

## Tibiototalcalcaneal Arthrodesis

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### ABSTRACT

The purpose of this multicenter retrospective study of 55 patients (56 ankles) who underwent simultaneous tibiototalcalcaneal arthrodesis with severe disease involving the ankle and subtalar joints was to determine improvement of pain and function. The surgical indications included osteoarthritis, posttraumatic injury, failed previous surgery, talar avascular necrosis, osteoarthritis, and rheumatoid arthritis involving the ankle and subtalar joints. The average age at the time of the operation was 53 years. The average time of follow-up was 26 months after the operation. Fusion was achieved in 48 ankles, with an average time of fusion of 19 weeks. Forty-eight of the 55 patients were satisfied with the procedure. The average leg length discrepancy was 1.4 cm. The average amount of dorsiflexion was 2 degrees and plantar flexion was 5 degrees. Following surgery, 42 patients complained of pain, 40 patients required shoe modification or an orthotic device, and 34 patients had a limp. Fourteen patients described their activity as unlimited. Based on the AOFAS evaluation, the patients scored an average of 66 on the ankle-hind foot scale following surgery. The most common complications were nonunion (8 ankles) and wound infection (6 ankles). This study demonstrates that tibiototalcalcaneal arthrodesis is an effective salvage procedure for patients with disease both involving the ankle and subtalar joints.

### INTRODUCTION

Patients with disease involvement of both the ankle and subtalar joints can have symptoms of pain, deformity, and limited ambulatory capacity on the affected

limb. Treatment options are limited; nonoperative measures may help decrease some of the symptoms, but much of pain and deformity remain. Surgical treatment is aimed at obtaining a painless, brace-free, plantigrade foot, and tibiototalcalcaneal arthrodesis offers an effective surgical treatment. This method was discussed by Russotti and Johnson<sup>13</sup> in 1988 and is not commonly performed. It has been reported infrequently, with the largest series being 30 cases<sup>4,9,10,11,12,13</sup>, and most series involve Charcot foot problems. The purpose of this study was to determine the frequency of this procedure and report on the clinical results, with use of the AOFAS evaluation for the ankle-hindfoot.

### MATERIALS AND METHODS

Between 1991 and 1998, tibiototalcalcaneal arthrodesis was performed by 9 surgeons at their respective 9 institutions on 55 patients (56 ankles), of which 30 patients were women (31 ankles) and 25 were men (25 ankles). The average age of the patients at the time of surgery was 53 years (range, 19 to 79 years).

The indications for surgery were severe arthrosis and associated deformity and pain involving both the ankle and subtalar joints from one of the following: posttraumatic injury (14 ankles), failed previous surgery (12 ankles), osteoarthritis (11 ankles), avascular necrosis of the talus (7 ankles), rheumatoid arthritis (6 ankles), failed total ankle replacement (2 ankles), Charcot-Marie-Tooth disease (2 ankles), and Charcot foot (2 ankles). All patients had failed nonsurgical treatment.

All patients were interviewed and underwent physical and radiographic examination. The average follow-up time was 26 months after the time of operation (range, 12 to 168 months). The physical examination involved evaluation of the limb for tenderness, position, and range of motion. The position of the foot was assessed in the standing position with a hand held

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goniometer. Weight-bearing radiographs were taken of the operated ankle in the anteroposterior, lateral and mortise planes, and of the foot in the anteroposterior and oblique planes. Fusion was determined by radiographic consolidation at the arthrodesis site.

The American Orthopaedic Foot and Ankle Society Clinical Rating System Ankle-Hind Foot Scale was used for evaluation. This includes subjective and objective factors into numerical scales to describe function, alignment, and pain.<sup>5</sup>

## SURGICAL TECHNIQUE

An intramedullary rod was used in 37 procedures, screws in 17 procedures, an external fixator in one procedure, and a plate and screws in one procedure. Autogenous bone grafting was utilized in 42 cases, and allograft in one case.

In most cases, the intramedullary fixation device was used. A transfibular approach is utilized between the sural nerve and the lateral branch of the superficial peroneal nerve, similar to the method described for ankle fusion.<sup>6</sup> The articular cartilage was removed from the tibiotalar joint with a sagittal saw. Frequently, a small medial incision was used to remove the medial malleolus. Next, the articular surface was removed from the subtalar joint. Any deformity involving the ankle or hindfoot was corrected with the saw cuts. The hind foot was placed in approximately 5 degrees of valgus with neutral dorsi-plantar flexion. The amount of external rotation was equal to the contralateral foot, approximately 5 to 10 degrees. If there was extensive bone loss, iliac crest bone graft was utilized.

