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Charcot Ankle Fusion with a Retrograde Locked Intramedullary Nail

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ABSTRACT

Twenty patients with severe neuropathic (Charcot) ankle deformities underwent 21 attempted ankle fusions with a retrograde locked intramedullary nail as an alternative to amputation. All had insensate heel pads and had failed at nonoperative methods of accommodative ambulatory bracing. In 11, the talus was either absent, or the deformity was of sufficient magnitude to require talectomy to align the calcaneus under the tibia for plantigrade weightbearing. Ages ranged from 28 to -68 (average 56.3) years. Nineteen were diabetic, 12 being insulin-dependent. Their average body weight was 102 kg, with 11 greater than 90 kg at the time of surgery. Eight had chronic large full thickness ulcers overlying, but not involving bone of the medial malleolus, medial midfoot, or proximal fifth metatarsal, at the time of surgery.

At a follow-up of 12 to 31 months, 19 achieved bony fusion. In the 10 patients where talectomy was not required, fusion was achieved at an average of 5.3 months without complications. In the patients who required talectomy, six of the patients required eight additional operations to achieve fusion. Three achieved fusion following removal of the nail and prolonged bracing. One opted for ankle disarticulation for chronic persistent infection, rather than attempt reoperation. One died of unrelated causes during the early postoperative period.

Retrograde locked intramedullary ankle fusion is a reasonable alternative to amputation in the neuropathic (Charcot) ankle that cannot be controlled with standard bracing techniques. The potential for morbidity requiring reoperation is greatly increased when the deformity is of sufficient magnitude to require talectomy to achieve alignment of the calcaneus in a plantigrade weight-bearing position under the tibia or when there are large open ulcers.

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INTRODUCTION

The management of neuropathic (Charcot) arthropathy of the foot and ankle remains controversial. Neurovascular, or neurotraumatic etiologies have been proposed, describing the rapid development of significant bony deformity of the foot and/or ankle. This major alteration in bony architecture applies loading and shearing forces during weightbearing to nonplantar skin and soft tissue in areas of the foot and ankle that do not have the ability to tolerate these forces.[4,6,7] This leads to tissue breakdown, ulceration over bony prominences, and the subsequent development of contiguous osteomyelitis.

Almost all of the patients that develop neuropathic (Charcot) deformity will develop bony deformity at the level of the midfoot. The vast majority can be successfully treated over a prolonged period of time with patient education, local footcare, accommodative shoe gear, and custom foot orthoses.[1,10] When accommodative methods do not prevent tissue breakdown and ulceration, and allow patients to walk with their foot in a plantigrade position, or when patients develop recurrent tissue ulceration, surgical correction of deformity is indicated. The goal of surgery is to provide, via bony stabilization or attempted fusion, a plantigrade foot supported by a viable and durable soft tissue envelope.[2,5,10,11,13] Once a stable, plantigrade foot has been obtained, the bending forces occurring during mid and terminal stance phases of gait can be accommodated by a combination of inlay depth shoe gear, custom pressure-dissipating accommodative foot orthoses, cushion heal, and rocker bottom sole.

The neuropathic (Charcot) ankle offers a significantly greater biomechanical challenge because of the long moment arm applied during terminal stance phase and the poor structural quality of host bone. This combination would make a locked intramedullary device appear to offer the soundest biomechanical construct to achieve stable, secure fixation, and ultimate ankle fusion. Retrograde locked intramedullary nailing has recently been shown to achieve ankle fusion as treatment for severe ankle arthritis, and other neuromuscular deformities where sacrifice of the talocalcaneal joint is justified to achieve rigid stabilization of the ankle and hindfoot.[8,9]

Although this device appears to be ideally designed for this difficult patient population, Kile et al.[8] had only one patient in their series, and Moore et al.[9] reported pseudarthrosis in two of seven neuropathic (Charcot) ankles. The goal at the inception of this project was to attempt surgical stabilization of the ankle and hindfoot in a consecutive series of patients with neuropathic arthropathy of the ankle who had failed rigorous nonoperative accommodative methods. The attempted fusion was offered to all of the patients in this group as an *alternative* to ankle disarticulation.

