Salvage Arthrodesis for Failed Total Ankle Arthroplasty
Medium-term Results in Eighteen Ankles

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Abstract

**Introduction.** The objective of this study was to investigate the clinical, radiographic and subjective outcome after salvage arthrodesis for failed total ankle arthroplasty (TAA), with a focus on salvage in inflammatory joint disease (IJD).

**Methods.** Between 1994 and 2005, salvage arthrodesis for failed mobile-bearing TAA was performed in 18 ankles (18 patients). Primary diagnosis was IJD in 15 and osteoarthritis in 3. Tibiotalar fusion was performed in 7 and tibiotalocalcaneal fusion in 11 ankles (in 9 out of these, the subtalar joint was already ankylosed). Serial radiographs were studied retrospectively by an independent observer for time to union. Clinical outcome at latest follow-up was measured by the AOFAS score, by the Foot function Index (FFI) and by VAS scores for pain, function and satisfaction.

**Results.** Blade plates were used in 7 ankles, all united. Nonunion developed in 7 IJD ankles stabilized by either a nail or screws or multiple K-wires. Revision arthrodesis was done for 4 nonunions, 3 were successful. Eleven patients (8 fused ankles, 3 nonunions) were available for clinical evaluation. At follow-up, their mean AOFAS score was 62.4; mean overall FFI was 70.1; VAS for pain was 20.1, for function 64.3, for satisfaction 73.8.

**Conclusions.** Blade plate fixation is successful in salvage ankle arthrodesis. A high nonunion rate was found after salvage ankle arthrodesis in IJD with other methods of fixation. Clinical results were relatively good. The three nonunions in follow-up had subjective results similar to the fused ankles. Several publications on primary ankle arthrodesis also showed an elevated nonunion rate in IJD.
Salvage arthrodesis for failed total ankle arthroplasty

7.1 Introduction

Total ankle arthroplasty (TAA) with use of a mobile-bearing design can be seen as an alternative for arthrodesis for the treatment of the painful arthritic ankle. Several reports exist on the medium-term to long-term results with use of these third-generation designs, showing acceptable results with 83.7 to 93.5 per cent survival at eight years\textsuperscript{1,2,3}.

If TAA fails, mostly as a result of mechanical loosening, either salvage arthrodesis or implant exchange must be a reliable salvage procedure. In most studies dealing with results after third-generation TAA, some information is given on the failures after TAA. Some earlier studies have addressed the results of salvage after failed TAA\textsuperscript{4,5,6,7}. These studies dealt with conversion to either tibiotalar or to tibiotalocalcaneal arthrodesis, and described the success rate of arthrodesis after failure of first-generation, constrained two-component designs, but gave limited information on the final clinical result. The number of ankles treated for rheumatoid arthritis (RA) in these studies is variable. Stauffer\textsuperscript{4}, and Groth and Fitch\textsuperscript{5}, were the first to report on the results of salvage arthrodesis after failed TAA. They found solid fusions in respectively all seventeen (underlying diagnosis not given) and eleven osteoarthritic (OA) cases. Kitaoka and Romness\textsuperscript{6} included ten cases of inflammatory joint disease (IJD) in their series of thirty-eight ankles. Union was achieved in thirty-three out of thirty-seven ankles (one patient died early after the salvage surgery, before union could occur). Only the series reported by Carlsson et al.\textsuperscript{7} included a relatively large number of patients with RA: sixteen out of twenty-one ankles. In their study, out of twenty-one arthrodeses seventeen united (four after a second attempt). In all of these studies patient satisfaction, pain and function were scored, but detailed subjective scores were not presented. Recently, some studies have been published on the salvage of mobile-bearing TAA. Hopgood et al.\textsuperscript{8} published the results of fusion for failed TAA in twenty-three ankles (twelve OA, eleven RA). They found good results in osteoarthritic ankles and in RA ankles treated by a retrograde nail. However, all four RA fusions stabilized by screw fixation failed to heal. Culpan et al.\textsuperscript{9} published successful results of fusion for failed TAA in sixteen ankles (mostly OA). They routinely used a tricortical strut graft from the iliac crest for defect filling and screws for fixation. Anderson et al.\textsuperscript{10} reported on sixteen salvage fusions in RA ankles with use of a retrograde nail and either allograft or autograft bone. Eleven healed at the first attempt, another two after repeat arthrodesis.