When an intramedullary rod was used, a small transverse incision was made on the plantar aspect of the heel at the level of the distal and middle third of the heel pad. A guide wire was placed through the calcaneus, talus, and into the tibia, and the position was confirmed with image intensification. Reaming was accomplished over the guide pin, and then the rod was placed in a retrograde fashion. The interlocking screws were drilled and filled. The wound was closed in layers over a drain, and a bulky compression dressing with splints was placed.

The drain was removed after 24 hours. The dressing and sutures were removed 10 to 14 days following surgery. A short leg cast was placed, and nonweight-bearing was continued for a total of 3 months, following which progressive weight-bearing was begun in a short leg walking cast. The extremity was protected with a cast until clinical and radiographic healing was satisfactory.

## RESULTS

Fusion was achieved clinically and radiographically in 47 patients (48 ankles), with an average time to fusion of 19 weeks (range, 12 to 65 weeks). These patients had no motion at the arthrodesis site and consolidation was seen radiographically. The average time of immobilization was 20 weeks.

Forty-eight of the 55 patients were satisfied with the procedure. Seven patients were not satisfied with the results, because of nonunion of the ankle arthrodesis in 5 patients, residual severe pain in one, and limited activity level in one. Two patients complained of severe pain, 7 of moderate, 33 of mild, and 13 had no pain.

Nine patients use an AFO, of which 2 had anterior tibial pain from a stress reaction to the rod. Thirty-one patients require some form of shoe modification. Most of the modifications consisted of a soft insert or orthotic device. Forty-one patients had limited activity, of which 2 used a wheelchair, and one was house bound. The remaining 14 patients described their activity as unlimited.

The average leg length discrepancy was 1.4 cm as measured with blocks. The average position of fusion was 3 degrees of valgus. The average range of motion of dorsiflexion was 2 degrees, and plantar flexion was 5 degrees, which took place through the distal tarsal joints. Wearing shoes, 35 patients had a flatfoot gait and limped.

The AOFAS ankle/hind foot score is based on pain (40% of the total score of 100 points), function (28%), motion (22%), and alignment (10%). The average postoperative ankle-hind foot scale was 66.

## COMPLICATIONS

Thirty-eight ankles healed without complications. There was nonunion of the ankle arthrodesis in 8 patients, superficial wound infection in 5, and there was one case of each of the following complications: deep wound infection (in one case involving a nonunion), skin necrosis, sural neuroma, suture granuloma, delayed union of the ankle arthrodesis, and stress fracture. Of the 8 cases with nonunion, 3 had fixation with screws and 5 had fixation with an intramedullary rod. Additional surgery was required in 16 patients, which included hardware removal in 11 cases, revision for nonunion in 2, and one case of each of the following: removal of a bone growth stimulator, placement of autograft for a nonunion, and resection of a postoperative sural neuroma. The patients with the superficial infections healed with antibiotics and local wound care. The patient with the

deep infection was treated with antibiotics and wet to dry dressings. The patient with the stress fracture healed after 1 month.

## DISCUSSION

Arthrosis involving both the ankle and subtalar joint is one of the most difficult problems facing the orthopaedic foot and ankle surgeon. Patients complain of moderate to severe pain, deformity, and disability. The goal of tibiototalcalcaneal arthrodesis is to alleviate pain and provide a stable plantigrade foot for ambulation. Often, bracing this type of deformity is not possible because of the severe deformity. In cases of failed ankle arthrodesis, failed total ankle replacement, and avascular necrosis of the talus, pain and instability progress. It would be preferable to avoid performing a fusion of both joints because of the significant loss of motion.<sup>6</sup> Following a pantalar arthrodesis, dorsiflexion is decreased 63% and plantar flexion 82%, which results in a significant increase in the amount of stress placed on the surrounding joints. However, arthrodesis of only the ankle joint when the subtalar joint is arthritic will likely result in residual symptoms in the subtalar joint.

Tibiototalcalcaneal arthrodesis has been reported infrequently<sup>4,9,10,11,12,13</sup> until recently and generally show good results. The aim of this study was to obtain data from multiple institutions to evaluate the frequency of the use of this procedure (56 cases from 9 orthopaedic foot and ankle practices), and determine the clinical outcome of this procedure. The AOFAS ankle/hindfoot score was used to provide a value from a system that is widely utilized. To our knowledge, this is the largest reported series of tibiototalcalcaneal arthrodesis.

