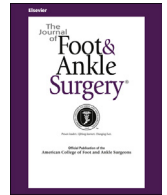




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## Original Research

## Comparison between Simple Radiographic and Computed Tomographic Three-Dimensional Reconstruction for Evaluation of the Distal Metatarsal Articular Angle

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## ABSTRACT

The hallux valgus is a pathologic condition in the forefoot that often causes pain and functional limitations. Assessing all deformity components, such as the distal metatarsal articular angle (DMAA) is essential to hallux valgus treatment. Nevertheless, interobserver agreement of DMAA is poor on plain radiographs. The present study compared computed tomographic (CT) 3-dimensional (3D) reconstruction with plain radiographic measurements for measuring the DMAA. We included 43 consecutive patients (77 feet), diagnosed with hallux valgus at the orthopedic outpatient clinic at Hospital de Clínicas de Porto Alegre (Porto Alegre, Brazil) from April 2014 to June 2015 in our prospective study. The DMAAs were measured by 2 observers using CT 3D reconstruction. The results were compared between observers and with the plain radiographic measurements using the concordance correlation coefficient and the Bland-Altman plot to determine the agreement between the 2 methods. The interobserver agreement of the CT 3D measurements was high (concordance correlation coefficient 0.90;  $p < .001$ ). Significant agreement was found between the plain radiographic and CT measurements (concordance correlation coefficient 0.667;  $p < .001$ ). The Bland-Altman plot showed that the difference between the plain radiographic and CT measurements increased when greater DMAA values were associated with the presence of metatarsal rotation. The interobserver agreement of DMAA measurements was greater on CT 3D reconstruction than on plain radiography. The poor interobserver agreement of the radiographic DMAA might have resulted from metatarsal rotation.

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Different variants of hallux valgus deformity exist and different therapeutic approaches are available. Several surgical techniques have been used for correction of a hallux valgus deformity, including osteotomy, soft tissue release, and arthrodesis. Thus, the main characteristics of each deformity need to be assessed to choose the best treatment option (1–3). Accordingly, angle measurement using



**Fig. 1.** Computed tomographic 3-dimensional reconstruction showing alignment with metatarsal rotation.

simple radiography is important to guide surgical treatment. The distal metatarsal articular angle (DMAA) is one of the most important radiographic angles in hallux valgus, and it has been shown that noncorrection of DMAA alterations is associated with early recurrence of the deformity, reduced range of motion of the metatarsophalangeal joint, and pain (1–5).

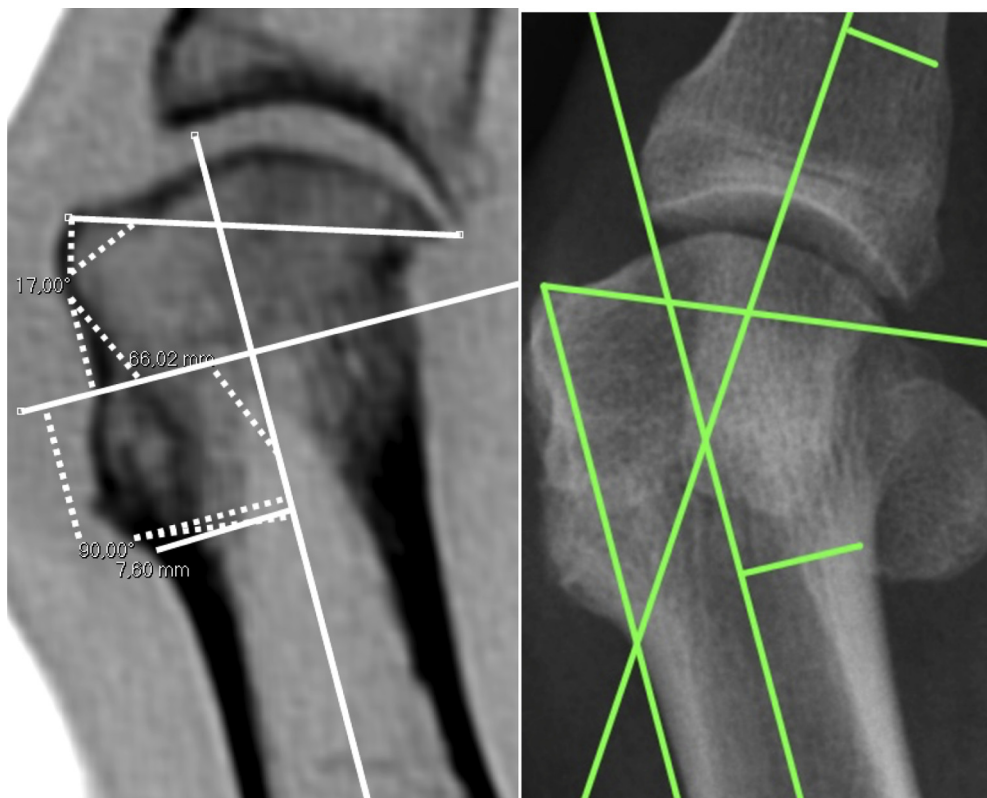
The DMAA angle indicates the lateral slope of the articular surface of the first metatarsal head, measured by a line that connects the lateral and medial limits of the articular surface with the longitudinal axis of the metatarsal. This lateral deviation must be identified in the

preoperative period because of the specific approach required for correction (6–8). Unusual surgical techniques such as biplane or periarticular osteotomy must be performed to correct the orientation of the articular surface and to prevent inadequate disorder correction (6,7). However, although some surgeons consider that this angle can be measured with good reliability using simple radiography (9), several studies have reported low interobserver agreement for DMAA measurements (4,10–13). In a cadaveric study, Vittetoe et al (13) found low interobserver reliability for the rotation of the first metatarsal.

Plain radiography shows a 2-dimensional image and thus might not provide an accurate measurement of the DMAA in cases with metatarsal rotation. As metatarsal rotation increases, the articular plantar surface takes a more lateral position on the radiograph, which can lead to overlapping images or error in defining the lateral articular surface limit. Similarly, because the plantar articular surface is larger and more rounded than the lateral articular surface, it can lead to an overestimation of the DMAA (4,14–16). Thus, the present study compared the plain radiographic measurements with those from DMAA and CT 3D reconstruction. Additionally, the difference between the plain radiographic and CT 3D reconstruction measurements was correlated with various radiographic parameters.

#### Materials and Methods

The ethics committee of the Hospital de Clínicas de Porto Alegre (Porto Alegre, Brazil) approved the present study. All the participants signed a consent form that had been previously approved by the ethics committee of Porto Alegre Clinics Hospital. The study was also approved by Plataforma Brasil, an online data sharing platform (project no. 25666213.1.0000.5327). Patients from the orthopedic and traumatology outpatient clinic were prospectively selected from April 2014 to June 2015. The inclusion criteria were a diagnosis of symptomatic hallux valgus with an indication for surgical treatment and age 15 to 85 years. Patients with neurologic disease, a history of foot fractures, or previous foot surgery were excluded. Of the 46 patients who met the inclusion criteria,



**Fig. 2.** Distal metatarsal articular angle measurements on computed tomographic 3-dimensional reconstruction images and plain radiographs.

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