

# Conversion of Tibiotalar Arthrodesis to Total Ankle Arthroplasty

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**Background:** Conversion of ankle arthrodesis to total ankle arthroplasty remains controversial. Although satisfactory outcomes have been published, not all foot and ankle surgeons performing total ankle arthroplasty have embraced this modality.

**Methods:** Twenty-three total ankle arthroplasties were performed in patients who had undergone a prior or an attempted ankle arthrodesis. The mean age at surgery was fifty-nine years (range, forty-one to eighty years), and the mean duration of follow-up was 33.1 months (minimum, twelve months). Indications for the procedure were symptomatic adjacent hindfoot arthritis (twelve patients) or symptomatic tibiotalar or subtalar nonunion (eleven) after tibiotalar calcaneal arthrodesis. We performed concomitant surgical procedures in eighteen ankles (78%), with the most common procedure being prophylactic malleolar fixation (70%). We prospectively evaluated clinical outcomes using the Short Form-36 (SF-36), Short Musculoskeletal Function Assessment (SMFA), and visual analog scale (VAS) for pain and assessed initial weight-bearing radiographs and those made at the most recent follow-up evaluation.

**Results:** The mean VAS pain score (and standard deviation) improved from  $65.7 \pm 21.8$  preoperatively to  $18.3 \pm 17.6$  at the most recent follow-up evaluation ( $p < 0.001$ ), with five patients being pain-free (VAS score = 0). The mean SMFA bother and function indexes improved from  $55 \pm 22.9$  and  $46.7 \pm 12.6$  preoperatively to  $30.6 \pm 22.7$  and  $25.4 \pm 17.4$  at the most recent follow-up visit ( $p = 0.001$  and  $p < 0.001$ , respectively). The mean SF-36 total score improved from  $37.7 \pm 19.3$  to  $56.4 \pm 23.1$  ( $p = 0.002$ ). The implant survival rate was 87%. Four (20%) of the tibial components and fourteen (70%) of the talar components that were not revised exhibited initial settling and then were seen to be stabilized radiographically without further change in implant position. Three total ankle replacements (13%) showed progressive talar subsidence, prompting revision. Ten patients (43%) had minor complications not requiring repeat surgery.

**Conclusions:** Short-term follow-up after conversion of ankle arthrodesis to total ankle arthroplasty demonstrated pain relief and improved function in a majority of patients. Patients who undergo this surgery frequently require concomitant procedures; we recommend prophylactic malleolar fixation when performing conversion total ankle arthroplasty. The rate of complications, particularly talar component settling and migration, is cause for concern. We do not recommend the procedure for ankle arthrodeses that included distal fibulectomy.

**Level of Evidence:** Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

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**D**efinitive surgical treatment for end-stage ankle arthritis remains a source of debate, with intermediate clinical outcomes after ankle arthrodesis and total ankle arthroplasty suggesting similar pain relief<sup>1-4</sup>. Although more surgeons are considering total ankle arthroplasty, ankle arthrodesis continues to be performed at a higher rate than total ankle

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arthroplasty. Reliable pain relief, high patient satisfaction scores, and improved overall function can be achieved with ankle arthrodesis<sup>5</sup>. Despite favorable outcomes reported for a majority of patients who have undergone ankle arthrodesis, a considerable number experience fair-to-poor results<sup>6</sup>. Considerable activity limitation, foot pain, and disability have been reported following ankle arthrodesis when compared with the normal contralateral extremity<sup>7,8</sup>.

Surgical interventions considered for pain related to a primary ankle arthrodesis include revision arthrodesis for nonunion, realignment osteotomies for malposition, and extension of the arthrodesis to the hindfoot for adjacent arthritis; results of these complex operations are generally satisfactory, but not always as favorable as anticipated<sup>6,9-13</sup>. Evidence-based guidelines are lacking

in terms of the best and safest approach to manage this unique situation. In fact, the treatment armamentarium has been recently expanded to include the conversion of an ankle arthrodesis to a total ankle arthroplasty<sup>9,10,14</sup>. Our purpose was to contribute to this growing and incomplete body of knowledge by examining patient-reported outcomes and complications following conversion of ankle arthrodesis to total ankle arthroplasty with use of implants that are currently available in the U.S.

### Materials and Methods

At our institution, patient-reported outcomes, complications, and radiographic findings prior to and following total ankle arthroplasty have been prospectively collected since 2007 and maintained in a prospective database. After obtaining institutional review board approval, we identified patients who had undergone conversion of tibiotalar arthrodesis to total ankle arthroplasty.

