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Case Reports and Series

An Innovative Approach to the Repair of Distal Tibia Nonunion Using a Retrograde Buried Tibio-Talar-Calcaneal Nail: A Case Report

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A R T I C L E I N F O

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A B S T R A C T

We report a case using retrograde tibial nailing as treatment of nonunion of a distal tibial osteotomy, which was performed as part of a complex reconstruction of distal tibial malunion with ankle arthritis. Although retrograde nailing has classically been used for tibial-talar-calcaneal arthrodesis, this method spares the subtalar joint. Preservation of some hindfoot motion by subtalar mobility allows for a decrease in the loss of function typically seen with tibial-talar-calcaneal arthrodesis.

The distal tibia is a common site of nonunion (1). The factors contributing to nonunion include fracture instability, interruption of the blood supply, infection, metabolic abnormalities, subordination of fracture healing to soft tissue coverage, fracture gapping, the degree of periosteal stripping, and nicotine use (2–7). Research has suggested that stabilization and an adequate blood supply are critical determinants of successful bone healing and repair, although often it is a combination of factors that result in nonunion (3,5–9).

Various methods of fixation have been successfully used in the treatment of tibial nonunions. Compared with bracing and external rigid fixation by casting, these methods provide mobility at the joints above and below, thereby minimizing the severity and level of atrophy, loss of range of motion, and other associated complications of fracture healing (4). However, Connolly (9) demonstrated that rigid fixation techniques, including plating, screws, and prolonged external fixation, contribute to maintenance of a fracture gap and prevent fracture compaction, both of which decrease healing and minimize the formation of the external callus necessary for union. In addition, the periosteal stripping that occurs with repair methods such as plating reduces the blood flow by removal of the periosteal circulation entering at the ligamentous and soft tissue attachments on the tibia (3). Other disadvantages of these methods include the inability for full weightbearing. Supportive treatment of nonunion, including electrical stimulation, low-intensity ultrasound therapy, and bone grafting, can be used as supplements to decrease the rate of nonunion (4,13,14).

Alternatively, fixation can be obtained with an intramedullary nail, which has been shown to result in successful union almost 90% of the time (10–12). Unlike compression plating and other methods of fixation, full weightbearing can be allowed postoperatively, allowing for compaction with maintenance of stability and a decreased risk of fracture gapping (4). Usually, the nails are placed using an anterograde approach. In the present case, a novel retrograde intramedullary nailing approach was used to achieve union. Typically, this approach has been reserved for tibial-talar-calcaneal arthrodesis. However, in this instance, it served as a unique and effective variation to treat a tibial nonunion.

Case Report

A 68-year-old male presented to the office of the senior author (M.R.) with a secondary deformity of the right lower leg (resulting from malunion of a distal tibial fracture) and pain in the ankle. Radiographs revealed severe recurvatum of the tibia and fibula (Fig. 1). Secondary to the recurvatum, severe post-traumatic arthritis had developed in the ankle joint. To have a plantigrade foot, a fixed severe equinus deformity had occurred at the ankle joint.

The patient underwent an index operative correction with posterior closing wedge osteotomy of the tibia and fibula to correct the angular deformity. An anterior approach was used to perform an isolated ankle arthrodesis to maintain subtalar motion. An anterior plate was used for the fusion, which also crossed the osteotomy site. Finally, the patient underwent simultaneous tibial-talar arthrodesis and supramalleolar posterior closing wedge osteotomy (Fig. 2).

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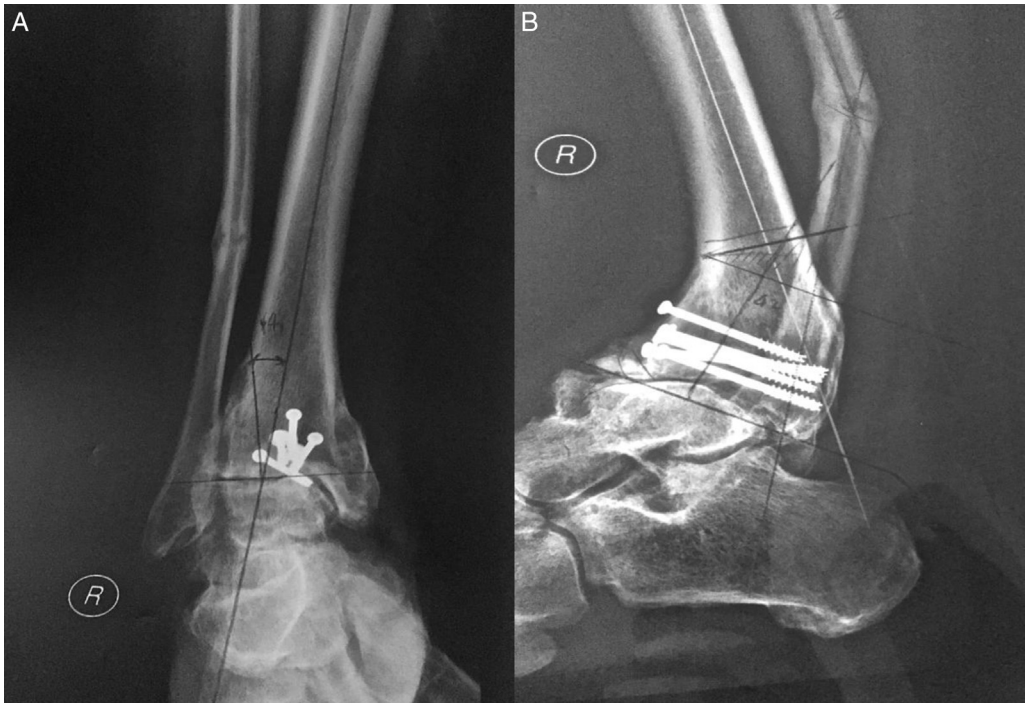

