Outcome of Total Ankle Arthroplasty in Patients with Rheumatoid Arthritis and Noninflammatory Arthritis

A Multicenter Cohort Study Comparing Clinical Outcome and Safety

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Background: Patients with rheumatoid arthritis often have degeneration of the ankle and ipsilateral hindfoot joints. Patients with rheumatoid arthritis undergoing total ankle arthroplasty have a higher risk of wound breakdown and infection. We compared intermediate-term clinical outcomes after total ankle arthroplasty in patients with rheumatoid arthritis and patients with noninflammatory arthritis.

Methods: Fifty patients with rheumatoid arthritis were compared with fifty patients with noninflammatory arthritis (the control group), matched for age within ten years, prosthesis type, and follow-up time. All patients underwent total ankle arthroplasty. Revisions and major complications were noted. Outcome scores included the Ankle Osteoarthritis Scale (AOS) and Short Form-36 (SF-36) Health Survey.

Results: The groups were similar with respect to body mass index and length of follow-up (mean, 63.8 months for the rheumatoid arthritis group and 65.6 months for noninflammatory arthritis group); the rheumatoid arthritis group was younger (mean, 58.5 years compared with 61.2 years). The mean AOS pain scores were significantly different in the rheumatoid arthritis and noninflammatory arthritis groups preoperatively ($p < 0.01$), but were similar following total ankle arthroplasty (mean and standard deviation, 18.5 ± 17.8 for the rheumatoid arthritis group and 19.7 ± 16.5 for the noninflammatory arthritis group; $p = 0.93$). Both groups showed significant improvement ($p < 0.05$) with regard to the AOS scores for pain and disability and SF-36 physical component summary scores following surgery. Postoperatively, AOS disability and SF-36 physical component summary scores were better for patients with noninflammatory arthritis. There were seven revisions in the rheumatoid arthritis group and five in noninflammatory arthritis group. There was one major wound complication in the rheumatoid arthritis cohort and none in the control cohort.

Conclusions: Patients with rheumatoid arthritis benefit from total ankle arthroplasty and have similar outcomes to patients with noninflammatory arthritis. The overall pain and disability were worse for patients with rheumatoid arthritis than for those with noninflammatory arthritis preoperatively, but this did not negatively influence their final outcomes. When properly treated, patients with rheumatoid arthritis achieve good results.

Level of Evidence: Prognostic Level III. See Instructions for Authors for a complete description of levels of evidence.

Peer Review: This article was reviewed by the Editor-in-Chief and one Deputy Editor, and it underwent blinded review by two or more outside experts. It was also reviewed by an expert in methodology and statistics. The Deputy Editor reviewed each revision of the article, and it underwent a final review by the Editor-in-Chief prior to publication. Final corrections and clarifications occurred during one or more exchanges between the author(s) and copyeditors.

Rheumatoid arthritis can affect many different joints. The ankle joint is commonly affected in patients with hindfoot disease, which leads to substantial disability in 50% of rheumatoid patients[1]. Until recently, patients with rheumatoid arthritis who had painful disabling tibiotalar arthritis underwent an ankle arthrodesis[2-4]. However, this treatment has been suggested to be salvage in nature[1,5], with persistent alterations in gait[5] and a higher than usual complication rate compared

Disclosure: One or more of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of an aspect of this work. In addition, one or more of the authors, or his or her institution, has had a financial relationship, in the thirty-six months prior to submission of this work, with an entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. Also, one or more of the authors has a patent or patents, planned, pending, or issued, that is broadly relevant to the work. No author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work. The complete **Disclosures of Potential Conflicts of Interest** submitted by authors are always provided with the online version of the article.

with ankle arthroplasty. These complications include nonunion[1-3,6-9], wound-healing difficulties[1,9,10], and a very stiff foot due to frequent involvement of ipsilateral joints[4,9]. Arthritis in the ipsilateral talonavicular and subtalar joints diminishes the ability of a patient with rheumatoid arthritis to compensate for a fused ankle[9], causing metatarsalgia, limited forward progression of the affected limb, and anteriorly based tibial pain[11,12]. Tibial stress fractures may occur[9,13].

