HOKKAIDO UNIVERSITY

Title	Outcome of Transfibular Ankle Arthrodesis with Ilizarov Apparatus
Author(s)	Onodera, Tomohiro; Majima, Tokifumi; Kasahara, Yasuhiko et al.
Citation	Foot & Ankle International, 33(11), 964-968 https://doi.org/10.3113/FAI.2012.0964
Issue Date	2012-11
Doc URL	https://hdl.handle.net/2115/53464
Rights	Copyright © 2012 by the American Orthopaedic Foot & Ankle Society
Type	journal article
File Information	FAI33-11_964-968.pdf

Hokkaido University Collection of Scholarly and Academic Papers : HUSCAP

Outcome of Transfibular Ankle Arthrodesis with the Ilizarov apparatus

ABSTRACT

Background: Both transfibular ankle arthrodesis with fibular onlay grafting and ankle arthrodesis using the Ilizarov apparatus have resulted in acceptable fusion rates. This study analyzed outcomes in our practice for all patients who underwent transfibular ankle arthrodesis with fibular onlay grafting using the Ilizarov apparatus.

Materials and Methods: A retrospective review was conducted of all patients who experienced severe ankle pain associated with osteoarthritis, rheumatoid arthritis, talar necrosis, or septic arthritis and underwent transfibular ankle arthrodesis with Ilizarov apparatus between 1995 and 2010. Postoperative clinical outcomes were evaluated for 42 consecutive patients (43 feet) who received primary or revision ankle arthrodesis using the Ilizarov technique at two centers. Mean duration of follow-up was 4.1 years (range, 1.5-13 years). Outcomes were assessed using the ankle-hindfoot scale of the American Orthopaedic Foot and Ankle Society. **Results:** All ankles fused successfully. Mean clinical outcome improved significantly from 36.2 (range, 8-64) preoperatively to 77.4 (range, 0-86; $P < 0.05$) postoperatively. **Conclusion:** Transfibular ankle arthrodesis using the Ilizarov external fixation system and fibular onlay strut grafting can achieve 100% bony union and lead to general improvements in clinical outcome. Forefoot stabilization with a forefoot ring achieves rigid stabilization resulting in a shorter duration of external fixation.

Level of Evidence: IV, Retrospective Case Series

Keywords: ankle; arthrodesis; Ilizarov technique; fibular strut graft

INTRODUCTION

Ankle arthrodesis is the traditional operative treatment for end-stage ankle osteoarthritis, rheumatoid arthritis, talar osteonecrosis, and septic arthritis. Numerous techniques have been described since the first ankle fusion technique was published in 1879.[2] More than 40 different surgical techniques have been described for ankle arthrodesis over the past 130 years. Several fixation techniques and surgical approaches have been considered for ankle arthrodesis, depending on the specific deformity, the condition of the bones and soft tissues, and the preferences and experience of the surgeon. Although early attempts were associated with high rates of nonunion (40%) and complications (60%),[5,15,17] current ankle fusion rates are approximately 90%, possibly due to improvements in operative techniques and fixation devices.[10,13]

The Ilizarov apparatus is a versatile external fixator that allows application of dynamic and multi-directional forces. The ability to correct the position of the hindfoot and forefoot by adjusting the frame as needed after the operation is a unique advantage of the Ilizarov method, allowing the ability to address intraoperative errors or early postoperative loss of position. These advantages contribute greatly to improvements in severe malalignment, failed fusion, and septic arthritis.

We report the fusion rate and clinical outcomes as assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle-hindfoot scale using the transfibular approach with the Ilizarov apparatus. We also measured the duration of external fixation and identified complications related to the operation.

MATERIALS AND METHODS

Between 1995 and 2010, a total of 43 consecutive patients seen by the senior authors and requiring ankle arthrodesis were referred for surgery at one of two centers. The main indication for surgery in all patients was severe ankle pain associated with osteoarthritis, rheumatoid arthritis, talar necrosis, or septic arthritis. A minimum

follow-up of 1.5 years was required. Institutional review board approval was obtained prior to initiation of this study. Patient demographics and ankle characteristics are shown in Table 1. Mean age of the 28 women and 15 men was 59.9 years (range, 16-79 years). Twenty-one patients had osteoarthritis, 11 had rheumatoid arthritis, three had talar necrosis, four had infection, one had Charcot arthropathy, and one showed loosening of total ankle arthroplasty.