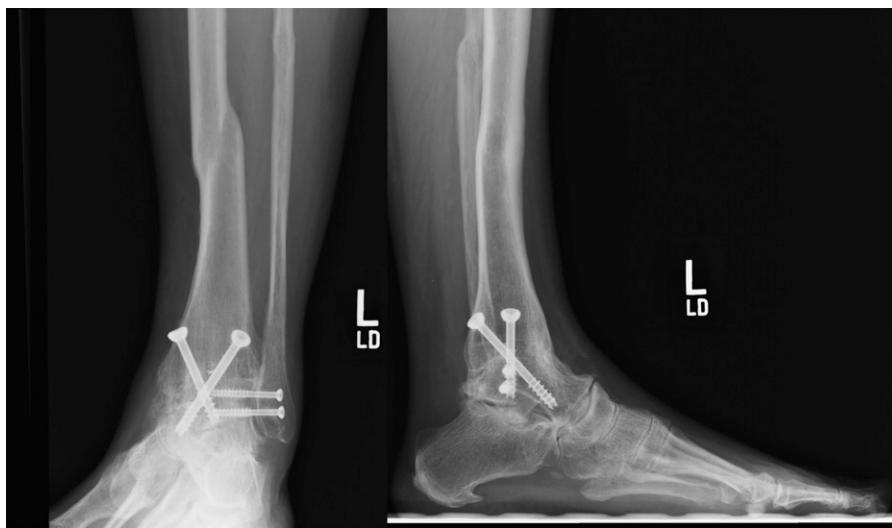


Fig. 1-A

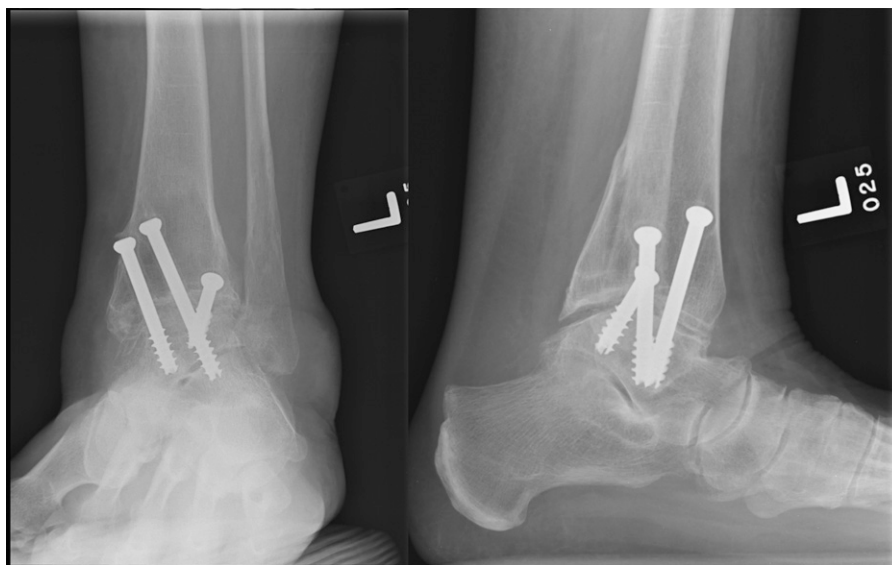


Fig. 1-B

**Figs. 1-A and 1-B** The most common indications for conversion of a painful ankle arthrodesis to a total ankle arthroplasty are adjacent hindfoot arthritis (**Fig. 1-A**) and unsuccessful tibiotalar arthrodesis (**Fig. 1-B**).

Patients were included if they were over the age of eighteen years at the time of the operation, had been followed for greater than twelve months after the total ankle arthroplasty, and had undergone a unilateral procedure. According to our institution's exclusion criteria for total ankle arthroplasty, no patients with diabetic neuropathy, active infection, or medical contraindications for reconstructive surgery were included.

Dedicated foot and ankle orthopaedic surgeons with extensive experience with total ankle arthroplasty performed all of the surgical procedures. The total ankle arthroplasties were performed with one of the three ankle prostheses currently available in the U.S.: the STAR Ankle (Small Bone Innovations, Morrisville, Pennsylvania), the INBONE (Wright Medical Technology, Arlington, Tennessee), or the Salto Talaris (Tornier, Bloomington, Minnesota). The selection of implant was at the surgeon's discretion. The INBONE was used in fourteen patients; the STAR Ankle, in seven; and the Salto Talaris, in two.

Our indications for conversion to total ankle arthroplasty included ankle arthrodesis with symptomatic painful adjacent hindfoot arthritis<sup>12</sup>, symptomatic tibiotalar nonunion<sup>9</sup>, and symptomatic subtalar nonunion after tibiotalocalcaneal arthrodesis<sup>2</sup>. Six of twelve patients with concomitant hindfoot arthritis had a malunited ankle fusion in equinus (Fig. 1).

Surgical procedures were performed concomitant with the total ankle arthroplasty in 78% of the patients (Table I). Five patients had had a distal fibular osteotomy at the time of the index arthrodesis, with two of them having had a complete distal fibular resection prompting fibular allograft reconstruction to improve lateral ankle stability after conversion to the total ankle arthroplasty.

### *Surgical Technique: Tips and Pearls*

Regardless of the implant used, conversion total ankle arthroplasty is performed with a relatively standardized surgical technique: implant removal, determination of the ideal joint line, optimal alignment, recreation of the ankle mortise,

tibial and talar resurfacing, implant balance, and confirmation of a satisfactory range of motion.

Implant removal is facilitated if an isolated anterior plate had been used; removal of the posterior-to-anterior tibiotalar lag screw is often challenging. Occasionally, staging the implant removal and conversion total ankle arthroplasty can be considered.

