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ORIGINAL ARTICLE

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# Follow-up study of ankle arthrodesis in severe hind foot deformity in patients with rheumatoid arthritis using an intramedullary nail with fins

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**Abstract** We report herein a retrospective study of 25 cases of ankle arthrodesis performed in 23 patients with rheumatoid arthritis (RA) using an intramedullary nail with fins, developed in 1994. Surgical treatment, postoperative management, and clinical evaluation are described. Clinical evaluation, at an average follow-up period of 7 years 1 month, was based on foot disease scores from the Japanese Orthopedic Association; we compared these scores pre- and postoperatively, and during follow-up. These parameters showed a significant difference between preoperation and the follow-up period. However, instability only significantly improved when compared between pre- and postoperation. Arthrodesis using an intramedullary nail with fins was effective for the treatment of severe deformity of the hind foot. Nonunion was not observed and no remarkable changes of the Chopart joint were recognized between preoperation and the follow-up period. In our series, delayed wound healing was recognized in 6 of 25 joints. However, infection or neuropathy and other complications were not found. Arthrodesis using an intramedullary nail with fins is a viable treatment option for severe deformity of the hind foot in RA patients, because nonunion was not recognized and the clinical results over an average 7-year follow-up period were good or satisfactory.

**Key words** Ankle arthrodesis · Hind foot deformity · Intramedullary nail with fins · Retrospective study · Rheumatoid arthritis (RA)

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## Introduction

Total ankle arthroplasty (TAA) is considered to have limited indications, because years of experience and observation have revealed that the long-term outcome of most series of total ankle arthroplasties is poor, especially in younger patients.[1] On the other hand, arthrodesis has become a mainstay of surgical treatment for severe destruction of the ankle caused by rheumatoid arthritis (RA).

Ankle arthrodeses have been employed to relieve pain and severe deformity of the hind foot.[2–7] However, methods such as compression arthrodesis and transfibular or anteromedial sliding graft arthrodesis have disadvantages that include the need for a long period of immobilization without bearing weight and a relatively high incidence of nonunion.[8] To overcome these problems, we have developed an intramedullary nail with fins shaped like longitudinal ridges. This device is composed of four 6-cm-long fins with sharp distal tips attached to a cylindrical nail to prevent rotation, pronation, and supination, and dorsoflexion and plantar flexion of the talocrural and subtalar joints.[9]

We report herein the clinical results of 25 cases of ankle arthrodeses for severe deformity of the RA ankle joint using an intramedullary nail with fins over an approximate 7-year follow-up period.

## Patients and methods

### Patients

From May 1994 to December 1999, 23 patients (22 females and one male) with RA underwent ankle arthrodesis using an intramedullary nail with fins at Nippon Medical School Hospital. Two patients underwent bilateral ankle arthrodesis and one patient underwent ankle arthrodesis after resection of infected TAA, giving a total of 25 joints. The average age at operation was 58.3 years, with a range of 43–76 years, and the average follow-up period was over 7 years with a range of 3.6–9 years (Table 1). Follow-up was pos-

**Table 1.** Patient profiles at the time of surgery

| Patient | Age (years) | Stage | Class | Follow-up (months) | Bone graft | Staple | Duration (weeks) | Complication | PWB[a] (weeks) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 48 | 4 | 3 | 109 | – | – | 0 | None | 1 |
| 2 | 69 | 4 | 2 | 109 | – | – | 0 | Delayed wound healing | 1 |
| 3 | 59 | 4 | 3 | 105 | – | – | 0 | None | 8 |
| 4 | 50 | 4 | 2 | 103 | – | – | 0 | None | 1 |
| 5 | 58 | 4 | 3 | 102 | – | – | 0 | None | 1 |
| 6 | 43 | 4 | 4 | 98 | – | – | 12 | None | 12 |
| 7 | 76 | 4 | 3 | 98 | + | – | 0 | None | 1 |
| 8 | 50 | 4 | 3 | 97 | – | – | 0 | None | 1 |
| 9 | 51 | 3 | 3 | 96 | – | – | 0 | None | 1 |
| 10 | 54 | 4 | 2 | 95 | + | – | 0 | None | 1 |
| 11 | 69 | 4 | 3 | 94 | – | + | 12 | Delayed wound healing | 6 |
| 12 | 51 | 3 | 3 | 87 | + | – | 0 | None | 1 |
| 13 | 58 | 4 | 3 | 87 | + | – | 0 | Delayed wound healing | 6 |
| 14 | 60 | 4 | 3 | 86 | + | + | 12 | None | 6 |
| 15 | 67 | 4 | 3 | 84 | + | + | 0 | Delayed wound healing | 3 |
| 16 | 58 | 3 | 3 | 83 | – | – | 0 | Delayed wound healing | 1 |
| 17 | 74 | 4 | 3 | 82 | – | – | 0 | Delayed wound healing | 1 |
| 18 | 64 | 3 | 2 | 79 | + | + | 8 | None | 8 |
| 19 | 71 | 3 | 3 | 79 | + | + | 8 | None | 8 |
| 20 | 68 | 4 | 3 | 78 | – | – | 0 | None | 1 |
| 21 | 67 | 4 | 3 | 77 | + | – | 0 | None | 6 |
| 22 | 50 | 4 | 3 | 65 | – | – | 0 | None | 1 |
| 23 | 59 | 4 | 4 | 53 | + | + | 12 | None | 12 |
| 24 | 75 | 3 | 2 | 44 | – | – | 0 | None | 1 |
| 25 | 75 | 3 | 2 | 44 | – | – | 0 | None | 1 |

