Morphometric Measurements of The Tibial Plateau Among the Kenyan Population

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***Abstract*- Background**: The tibial plateau is the upper most surface of the tibia bone which forms the knee joint together with femoral condyles. It has a medial and lateral condyle. There are increasing cases of osteoarthritis of the knee with increasing age and trauma, hence the need for knee arthroplasty to restore functional anatomy of the knee. Arthroplasty requires accurate sizing of implants to the damaged knee, which will be guided by knowing morphometric measurements of Kenyan tibial plateaus which are unique to those of other populations.

Objective: To determine the morphometric measurements of the tibial plateau in dry human tibias of Kenyans.

Methodology: An anatomical cross-sectional study of dry tibia bones was done at the National Museums of Kenya, Zoology department, Osteology section. A total of 256 adult tibia bones were sampled in a consecutive non probabilistic purposive manner. For tibia bones with identifiable gender, male and female bones, which comprised all bones identifiable by gender in the museum, were separated and measurements taken. Additional bones with unknown gender were also taken to get to the sample size. Morphometric measurements of the tibial plateau were then taken using a digital vernier caliper and recorded on a data collection sheet and then transferred to Ms Excel Spreadsheet 2016. The data was analyzed using t-test.

Results: A total of 256 tibia bones were studied. Of these 131 bones (51.2%) were male, 91 bones (35.5%) female and 34 bones (13.3%) of unknown gender. There were 130 bones (50.8%) from the right side and 126 bones (49.2%) from the left side. The mean measurement for transverse width was 68.6mm (2.2) while for anteroposterior length was 48.6mm (1.7). The mean for the lateral plateau transverse width was 26.7mm (0.9) while for lateral plateau anteroposterior length was 36.5mm (1.3). The mean for the medial plateau transverse width was 26.6mm (1.1) while for the medial plateau anteroposterior length was 41.0mm (2.2). There was no statistically significant difference in measurements of the right and left tibial plateaus ($p>0.05$). Male tibial plateaus were larger than the female in all parameters measured ($p<0.05$).

Conclusion: Tibial plateau measurements of the Kenyan population are unique compared to those of other populations. The right and left tibial plateaus were essentially of the same size. Male tibial plateaus were larger than those of females.

Recommendation: Tibial plateau measurements of Kenyan population are unique compared to other populations hence need to develop implants suitable for them. Male tibial plateaus are larger than those of females hence need to develop implants suitable for each gender. Further studies to study 3D shapes of the tibial plateau for better understanding are recommended.

***Index Terms*-** Arthroplasty, morphometric measures, tibial plateau, tibia.

INTRODUCTION

The tibial plateau is the upper articular surface of the tibia. The plateau is formed into two concave articular areas; the medial condyle which is oval anteroposteriorly and the lateral condyle which is almost circular and slightly smaller than the former. They articulate with the corresponding femoral condyles to form part of the knee joint. The tibial plateau, a critical component of the knee joint, plays a crucial role in weight-bearing and joint stability. Understanding the morphometric measurements of the tibial plateau is essential for orthopedic surgeons, anthropologists, and researchers, as it provides valuable insights into population-specific anatomical variations and aids in the design of orthopedic implants tailored to diverse ethnic groups (Sinnatamby, 2011).

The knee joint is the most commonly affected joint by osteoarthritis which is the most common pathological disorder of knee. Cases of osteoarthritis are increasing with age with resultant disability (Akinpelu, Maduagwu, Odele & Alonge, 2011), increasing the need for knee replacement to restore anatomy and function. The morphometric measurements of the superior articular surface of the tibia have been found to differ among populations. Variations in morphometry among different populations of the world have been established from various studies (Murlimanju et al., 2016). These parameters have been

well studied among Caucasian, Indian and East Asian populations. Still, there is a paucity of information about the proximal tibia morphometric parameters of the African population. In a revision of 30 studies, only 3 of them, including 130 knees, belonged to black subjects, none African (Kim et al., 2017). Also, different anatomical profiles would not fit correctly with conventional knee prosthesis components (Gupta, Phan & Scwhwarzkopf, 2015).

The morphometric measures of the tibial plateau have been done using dry bones (direct method) (Murlimanju et al., 2016), and indirect methods which include computed tomography (CT) (Moghtadaei, Moghini & Shahoseini, 2015) and magnetic resonance imaging (MRI) (Fan et al., 2017).

Tibia plateau morphometric measurements may not differ based on laterality. Lakati and Ndeleva in 2018 did a prospective study about tibial plateau morphometric measures among the Kenyan population in two universities' human anatomy departments utilizing human dry tibia bones (Kenyatta University and Egerton University). The findings were striking as they showed that there was no difference in terms of morphometric tibia plateaus between right and left tibia bones (Lakati & Ndeleva, 2018).

