Original communication

Anatomy Journal of Africa, 2014; 3 (1): 243 - 249

MORPHOMETRIC CHARACTERISTICS OF THE FIBULAR INCISURA IN ADULT KENYANS

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ABSTRACT

To describe the morphometry of the fibular incisura in a sample Kenyan population, a total of 156 tibiae were obtained for the present study from the Department of Human Anatomy, University of Nairobi and the osteology collection of the National Museums of Kenya, Nairobi. The height, width and depth of the fibular incisura as well as the length of the anterior and posterior incisural tubercles were measured using a digital pair of vernier calipers (SealeyProfessional Tools™). Average values for the height, depth and width of the fibular incisura were 32.35± 4.14mm, 3.44±0.87mm and 21.50±2.37mm respectively while average lengths of the anterior and posterior tubercles of the fibular incisura were 11.40±1.89mm and 16.11±2.08mm respectively. Majority of tibiae (75%) had a shallow concave fibular incisura (< 4.0mm). There were statistically significant differences between males and females in all these dimensions. Shallow fibular incisurae in the majority of the tibiae studied, as well as the predominant shallower, shorter incisurae in female subjects suggests an inherent osteological weakness in the tibiofibular syndesmosis. Data obtained in the current study provides baseline values to guide interpretation of diagnostic images.

Key words: Fibular incisura, tibio-fibular syndesmosis.

INTRODUCTION

The interosseous border of the tibia splits distally into anterior and posterior edges that project into anterior and posterior tubercles. These edges and tubercles enclose the fibular incisura (FI), a notch that articulates with the fibula (Williams *et al.*, 2005). This articulation, together with its associated ligaments, forms a syndesmosis that constitutes the 'mortise' which articulates with the 'tenon', the talus, at the talocrural joint. In this regard, the FI and the distal fibula form an anatomical unit whose stability depends largely on the FI's morphometry (Taser *et al.*,, 2009). Pertinent to this is thepopulational, inter-individual and sexual variability of osteometric dimensions (Igbigbi, 2003). It would therefore be important to avail data on the morphometry of the FI amongst individuals of African descent. However, these data are scarce and are altogether lacking from indigenous Kenyans. This study therefore sought to describe the morphometry of the FI amongst Kenyans with view to providing data that may guide the interpretation of diagnostic images of the ankle joint.

To cite. Misiani M, Mandela P, Obimbo M, Olabu B, Gikenye G. Morphometric characteristics of the fibular incisura in adult Kenyans. Anatomy Journal Of Africa 2014; 3 (1): 216-222.

MATERIALS AND METHODS

A total of 156 tibiae (91 male and 65female), obtained from the department of Human Anatomy and the osteology collection at the National Museums of Kenya (Nairobi), were used in the current study. These included tibiae with completely fused epiphyseal plates indicating they belonged to adults and whose sex could be identified from the records (Table 1).Tibiae with chipped 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 verniercalipers (Sealey Professional Tools ™, United Kingdom; accurate to 0.01 mm) by the author. To minimize intra-observer errors, several measurements of the same dimension were done and an average of these measurements was then recorded.The means and standard deviations of the width, height and depth of the FI, and the length of the posterior and anterior tubercles were calculated using SPSS software (Version 17.0, Chicago, Illinois). The statistical significance of the differences in the means of the measured dimensions between the sexes was determined using independent Student's *t* – test. A *p value* of <0.05 was considered statistically significant at 95% confidence interval.For those dimensions that displayed linear associations Pearson's correlation test was carried out to establish the strength of this association. Tables are used to present the data.

The dimensions measured included: the width of the fibular incisura which is the distance between anterior and posterior tubercles 1 cm proximal to the tibial plafond and the depth of the FI,the distance from the deepest point of the FI to a line between tips of the anterior and posterior tubercles. Other measurements included the length of the anterior (Chaput's) tubercle defined asthe distance from the deepest point of the FI to the tip of the anterior tubercle; the length of the posterior (Volkmann's) tubercle taken asthe distance from the deepest point of the FI to the tip of the posterior tubercle; the height of the FI which is the vertical distance between the tibial plafond and the point where the interosseous border splits into anterior and posterior edges (Figure 1).

