RA than in osteoarthritis—has the potential to adversely affect surgical outcomes.[8,9]

This study evaluated the clinical outcomes and implant survivorship of mobile-bearing TAAs performed in consecutive ankles of RA patients. Risk factors associated with revision surgery were also analyzed. We hypothesized that TAA would result in significant clinical improvement and satisfactory prosthesis survivorship in RA patients.

MATERIALS AND METHODS

This study was approved by the Institutional Review Board of our institution, which waived the requirement for informed consent due to the retrospective nature of the study (approval number: 4-2025-0060).

Between September 2004 and September 2022, 38 consecutive primary TAAs were performed in 36 RA patients. The HINTEGRA prosthesis (Newdeal SA, Lyon, France) and the SALTO prosthesis (Tornier SA, Saint Ismier, France)—both third-generation, three-component, mobile-bearing, uncemented implants—were used in all cases. All procedures were performed at a single, non-developer center by one orthopedic foot and ankle surgeon who had extensive experience in TAA and no affiliation with the prosthesis developers.

The indication for TAA was painful end-stage ankle arthritis unresponsive to conservative treatment with confirmed cases of RA diagnosed by a rheumatologist. For inclusion in the final cohort, patients were required to have a minimum follow-up duration of 2 years. Exclusion criteria were osteonecrosis of the talus, history of septic arthritis, conversion from ankle arthrodesis, neuroarthropathy, and follow-up duration shorter than 2 years.

Perioperative modification of antirheumatic medications

Antirheumatic medications were managed perioperatively in consultation with a rheumatologist. In most cases, conventional synthetic disease-modifying antirheumatic drugs were continued throughout the perioperative period.[10] Biologic agents were withheld during the perioperative period; they were resumed 2 weeks postoperatively upon confirmation that wound infection was absent.[10] If necessary, nonsteroidal anti-inflammatory drugs were continued at the current dose.

Surgical technique and postoperative care

All procedures were performed under general or spinal anesthesia. TAAs were conducted in a standardized manner, as introduced by the prosthesis developers.[11,12] For ankles with preoperative deformity, concomitant procedures were performed to achieve ankle neutral alignment using previously described techniques for addressing deformity.[13-15]

Patients were permitted to bear weight as tolerated immediately after TAA while wearing a below-knee cast for 4 weeks. In cases involving realignment osteotomy, non-weight bearing was maintained for 6 weeks postoperatively with a below-knee cast. After cast removal, progressive weight bearing with an ankle boot brace was initiated, along with ROM and muscle-strengthening exercises.

Clinical evaluation

Baseline demographic data—including age, sex, body mass index, and medical history, such as RA subtype and antirheumatic medication use—were collected from electronic medical records.

To evaluate functional outcomes, visual analog scale pain scores, ankle osteoarthritis scale (AOS) pain and disability scores,[16] and ankle ROM were assessed preoperatively; at 1, 3, 6, and 12 months postoperatively; and annually thereafter. Assessments were performed by registered nurses blinded to the purpose of the study. The AOS is a validated, disease-specific instrument for evaluating ankle arthritis.[17]

All additional procedures, reoperations, and complications were recorded. Concomitant procedures were defined as those performed during the primary TAA. Subsequent procedures were defined as those performed after the index TAA without involvement of TAA components. Revision was defined as any reoperation involving a TAA component. Major revision (prosthesis failure) was defined as exchange or removal of any metal component; minor revision was defined as exchange of the polyethylene inlay. The interval between TAA and revision surgery was recorded for survival analysis.

Radiographic evaluation

All patients underwent standardized standing anteroposterior and lateral ankle radiographs preoperatively. Postoperatively, fluoroscopy-assisted standing anteroposterior and lateral radiographs were obtained. Computed tomography with metal artifact subtraction was used during follow-up to detect periprosthetic osteolysis. Computed tomography scans were performed every 2 years in patients without radiographic evidence of osteolysis and more frequently in those with suspected new or progressive osteolysis.[18] Radiographic measurements were conducted by two fellowship-trained foot and ankle surgeons uninvolved in patient care and blinded to clinical data. Each measurement was performed twice; mean values were recorded after the exclusion of maximum and minimum values to reduce bias.