Determining the ideal joint line is sometimes difficult, particularly with a uniform, solid ankle fusion. In general, we plan for maximum talar bone preservation, perhaps elevating the joint line slightly from what may be considered physiologic. However, moving the joint line proximally must be performed judiciously since the tibia narrows considerably and this may increase the risk of a medial malleolar stress fracture (Fig. 2).

Alignment is determined with extra-articular guides in two of the systems and with an intramedullary alignment guide in the third. The techniques to establish alignment do not vary much from those used in primary total ankle arthroplasty. Independent tibial and talar cutting guides are used in the two systems utilizing extramedullary alignment, whereas a monoblock cutting guide is used in the one utilizing intramedullary alignment. Irrespective of the system selected, the malleoli need to be protected and residual talar bone for talar component support must be optimized. We tend to select relatively small cutting blocks for tibial preparation as the prepared tibial surfaces may be carefully enlarged to accommodate a larger component. The talar preparation should not only preserve residual talar height but also avoid excessive lateral and/or medial talar body resection.

All cases required generous gutter debridement after recognition of its physiologic position in an attempt to recreate the native anatomy. If a monoblock system is used for conversion, optimal positioning of the reference intramedullary guide and use of a smaller cutting guide than may be suggested by the clinical appreciation of the surgeon during the operation are critical to recreate the ankle joint. Typically, a talar component one size smaller than the



Fig. 2-A

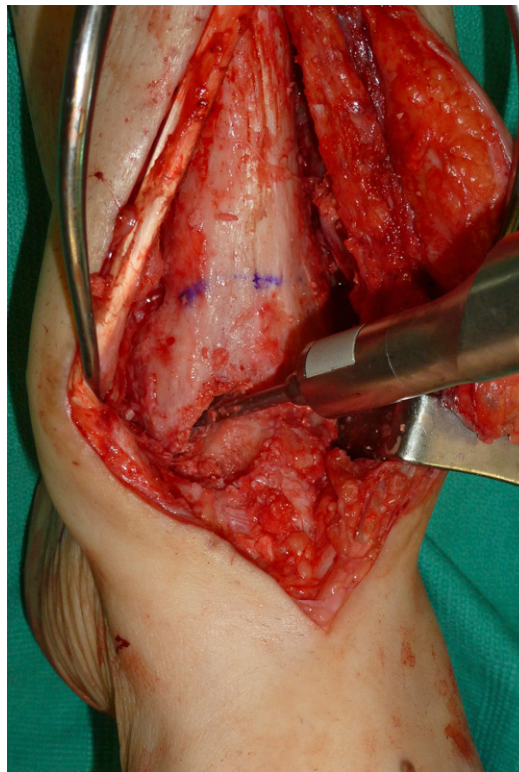


Fig. 2-B

**Figs. 2-A through 2-D** Surgical technique. **Figs. 2-A and 2-B** The joint line must be identified either clinically or radiographically. While it is ideal to restore the native articular line, some cases require placement of the initial cut proximally to provide sufficient bone stock for the talar component.



**TABLE I Concomitant Surgical Procedures**

Procedure	No. (%)
Prophylactic fixation of the malleoli	16 (70)
Subtalar fusion	6 (26)
Gastrocnemius recession or Achilles lengthening	6 (26)
Open reduction and internal fixation of fibular nonunion	2 (9)
Periarticular (gutter) debridement	1 (4)
Prophylactic radial forearm free flap	1 (4)
Talonavicular fusion	1 (4)

tibial component should be anticipated during surgical planning, ensuring that the gutters have been adequately prepared and to compensate for bone loss during talar preparation.

During tibial preparation, the resection level, rotation, and slope are addressed as they are in primary total ankle arthroplasty. As the posterior tissues may be scarred to the posterior bone, fluoroscopy may be necessary to confirm saw blade position. The sagittal slope for the tibial and talar components may be difficult to achieve, especially when the ankle arthrodesis is malunited in equinus, where excessive posterior talar resection will jeopardize talar component support. This situation can be particularly challenging when the surgeon is using a

monoblock cutting guide, properly aligned with the tibial shaft. In this situation, the talar cut should be performed independently after the tibial cut and gutter preparations are completed. Once the ankle is able to be moved through a range of motion, dorsiflexion will place the talar dome in an adequate position for preparation.

After the tibial and talar cuts are performed, the ankle should be maintained in a stable position, regardless of the system used, until the gutters are adequately recreated to avoid malleolar fractures. With the reciprocating saw, resection of 2 to 3 mm slightly toward the malleoli rather than the talar dome will ensure adequate support of the talar component, while properly recreating the gutter.

After the bone preparation is completed and the resected bone is removed, we attempt to remove scar tissue in the posterior aspect of the ankle and the posterior gutters. Only after these steps have been completed, do we attempt to mobilize the ankle joint. If the joint remains locked, consideration is given to releasing more tissue or resecting more bone. Bone defects from prior implant removal require bone-grafting to avoid cyst formation or prevent weakening of the bone before implantation of the definitive components.

