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Operative Techniques in
Orthopaedics

The INBONE Total Ankle Replacement

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Total ankle replacement represents an alternative to arthrodesis in the setting of advanced ankle arthrosis. The INBONE total ankle system is a Food and Drug Administration-approved, nonmobile-bearing implant with intramedullary modular stems that afford additional fixation in both the tibia and talus. Although approved for use only with cement, it is used universally without cement. A sophisticated leg assembly and intramedullary guidance system greatly increase the accuracy of implant position. Increased polyethylene thickness with a saddle geometry spreads out stresses across the ankle joint while maintaining stability. Although formal clinical data have not been published, the implant shows promise and may be well suited not only for standard primary total ankle replacement, but also in the setting of instability, moderate deformity, or failure of previous arthroplasty. As always, patients should be alerted to the potential complications with total ankle replacement. The purpose of this article is to describe the surgical technique for implanting the INBONE total ankle.
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Arthrodesis has previously been the mainstay of treatment of severe painful arthritis of the ankle. However, ankle fusion leads to alteration in gait,[1] the development of arthritis in other joints of the ipsilateral foot,[2,3] and dissatisfaction at long-term follow-up.[4] Total ankle arthroplasty (TAA), which preserves ankle range of motion, reduces demand placed on adjacent joints, and has been able to restore normal gait patterns, is becoming an increasingly attractive option.[5,6] Recent prospective data suggest that ankle replacement achieves similar pain relief and better function when compared with arthrodesis.[7]

TAA is now in the more advanced phases of the third generation of development. The first generation was little more than an upside-down hip cemented in position. The second-generation implants were also cemented and constrained, leading to high rates of failure.[8,9] Third-generation implants have improved designs with less constraint and use entirely noncemented fixation techniques.[10] These have reduced previously high failure rates attributable to impingement, subluxation, loosening, and subsidence.[11]

One of the newest of this generation is the INBONE prosthesis (Wright Medical Technology, Arlington, TN), one of four TAA designs in the United States approved by the Food and Drug Administration (FDA). Its intramedullary modular design with a leg holder, based on the success of intramedullary instrumentation systems used in total-knee replacements, holds promise in providing the operating surgeon guides for accurate alignment to ensure a stable prosthesis.

INBONE Design Features

The INBONE total ankle replacement is a fixed-bearing design with a modular stem system for both the tibial and talar components (Fig. 1). Both stems significantly increase vertical fixation and therefore remove load from the bearing surfaces of the implant. On the tibial side, this precludes having to achieve fixation with a large tibial plafond component that may sacrifice portions of the malleoli. The tibial component has a stem that is inserted by threading segments, piece by piece, into the tibial metaphysis. These additional modular segments (12-18 mm in diameter) are added together to form the tibial stem. Determination of how many segments to use depends on the surgeon's determination of how much stability is needed or how much the stem should pass beyond a simultaneous supramalleolar osteotomy performed for correction of a distal tibial malunion. Normally, 4 segments are used. Unlike some other ankle replacements, the INBONE implant does not resurface either of the malleoli.

The talar component uses a double saddle design and entirely replaces the superior aspect of the natural talus after a

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flat dome resection. It does not replace either the medial or lateral side of the talus. The size of standard talar stems used (10 or 14 mm) depends on the vertical height of the talus remaining after the talar dome cut and the distance from the implant to the subtalar joint. Normally, the 10-mm stem is used with sizes 2 and 3, and the 14-mm stem is for the larger prostheses. Of course, as mentioned previously, this is dependent on the remaining thickness of the talus. Not infrequently, in the revision ankle arthroplasties, the shorter 10-mm stem is used because removal of the original talar component results in some loss of talar height. Longer calcaneal stems (48, 58, or 66 mm in length, and 13 or 26° of lateral angulation) have been developed but are not currently FDA approved. These would be used to span the subtalar joint, providing additional support to the talar component and, of course, would effectively eliminate any motion in the subtalar joint.

Unique to the INBONE total ankle is the alignment system, which requires setting the leg in a holder (Fig. 2). The holder involves simultaneous alignment of the talus with the tibia. Once achieved, a drill is passed from the plantar foot through the calcaneus, talus, and tibia. This route passes just anterior to the posterior facet of the subtalar joint, through the center of the talar body, and into the center of the tibial metaphysis, much like the guide pin for a retrograde ankle arthrodesis nail. Although many argue that it is undesirable to violate the subtalar joint with the drill when implanting the INBONE prosthesis, the designers of the alignment guide maintain that if the device is applied appropriately, the drill safely negotiates the subtalar joint between the arterial anastamosis on the inferior talar neck and the posterior facet's articulation with the inferior talus. In the senior author's experience, this 6-mm hole has not led to clinical problems with regard to subtalar pain. However, the senior author has seen cases with subsidence in cases in which too much talus is removed or when there has been a previous complete subtalar "clean out" arthrodesis wherein the blood supply to the talus has been compromised.

Figure 1 The INBONE system total ankle prosthesis. Photo courtesy of Wright Medical.

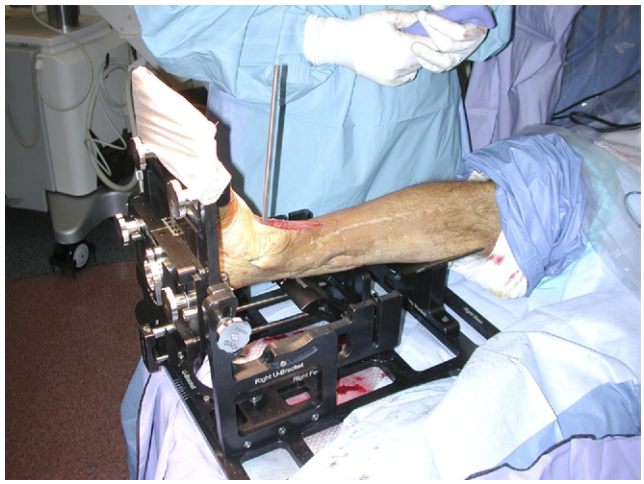

Figure 2 This intraoperative photo demonstrates the position of a right leg in the holder. The system allows for precise positioning of the ankle for later steps in the procedure.

Four polyethylene thicknesses are available for each size of implant (Table 1). This choice allows for increased stability, which is particularly helpful in cases with previous bone loss. Thicker revision polyethylene components are also available and particularly valuable in the setting of TAA revisions. The INBONE polyethylene inserts are broader than most other designs and in theory spread out stresses reducing delamination wear.

Indications and Contraindications

A total-ankle replacement is indicated in patients with end-stage painful debilitating ankle arthritis who have failed conservative treatment. Patients with traumatic or inflammatory arthritis or painful or nonunited previous arthrodesis of the ipsilateral hind foot and/or fusion of the contralateral ankle joints are candidates for ankle replacement. The usual source

Table 1 Polyethylene Sizes Available for Given Components

Tibial Component Size	Available Polyethylene Sizes, mm
2	7, 9, 11,* 13*
3	8, 10, 12,* 14*
4	9, 11, 13,* 15*
5	9, 11, 13,* 15*
6	9, 11, 13,* 15*

*The most commonly used sizes.