Preoperative radiographic grading of ankle joint destruction was performed using the method proposed by Larsen, et al.[19] The tibiotalar angle was defined as the angle between the anatomic axis of the tibia and a line perpendicular to the articular surface of the talar dome or the superior border of the talar component (Fig. 1).[20] Periprosthetic osteolysis was defined as a demarcated hypodense lesion ≥2 mm in width without bony trabeculae on computed tomography images.[21]

Statistical analysis

The Kolmogorov–Smirnov test was used to assess data normality for each variable. Depending on the distribution, either a paired t-test or Wilcoxon signed-rank test was performed to compare preoperative and final follow-up values. To analyze risk factors associated with revision surgery, the chi-square test or Fisher's exact test was used for categorical variables; the independent t-test or Mann–Whitney U test was utilized for continuous variables. Significant variables in univariate analysis were eligible for entry into multivariate logistic regression models. The probabilities of prosthesis failure and revision surgery were estimated using Kaplan–Meier analysis. *P*-values <0.05 were considered statistically significant. All statistical analyses were performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA).

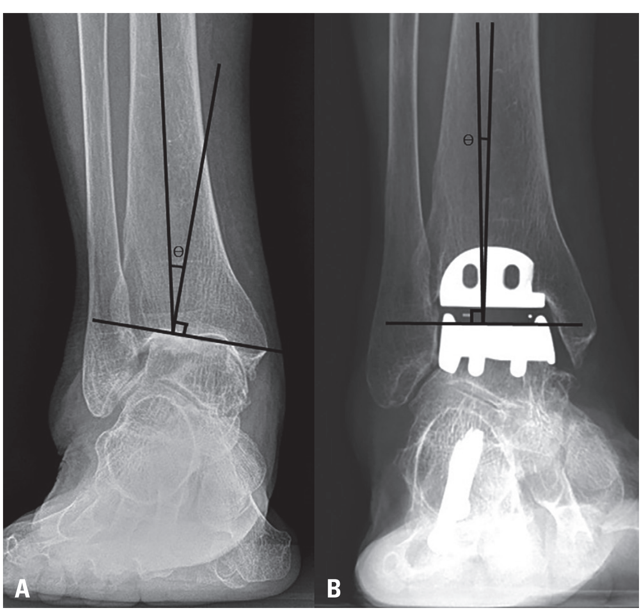

Fig. 1. Standing anteroposterior radiograph of the ankle illustrating the tibiotalar angle. (A) Preoperative tibiotalar angle, defined as the angle between the anatomic axis of the tibia and a line perpendicular to the articular surface of the talus. (B) Postoperative tibiotalar angle, defined as the angle between the anatomic axis of the tibia and a line perpendicular to the superior border of the talar component.

RESULTS

Baseline demographic data are presented in Table 1. Four ankles (four patients) were excluded for not meeting the minimum follow-up requirement of 2 years without any reoperation performed prior to loss to follow-up. The final cohort included 34 ankles (32 patients), with a median age of 62.0 years (range, 33–79 years). Hindfoot arthritis and preoperative hindfoot fusion (spontaneous or surgical) were observed in 18 ankles (52.9%). The mean follow-up duration was 95.5 months (range, 26–221 months).

Clinical and radiographic outcomes

Clinical and radiographic outcomes are summarized in Fig. 2. All functional scores and ankle ROM significantly improved from the preoperative assessment to the final follow-up (all *p* <0.001). The mean improvement in total AOS score (average of pain and disability subscores) was 39.1, exceeding the previously reported minimal clinically important difference of