Given these limitations, procedures that preserve hindfoot motion such as total ankle arthroplasty have been pursued[1]. The intermediate outcomes of total ankle arthroplasty in patients with rheumatoid arthritis have been documented[10,11,14], but no controlled, prospective, multicenter comparative study has been done, to our knowledge. The purpose of this study was to compare the intermediate-term clinical outcomes and safety of total ankle arthroplasty in patients with rheumatoid arthritis and a matched cohort of patients with noninflammatory arthritis undergoing the same procedure.

Materials and Methods

A cohort of fifty patients with rheumatoid arthritis who underwent total ankle arthroplasty from 2001 to 2008 was identified from the Canadian Orthopaedic Foot and Ankle Society (COFAS) Prospective Ankle Reconstruction Database (the rheumatoid arthritis group). Patients with symptomatic end-stage ankle arthritis of various etiologies from four centers across Canada were enrolled in this database: Dalhousie University/Queen Elizabeth II Health Sciences Center, University of Toronto/St. Michael's Hospital, University of British Columbia/St. Paul's Hospital, and Vancouver Island Health Authority. Ethical approval was obtained from the review boards of the participating institutions, with consent to centralize the data. Informed consent was obtained from all participating patients prior to enrollment in the database and prior to surgery. The control group consisted of fifty patients with noninflammatory arthritis identified in the same database and matched for age (within ten years), type of prosthesis, and follow-up time.

Inclusion criteria were end-stage ankle arthritis amenable to surgical treatment with ankle arthroplasty, confirmed rheumatoid arthritis in the rheumatoid arthritis cohort and noninflammatory arthritis in the noninflammatory arthritis cohort, and the ability and willingness to provide informed consent. Patients with prior or concomitant hindfoot arthrodesis were included within the study groups. Exclusion criteria were incomplete data or follow-up of less than two years, poorly controlled diabetes or any Charcot or neuropathic changes, revision of a prior ankle replacement or ankle arthrodesis, language barriers, cognitive impairment, or other circumstances that prevented follow-up evaluation.

Ankle joint replacement was performed using one of four prosthesis designs. The Agility prosthesis (DePuy Orthopaedics, Warsaw, Indiana) is a semiconstrained cobalt-chromium and titanium ankle replacement. The STAR (Scandinavian Total Ankle Replacement; Waldemar LINK, Hamburg, Germany; now distributed by Small Bone Innovations, Morrisville, Pennsylvania), the Mobility prosthesis (DePuy, Leeds, United Kingdom), and the HINTEGRA prosthesis (Integra LifeSciences, Plainsboro, New Jersey) are cobalt-chromium mobile-bearing ankle replacements. An implant was chosen on the basis of surgeon preference, implant availability, and surgeon familiarity with the device. Implant type was not determined by clinical factors.

Information collected included demographics, previous and additional surgical procedures at the time of the total ankle arthroplasty, major complications, and clinical outcomes. Clinical outcome was assessed using the validated, joint-specific Ankle Osteoarthritis Scale (AOS)[15] and the generic, health-related quality-of-life Short Form-36 (SF-36) Health Survey Standard Version 2.0[16], both of which are included in the Foot and Ankle Follow-up Questionnaire developed by a coalition of ten orthopaedic associations, including the American Academy of Orthopaedic Surgeons. In the AOS, a lower score indicates less pain and disability and a better outcome. In the SF-36, a higher score indicates better physical and mental health and a better outcome. Outcome questionnaires were completed preoperatively, one year following total ankle replacement, and annually thereafter. The most recent postoperative scores available for all patients, regardless of their revision status, were used for analysis. Length of follow-up was calculated on the basis of the index ankle replacement surgery. Complications were coded according to the complication grading system developed and confirmed by the COFAS Ankle Arthritis Research Group (see Appendix). Postoperative realignment procedures to the hindfoot and pain requiring reoperation were also noted, but were not considered complications.