The goal of this study was to determine whether salvage arthrodesis could be an adequate second line of defense after failed mobile-bearing TAA, with a special attention to salvage of the failed ankle prosthesis in patients suffering from IJD. Secondary research questions were: which salvage arthrodesis techniques were successful, and what was the subjective outcome of the salvage arthrodesis.
7.2 Material and Methods

7.2.1 Patient Demographics
This study was approved by the Institutional Review Board, and all patients seen at follow-up gave informed consent. Total ankle arthroplasty with use of a mobile-bearing design was introduced in our institution in 1988, and, until 2000, was mainly carried out in patients suffering from IJD (mostly RA)². During the study period, conversion to a tibiotalar or tibiotalocalcaneal arthrodesis was the standard surgical treatment for failed TAA, and revision TAA was carried out only in a few selected cases.

Between 1994 and 2005, a total of eighteen patients (18 ankles) underwent a salvage arthrodesis for failed TAA at our institution (Table 1). Mean age at surgery was 55 years (range, 27 to 76 years). There were fifteen patients with a diagnosis of IJD (mostly RA) and three patients with a diagnosis of osteoarthritis. At the time of the salvage procedure, nine hindfeet in the arthritic population were ankylosed, either by a formal surgical fusion or having occurred spontaneously.

7.2.2 Surgical Technique
Sixteen out of eighteen salvage procedures were done by two experienced foot and ankle surgeons, two other surgeons each performed one salvage procedure.

The chosen stabilization technique depended on the following factors: condition of the subtalar joint at the time of surgery, quality of the local bone, and the extent of local bone loss. Blade plates (either an AO humeral plate or an AO child hip plate, Synthes GmbH, Solothurn, Switzerland) were used in seven tibiotalar arthrodeses, implanted either at the anterior or the lateral aspect of the ankle. Compression at the arthrodesis site was applied with the aid of an AO compression device. Blade plate fixation was our preferred technique in the presence of a normal subtalar joint, as rigid fixation could be obtained without interference with the subtalar joint in such cases. In six ankles a locking nail was used to stabilize the ankle, implanted in a retrograde fashion. In four ankles two to three compression screws were used, and one ankle in an elderly RA patient with severe osteopenia was stabilized by multiple K-wires.

In fourteen ankles a cancellous autologous bone graft was used to fill osseous defects, mostly harvested locally. In three ankles morselized allograft bone was used, in one of these combined with an autograft.
7.2.3 Clinical Evaluation

Medical charts of the failed ankle arthroplasties were reviewed in detail for patient characteristics, reason for failure of the prosthesis, operative technique of the arthrodesis, and for any postoperative complication or reoperation. At the time of the final evaluation, in 2008, the following clinical instruments were used to assess the clinical result of all ankles in follow-up:

1) The Ankle-Hindfoot Score developed by the American Orthopaedic Foot and Ankle Society (AOFAS). It is a 100-point score, constituted of both subjective and objective clinical parameters. The maximum attainable AOFAS score is 89 points after a tibiotalar arthrodesis, and after a tibiotalocalcaneal arthrodesis it is 86 points.

2) The Foot Function Index with verbal rating scales (FFI-5pt). This is a questionnaire of 23 items, which refers to complaints in the foot and ankle during daily life. The FFI-5pt measures pain and mobility limitation as the impact of foot problems on foot function. The scale consists of 23 items divided into 3 subscales: limitation (5 items), pain (9 items) and disability (9 items). The items of the FFI-5pt are rated on a 5 point-scale, ranging from ‘never’ (0) to ‘always’ (4) on the limitation subscale, from ‘no pain’ (0) to ‘intense pain’ (4) on the pain subscale and from ‘no difficulty’ (0) to ‘impossible’ (4) on the disability subscale. The respondent is asked, for each item, to tick the box that best corresponds with the impact of the foot complaints in terms of limitation, pain and disability. If function loss is not a result of foot complaints, the respondent is asked to tick the box “not applicable”. That item is then not included in the calculations. To calculate the subscale scores the item scores are summed up, divided by the maximum possible sum of the item scores and then multiplied by 100 in order to calculate the definitive subscale scores. The total score is the mean of the subscale scores and ranges from 0 to 100. Higher scores indicate more limitation, pain and disability, respectively. A Dutch version of the FFI-5pt has been validated.