Preoperative assessment included clinical outcomes based on the AOFAS ankle-hindfoot scale.[11] Postoperative clinical outcomes were evaluated on the basis of data derived from physical examination. Three patients moved out to a distant place and were followed by a local orthopaedic surgeon. We also assessed all complications. All postoperative imaging, performed at the most recent follow-up, was reviewed to determine nonunion. If failure of bone union was suspected, CT was performed in addition to radiography. Fusion was assessed by a surgeon not involved in the surgery (T.O.). Statistical analysis was carried out to compare mean outcome scores between pre- and postoperatively using Student's paired t-test. Statistical difference was considered significant for values of $p < 0.05$.

Surgical Procedure

Access to the ankle was gained through a lateral approach centered on the fibula. The fibula was osteotomized approximately 6 cm proximal to the distal tip, taking care to preserve the posterior soft tissue and vascular envelope of the distal fibula. The anterior syndesmosis was resected to allow the distal fibula strut to hinge posteriorly. Osteophytes and degenerative scar tissue were removed. The tibio-talar joint, lateral surfaces of the tibia and talus, and medial surface of the fibula strut were denuded with an osteotome and curette. Cancellous bone was harvested from the iliac crest. Cortical bone was also harvested when necessary. After grafting the cancellous and cortical bone, the ankle joint was temporarily fixed from calcaneus to tibia with two 3-mm Kirschner wires. A distal fibular strut was then placed across the ankle

joint with the cancellous surface against the prepared tibia and talus. The fibular strut was secured to the tibia and talus with two parallel 4.0-mm bioabsorbable poly-L-lactide screws, as bioabsorbable screws have an elastic property that allows minor adjustment using the Ilizarov apparatus postoperatively. After closure of the wound in anatomical layers, the Ilizarov apparatus was applied. Ring fixators at the proximal tibia and supramalleolar region were initially anchored with tensioned wires. A talar half-ring was anchored with two to four tensioned wires. A calcaneal half-ring was additionally anchored with tensioned wires through the calcaneus and through the metatarsals for high-risk patients such as those with talar osteonecrosis, septic arthritis, failed ankle arthrodesis, or Charcot joint. In later cases, a forefoot half-ring with tensioned wires was used in all cases.

Prophylactic antibiotics based on intravenous administration of 1 g of Cefazoline sodium for three days were administered to all patients postoperatively. After intravenous administration, oral administration of 100 mg of Cefdinir three times daily for four days was performed. Partial weight-bearing was permitted after decreasing swelling. Patients were assessed clinically and radiographically each week for the first month, then every two weeks until fusion. After clinical and radiographic evidence of fusion, the Ilizarov apparatus was removed. A below-the-knee walking brace was placed for 4 weeks.

RESULTS

The mean duration of surgery was 191.4 min (range, 108-308 min) (Table 2). The mean of tourniquet time was XXX min (range, XX-XXX min) and the mean of blood loss was XXX ml (range, XXX-XXX ml). Autogenous iliac bone graft was required for 40 patients (93%). Allogenous bone graft was used for 1 patient (2%), while 2 patients (5%) required no bone graft. Stabilization was achieved with a forefoot ring in 37 patients (85%), while 6 patients (15%) were stabilized without forefoot stabilization. Mean duration of follow-up was 4.1 years (range, 1.5-13 years). All

patients achieved bony fusion on anteroposterior and lateral radiographs of the ankle. Mean duration of external fixation was 117.8 days (range, 70-455). Forefoot stabilization using a forefoot ring tended to shorten the duration of external fixation (without forefoot stabilization, 148.4 days; with forefoot stabilization, 113.2 days; $P = 0.15$).

With regard to complications associated with the surgery, 5 cases (12%) showed superficial infection and were satisfactorily treated using antibiotics. One patient (2%) with severe lymphedema experienced delayed wound healing and required outpatient care for a month. Three patients (7%) underwent additional operations on the ankle. Two patients (5%) showed deep infection and underwent successful ankle fusion after irrigation. One patient (2%) received placement of a nerve stimulator for complex regional pain syndrome (CRPS). Although the ankle was successfully fused, persistent pain continued and below-the-knee amputation was performed 9 months postoperatively. Mean score for all patients on the AOFAS ankle-hindfoot scale improved significantly from 36.2 (range, 8-64) preoperatively to 77.4 (range, 0-86) postoperatively ($P < 0.01$).

