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Effect of Retrograde Reaming for Tibiotalocalcaneal Arthrodesis on Subtalar Joint Destruction: A Cadaveric Study

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ABSTRACT

Recent published data have suggested successful union of subtalar and tibiotalar joints without formal debridement during tibiotalocalcaneal (TTC) fusion procedures. Although previous studies have reported on the importance of the proper guidewire starting point and trajectory to obtain appropriate hindfoot alignment for successful fusion, to our knowledge, no studies have quantified the amount of articular damage to the subtalar joint with retrograde reaming. We hypothesized that reaming would destroy >50% of the posterior facet of the subtalar joint. The bilateral lower extremities of 5 cadavers were obtained and the subtalar joints exposed. Retrograde TTC nail guidewires were inserted, and a 12-mm reamer was passed through the subtalar and ankle joints. Pre- and postreaming images of the subtalar joint were obtained to compare the amount of joint destruction after reaming. We found an average of 5.89% articular destruction of the talar posterior facet and an average of 4.01% articular destruction of the posterior facet of the calcaneus. No damage to the middle facets of the subtalar joint was observed. TTC nailing is a successful procedure for ankle and subtalar joint fusion. Published studies have reported successful subtalar union using TTC nailing without formal open debridement of the subtalar joint, preserving the soft tissue envelope. TTC nail insertion using a 12-mm reamer will destroy 5.89% and 4.01% of the respective talar and calcaneal posterior facets of the subtalar joint.

Severe arthrosis and deformity of both ankle and subtalar joints are common causes of pain and morbidity in patients. Tibiotalocalcaneal (TTC) arthrodesis is a technique commonly used for the treatment of pain and deformity of ankle and subtalar joints. Fusion of the tibiotalar and subtalar joints is a reliable surgery designed to provide pain relief, rapid healing, and a return to function through a stable plantigrade fusion mass (1–4).

TTC arthrodesis can be a technically demanding surgery, because patients often have a compromised soft tissue envelope from metabolic disease, trauma, or previous surgeries. Multiple fusion techniques have been described, including screw fixation, blade–plate constructs, external fixators, and intramedullary devices (5,6). Of the many types, the blade–plate and retrograde intramedullary nail constructs have been the most successful (2,3,6–13). In patients predisposed to wound complications, greater emphasis has been placed on minimally invasive techniques to achieve successful arthrodesis (2,3,8–10,12,13).

Despite using minimally invasive retrograde intramedullary nail constructs, current surgical techniques recommend formal subtalar and tibiotalar articular debridement to promote successful union. Formal joint debridement, however, requires greater surgical dissection, which prolongs the operative time and increases the risk of soft tissue insult, in particular, damaging the contents of the tarsal tunnel and peroneal tendons. Mader et al (2,3) reported that retrograde reaming of the subtalar joint leads to solid clinical and radiographic union of the subtalar joint without formal debridement of the subtalar joint.

Hyer and Cheney (14) performed a cadaveric study to evaluate the importance of the guidewire starting point for achieving correct hindfoot alignment to allow successful fusion. Using antegrade guidewire placement from the tibia through the ankle and subtalar joints, the investigators reported 70% of guidewires entered the tibiotalar joint lateral to the midline of the talus. This can cause the nails to miss the talus, violate the lateral talar wall, or miss the medial body of the calcaneus, thereby influencing the success of the fusion obtained (14). We were unable to find any English language publications quantifying the degree of subtalar joint destruction achieved with retrograde intramedullary reaming of the subtalar joint. The purpose of the present cadaveric study was to assess the percentage of posterior and middle facets of the subtalar joint that are affected by

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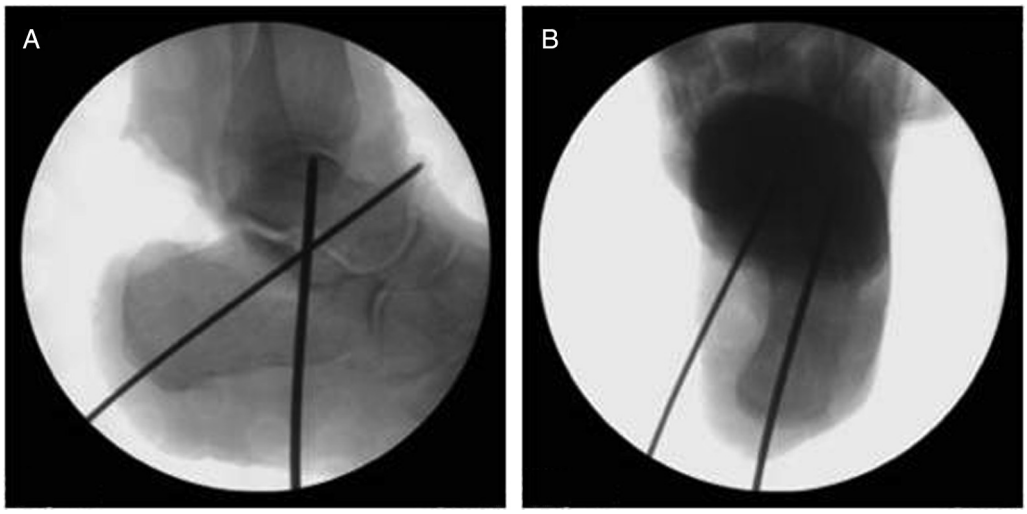