Table 1. Patient Demographic and Radiographic Characteristics

Characteristic	Value
Ankles	34
Patients	32
Age at operation, yr	62.0 (33–79)*
Sex	
Female	31 (91.2)
Male	3 (8.8)
Ankle side	
Right	20 (58.8)
Left	14 (41.2)
Body mass index, kg/m^2	24.8 (19.0–33.6)*
Prosthesis	
HINTEGRA	32 (94.1)
SALTO	2 (5.9)
Preoperative radiology	
Tibiotalar angle, degrees	9.1 (0.7–31.1)†
Hindfoot arthritis or spontaneous fusion	18 (52.9)
Larsen grade	
Grade 3	2 (5.9)
Grade 4	22 (64.7)
Grade 5	10 (29.4)
Mean follow-up period, months	95.5 (26–221)†
Serology	
Seropositive	23 (67.6)
Seronegative	11 (32.4)
Medication	
Conventional synthetic disease-modifying antirheumatic drug	25 (73.5)
Steroid	20 (58.8)
Biologic agent	7 (20.6)

Data are presented as *median (range), †mean (range), or n (%).

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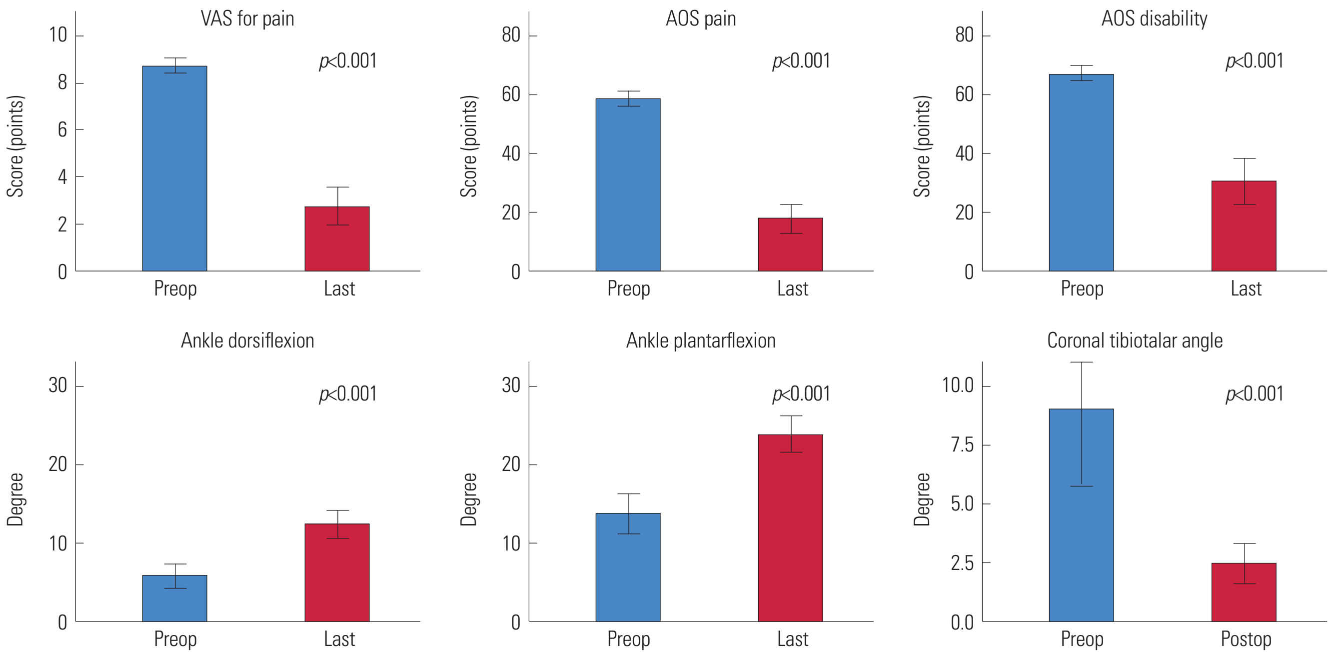

Fig. 2. Clinical and radiographic outcomes. VAS, visual analog scale; AOS, ankle osteoarthritis scale.

