Ankle arthrodesis with cross-screw fixation

Good results in 36/40 cases followed 3–7 years

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Tibiotalar arthrodesis by an anterior approach, using internal compression with cancellous screws, offers wide exposure, good possibilities of correcting deformities, and good bony apposition. From 1987 to 1991, we used this technique in 42 ankle joints (40 patients). The indications were posttraumatic arthrosis, rheumatoid arthritis, neurogenic paralysis, sequelae of septic arthritis, necrosis of the talus and failed ankle arthrodesis. In 13 ankles with severe deformity, a bone graft was also used. 38 patients (40 ankle joints) were available for follow-up after 4 (3–7) years. Solid union was achieved in 38 ankles after an average of 13 weeks. The clinical result was good-to-excellent in 36 ankles. We conclude that this is a simple and effective method for ankle arthrodesis in both low-risk and, coupled with bone grafting, in properly selected high-risk patients.

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Since 1879, more than 40 different surgical techniques have been described for fusion of the tibiotalar joint (Helm 1990). Complications include pseudarthrosis in 10–40% and infection in 25–40% (Morrey and Wiedeman 1980, Hagen 1986, Lynch et al. 1988, Frey et al. 1994). To solve these problems, a simple technique with crossed screws was developed by Morgan et al. (1985), who used a wide exposure from an anterior approach, correction of the deformity, broad cancellous bone contact and rigid internal fixation using 2–3 cancellous screws. The method is mainly of value in arthrosis with mild deformity and good bone quality (Holt et al. 1991, Mann et al. 1991, Thordarson et al. 1992, Frey et al. 1994). Some reports have described the method used for patients with high risks of failure due to underlying disease, but gave few details (Morgan et al. 1985, Moeckel et al. 1991).

We retrospectively reviewed our experience of anterior ankle fusion with cancellous screw fixation in selected cases supplemented with bone grafting .

Patients and methods

From 1987 to 1991, one of the authors (YJC) performed 42 internal compression tibiotalar arthrodeses in 40 patients, using a uniform operative technique. 2 patients with posttraumatic arthrosis were lost to follow-up after union was obtained. Bilateral arthrodesis was performed in 1 man and 1 woman. Thus, 38 of the 40 patients were available for clinical and radiographic follow-up (Table 1). 24 patients were men and 14 were women. Mean age at surgery was 49 (26–72) years. The average length of follow-up was 4 (3–7) years. The indications were posttraumatic arthrosis (18), rheumatoid arthrosis (7), paralytic ankle (4), postseptic arthrosis (4), nonunion after previous tibiotalar arthrodesis (4), and osteonecrosis of the talus (3). Ankle deformities resulting from bony destruction were common. Severe deformity included 6 valgus, 18 varus and 4 equinus deformities. Among these, 10 cases had anterior subluxation of the ankle joint.

High-risk patients were defined as those with certain predisposing factors that could increase the risk of nonunion and infection (Morgan et al. 1985, Cracchiolo et al. 1992, Kitaoka et al. 1992, Frey et al. 1994, Thordarson et al. 1994). These factors included a massive loss of bone from a previous fracture or of unknown etiology (3), poor quality of bone due to rheumatoid arthrosis (7), sequelae of neurogenic paralysis (4) and postseptic arthrosis (4), osteonecrosis of the talus (3), failed ankle arthrodesis (4), and diabetic neuropathy associated with posttraumatic arthrosis (1). 24 patients (26 ankles) belonged to the high-risk group.

Radiographic assessment included the time needed for fusion, and the final fusion position. The rotation, equinus and varus-valgus positions were measured on clinical examinations and radiographs (Buck et al. 1987). Using the system described by Morgan et al.

Table 1. Data on the 38 patients (40 ankles)

