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Tibial slope in total ankle arthroplasty: Anterior or lateral approach☆

Federico Giuseppe Usuelli, MD[a,*], Camilla Maccario, MD[a,b], Cristian Indino, MD[a], Luigi Manzi, MD[a], Christopher Edward Gross, MD[c]

[a] IRCCS Istituto Ortopedico Galeazzi, Milan, Italy
[b] Universita' degli Studi di Milano, Milan, Italy
[c] Department of Orthopaedics, Medical University of South Carolina, Charleston, SC, USA

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ABSTRACT

Background: A new total ankle arthroplasty (TAA) system performed through a lateral approach provides direct visualization of the centre of rotation, allowing for accurate reconstruction of the joint alignment and less bone resection. Radiographic references are needed to describe deformities and plan the surgical procedures. The tibial slope is an important factor when treating malalignment. The aim of this study is to show if there is any difference regarding the post-operative tibial slope (β angle) measurement comparing a fixed-bearing TAA through a lateral approach and a mobile-bearing TAA through an anterior approach.

Methods: The study included 217 ankles. Between May 2011 and April 2015, 77 patients underwent a TAA with a mobile-bearing implant through an anterior approach and 45 with a fixed-bearing implant through a lateral approach: in these patients the β angle was measured 2 and 12 months postoperatively. 95 subjects with unilateral post-traumatic ankle arthritis composed the control group: in these patients we measured the anterior distal tibial angle (ADTA) of the controlateral, non arthritic tibiotalar joint.

Results: In the mobile-bearing group, the mean β angle at 2 and 12 months postoperatively was 86.4 ± 3.1 and 86.8 ± 3.1 (p-value = 0.12). In the fixed-bearing group, the mean β angle at 2 and 12 months postoperatively was 83.1 ± 5.4 and 83.9 ± 6.5 (p-value = 0.26). A statistically significant difference was found between the β angle of the two groups. In the control group the mean ADTA was 84.9 ± 2.5. A non-statistically significant difference was observed only between β angle of the fixed-bearing group and the ADTA of the control group.

Conclusions: Regarding the tibial slope, fixed-bearing TAA through a lateral approach showed a more anatomic placement. In contrast, β angle in mobile-bearing group appeared more reproducible than fixed-bearing group.

1. Introduction

Ankle arthrodesis (AA) and total ankle arthroplasty (TAA) are standard procedures for ankle osteoarthritis when conservative treatment has failed [4,11]. Modern three-component TAA designs provide significantly better results than their predecessors [20,21]. Promising reports of mid- to long-term success of next-generation TAA continue to emerge, as indications and techniques for the use of these devices become better defined and the designs of the implants themselves continue to evolve and improve [15].

Traditionally, TAA has been performed through the use of an anterior approach, though some implants in the past have been inserted transfibularly. However, recently, a new TAA design uses a lateral approach. The transfibular access to the ankle joint provides direct visualization of the centre of rotation corresponding to the central point of the body of the talus as defined by Lundberg et al. in 1989 [13]. This theoretically allows for more accurate reconstruction of the joint alignment and kinematics as well as far less bone resection than other implants. Additionally, lateral access allows the implants to be placed perpendicular to the trabeculae of the tibia and talus; this may improve the transfer of forces from bone to implant and decrease the shear forces at the bone-implant interface [16].

The beta angle is an important factor when treating malalignment of the ankle. This angle is subtended by the longitudinal axis of the tibia and the articular surface of the tibial component on

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* Corresponding author at: C.A.S.C.O. IRCCS Istituto Ortopedico Galeazzi, Via Riccardo Galeazzi 4, 20161 Milan, Italy.
E-mail address: fusuelli@gmail.com (F.G. Usuelli).

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the lateral view [3]. The angle is essential when deformities of the ankle in the sagittal plane require correction. TAA with non-physiologic angles has been shown to result in pain, edge loading, polyethylene wear of the inlay, and instability of the joint [8]. When performing a TAA, restoring and maintaining the appropriate position of the tibial and talar components are important for the long-term success of the prosthesis [6,9,17]. In particular, the original centre of rotation of the tibiotalar joint should be re-established to achieve good clinical results and to prevent instability, aseptic loosening, premature wear, and dislocation of the ankle [2].

The aim of this study is to demonstrate if there is any difference regarding the beta angle comparing a TAA performed through a lateral approach, a TAA performed using an anterior approach, and a control group. Our hypothesis is that TAA through a lateral approach allows one to position the tibial component with a tibial slope more similar to the anatomic tibial slope than a TAA through an anterior approach.

2. Materials and methods

The study was approved by our institutional review board. The study included 217 ankles. One hundred twenty-two patients underwent primary TAA from May 2011 to April 2015: the 3-component, mobile-bearing HINTEGRA implant (Newdeal SA, Lyon, France) was used in 77 patients through an anterior approach and the 2-component Zimmer Trabecular Metal Total Ankle prosthesis (Zimmer, Warsaw, IN) was implanted in 45 cases through a transfibular approach. The surgeries were performed by a single senior orthopaedic foot and ankle surgeon who had extensive total ankle replacement experience. The control group included 95 patients who were referred to our department for unilateral post-traumatic arthritis. Our standardized protocol included bilateral weightbearing plain radiographs (anteroposterior (AP), mortise, and lateral) for surgical planning. To avoid distortion of the dimensions, the focus of the radiograph was centralized exactly on the ankle joint of the patients who were standing upright. Lateral views in standing patients were obtained with the following predetermined quality criteria: the distal fibula had to project onto the posterior third of the distal tibia, and the medial joint line of the talus had to superimpose on the lateral joint line [14].