Table 2. Concomitant Procedures

Procedure	Ankles
Medial deltoid release	9 (26.5)
Adjacent joint arthrodesis	7 (20.6)
Talonavicular	1 (2.9)
Subtalar	3 (8.8)
Syndesmosis	1 (2.9)
Triple	1 (2.9)
Percutaneous tendo-Achilles lengthening	6 (17.6)
Lateral plication	3 (8.8)
Gastrocnemius recession	3 (8.8)
Bone graft for bone defect	2 (5.9)
Gastrocnemius recession	2 (5.9)
First metatarsal dorsiflexion osteotomy	2 (5.9)
Calcaneal lateral closing-wedge osteotomy	1 (2.9)
Calcaneal medial displacement osteotomy	1 (2.9)
Posterior tibial tendon debridement	1 (2.9)
Flexor digitorum longus tendon transfer	1 (2.9)
Medial malleolus fixation	1 (2.9)

Data are presented as n (%).

Table 3. Reasons and Types of Revision Surgery

	Ankles
Reason	
Progressive periprosthetic osteolysis	3 (8.8)
Asymmetric polyethylene inlay wear	2 (5.9)
Residual valgus deformity	2 (5.9)
Polyethylene inlay breakage	1 (2.9)
Instability	1 (2.9)
Deep infection	1 (2.9)
Procedure	
Minor revision	
Auto-iliac bone grafting, valgus correction, and polyethylene inlay exchange	2 (5.9)
Auto-iliac bone grafting and polyethylene inlay exchange	1 (2.9)
Varus correction and polyethylene inlay exchange	1 (2.9)
Polyethylene inlay exchange	1 (2.9)
Major revision	
Conversion to tibiotalocalcaneal arthrodesis	1 (2.9)

Data are presented as n (%).

28.0 points.[22] The mean tibiotalar angle improved significantly from 9.1° (range, 0.7°–31.1°) preoperatively to 2.5° (range, 0°–8.8°) at final follow-up (p<0.001). Periprosthetic osteolysis was observed in 17 ankles (50.0%).

Concomitant and subsequent procedures

Concomitant procedures are summarized in Table 2. The most common procedure was medial deltoid ligament release, performed in 9 ankles (26.5%) to correct preoperative varus deformity. Arthrodesis of an adjacent joint was performed in 7 ankles (20.6%). Percutaneous tendo-Achilles lengthening and gastrocnemius recession were conducted to improve joint stiffness in 6 (17.6%) and 3 (8.8%) ankles, respectively.

Subsequent procedures were performed in 4 ankles (11.8%). Medial malleolus fixation was conducted in 2 ankles (5.9%) due to periprosthetic fractures occurring after the index TAA. Arthroscopic debridement for gutter pain was performed in 1 ankle (2.9%); curettage with bone grafting for a tibial osteolytic cyst was required in 1 ankle (2.9%).

Revision, prosthesis failure, and risk factors associated with revision

The reasons for revision surgery and the corresponding procedures are listed in Table 3. Revision surgery was performed in 6 ankles (17.6%). Major revision for prosthesis failure was required in 1 ankle (2.9%), which developed deep infection 6 months after TAA and was managed with two-stage conversion to tibiotalocalcaneal arthrodesis. Minor revisions were performed in 5 ankles (14.7%) for progressive osteolytic cysts without metal component loosening, asymmetric polyethylene inlay wear, residual deformity, and instability. The mean interval between the index TAA and revision surgery was 50.2 months (range, 6–108 months).

Kaplan–Meier survival analysis of TAAs is shown in Fig. 3. Prosthesis survivorship rates were 97.4% at both 5 and 10 years postoperatively. Revision-free survivorship rates were 81.5% and 74.7% at 5 and 10 years, respectively. Comparative analyses were performed to identify risk factors for revision; no individual factor was significantly associated with revision (Table 4). No patient experienced minor wound complications or nerve injury.