All of the prostheses locally used in TKA have been sized and manufactured using dimensions of tibiae from different populations, which may be different from those of the local population. Studies have shown that morphometric measurements of the proximal tibia differ between populations and between genders (Kwak et al., 2007). Local studies have also shown that the morphometric measurements of the femur from the local population differ from those of other populations (Lakati & Ndeleva, 2018; Murlimanju et al., 2016).

Morphology of the plateau of the tibia, especially size and shape, have great influence in TKA (Dai & Bischoff, 2013) through the development of tibial tray families that reflect adequately the diversity of global anatomy using appropriate number of components.

Total knee replacement has become a standard orthopaedic procedure with the advancement of orthopaedic practice in the Kenyan population. However, most of the implants used are imports manufactured elsewhere. With variations in morphometric measures of the plateau of the tibia among different population sets (Misir, Yildiz & Kizkapan, 2019), it is imperative to have values for the Kenyan population to guide manufacturers on the suitable sizes for the Kenyan people.

The objective of this study was to determine the morphometric measurements of the tibial plateau in dry human tibias of the Kenyan population.

METHODOLOGY

This study was done at the National Museums of Kenya, Zoology department, Osteology section.

This was an anatomical cross-sectional study involving measurements of the various aspects of the tibial plateau in dry human tibias. This was a study done on dry adult human tibia bones.

All skeletally mature tibia bones with were incorporated into the study.

Tibia bones with abnormal or defaced features on the proximal end were excluded from the study.

The sample size was 256 dry human tibia bones, 131 male bones, 91 female bones and additional 34 bones of unknown gender.

The specimens included all dry bones which met the inclusion criteria. Measurements were taken using a digital vernier caliper (Mitutoyo, Japan) at the National Museums of Kenya, Nairobi. The measurements taken were then recorded on data collection sheet and later transferred to digital form for storage. The measurements were taken thrice and recorded. The average was then calculated to reduce errors from a single measurement and thus improve accuracy.

The measurements taken included total transverse width, the total anteroposterior length of the intercondylar area, transverse widths of medial and lateral tibial plateaus and anteroposterior lengths of both medial and lateral tibial plateaus.

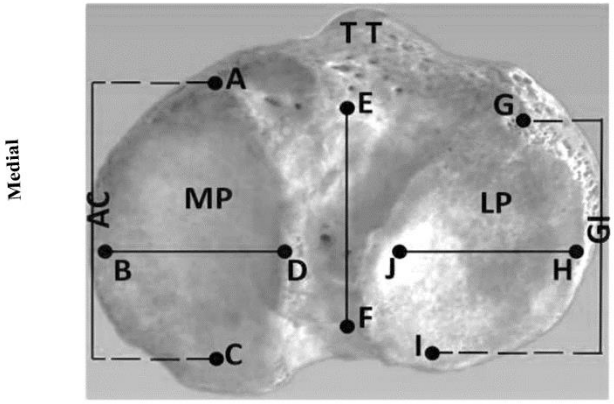

Figure 2.1.2.1: Morphometric Anatomy of the Tibia Plateau in Nigerians (Eboh et al., 2021).

Key: **AC:** Medial plateau anteroposterior length; **BD:** Medial plateau transverse width; **EF:** Anteroposterior length; **GI:** Lateral plateau anteroposterior length; **JH:** Lateral plateau transverse width; **MP:** Medial tibial plateau; **TT:** Tibial tuberosity.

The analysis was done using STRATA version 16.1. The measurements were summarized as means and corresponding standard deviations as the data assumed normal distribution. Medians were also determined from the data.

The values for the right and left sides were compared and statistical significance determined.

Values for males and females were also compared and statistical value determined. Independent (unpaired) samples t-test was used to test if there was a significant mean difference between data on the right and left sides, and between female and males.

Before the study commenced, approvals were obtained from Moi University/MTRH Institutional Research and Ethics Committee (IREC) and approval number is FAN-0004482.

Approval was also sought from the National Museums of Kenya and affiliation letter was obtained. Additionally, permission was sought from NACOSTI and NACOSTI license number NACOSTI/P/23/28102 was obtained.

The study was conducted as per the Anatomy Act Chapter 249-3 of the Laws of Kenya (Forbes, 1952) which entitles a person registered as a student of any approved school of anatomy to examine cadavers anatomically.

The data collected was secured under lock and key and those in electronic format were secured with passwords. After using the data, they will be disposed of as per regulations.

Confidentiality and anonymity were maintained throughout data collection, storage and analysis.

STUDY FINDINGS

A total of 256 dry human tibia bones were examined. Of these 131 were from the male gender accounting for 51.2% of the total human tibias examined. Female tibias examined were 91 accounting for 35.5% of the total bones examined. Those of unknown gender were 34 accounting for 13.3% of the sample size. The tibias of the right side examined were 130 accounting for 50.8% of the study sample while those of the left side were 126 accounting for 49.2% of the study sample.