Statistical Analysis

Differences in demographic characteristics between the rheumatoid arthritis and noninflammatory arthritis cohorts at baseline were assessed using paired sample Student t tests. Outcome measures (AOS pain, AOS disability, and the SF-36 physical component summary [PCS] and mental component summary [MCS] scores) were analyzed as the dependent variables in a series of 2×2 mixed analyses of variance (ANOVAs), where the first factor was treatment (with 2 points, preoperative and final postoperative) and the second factor was arthritis etiology (with two levels, rheumatoid arthritis and noninflammatory arthritis), and using treatment as the repeated measure. A p value of <0.05 was considered significant. Significant interactions as determined by ANOVA were evaluated using paired sample Student t tests; the Bonferroni correction was used to account for multiple testing and was considered significant only for comparisons for which $p \leq 0.01$ (i.e., $p \leq 0.05/4$ or $p \leq 0.05/5$ when four or five t tests, respectively, were conducted).

Source of Funding

Direct or indirect research funding support for this study was received from Integra LifeSciences. An unrestricted research grant was received from DePuy to support data collection on the Mobility prosthesis for each patient entered in the COFAS database. Some patients receiving a Mobility total ankle replacement at the Dalhousie site were also part of an independent radiostereometric analysis study that was supported by an unrestricted research grant from DePuy.

Results

From November 2001 to December 2008, 281 ankles (223 in the noninflammatory arthritis group and fifty-eight in the rheumatoid arthritis group) underwent total ankle replacement. At the two-year follow-up evaluation, 267 ankles (211 and fifty-six ankles, respectively) were available for analysis. One patient (in the noninflammatory arthritis group) died within two years for reasons unrelated to the ankle replacement, two patients (in the noninflammatory arthritis group) declined to participate postoperatively, four (two in each group) were lost to follow-up, and seven ankles (in the noninflammatory arthritis group) had incomplete data. Six of the remaining fifty-six ankles in the rheumatoid arthritis group could not be successfully matched to controls with complete follow-up data. Thus, fifty ankles with rheumatoid arthritis that underwent total ankle arthroplasty were matched on the basis of age (within ten years because of the tendency of patients with rheumatoid arthritis to be younger), implant type, and length of follow-up period to fifty ankles with noninflammatory arthritis that underwent total ankle arthroplasty during the same period.

The baseline characteristics of the two patient groups are summarized in Table I. The rheumatoid arthritis cohort included fifteen men (30%) and thirty-five women, while the noninflammatory arthritis cohort consisted of twenty-one men

TABLE I Patient Demographics

	Rheumatoid Arthritis (n = 50)	Noninflammatory Arthritis (n = 50)
Sex *(no. [%])*		
Female	35 (70)	29 (58)
Male	15 (30)	21 (42)
Age at time of surgery* *(yr)*	58.5 ± 11.5 (55.2 to 61.8)	61.2 ± 8.3 (58.8 to 63.5)
Body mass index* *(kg/m^2)*	25.9 ± 5.4 (24.4 to 27.5)	28.0 ± 5.7 (26.4 to 29.6)
Length of follow-up* *(mo)*	63.8 ± 23.3 (57.2 to 70.4)	65.6 ± 20.9 (59.7 to 71.6)
Implant system *(no. [%])*		
STAR	16 (32)	16 (32)
HINTEGRA	13 (26)	13 (26)
Mobility	10 (20)	10 (20)
Agility	11 (22)	11 (22)

*Data are given as the mean and the standard deviation, with the 95% confidence interval in parentheses.

(42%) and twenty-nine women. The mean follow-up period (and standard deviation) was 63.8 ± 23.3 months for the rheumatoid arthritis group and 65.6 ± 20.9 months for the noninflammatory arthritis group. Both groups were overweight; the mean body mass index (BMI) was 25.9 ± 5.4 (95% confidence interval [CI]: 24.4 to 27.5) for the rheumatoid arthritis group and 28.0 ± 5.7 (95% CI: 26.4 to 29.6) for the noninflammatory arthritis group ($p = 0.06$). The rheumatoid arthritis group was significantly younger (mean, 58.5 ± 11.5 years) than the noninflammatory arthritis group (mean, 61.2 ± 8.3 years; $p = 0.01$).

