Medial Malleolar Osteotomy for the Correction of Varus Deformity during Total Ankle Arthroplasty: Results in 15 Ankles

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Chapter 6

Abstract

Background Preoperative deformity in the frontal plane in the arthritic ankle is a risk factor for failure after total ankle arthroplasty. Medial malleolar lengthening osteotomy was developed to correct varus malalignment.

Materials and Methods From 1998 to 2005 total ankle arthroplasty combined with medial malleolar lengthening osteotomy was done in 15 ankles (13 patients) with a mean preoperative varus deformity of 14.9 (SD 7.8) degrees. Diagnosis was instability arthritis in 11 ankles (9 patients) and inflammatory joint disease in 4 ankles (4 patients). Two mobile-bearing designs were used. Osteosynthesis of the osteotomy was done in 2 ankles, for the remaining 13 osteotomies no fixation was carried out.

Results Follow-up was 5 (2-8) years. Neutral alignment was obtained in all ankles. In 3 patients residual hindfoot varus remained, for which a second-stage hindfoot correction was done. Two rheumatoid ankles developed a symptom-free nonunion of the medial malleolus, all other malleolar osteotomies united. One tibial component, implanted with too much anterior slope, developed early aseptic loosening and was revised. Debridement for talar-malleolar arthritis was done in two ankles. Of the 14 ankles in follow-up, 12 were rated as excellent or good, one as fair. One ankle with subsidence of the talar component was rated as unsatisfactory. AOFAS score increased from 30.8 preoperative to 81.0 at follow-up ($p < 0.01$).

Conclusion Medial malleolar lengthening osteotomy is an easy technique for the realignment of the varus ankle at the time of total ankle arthroplasty, and serves as an alternative to medial ligament release or lateral ligament reconstruction.
6.1 Introduction

Posttraumatic arthritis of the ankle joint, either due to intra-articular fractures or to chronic lateral ligament insufficiency, and rheumatoid arthritis (RA) are the main indications for reconstructive surgery of the ankle joint. In recent years total ankle arthroplasty (TAA) has gained popularity, although this procedure has not yet been widely accepted as a treatment option for the severely affected ankle joint.

Stability in neutral alignment is of paramount importance for a good long-term result after TAA. In posttraumatic arthritis, a varus deformity of the ankle joint is seen regularly, especially as a result of arthritis due to chronic lateral ligament insufficiency (instability arthritis). In the rheumatoid ankle, varus deformity also occurs. In ankles with a preoperative deformity in the coronal plane, edge loading of the prosthesis is a frequent complication. In a series of TAA for inflammatory joint disease (IJD), ankles with a preoperative deformity in the coronal plane of more than 10 degrees had a significantly reduced survival rate compared to neutrally aligned ankles: 48% versus 90% after eight years. In general, such a deformity is not easily correctible, and, therefore, has been considered a contraindication for total ankle arthroplasty.

Kofoed described a talar sculpturing technique for correction of deformity in the coronal plane, if necessary combined with lateral ligament reconstruction in varus ankles with lateral ligament laxity. An alternative would be to perform a lengthening procedure at the medial side, just like for the correction of a varus deformity in the knee during total knee arthroplasty. Bonnin et al. described good results after proximal and distal deltoid ligament release for varus deformity. Haskell and Mann advised either lateral ligament reconstruction or deltoid ligament release or both to stabilize the replaced joint in neutral alignment. We used medial ligament release on a limited scale. However, after the occurrence of a severe skin necrosis in one ankle, we abandoned this technique. Then, lateral ligament reconstruction with use of the peroneus brevis tendon according to Kofoed was used. However, early recurrent instability complicated this procedure. Therefore, in 1998, as an alternative to deltoid ligament release, lengthening osteotomy of the medial malleolus was developed in order to balance the arthritic ankle with varus deformity during total ankle arthroplasty. As early results were encouraging, a study of all varus ankles treated by this technique was started in order to investigate the correction obtained and the clinical and radiographic outcome. To our knowledge this technique and its results have not been described before.
Figs. 1-A through 1-D Radiographs of a 51-year-old man with bilateral instability arthritis. This case was the first ankle where total ankle arthroplasty was combined with a medial malleolar osteotomy. Fig. 1-A Preoperative weightbearing view, showing a 15 degrees varus deformity of the left ankle joint. Fig. 1-B and 1-C Postoperative anteroposterior and lateral views, showing restoration to neutral alignment of the ankle by medial malleolar lengthening osteotomy and of the hindfoot by a calcaneal closing-wedge osteotomy. An incomplete fracture of the anterolateral aspect of the distal tibia was present, however, did not require fixation. Fig. 1-D At follow-up, the malleolar osteotomy has healed in a lengthened position, and the intraoperative distal tibial fracture has also united. The clinical result was excellent.

