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Evaluation of the 1st metatarso-sesamoid joint using standing CT — The Stanmore classification☆

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ABSTRACT

Background: Little is understood about the role that relative sesamoid displacement and chondral wear have on outcome after hallux valgus (HV) surgery. All existing methods to evaluate relative sesamoid displacement have limitations and furthermore, there have been no radiographic studies evaluating metatarso-sesamoid joint wear. Standing CT scan circumvents many of the existing problems in evaluation of relative sesamoid displacement, and also enables the first radiographic study assessing metatarso-sesamoid joint wear.

Methods: Fifty feet (in 43 patients) with symptomatic HV (Group A) were compared with a control group of 50 feet (50 patients) (Group B). All images were standardised to enable reproducible measurements. The hallux valgus angle, Intermetatarsal angle, sesamoid rotation angle, sesamoid position and metatarso-sesamoid joint space were measured in all patients.

Results: The intra and inter-observer reliability correlation showed that the standing CT assessment of sesamoid position (1.000), rotation (0.991) and metatarso-sesamoid joint space (0.960) were highly reproducible.

There was a highly significant difference ($p < 0.0001$) in sesamoid position, sesamoid rotation and metatarso-sesamoid joint space between Group A and Group B.

Conclusions: Standing CT has been shown to be a reproducible and accurate method of assessing the relative sesamoid displacement and metatarso-sesamoid joint space narrowing. The results have been used to propose a novel standing CT based classification of hallucal sesamoids, considering the degree of displacement and wear. This classification may ultimately facilitate research to provide new insight into the effect relative sesamoid displacement and chondral wear have on outcomes from hallux valgus surgery.

1. Introduction

There is considerable debate about the role that relative sesamoid displacement and metatarso-sesamoid joint space narrowing (as a proxy for chondral wear) have on symptoms of hallux valgus (HV) and treatment outcomes. An accurate method to evaluate these is therefore essential, however all the current techniques have problems. Once an accurate method has been devised, it can be used to classify a patients degree of relative sesamoid displacement and metatarso-sesamoid joint space narrowing, to then allow investigation into how these factors affect outcome from hallux valgus surgery. For example, it may be postulated that those patients with very displaced and worn sesamoids at presentation, have poorer outcomes after re-alignment surgery and may fare better with metatarso-phalangeal joint fusion. It is not possible to investigate this until an accurate and reproducible method of sesamoid assessment is reported.

In HV, the metatarsal head drifts medially into varus, and slips off the sesamoid apparatus, which stay tethered in position by the adductor hallucis tendon and the inter-metatarsal ligament (which attach to the tibial sesamoid). This explains how the sesamoid displacement is relative to the metatarsal head. As the deformity progresses, the medial sesamoid can come to lie under or lateral to the crista, and the lateral sesamoid ceases to articulate as it lies in

☆ Levels of evidence: Level 3 retrospective comparative study.

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the 1st web space. Furthermore, as the metatarsal head moves off the sesamoid apparatus, it pronates due to altered muscular forces, which adds a rotational component to relative sesamoid displacement [1].

Existing methods to evaluate **relative sesamoid displacement** are unreliable. Weight-bearing AP radiographs have been shown to be misrepresentative due to the rotational component to the deformity [2–5] (Tangential axial) views overcome this problem, however in order to obtain the image, they are all taken with the hallux in a non-physiological, dorsiflexed position (variably between 40–75°), and it has been shown that the position of the sesamoids varies with the amount of hallux dorsiflexion [6]. Conventional cross sectional imaging techniques, such as CT and MRI, circumvent this problem, however are not load bearing.

All previous studies looking into **metatarso-sesamoid joint space narrowing** in HV are cadaveric [7–9], or intraoperative, either open [10–12] or arthroscopic [13]. There are no reports of metatarso-sesamoid joint space measurement using imaging.

A standing CT scanner (PedCAT, Curvebeam, Warrington, USA) is a novel technology that allows 3D CT imaging with full weight bearing. The software has a 3D window that can be fully manipulated to show axial reformats, parasagittal reformats and coronal reformats. The procedure time is between 19 and 68 s. The radiation dose for adults for unilateral pedCAT is 1.4 μs (three standard radiographs from one foot is 0.7 μsv) [14] Bespoke software (Cubeview, Curvebeam, Warrington, USA) allows for manipulation of the images to standardise assessment and capture accurate measurements.

The standing CT scanner therefore offers a method to evaluate relative sesamoid displacement on an axial view, with the hallux in a neutral position, with the patient fully weight bearing. It also offers a resolution sufficient to measure joint space thickness, in a weight bearing position. It consequently may represent a more accurate method of assessing the sesamoids.

