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Quantification of Subtalar Posterior Facet Involvement During Intramedullary Guidance of Total Ankle Arthroplasty: A Cadaveric Study

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ABSTRACT

Total ankle arthroplasty is an evolving treatment of ankle arthritis. One implant uses intramedullary guidance to enhance accuracy by accessing the tibial canal through the inferior aspect of the foot, potentially placing the subtalar joint articulation at risk. The purpose of the present cadaveric anatomic evaluation was to identify posterior subtalar articular facet joint involvement during intramedullary guidance to the tibial canal. Ten below-the-knee cadaveric specimens were used. After drilling into the tibial medullary canal with a 6-mm drill bit and using the standard targeting jig, the specimens were dissected, and the posterior facet was evaluated. We graded posterior facet involvement according to the location of the drill hole and, if within the facet, the percentage of the facet violated by the drill bit, with 100% representing the full circumference of the 6-mm drill bit. Of the 8 specimens in which the drill bit passed through the subtalar posterior articular facet, the encroachment was peripheral in all cases, with no specimen showing circumferential 6-mm drill bit articular penetration (no cases with 100%). Sinus tarsi penetration occurred in 20% of the cases. The dissections with articular involvement included 3 specimens with >50% of the drill bit penetrating and 5 with <50%. The portion of the posterior facet involved among the specimens that were violated was anterocentral in the joint. A risk of damage to the posterior facet of the subtalar joint exists with intramedullary total ankle systems. Our study has demonstrated that the drill bit will involve the anterocentral and anterolateral portions of the posterior facet of the subtalar joint, with <6 mm articular disruption in all cases.

Ankle arthritis is a debilitating process that can lead to pain, deformity, and decreased functional capacity. Unlike primary arthritis of the hip and knee, ankle arthritis typically results from trauma. Rodrigues-Pinto et al (1) found that 65% of the ankle arthritis of patients undergoing ankle arthroplasty was post-traumatic. This makes ankle arthritis unique compared with hip and knee arthritis for which primary osteoarthritis is more common.

Treatment of ankle arthritis ranges from nonoperative management, such as bracing, anti-inflammatory drugs, or injections, to operative options, such as ankle fusion or ankle replacement. The reference standard operative treatment for end-stage ankle arthritis is ankle arthrodesis; however, substantial complications have been associated with this procedure, including nonunion, malunion, and limited hindfoot motion, which can lead to increased stress and arthritis at the adjacent joints. Even when successful fusion has been obtained, some patients will be dissatisfied (2). It has been reported that 79% of patients have pain when walking on irregular surfaces, 75% have continued pain when walking up or down stairs, and 64% experience pain with prolonged activities (3). Adjacent joint arthritis can be expected to occur in 50% of patients 8 years after ankle arthrodesis and 100% of patients >20 years after ankle arthrodesis (4,5).

During the past decade, total ankle arthroplasty has evolved as an operative option to preserve ankle motion, function, and gait and to spare the adjacent joints from taking on more of the weightbearing stress. This resurgence in interest has created advances in ankle arthroplasty technology with design, biomechanics, and instrumentation for implantation seeing significant improvements since the first-generation implants in the 1970s.

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Conflict of Interest: Gregory C. Berlet and Christopher F. Hyer are paid consultants to Wright Medical Technology, Inc. (Arlington, TN).

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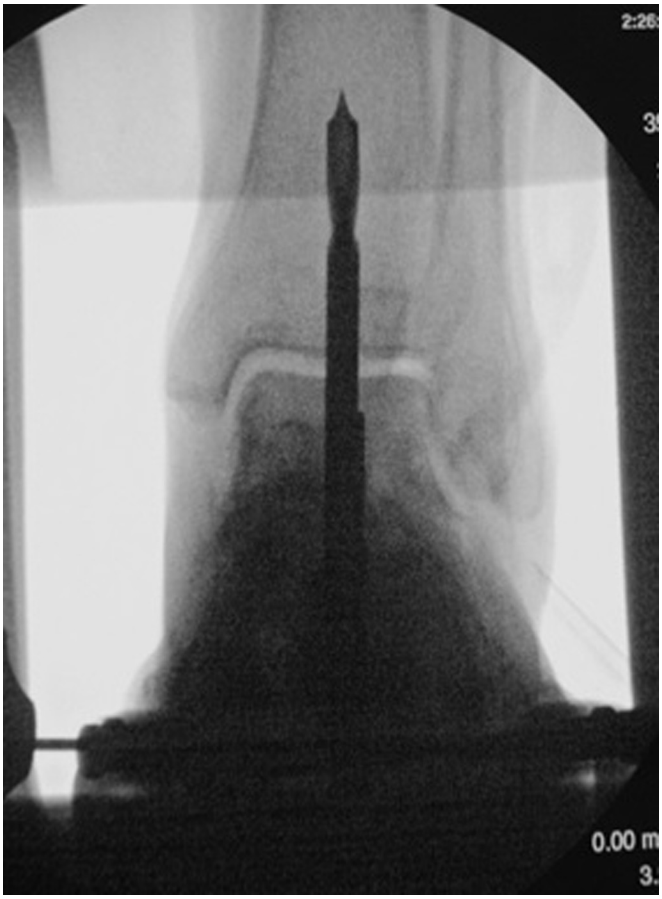