Fig. 1. Preoperative clinical radiographs. (*A*) Anteroposterior radiograph of tibial malunion. Note screws from previously performed operation, which resulted in malunion. (*B*) Lateral radiographs demonstrating tibial malunion and recurvatum of right tibia and fibula. The screws seen represent those from the initial operation to correct the original fracture, which resulted in malunion. Also note severe post-traumatic arthritis of the tibio-talar joint secondary to tibial angulation. Posterior wedge osteotomy was performed to correct the deformity. Dark lines represent the axes of the proximal and distal segments of tibia and were used to determine the size of the osteotomy performed.

The 2-month postoperative follow-up visit revealed a solid ankle arthrodesis and distal tibial nonunion at the site of the posterior wedge osteotomy. Radiographs revealed failure of 2 screws on the anterior plate (Fig. 2). The patient was treated with casting and electric external bone growth stimulation; however, the nonunion remained persistent 5 months postoperatively.

In a second-stage operation, the hardware was removed. The distal tibial nonunion was treated by a retrograde nail designed for tibial-talar-calcaneal arthrodesis, which buried in the talus, engaging the arthrodesed tibial talar segment and tibial shaft, bypassing the calcaneus, and sparing the subtalar joint (Fig. 3). The nail was placed through an incision in the plantar surface of the right foot, giving access to the plantar calcaneal surface.

Reamers and the nail were passed through the calcaneus and talus anterior to the posterior facet, preserving the integrity of the subtalar joint. Reaming crossed the nonunited tibial segment. Proximal and distal interlocking screws were placed to provide rotational stability. The retrograde approach acted as a method of internal fixation for the distal tibial nonunion. An internal electrical bone stimulator was also placed to further potentiate successful union.

At the 1-month follow-up visit, radiographs revealed external callus formation, indicative of healing. By 2 months postoperatively, radiographs demonstrated successful union of the distal tibia osteotomy. The recurvatum deformity of the leg had also been corrected. At the 2-year follow-up visit, the patient had 50% subtalar motion, centered in neutral and functional.

Discussion

The main goal of the operative correction was to revise the plating of a posterior wedge osteotomy and tibial-talar arthrodesis that had resulted in distal tibial nonunion and successful fusion of the joint. In the second operative procedure, a retrograde tibial intramedullary nail was placed through the calcaneus and buried in the talus, continuing into the tibia and resulting in bypass of the calcaneus and preservation of the subtalar joint. This innovative approach, combined with an internal electrical bone growth stimulator, resulted in tibial union at the 8-week follow-up point.

Bypassing the calcaneus and burying the intramedullary nail into the talus preserved the integrity of the subtalar joint, despite passing the nail through the calcaneus and posterior talocalcaneal joint and into the talus. Protection of the subtalar joint, also known as the lesser ankle joint (15), preserves some degree of mobility of the hindfoot in patients who have undergone fusion of the tibial–talar joint compared with standard retrograde intramedullary nail tibio-talar-calcaneal arthrodesis.

The subtalar joint consists of 3 articulating surfaces between the talus and calcaneus, known as the anterior, middle, and posterior surfaces. Often, the anterior and middle facets are seen as 1 surface; however, other anatomic variations include 3 separate or 1 continuous surface (15). Owing to the shape of the posterior facets, the motion at the subtalar joint does not occur on a fixed hinged axis, but rather in an oblique plane, with a mobile axis allowing shift and glide of the joint (16,17). The motion produced at the subtalar joint is flexion-supination-adduction or extension-pronation-abduction (16,18). Sealy et al (19) have demonstrated that an increase in sagittal motion occurs at the hindfoot subtalar joint and midfoot medial column that allows for improved function and quality of life postoperatively.

In conclusion, retrograde buried tibial nailing proved to be an effective and novel method of internal fixation for distal tibial osteotomy nonunion. No further impairment of range of motion occurred because the rod only engaged the talus and tibia, which had previously undergone arthrodesis, bypassing the calcaneus and subtalar joint. The spared subtalar joint, along with the medial column,