DISCUSSION

Ankle arthrodesis shows various disadvantages, but is considered the standard treatment for end-stage ankle osteoarthritis, rheumatoid arthritis, talar osteonecrosis, and septic arthritis. Potential complications in the short term include nonunion, malalignment, and deep infection. Disturbed gait[14,19] and adjacent joint arthritis[6,18] are also described as substantial risks after fusion. Total ankle replacement can potentially overcome these disadvantages, but the rate of subsequent major complications is reportedly higher than that after arthrodesis.[12]

Transfibular ankle arthrodesis and fibular onlay strut grafting have been discussed in multiple studies.[1,3] This technique allows for minimal shortening of the limb,

adjustment of dorsiflexion at the time of fixation, provision of a large bony surface for healing, and increase stability with the use of fibular strut grafting.

Use of the Ilizarov apparatus for ankle fusion has been reported to result in a high fusion rate, including in complex and revision cases.[4,7-9] Our results for transfibular arthrodesis using the Ilizarov apparatus confirm a 100% union rate against the various pathogeneses. The fusion rate in our study resulted in significantly improved postoperative AOFAS ankle-hindfoot scale score at final follow-up.

Duration of surgery has not been discussed in other studies using the Ilizarov technique.[4,7-9,16] Our operative time (190.6 ± 43.7 min) seems long because of the complex operative procedure and wide variety in ankle pathogeneses treated.

The Ilizarov apparatus has several limitations, including complexity of application, a bulky frame requiring patient compliance, and the risk of specific complications such as pin tract infection. Despite these limitations, the frame confers sufficient stiffness in bending and torsion to allow weight-bearing immediately postoperatively.

The complications that occurred in this study were consistent with complications reported in other studies,[7-9] with superficial infections occurring most frequently. Superficial infection does not seem to affect clinical outcomes, whereas deep infection seems to have a slightly detrimental effect on the final result. This finding is consistent with results from other studies.[7-9] One patient in this series was diagnosed CRPS, resulting in below-the-knee amputation. Nerve-associated complications have also been reported in other studies of ankle arthrodesis using a transfibular approach,[1,3] suggesting that a transfibular approach might be associated with a risk of CRPS.

Most surgeons add forefoot stabilization using a forefoot ring.[4,7-9,16] In our series, the 6 cases stabilized without a forefoot ring required a relatively longer duration of external fixation compared to the 37 cases stabilized with a forefoot ring, suggesting that use of a forefoot ring can shorten the duration of applying external fixation.

In conclusion, transfibular ankle arthrodesis with fibular onlay grafting using the Ilizarov apparatus represents a worthwhile procedure. Although this technique is complex, increasing the complication rate and time needed in the external frame, the final clinical outcomes appear satisfactory.

FIGURE LEGENDS

Figure 1: A standard postoperative photograph. **A)** Anteroposterior view. **B)** Lateral view.

Figure 2: A standard postoperative radiograph. **A)** Anteroposterior view. **B)** Lateral view.

Table 1: Patient demographics.

Table 2: Summary of the results.