[a] Partial weight bearing

sible in 22 out of 25 ankles. Based on X-ray images, damage of the subtalar joint was graded from 0 to 5 according to the Larsen method.[9] Almost all of the talocrural joints were grade 4 according to the Larsen classification. The number of joints at grade 1 was 0; at grade 2, 2; at grade 3, 11; at grade 4, 10; and at grade 5, 2.

The indications for surgery in all patients were severe, disabling ankle pain and deformity. The patients had been leading a relatively active daily life, and age was not a limiting factor.

## Surgical technique

The distal tibia was cut perpendicular to its long axis using a power saw and an osteotome posteriorly, removing only enough bone to create a flat surface. This cut was extended to the lateral border of the medial malleolus, leaving it intact. The talar dome was cut parallel to the tibia cut, removing minimal bone to create a flat surface. Any deformity of the ankle was corrected by removal of an appropriate bone wedge. The fibula was also cut at the same level or at a level higher than the tibia to obtain better position of the tibial and talar cut surface. The distal fibula was used as a bone graft in some cases. The optimal position of the foot was a neutral position of the ankle with a neutral or slightly valgus hind foot.

After correction and fixation of both talocrural and subtalar joints, internal fixation was performed as follows. A short incision was made in the plantar surface of the foot to expose the calcaneus, and a guide wire was passed through the calcaneus and talus into the tibia under an image intensifier. A reamer was first used, followed by a nail of appropriate size. The nail was inserted over the guide wire and passed across the subtalar and ankle joints into the tibia medullary canal using an impactor for the nail (Fig. 1). The distal end of the nail was driven 5–10 mm inside the calcaneus to prevent the nail from sliding distally after surgery. Transfixation screws and an end cap were inserted using a targeting device with the impactor for the nail.

## Postoperative management

Patients were asked to bear weight according to their degrees of pain, with or without the grafted bone. Sixteen out of 25 joints were able to bear weight until 3 weeks after surgery. If there was concern that solid internal fixation could not be obtained because of poor bone stock, a below-knee cast was applied for 8–12 weeks postoperatively until fusion was confirmed radiographically.

## Clinical assessment and statistical analysis

Clinical assessment was performed using the 100-point rating system for foot diseases from the Japanese Orthopaedic Association (JOA): pain (0–20 points), deformity (forefoot, 0–10 points; hind foot, 0–20 points), range of motion (forefoot, 0–5 points; hind foot, 0–5 points), instability (0–10 points), walking ability without cane (0–10 points), muscle strength (0–5 points), sensation (0–5 points), activity of daily living (ADL; 0–10 points).

The Wilcoxon signed rank test was used to compare the total scores and the score of each item at the three points