RESULTS

The mean width, height and depth of the FI as well as the mean length of the anterior and posterior tubercles are presented in table 1.

Table 1: Measurements of the dimensions of the fibular incisura

Measure	Range (mm)	Mean (mm)	Std. Deviation
Height of the fibular incisura	21.2- 43.8	32.35	4.14
Depth of the fibular incisura	1.8- 6.4	3.44	0.87
Width of the fibular incisura	10.1- 26.6	21.50	2.37
Length of the anterior tubercle	7.2- 17.7	11.40	1.89
Length of the posterior tubercle	9.0- 20.6	16.11	2.08

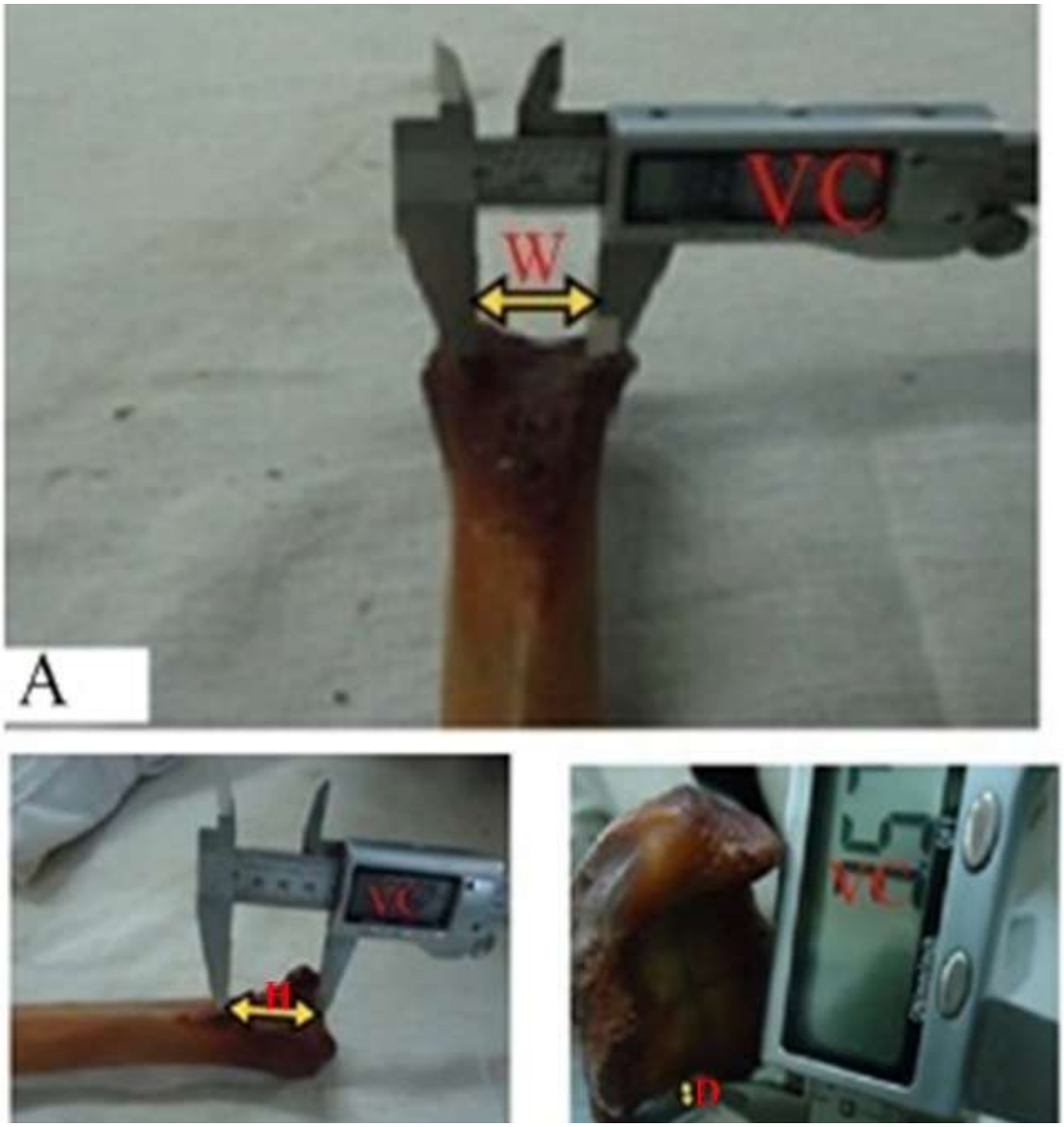

Figure 1: Measurements of the tibia and the fibular incisura. **Fig 1-a:** Photograph showing measurement of the width of the fibular incisura (**W**) using a pair of digital vernier calipers (**VC**). This dimension was defined as the distance between anterior and posterior incisural tubercles measured 1 cm proximal to the tibial plafond (Taser *et al*., 2009).**Fig 1-b:** Photograph showing measurement of the height of the fibular incisura (**H**) using a pair of digital vernier calipers (**VC**). This dimension was defined as the vertical distance between the tibial plafond and the highest extent of the fibular incisura (Taser *et al*., 2009). **Fig 1-c:** Photograph showing measurement of the depth of the fibular incisura (**D**) using a pair of digital vernier calipers (**VC**). This dimension was defined as the distance from the deepest point of the fibular incisura to a line between tips of the anterior and posterior tubercles (Sora *et al*., 2004; Taser *et al*., 2009). The fibular incisura was classified as deep concave (≥4.0 mm) and shallow concave (< 4.0 mm) (Taser *et al*., 2009).

The mean length of the posterior tubercle was larger than the mean length of the anterior tubercle. This difference was statistically significant ($p< 0.05$). The posterior tubercle was longer than the anterior tubercle in 137 (87.8%) of the cases. In all dimensions measured, males had longer measurements than females ($p<0.05$) (Table 2).

Table 2: Sex differences in the dimensions of the fibular incisura

Dimension	**Distance (mm)**		**Student's t-test**
	Male	**Female**	***p* value**