DISCUSSION

This study presents the outcomes of 34 TAAs performed in RA patients with a mean follow-up duration of 95.5 months. Mobile-bearing TAA led to significant improvements in pain and ankle function, with favorable prosthesis survivorship over a minimum 2-year follow-up period. Additionally, no disease-specific complications or identifiable risk factors for revision were observed during follow-up. These findings support the

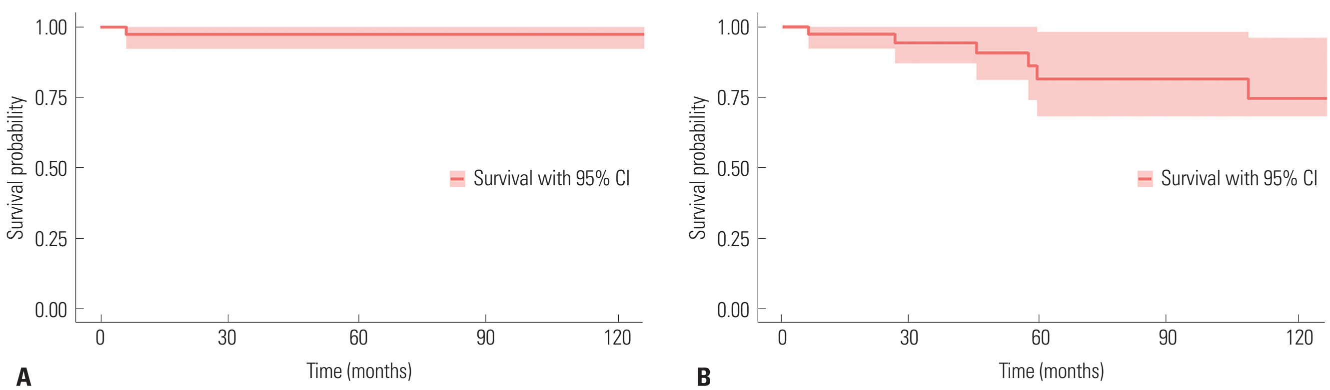

Fig. 3. Kaplan–Meier survival plots of total ankle arthroplasty. Shaded areas represent 95% confidence intervals (CIs). (A) Survival plot using exchange or removal of a metallic component as the endpoint. (B) Survival plot using all-cause revision surgery as the endpoint.

Table 4. Univariate Analysis of Risk Factors for Revision

	No revision (n=28)	Revision (n=6)	*p*
Age, yr*	63.0 (55.8–68.0)	55.0 (52.5–59.0)	0.101§
Sex†			>0.999¶
Female	25 (89.3)	6 (100.0)	
Male	3 (10.7)	0	
Ankle side†			0.061¶
Right	19 (67.9)	1 (16.7)	
Left	9 (32.1)	5 (83.3)	
Body mass index, kg/m²*	24.8 (22.9–26.4)	23.7 (20.5–24.9)	0.695§
Steroid use†	16 (57.1)	4 (66.7)	>0.999¶
Biologic agent use†	5 (17.9)	2 (33.3)	0.580¶
Seropositive†	17 (60.7)	6 (100.0)	0.145¶
Diabetes mellitus†	5 (17.9)	1 (16.7)	>0.999¶
Hindfoot arthritis†	14 (50.0)	4 (66.7)	0.660¶
Preoperative/concomitant hindfoot fusion†	8 (28.6)	3 (50.0)	0.363¶
Preoperative tibiotalar angle‡	8.1 (0.7–26.8)	13.7 (2.1–31.1)	0.271**
Postoperative tibiotalar angle‡	2.3 (0–7.5)	1.5 (0.3–3.1)	0.432**
Preoperative Larsen grade 5†	9 (32.1)	1 (16.7)	0.644¶

Data are presented as *median (interquartile range), †n (%) of ankles, or ‡mean (range).
§Student's t-test; ¶Fisher's exact test; **Mann–Whitney U test.

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use of TAA as a viable surgical option for RA patients with painful end-stage ankle arthritis.