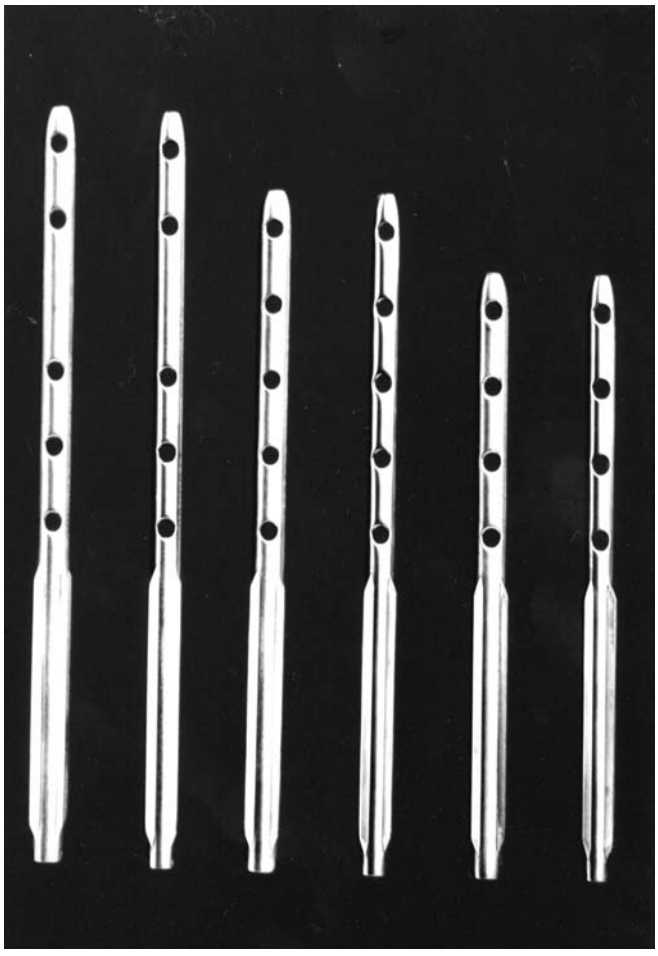


**Fig. 1.** Photographs of several intramedullary nails with fins. Four 6-cm-long fins with sharp distal tips are attached to a cylindrical nail to prevent rotation, pronation, and supination, and dorsoflexion and plantar flexion of the tibiotalar and subtalar joints

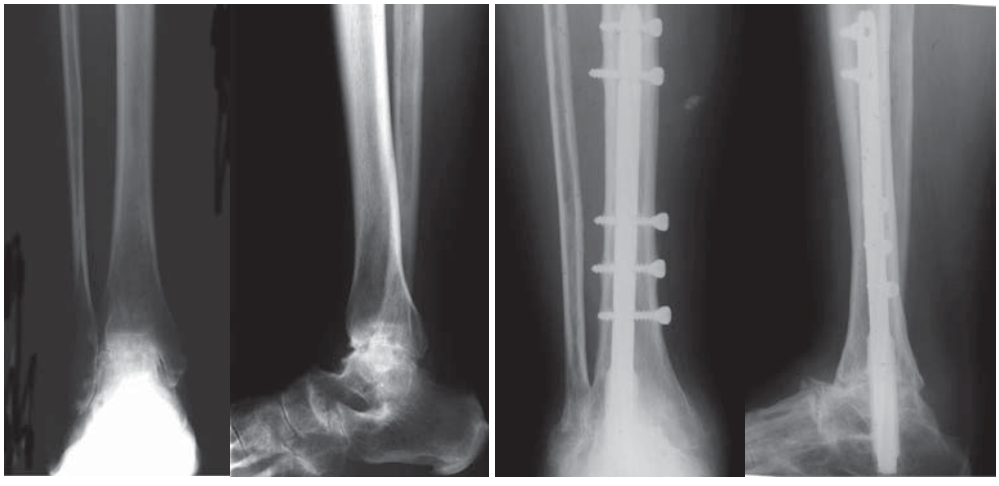
(preoperation, postoperation [namely, at the time of discharge after surgery] and the follow-up period). *P* values of less than 0.05 were considered to indicate a significant difference.

## Results

The perioperative management and assessment of arthrodesis were as follows. Ten out of 25 joints received a bone graft with the chips of a part of the fibula distal end and 6 were subjected to internal fixation using staples. The five joints were immobilized with a below-knee cast from 8 to 12 weeks. Weight bearing was started 3.1 weeks after the operation on average, with a range of 1–12 weeks. The decision when to start weight bearing was based on whether there was bone grafting or not. Arthrodesis of the ankle in an optimal position, namely neutral position or slightly valgus hind foot, was achieved in all patients, and all exhibited osseous fusion until 14 weeks postoperatively (Figs. 2, 3). Osseous fusion was considered to be present when trabeculae crossing the site of the arthrodesis were seen radiographically, resulting in the disappearance of the gap. Two surgical rheumatologists independently evaluated the radiographs.