METHODS

Twenty-one ankle fusions with retrograde locked intramedullary nails were attempted in 20 consecutive patients with severe neuropathic (Charcot) deformity of the ankle, in all cases, as an alternative to amputation. After informed consent, three similar patients opted for elective ankle disarticulation during the period of the study. There were 11 women and 9 men. The average age of the patients was 56.3 years (range 28–68 years). Nineteen were diabetic, with 12 being insulin-dependent for an average of 16.8 years (range 4–30 years). One patient had an incomplete diplegic paraplegia with diminished sensation because of a congenital spine deformity. Most of the patients were morbidly obese. The average body weight at the time of surgery was 95.5 kg (range 51–181 kg), with 14 weighing greater than 90 kg. Eight of the patients had large full-thickness ulcers in the region of the foot where they were bearing weight; however, no bone was exposed. Radiographs of the underlying bone showed no evidence of contiguous osteomyelitis. None of the patients had evidence of vascular insufficiency, as neuropathic (Charcot) arthropathy is characterized by increased blood flow and proliferative hypertrophic, hypervascular granulation tissue at the site of disease expression.

Surgical Technique

Patients were positioned supine on a standard operating table. When ulcers were present on the surgical extremity, surgery was delayed and local wound care including debridement and frequent dressing changes were performed until the ulcers had a healthy appearing granulation base, had no exposed bone, and did not appear to be clinically infected. At the time of surgery, a standard 5-minute providone-iodine scrub preceded spraying the limb with providone-iodine solution. Tissue at the base of the ulcers, bone underlying the ulcers, and tissue from the neuropathic (Charcot) joints were cultured. Positive cultures were treated with parenteral culture-specific antibiotic therapy for 6 weeks, followed with a minimum 6 weeks period of culture-appropriate oral antibiotic therapy.

Surgery was performed through medial and lateral incisions overlying the malleoli. The lateral malleolus was excised just above the joint line, and the medial malleolus was obliquely divided just proximal to the joint line and excised. The articular surface of the distal tibia was removed perpendicular to the axis of the tibia with a power saw. When the talus was present, a power saw was used to remove the articular surface and fashion a flat surface to maximize bony contact with the tibia. The proposed position of the calcaneus was directly underneath the tibia in the frontal plane, eliminating the normal ankle valgus, mindful of the fact that normal anatomy was grossly distorted and most of the patients were morbidly obese. Calcaneal positioning underneath the tibia was often dictated by the availability of dynamically acceptable bone. Under fluoroscopic control, a 1/8-inch Kirschner wire was used as a guide drilled retrograde through the plantar surface of the calcaneus proximally into the medullary canal of the tibia. Cannulated reamers were then passed over the guide wire prior to driving the nail up through the calcaneus. The calcaneus was underreamed by 1 mm, and the tibia was overreamed by 0.5 mm. The final tibial reaming was performed directly through the most accessible surgical incision. Initially, the surgery was performed with a proximally curved nail designed for use in the distal femur (Smith & Nephew Richards, Memphis, TN). Later patients were treated with a straight version designed specifically for ankle fusion with two or three holes being available for distal locking. (Revision Nail, Smith & Nephew Richards) By using fluoroscopy, the end of the nail was impacted flush with the plantar surface of the calcaneus. The insertion/aiming device allows insertion of the percutaneously placed locking screws without routine fluoroscopy. Placement of the nail and locking screws were checked fluoroscopically before wound closure.[14]

When the talus was absent because of the disease process, or when the deformity was of sufficient magnitude to necessitate talectomy to align the calcaneus under the tibia, the procedure was modified to the specifics of the individual patient. The initial nail (designed for treating supracondylar femur fractures) allowed placement of one transverse distal locking screw in the calcaneus and one in the talus. An early adaptation was performed in three patients where the talus was absent or removed, or when the calcaneal

