

## Revision of Ankle Arthrodesis

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### ABSTRACT

From 1989 to 1996, we treated 18 cases (10 males, eight females; average age 48.2 years) of failed ankle arthrodesis by revision of ankle arthrodesis and followed their progress for at least two years. The average time interval between original surgery and revision was 17.3 months. Revisions were needed due to infection in one case, nonunion in 10 cases, and malalignment in seven cases. The salvage operations included debridement in the infective case, refreshed pseudoarthrosis in nonunion cases, and corrective osteotomy in malalignment cases. Sixteen cases were fixed by cross screws with internal compression, one infective case was fixed by an external fixator, and one case with bone loss was fixed with buttress plate. The average follow-up period was 40.4 months. There was one nonunion and two delayed unions, with an ultimate fusion rate of 94%. The average AOFAS ankle-hindfoot score was 70.9 at final follow up. There was one excellent result (5.6%), five good results (27.8%), 11 fair results (61%), and one poor result (5.6%), and the overall results were poorer compared with our series of primary arthrodesis. The time to fusion also took longer in the revision cases (average 2.7 months in primary cases and 4.8 months in revision cases). Fusion techniques that ensure solid union in a functional position are essential. If an ankle arthrodesis fails, however, revision is a salvage procedure that can achieve an acceptable result.

**Key Words:** Ankle Arthritis; Ankle Arthrodesis.

### INTRODUCTION

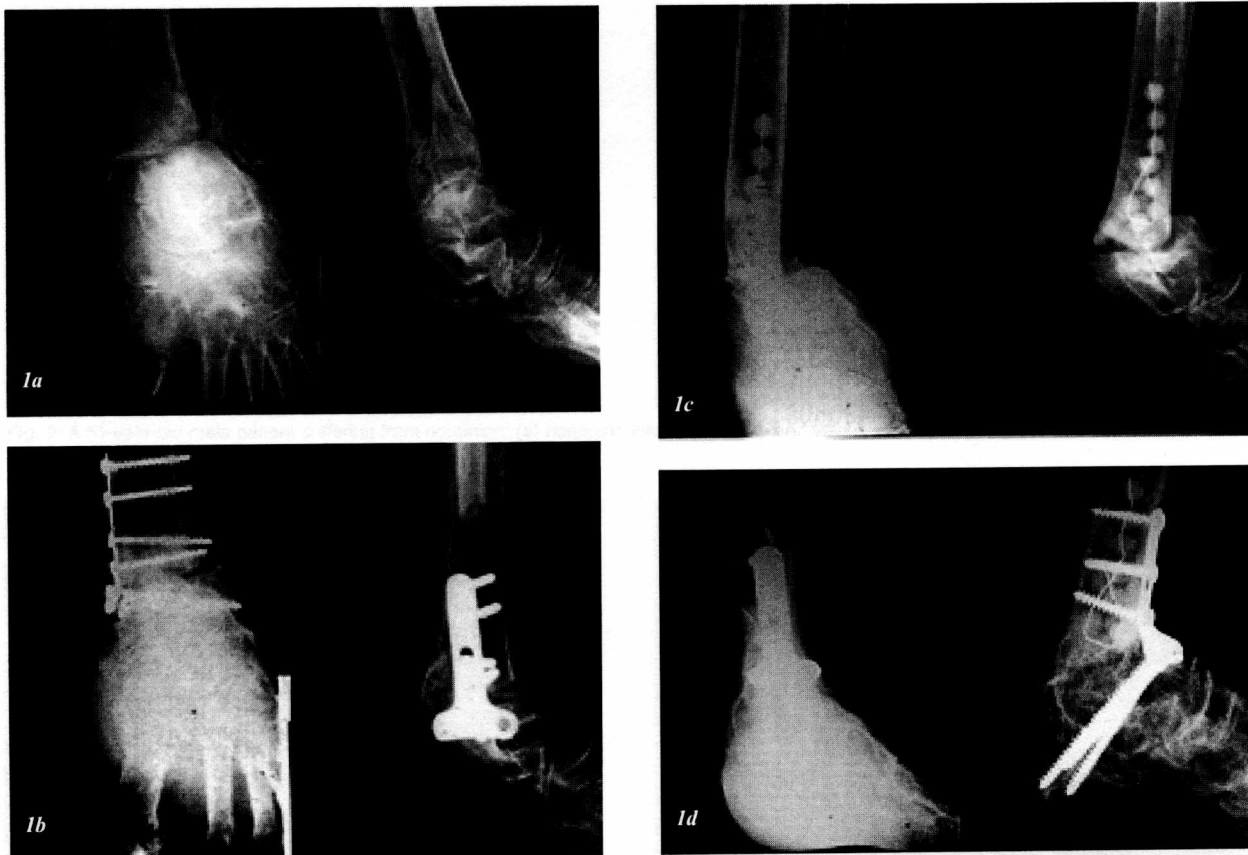
Ankle arthrodesis has been used to treat disabled ankles for many decades, but the results have been variable. In recent years, many authors have reported higher success rates because of improved fusion techniques and a better understanding of the functional fusion position. However, failures of ankle arthrodesis still occur. For disabling ankle arthritis, successful ankle arthrodesis can provide a painless and stable hindfoot with a relatively normal gait and limited functional loss. To achieve these goals, however, the ankle has to be solidly fused in an optimal position and the neighboring joints must provide compensatory motions after ankle fusion. The major causes of failure in ankle arthrodesis is nonunion, which has been improved by advanced techniques using intra-articular compression methods; the nonunion rate has been reported to range from 0% to 40%.<sup>3,15</sup> In addition to nonunion, the reasons for failure include infection, hindfoot arthritis, malalignment, and neurovascular injury. In spite of the relatively common occurrence of unsuccessful ankle arthrodesis, few reports have directly addressed how to treat these failures. Although several investigators mentioned a second surgery, they gave few details.<sup>5,10,13-14,16-17</sup> The few reports focusing on revision ankle arthrodesis were mostly related to the salvage of nonunion,<sup>6-7,9</sup> whereas revision for other causes of failure was reported in only one paper.<sup>1</sup> There has been a high rate of unsatisfactory results after revision ankle arthrodesis, although union rates ranged from 77% to 85%.<sup>1,6-7,9</sup> This paper reviews our results of revision ankle arthrodesis for cases of nonunion, malalignment, and infection, along with functional follow-up data.