3) Visual Analogue Scales (VAS) with a scale from 0 to 100, to score pain (0 is no pain and 100 the most severe pain), limitation of function (0 is complete limitation of function, 100 is a normal function), and satisfaction of the treatment result (0 is fully unsatisfied, 100 fully satisfied).

The latter two instruments were used for a subjective evaluation of the outcome of the salvage procedure at latest follow-up.
7.2.4 Radiographic Evaluation
For the radiographic evaluation, the serial radiographs were evaluated for the time to fusion (at first or at second attempt) and for the alignment of the fused ankle in the coronal and the sagittal plane. This radiographic evaluation was done by a radiologist (JPK) not involved in the care of these patients.

7.2.5 Statistics
Data of all patients were recorded in an especially developed ankle module of the Project Manager data management program (Dpt. of Medical Statistics, Leiden University Medical Center, Leiden, The Netherlands). Two-sided Fisher’s exact test was used to analyze the influence of fixation method (blade plate vs. nail or screws) in the IJD population. Confidence intervals and Fisher’s exact test were computed with SPSS software (version 14; SPSS, Chicago, IL, USA).

7.3 Results
In 2008, at latest follow-up, the mean follow-up time of all salvaged ankles (patients deceased and in follow-up) was 7.3 years (range, 3.1 to 12.1 years).

7.3.1 Union Rate and Method of Fixation
The individual outcome of all ankles is given in Table 1. Eleven out of eighteen ankles healed after a first-attempt salvage arthrodesis. Mean time till solid fusion in this group was 6.3 months (range, 2 to 16 months; 95% confidence interval 3.5 to 9.1). All seven nonunions occurred in the rheumatoid ankles, accounting for 47 per cent nonunion rate in this group after first-attempt fusion. Four patients with a nonunion underwent a second-attempt salvage arthrodesis, resulting in union in two ankles. One more united after a third attempt, resulting in a final nonunion rate in the rheumatoid ankle group of 27 per cent. These cases will be described in the paragraph below.

In seven ankles a blade plate was used at the first-attempt salvage procedure, and all of these united (Fig. 1). Three out of six first-attempt procedures stabilized with a retrograde nail developed a nonunion (Fig. 2). Furthermore, two out of four screw fixations and the salvage arthrodesis stabilized by K-wires failed to heal. The difference in union rate between the rheumatoid ankles stabilized by a retrograde nail or screws and by a blade plate was not statistically significant (p = 0.08).

Seven out of eight rheumatoid ankles, in which autologous bone graft, derived from locally removed bone was used, healed after a first-attempt salvage. Three out of five rheumatoid ankles, in which an autologous bone graft from the iliac crest was used healed after first-attempt salvage arthrodesis. In two rheumatoid ankles only allograft
was used, both resulting in nonunion. In three osteoarthritic ankles, treated by blade plate fixation and additional bone graft, an early fusion was seen.

**Figs. 1-A through 1-C** Radiographs of a man with long-standing RA and a preoperative varus deformity of the ankle of 20 degrees (case 3). **Fig. 1-A** Anteroposterior view after implantation of an LCS prosthesis. There is a persistent varus deformity and edge-loading of the prosthesis. **Figs. 1-B and 1-C** Anteroposterior and lateral views after conversion to tibiotalar arthrodesis. The arthrodesis was stabilized by a humeral blade plate, implanted at the lateral side. Debris originating from the edge-loading of the metallic components is visible at the arthrodesis site.

