

Anthropometric Measurements of the Distal Femur in Adult Sudanese Population

Abstract

Background: Acquiring knowledge about anatomic and geometric measurement of bone is among the most vital parameters in knee arthroplasty and has a significant effect on the subsequent outcomes. The aim of this study is to obtain anthropometric measurements of the distal femur of adult Sudanese Population and to compare the results with other populations.

Methods: This descriptive study conducted at Alamal hospital in Khartoum, Sudan, between Sep. 2020 and Feb. 2021, included all adult patients attending the radiology clinic for CT scan with normal knees. The Femoral medio-lateral (ML) and anteroposterior (AP) dimensions of the distal femora were measured. The collected data was analysed using statistical package for social science (SPSS).

Results: 385 adult Sudanese were studied. The mean age was 59.1 ± 18.5 years (Range 20-86 years). 69.9% were male and 30.1% female. 45% were left knees and 55% right. The mean ML diameter was 76.6 ± 6.0 mm (rang 66.7-88.2mm), and the mean of AP was 45.640 ± 4.9 mm (range 37.2-54mm). The anthropometric measurements of the distal femur of Sudanese people fall between Greek and Korean.

Conclusion: There were differences in mean ML and AP dimensions between the Sudanese population and other ethnic groups which should be kept in mind when designing Total Knee Arthroplasty implants.

Keywords: Femur, Knee, Knee Arthroplasty, Sudan, Epidemiologic Measurements

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Introduction

Knee arthroplasty is a reliable procedure that provides pain relief and improves the patient's functional status ⁽¹⁾. The most common clinical diagnosis requiring knee arthroplasty is primary Osteoarthritis (OA). However, other potential underlying diagnoses include: inflammatory arthritis, fracture (post-traumatic OA and/or deformity), dysplasia, and malignancy ⁽²⁾. Total Knee Arthroplasty (TKA) is an excellent treatment option for individuals with symptomatic osteoarthritis who have failed conservative treatment, while partial knee arthroplasty (PKA) is for osteoarthritis localized to one compartment of the knee and who have failed conservative treatment ^(1,3). During TKA accurate bone cutting, adequate balancing of the soft tissues and proper coverage of the resected surface with a proper size implant are important factors for achieving a successful outcome such as; functional range of motion and proper patellar tracking ⁽⁴⁾. Additionally, a properly shaped prosthesis can provide the best coverage and avoid soft tissue impingement. This in turn, reduces a number complication which can arise from the mismatch between the prosthesis size and the bone e.g. stiffness, bleeding, loosening and per-prosthetic fractures ⁽⁴⁻⁶⁾. Majority of the existing TKA implants are designed based on the Caucasian population ⁽⁷⁾. However, both ethnic and gender differences in the anthropometric measurements of the distal femur have been reported in the literature. For instance, Johan Bellemans et al found that both morph type and gender influence the medio-lateral dimension of the distal femur ⁽⁸⁾. Additionally, many studies have highlighted the variations in the anteroposterior (AP) and the medio-lateral (ML) measurements of the distal femur among different ethnic groups such as; Indian, Kenyan, Korean, Iranian,

Malay, Chinese and Greek in addition to emphasize on the differences between these ethnic groups and Caucasian Ethnicity⁽⁹⁻¹⁴⁾ Table (1). Nevertheless, to the best of our knowledge, there is no published research studying these measurements among Sudanese population.

Considering that, most of the available TKA prostheses might have a mismatch when implanted in other ethnic group. In other words, implant designed for a particular population might not be suitable for others. Hence, the desirable goals of the surgery cannot be achieved unless these differences were taken into consideration by the designing companies.

This study aims to assess the anthropometric measurements of the distal femur among Sudanese population and to compare between this measurements and the measurements of other ethnic groups in order to enrich both the local and international literature in addition to providing information about the differences in Sudanese population to be taken into account by the prosthesis designers while developing knee implants.

Methods

This descriptive study was conducted between September 2020 and Feb 2021 at Alamal Hospital – which has one of the biggest radiology centres – in Khartoum, Sudan. All adult people undergoing CT-Angiography for reasons not related to knee pathology were included. Patients with previous fractures, patients who had previous knee surgery, patients with epiphysio-metaphyseal disease or any tumour near knee joint, and patients with any congenital abnormality affecting knee joint were excluded.