### MATERIALS AND METHODS

We retrospectively studied 18 cases of revision ankle arthrodesis that were performed between 1989 and 1996. All of these cases were followed for at least two years. The patients included 10 males and eight

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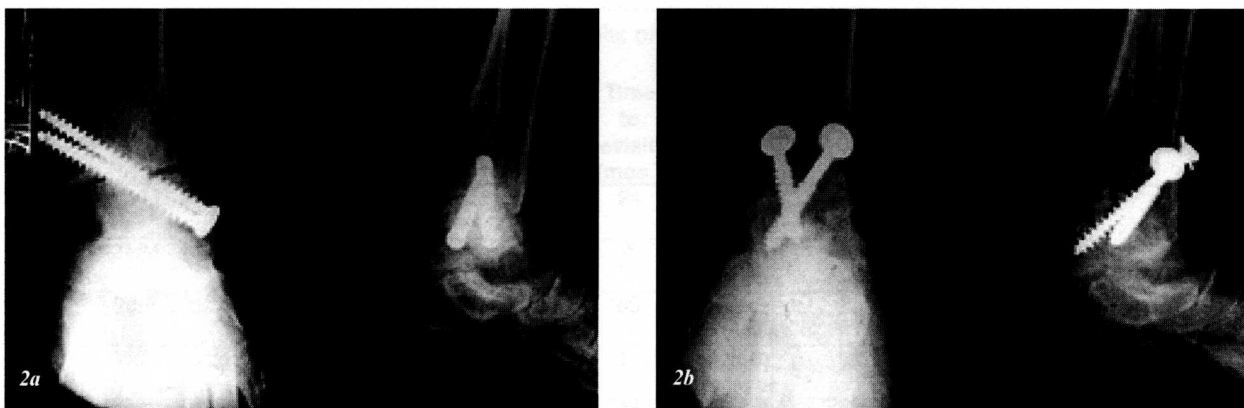