Beyond the poor outcomes associated with first-generation TAAs, the overall outcomes of modern TAAs in recent literature have been favorable. Several meta-analyses and individual studies have revealed intermediate- to long-term survival rates of modern TAAs ranging from 70% to 90%.[4,18,23-26] Favorable outcomes have also been observed in RA patients. Doets, et al.[20] conducted a retrospective analysis of 93 TAAs performed in patients with inflammatory joint disease (primarily RA) and reported a survivorship rate of 84% at 8 years postoperatively, along with clinically significant functional improvement. Hirao, et al.[27] evaluated 50 TAAs in 44 RA patients with a mean follow-up of 7.1 years and observed significant improvement in clinical scores, with a revision rate of 4% (2 ankles), despite talar component subsidence in 8 ankles (16%). In a retrospective case series of 39 TAAs with a mean follow-up of 5.0 years, Yano, et al.[28] reported an estimated 10-year implant survival rate of 88.4%, using implant removal as the endpoint, along with satisfactory patient-reported outcomes. Comparable outcomes have also been reported for TAAs in RA patients relative to those with noninflammatory arthritis. Pedersen, et al.[29] conducted a matched cohort study analyzing intermediate-term outcomes after TAA in patients with RA and noninflammatory arthritis. Similar AOS pain and disability scores were observed at final follow-up, despite worse preoperative scores in the RA group. Cho, et al.[30] found that TAA yielded comparable clinical outcomes between RA and osteoarthritis patients in a prospective comparative study, except for lower sports activity scores in the RA group. In a recent systematic review and meta-analysis, Mousavian, et al.[31] demonstrated no statistically significant differences in intermediate-term American Orthopaedic Foot and Ankle Society scores, complication rates, revision rates, or survival rates between patients with inflammatory and noninflammatory arthritis. In the present study, we observed significant functional improvements and prosthesis survivorship rates of 97.4% at both 5 and 10 years after primary TAA. Compared with previous results, these findings are favorable.

All-cause revision-free survivorship rates, including minor revisions, were 81.5% and 74.7% at 5 and 10 years after TAA, respectively. The most common cause of revision was progressive periprosthetic osteolysis. Although most osteolytic cysts in this cohort were asymptomatic and non-progressive, untreated progressive osteolytic cysts could lead to aseptic loosening or subsidence of the metal components.[32] Serial CT monitoring and proactive minor revision with bone grafting may be effective in preventing prosthesis failure.[32] Another frequent cause of revision was residual malalignment with asymmetric polyethylene inlay wear. Reassessment and correction of residual deformities with polyethylene inlay exchange before metal component contact occurs may reduce the risk of prosthesis failure. Given the suboptimal outcomes of revision TAA and the complexity of salvage arthrodesis for failed TAA, appropriate minor revision prior to prosthesis failure is essential for achieving satisfactory long-term outcomes after TAA.[33,34]

Patients with RA and ankle arthritis exhibit several disease-specific characteristics that may influence outcomes after TAA. One notable concern is the immunosuppressive state and compromised soft tissue envelope resulting from prolonged treatment with antirheumatic medications, including disease-modifying antirheumatic drugs and corticosteroids. Theoretically, wound-healing complications and deep infections may occur more frequently in RA patients compared to individuals with noninflammatory arthritis.[31] An elevated risk of postoperative infection has been demonstrated among RA patients undergoing knee and hip arthroplasty.[6] Bongartz, et al.[35] analyzed 657 hip or knee arthroplasties in RA patients and compared the outcomes with those in a matched cohort of osteoarthritis patients; RA patients displayed a fourfold greater risk of prosthetic joint infection. In a recent meta-analysis, Qiao, et al.[36] demonstrated that RA patients had a 1.6-fold higher risk of overall infection and a twofold higher risk of deep infection after total knee arthroplasty compared with osteoarthritis patients. In the context of TAA, evidence remains mixed. Raikin, et al.[7] retrospectively reviewed 110 consecutive TAAs and reported that patients with inflammatory arthritis had a 14.03-fold increase in the risk of major wound complications requiring reoperation. Yano, et al.[28] observed a wound complication rate of 25.6% after TAA in RA patients. In contrast, Cho, et al.[30] found that wound complication and deep infection rates after TAA were comparable between RA patients and osteoarthritis patients. Similar findings were reported in earlier studies.[27,29,37] In the present study, no wound-healing complications were observed, and the overall infection rate was 2.9% (one deep infection). Careful preoperative assessment of soft tissue condition and meticulous intraoperative dissection, without prolonged cessation of antirheumatic medications during the perioperative period, may have reduced our post-TAA wound complication and infection rates. Although disease activity was not assessed in the present study, elevated disease activity itself can also induce postoperative complications.[38-40] Thus, preoperative disease control may be important for minimizing complications.