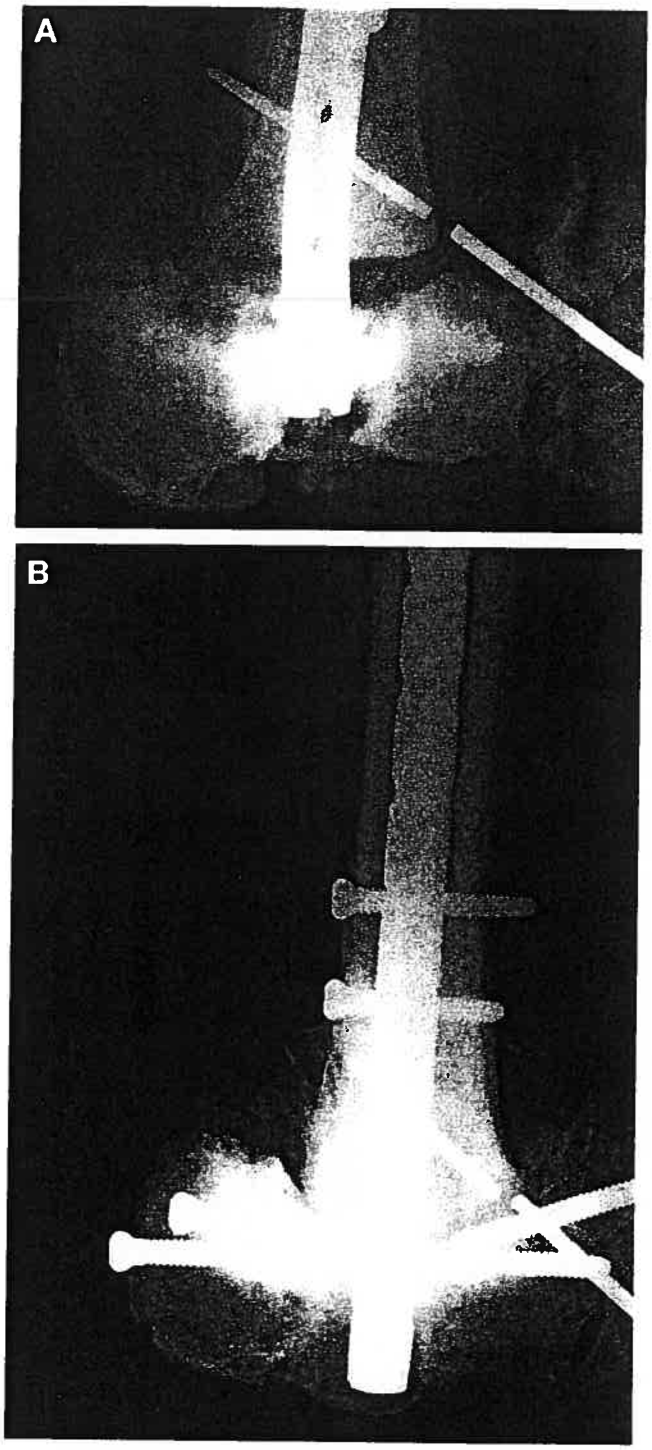

Fig. 1. Fifty-eight-year-old, insulin-dependent, 90-kg, type-II diabetic. *A*, Poor distal fixation was achieved in this osteopenic calcaneus with excised talus. *B*, Radiographic fusion after surgical revision and protected weightbearing.

bone was extremely osteopenic. In these patients, the nail and aiming/insertion device were rotated 90° to allow percutaneous placement of long locking screws from posterior to anterior (Fig. 1). Removed bone was morselized and packed about the fusion site.

After bony stabilization, the remaining ulcers were excised, when possible, lessened in size, or debrided. Wound management was accomplished with providone-iodine saturated gauze dressings that were changed weekly at the time of case changes. Skin staples were used for wound closure and were never removed before 3 weeks after surgery. Postoperatively, the limbs were immobilized in a short leg cast for 8–12 weeks. Weight bearing was delayed, if possible, for 6–8 weeks. Because of their large body mass, many of the patients were incapable of remaining nonweightbearing.