### Assessment

We assessed patient-reported health and function data obtained preoperatively and at routine annual clinical follow-up visits with the Short Form-36 (SF-36), Short Musculoskeletal Function Assessment (SMFA), and visual analog scale (VAS) for pain (0 to 100-mm scale).

Ankle range of motion was assessed clinically with use of a universal goniometer with the proximal arm parallel to the axis of the fibula and the distal arm parallel to the long axis of the fifth metatarsal.

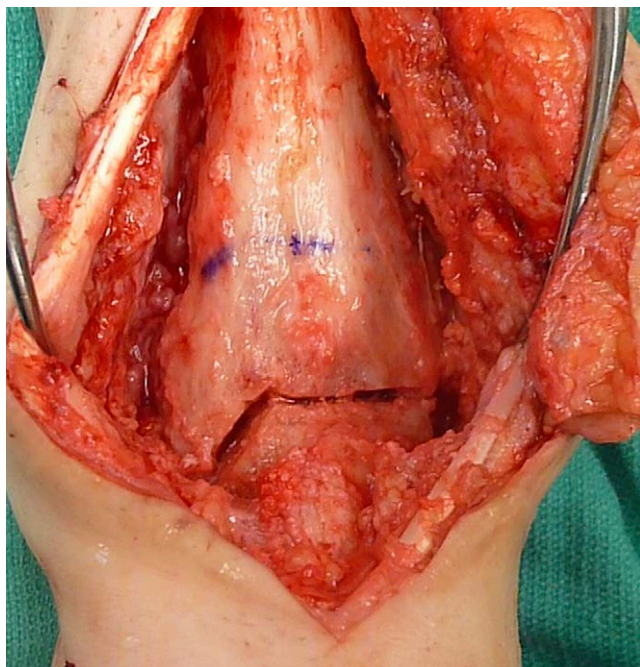


Fig. 2-C

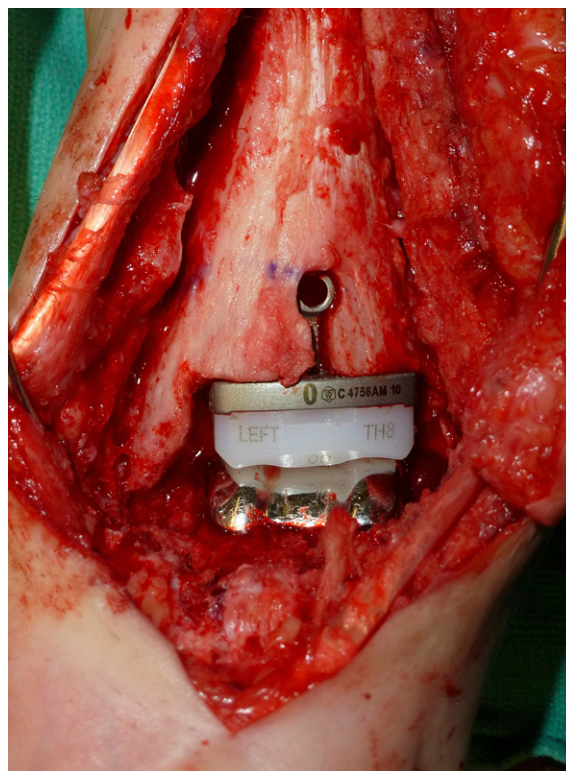


Fig. 2-D

**Fig. 2-C** After the tibial and talar cuts are performed, the ankle should be maintained in a stable position, regardless of the system used, until the gutters are adequately recreated to avoid malleolar fractures. With the reciprocating saw, resection of 2 to 3 mm slightly toward the malleoli rather than the talar dome ensures adequate support of the talar component, while properly recreating the gutter. **Fig. 2-D** Bone defects from prior implant removal require bone-grafting to avoid cyst formation or prevent weakening of the bone before definitive components are implanted.

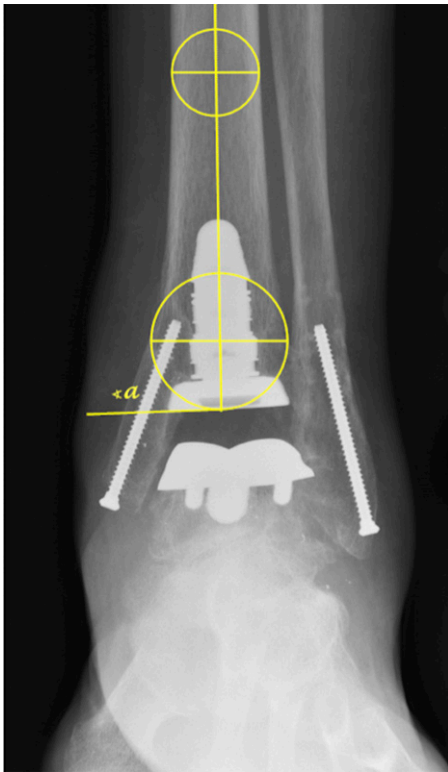


Fig. 3-A

**Figs. 3-A and 3-B** Radiographic measurements. **Fig. 3-A** The  $\alpha$  angle, which corresponds to the tibial coronal implant angle, is formed by the intersection of the tibial mechanical axis and the flat portion of the tibial component at the medial side.