Twelve patients with rheumatoid arthritis and one patient with noninflammatory arthritis had undergone hindfoot joint fusion prior to the total ankle replacement (six spontaneous fusions and six arthrodeses in the rheumatoid arthritis group and one arthrodesis in the noninflammatory arthritis group). Thirty-one patients (62%) in the rheumatoid arthritis group underwent thirty-nine concomitant procedures during total ankle arthroplasty, and eleven patients (22%) in the noninflammatory arthritis group underwent fifteen concomitant procedures (Table II). These were predominantly triple arthrodeses, midfoot arthrodeses, and tendon transfers.

Clinical Outcome Scores

Clinical outcome scores for each group, preoperatively and at the time of final follow-up, are shown in Figure 1. The most

TABLE II Additional Procedures at the Time of Total Ankle Arthroplasty

Procedure	Rheumatoid Arthritis (n = 50)	Noninflammatory Arthritis (n = 50)
Total ankle arthroplasty only	19	39
Hindfoot		
Subtalar arthrodesis	5	4
Talonavicular arthrodesis	2	0
Calcaneocuboid arthrodesis	1	0
Triple arthrodesis	11	1
Calcaneal osteotomy	2	6
Midfoot		
Arthrodesis	12*	3
Forefoot		
Arthrodesis (first metatarsophalangeal joint)	2	0
Tendon transfer		
Peroneus longus to peroneus brevis	4	0
Flexor digitorum longus	0	1

*Arthrodeses involved the navicular cuneiform and first tarsometatarsal, or the first and second tarsometatarsal.