Case	Age	Sex	Etiology	Risk	Preop. bony condition	Preop. deformity	Type of graft	Weeks to union	Complications	Follow-up months	Clinical result
1	64	M	1	L	2	1	1	13	1	86	2
2	52	M	1	L	1	1	1	10	1	82	1
3	62	M	1 (l)	H	3	2,4	2	12	1	74	2
			1 (r)	H	3	2,4	2	14	1	70	2
4	59	F	1	L	2	1	1	10	1	71	1
5	52	M	1	L	2	3	1	12	1	70	1
6	55	M	1	L	2	2	1	11	1	64	1
7	48	M	1	L	1	1	1	10	1	63	2
8	44	M	1	L	1	3	1	11	1	57	1
9	54	M	1	L	2	1	1	12	1	54	1
10	28	F	1	L	1	3	1	7	1	52	1
11	48	M	1	H	3	2,4	2	11	1	50	2
12	54	M	1	L	2	1	1	12	1	42	1
13	59	F	1	L	2	3	1	11	1	40	2
14	56	M	1	H	3	2,4	1		2	40	4
15	62	F	1	L	2	1	1	11	1	40	2
16	72	M	1	L	2	3	1	14	1	39	1
17	50	F	1	L	2	1	1	13	1	38	2
18	48	F	2	H	2	3	1	13	1	61	2
19	52	F	2	H	3	2	2	13	1	58	2
20	54	M	2	H	3	2	3	17	7	54	3
21	62	F	2 (r)	H	3	2,4	3	15	1	53	2
			2 (l)	H	3	2,4	2	17	1	48	2
22	57	F	2	H	2	2	1	15	1	49	2
23	42	F	2	H	2	1	1	14	1	38	2
24	41	F	3	H	2	1	1	12	1	61	2
25	42	M	3	H	3	2	2	14	1	51	2
26	52	M	3	H	2	1	1	12	1	45	2
27	35	M	3	H	2	1	1	13	1	40	1
28	44	F	4	H	3	2	3	20	1	51	2
29	56	M	4	H	3	2,4	3	15	3,4	47	3
30	42	M	4	H	3	2	2	15	5	41	2
31	33	M	4	H	3	1	2	13	1	39	1
32	39	F	5	H	2	4,5	1	14	1	61	2
33	45	M	5	H	2	2,5	1	13	1	58	2
34	42	M	5	H	1	5	1	12	1	51	2
35	26	M	5	H	1	5	1	10	1	39	1
36	52	M	6	H	4	2,4,5	3	49	6	57	4
37	40	M	6	H	4	2,4	3	14	1	42	2
38	39	F	6	H	4	2	3	17	1	37	2

Etiology
- 1 Post-traumatic arthrosis
- 2 Rheumatoid arthrosis
- 3 Postseptic arthrosis
- 4 Failed ankle arthrodesis
- 5 Neurogenic paralysis
- 6 Osteonecrosis of talus
- r Right side
- l Left side

Risk
- H High-risk patient
- L Low-risk patient

Pre-operative bony condition
- 1 Normal
- 2 Osteoporosis or mild bone loss
- 3 Severe bone loss
- 4 Talar body collapse

Preoperative deformity
- 1 Any talar tilt of less than 10°
- 2 Varus (> 10°)
- 3 Valgus (> 10°)
- 4 Anterior subluxation of talus
- 5 Equinus

Clinical outcome
- 1 Excellent
- 2 Good
- 3 Fair
- 4 Poor

Type of graft
- 1 No graft
- 2 Tibial condyle
- 3 Sliding graft

Complications
- 1 No
- 2 Nonunion
- 3 Subtalar varus
- 4 Reflex sympathetic dystrophy
- 5 Deep infection
- 6 Delayed union
- 7 Superficial infection

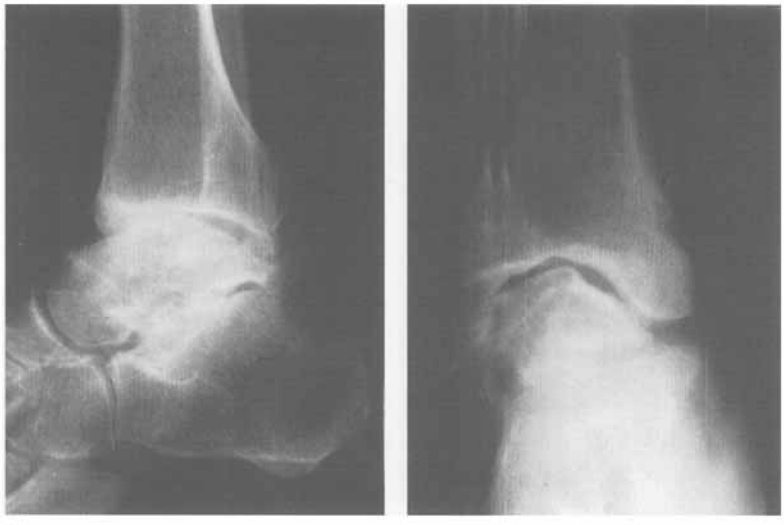
(1985), the clinical outcome was graded as excellent if there was solid fusion, no pain, no limp, no job restriction, and an esthetic appearance; good if there was solid fusion, mild pain, mild occasional limp, same job with some restrictions, and acceptable appearance; fair for a solid fusion, moderate pain, constant limp, job change, and poor appearance; and poor for any ankle with a failure of fusion or severe pain.

