Computed Navigation Guidance for Ankle Replacement in the Setting of Ankle Deformity

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KEYWORDS

• Preoperative navigation • Patient-specific instrumentation • Total ankle arthroplasty • Ankle deformity • PROPHECY • INBONE II • INFINITY

KEY POINTS

- Total ankle replacement represents a reliable treatment option for end-stage ankle arthritis.
- Patient-specific instrument guidance makes use of computed tomography scans to create an alignment guide that is specific to each patient's unique anatomy.
- Preoperative computed navigation guidance allows the surgeon to plan and execute the most appropriate bone cuts and implant positioning while correcting any associated deformities with reproducible results within 2° of the planned target alignment.
- Preoperative computed navigation guidance extends the indications for total ankle replacement.

INTRODUCTION

The use of preoperative imaging-derived patient-specific instrumentation[1] is not a new concept in total joint arthroplasty. It has been used in both total knee and hip arthroplasty

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to improve accuracy of implant alignment and reduce operative times.[2–6] More recently, this technology has been implemented for use in total ankle replacement (TAR). Preoperative computed tomography (CT)-derived patient-specific guides (PROPHECY; Wright Medical Technology, Memphis, TN) have been developed for this purpose.[7–9]

Survivorship of TARs has yet to match that of knee and hip arthroplasty.[10] Despite advances and improving results, ankle deformities represent a great challenge to foot and ankle surgeons and are common in cases of end-stage ankle arthritis. Many surgeons have considered preoperative coronal plane deformity of greater than 10° a contraindication for a TAR due to the increased risk of instability, subluxation, and implant failure.[11,12] Doets and colleagues[13] reported increased failure rate in ankles with a preoperative coronal plane deformity greater than 10°, with an average survival rate of only 48% at 8 years. The unique anatomy and biomechanics of the ankle joint dictates that any minor malpositioning of the total ankle components results in an increase in peak pressures and decrease in contact areas. This contributes to polyethylene wear and subsequent implant failure.[14,15] In addition, compared with knee and hip arthritis, patients requiring TAR for end-stage ankle arthritis tend to be younger and relatively more active. As such, accuracy of component placement with restoration of mechanical and kinematic joint axes is of paramount importance for a good outcome following TAR.

Patient-specific instrument guidance makes use of CT or MRI scans of the ankle joint to create an alignment guide for each component of the implant that is specific to each patient's unique anatomy. This results in a custom fit of the implant, aligned with the appropriate axes as selected by the surgeon, which optimizes load distribution and avoids the need for sizing of implants intraoperatively. This, in turn, improves the accuracy and reproducibility of the implanted components and may potentially reduce the incidence of implant failure.[16,17]

SURGICAL TECHNIQUE

The PROPHECY preoperative navigation alignment guide is the first described system used in the foot and ankle to provide preoperative implant position planning. This guide is intended for use with the INFINITY Total Ankle System (Wright Medical Technology) and the INBONE II Total Ankle System (Wright Medical Technology).

These systems are indicated for use in patients with end-stage ankle arthritis who are suitable for a TAR. Contraindications for use include active infection, vascular insufficiency, inadequate bone stock, neuropathic joints, severe neuromuscular conditions, and excessively high-demand patients.

Preoperative Planning

Preoperatively, after reviewing the weightbearing radiographs of the foot and ankle (**Fig. 1**), the patient undergoes a CT scan following the PROPHECY Ankle CT Scan protocol. This ideally includes hip-to-foot CT scout images, although knee-to-foot images are acceptable.[18] High-resolution scans of the knee, foot, and ankle are required.

These scans are then used to produce a 3-dimensional (3D) computer bone model with anatomic reference points on the tibia and talus. In addition, the CT scan is used to assess preoperative coronal plane, sagittal plane, and rotational deformity, and identify the mechanical and anatomic axes on both coronal and sagittal images. This allows the surgeon to choose the tibial mechanical or anatomic axis for positioning of the tibial component, taking into account any deformity that may be present in the tibia. The 3-D model also allows the medial and lateral gutter angles of the tibial plafond to be identified, and these are used to determine axial rotation.