6.2 Materials and Methods

All ankle arthroplasty patients in our hospital enter a prospective follow-up protocol approved by the institutional review board. Patients participating in this study all gave informed consent. Our experience with mobile-bearing ankle arthroplasty started in 1988, when the Low Contact Stress (LCS®, DePuy, Warsaw, Indiana) was introduced in our hospital. From 1993 till 2004 the Buechel-Pappas prosthesis™ (Endotec, South Orange, New Jersey) has been used. The Buechel-Pappas prosthesis™ evolved from the LCS design. From 2004 onwards a new mobile-bearing design was used, the Ceramic Coated Implant (CCI) Evolution total ankle prosthesis, Van Straten Medical, Nieuwegein, The Netherlands (Fig. 2). In contrast to the Buechel-Pappas™ prosthesis, the tibial component of the CCI prosthesis has a fixation fin instead of a stem and the talar component requires a triple-V shaped resection of the talar dome instead of a curved resection.
Figs 2-A through 2-C Radiographs of the Ceramic Coated Implant Evolution ankle prosthesis, as implanted in a 55-year-old woman with instability arthritis. **Fig. 1-A** Preoperative view, showing a 22 degree varus deformity. **Figs. 2-B and 2-C** Anteroposterior and lateral views, showing the two-year radiographic result with solid healing of the malleolar osteotomy, that was stabilized by two wires.
6.2.1 Surgical Technique
The thigh was routinely placed in a leg holder, with the knee flexed about 60 degrees to relax the calf muscles and to rotate the lower leg to a neutral position. A straight anterior midline approach was used. After incision of the skin and the extensor retinaculum, the interval between the anterior tibial and the extensor hallucis tendons was used to reach the anterior capsule, which was then opened medially and reflected laterally as a sleeve together with the dorsal pedis artery. The tourniquet was inflated after the arthrotomy and before the beginning of the preparation of the osseous surfaces. The preparation of the osseous surfaces was started by a limited resection of the lower surface of the distal tibia, aiming for a horizontal resection of the distal tibia in the frontal plane and for a 7 degree anterior slope, as recommended by Buechel et al.\textsuperscript{10}. After having finished the preparation of distal tibia and talus, a non-cemented talar and a non-cemented tibial component were implanted. Only at this time, if after insertion of the trial bearing a varus tilt remained, resulting in edge loading of the components, a lengthening osteotomy of the medial malleolus was performed. The osteotomy was directed in a slightly oblique direction. It was then mobilized with an osteotome and by downward sliding of the distal part of the medial malleolus, the ankle became balanced in a neutral position (Fig. 3). The downward sliding of the distal fragment was limited, rarely exceeding 4 to 5 mm, and in no case required traction at the distal fragment. The thickest possible polyethylene liner was then introduced in between these components. In general, no fixation of the medial malleolus was required. Routine wound closure with careful suturing of the extensor retinaculum finished the procedure. The ankle was immobilized in a below-knee cast, usually for a period of 6 weeks, with weightbearing to tolerance from 3 to 5 days after surgery.
6.2.2 Clinical and Radiographic Evaluation

The results of all total ankle replacements for end-stage arthritis with a pre-existing varus deformity that were treated by this medial malleolar lengthening technique and with a minimum follow-up of 24 months were studied prospectively using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle/hindfoot score and a qualitative subjective scale for clinical evaluation. Evaluation moments were: pre-operatively and postoperatively at 6 weeks, 3 months, one year and then annually or bi-annually. If the medial malleolar osteotomy had not united after 3 months, in most cases a follow-up moment was arranged at 6 months. Postoperative ankle-hindfoot alignment was evaluated clinically with the patient standing, using a goniometer. Furthermore, at the most recent follow-up, a validated translation of the Foot Function Index (FFI) 23 items 5-point verbal rating scales questionnaire, and a Visual
Analogue Scale (VAS) for pain (scale from 0 to 100, where 0 is no pain and 100 the most severe pain) and for satisfaction (scale from 0 to 100, where 0 is fully unsatisfied and 100 fully satisfied) were also used for the evaluation of the clinical result. The FFI scores range from 0 to 100; the higher the score, the more limitation, pain and disability respectively.