RESULTS

Nineteen of the 21 ankles progressed to fusion at an average of 20 months (range 3–31 months). The talus was retained in ten of the patients, allowing sufficient distance for two distal locking screws. These patients progressed to clinical and radiographic fusion at an average of 5.3 months (range 3–8 months). One of the patients in this group died during the early postoperative period because of unrelated causes. None of the other patients had complications (Fig. 2).

Eleven of the patients had either an absence of the talus, or their deformity was of sufficient magnitude that placement of the calcaneus underneath the tibia could only be accomplished following talectomy. Eight of these patients had large full-thickness ulcers overlying the ends of the medial or lateral malleoli, medial surface of the midfoot, or proximal fifth metatarsal where they had been weightbearing in their accommodative shoes/orthoses. Three required revision of their surgery with 90° rotation of the nail and distal locking screws to accomplish improved distal fixation. Six developed late postoperative wound infections. Two resolved with incision and drainage combined with culture-specific antibiotic therapy. Three required nail removal, all achieving eventual fusion without evidence of deep infection, after nail removal, debridement, culture-specific antibiotic therapy, and prolonged cast immobilization or protective bracing. One patient elected ankle disarticulation rather than attempted surgical revision. (Fig. 3)

DISCUSSION

The midfoot is the most common location for the development of neuropathic (Charcot) deformity. This is most likely explained by the magnitude of indirect bending force applied to the ankle during mid and terminal stance phases of gait. After correction of midfoot deformity, large cancellous bone screws ap-