### 7.3.2 Complications and Reoperations

One patient (# 13) required nail extraction at four months because of a deep infection. The ankle appeared to have fused, and no further surgical treatment was necessary. Another patient (# 17), stabilized by a blade plate, also required hardware extraction at four months because of low-grade infection. Although this ankle was solidly fused, further debridement and soft-tissue procedures became necessary at follow-up because of a small persisting fistula. One patient (# 7), stabilized by a locking nail, developed a delayed union. It eventually united 16 months postoperatively, 6 months after dynamisation of the nail. Seven patients with successful first-attempt salvage arthrodesis required hardware removal because of hinder from the material.

In seven patients, all suffering from IJD, a nonunion developed after the first-attempt salvage arthrodesis. Three of them refused further surgery, in two as they had
a stiff and painfree fibrous nonunion. Four nonunions underwent further surgery. Their details are as follows:

One patient (# 9), underwent a salvage arthrodesis stabilized by screw fixation. Her hindfoot had already been fused prior to the TAA. Four months after the initial salvage, a re-arthrodesis with use of a blade plate had to be done for a nonunion, resulting in a solid fusion. However, some months after implant removal she developed a spontaneous talar neck fracture, for which a reoperation had to be carried out.

Case # 11 developed mechanical loosening four years after a 2-stage revision TAA for deep infection. The arthrodesis, stabilized by a retrograde nail, ended in a fibrous nonunion. For recurrent symptoms, a second attempt with a blade plate was done six years after the first salvage procedure. It was complicated by a wound dehiscence and an early deep infection, for which multiple debridements had to be carried out. Eventually, the ankle united after a third-attempt salvage with a compression locking nail.

Case # 12 developed mechanical loosening three years after her primary TAA. Her ipsilateral hip was ankylosed in a position of slight flexion and significant external rotation long before the primary TAA. An arthrodesis with use of a retrograde nail was done. After material extraction and debridement for an infected nonunion, a re-arthrodesis with use of an external fixator and autologous bone graft was done. Despite all efforts, a nonunion remained as end result. The ankylosed hip in this case probably has contributed to both the early mechanical loosening of the primary TAA and to nonunion of the salvage procedure. Total hip arthroplasty has been offered to this patient, which she repeatedly refused.

Case # 15 was a failed primary TAA due to a severe wound dehiscence with open joint. A 1-stage salvage arthrodesis, stabilized by a locking nail, was done two months after the index surgery. This resulted in a low-grade infected nonunion, for which a 2-stage rearthrodesis with use of an external fixator was carried out. The ankle united, but was complicated by a septic arthritis of the talonavicular joint, requiring subsequent surgery.

7.3.3 Clinical Outcome and Radiographic Alignment

The clinical outcome at latest follow-up could be collected in eleven patients (six patients had deceased and one elderly female RA patient with a solid ankle fusion, case # 15, was wheelchair bound due to generalized arthritic disease and judged herself not to be able to give a reliable subjective outcome). Mean interval since the salvage arthrodesis in this group was 7.8 years (range, 3.1 to 12.1 years). The mean AOFAS score was 62.4 (range, 38 to 89; 95% confidence interval, 53.6 to 71.1), and the mean overall FFI score was 70.1 (95% confidence interval, 61.9 to 78.3). The mean VAS for pain was 20.1 (95% confidence interval, 7.2 to 33.0), the mean VAS for function was
64.3 (95% confidence interval, 44.9 to 83.6), and the mean VAS for satisfaction was 73.8 (95% confidence interval, 61.1 to 86.5). The three rheumatoid ankles in follow-up with a persistent nonunion had subjective results similar to the fused ankles.

The radiographic alignment of the eleven ankles which healed after first-attempt salvage were as follows: the mean sagittal angle was 5.7 degrees of equinus (95% confidence interval, 0.6 to 10.8). Eight patients had a neutral alignment in the coronal plane (0 to 5 degrees valgus), two ankles had healed in slight varus and one ankle had healed in 15 degrees of valgus.

