Arthrodesis of the ankle in the presence of a large deformity in the coronal plane

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A consecutive series of 23 patients (25 ankles) with osteoarthritis of the ankle and severe varus or valgus deformity were treated by open arthrodesis using compression screws. Primary union was achieved in 24 ankles one required further surgery to obtain a solid fusion. The high level of satisfaction in this group of patients reinforces the view that open arthrodesis, as opposed to ankle replacement or arthroscopic arthrodesis, continues to be the treatment of choice when there is severe varus or valgus deformity associated with the arthritis.

Surgical treatment may be considered for patients with osteoarthritis of the ankle when bracing, and other conservative measures, have failed to relieve the symptoms. Open arthrodesis of the ankle has an incidence of nonunion of between 7% and 15%, and if that occurs further surgery is necessary.¹⁻⁵ Arthroscopic fusion can be considered when there is only a minor degree of varus or valgus deformity, but it is not advisable when the deformity is severe because of difficulty in obtaining an adequate correction.^{6,7} Ankle replacement is also contraindicated because of the risk of recurrent deformity.^{8,9} It seems, therefore, that open arthrodesis will remain the treatment of choice for those patients whose ankles are in a severe varus or valgus. We did not find in our literature review any report describing the outcome of surgery specifically for these patients. We therefore describe the outcome of a group of these patients in relation to the results described in the literature^{1-9,10} for ankle arthrodesis in any patient.

Patients and Methods

From the operating theatre records we identified all patients who had undergone an open arthrodesis of the ankle between October 2001 and June 2004 under the care of the senior author (PLRW). There were 25 consecutive procedures in 23 patients with osteoarthritis and a deformity in the coronal plane of at least 20° (20° to 45°) (Table I). Those with inflammatory arthropathy were excluded. There were 21 men and two women. Bilateral fusions were carried out in two patients; there were eight left and 17 right ankles. The mean age of the patients at the time of surgery was 62 years (39

to 84) (Table II). Six patients had post-traumatic arthritis, five due to a previous fracture and one following a severe injury to the lateral ligament. The remainder had generalised primary osteoarthritis with arthritic changes in the hips, knees or opposite ankle. Five had required either hip or knee replacements. The mean period of follow-up following arthrodesis was 20 months (12 to 36) and all patients were available for review.

The operation was carried out through an anterior approach with radiographic control using an image intensifier during placement of the guide wires and screws. The method of choice used two parallel 6.5 mm cannulated screws with washers (ACE DePuy, Leeds, United Kingdom), with a guide block to ensure that the screws were parallel (Fig. 1). A washer was usually necessary because the screws pass obliquely through the cortex of the tibia. The cortex is thin distally. This leaves the screw rather prominent and it may be necessary to remove the screws at a later date. The patient is advised about this. In ankles with a varus deformity a fibular osteotomy was performed if necessary in order to achieve a full correction and to place the foot in a neutral plantigrade position. This osteotomy was carried out through the same anterior incision. The fibula was approached from its articular surface and approximately 1 cm of bone was resected at the level of the joint line. This technique leaves the distal portion of the malleolus *in situ* and so preserves its function as a pulley for the peroneal tendons. The surfaces come into close contact when the varus is corrected, and no fixation of the fibula is necessary. When there was

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Table I. Pre-operative deformity

Number of ankles	Deformity	Mean angle (°, range)
5	Valgus	26 (20 to 35)
20	Varus	28 (20 to 45)

Table II. Patient demographics (two male patients appear twice, as they had fusion of both the ankles)

Gender	Number	Mean age in years (range)
Female	2	66 (55 to 77)
Male	23	62 (39 to 84)

Fig. 1a

Fig. 1b

Radiographs showing preferred surgical method, using parallel medial compression screws.

fixed plantar flexion of the first metatarsal, a proximal dorsal wedge osteotomy was performed and secured with a staple. This prevents excessive pressure developing under the metatarsal head after correction of the varus deformity of the ankle because it lifts the lateral and lowers the medial side of the forefoot. When this position has become inflex-

Fig. 2

Anteroposterior radiograph showing the angular measurement of the pre-operative deformity; 'd' is the angle between the anatomical axis of the tibia and a line perpendicular to the articular surface of the talus. When this is severely eroded an estimate is made by reference to the sides of the talus that are usually well preserved.

ible it cannot adapt to the change in position resulting from the fusion.