Operative technique

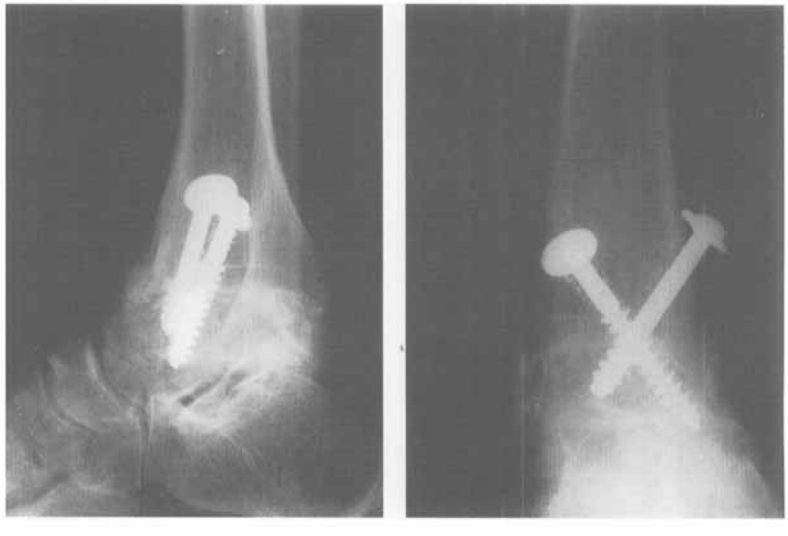
An anteromedial skin incision was made to expose the distal tibia and talus. The articular cartilage in the tibiotalar and talomalleolar surfaces was removed, with an attempt to preserve the bony contour of the tibial plafond and the talar dome. This procedure gives maximal bony contact and easy manipulation for the fusion position. For the severe deformities

with destruction of the tibial plafond, we used an osteotome to create a plafond which provided a neutral contour for the talus to fit in, and filled the gap between the tibial plafond and talus with a bone graft. Soft tissue release was performed in 12 ankles, which included posttraumatic arthrosis (4), paralytic ankle (4), failed ankle arthrodesis (3) and osteonecrosis of the talus (1). The release included the anterior capsulotomy with extensive subperiosteal dissection of the distal tibia and fibula to correct the varus or valgus deformity or a posterior capsulotomy through the tibiotalar space to correct the equinus deformity, and both procedures to correct an anterior talar subluxation with tilting. The foot position was neutral in the sagittal plane, neutral or slightly valgus in the coronal plane and mildly externally rotated in the horizontal plane. The internal fixation was done with 2 cancellous screws (6.5 mm in diameter) inserted from the distal tibia, across to each other, into the talus. Earlier in the series (6 ankles), the screws were inserted through the operative wound. Later in the series (36 ankles), the screws were inserted through stab wounds on each side of the operative wound. The lateral screw was inserted anteriorly to the lateral malleous. This modification had the advantage of inserting the screws anteriorly in the talus. An additional screw was inserted when 2 screws did not provide adequate stability during manipulation (6 ankles). The space between the talus and the malleoli was filled with bone chips, taken from around the ankle joint. In patients with good apposition and rigid fixation, no bone grafting was needed.

Figure 1. Case 6. A 55-year-old man with posttraumatic arthrosis.