Height of the fibular incisura	31.41±3.66	29.85±2.33	0.028*
Depth of the fibular incisura	3.40±0.96	2.9±0.66	0.010*
Width of the fibular incisura	22.2±1.83	20.52±1.83	0.001 *
Length of the anterior tubercle	11.49±1.97	10.9±1.60	0.159
Length of the posterior tubercle	16.84±2.13	16.08±1.42	0.069

- Statistically significant at 95% confidence interval.

Table 3: Comparison of depth of the fibular incisura in different populations

Study	**Technique**	**Population**	**Mean depth**
Present study	Direct bone measurements	Kenyan	3.44±0.87
Present study	Direct bone measurement	Kenyan, Male	3.40±0.96
Present study	Direct bone measurements	Kenyan, Female	3.90±0.66
Yildrim*et al*., 2003	MRI	Turkish, Male	3.6
		Turkish, Female	2.9
Sora*et al*., 2004	Plastination study	Austrian	5.07±0.76
Kin*et al*., 2008	CT	Korean	3.1
Taser *et al*., 2009	Direct bone measurement	Turkish	3.68±1.49
Taser *et al*., 2009	Direct bone measurement	Turkish, Male	3.67±1.55
Taser *et al*., 2009	Direct bone measurement	Turkish, female	3.70±1.44

DISCUSSION

The height of the fibular incisura in the current study was found to be 32.35±4.14 mm a lower, though comparable value, to results obtained by Taser *et al*., 2009 of 39.14±2.75 mm who studied bones of individuals of Turkish descent. Since both measurements were done on dry bone and the parameters were defined similarly, it is plausible that this disparity could be due to populational variations between the indigenous Kenyan and Turkish individuals. A shorter FI indicates a lower bifurcation of the interosseoustibial ridge (Standring, 2008). Since the depth of the fibular incisura increases proximo-distally, a lower division of the interosseoustibial ridge results in a shallower fibular incisura(Hermans *et al*.,, 2010).

A comparison of the height of the fibular incisura between males and females was done. The statistically significant difference between the height of the incisura in males and females and could be explained by the shorter tibiae among female subjects. This observation has been reported by previous workers (Ebraheim*et al*.,, 1998; Taser *et al*.,, 2009) and could explain the predominance of shallower fibular incisura in female subjects.