Figs. 2-A through 2-C Radiographs of a woman with RA and a Buechel-Pappas prosthesis implanted at the age of 43 years (case 8). She had a preoperative valgus deformity of 10 degrees. **Fig. 2-A** Anteroposterior view three years postoperatively, when, due to a malleolar insufficiency fracture, a recurrent valgus deformity with edge-loading of the prosthesis had developed. **Fig. 2-B** A tibiotalocalcaneal arthrodesis was performed, stabilized by a retrograde locking nail. **Fig. 2-C** Two years after the salvage procedure the nail had been removed. Six years later, a fibrous nonunion exists. The ankle was fairly asymptomatic and did not require a second-attempt procedure.
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<th>Diagnosis‡</th>
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<th>Failure Scenario</th>
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<th>Type of Fusion#</th>
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‡ JIA = Juvenile Idiopathic Arthritis; RA = Rheumatoid Arthritis; NsO = Nonspecific Oligoarthritis; OA = Osteoarthritis.
¶ LCS = New Jersey Low Contact Stress; BP = Buechel-Pappas; CCI = Ceramic Coated Implant.
# TT = Tibiotalar; TTC = Tibiotalocalcaneal.
*Allo = Allograft; AuL = autologous bone graft harvested locally; AuP = autologous bone graft from pelvis; AuFH = autologous bone graft from femoral head.
7.4 Discussion

Salvage arthrodesis should be a reliable treatment option if TAA fails and revision by implant exchange is impossible due to bone loss, deformity, or infection. Several reports show that salvage arthrodesis for failed ankle replacement has a mean fusion rate of 94 per cent (range, 74 to 100 per cent)\textsuperscript{5,6,7,8,9,10,13}. These results are comparable to the success rate of primary ankle arthrodesis. Haddad et al.\textsuperscript{14}, in a meta-analysis, described a 90 per cent union rate after primary ankle arthrodesis. In general, the success rate of primary ankle arthrodesis in RA is less good. Dereymaker et al. had a 36 percent nonunion rate in a series of fourteen ankles\textsuperscript{15}. Anderson et al. had a 26 per cent nonunion rate in ankles stabilized by screw fixation\textsuperscript{16}. Better results were published from the same institution when a retrograde nail had been used: one nonunion out of 26 tibiotalocalcaneal fusions\textsuperscript{17}. The largest series of ankle fusions in RA, performed through a transfibular approach, was published by Mäenpää et al. from the Rheumatism Foundation Hospital in Finland\textsuperscript{18}. In their series of 130 ankles a 90 per cent union rate was found. They concluded that ankle arthrodesis in RA is a demanding procedure, and that the operation should be performed by an experienced surgeon, and furthermore that correction of malalignment and the use of bone grafts are of crucial importance for fusion.

In our series, primary nonunion occurred only in the rheumatoid ankles. This underlines the fact that it is apparently more difficult to obtain solid union of both primary and salvage ankle arthrodesis in these patients. Fortunately, three out of four second-attempt procedures were successful, and of the three non-reoperated patients two developed a stable fibrous nonunion. Subjective outcome after salvage arthrodesis was relatively good, with fair to good FFI scores, and mostly low VAS pain and good VAS satisfaction scores.

In our hands, blade plate fixation for tibiotalar arthrodesis was the most successful technique, although, with the numbers available, no statistically significant differences could be found in comparison with more widely used methods. The advantage of blade plate fixation is that a very stable fixation can be obtained and that no hardware is present inside the arthrodesis site. Good results with blade plate fixation for tibiocalcaneal and tibiotalocalcaneal arthrodesis have been published\textsuperscript{19,20}. The advantage of blade plate fixation is furthermore supported by the biomechanical testing study by Chiodo et al.\textsuperscript{21}. They found a greater stability of tibiotalocalcaneal arthrodesis stabilized by a blade-plate-and-screw construct in comparison with a retrograde intramedullary locking nail. As far as we know, no results have yet been published on blade plate fixation for tibiotalar arthrodesis.

In conclusion, in osteoarthritis the union rate of salvage ankle arthrodesis is
good, and comparable to the outcome of primary ankle arthrodesis. In rheumatoid ankles, both primary arthrodesis and salvage arthrodesis are demanding procedures, and should probably best be done by experienced surgeons in specialized centers. Stabilization by a blade plate appears to be a promising technique for salvage ankle arthrodesis.

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**References**

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