Radiographic evaluation was performed in a standardized fashion as described by Doets et al. The angle between the long axis of the tibia and the line perpendicular to the talar dome on the preoperative weightbearing anteroposterior view of the ankle was defined as the preoperative alignment of the ankle joint. At follow-up, nonweightbearing anteroposterior and lateral radiographs aimed to be parallel to the base plate of the tibial component were made, if necessary using fluoroscopy. The serial radiographs were evaluated by a radiologist (JPK) who was not involved in the care of these patients. The angular position of the tibial component was defined as the angle between the base plate of the tibial component and the long axis of the tibia on both views. The angular position of the talar component on the lateral radiograph was defined as the angle parallel to the fins of the talar component and a line drawn from the most dorsal part to the center of the anterior part of the talus. This talar reference line was chosen as it could reliably be drawn also in the event of a fused subtalar joint. The position of the talar component in the frontal plane in relation to the hindfoot was difficult to assess accurately on plain radiographs, and was assessed semi-quantitatively. The occurrence of radiolucent lines next to the prosthetic components was measured on the anteroposterior and lateral radiographs for the tibial component and on the lateral radiograph for the talar component. Our criterion for migration of a component was an angular change in position of more than 3 degrees or a subsidence of more than 3 mm in one of the views or a complete radiolucent line of more than 1 mm in both views for the tibial component and on the lateral view for the talar component. The polyethylene bearing (which had two small metallic markers) was assessed for subluxation in the sagittal and frontal planes and for other abnormalities (gross wear or fracture). Any other adverse phenomenon occurring at follow-up was recorded.

6.2.3 Statistical Analysis

All data were recorded in an ankle module of the Project Manager data management program (IMSOR, Leiden, The Netherlands). Student’s paired t test was used to evaluate the prospectively studied clinical outcome parameters. Differences were considered significant when $p < 0.05$. Statistical evaluation was done with SPSS software (version 14).
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6.3 Results

6.3.1 Patient Demographics and Perioperative Data
From September 1998 to January 2005 fifteen ankles (thirteen patients, nine men (two bilateral) and four women) with a varus deformity or varus instability were treated by a primary TAA combined with a lengthening osteotomy of the medial malleolus. Diagnosis was instability arthritis in nine patients (eleven ankles) and IJD in four. In twelve ankles a Buechel-Pappas™ prosthesis was implanted, and in three ankles a CCI Evolution prosthesis. Mean preoperative varus deformity was 14.9 degrees (SD 7.8 degrees; range, 3 to 30 degrees). Four ankles had a preoperative varus deformity of less than 10 degrees (instability arthritis 2, IJD 2). Mean follow-up was 61 (range, 24 to 99) months. Patient demographics are listed in Table 1.

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. of Ankles (Patients)</th>
<th>Age* (yr)</th>
<th>Women/Men</th>
<th>Preoperative Varus* (degrees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instability Arthritis</td>
<td>11 (9)</td>
<td>55.8 (47-69)</td>
<td>2/9</td>
<td>14.4 (3-30)</td>
</tr>
<tr>
<td>RA</td>
<td>2 (2)</td>
<td>74.5 (69-79)</td>
<td>1/1</td>
<td>20 (10-30)</td>
</tr>
<tr>
<td>Miscellaneous Arthritis#</td>
<td>2 (2)</td>
<td>37.5 (31-44)</td>
<td>2/-</td>
<td>12.5 (5-20)</td>
</tr>
<tr>
<td>All diagnoses</td>
<td>15 (13)</td>
<td>55.5 (31-79)</td>
<td>5/11</td>
<td>14.9 (3-30)</td>
</tr>
</tbody>
</table>

* Mean values, with the range in parentheses. # Juvenile Chronic Arthritis 1, Oligoarticular Arthritis 1.

Internal fixation of the osteotomy was judged to be necessary in two ankles on the basis of a persisting anterior drawer sign after the prosthetic components had been inserted. All other medial malleolar osteotomies were not stabilized as there was sufficient stability by the soft tissue envelope. They were just immobilized by the routine postoperative plaster cast. Compared to ankle arthroplasty without a preoperative deformity in the frontal plane, relatively thick polyethylene bearings were used, having a height of between 7 and 11 mm. In the first ankle treated by this procedure, in addition to the ankle replacement, a valgus closing-wedge osteotomy of the calcaneus (Dwyer-type) was performed for correction of a varus hindfoot. Superficial wound healing disturbances were seen in two ankles (one male patient, suffering from bilateral instability arthritis). These wounds healed by prolonged cast immobilization.