Tibiototalcalcaneal arthrodesis has been described by Johnson<sup>13</sup> to treat severe pain and deformity involving the hind part of the foot and ankle. Johnson initially reported on this procedure using multiple internal screws or an external fixator. The indications were failed arthrodesis of the ankle, failed total ankle arthroplasty, osteonecrosis of the talus, intra-articular fracture at the ankle that was un-united or malaligned, and neuropathy involving both joints. Satisfactory results were obtained in 75 per cent of 21 patients, and fusion was achieved in 18 patients.

Johnson later devised an intramedullary fixation device (Revision Nail, Smith & Nephew Richards Inc., Memphis, TN) for this procedure to improve on the stability of the fixation, and would avoid complications associated with external fixation devices. Kille<sup>4</sup> reporting on using this intramedullary fixation device obtained 87% satisfactory result in 30 patients, and fusion was complete in 28 patients. Twenty-six

patients felt that the operation had been worthwhile. There was 1 superficial skin slough, 2 deep infections, 1 prominent plantarward rod, and one death from pneumonia. There were 2 patients with stress reactions at the proximal end of the nail that healed with immobilization.

In a similar report by Moore et al.<sup>9</sup>, retrograde intramedullary rodding was evaluated retrospectively in 19 ankle arthrodesis in 16 patients. The procedure was done as a salvage procedure in each patient for significant posttraumatic arthrosis and bone loss, concomitant subtalar arthrosis, and severe osteopenia. Union occurred in 14 ankles. The complications were nonunion in 5 ankles, one deep infection, and one broken rod. Thirteen of the 16 patients were ambulatory, and 9 used an AFO or shoe modification.

This study only had one patient with a Charcot joint of the 51 ankles. In contrast, Pinzur and Kelikian<sup>12</sup> reported on 20 patients (21 ankles) with severe neuropathic (Charcot) ankle deformities who were treated with a retrograde locked intramedullary nail. Nineteen of the 21 ankles went on to fusion at an average of 20 months. In ten of the patients, the talus was retained. There were 6 patients who developed late postoperative wound infections, of which, 3 required removal of the nail. One patient with an infection elected to undergo an ankle disarticulation. The authors stated that use of the retrograde locked intramedullary nail is an excellent method of obtaining ankle fusion in the Charcot patient.

Papa et al.<sup>11</sup> reported on 2 cases of tibiototalcalcaneal arthrodesis for intractable diabetic neuropathic arthropathy of the foot and ankle. One patient had a partial wound slough, but fused in 4 to 5 months. They preferred internal fixation for their patient population who are prone to infection. In another study by Papa et al.<sup>10</sup>, 13 patients underwent tibiototalcalcaneal fusion for posttraumatic osteoarthritis of the ankle and hind foot. They included patients who underwent pantalar arthrodesis, and the results were not separated for from each type of fusion. Eighty-one percent were much improved, but 95% had residual pain. Overall, the union rate was 86%, and the mean time to fusion was 14 weeks. The mean amount of shortening was 1.5 cm. There were 3 nonunions (pantalar and tibiototalcalcaneal). The authors found that their nonunion rate was low, considering that extended arthrodesis was performed. They concluded that it is a complex and technically demanding procedure but a reasonable alternative to amputation.

Felix and Kitaoka<sup>2</sup> report the result of 26 ankle arthrodeses performed for rheumatoid arthritis on 21 patients. In their series, tibiototalcalcaneal arthrodesis was performed in 12 ankles. They did not distinguish

results of the ankle arthrodesis from the tibiotalocalcaneal arthrodesis patients. Fixation was achieved with external fixation or internal fixation with multiple screws. Nearly all patients were satisfied, and union was achieved in 96%. Their union and complication rate were found to be comparable with rates for arthrodesis for posttraumatic and degenerative arthritis. The authors concluded that for the treatment of rheumatoid arthritis, arthrodesis provides more reliable long term function, and remains the standard of treatment. They also emphasize that patients be educated that they will not have a normal joint function and will continue to have limitations.

Rigid internal fixation with good bony apposition is important for successful fusion. Biomechanical analysis of hindfoot fixation using an intramedullary rod was compared to three cross-cannulated screws<sup>3</sup>. The intramedullary rod with one distal screw inserted provided more stiffness to the hindfoot. We prefer the use of the intramedullary rod when possible. External fixation may be used if the bone stock is insufficient. Autogenous corticocancellous bone graft may be necessary with severe bone deficits.

The time to fusion in this study, 19 weeks, is prolonged as compared to ankle arthrodesis (13.8 weeks)<sup>7</sup>. This is not surprising because the patients in this study had more severe disease. In a retrospective study on arthrodesis of 81 ankles by Mann and Rongstad<sup>7</sup>, there were 10 nonunions, (12%). The average postoperative score for ankle-hindfoot on the AOFAS evaluation was 74 points, and the rate of the patient satisfaction was 65 (89%) of the 73 patients. In our study, the AOFAS clinical rating system score was consistent with expectations of improved pain and function but with some residual limitations. Many of these patients have co-morbidities that further limit function, such as rheumatoid arthritis. Also, with extensive disease there is usually soft-tissue problems that affect healing and symptoms.