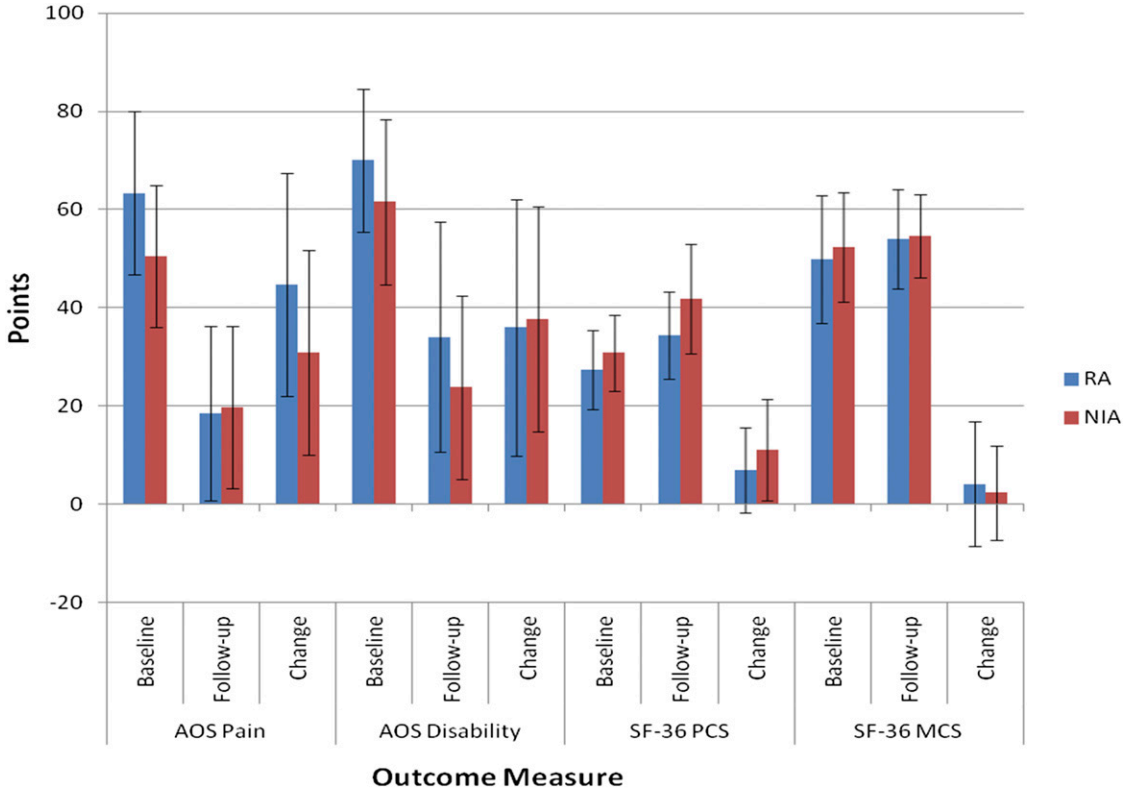

Fig. 1

The mean clinical outcome measure scores (and standard deviation) before (baseline) and after total ankle arthroplasty (follow-up), and absolute change from preoperative to postoperative (change), in the patients with rheumatoid arthritis (RA; n = 50) or noninflammatory arthritis (NIA; n = 50). AOS = Ankle Osteoarthritis Scale, SF-36 = Short Form-36 Health Survey, PCS = physical component summary score, and MCS = mental component summary score.

recent postoperative outcome scores available are presented for all patients, including those who underwent revision.

For AOS pain scores, the ANOVA indicated a significant interaction effect between treatment (preoperative and final postoperative) and arthritis etiology (rheumatoid arthritis and noninflammatory arthritis) ($p = 0.003$). Consequently, paired sample Student t tests were conducted to evaluate the significant interaction, with p values judged significant at $p \leq 0.01$ to account for multiple testing. The mean AOS pain score was significantly higher, i.e., worse, in the rheumatoid arthritis group than in the noninflammatory arthritis group preoperatively ($p < 0.01$). This difference disappeared postoperatively, and the two groups had similar levels of pain following total ankle arthroplasty (mean, 18.5 ± 17.8 points for the rheumatoid arthritis group and 19.7 ± 16.5 points for the noninflammatory arthritis group; $p = 0.93$). The mean AOS pain scores improved significantly following total ankle arthroplasty for both the rheumatoid arthritis ($p < 0.01$) and noninflammatory arthritis ($p < 0.01$) groups. The mean change in AOS pain score from preoperative to postoperative was significantly greater in the rheumatoid arthritis group (−44.8 ± 22.7 points) compared with the noninflammatory arthritis group (−30.9 ± 20.9 points; $p = 0.01$). Thus, the rheumatoid arthritis group, which had a higher level of pain preoperatively (63.3 ± 16.6 points compared with 50.5 ± 14.5 points in the noninflammatory arthritis group), improved to a pain level equivalent to that of the noninflammatory arthritis group following total ankle arthroplasty.

For AOS disability scores, the ANOVA indicated no significant interaction effect between treatment and arthritis etiology ($p = 0.61$). The treatment main effect was significant ($p < 0.001$), indicating that mean AOS disability scores improved significantly from the preoperative evaluation to the final follow-up in both groups (Fig. 1). The between-groups main effect was also significant ($p = 0.01$), indicating that the rheumatoid arthritis group reported significantly more disability than the noninflammatory arthritis group preoperatively (mean, 70.0 ± 14.6 points versus 61.6 ± 16.8 points) and postoperatively (mean, 34.0 ± 23.4 points versus 23.8 ± 18.7 points).

For SF-36 PCS scores, the ANOVA indicated a significant interaction effect between treatment and arthritis etiology ($p = 0.02$). Therefore, paired sample Student t tests were conducted to follow-up the significant interaction, for which a p value of ≤0.01 was judged significant to account for multiple testing. The mean SF-36 PCS scores (Fig. 1) were similar for the two groups preoperatively (mean, 27.4 ± 8.0 for the rheumatoid arthritis group and 30.8 ± 7.8 for the noninflammatory arthritis group; $p = 0.03$), and scores improved significantly following total ankle arthroplasty for both the rheumatoid arthritis ($p < 0.01$) and noninflammatory