Total of 385 knee radiographs were studied. The ML and AP dimensions of the distal femur were measured using a viewing plane that was placed perpendicular to the mechanical axis of the femur (6° greater than the anatomical axis). The measurements were taken in the cuts that were 8-9 mm from the articular surface of the medial femoral

condyle. These cuts were chosen, as the normal distal femoral cut taken in TKA is 9mm. The ML was defined as the maximum length measured on the cut surface (viewing plane) along the femoral trans-epicondylar axis. The AP dimension was measured as the average of the distances between the most posterior point of the posterior condyle and the most anterior point of the corresponding anterior condyle, both for the medial and lateral condyles. Data were collected and analyzed by SPSS (version 26).

Results

The mean age was 59.1±18.5 years. (Range 20-86 years). 269(69.9%) of the patients were male, and 117(30.1%) female. 173(45%) were left while 212(55%) were right.

The mean ML diameter of the knee was 76.6±6.0mm (rang 66.7-88.2mm), while the mean AP diameter was 45.640±4.9mm (range 37.2-54mm) Table (1).

The mean AP, and ML diameter were 46.6±4.7 (range 37-54mm, and 78.8±5.5, range 66-88mm) respectively in male, and 43.5±4.6 (range 37.9-50mm), and 72.75±5.4 (range 67-88mm) respectively in female cases.

There were no statistically significant difference in mean ML, and mean AP between male and female, $p = 0.145$.

Discussion

This is a descriptive study of anthropometric measurements of 385 adult Sudanese using CT-Angiography images. As shown in table (1), the mean ML of the knee among participants was 76.6±6.0mm and the mean of AP was 45.640±4.9mm.

As the mismatch between the implant and the bone can lead to disastrous complications⁽¹⁵⁾, the first priority in selecting a suitable implants which is neither short, nor overhangs in any dimension. Sudan is ethnic differences have not received much focus given that most existing TKA implant designs are based on the western populations.

Although it was not statistically significant, in this study male cases had larger average of ML width than females similar to the results

of Johnston A et al cadaveric study in a British population ⁽¹⁶⁾. Similarly, Mahfouz M, et al reported that males had larger knees, than females with a mean of 5-mm-larger anteroposterior dimension, in all ethnic groups included in their study ⁽¹⁷⁾.

This study is highlighting that Greek had the largest mean ML diameter of 83.9 ± 6.3 mm, followed by Sudanese 76.63 ± 6.00 mm, Korean

70.2 ± 5.5 mm, and Iranian 67.06 ± 6.3 mm. The Indian people had the shortest mean ML width 62.7 ± 4.8 mm while longest mean AP width was reported among Indian 61.50 ± 5.62 mm, followed by Kenyan 61.2 ± 4.17 , Iranian 60.82 ± 3.9 , and Malay 59.88 ± 5.37 mm. The shortest AP diameter is in Korean 43.9 ± 3.8 mm, and Sudanese 45.64 ± 4.96 mm Table (1).

Table 1: Medio-lateral and anteroposterior distal femoral diameters in various studies

Author	Ethnicity	ML(mm)	AP(mm)
This study	Sudanese	76.63 ± 6.00	45.64 ± 4.96
Lakati KC, et al (12)	Kenyan	68.4 ± 5.19	61.2 ± 4.17
Terzidis et al (13)	Greek	83.9 ± 6.3	58.5 ± 4.0
Shah et al (9)	Indian	62.7 ± 4.8	62.7 ± 4.8
Moghtadaei et al (10)	Iranian	67.06 ± 6.3	60.82 ± 3.9
Ewe et al (11)	Malay	65.46 ± 6.23	59.88 ± 5.37
Ewe et al (11)	Indian	65.33 ± 4.56	61.50 ± 5.62
Ewe et al (11)	Chinese	64.68 ± 4.47	59.45 ± 4.33
Kwak et al (14)	Korean	70.2 ± 5.5	43.9 ± 3.8

Conclusion

While the mean ML diameter among participants was 76.6 ± 6.0 mm, and AP diameter was 45.64 ± 4.9 mm. The mean ML and AP measurements of the distal femur among Sudanese population differ from other ethnic groups. The observation of such Sudanese population's specific measures by implant manufacturers is highly recommended. Further studies are needed to evaluate any clinical impact of implant designs based on these ethnic differences.

Ethical Consecrations

Prior to the commencement of the study ethical approval was obtained from the ethical committee at the Faculty of Medicine and Health Sciences, Omdurman Islamic University. Research code

(SD.REC.OIU.0812.003). Informed consent was obtained from all patients included in the study.

Conflict of interest

Authors declare that he has no conflict of interest.

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