The ADTA angle of the controlateral, non arthritic tibiotalar joint was measured using plain radiographs available in our Picture Archiving and Communication System (PACS): it is a measure of the tibial tilt defined by the angle between a line from the anterior to the posterior border of the tibial joint surface and the tibial axis measured on the anterior side [14].

Our surgical indications included patients with end-stage ankle osteoarthritis with debilitating pain and function who had failed conservative management.

All prostheses were implanted using the manufacturer's described technique [3,7].

Radiographic examination included anteroposterior (AP) and lateral view radiographs. For the lateral imaging, patients were weight-bearing on a low bench, straddling the image receptor with the beam focused at the centre of the ankle joint to reduce image distortion. A standard protocol was used to limit the effect of rotation differences. Images were taken 2 and 12 months after the surgical procedure in TAA groups, while the pre-operative radiographs of the contralateral side taken for the preoperative planning composed the images of the control group.

In the control group, we measured the anterior distal tibial angle (ADTA: normal value $83.0 \pm 3.6^{\circ}$) [14]. The angle is subtended by the anatomic axis of the tibia and the line connecting the distal points on the anterior and posterior tibial articular surface on the anterior side (Fig. 1). The tibia axis was defined as the line connecting the centres of two circles designed over the proximal and the distal tibia adjusting their radius to the anterior and posterior tibial cortices [2]. In the TAA group, the placement of the tibial component was assessed by measuring the beta angle (β-angle: normal value $85.0 \pm 2.0^{\circ}$) [3]. This angle is subtended anteriorly by the longitudinal axis of the tibia and the articular surface of the tibial component on the lateral view (Fig. 2). All radiological measurements were made using the standard tools in our PACS and evaluated by two orthopaedic surgeons, who were not directly involved in the surgical procedure. In the coronal plane, the α-angle is measured. This is formed by the angle between the anatomic axis of the tibia and the articular surface of the tibial component on the AP view (normal value $90.0 \pm 2.0^{\circ}$) [3].

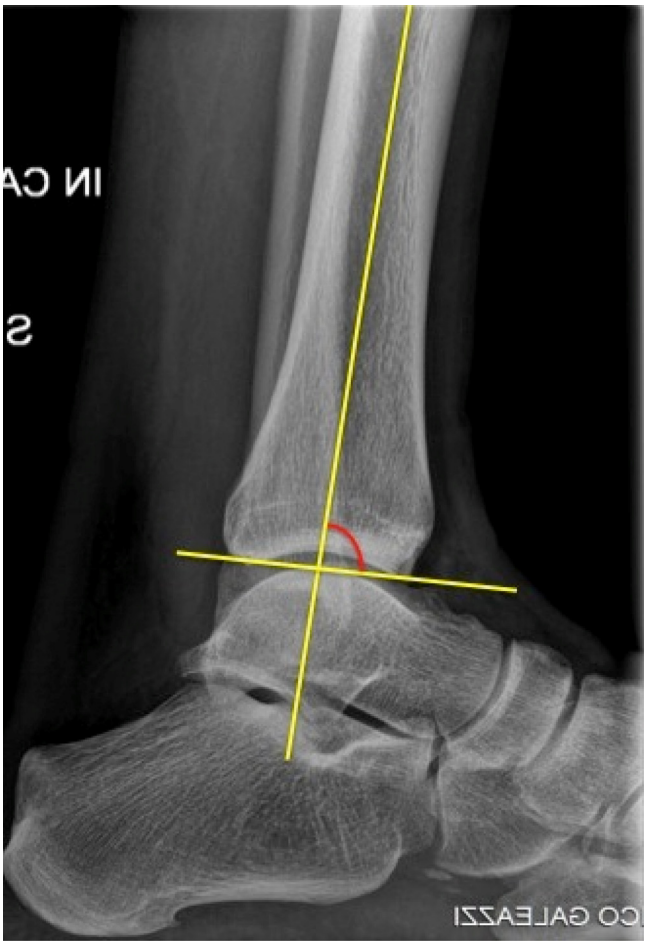

Fig. 1. ADTA: on the lateral radiograph, it is the anterior angle formed from the anatomic axis of the tibia and the line connecting the distal points on the anterior and posterior tibial articular surface.

3. Statistical analysis

The statistical analysis was performed by Matlab statistical toolbox version 2008 (MathWorks, Natick, MA, USA). The statistical tests that were performed were the Student t-test and Fisher–Snecodor F-test for equality of variances. Significance was defined with a p-value <0.05.

4. Results

A total of 217 ankles were included in the study. 77 received a HINTEGRA TAA (male 44, female 33) and 45 received a Zimmer TAA