TABLE III Complications Following Total Ankle Arthroplasty

Case	Complication Code*	Prosthesis	Time from Surgery *(mo)*	Management of Implants
Rheumatoid arthritis group				
1	3 – aseptic loosening	Agility	12	Components removed and conversion to arthrodesis
2	3 – aseptic loosening	Agility	32	Components removed and conversion to arthrodesis
3	5 – infection	Agility	49	Implant removal and insertion of OSTEOSET bone graft substitute with antibiotic (Wright Medical, Arlington, Tennessee)
4	1 – fractured polyethylene liner	STAR	76	Polyethylene liner exchanged
5	3 – malposition†	HINTEGRA	36	Replacement of tibial component and polyethylene liner
5	3 – malposition†	HINTEGRA	70	Removal of implants and conversion to arthrodesis
6	3 – aseptic loosening	HINTEGRA	1	Revision to other mobile-bearing prosthesis
6	3 – aseptic loosening	HINTEGRA	67	Removal of implants and conversion to arthrodesis
Noninflammatory arthritis group				
7	3 – aseptic loosening	Agility	86	Removal of implants
8	3 – aseptic loosening	STAR	72	Replacement of polyethylene liner and bone graft
9	3 – malposition†	STAR	38	Revision of STAR prosthesis to HINTEGRA total ankle arthroplasty prosthesis
10	3 – malposition†	STAR	65	Replacement of polyethylene liner
11	3 – aseptic loosening	STAR	52	Replacement of polyethylene liner and bone graft
12	1 – fractured polyethylene liner	STAR	97	Replaced polyethylene liner
13	3 – aseptic loosening	STAR	120	Tibiotalocalcaneal arthrodesis
14	3 – aseptic loosening	STAR	120	Pantalar arthrodesis
15	3 – malposition†	HINTEGRA	51	Removal of implants and tibiotalocalcaneal arthrodesis

*Classified according to the system developed by the Canadian Orthopaedic Foot and Ankle Society (see Appendix). †Malposition was defined as incorrect placement or subsidence and/or movement of the talar and/or tibial implant in any orthogonal plane, causing symptoms that required revision.

arthritis ($p < 0.01$) groups. The mean SF-36 PCS scores at the time of final follow-up were significantly different between the groups (34.4 ± 8.8 points for the rheumatoid arthritis group versus 41.8 ± 11.1 points for the noninflammatory arthritis group; $p < 0.01$); however, the mean change from preoperative to postoperative was not significantly different between the groups (6.9 ± 8.6 points for the rheumatoid arthritis group versus 11.0 ± 10.3 points for the noninflammatory arthritis group; $p = 0.02$). Thus, while the physical health of both groups improved following total ankle arthroplasty, the noninflammatory arthritis group demonstrated a greater mean change and significantly better physical health at the time of final follow-up.

For SF-36 MCS scores (Fig. 1), the ANOVA indicated no significant interaction effect between treatment and arthritis etiology ($p = 0.19$) or between the groups ($p = 0.79$). However, the treatment main effect was significant ($p = 0.04$), indicating an improvement from preoperative to final follow-up of 4.1 ± 12.8 points for the rheumatoid arthritis group and 2.3 ± 9.6 points for the noninflammatory arthritis group.

Complications

Six patients in the rheumatoid arthritis group experienced eight major complications (16%) (Table III) according to the COFAS complication grading system developed and confirmed by the COFAS Ankle Arthritis Research Group (see Appendix). Metal components were removed from five patients (five ankles that had seven revisions); four of the revisions were done because of aseptic loosening. Four of the revised ankles had conversion to arthrodesis. Two patients had polyethylene liners exchanged. In the noninflammatory arthritis group, nine patients experienced nine major complications (18%): five had revision of metal implants, with four converted to arthrodesis, and four additional patients required polyethylene liner exchanges. The average time to revision was forty-three months (range, twelve to seventy months) in the rheumatoid arthritis group and seventy-eight months (range, fifty-one to 120 months) in the noninflammatory arthritis group. In the rheumatoid arthritis group, one ankle (2%) developed a deep infection requiring removal of the implant; no deep infections occurred in the noninflammatory arthritis

TABLE IV Additional Procedures Performed After the Total Ankle Arthrodesis for Reasons Not Defined as Complications