The aim of this study is therefore to assess whether the standing CT scanner can provide an accurate, reproducible method to evaluate relative sesamoid displacement (both translation and rotation) and metatarso-sesamoid joint space (as a proxy for chondral wear). It is also to then propose a classification system for the relative displacement and degree of chondral wear of the sesamoids. The latter can then be used to classify a patient's sesamoids via imaging at presentation, to then see if this correlates with symptoms and outcome from surgery.

2. Patients & methods

A group with HV (Group A) was compared to a group without HV (Group B). The project received IRB approval.

Group A: Fifty feet (in 43 patients) with symptomatic HV. The subjects had a mean age of 53.4 years (range 21.3–85.1) years. Patients who had previous forefoot surgery or trauma were excluded, as were patients with known severe hallux rigidus (less than 40° hallux dorsiflexion, positive grind test); inflammatory arthritis (such as rheumatoid arthritis, or gout) or metabolic/endocrine pathology (e.g. Paget's disease, hypothyroidism, acromegaly). This was to exclude patients with other causes for chondral damage other than deformity.

Group B: Fifty feet (50 patients) with a mean age 53.3 years (range 18.1–83.0). These subjects had undergone a standing CT scan for pathology unrelated to the forefoot (e.g. for talar osteochondral defects) and each of these subjects was confirmed to have no clinical or radiographic findings of HV or hallux rigidus.

2.1. Radiographic standardisation

All patients were scanned in a bipedal standing position with the feet facing forwards. Where possible both knees were fully extended. The images were manipulated using Cubeview software

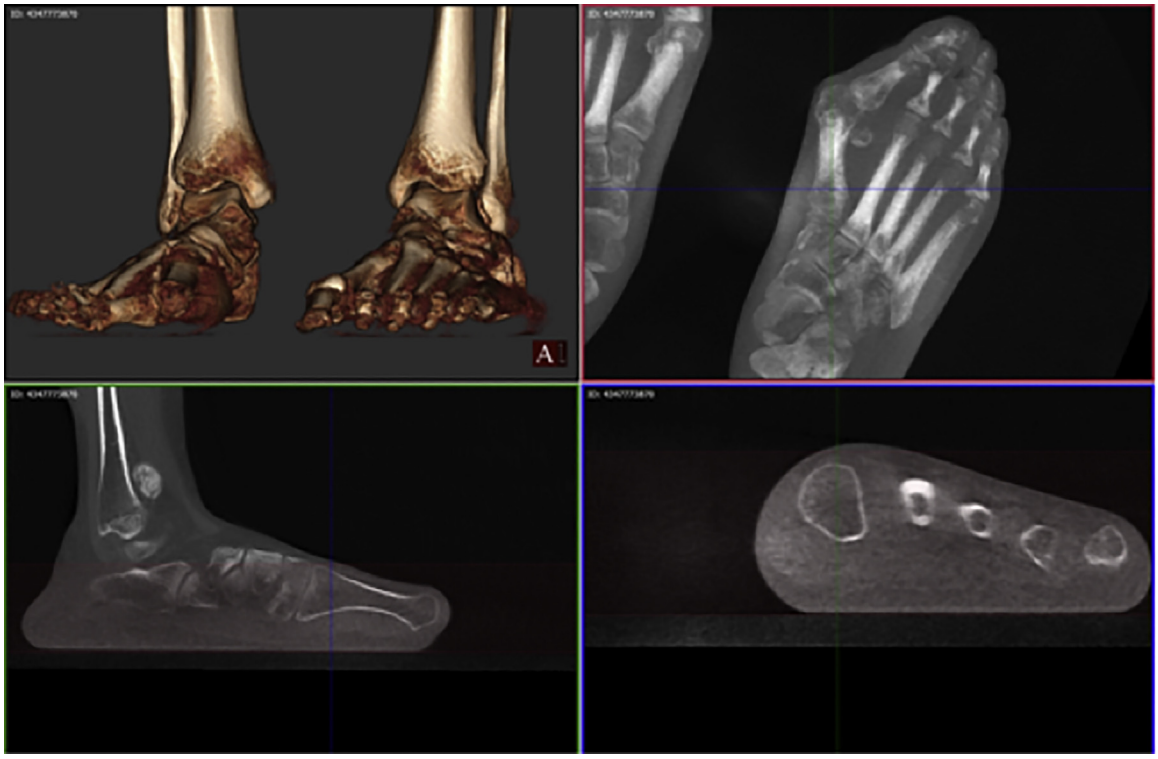

Fig. 1. Standardisation of the images. The images have been manipulated to be plantargrade on the parasagittal (bottom left) and coronal (bottom right) views. The 1st metatarsal was aligned to be vertical on the AP plane (top right). This ensured the coronal cuts were perpendicular to the metatarsal shaft.

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