The mean of the total transverse width was 68.6 mm with a standard deviation of 2.2 mm. The range of this measurement was from 62.99 mm to 75.12 mm.

The mean of the total anteroposterior length was 48.6 mm with a standard deviation of 1.7 mm. The range of the values for this measurement were from 44.3 mm to 53.1 mm.

The mean of the transverse width of the lateral tibial plateau was 26.7 mm with a standard deviation of 0.9 mm. The range of the values for this measurement were from 24.2 mm to 29.3 mm.

The mean of the anteroposterior length of the lateral tibial plateau was 36.5 mm with a standard deviation of 1.3 mm. The range of the values for this measurement were from 33.6 mm to 39.9 mm.

The mean value for the transverse width of the medial tibial plateau was 26.6 mm with a standard deviation of 1.1 mm. The range of the values for this measurement were from 23.98 mm to 29.82 mm.

The mean value for the medial plateau anteroposterior length was 41.0mm with a standard deviation of 2.2 mm. The range of the values for this measurement were from 36.3 mm to 45.9 mm.

The mean value for the total transverse width of the right tibial plateau was 68.6 mm with a standard deviation of 2.2 mm while that of the left side was 68.7 mm with a standard deviation of 2.3 mm.

The mean value for the total anteroposterior length of the right tibial plateau was 48.6 mm with a standard deviation of 1.6 mm while that of the left was 48.6 mm with a standard deviation of 1.8 mm.

The mean value for the transverse width of the right lateral tibial plateau was 26.7 mm with a standard deviation of 1.0 mm while that of the left was 26.7 mm with a standard deviation of 0.8 mm.

The mean value of the anteroposterior length of the right lateral tibial plateau was 36.5 mm with a standard deviation of 1.5 mm while that of the left was 36.5 mm with a standard deviation of 1.2 mm.

The mean value of the transverse width of the right medial tibial plateau was 26.6 mm with a standard deviation of 1.1 mm while that of the left was 26.6 mm with a standard deviation of 1.1 mm.

The mean anteroposterior length of the right medial tibial plateau was 40.9 mm with a standard deviation of 2.2 mm while that of the left was 41.1 mm with a standard deviation of 2.2 mm.

Among the males, the mean value of the total transverse width was 69.5 mm with a standard deviation of 2.1 mm while among the females it was 67.1 mm with a standard deviation of 1.9 mm.

The mean value for the total anteroposterior length among the males was 49.3 mm with a standard deviation of 1.5 mm while among the females the mean value was 47.4 mm with a standard deviation of 1.5 mm.

Among the males, the mean value for the lateral tibial plateau transverse width was 26.9 mm with a standard deviation of 0.7 mm while the mean value of the females was 26.5 mm with a standard deviation of 1.2 mm.

The mean value of the anteroposterior length of the lateral tibial plateau among the males was 36.9 mm with a standard deviation of 1.3 mm while that among the females was 35.7 mm with a standard deviation of 1.1 mm.

Among the males, the mean value of the transverse width of the medial tibial plateau was 27.0 mm with a standard deviation 1.1 mm while that of females was 25.9 mm with a standard deviation of 0.9 mm. The mean value of the medial tibial plateau anteroposterior length among the males was 42.2 mm with a standard deviation of 2.0 mm while that of the females was 39.1 mm with a standard deviation of 1.4 mm.

CONCLUSION

In conclusion, the study sampled more male tibias compared to the female, and that the right side tibias were more than the left.

The various morphometric measurements taken for the transverse width and anteroposterior length of the tibial plateau varied with those of other populations done in other studies. The total transverse width measurement of the tibial plateau of the Kenyan population was similar to those of some populations but varied with those of others from previous studies. The total anteroposterior length measurement of the tibial plateau of the Kenyan population was similar to those of some populations but varied with those of others from other studies.

The transverse width and the anteroposterior length of the lateral tibial plateau of the Kenyan population are similar to those of some populations but varied with those of other populations from other studies. The lateral tibial plateau anteroposterior length measurements of the Kenyan population were similar to those of

some other populations but vary with those of other populations from other studies.

The transverse width and the anteroposterior length of the medial plateau of the Kenyan population were similar to those of some populations but varied with those of other populations from other studies. Medial tibial plateau anteroposterior length measurements of the Kenya population were similar to those of some populations but varied with those of others from previous studies.

Comparison of the morphometric measurements of the right and left tibial plateaus of the Kenyan population shows they were similar in all the parameters measured.

Comparison of the morphometric measurements of the tibial plateaus of males and females show that the Male measurements were larger than those of female in all the parameters measured.

DISCUSSION (MISSING)

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