Twenty-three out of 25 joints in which talocrural arthrodesis was performed also exhibited fusion of the subtalar joints. However, two cases of mutilans type did not exhibit osseous fusion of the subtalar joints and no symptoms caused by the subtalar joints were observed. In 3 out of 25 joints, arthrodesis of the Chopart joint in the adjacent joints including the subtalar and Lisfranc joints was recognized after ankle arthrodesis. The Chopart joint of the residual 22 joints was not markedly changed between preoperation and postoperation. In 17 out of 22 joints, osteoarthritic change of the Chopart joint, and in 5 joints spontaneous fusion of the Chopart joint, were recognized before surgery. Figures

**Fig. 2.** Case 1, a 51-year-old woman with rheumatoid arthritis. Preoperative and 3-year postoperative radiographs. Talocrural and subtalar joints show almost fibrous ankylosis and destructive changes. She is relatively young and has high activity in daily life. This case was considered as a good indication of an ankle arthrodesis. Total ankle scores improved from 53 points before surgery to 73 points 3 years after surgery



Pre-operation

Post-operation

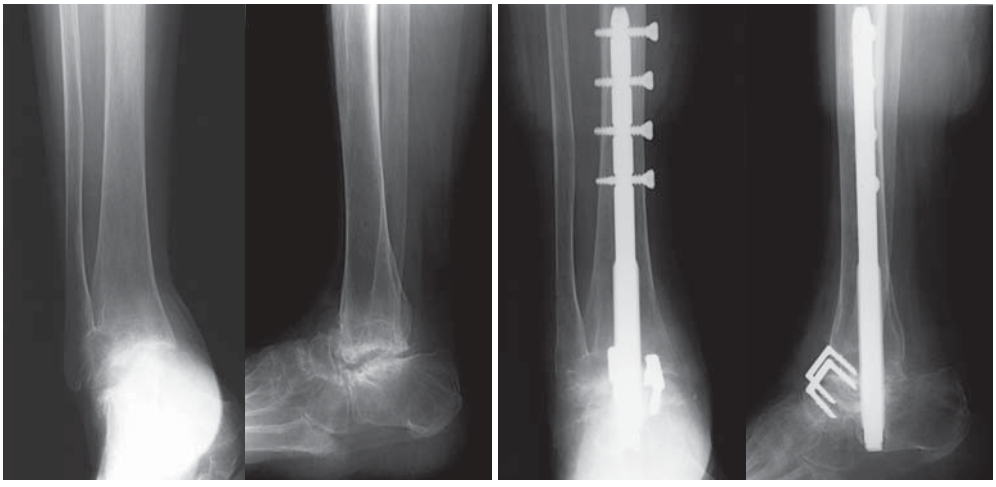



**Fig. 3.** Case 2, a 63-year-old woman with rheumatoid arthritis. Preoperative and postoperative radiographs. According to the preoperative radiograph, this case shows severe varus deformity and severe pain, considered to be an indication of ankle arthrodesis. Bone graft and augmentation with staples were performed. Total ankle scores improved from 22 points before surgery to 52 points 5 years after surgery

2 and 3 show the radiographs obtained pre- and postoperatively, and during the follow-up period. All of these cases show panarthrodesis of talocrural and subtalar joints.

In the clinical assessment, total scores significantly improved in all patients from 35.9 ± 10.6 points before surgery to 64.3 ± 9.3 points after surgery and 59.3 ± 8.3 points in the follow-up period. Pain scores also significantly improved from 5.7 ± 3.1 points before surgery to 17.8 ± 2.8 points after surgery and 17.2 ± 3.4 points in the follow-up period. The mean score for deformity of the hind foot also increased from 6.2 ± 5.4 points to 17.1 ± 3.0 and 16.7 ± 3.2 points. Walking ability increased from 2.7 ± 2.0 points to 5.0 ± 1.7 and 4.2 ± 1.8 points. Walking ability and ADL significantly improved when compared between pre- and postoperation, and preoperation and the follow-up period.

In terms of instability, scores improved from 3.9 ± 3.1 points before surgery to 6.3 ± 3.2 points after surgery and 4.3 ± 2.6 points in the follow-up period. However, instability only significantly improved when compared between pre- and postoperation (Fig. 4). Muscle strength and sensation remained unchanged in almost all patients between pre- and postoperation or preoperation and the follow-up period.

All patients were satisfied with the outcome of the operation. Eight patients had delayed wound healing that cleared with dressing changes. No other complications were experienced.