Two fellowship-trained foot and ankle surgeons, who had not been involved in the surgical interventions, assessed alignment and component position on radiographs at two time points: initial weight-bearing (six weeks after surgery) and the most recent follow-up visit. Each radiograph was measured twice by each reviewer in order to assess both intraobserver and interobserver reliability. Radiographs were made with use of a standardized protocol

as previously described<sup>15</sup>. Angular measurements were performed with use of a calibrated Picture Archiving and Communication System (PACS) system (General Electric Healthcare, U.K.) loaded with TraumaCad digital templating software (Voyant Health, Columbia, Maryland).

Tibial and talar component alignments were assessed with standardized methods as previously described<sup>16-20</sup> (Fig. 3).

Differences between the preoperative and most recent patient-reported outcomes were assessed with use of a series of paired t tests. In addition, paired t tests were completed on all radiographic measures of interest to understand changes in component migration. The level of significance was set at 0.05 for each test. An intraclass correlation coefficient (ICC) was calculated<sup>21</sup> to determine intraobserver and interobserver reliability for each of the radiographic measurements. All statistical analyses were completed with use of SPSS version 20 (IBM, Armonk, New York).

### Source of Funding

There was no external funding for this investigation.

### Results

We performed twenty-three total ankle arthroplasties in patients with symptoms related to an ankle arthrodesis, including those with pain despite successful fusion and those with painful ankle nonunion after an attempted arthrodesis. The mean patient age at surgery was fifty-nine years (range, forty-one to eighty years); there were sixteen female and seven male patients. The sex proportion was similar between the complete database and the cohort in this study. The mean duration of postoperative follow-up was 33.1 months (range, twelve to 101 months). The mean time from the index arthrodesis to the total ankle arthroplasty was 84.5 months (range, 5.8 to 362.6 months).

The results of routine preoperative and postoperative clinical and radiographic evaluations were reviewed for all twenty-three patients. The analysis of the functional outcomes was based on the eighteen patients (78%) for whom we had complete preoperative and postoperative assessments. The mean VAS pain score (and standard deviation) improved from  $65.7 \pm 21.8$  preoperatively to  $18.3 \pm 17.6$  at the most recent follow-up visit ( $p < 0.001$ ), with five patients being pain-free (VAS score = 0) and eight patients with a VAS score of  $< 10$ . Respectively, the

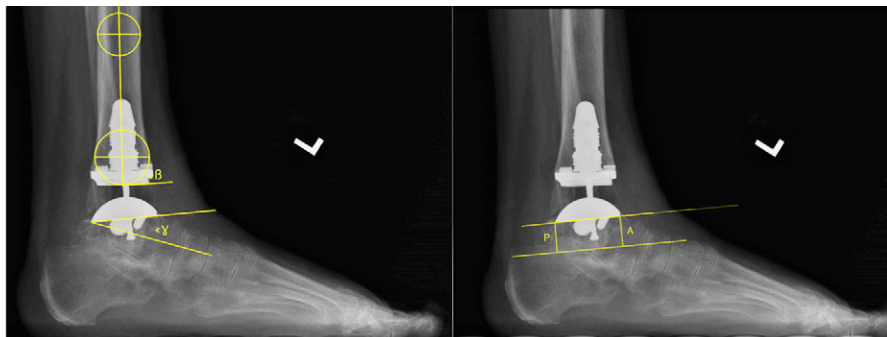


Fig. 3-B

The  $\beta$  angle, which corresponds to the tibial sagittal implant angle, is formed by the intersection of the tibial mechanical axis and the flat portion of the tibial component. The  $\gamma$  angle is determined by the axis of the talar component and a line bisecting the talar neck. In addition, the perpendicular distance from the anterior (A) and posterior (P) talar component position to a line intersecting the calcaneal tubercle and the most dorsal aspect of the talonavicular joint was measured. A change of  $> 2^\circ$  from the position of the tibial base or radiolucencies that progressed  $> 2$  mm from one time point to another were defined as migration. A change of  $> 5$  mm or  $> 5^\circ$  in the position of the talar component was defined as migration<sup>16,20</sup>.

TABLE II SF-36 Scores (N = 18)

	Mean and Standard Deviation ( <i>points</i> )		P Value
	Preop.	Most Recent Follow-up	
Body pain	25.6 ± 16.6	56.5 ± 22.8	<0.001*
General health	68.5 ± 23.6	63.9 ± 22.6	0.418
Mental health	60.9 ± 26.6	70.0 ± 22.6	0.055
Physical function	16.9 ± 10.7	37.2 ± 25.0	0.003*
Role emotional	33.3 ± 44.1	60.8 ± 42.9	0.064
Role physical	13.9 ± 30.0	40.7 ± 40.2	0.015*
Social function	43.1 ± 25.4	73.6 ± 28.1	<0.001*
Vitality	39.4 ± 23.6	49.4 ± 28.5	0.118
Physical health component summary	32.9 ± 16.9	49.6 ± 22.3	0.004*
Mental health component summary	49.0 ± 23.5	63.2 ± 25.1	0.014*
Total score	37.7 ± 19.3	56.4 ± 23.1	0.002*