Fig. 1. (*A*) Harris heel and (*B*) lateral foot fluoroscopic radiographs demonstrating guidewire placement before reaming.

retrograde intramedullary reaming. We hypothesized that reaming of the subtalar joint, associated with the TTC fusion nail, would result in destruction of >50% of the articular surface of the posterior facet and <10% of the middle facet.

Materials and Methods

Five pairs of lightly embalmed cadaver legs were obtained and transtibial amputation was performed, yielding 10 specimens. The donors consisted of 5 female cadavers, age range 61 to 96 years. Any history of traumatic ankle and hindfoot injuries were unknown to us.

After transtibial amputation, the subtalar joint of each cadaveric specimen was dissected and exposed, with attention given to avoiding articular facet destruction. Three-dimensional images using the Eykona® camera (Eykona Medical Ltd., Oxford, UK) were obtained of the talar and calcaneal posterior and middle facets. Using the Eykona® Wound Measurement System software (Eykona Medical Ltd.), the surface area of the posterior facet was calculated.

The subtalar joints were reduced for optimal fusion, with neutral ankle flexion, 5° of hindfoot valgus, and 10° of external rotation. Using fluoroscopy (model no. OEC 9600; General Electric, Fairfield, CT), a 4.2-mm, center-tipped drill was placed retrogradely through the calcaneus and subtalar joint and into the tibia. The guidewire position was confirmed on anteroposterior, lateral, and axial images (Fig. 1). A 12-mm opening reamer (Stryker® T2 Ankle Arthrodesis Nail System, Stryker®, Mahwah, NJ) was passed over the wire up to the tibia using fluoroscopic guidance (Fig. 2). The reamers were removed and the subtalar joints imaged again using the Eykona® camera. The cross-sectional area of the posterior and middle facets violated with the reamer was calculated.

The measured differences in articular debridement of the talar and calcaneal posterior and middle facets using standard retrograde reaming were determined and presented as a percentage of total joint destruction.

Fig. 2. Lateral foot fluoroscopic radiograph demonstrating 12-mm reamer within the subtalar joint.

Results

Retrograde reaming using a 12-mm opening reamer (Stryker® T2 Ankle Arthrodesis Nail System, Stryker®) was performed on a sample of 5 paired subtalar joints, with attention to the amount of articular debridement of the talar and calcaneal posterior and middle facets (Fig. 3).

The mean native surface area of the talar posterior facet was 5.873 ± 0.844 (range 4.45 to 6.92) cm^2. After reaming with a 12-mm reamer, the resultant mean surface area of the talar facets was 5.552 ± 0.976 (range 3.46 to 6.55) cm^2. The mean amount of joint destruction was 0.321 ± 0.246 (range 0.15 to 0.99) cm^2. This represented 5.886% of the posterior of the talus destroyed. The middle facet was not damaged in any of the specimens.

The mean native surface area of the calcaneal posterior facet was 5.564 ± 1.001 (range 3.48 to 6.43) cm^2. After reaming with a 12-mm reamer, the resultant mean surface area of the calcaneal facets was 5.346 ± 1.004 (range 3.41 to 6.30) cm^2. The mean area of posterior facet damage was 0.218 ± 0.1046 (range 0.07 to 0.36) cm^2. This represented 4.012% of the calcaneal surface of the subtalar joint destroyed, again without damage to the middle facet in any of the specimens.

Discussion

Patients with advanced ankle and subtalar arthritis present a difficult therapeutic challenge. Severe arthritis and deformity cause considerable pain and functional disability, which, in many cases, respond poorly to nonoperative measures. Furthermore, operative management of these patients is particularly challenging, with nonunion and wound infections representing common complications associated with ankle arthrodesis procedures (2–4,15–18).

In their study, Frey et al (17) reviewed a series of 78 ankle arthrodeses and reported that complications occurred in 44 patients (56%) when followed up for an average of 4 years. Of these reported complications,