A wool and crepe dressing was applied in the operating room and changed for a weight-bearing cast between the first and third post-operative days. All patients were mobilised taking weight as pain permitted. The cast was changed and the sutures removed after six weeks. A fresh cast allowing free weight-bearing was used for a further six weeks. The pre-operative deformity of the ankle in the coronal plane (Fig. 2) was measured as described previously by Wood and Deakin.⁸ A similar assessment was made after the operation, provided that the anatomy of the talus had not been altered too severely by the surgery. When this was not possible we estimated the angle using the axis of the os calcis. Patients were followed up until there was radiographic and clinical union. One required a further procedure because of nonunion. Figures 3 and 4 show typical pre- and post-operative clinical and radiological appearances.

All patients were assessed at routine outpatient appointments. They were asked about their walking distance, the use of walking aids, the ability to climb stairs and return to work. The validated ankle and hindfoot score of the American Orthopaedic Foot and Ankle Society (AOFAS)¹¹ was calculated as an objective assessment of the patients before and after operation.

Results

Fig. 3a

Fig. 3b

Clinical photographs of a 47-year-old man with varus osteoarthritis of the ankle following a fracture. a) Pre-operatively he is bearing weight on the lateral border of the foot, and has a mechanical axis falling medial to the tibia and b) post-operatively the foot is plantigrade with a broad and solid weight-bearing surface. The mechanical axis has been restored.

Fig. 4a

Fig. 4b

Radiographs of the patient shown in Figure 3, a) before operation, with a large varus deformity and erosion of the medial malleolus, and b) post-operatively, demonstrating a united ankle arthrodesis using two parallel screws with washers, a transarticular fibular osteotomy in good apposition, and a staple in the first metatarsal base following a dorsiflexion osteotomy.

Of the 20 varus ankles, 13 required a resection osteotomy of the lateral malleolus to allow correction of the deformity. Union of the fibular osteotomy occurred in all instances. In two cases in which the skin was adherent to the malleolus, the osteotomy was achieved through a separate lateral incision. Four patients had a fixed plantar flexion deformity of the first ray and a proximal dorsiflexion osteotomy of the first metatarsal was then carried out. The planned technique of employing two medial screws was used in 19 ankles, 15 of which had screws accurately placed parallel to each other. An additional screw was used in six ankles. One or two anterior staples were required to enhance the fixation in nine patients early in the series, but as experience

was gained this was found to be unnecessary. The manufacturer's guide was used to ensure that the wires, and subsequently the screws, were parallel. This guide was found to be an important part of the surgical technique.

The mean time in a cast was 11.4 weeks (10 to 12).

Complications. The wound took nine weeks to heal in one ankle but eventually bony union was obtained. The fusion failed to unite in a 52-year-old man who had a 20° varus deformity of both ankles and severe pain on walking. The first ankle, which is also included in this study, fused with an excellent outcome. The second side developed a non-union. It was immobilised in a cast for ten weeks and appeared both clinically and radiologically to have united.

Fig. 5a

Fig. 5b

Fig. 5c

Fig. 5d

Radiographs of a patient with a nonunion. Union was achieved following a revision procedure.

Table III. Use of walking aid (number of patients; two patients had both the ankles fused)

	Stick	No stick
Pre-operative	16	7
Post-operative	5	20

However, as he increased his level of activity he experienced increasing pain on the medial side. The screws were removed in the erroneous belief that they were the cause of the pain. The pain persisted, making it apparent that it was due to nonunion. The patient subsequently had a revision with bone grafting, and at 24 months following the primary operation had a solid fusion and had returned to full activity with little pain (Fig. 5).