\*A significant difference between preoperative and follow-up values.

mean SMFA bother and function indexes improved from  $55 \pm 22.9$  and  $46.7 \pm 12.6$  preoperatively to  $30.6 \pm 22.7$  and  $25.4 \pm 17.4$  at the most recent follow-up visit ( $p = 0.001$  and  $p < 0.001$ , respectively) (Fig. 4). The mean SF-36 total score improved from  $37.7 \pm 19.3$  to  $56.4 \pm 23.1$  ( $p = 0.002$ ). A comparison of the preoperative and postoperative SF-36 subscores is presented in Table II. At the most recent follow-up visit, the mean active ankle range of motion was  $2^\circ \pm 2.9^\circ$  of dorsiflexion and  $19.9^\circ \pm 9.3^\circ$  of plantar flexion.

Intraobserver and interobserver ICC values were 0.973 and 0.988, respectively, for the measurements of the tibial component angle on the anteroposterior radiographs and 0.919 and 0.944 for the measurements on the lateral radiographs. The anterior measurement, posterior measurement, and talonavicular angle used to assess talar migration demonstrated excellent interobserver reliability with ICC values of 0.987, 0.929, and 0.952, respectively, and excellent intraobserver reliability with ICC values of 0.980, 0.981, and 0.988, respectively.

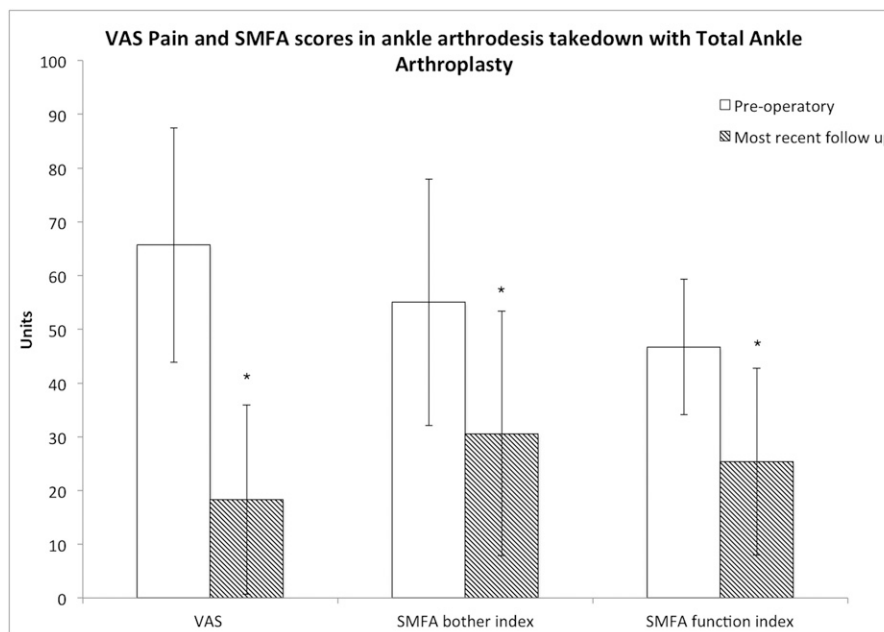


Fig. 4

Preoperative and most recent follow-up VAS pain scores and SMFA scores for patients treated with conversion of ankle arthrodesis to total ankle arthroplasty. Normative data for the SMFA bother and function indexes in the U.S. population are  $13.77 \pm 18.59$  and  $12.70 \pm 15.59$ , respectively<sup>24</sup>.

TABLE III Tibial and Talar Component Radiographic Angles and Position

Variable	Mean and Standard Deviation		P Value
	Initial Weight-Bearing Radiograph	Most Recent Radiograph	
$\alpha$ angle: tibial coronal implant angle ( <i>deg</i> )	1.4 ± 1.0	1.5 ± 1.0	0.620
$\beta$ angle: tibial sagittal implant angle ( <i>deg</i> )	1.8 ± 1.3	2.1 ± 1.0	0.135
$\gamma$ angle: talar component angle from talar neck axis ( <i>deg</i> )	17.3 ± 3.9	16.7 ± 4.6	<0.001*
Mean anterior talar component position ( <i>mm</i> )	8.2 ± 4.0	6.9 ± 4.7	0.003*
Mean posterior talar component position ( <i>mm</i> )	16.3 ± 4.4	15.0 ± 6.0	0.039*
Offset ratio ( <i>mm</i> )	2.02 ± 1.9	2.6 ± 2.5	0.229

\*A significant difference between preoperative and follow-up values.