Another important characteristic of RA patients is the frequent involvement of ankle-adjacent joints, which increases the likelihood of hindfoot fusion, either due to spontaneous ankylosis or previous arthrodesis.[5] Lewis, et al.[9] reported inferior outcomes for TAAs performed with ipsilateral hindfoot arthrodesis relative to isolated TAAs, in terms of both functional outcomes and prosthesis survivorship, in a retrospective comparative study of 404 primary TAAs. Cody, et al.[8] retrospectively analyzed 533 TAAs with a mean follow-up of 7 years and identified ipsilateral hindfoot arthrodesis as an independent risk factor for prosthesis failure. Kim, et al.[41] found similar complication and failure rates between ankles treated with TAA alone and those treated with TAA combined with hindfoot arthrodesis; however, a higher rate of posterior osteolysis was observed in the hindfoot fusion group, which may influence long-term outcomes. In the present study, the prevalence of hindfoot fusion was higher in the revision group, although this difference was not statistically significant. Other factors—including type of antirheumatic medication, serologic status, and degree of preoperative bone destruction—were not significantly associated with increased revision risk. These findings combined with the overall favorable prosthesis survivorship in the present study suggest that achieving neutral alignment and a well-balanced ankle by performing adequate concomitant and/or subsequent procedure if needed, based on general TAA principles, is essential for a satisfactory outcome in RA patients; RA-specific surgical algorithms are not needed.

This study had some limitations. First, the retrospective design introduced an inherent risk of assessment bias. To mitigate this risk, we used prospectively collected data from consecutive patients and blinded the senior author to data collection and analysis. Second, the study reflects the experience of a single surgeon at a single center, which may limit its generalizability. Third, the relatively small sample size limits statistical power to detect certain risk factors. Fourth, laboratory data and disease activity were not analyzed—some patients followed for RA at other institutions did not undergo inflammatory marker testing at our center. Finally, there was no comparison group involving TAAs for other etiologies or alternative surgical techniques. Future studies with prospective designs and larger cohorts are needed to address these limitations.

In conclusion, mobile-bearing TAA resulted in favorable clinical outcomes and prosthesis survivorship among RA patients. No disease-specific factors were associated with revision surgery. These findings support TAA as a feasible surgical option for RA patients with painful end-stage ankle arthritis.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author only upon reasonable request.

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AUTHOR CONTRIBUTIONS

Conceptualization: Jin Woo Lee and Kwang Hwan Park. Data curation: Yeo Kwon Yoon, Dong Woo Shim, and Kwang Hwan Park. Formal analysis: Yeo Kwon Yoon and Dong Woo Shim. Funding acquisition: Kwang Hwan Park. Investigation: Yeo Kwon Yoon, Dong Woo Shim, and Jin Woo Lee. Methodology: Yeo Kwon Yoon, Seung Hwan Han, Kwang Hwan Park, and Jin Woo Lee. Project administration: Seung Hwan Han, Kwang Hwan Park, and Jin Woo Lee. Resources: Seung Hwan Han, Kwang Hwan Park, and Jin Woo Lee. Software: Yeo Kwon Yoon. Supervision: Seung Hwan Han, Kwang Hwan Park, and Jin Woo Lee. Validation: Yeo Kwon Yoon, Dong Woo Shim, and Seung Hwan Han. Visualization: Yeo Kwon Yoon. Writing—original draft: all authors. Writing—review & editing: all authors. Approval of final manuscript: all authors.

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