Outcomes. For the 24 ankles which united primarily the mean AOFAS pain score before operation was 10.5 (0 to 20) and 35.2 (20 to 40) at final follow-up. All patients reported reduced pain after the operation.

The mean AOFAS function score before operation was 25.5 (11 to 39), improving to 43.7 (31 to 58) at follow-up. All patients were able to walk further after ankle fusion than pre-operatively.

The reliance on a walking stick was reduced for most patients (Table III) and a few found that their ability to ascend and descend stairs had improved (Table IV).

Ten of the patients (11 ankles) had retired from work due to their age at the time of surgery. Of the remainder, ten who were working returned to their pre-operative occupations. One returned to a sedentary occupation and the other remains unable to work because of pain in the ankle.

All the patients were pleased with the outcome of surgery as regards to reduction in pain, walking distance and the overall result. One patient was satisfied overall because his function was excellent and he was able to walk long distances over rough terrain, but he was disappointed about a slight residual deformity of 4°, having had a 24° varus deformity before operation.

Radiographic. In 18 ankles the residual deformity was within 5° of neutral and the mean correction achieved was

Table IV. Ability to ascend and descend stairs (number of patients)

	Normal	One by one, placing both feet on every step	Unable
Pre-operative	2	22	1
Post-operative	8	17	0

25° (15° to 41°). In the other seven ankles the mean residual deformity was 9° (6° to 12°) and the mean correction achieved was 21°, but this was a marked improvement compared to before operation.

Discussion

Arthrodesis of the ankle is a challenging procedure that must be undertaken with care in order to provide the best possible outcome.¹² The alteration in gait¹³⁻¹⁷ and the potential complications, particularly nonunion and, in the longer term, degeneration of adjacent joints,^{13,18-23} make arthroplasty an attractive option, and this is now becoming a realistic alternative for some patients. However, there is evidence that a good outcome can be expected with a deformity in the coronal plane of up to 10°,⁹ but a deformity of 15° or more significantly increases the risk of rapid mechanical failure making this a relative contraindication to ankle replacement.⁸ Thus, arthrodesis remains the best and perhaps the only surgical option for patients with severe varus or valgus deformity of the ankle.

In this consecutive series of ankle arthrodeses we had high patient satisfaction, at least in the short term. The concern about adjacent joints developing arthritis has not been addressed. The improvements in pain and function score as demonstrated by the AOFAS ankle and hindfoot scoring system were highly statistically significant. The nonunion rate of 4% (one ankle) is satisfactory compared to those described previously, and may be a result of improved surgical technique, giving rigid internal fixation with cannulated screws that can be accurately placed using radiographic control.

However, few patients had improved in their ability to climb stairs, indicating that the arthrodesed ankle does not give normal gait or function for all activities. More encouraging is the observation that most patients had reduced need for walking aids, and that none walked less well than before operation.

Prior to operation the direction of movement of the ankle had become so distorted that it was of little functional value. Its abolition was therefore not found to be of any detriment. The combination of relief of pain and restoration of the foot to a plantigrade position leads to a satisfactory outcome. In the presence of a deformity in the coronal plane of 20° or more, osteoarthritis of the ankle joint can be satisfactorily treated by arthrodesis, using an open anterior approach and solid internal fixation with cannulated 6.5 mm

screws and washers. A low rate of nonunion can be achieved and high patient satisfaction. We recommend arthrodesis as the procedure of choice when there is a large deformity in the coronal plane and painful osteoarthritis of the ankle.