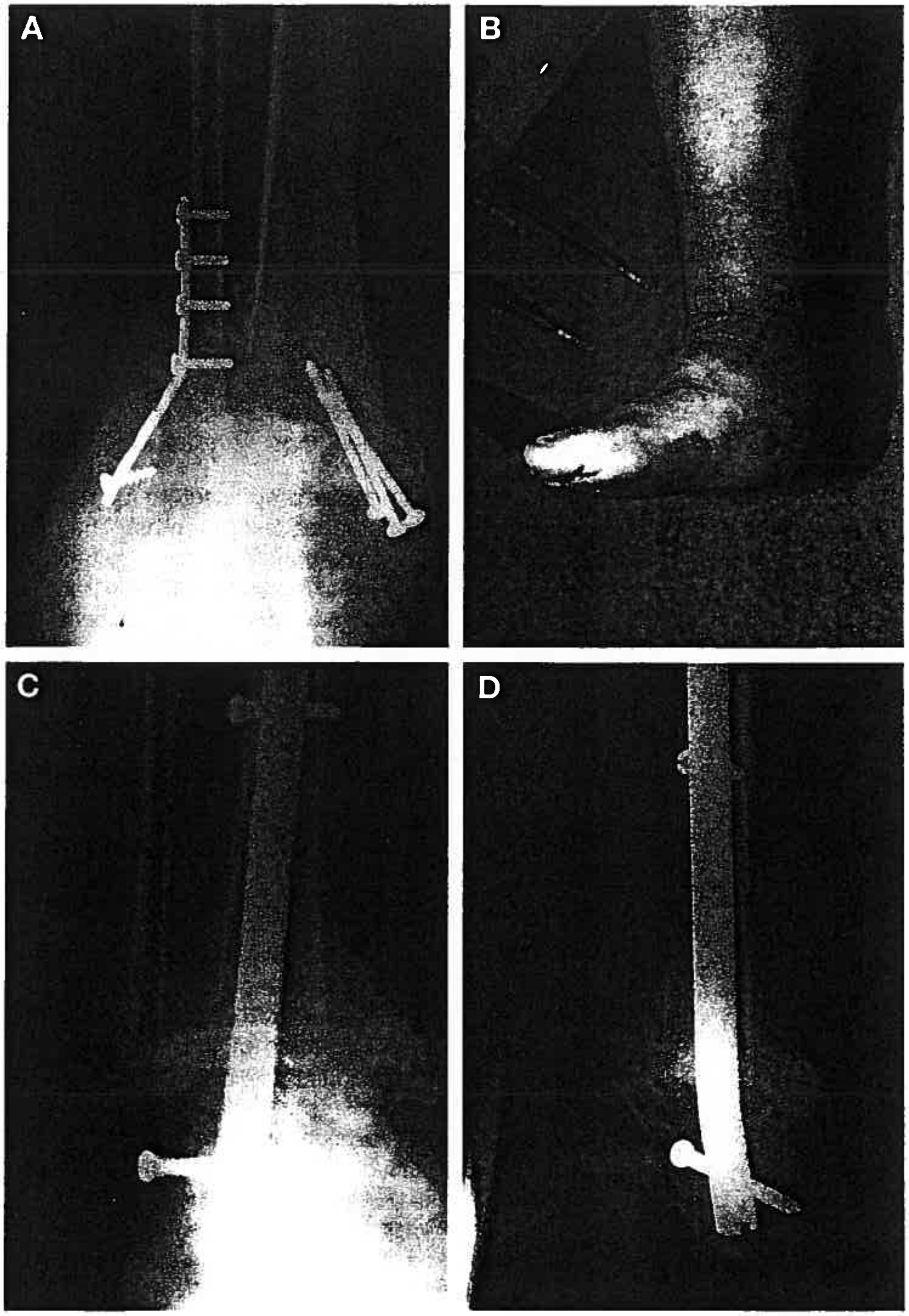

Fig. 2. Sixty-three-year-old, insulin-dependent, 95-kg, type-II diabetic. *A*, Radiograph at presentation after open reduction of simple ankle fracture. *B*, Wagner grade 0 foot. *C*, *D*, radiographs 6 months after ankle fusion.

pear to offer sufficient stability to achieve bony stabilization and ultimate fusion.[12,13] It is well accepted that ankle fusion is difficult to achieve in the neuropathic (Charcot) ankle because of the poor dynamic quality of the native bone and the inability to achieve a stable biomechanical construct with screws, plates, or external fixeters. This high potential for mechanical failure has fostered interest in the application of locked intramedullary nailing as a method of achieving rigid internal fixation and eventual fusion in this difficult subpopulation of patients.

The results of this series reveal that retrograde locked intramedullary nailing is an excellent method of achieving ankle fusion in the neuropathic (Charcot) patient, with a low potential morbidity, when the talus can be reduced under the tibia. When the talus has been destroyed by the disease process, or the deformity is so severe that talectomy is necessary to