6.3.2 Clinical Outcome
Follow-up was completed as of January 2007. No patients were lost to follow-up.

Neutral alignment was obtained in all ankles at the level of the ankle joint, but
a slight residual varus at the hindfoot persisted in three ankles (in two as a result of
an ankylosed subtalar joint with varus malalignment). These three ankles underwent
a second-stage corrective procedure of the hindfoot. Another ankle underwent suc-
cessful arthroscopic and open debridement for persistent pain due to talar-malleolar
arthritis. Furthermore, in one ankle, where the tibial component had been implanted
with excessive anterior slope (15 degrees), an anterior subluxation persisted, result-
ing in early anterior tilting with aseptic loosening of the tibial component. This tibial
component was revised 16 months after the index surgery. Details of all reoperations
are given in Table 2.

Mean follow-up of all ankles in follow-up (n=14) was 64 (range, 24-98)
months. The AOFAS ankle score increased from 30.8 (SD 11.4; range, 14-53) pre-
operative to 81.0 (SD 14.3; range, 54-100) at latest follow-up (p <0.001). Dorsiflexion
increased significantly (p <0.01) from a preoperative mean of 4.3 degrees (range,
-12 to 15 degrees) to a mean of 9.5 degrees (range, 0 to 25 degrees) at latest follow-
up. Plantarflexion remained the same, with a mean of 30.1 degrees preoperative
and at follow-up.

Patients rated their ankles as very satisfactory in seven, satisfactory in five,
and one ankle was rated as fair. Furthermore, one ankle was rated as unsatisfactory.
This ankle developed mechanical loosening of the talar component in a rheumatoid
ankle with pre-existing medially localized talar bone loss (discussed below).

At the most recent follow-up, patient-assessed results were as follows. The
FFI total score was 19.7 (SD 12.4), the pain subscore was 24.1 (SD 16.4), the dis-
ability subscore 23.5 (SD 15.3), and the limitations subscore 11.6 (SD 8.3). The VAS
for pain was 27.1 (SD 24.4) and the VAS for satisfaction was 76.1 (SD 23.5).

6.3.3 Radiographic Findings
In this study, the malleolar lengthening osteotomy was carried out at either the base
of the medial malleolus (nine ankles) or halfway in the medial malleolus (six ankles).
Two malleolar osteotomies, both in patients with IJD, and both located at the base
of the medial malleolus, developed a stable and symptom-free nonunion. Both non-
unions occurred in ankles with some residual varus deformity at the level of the hind-
foot (Table 2). The remaining thirteen united after a mean interval of seven months
(range, 3 to 12 months). Two tibial components showed initial migration, one into
varus, and one an anterior tilt. The tibial component with varus tilt stabilized sec-
ondarily and showed no radiolucent lines with longer follow-up (77 months). Details
of the tibial component that developed an anterior tilt were described above. Of the
thirteen tibial components without signs of migration ten showed no radiolucent lines
and three showed partial radiolucent lines. One talar component in a rheumatoid an-
kle with steroid-induced osteopenia developed aseptic loosening with subsidence of
the talar component and edge loading 30 months after the index surgery. A revision procedure was offered to this patient but was refused as the symptoms remained at an acceptable level. All other talar components showed a complete osseointegration without migration. No edge-loading or bearing subluxation was seen in the thirteen ankles with stable implants.

<table>
<thead>
<tr>
<th>TABLE 2  Overview of the Reoperations</th>
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<tbody>
<tr>
<td>Gender, Age (yr)</td>
</tr>
<tr>
<td>M, 54</td>
</tr>
<tr>
<td>F, 44‡</td>
</tr>
<tr>
<td>M, 66‡</td>
</tr>
<tr>
<td>M, 59</td>
</tr>
<tr>
<td>M, 54</td>
</tr>
</tbody>
</table>

* IA = Instability arthritis; RA = Rheumatoid arthritis. ‡ Patients with a nonunion of the medial malleolus