REFERENCES

1. **Akra, GA; Middleton, A; Adedapo, AO; Port, A; Finn, P**: Outcome of ankle arthrodesis using a transfibular approach. J Foot Ankle Surg. **49**: 508-512.2010.
2. **Albert, E**: Zur Resektion des Kniegelenkes. Wien Med Press. **20**: 705–708.1879.
3. **Colman, AB; Pomeroy, GC**: Transfibular ankle arthrodesis with rigid internal fixation: an assessment of outcome. Foot Ankle Int. **28**: 303-307.2007.
4. **Eylon, S; Porat, S; Bor, N; Leibner, ED**: Outcome of Ilizarov ankle arthrodesis. Foot Ankle Int. **28**: 873-879.2007.
5. **Frey, C; Halikus, NM; Vu-Rose, T; Ebramzadeh, E**: A review of ankle arthrodesis: predisposing factors to nonunion. Foot Ankle Int. **15**: 581-584.1994.
6. **Fuchs, S; Sandmann, C; Skwara, A; Chylarecki, C**: Quality of life 20 years after arthrodesis of the ankle. A study of adjacent joints. J Bone Joint Surg Br. **85**: 994-998.2003.
7. **Hawkins, BJ; Langerman, RJ; Anger, DM; Calhoun, JH**: The Ilizarov technique in ankle fusion. Clin Orthop Relat Res. 217-225.1994.
8. **Johnson, EE; Weltmer, J; Lian, GJ; Cracchiolo, A, 3rd**: Ilizarov ankle arthrodesis. Clin Orthop Relat Res. 160-169.1992.
9. **Katsenis, D; Bhave, A; Paley, D; Herzenberg, JE**: Treatment of malunion and nonunion at the site of an ankle fusion with the Ilizarov apparatus. J Bone Joint Surg Am. **87**: 302-309.2005.
10. **Kitaoka, HB**: Arthrodesis of the ankle: technique, complications, and salvage treatment. Instr Course Lect. **48**: 255-261.1999.
11. **Kitaoka, HB; Alexander, IJ; Adelaar, RS, et al.**: Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. **15**: 349-353.1994.
12. **Krause, FG; Windolf, M; Bora, B, et al.**: Impact of Complications in Total Ankle Replacement and Ankle Arthrodesis Analyzed with a Validated Outcome Measurement. J Bone Joint Surg Am. **93**: 830-839.2011.
13. **Mann, RA; Rongstad, KM**: Arthrodesis of the ankle: a critical analysis. Foot Ankle Int. **19**: 3-9.1998.
14. **Mazur, JM; Schwartz, E; Simon, SR**: Ankle arthrodesis. Long-term follow-up with gait analysis. J Bone Joint Surg Am. **61**: 964-975.1979.
15. **Morrey, BF; Wiedeman, GP, Jr.**: Complications and long-term results of ankle arthrodeses following trauma. J Bone Joint Surg Am. **62**: 777-784.1980.
16. **Salem, KH; Kinzl, L; Schmelz, A**: Ankle arthrodesis using Ilizarov ring fixators: a review of 22 cases. Foot Ankle Int. **27**: 764-770.2006.
17. **Scranton, PE, Jr.; Fu, FH; Brown, TD**: Ankle arthrodesis: a comparative clinical and biomechanical evaluation. Clin Orthop Relat Res. **151**: 234-243.1980.
18. **Takakura, Y; Tanaka, Y; Sugimoto, K; Akiyama, K; Tamai, S**: Long-term results of arthrodesis for osteoarthritis of the ankle. Clin Orthop Relat Res. **361**: 178-185.1999.

19. **Thomas, R; Daniels, TR; Parker, K**: Gait analysis and functional outcomes following ankle arthrodesis for isolated ankle arthritis. J Bone Joint Surg Am. **88**: 526-535.2006.