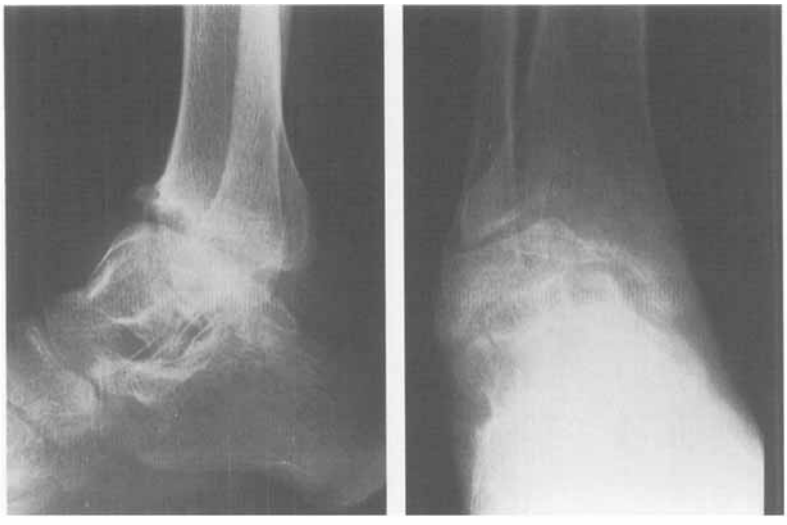
Preoperative varus tilting of the talus with destruction of the tibial plafond.



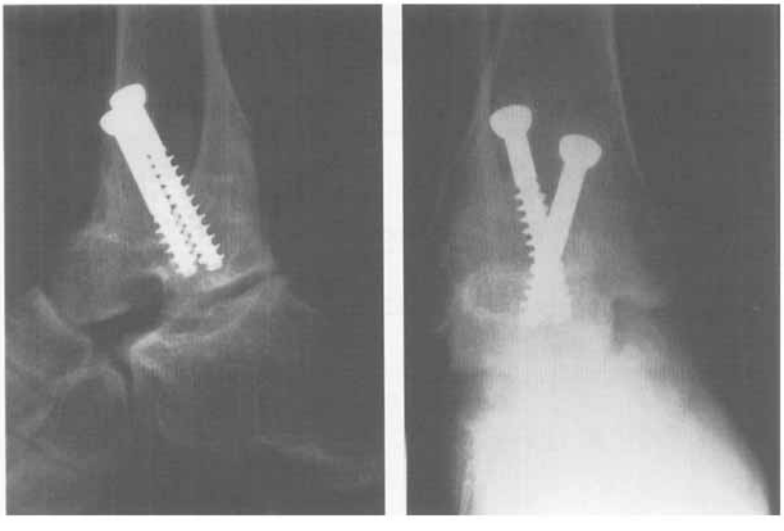
Solid union with cross-screws from distal tibia into anterior talus (5 years).

However, in 13 patients (15 ankles) with a defect due to severe bone loss or with poor bony quality, or failed ankle fusion, or osteonecrosis of the talus, a supplemental bone graft was used (Table 1). The bone graft was taken from the ipsilateral tibial condyle or from the distal tibia, as described in the Blair ankle fusion (Moeckel et al. 1991). Intraoperative radiographs were taken to confirm the position and the screw lengths and a short leg plaster cast was applied. After the wound healed, an ankle-foot-orthosis was applied and partial weight bearing was allowed for most patients from 6 weeks postoperatively. In those patients who required bone grafting, weight bearing was restricted during the first 8 weeks after operation.

Figure 2. Case 11. A 48-year-old man with posttraumatic arthrosis.



Preoperative varus tilting and anterior subluxation of talus, with destruction of tibial plafond.



Tibial condylar bone grafting was used. Solid union with cross-screws inserting from anterior tibia into posterior talus (4 years).

Results

Fusion was judged radiographically by obliteration of the tibiotalar joint space and the appearance of bony trabeculae crossing the fusion site. 38 of the 40 ankles achieved solid fusion after an average of 13 (7–20) weeks. Of 13 patients with an additional bone graft, union occurred in 12, after an average of 15 (12–20) weeks. There were 1 case of delayed union and 1 of nonunion. Delayed union occurred in a patient with talar body necrosis, who received an anterior tibial sliding graft at the fusion site (case 36). Clinically, the ankle joint was stiff and stable. The patient could walk with tolerable pain. Radiographically, there were no crossing trabeculae at 6 months after operation, but radiographic union occurred 5 months later. Nonunion occurred in a 56-year-old man with diabetic peripheral neuropathy and a neglected trimalleolar fracture-dislocation (case 14). This case was wrongly treated as merely a posttraumatic arthrosis, and no bone grafting was performed. The patient refused to use any external support after ankle arthrodesis. Finally, he asked for a below-knee amputation 4 months after the operation.