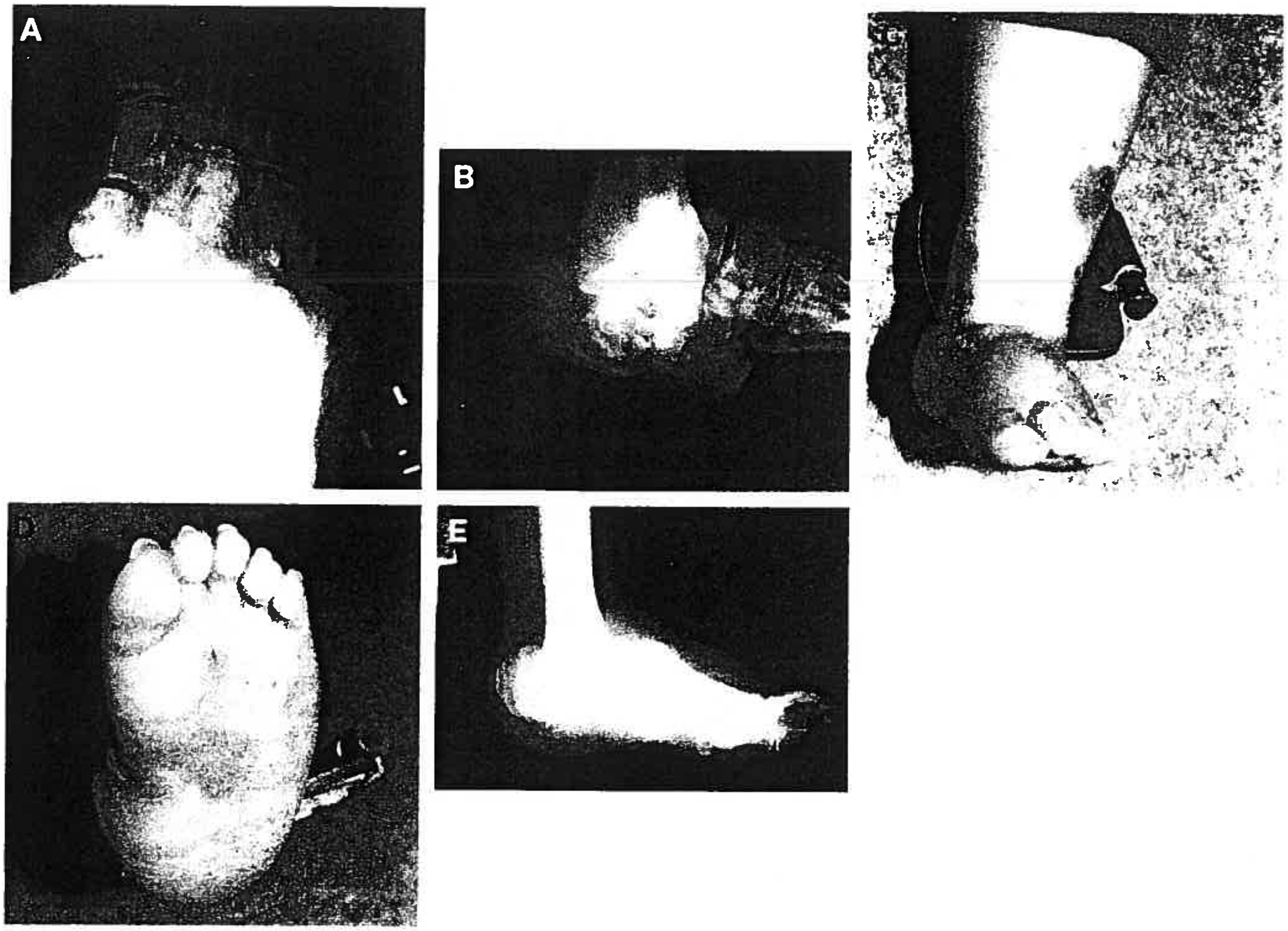

Fig. 3. Fifty-seven-year-old, insulin-dependent, blind, 110-kg, type-II diabetic patient with progressive deformity of the ankle that was not controllable with a custom-contoured total contact bivalved polypropylene ankle-foot orthosis (CROW Walker). *A, B,* weight-bearing radiographs before surgery. Because of persistent post-operative drainage, the nail was removed, weightbearing was allowed in a walking cast, and parenteral culture-specific antibiotics were used for 12 weeks. *C, D,* Wagner grade 0 foot and (*E*) radiograph at 1 year after surgery.

achieve positioning of the calcaneus in a plantigrade weightbearing position, the potential for mechanical failure is greatly increased. In these patients, ankle disarticulation should be seriously considered before embarking on an attempted fusion, as failure might necessitate transtibial amputation as opposed to Syme ankle disarticulation. Ankle fusion should be considered as an alternative to amputation, and that a high probability for complication exists. The dynamic quality of the calcaneal bone, the proliferative inflammatory process, and/or the persistence of infection, makes achieving a functionally acceptable result even more difficult in this difficult subpopulation of patients. On occasion, we have enhanced bony fixation by rotating the nail 90° and directing the distal locking screws from posterior to anterior. In these patients, serious consideration of ankle disarticulation should be entertained before embarking on an attempted fusion, as failure might necessitate transtibial amputation as opposed to Syme's ankle disarticulation.

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