Case	Prosthesis	Time from Surgery *(mo)*	Ancillary Procedures
Rheumatoid arthritis group			
16	STAR	13	Lateral closing-wedge calcaneal osteotomy
17	HINTEGRA	14	Lateral closing-wedge calcaneal osteotomy
18	Mobility	2	Skin graft due to superficial skin necrosis
Noninflammatory arthritis group			
8	STAR	6	Lateral closing-wedge calcaneal osteotomy
9	STAR	19	Lateral closing-wedge osteotomy
19	STAR	18	Lateralizing calcaneal osteotomy
20	HINTEGRA	9	Lateralizing calcaneal osteotomy
21	HINTEGRA	6	Lateral closing-wedge calcaneal osteotomy
21	HINTEGRA	32	Synovectomy
22	HINTEGRA	10	Lateralizing calcaneal osteotomy
23	STAR	19	Gutter debridement and ligament repair
24	HINTEGRA	3	Lateralizing calcaneal osteotomy and midfoot arthrodesis

group. There was a higher rate of additional procedures after total ankle arthroplasty for reasons other than surgical complications in the noninflammatory arthritis group (18%) compared with the rheumatoid arthritis group (6%) (Table IV). Most procedures were lateral closing-wedge calcaneal osteotomies or lateralizing calcaneal osteotomies. One wound complication in the rheumatoid arthritis group required a skin graft.

Discussion

Intermediate, five-year outcomes of total ankle arthroplasty demonstrated that patients with rheumatoid arthritis improved from a greater level of pain preoperatively than that in a matched cohort of patients with noninflammatory arthritis, and both groups reported similar levels of pain relief at the time of final follow-up. In contrast, while both groups showed a similar improvement in function following total ankle arthroplasty, the noninflammatory arthritis group reported better function at the time of final follow-up. Comparison of groups of this size (i.e., fifty patients per group) with similar demographics has not previously been possible in other studies of total ankle arthroplasty in a rheumatoid arthritis population.

The patients with rheumatoid arthritis in this study showed a significant and substantial reduction in hindfoot pain following total ankle replacement, with pain levels equivalent to those for the noninflammatory arthritis group at the time of final follow-up. The rheumatoid arthritis cohort demonstrated a significant reduction in AOS disability score after surgery, similar to the reduction observed in the noninflammatory arthritis group, but the preoperative and final disability scores of the rheumatoid arthritis group were higher. The AOS disability scale is more reflective of overall function; therefore, this disparity is expected, given the systemic nature of rheumatoid arthritis that causes involvement of multiple lower-extremity joints. This phenomenon is also reflected by the greater number of concomitant procedures required during total ankle replacement surgery in the rheumatoid arthritis cohort (thirty-nine procedures in 62% of rheumatoid arthritis patients compared with fifteen procedures in 22% of noninflammatory arthritis patients).

The results of total ankle arthroplasty in this study are similar to those previously reported. A study of twenty-one patients with rheumatoid arthritis evaluated at six years following total ankle arthroplasty using the TNK cemented prosthesis[17] and another study of twelve rheumatoid arthritis patients at 6.4 years following total ankle arthroplasty with uncemented prostheses[11] noted reliable pain relief and good functional results. A prospective study of total ankle arthroplasty using cemented two-piece or three-piece ankle replacements in twenty-two patients with rheumatoid arthritis and eighteen patients with noninflammatory arthritis from a single center found similar pain scores for both groups but better function in patients with noninflammatory arthritis at one year following total ankle arthroplasty[18]. Outcomes were consistent through ten years of follow-up.

We observed a modest, but significant, improvement in SF-36 MCS scores in both groups. An increase of ≥2.5 points in SF-36 MCS scores is considered the minimal clinically important difference in patients with rheumatoid arthritis[19]. This suggests that the change in the SF-36 MCS score in our study was sufficiently large in the rheumatoid arthritis group (mean, 4.1 ± 12.8 points) to have clinical importance, but not in the noninflammatory arthritis group (mean, 2.3 ± 9.6 points).

Previous studies of total ankle arthroplasty in patients with rheumatoid arthritis have noted revision rates of 9% at 2.7 years[20], 4% at five years[11], 16% at eight years[21], and 11% at ten years[17] of follow-up. The revision rate in the current study was 12% in the rheumatoid arthritis group and 10% in the noninflammatory arthritis group. The mean time to revision in this study was 6.5 years in the noninflammatory arthritis group compared with only four years in the rheumatoid arthritis group, in contrast to a previously reported median time to revision for cemented two-component or three-component prostheses of four years for patients with noninflammatory arthritis and five years for patients with rheumatoid arthritis[18].