TABLE IV Additional Surgical Procedures in Patients Not Requiring Metal Component Revision

Case	Description
1	Presented with symptomatic subtalar joint osteoarthritis 3 yr after conversion of varus nonunited ankle arthrodesis to total ankle arthroplasty. Underwent subtalar joint arthrodesis, polyethylene exchange, and peroneus longus-to-brevius transfer. 14 mo later, persistent hindfoot pain, despite solid fusion at arthrodesis site. Additionally, tibial component varus malalignment without loosening was documented. Therefore, supramalleolar opening wedge tibial osteotomy with talonavicular and calcaneocuboid concomitant arthrodesis performed
14	Presented with residual varus deformity of hindfoot with medial impingement after total ankle arthroplasty. Underwent lateralizing calcaneal osteotomy, plantar fascia release, and medial open debridement with deltoid ligament release
15	Open debridement for ankle impingement
16	Posterior arthroscopy and percutaneous Achilles tendon lengthening to treat ankle impingement and improve dorsiflexion

Three of the twenty-three patients required revision surgery and were excluded from the radiographic analysis. Tibial and talar component angles and positions are summarized in Table III. Three patients (15%) presented with a tibial angular change of  $>2^\circ$  (range,  $2.25^\circ$  to  $3.0^\circ$ ) since the initial weight-bearing radiograph. Four patients (20%) presented with tibial component settling, with an angular change between  $1^\circ$  and  $2^\circ$  during the first year following surgery. Two patients (10%) presented with a change in the talar component position of  $>5$  mm or  $>5^\circ$ . These radiographic changes were seen to have remained stable at the time of the most recent follow-up. Fourteen patients (70%) presented with talar component settling, which was designated as a change in component position between 1 and 5 mm or between  $1^\circ$  and  $5^\circ$  during the first year following surgery.

Twenty (87%) of the twenty-three patients retained their metal implants at the time of final follow-up. Using the classification described by Glazebrook et al.<sup>21</sup>, we observed low-grade complications in ten ankles (43%), including intraoperative malleolar fracture (two ankles), superficial wound problems (five), and transient irritation of the deep peroneal nerve (one) and tibial nerve (two). These were successfully managed uneventfully with internal fixation during total ankle arthroplasty, local wound care, and neuropathic pain medication, respectively. We observed one medium-grade complication, a postoperative

medial malleolar stress fracture necessitating open reduction and internal fixation, in one ankle (4%).

Seven patients (30%) required additional surgery. Of these, three patients (13%) had high-grade complications, all consisting of symptomatic progressive aseptic talar component loosening necessitating talar component revision. Two of these patients had successful revision, and the third eventually required conversion to a tibiotalocalcaneal arthrodesis. Both total ankle arthroplasties that were done to convert an ankle arthrodesis originally performed with a total distal fibulectomy failed. Four patients (17%) required additional surgery without a component exchange; details of those cases are provided in Table IV.

## Discussion

Our results demonstrate that conversion of an ankle arthrodesis to a total ankle arthroplasty leads to significant pain relief and satisfactory functional outcomes in a majority of patients, with an 87% implant survival rate at the time of early-to-intermediate follow-up. Experience with this procedure is currently limited, with only two previously published series in the literature<sup>9,10</sup>, to our knowledge. Greisberg et al.<sup>9</sup> reported the results at a mean of thirty-nine months following conversion of ankle arthrodeses to total ankle arthroplasties with the Agility prosthesis (DePuy, Warsaw, Indiana) in twenty-three ankles. Five of those ankles had undergone resection of the lateral malleolus during the arthrodesis,



TABLE V Comparison of Published Studies of Conversion of Ankle Arthrodesis to Total Ankle Arthroplasty

Study	No. of Patients	Follow-up Rate (%)	Mean Duration of Follow-up (mo)	Failure Rate (%)	Mean VAS Score (Preop. → Follow-up)	Pain-Free (%)	Intraoperative Malleolar Fracture (%)
Greisberg et al. <sup>9</sup>	23	83%	39	42	—	—	43
Hintermann et al. <sup>10</sup>	28	96%	56	13	7.5 → 1.8	17	19
Present study	23	100%	33	13	6.5 → 1.8	21	9

predisposing the total ankle prosthesis used in the conversion to symptomatic valgus talar tilt.

In the current study, one patient in whom the distal part of the fibula had been preserved during the index ankle arthrodesis had a failure of the total ankle arthroplasty due to progressive lateral talar tilt and translation. Although the conversion to the total ankle arthroplasty was uncomplicated, with the implants seen to be stable and well-aligned at the completion of the surgery, the talar component tilted into valgus and translated laterally. We attributed this problem to foot malalignment and development of medial ligament attenuation. Despite repeat surgery with a medial displacement calcaneal osteotomy and deltoid reconstruction with a semitendinosus allograft, the ankle deformity persisted, prompting explantation of the prosthesis and conversion to a tibiotalar calcaneal arthrodesis, which was successful. Our experience with conversion total ankle arthroplasty in patients in whom the ankle arthrodesis had been performed with complete distal fibular resection reflects that in two prior studies<sup>9,10</sup>: the lack of a distal part of the fibula is a contraindication for the procedure. In our two patients who lacked the distal part of the fibula, the total ankle prosthesis demonstrated progressive valgus talar tilt and lateral talar translation at the time of follow-up. Lateral malleolar allograft reconstruction and talar component revision stabilized the valgus deformity. Given that certain patients may later be candidates for conversion total ankle arthroplasty, we recommend that ankle arthrodesis be performed without resecting the distal part of the fibula.