**Fig. 1:** A 56-year-old female patient suffering from infective nonunion: (a) traumatic arthritis after ankle fracture; (b) primary ankle arthrodesis with fibulectomy and plating; (c) debridement and removal of implants because of infection; (d) revision ankle arthrodesis and final fusion.

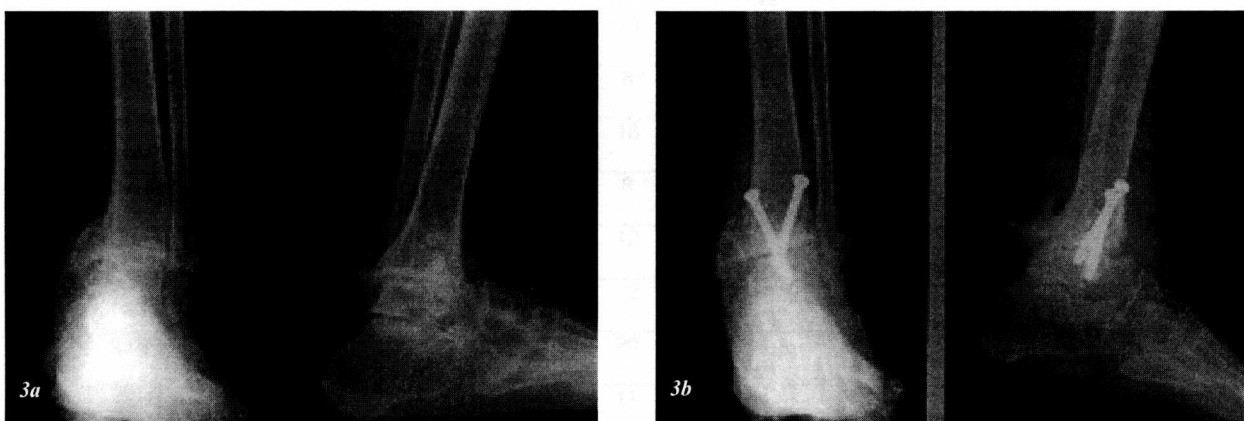
females, with a mean age of 48.2 years (range, 24 to 70 years). Thirteen patients were referred from other hospitals; the reasons for primary arthrodesis were unknown in five of these patients due to lack of sufficient data. Reviewing the history of the remaining 13 cases showed that the reasons for primary ankle arthrodesis were five cases of osteoarthritis, three cases of traumatic arthritis, three cases of paralytic deformity, one case of tuberculosis infection, and one case of club foot. The initial fusion techniques included modified Blair's method<sup>12</sup> in eight cases, screw fixation in five cases, double-staple fixation in two cases, plate fixation in two cases, and external fixation in one case. The time interval between primary and revision arthrodesis ranged from four to 60 months, with an average of 17.3 months. The reasons for revision included 10 cases of nonunion, seven cases of malalignment, and one case of infection.