Infection occurred in 2 cases. Case 20 had a superficial wound infection which resolved with antibiotics. Case 30 had been treated with external fixation for infected nonunion of an ankle fusion. The previous infection had subsided 8 months before the present operation, but a deep infection developed postoperatively. This was successfully treated with debridement and antibiotics. Both of these patients achieved solid union. In the earlier cases in this series, there were 2 ankles with penetration of the screw tip into the subtalar joint. The screws were removed early, and neither patient developed subtalar arthrosis. Reflex sympathetic dystrophy occurred in a 56-year-old man (case 29), who followed a program of physical therapy for 6 months until the symptoms subsided.

The fusion position of the ankle joint was assessed radiographically. The fusion position in the sagittal plane ranged from 5° of dorsiflexion to 5° of plantar flexion, and averaged 2° of plantar flexion. The hindfoot axis in the coronal plane ranged from 10° of valgus to 3° of varus, and averaged 3° of valgus. The ro-

tational alignment in the horizontal plane ranged from 2° to 10° of external rotation, and averaged 4° of external rotation. Radiographically, no change in the fusion position was observed from the initial postoperative period to the end of follow-up.

The clinical functional result was rated as excellent in 14 ankles and good in 22 ankles. 2 ankles were rated fair, including 1 patient with moderate pain in the midfoot and hindfoot, and 1 patient with residual varus deformity of the subtalar joint. The cases of nonunion and delayed union were rated as poor.

Discussion

The goals of ankle arthrodesis are to eliminate pain and deformity by a solid fusion and to obtain a neutralized plantigrade foot (Scranton et al. 1985, Buck et al. 1987, Mann et al. 1991). To achieve these goals, we chose a neutral foot position, a broad bony apposition, a bone graft in selected patients and rigid compression. Anatomic alignment of the ankle joint at the time of fusion is essential (Mazur et al. 1979, Buck et al. 1987). Before performing a tibiotalar fusion, preexisting foot deformities must be corrected. This correction allows appropriate axial load transmission for bone healing and good alignment for walking. We preserved the contour of the tibial plafond and the talar dome to create a broad contact surface for the fusion. We used a bone graft in high-risk patients which may decrease the risk for pseudarthrosis (Scranton 1985, Moeckel et al. 1991). Finally, ever since Charnley popularized the concept of compression at the fusion site, the results of ankle fusion have improved (Charnley 1951, Helm 1990, Holt et al. 1991). 90–100% of ankle fusions, using internal compression with screws, healed (Morgan et al. 1985, Holt et al. 1991, Mann et al. 1991, Maurer et al. 1991); 38/40 ankles in our series healed.

Cross-screws have been recommended for low-risk patients (Mann et al. 1991, Frey et al. 1994). If the procedure is attemped in high-risk patients (severe deformity with poor bony quality, pseudarthrosis of a failed ankle fusion, osteonecrosis of the talar body, and a neurotrophic joint with sensory impairment), modification of the basic technique is necessary. By using corrective osteotomy of the tibiotalar joint, bone grafting, and a longer postoperative immobilization period, we were able to achieve a satisfactory result, even in the high-risk patients.

Ankle arthrodesis may be performed with internal or external fixation (Cracchiolo et al. 1992, Frey et al. 1994). The pitfalls of the external fixator include a bulky apparatus, pintract infection and lack of a uniform compression force (Charnley 1951, Moeckel et al. 1991, Cracchiolo et al. 1992). Thordarson et al. (1992), comparing the Calandruccio external fixator (Hagen 1986) to cross-screw fixation in a mechanical study, found that screw-fixation provided more rigidity in the sagittal plane and rotation torque than the fixator. None of our cases had inadequate stability with screw-fixation.

The screws may be crossed or parallel. In an experimental study, Friedman et al. (1994) found that crossed screws gave more stability than parallel screws, especially in resisting torsional stresses.

The infection rate was low in our series. This may be because soft tissue stripping and the use of implants were kept to a minimum (Morgan et al. 1985, Holt et al. 1991). Previous studies, supported by our findings, have suggested that the union rate with cross-screws compares favorably with other techniques of internal fixation which require more extensive soft-tissue dissection and resulted in a higher infection rate (Maurer et al. 1991, Frey et al. 1994). The anterior approach with the patient in the supine position also provides the advantage of accurate clinical positioning before fusion, especially in cases of severe deformity with difficult anatomic realignment (Morgan et al. 1985, Helm 1990).

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