## Discussion

Total ankle arthroplasty has not always been a very successful procedure. When used in the surgical treatment for severe destruction of the ankle joint caused by RA, TAA has a high failure rate and has given disappointing results for the painful, disabled RA ankle,[10] because of the high incidence of complications. Despite this, in recent years early reports of TAA have been very encouraging with good short-term results.[11,12]

In RA patients having severe pain of ankle joints and restricted ADL due to multiple joint arthroplasties, it is very important that they are relieved of their ankle joint pain, which will result in the improvement of their ADL. Firm internal fixation for ankle arthrodesis has the following advantages: shortening of the period of immobilization, exact osseous fusion of the ankle joint, and earlier return to routine function. In recent years, the rates of fusion have been reported as approximately 93%–95%[13–15] with the need for a long period of no weight bearing and immobilization after surgery. Firm internal fixation permits earlier weight bearing without immobilization.

In our procedures we attempted to achieve firm internal fixation, earlier weight bearing, and restriction of rotation, pronation, and supination of the ankle joint with transverse screws and fins. Even if an intramedullary nail with transverse screws and fins is used, we cannot always and sufficiently control osseous fusion, because of severe osteoporosis with disuse bone atrophy or steroid treatment in RA patients. Because of poor fixation in osteoporotic bone as well as RA or the danger that prominent screw heads may cause necrosis of overlying skin, the transverse screw should not be used.

Many reports of ankle arthrodesis using intramedullary nailing are available.[4,16–18] One negative aspect of retrograde intramedullary nailing for ankle arthrodesis is the necessity to fuse the subtalar joint along with the ankle joint. However, compression arthrodesis of the ankle has an adverse effect on subtalar movement.[19] In our experience, this nail may be utilized with less damage (grade 2) to the subtalar joints. In RA patients rigid talocrural arthrodesis may induce varus or valgus deformity of the adjacent joint as well as the subtalar joint in the future. Horibe et al. reported that the destruction of the adjacent joints, namely the Chopart,