The infective case was treated by debridement and external fixation. Due to severe bone stock loss, one case of nonunion was fixed by an AO buttress plate (Fig. 1). The other 16 cases were all fixed by cross

screws with compression. No bone graft was used in this series. For the nonunion cases, the pseudoarthrosis was done by complete debridement of the fibrous tissue and remaining cartilage to create a cancellous bony contact between the tibia and talus. Sometimes additional bone resection was needed to realign the ankle in an ideal fusion position (Fig. 2). For the cases of malunion with poor alignment, the fusion site was first osteotomized perpendicular to the long axis of the tibia by a power saw to create a tibial plafond, then we moved the foot into the fusion position and cut the talar side parallel to the distal tibial cut (Fig. 3). All cases were finally fixed in 90° dorsiflexion, 5 to 10° valgus, and external rotation with the talus in posterior translation. Short leg casts were used in all cases, except the infective case, who was treated by external fixation. The casts were used until follow up X-ray examination showed solid fusion. Non-weight bearing was advised for the initial six weeks and followed by partial weight bearing till removal of the cast. At follow up, weight-bearing X-rays were used to check the union condition and fusion alignment. Ankle Hind Foot Scale<sup>8</sup> of



**Fig. 2:** A 51-year-old male patient suffering from nonunion: (a) nonunion with fibulectomy and valgus malalignment; (b) revision with cross screws and union in a functional position.



**Fig. 3:** A 55-year-old female patient suffering from malunion: (a) preoperative X-ray showing malalignment of the varus and hyperdorsiflexion; (b) postoperative X-ray showing the correction of malalignment by corrective osteotomy.

American Orthopaedic Foot Ankle Society comprising 40 points for pain, 50 points for function, and 10 points for alignment were evaluated at final follow-up and classified as the following: excellent (85 to 100 points), good (70 to 84 points), fair (45 to 69 points), and poor (0 to 44 points).

## RESULTS

The 18 cases of revision ankle arthrodesis were followed up for an average of 40.4 months (range, 28 to 68 months). There was one nonunion, two delayed unions (union time more than six months), and 15 solid unions. The fusion rate was 94% (17 of 18 cases), and the average union time was 4.8 months (range, 2.5 to 10 months) for these 17 cases. The final follow-up score ranged from 38 to 86, with an average of 70.9. There was one (5.6%) excellent result, five (27.8%) good results, 11 (61%) fair results, and one (5.6%) poor result (Table 1).

## DISCUSSION

Although the current reports on ankle arthrodesis have high success rates, with union rates up to 100%, nonunion is still considered the most frequent cause of failure in ankle arthrodesis. The union rate of the few papers focusing on revision ankle arthrodesis ranged from 77% to 85%.<sup>1,6-7,9</sup> Because it is difficult to achieve fusion between the long-axis tibia and the small surface of the talus, the following factors are very important: complete denuding of joint cartilage and good cancellous bony contact apposition, fixation with derotation and compression, and additional cast immobilization until solid fusion is achieved.

In our revision procedure for nonunion ankle arthrodesis, the remaining fibrocartilage was generally found in the attempted fusion site, and fracture of the sliding bone graft was frequently noted in Blair fusion. In this series, six of the 10 nonunion cases were originally done with non-compression methods (Blair: five cases, staples:

**Table 1:** Overview of patients' data and follow-up results of revision ankle arthrodesis.

Patient	Age/ Sex	Etiology	Initial Fusion	Reason for Revision	Time to Revision (mos.)	Revision Fixation	Union Time (mos.)	AOFAS Ankle- hindfoot score	Follow-up (mos.)	Result
1	63/M	paralytic	cross screws	nonunion*	24	cross screws	4	80	48	good
2	24/M	trauma	cross screws	infection	4	external fixation	6	68	60	fair
3	70/F	osteoarthritic	Blair	nonunion	60	cross screws	4	68	36	fair
4	51/M	osteoarthritic	screws	nonunion*	11	cross screws	5.5	69	28	fair
5	37/F	unknown	Blair	varus	24	cross screws	2.5	67	29	fair
6	62/M	osteoarthritis	screws	varus	12	cross screws	4	68	30	good
7	52/M	osteoarthritis	staples	valgus	10	cross screws	2.5	69	31	fair
8	36/M	trauma	Blair	varus	8	cross screws	3	67	28	fair
9	69/F	osteoarthritis	Blair	valgus	18	cross screws	4.5	68	40	fair
10	56/F	trauma	plating with infection	nonunion	8	cross screws plating	6	82	57	fair
11	55/F	unknown	external	varus	12	cross screws	3	69	30	good
12	65/F	paralytic	cross screws	nonunion	12	cross screws	?**	68	28	fair
13	25/M	club foot	Blair	nonunion	20	cross screws	5	38	68	poor
14	42/F	unknown	plating	equinus	11	cross screws	4	86	38	excellent
15	35/M	paralytic	Blair	nonunion	22	cross screws	15	35/M	paralytic	Blair
16	50/F	unknown	Blair	nonunion	18	cross screws	10	78	36	good
17	42/M	unknown	Blair	nonunion	20	cross screws	4	81	45	good
18	42/M	tuberculosis	staples	nonunion	18	cross screws	4.5	69	62	fair