6.4 Discussion

Coronal plane deformity is a relatively frequent phenomenon in the arthritic ankle. In the posttraumatic ankle, chronic lateral ligament insufficiency can be considered the main underlying cause of varus deformity. Another factor leading to varus deformity can be a varus inclination of the tibial plafond. Varus deformity can be also be seen in IJD, probably as a result of eccentric cartilage destruction and attenuation of the lateral ligaments by chronic synovitis. In a personal series, the incidence of varus deformity in patients with IJD requiring replacement of the ankle was twelve out of eighty (15 per cent). If surgical reconstruction is considered (either fusion or arthroplasty), coronal plane deformity should be corrected in order to obtain a good and lasting result. Failure to correct such a deformity in TAA will lead to an increased
rate of edge loading, bearing subluxation and early failure\(^1\)\(^4\).

A simple way to improve the results of total ankle arthroplasty is to exclude patients with coronal plane deformity. Therefore, some authors considered a significant (>10 to 15 degrees) of talocrural or hindfoot malalignment a contraindication for total ankle arthroplasty\(^1\)\(^4\)\(^15\). The other, more difficult way would be to develop a reliable and reproducible surgical technique to produce a well-aligned and stable ankle.

Kofoed\(^5\)\(^6\) advised a talar sculpturing technique for correction of coronal plane deformity, if necessary combined with lateral ligament reconstruction using the peroneus brevis tendon to improve stability in the varus ankle. Bonnin et al.\(^7\) reported good results after extensive deltoid ligament release in a subgroup of fourteen varus ankles, as part of a study on ninety-three ankle replacements. Their follow-up was short: 35 months, and no specific details were given of this subgroup concerning diagnosis, preoperative alignment and amount of correction obtained at surgery. It has been suggested that arthrogenic muscle inhibition due to damaged mechanoreceptors in the lateral ligaments is present in patients with functional ankle instability\(^16\). As an extensive medial ligament release could result in additional damage to mechanoreceptors located in the deltoid ligament, such a procedure might worsen the muscular control of the replaced ankle. Haskell and Mann\(^8\) advised either to stabilize the varus ankle by lateral ligament reconstruction, as proposed by Kofoed, or to realign it through a deltoid ligament release, or a combination of these procedures. They reported good results after reconstruction in congruent ankles, but had a high rate of early edge-loading after TAA in varus-incongruent ankles: four out of ten. Non-anatomic lateral ligament reconstruction is known to have mixed results for repair of chronic laxity in the non-arthritic ankle\(^17\)\(^18\). Therefore, it appears questionable that a non-anatomic peroneus brevis tendon reconstruction will durably restore stability after total ankle arthroplasty.

As we had inferior results with either medial ligament release (skin necrosis) and lateral ligament reconstruction (recurrent instability) after TAA in the arthritic varus ankle, it was decided to try to balance the ankle joint by a lengthening procedure of the medial malleolus without an additional reconstruction of the lateral ligament complex. Our results show that a varus deformity of up to 30 degrees at the level of the ankle joint can reliably be corrected by this procedure. Except for one ankle with talar component subsidence and one ankle with early failure due to tibial component malposition, all other ankles obtained a good result without a recurrence of varus deformity at the ankle joint after a mean follow-up of five years. However, residual deformity at the hindfoot, not corrected at the index operation, required subsequent surgery in three ankles. In retrospect, these hindfoot deformities should have been corrected either at the time of total ankle arthroplasty or as the first intervention of a
two-stage procedure. In view of the two implant failures and the four secondary procedures in this study, results with this procedure are until now still inferior compared to results of TAA in well-aligned ankles. To further improve our results, the following surgical modifications have been introduced: a) the lengthening osteotomy is done halfway down the medial malleolus; b) the medial gutter is routinely debrided; c) the tibial component is implanted with no or only minimal anterior slope; and d) any hindfoot deformity is corrected prior to or simultaneously with the arthroplasty.

In conclusion, lengthening osteotomy of the medial malleolus can be considered a simple and effective procedure for the correction of varus malalignment at the time of total ankle arthroplasty, and an alternative to medial ligament release or lateral ligament reconstruction. Fixation of the osteotomy by hardware is not required routinely. Time to union of the osteotomy can be relatively long, but a delay in radiographic union does not lead to a delay in rehabilitation. There is no increased risk of disturbed wound healing. Correct implant position and complete correction of a concurrent hindfoot varus remain crucial factors for a good long-term result.

References