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References

1. Abidi NA, Gruen G, Conti SF. Ankle arthrodesis: indications and techniques. *J Am Acad Orthop Surg* 2000;8:200-9.
2. Frey C, Halikus NM, Vu-Rose T, Ebramzadeh E. A review of ankle arthrodesis: predisposing factors to non-union. *Foot Ankle Int* 1994;15:581-4.
3. Perlman MH, Thordarson DB. Ankle fusion in a high risk population: an assessment of non-union risk factors. *Foot Ankle Int* 1999;20:491-6.
4. Dohm M, Purdy BA, Benjamin J. Primary union of ankle arthrodesis: review of a single institution/multiple surgeon experience. *Foot Ankle Int* 1994;15:293-6.
5. Hagen RJ. Ankle arthrodesis: problems and pitfalls. *Clin Orthop* 1986;202:152-62.
6. Raikin SM. Arthrodesis of the ankle: arthroscopic, mini-open, and open techniques. *Foot Ankle Clin* 2003;8:347-59.
7. Glick JM, Morgan MS, Myerson TG, Sampson TG, Mann JA. Ankle arthrodesis using an arthroscopic method: long term follow up of 34 cases. *Arthroscopy* 2006;12:428-34.
8. Wood PLR, Deakin S. Total ankle replacement: the results in 200 ankles. *J Bone Joint Surg [Br]* 2003;85-B:334-41.
9. Haskell A, Mann RA. Ankle arthroplasty with preoperative coronal plane deformity: short term results. *Clin Orthop* 2004;424:98-103.
10. Hoppgood P, Kumar R, Wood PLR. Ankle arthrodesis for failed total ankle replacement. *J Bone Joint Surg [Br]* 2006;88-B:1032-8.
11. Kitaoka HB, Alexander IJ, Adelaar RS, et al. Clinical rating systems for the ankle-hindfoot, midfoot, hallux and lesser toes. *Foot Ankle Int* 1994;15:349-53.
12. Lance EM, Parval A, Fries I, Larsen I, Patterson RL Jr. Arthrodesis of the ankle joint: a follow-up study. *Clin Orthop* 1979;142:146-58.
13. Muir DC, Amendola A, Saltzman CL. Long-term outcome of ankle arthrodesis. *Foot Ankle Clin* 2002;7:703-8.
14. Mann RA, Van Manen JW, Wapner K, Martin J. Ankle fusion. *Clin Orthop* 1991;268:49-55.
15. Lynch AF, Bourne RB, Rorabeck CH. The long-term results of ankle arthrodesis. *J Bone Joint Surg [Br]* 1988;70-B:113-16.
16. King HA, Watkins TB Jr, Samuelson KM. Analysis of foot position in ankle arthrodesis and its influence on gait. *Foot Ankle* 1980;1:44-9.
17. Hefti FL, Baumann JU, Morscher EW. Ankle joint fusion: determination of optimal position by gait analysis. *Arch Orthop Trauma Surg* 1980;96:187-95.
18. Morgan CD, Henke JA, Bailey RW, Kaufer H. Long-term results of tibiotalar arthrodesis. *J Bone Joint Surg [Am]* 1985;67-A:546-50.
19. Morrey BF, Weideman GP. Complications and long-term results of ankle arthrodeses following trauma. *J Bone Joint Surg [Am]* 1980;62-A:777-84.
20. Aaron AD. Ankle fusion: a retrospective review. *Orthopedics* 1990;13:1249-54.
21. Buchner M, Sabo D. Ankle fusion attributable to posttraumatic arthrosis: a long-term followup of 48 patients. *Clin Orthop* 2003;406:155-64.
22. Trouiller H, Hansel L, Schaff P, Rosenmayer B, Refior HJ. Long-term results after ankle arthrodesis: clinical, radiological, gait analytical aspects. *Foot Ankle Int* 2002;23:1081-90.
23. Sheridan B, Robinson D, Hubble M, Winson I. Ankle arthrodesis and its relationship to ipsilateral hind- and mid-foot arthritis. *J Bone Joint Surg [Br]* 2006;88-B:206-7.