\*Broken screws

\*\*Still nonunion at 18 months follow up

one case) two of three cases that were originally fixed with screws failed due to early removal of the cast followed by broken screws and one case that was originally fused by plating had infective nonunion. Since external fixation has been used for revision ankle arthrodesis, and the result have not been satisfactory,<sup>9,11</sup> we used cross screws fixation in 16 of our 18 cases and all except one case eventually achieved solid fusion. Although in two cases the union was delayed until more than six months postoperatively and one case could not achieve union at final follow-up (18 months) and was thus classified as nonunion. In the two cases of delay

union, we just kept on casting and waited for the consolidation of callus, which was slowly progressive in follow up X-rays. The union rate of 93.8% (15/16) was comparable to our primary ankle arthrodesis using the same method of cross screws compression, but the fusion time (average, 4.6 months) was longer than that of the primary cases (average, 2.7 months).<sup>4</sup> The delay may be due to the deterioration of soft tissue and vascular circulation by repeated surgeries or the underlying neurological disorder of the three cases with union problems (two cases of paralytic foot and one case of unknown etiology). In ankle arthrodesis, sometimes a bone graft is used



to fill the bony defect between the contact surfaces at the fusion site. If the fusion site is well prepared to have a cancellous contact surface with good apposition, fixation using the compression method is the key to achieving union. No bone graft was used in this series, yet we still obtained a high union rate. Thus, it appears that a bone graft is not always necessary, even in revision ankle arthrodesis.

Although malaligned fusion has a critical influence on functional results and patients' satisfaction with ankle arthrodesis, no reports of revision ankle arthrodesis have focused on malalignment and only one paper has mentioned it. Malaligned fusion generally was found soon after removal of the cast, as patients were dissatisfied with their inability to bear weight on the foot. Malalignment causes soft tissue unbalance and has adverse effects on the neighboring joints, which leads to a painful hindfoot. We found that the time interval to revision in malalignment cases (average, 13.6 months) was shorter than that of nonunion cases (average, 21.3 months), meaning that patients with malalignment are less able to tolerate the poor results and surgeons maybe quicker to revise a malunion as they will not spend time waiting to see if it improves as they may do with a delayed union or nonunion. To avoid malaligned union, we prefer an anterior approach, which provides an entire view of the ankle for easy assessment of the fusion position and preserves the fibula to prevent lateral shifting, which causes a valgus hindfoot. To prevent a varus malalignment, cutting the tibial plafond perpendicular to tibial axis and cutting the talus parallel to the plafond cut with putting the foot in functional position are both important. Also important are the posterior translation of the talus along with the medial wall of tibial plafond, which helps to prevent coronal rotation and to decrease the lever arm of the foot.

The AOFAS Ankle-hindfoot score of our revision ankle arthrodesis cases was 33.4% excellent and good results. This score was poorer than our primary ankle arthrodesis, which was 79.5% excellent and good results.<sup>2</sup> Ankle arthrodesis is a difficult technique in which both achieving solid union and fusion in functional position are equally important, and the results are not always satisfactory even when done well. The decision to perform ankle arthrodesis must be thought of as the last resort after considering other alternatives such as cheilectomy, low tibial osteotomy, or even prosthesis

replacement.<sup>2</sup> Because the rate of union and the prevalence of complication does not differ appreciably from those of primary procedures, once a patient's ankle has failed to fuse after arthrodesis, revision ankle arthrodesis appears to be the treatment of choice.