Figure 1

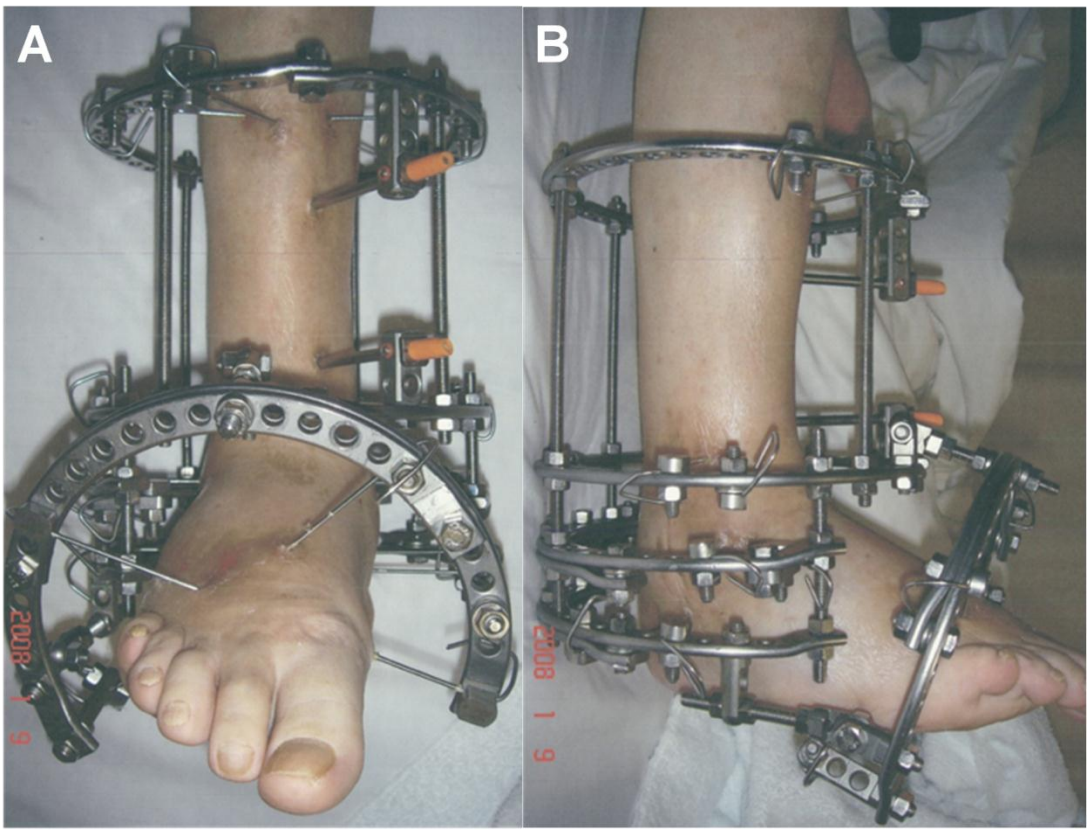

Figure 2

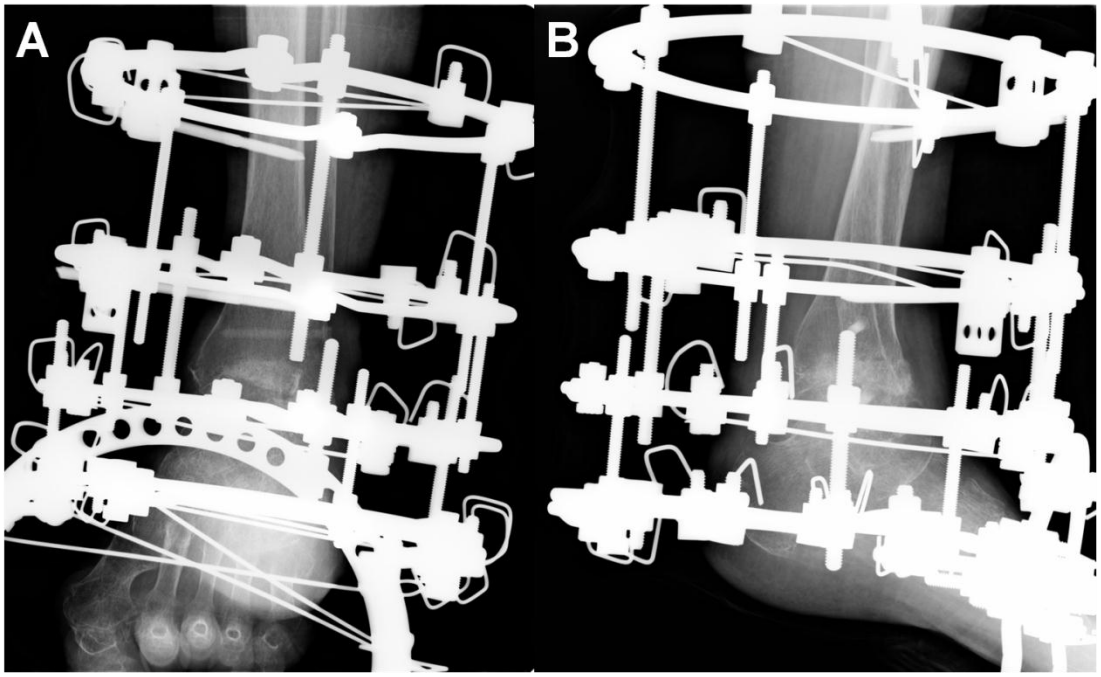

Table 1: Patient demographics

Variable	Result
Sex	
Female	**28 (65%)**
Male	**15 (35%)**
Age (years)	**60.2 (range, 16 to 79)**
Indication for fusion	
Osteoarthritis	**21 (49%)**
Rheumatoid arthritis	**11 (25%)**
Talar necrosis	**3 (7%)**
Infection	**4 (9%)**
Charcot arthropachy	**1 (2%)**
TAA loosening	**1 (2%)**

***TAA, total ankle arthroplasty**

Table 2: Results

Variable	Result
Duration of surgery (min)	194.8 (range, 108 to 308)
Source of bone graft	
Autogenous	40 (93%)
Allogenous	1 (2%)
no graft	2 (5%)
Forefoot stabilization (-)	6 (15%)
(+)	37 (85%)
Duration of external fixation (days)	117.8 (range, 70 to 455)
Forefoot stabilization (-)	148.4 (range, 90 to 250)
(+)	113.2 (range, 70 to 455)
Complication	
Superficial infection	5 (12%)
Deep infection	2 (5%)
delayed wound healing	1 (2%)
CRPS	1 (2%)
Duration of follow-up (years)	4.1 (range, 1.5 to 10)
Clinical outcome	
Pre-ope AOFAS Ankle-Hindfoot scale	36.2 (range, 8 to 64)
Post-ope AOFAS Ankle-Hindfoot scale	78.6 (range, 0 to 86)

*CRPS, complex regional pain syndrome; AOFAS, american orthopaedic foot and ankle society