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Sexual dimorphism in the morphometric characteristics of the tibial plafond and medial malleolus

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ABSTRACT:

Introduction: The present study was planned to determine sexual dimorphism in the morphometry of the tibial plafond and medial malleolus in a sample Kenyan population.

Materials and methods: A hundred and fifty six tibiae from the Department of Human Anatomy, University of Nairobi and the osteology collection of the National Museums of Kenya, Nairobi were used. Measurements were taken directly from the bone using a digital pair of vernier calipers (Sealey Professional ToolsTM). Means and frequencies were determined and compared using Student's t-test. Data are presented using tables.

Results: The mean width of the tibial plafond was 26.55 mm \pm 2.18 mm (range 21.7-35.4 mm). The average the length of the tibial plafond was 28.61 mm \pm 2.29 mm (range 21.7-36.2 mm). The average height of the medial malleolus was 14.19 \pm 1.89mm, whilst the average breadth of the medial malleolus was 21.88 \pm 2.22 mm. There were statistically significant differences between males and females in these dimensions with males having larger measurements of the same.

Conclusion: These are baseline data on the osteometric characteristics of the tibial component of the talocrural joint in adult Kenyans. The statistically significant differences in these dimensions in males and females are important in interpreting diagnostic images and guiding the continued design of ankle joint prostheses.

Keywords: Medial malleolus , Tibial plafond

INTRODUCTION

The distal tibia, together with the fibula make a syndesmosis which forms the 'mortise' that articulates with the 'tenon', the talus at the talocrural joint. The tibial articulation with the talus occurs majorly with the tibial plafond (TP); a saddle shaped facet on the distal end of the tibia and the medial

surface of the medial malleolus (MM) (Standing, 2008). The morphometry of the distal tibia is important when the stability of these articulations is put into consideration (Taser *et al.*, 2009). Moreover, these morphometric parameters find clinical application in imaging diagnosis of fractures of the TP (Topliss *et al.*, 2005) and the MM (Fessy *et al.*,

1997). Pertinent to this are interindividual, sexual and populational variations in osteometric dimensions (Igbigbi, 2003; Taser et al. 2009). These differences, brought about by dissimilarities in muscle bulk, hormonal levels and differential loading, would be expected especially in these articular facets of the tibia. This is because the distal tibia bears body weight in a relatively small surface area during the stance phase of gait is thus subjected to high biomechanical strains that in turn affect bone modeling (Burghardt *et al.*, 2010). This necessitates the provision of population specific osteometric data. This study aims to provide data that can be standardized to offer the much needed information regarding these dimensions amongst adult Kenyans.

MATERIALS AND METHODS

A total of 156 tibiae, obtained from the department of Human Anatomy and the osteology collection at the National Museums of Kenya (Nairobi). These included tibiae of both sexes with completely closed epiphyseal plates indicating they belonged to adults. Tibiae with chipped condyles, malleoli and incisural tubercles or those that exhibited any sign of previous fracture in life were not included in the study. Measurements were taken directly on the bone using a digital pair of Vernier calipers (Sealey Professional Tools™, United Kingdom; accurate to 0.01 mm). To minimize intra-observer errors, three measurements of the same dimension were done and an average of these measurements recorded.

Measurements

The dimensions of the medial malleolus (MM) measured included its height (the distance from its base at the tibial plafond to its tip and the breadth), which is defined as its anteroposterior length (Fessy *et al.*, 1997); the width of the tibial plafond (TP), which is the mediolateral dimension of the talar facet at the middle of the joint and the length of the TP; and the anteroposterior dimension of the talar facet at the middle of the joint (DeSilva, 2008).

Statistics

The means and standard deviations of the width, height and depth of the FI, the height and breadth of the MM and the length and width of the tibial plafond TP were calculated using SPSS software (Version 17.0, Chicago, Illinois). Frequencies and percentages were determined. The Student's *t* – test was used to determine statistically significant differences in the means of the measured dimensions between the sexes, with $p < 0.05$ considered statistically significant at 95% confidence interval.

RESULTS

The mean length and width of the TP as well as the height and breadth of the MM are presented in table 1. Differences in the mean length and width of the TP and the breadth of the medial malleolus in males and females were statistically significant ($p < 0.05$). The sex difference in mean height of the medial malleolus was however not statistically significant ($p > 0.05$) (Table 1).

Table 1: Descriptive measurements and sex differences in dimensions of the tibial plafond and medial malleolus

Dimension (mm)	Distance (mm)			Student's t-test
	Both sexes	Males	Females	p value
Width of the tibial plafond	26.55±2.18	26.82±1.84	25.15±1.53	<0.001
Length of the tibial plafond	28.61±2.39	29.87±1.84	27.76±1.78	<0.001
Height of the medial malleolus	14.19±1.89	15.03±1.69	14.49±1.17	<0.001
Breadth of the medial malleolus	21.88±2.22	22.09±1.98	20.85±1.81	<0.001

DISCUSSION

The articular surface and medial bank of the mortise in the talocrural joint are best described using dimensions of the MM and TP. describing (Fessy *et al.*, 1997). These measurements find utility in considering the stability of this joint, in guiding the continuing design of prostheses for use in ankle arthroplasty and in interpretation of diagnostic images of the ankle joint. There are few studies which describe the morphometry of the TP and the MM (Fessy *et al.*, 1997), and none have been done on dry bones. Previous studies have employed radiographic techniques (Marianni and Patella, 1977; Fessy *et al.*, 1997), whereas the current study, makes use of dry bones and therefore adds to this body of knowledge. The mean length and width of the tibial plafond are lower than results from the radiological study done on an Italian populace (Marianni and Patella, 1977) and that of individuals of French descent (Fessy *et al.*, 1997). In these studies, workers recorded an average length and width of the TP of 34.5±2.3mm and 30.8±3mm respectively (Fessy *et al.*, 1997) and a mean length of the TP of 35.52±3.32mm (Marianni and Patella, 1977). Further, the mean height and breadth of the medial malleolus obtained from the

current study of 12.49±1.89mm and 20.78±2.22mm respectively are also lower than results recorded by these two previous studies of ankle joint morphometry. Fessy *et al.* (1997) obtained an average height of the medial malleolus of 13.1±1.8mm while Marianni and Patella (1977) recorded an average height of the malleolus of 13.43mm. Though the methodological differences limit direct comparison, the differences in these dimensions suggests populational variability. The smaller values recorded in the present study therefore suggests a smaller articulation at the ankle joint in the sample population studied. This should be noted in prostheses design as well as in interpretation of diagnostic images.

The larger measurements in the subjects is in keeping with the knowledge that males generally have wider ankle joints (Hayes *et al.*, 2006). However, the difference in the height of the medial malleolus was not statistically significant ($p > 0.05$) though females had relatively shorter malleoli. These observations could be due to differential loading at this joint among the sexes (Burghardt *et al.*, 2010), and should be noted in imaging diagnosis of ankle joint fractures and in prosthesis design.

In conclusion, the morphometry and anatomical variability of the TP and MM observed in this study should be taken to account in interpretation of

diagnostic images of the talocrural joint and hence guide appropriate interventions including surgical reconstruction as well as prostheses design.

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