The scores obtained in this study will be helpful to compare to longer follow-up studies for this procedure. In addition, these values may be used to compare to other procedures involving the ankle and subtalar joints, for example, combined total ankle replacement and subtalar arthrodesis.

The position of the tibiotalocalcaneal arthrodesis is extremely important as with other fusions of the foot and ankle. The optimum position is neutral flexion and 5 degrees of valgus, and 5 to 10 degrees of external rotation.<sup>1</sup> The final result of fusion is dependent on the bony cuts and quality of the bone stock. It is not uncommon for bone affected by chronic disease such as posttraumatic arthritis or rheumatoid arthritis to have some shifting or settling during the healing

process. Rigid internal fixation may help to avoid this situation. The average amount of shortening of the operated limb was 1.4 cm, and was tolerable for most of the patients. Most did not require a heel lift.

The most common complications with arthrodesis of the foot and ankle are infection, skin slough, neuroma, nonunion, or malunion.<sup>6</sup> The postoperative complication is higher for tibiotalocalcaneal arthrodesis because of previous operations, loss of adequate bone stock, and co-morbidities. The incidence of nonunion in this study is similar to other reports of this procedure. The incidence of infection was slightly higher than seen with ankle fusions. This probably is caused by already compromised soft tissue of the foot and ankle that limits healing capacity. Thus, it is important to evaluate the patient's vascular status and note the risk of complications.

## CONCLUSION

Tibiotalocalcaneal arthrodesis is a salvage operation to treat a difficult problem; normal function is not expected with arthrodesis of these two major joints. However, it can be concluded that it is a good treatment option to improve pain and function. As stated by previous studies, we emphasize that patients must be informed that they will not have a normal joint and will continue to have limitations.

## REFERENCES

1. **Buck P, Morrey BF, Chao EYS:** The optimum position of arthrodesis of the ankle: A gait study of the knee and ankle. *J. Bone Joint Surg.*, **69A**:1052-1062, 1987.
2. **Felix NA, Kitaoka HB:** Ankle arthrodesis in patients with rheumatoid arthritis. *Clin. Orthop.*, **349**:58-64, 1998.
3. **Fleming SS, Moore TJ, Hutton WC:** Biomechanical analysis of hindfoot fixation using an intramedullary rod. *J. Southern Orthop. Assoc.*, **7**:19-26, 1998.
4. **Kile TA, Donnelly RE, Gehrke JC, Wener ME, Johnson KA:** Tibiotalocalcaneal arthrodesis with an intramedullary device. *Foot Ankle Int.*, **15**:669-673, 1994.
5. **Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M:** Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int.*, **15**:349-353, 1994.
6. **Mann RA:** Arthrodesis of the foot and ankle. In Mann RA, Coughlin MJ (eds.), *Surgery of the Foot and Ankle*, Ed. 6. St. Louis, C.V. Mosby, 1993, pp. 673-713.
7. **Mann RA, Rongstad KM:** Arthrodesis of the ankle: A critical analysis. *Foot Ankle Int.*, **19**:3-9, 1998.
8. **Mann RA, Van Manen JW, Wapner K, Martin J:** Ankle fusion. *Clin. Orthop.*, **268**:49-55, 1991.
9. **Moore TJ, Prince R, Pochatko D, Smith JW, Fleming S:** Retrograde intramedullary nailing for ankle arthrodesis. *Foot Ankle Int.*, **16**:433-436, 1995.
10. **Papa JA, Myerson MS:** Pantalar and tibiotalocalcaneal arthrodesis for post-traumatic osteoarthritis of the ankle and hind foot. *J. Bone Joint Surg.*, **74A**:1042-1049, 1992.
11. **Papa JA, Myerson MS, Girard P:** Salvage, with arthrodesis, in

- intractable diabetic neuropathic arthropathy of the foot and ankle. *J. Bone Joint Surg.*, **75A**:1056-1066, 1993.
12. **Pinzur MS, Kelikian A**: Charcot ankle fusion with a retrograde locked intramedullary nail. *Foot Ankle Int.*, **18**:699-704, 1997.
13. **Russotti GM, Johnson KA, Cass JR**: Tibiotalocalcaneal arthrodesis for arthritis and deformity of the hind part of the foot. *J. Bone Joint Surg.*, **70A**:1304-1307, 1988.