Fig. 1. Anteroposterior fluoroscopy during intramedullary guidance.

Fig. 2. Lateral fluoroscopy during intramedullary guidance.

Despite the improvements in technology for ankle arthroplasty, the question regarding adjacent joint arthritis remains. It is well known that some patients undergoing ankle arthroplasty already have preoperative adjacent joint arthritis and might or might not experience improvement after arthroplasty. However, patients will develop adjacent arthritis after ankle arthroplasty. Wood et al (6) found that 43% of their patients who had undergone extramedullary-guided ankle arthroplasty had had preoperative subtalar arthritis and 57% had not. Of the 57% who had not had preoperative subtalar arthritis, 15% had developed degeneration of the subtalar joint at the 5-year postoperative follow-up examination. The association of subtalar arthritis and total ankle arthroplasty is unclear; however, as the published data on total ankle arthroplasty increases, so will our understanding of adjacent joint arthritis.

In an effort to better understand the influence of an intramedullary drill guide used in total ankle replacement, we measured the percentage of the 6-mm drill that violated the posterior facet of the subtalar joint in cadaver specimens undergoing intramedullary instrumented total ankle replacement.

Materials and Methods

Using the standard surgical technique guide and instrumented jig for the intramedullary total ankle arthroplasty system, 10 fresh-frozen and thawed below-the-knee cadaveric specimens were studied at the San Diego Cadaver Anatomy Research Symposium. The mean age at death was 68.1 (66.5 $\pm$ 34) years. The specimens consisted of 3 females (30%) and 7 males (70%). No inclusion or exclusion criteria were used to choose the cadavers. Surgery was performed by fellowship-trained surgeons with extensive experience with the intramedullary-based system.

We used a large C-arm fluoroscopy machine to assist with the technique. Each specimen was positioned on the leg holder frame, and fluoroscopic images were taken to obtain an ankle mortise and lateral projection (Figs. 1 and 2). Once the images and positioning were satisfactory, the specimen was secured to the leg holder using guide pins and the Coban™ Self-Adherent Wrap (3M Corporation, St. Paul, MN). Next, the targeting arms for the system were aligned with the medullary canal of the distal aspect of the tibia as viewed on the mortise and lateral views. Once satisfactory alignment was achieved, an incision was made in the plantar hindfoot, and blunt dissection was continued down to the inferior aspect of the calcaneus. The 6-mm drill was then used to access the tibial canal using the "peck drilling" technique, as outlined in the technique guide. The drill bit traversed the calcaneus and talus. After placing the 6-mm drill into the tibial medullary canal on the anatomic axis, all instrumentation was removed from the specimen, and the specimen was removed from the leg holder. Each of the specimens was then carefully dissected, and the posterior facet of the subtalar joint was evaluated (Figs. 3 and 4). Photographs were taken of each specimen to document the involvement. The amount of posterior facet violation was graded according to the location of the drill hole in respect to the articular facet. If within the facet, we determined what percentage of the drill had encroached on the posterior facet. We assigned the percentage of 6-mm drill bit involvement as follows: (1) 0%, (2) $<$50%, (3) 50%, (4) $>$50%, and (5) 100%. These percentages were determined by connecting the 2 edges of the adjacent intact cartilage and estimating the void of cartilage in the area of the circle. We then identified which region of the posterior facet was involved: anterocentral, anteromedial, or anterolateral (Fig. 5).

Results

The prevalence of violation of the posterior facet by the drill bit was 80% (8 of 10 specimens). The remaining 2 specimens (20%) did not have articular facet damage; instead, the drill bit had passed in the nonarticular portion of the sinus tarsi. Of the 8 with non-sinus tarsi penetration, 5 (50%) had $\leq$50% encroachment of the 6-mm drill bit and 3 (37.5%) $>$50% encroachment. No specimens had 100% facet involvement.

The region of the posterior facet involved was consistent among all 8 specimens violated and was located anterocentral in the joint. The 2 specimens with no involvement of the posterior facet had drill holes