In terms of functional outcomes, Greisberg et al. evaluated nineteen ankles and found that four had no pain and six had mild pain after conversion of a painful arthrodesis to a total ankle arthroplasty and noted that patients who had had a clear origin of the arthrodesis-related pain, such as subtalar arthritis, did better than those who had had pain of unknown origin<sup>9</sup>. In a study in which thirty ankle arthrodeses were converted to total ankle arthroplasty in twenty-eight patients, Hintermann et al. reported a significant pain reduction from a mean VAS score of 7.5 preoperatively to 1.8 at the time of follow-up, with 17% of patients having no pain<sup>10</sup>. Our results are comparable with the findings in these previous studies; we demonstrated significant improvements in the mean VAS pain, SF-36, and SMFA scores (Table V).

Although the conversion to the total ankle arthroplasty was successful in a majority of our patients, we acknowledge that it is a technically challenging procedure with a high potential complication rate. An intraoperative malleolar fracture rate of 18.5% to 43% has been reported in previous studies<sup>9,10</sup>. In our

series, 70% of patients underwent prophylactic malleolar fixation (Fig. 5). This additional measure could explain the lower prevalence of intraoperative fractures (9%) compared with those previously reported. In ankle arthrodeses that include preparation of the medial and lateral talar-malleolar articulations and progress to fusion, reestablishing the ankle gutters may be difficult. In addition, ankle arthrodesis may lead to malleolar stress shielding and osteopenia. While we do not have evidence to support prophylactic malleolar fixation, we routinely place screws in both malleoli when performing conversion total ankle arthroplasty.

We demonstrated excellent intraobserver and interobserver reliability using previously reported methods of radiographic measurements after total ankle arthroplasty. Nelissen and colleagues<sup>22</sup> suggested that some transient component migration, particularly talar component migration, is to be expected. After excluding revisions, we observed transient talar and tibial component settling in 70% and 20% of ankles, respectively,



Fig. 5  
Prophylactic fixation of the malleoli is performed with cannulated screws before the surgeon proceeds with the tibial cut to avoid intraoperative malleolar fractures.



and talar and tibial component migration in 10% and 15%, respectively. The rates of settling and migration in the current study of conversion total ankle arthroplasty in patients with a prior ankle arthrodesis are higher than those reported after routine primary total ankle arthroplasty<sup>23</sup>. Two theories for the higher rate of component settling and subsidence are (1) osteopenia due to prolonged stress shielding of the bone with ankle arthrodesis and (2) violated talar dome vascularity, especially after previous surgical procedures, jeopardizing optimal osseous implant integration. We recommend careful evaluation and active surveillance of patients during the postoperative period after conversion total ankle arthroplasty in order to monitor potential component settling and subsidence.

Several authors<sup>7,8</sup> have reported a high prevalence of symptomatic adjacent-joint degeneration after an ankle arthrodesis. As anticipated, our most prevalent indication for the procedure was painful hindfoot arthritis. Although we have performed conversion total ankle arthroplasty and ipsilateral hindfoot arthrodesis simultaneously, we recommend performing conversion total ankle arthroplasty in isolation. Comprehensive talar preparation and extensive gutter debridement combined with surgical exposure and preparation for the arthrodesis places the talar body at a high risk for osteonecrosis. In our experience, this risk is highest with use of the retrograde intramedullary alignment system, which passes instruments through the calcaneus and across the subtalar joint into the talus and tibia. Moreover, some of our patients have experienced minimal symptoms and markedly improved function following conversion total ankle arthroplasty for adjacent hindfoot arthritis and did not require hindfoot arthrodesis.

This study has several limitations. First, it is retrospective, albeit from a prospectively collected database. Also, there was no comparison with alternative treatments such as extension of the arthrodesis to the hindfoot, realignment osteotomies, or amputation. Longer follow-up is necessary to provide important information regarding potential component settling and migration after conversion total ankle arthroplasty.

Our study has several strengths. First, two evaluators performed the radiographic assessment and demonstrated excellent reliability utilizing the described methods. The strict criteria that we utilized for component settling and subsidence provided previously unreported radiographic evidence of component behavior at the time of early-to-intermediate follow-up after conversion total ankle arthroplasty. Second, we incorporated three different validated functional outcomes instruments, providing a means to thoroughly evaluate this treatment modality from a patient's perspective. Finally, to the best of our knowledge, this is

the only study of functional and radiographic outcomes of conversion total ankle arthroplasties done with prostheses that are currently available in the U.S.

In conclusion, conversion of ankle arthrodesis to total ankle arthroplasty led to pain relief and improved function in a majority of patients. The implant survival rate was 87%. The rate of complications, particularly talar component settling and migration, is a cause for concern. In order to reduce the risk of intraoperative malleolar fracture during the procedure, prophylactic fixation of the malleoli should be considered. Complete distal fibulectomy during the index ankle arthrodesis leads to worse results with conversion total ankle arthroplasty. ■

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