In the rheumatoid arthritis group, a deep infection in one patient (2%) required removal of the implant, and a superficial wound complication in another patient required a skin graft. In other studies of total ankle arthroplasty in rheumatoid arthritis patients, rates of wound infections that required arthrodesis have been reported to range from 2% to 5%[11,18,20,21].

The rheumatoid arthritis group underwent a greater number of additional procedures at the time of the ankle replacement to manage associated arthritis, correct deformity of the hindfoot, and achieve a plantigrade foot. The additional procedures were required to achieve the same goal, i.e., a correctly aligned, functional appendage, as in the noninflammatory arthritis group. Interestingly, the noninflammatory arthritis group underwent a greater number of hindfoot osteotomies as a second procedure after total ankle arthroplasty, to correct hindfoot malalignment postoperatively and protect the ankle replacement.

There was a difference in mean age between the groups (58.5 years in the rheumatoid arthritis group and 61.2 years in the noninflammatory arthritis group) because of the broad age range used for matching and the fact that patients with rheumatoid arthritis generally receive ankle replacements at a younger age than those with noninflammatory arthritis. While this difference was significant, we do not consider it to be clinically relevant for the impact on outcomes. The mean age of the patients with rheumatoid arthritis in the present study is comparable with that reported in previous studies, with the average age of such patients ranging from fifty-five to sixty years old[17,18,20-22].

The rheumatoid arthritis group had more women than the noninflammatory arthritis group. Scandinavian ankle registry studies of total ankle replacements have found either no sex difference in revision rates[23,24] or a higher risk of revision in women younger than sixty years that disappeared with advancing age[25]. In 107 patients who underwent ankle arthrodesis or total ankle replacement, women had significantly lower health state values (0.64) than men (0.69) at one year following surgery[26]. It is not known whether this sex effect would be observed with longer follow-up.

Limitations of this study include the difficulty in matching rheumatoid arthritis and noninflammatory arthritis patients. Despite matching age within ten years, the patients with rheumatoid arthritis were, on average, 2.7 years younger than those with noninflammatory arthritis. Patients were not matched according to sex, and the rheumatoid arthritis group had more women. This is not unexpected. Patients were not matched according to hip, knee, or contralateral ankle involvement, which could potentially negatively influence clinical outcomes. Patients were not matched on the basis of BMI, but the groups were similar. Other limitations are related to the lack of information contained in the database. We were unable to do a more thorough comparison of minor wound-healing problems that did not require surgical intervention. Nevertheless, we did identify the one deep infection that occurred in the rheumatoid arthritis group and required implant removal and a skin graft. Rheumatoid arthritis is a significant risk factor for major wound complications after total ankle arthroplasty[10].

In summary, total ankle arthroplasty provides good outcomes in patients with rheumatoid arthritis in the intermediate term. The overall health of the patients with rheumatoid arthritis was worse than that of the patients with noninflammatory arthritis preoperatively but did not negatively influence outcomes following total ankle arthroplasty. Preoperatively, the patients with rheumatoid arthritis experienced more pain than the noninflammatory arthritis group, but postoperative pain outcomes were equivalent. Patients with rheumatoid arthritis self-report a quality of life as well as levels of pain and disability similar to those of patients with noninflammatory arthritis, even though patients with rheumatoid arthritis are historically at higher risk for infection and wound-healing complications[1,9,10] and appear to undergo revisions sooner than patients with noninflammatory arthritis. Appropriate surgical precautions are required to minimize soft-tissue complications in patients with rheumatoid arthritis. These patients require careful preoperative education, and surgeons need to make appropriate implant selection to achieve good results and reduce reoperation rates.

Appendix

(eA) A table showing the classification system for complications of total ankle arthroplasty and ankle arthrodesis, developed by the Canadian Orthopaedic Foot and Ankle Society, is available with the online version of this article as a data supplement at jbjs.org. ■

NOTE: The authors thank Dagmar Gross for assistance with the preparation of this manuscript.

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