## REFERENCES

1. **Anderson, JG; Coetzee, JC; Hansen, ST:** Revision ankle fusion using internal compression arthrodesis with screw fixation. *Foot Ankle Int*, **18(5)**:300-309, 1997.
2. **Cheng, YM; Huang, PJ; Hung, SH; Chen, TB; Lin, SY:** The surgical treatment for degenerative disease of the ankle. *Int Orthop (SICOT)*, **24**:36-39, 2000.
3. **Frey, C; Hallkus, NM; Vu-Rose, T; Ebramzadeh, E:** A review of ankle arthrodesis: predisposing factors to nonunion. *Foot Ankle Int*, **15**:581-584, 1994.
4. **Fu, YC; Huang, PJ; Tien, YC; Hung, SH; Cheng, YM; Lin, SY:** Ankle arthrodesis: internal non-compression arthrodesis versus internal compression arthrodesis. *Kaohsiung J Med Sci*, **15**:550-555, 1999.
5. **Johnce Jr, EW; Boseker, EH:** Arthrodesis of the ankle. *Arch Surg*, **97**:766-773, 1968.
6. **Kirkpatrick, JS; Goldner, JL; Goldner, RD:** Revision arthrodesis for tibiotalar pseudoarthrosis with fibular onlay-inlay graft and internal screw fixation. *Clin Orthop*, **268**:29-36, 1991.
7. **Kitaoka, HB:** Salvage of nonunion following ankle arthrodesis for failed total ankle arthroplasty. *Clin Orthop*, **267**:37-43, 1997.
8. **Kitaoka, HB; Alexander, IJ; Adelaar, RS; Nunley, JA; Myerson, MS; Sanders, M:** Clinical rating systems for the ankle-hindfoot, mid foot, hallux and lesser toes. *Foot Ankle*, **15**:349-353, 1994.
9. **Kitaoka, HB; Anderson, PJ; Morry, BF:** Revision of ankle arthrodesis with external fixation for nonunion. *J Bone Joint Surg*, **74A**:1191-1200, 1992.
10. **Lance, EM; Paval, A; Fries, I; Larsen, I; Patterson Jr, RL:** Arthrodesis of the ankle joint: a follow-up study. *Clin Orthop*, **142**:146-158, 1979.
11. **Levine, SE; Myerson, MS; Lucas, P; Schon, LC:** Salvage of pseudoarthrosis after tibiotalar arthrodesis. *Foot Ankle Int*, **18(8)**:580-585, 1997.
12. **Lin, SY; Cheng, YM; Huang, PJ; Tien, YC; Yap, WK:** Modified Blair method for ankle arthrodesis. *Kaohsiung J Med Sci*, **14**:217-220, 1998.
13. **Morry, BF; Wiedeman Jr, GP:** Complications and long-term result of ankle arthrodesis following trauma. *J Bone Joint Surg*, **62A**:777-784, 1980.
14. **Said, E; Hunka, L; Siller, TN:** Where ankle fusion stands today. *J Bone Joint Surg*, **60B(2)**:211-214, 1978.
15. **Scranton Jr, PE:** An overview of ankle arthrodesis. *Clin. Orthop*, **268**:96-101, 1991.
16. **Scranton Jr, PE; Fu, FH; Brown, TD:** Ankle arthrodesis: a comparative clinical and biomechanical evaluation. *Clin Orthop*, **151**:234-243, 1980.
17. **Stewart, MJ; Beeler, TC; McConnell, JC:** Compression arthrodesis of the ankle: evaluation of a cosmetic modification. *J Bone Joint Surg*, **65A**:219-225, 1983.