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MORPHOMETRIC ANALYSIS OF HIND FOOT ANKLE BONES

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ABSTRACT

Analysis of injury biomechanics includes quantification of geometry, material properties, loading profiles, and boundary conditions. Variation of those factors will result in different injury mechanisms and/or tolerance. Geometric variation is particularly important for quantification of inter-personal differences in injury risk and injury characteristics/outcomes. Accordingly, it remains an ongoing hypothesis of this line of research that variation in geometric characteristics of the foot and ankle will contribute to differing injury risk and/or outcomes. The purpose of this study was to determine how the morphology of hind foot bones (calcaneus, talus, distal tibia) varied between specimens. In this study authors have quantified repeatable geometric measurements to quantify inter-personal anatomical differences for calcaneus, talus and distal tibia. Computed Tomography (CT) scans were obtained from 71 human male cadaver lower extremity specimens. The mean (± standard deviation) for age, height, and weight of the specimens used in this study were 63.5±12.1 years, 177.2±6.2 cm, and 81.4±14.3 kg respectively. Calcaneus, talus, and distal tibia morphometric parameters were quantified. For calcaneus, length of calcaneal axis (82±4.7mm), posterior facet (29±2.5mm), anterior process (23±2.2mm) and height of posterior (31±2.7mm) and anterior facet (25±1.7mm) was quantified. For talus, depth (35.6±2.7mm) and width (34.5±2.4mm) were quantified. For distal tibia, epiphyseal plate width (49.8±3.2mm) and epiphyseal plate depth (42.7±2.4 mm) were quantified. All measurements demonstrated good intra-observer agreement when quantifying the coefficient of variability and Bland-Altman statistics.

Keywords: Morphology, morphometrics, hind foot, calcaneus, talus, distal tibia

INTRODUCTION

Analysis of injury biomechanics includes quantification of geometry, material properties, loading profiles, and boundary conditions. Variation of those factors may result in different injury mechanisms and/or tolerance. Geometric variation is particularly important for quantification of inter-personal differences in injury risk and injury characteristics/outcomes. Accordingly, it remains an ongoing hypothesis of this line of research that variation in geometric characteristics of the foot and ankle will contribute to differing injury risk and/or injury outcomes.

A recent review of injuries in UK military (2003-2014) have shown that the majority of combat-related hind foot injuries (84%) occurred from improvised explosive devices [1]. The most common bones to fracture from these insults were calcaneus, talus and distal tibia. Similar incidences of hind foot fractures are mirrored in mine victims [2]. Some morphometric investigation of the calcaneus has been accomplished previously [3], [4]. Qiang and colleagues analyzed geometry of the calcaneus from CT scans of men and women. Statistically significant differences in height, weight, and body mass index (BMI) were identified based on sex. A majority of metrics quantified by Qiang and colleagues were significantly different ($p<0.05$) between men and women, although the authors acknowledged a large range of measurement values were likely due to considerable inter-personal differences. While that study was well sampled and demonstrated excellent reliability and reproducibility, the focus was only on measurement of geometric parameters in calcaneus region of hind foot. Other studies have investigated morphological differences in calcaneus between left and right leg [4].