The mean depth of the fibular incisura from the current study was 3.44±0.87mm. This value is comparable to that obtained in previous studies (Kin*et al*., 2008; Taser *et al*., 2009). Kim and colleagues obtained a mean depth of 3.1mm while Taser and co-workers obtained a mean depth of 3.68±1.49mm. The mean depth obtained in the current study was however less than a mean depth of 5.07±0.76mm obtained by Sora*et al*., (2004) in a plastination study, a difference that could have arisen from the different methodology employed.

Male subjects had deeper incisurae compared to females. The mean depth of 3.40±0.96mm in males and 2.90±0.66mm obtained in the current study was comparable average depth of 3.60mm in males and 2.9mm in females obtained in a magnetic resonance imaging study (Yildrim*et al*., 2003). Comparison of the depth of the fibular incisura among sexes in the current study demonstrated a statistically significant difference in the depth of the incisura in contrast to the findings by Taser et al (2009) who found no statistically significant difference in the depth of the incisura among males and females. This could be due to the greater sample size used in the current study as these workers used 35 tibiae as well as populational differences in osteometric dimensions due to differences in body habitus.

In the current study, 75% of the fibular incisurae studied were shallow concave in shape. This represents a higher proportion than that obtained by Taser *et al* (2009) who reported that 65% of incisurae were shallow concave. This is also a higher proportion than that reported by Ebraheim*et al*., (1998) who reported that 40 % were shallow concave. This difference could be attributed to the shorter incisurae observed in the current study. Moreover, 71.4% of tibiae from male subjects and 93.8% of tibiae from female subjects had shallow fibular incisurae which represents a higher proportion of shallow concave fibular incisurae than results obtained obtained by Mavi *et al*.,, (2002) who reported that 54.7% of the male subjects had deep (≥4.0mm) incisurae compared to 29.6% among females. This difference could be attributed to the shorter incisurae observed in the current study as well as the difference in the methodology employed in this study since these investigators used magnetic resonance imaging.

Shallow fibular incisurae have been implicated in the pathomechanics of

displacement of the fibula associated with fracture dislocation that results in instability of the tibiofibular syndesmosis and the ankle joint (Hermans *et al.*,, 2010). However, the etiology of syndesmotic injury is multifactorial (Kin *et al.*,, 2008) and as such, other stability factors of the tibiofibular syndesmosis should be investigated in considering predisposition to this condition (Mavi *et al.*,, 2002). A shorter height of the fibular incisura indicates a lower bifurcation of the interosseous tibial ridge (Standring, 2008). Since the depth of the fibular incisura increases proximo-distally, a lower division of the interosseous tibial ridge results in a shallower, narrower fibular incisura (Hermans *et al.*, 2010).

The average width of the fibular incisura in the present study is comparable to the value obtained by Taser *et al.*, (2009) of 23.26±3.11mm. The width of the fibular incisura is representative of the size of the tibiofibularsyndesmosis (Hermans*et al.*,, 2010) since a wider incisura indicates a greater separation of the anterior and posterior incisural tubercles. This translates to a shallower incisura(Hocker and Pachucki, 1989) that predisposes an individual to instability of the tibiofibularsyndesmosis.

The mean lengths of the anterior and posterior tubercles among Kenyans according to this study are 11.40±1.89mm and 16.11±2.08mm respectively. The mean length of the anterior tubercle among the Turkish population obtained from measurements on dry bone is 10.89±2.08mm (Taser *et al.*, 2009) while that of the posterior tubercle is 13.28±1.49mm. A comparison between males and females in the current study of the mean length of the anterior and posterior tubercles showed no statistically significant difference ($p > 0.05$). This observation has also been reported among individuals of Turkish descent (Yildrim*et al.*, 2003). Dimensions of the tibial tubercles can be used to infer the location of the fibula in the fibular incisura. Sora*et al.*, (2004) concluded from a plastination study of the ankle joint that the fibula is situated posteriorly in the FI. There is a relationship between the position of the fibula and recurrent ankle instability. In syndesmoses with a more posteriorly positioned fibula, there is less structural stability and they are therefore more susceptible to sprains (McDermott *et al.*, 2004).

In conclusion, the morphometry and anatomical variability of the FI revealed in this study should be taken to account in assessing the stability of the talocrural joint and interpretation of diagnostic images of the tibiofibular syndesmosis and talocrural joint.

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