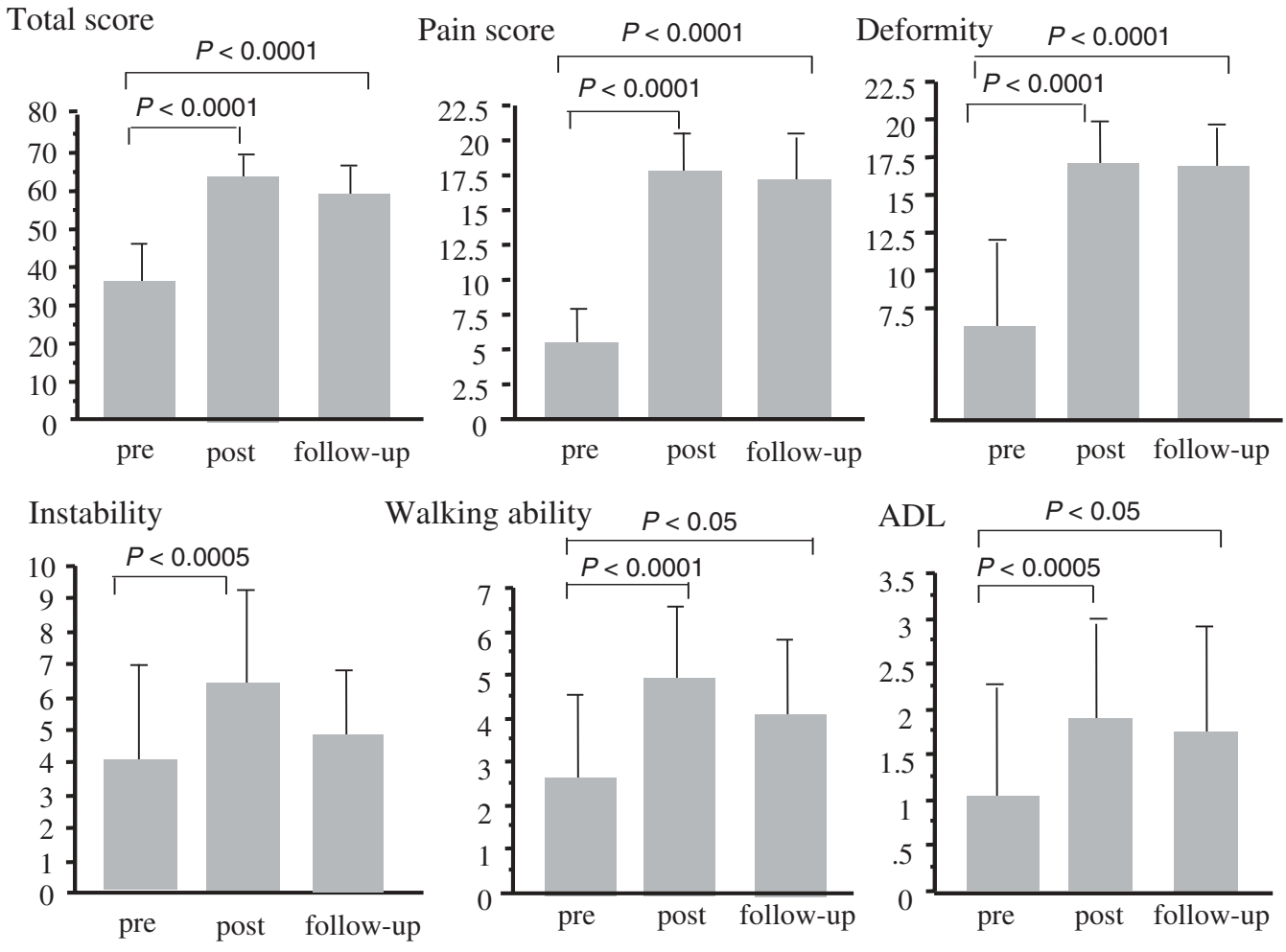



**Fig. 4.** Changes of several clinical scores based on the Japanese Orthopaedic Association at preoperation, postoperation, and the follow-up period. Total score, pain score, deformity, walking ability, and activity of daily living (*ADL*) significantly improved when compared between pre- and postoperation and between preoperation and the follow-up period. However, instability only significantly improved when compared between pre- and postoperation

subtalar, and Lisfranc joints, is accelerated by the abnormal movement of the ankle.[20] Adam and Ranawat reported that sublaxation of the subtalar joint occurred in about 80% of patients after talocrural arthrodesis, resulting in varus or valgus deformity of the subtalar joint.[21] Verhelst et al. reported that the shorter immobilization period and the patient's younger age reduced the occurrence of the degree of osteoarthritis.[22] Considering this, it may be feasible to fix the talocrural and subtalar joints at the same time. Most of the subtalar joints in our RA patients were ranked higher than grade 3 and the destruction and deformity of the subtalar joints were considered progressive, so the rigid fixation of the only talocrural joint might conversely accelerate the deformation of the subtalar joint. Shibata reported that the Chopart joint that had a solid fusion exhibited no remarkable changes during an average follow-up period of longer than 9 years.[4]

In our results, remarkable changes of the Chopart joint as compared to preoperation were only recognized in 3 out of 25 joints. In the other 22 cases, no remarkable changes of the Chopart joint were recognized between preoperation and the follow-up period. It is still unclear whether these OA changes or fusion of the Chopart joint is due to the natural history of the RA or the change in alignment of the foot after fixation of the talocrural and subtalar joints.

Some complications besides nonunion, such as delayed wound healing, infection, and neuropathy, have been reported after ankle arthrodesis for RA. Moran et al. followed up 30 cases of ankle arthrodeses in patients with RA for 5 years and found 12 cases nonunion and 12 cases of wound breakdown and infection.[23] Cracchiolo et al. indicated that in 32 cases of arthrodeses of the ankle joint in 26 patients with RA, nonunion was 22%, infection was 33%, misalignment 16%, and neurapraxia 9%.[24] Smith and Wood reported that 4 out of 11 patients with severe RA of the ankle joint who underwent arthrodesis with external fixation suffered pin tract sepsis while 3 showed delayed union.[25] On the other hand, Felix and Kitaoka reported

delayed wound healing in 2 out of 26 ankle joints, superficial ulceration in one, and sural neuritis in one.[26] In our results, delayed wound healing was recognized in 6 out of 25 joints. However, infection or neuropathy and other complications were not recognized. Ankle arthrodesis also does not provide ideal cosmetic results to the anatomy and function of the ankle joint. Despite these limitations, this method is effective for relieving pain in patients with severe deformity of the hind foot.

We conclude that arthrodesis using an intramedullary nail with fins represents good treatment for severe deformity of the hind foot in RA patients, because nonunion was not recognized and the clinical results over the 7-year average follow-up period were good or satisfactory. However, in cases of severe deformity, circulation insufficiency and delayed wound healing were recognized.

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