A radiographic study of the femoral and tibia condyle angles in adult nigerians

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Abstract

Morphometry of the bony components of the knee joint is important in clinical, forensic and medico-legal applications**.** The aim of this study was to evaluate the mean values of the femoral and tibia condyle angles of the normal knee joint of Nigerians. A total of 500 standard Anteroposterior radiographs of the knee of Nigerians collected from the radiology departments of various teaching hospitals across Nigeria were used. From the obtained radiographs, the femoral condyle and tibia condyle angles were measured using meter rule and goniometer by standard protocols described by literature. Analysis was done using SPSS 20.0 version; hence mean and standard deviation was obtained. Z-test was used to compare mean values at 0.05 significant levels. The index of sexual dimorphism was also applied to ascertain level of sexual difference. The results showed sexual dimorphism in the femoral and tibia condyle angles measured ($p<0.05$). Racial dissimilarities were seen in mean values when compared with other races. Knowledge of these values is important in evaluation of sex, racial differences and in clinical applications. Thus, it is recommended that anatomist, forensic anthropologist, radiologists, orthopedic surgeons and orthopedic manufacturing companies adopts these findings as a reference guide for the Nigerian population.

Keywords: femoral condyle angle, tibia condyle angle, knee joint, sexual dimorphism, Nigerian adults

1. Introduction

Radiographic anatomy is the study of the structure of the body using x-ray. It provides information about normal structures in living individuals as affected by muscle tone body fluids, pressures and gravity. Studies of the knee joint in radiographs gives an understanding of the normal anatomy of the knee and hence diagnosis of pathologic conditions that may arise [1]. The bones of the knee joint form linear distances from markable points on themselves as well as on the knee joint and varying angles with each other. This is termed the Axial relationship [1, 2]. The values of these angles and lengths from these points calculated from radiographs are used as diagnostic tools to injury or pathologic conditions of the knee joint, sexual and racial identification and baseline data for appropriate determination of sizes in the design of prosthesis [3]. The femur and tibia condyle angles are two of such relationships. It should be known how far normal standards deviate and where pathological values can be expected [2]. Anatomical knowledge of the femur condyle and tibia condyle angle is essential in the diagnosis and treatment of some knee conditions, in the manufacture of knee prosthesis and in forensics for sexual and racial identification. However, there is paucity of data on these parameters in Nigerians hence the need to have reference values. The Femoral Condyle Angle is the angle between axis of femoral shaft (AFS) and axis of femoral condyle (AFC) and the Tibia Condyle Angle is the angle between the axis of tibia shaft (ATS) and axis of tibia condyle (ATC) [2]. Keats et al (1966) [2], gave the femoral condyle angle as 75 - 85^0 for both males and females with an average of $\bar{x}$ 81^0 and the Tibia condyle angle as 85^0 - 100^0 for males and 87^0 - 98^0 for females with an average $\bar{x}$ of 93^0. Deviation from these value suggested fractures as well as knee osteoarthritis. Researches from different authors have suggested that difference in parameters of bones exists among different races and have tried to figures out the relationships of these variations to increased knee pathology. It has also been argued that sexual and racial differences exist in the femur bone a fact that could lead to mismatched prosthesis if not taken into consideration and also in other anthropometric applications [4, 5]. It is well known that Asian sub population are smaller with shorter stature compared to their Caucasian counterparts [6]. it follows that these discrepancies may give rise to implant size mismatch with the resected bony surfaces of Nigerian patients since most of these prosthetic components are imported [4, 5]. Some studies have suggested that due to the comparatively larger built and stature of the African population they may have larger bony structure and components than their western counterparts and many surgeons believe that imported implants which are mainly designed from the morphometric data gained from the western population may not be suitable for patients located in African countries (Nigerians inclusive). The Femoral and Tibia Condyle Angles therefore could serve as reference standard for Manufacture of appropriate knee prosthesis for the Nigerian Population taking into consideration sex and side.

2. Materials and methods

Five hundred (500) x-ray films of Adult Nigerians (250 males and 250 females) were randomly selected from Normal

Anteroposterior radiographs of the knee joint.

The femoral condyle and tibia condyle angle were measured directly from Antero posterior radiographs of the knee joint as follows:

- **Femoral Condyle Angle:** Is the angle between axis of femoral shaft (AFS) and axis of femoral condyle (AFC) Keats et al (1966) [2]. It is measured by drawing a line along the axis of the femur and another line along the axis of the femoral condyles. The angle is then measured between both lines with a goniometer.
- **Tibia Condyle Angle:** Is the angle between the axis of tibia shaft (ATS) and axis of tibia condyle (ATC). Keats et al (1966) [2]. It is measured by drawing a line along the axis of the tibia and another line along the axis of the tibia condyles. The angle is then measured between the lines with a goniometer.

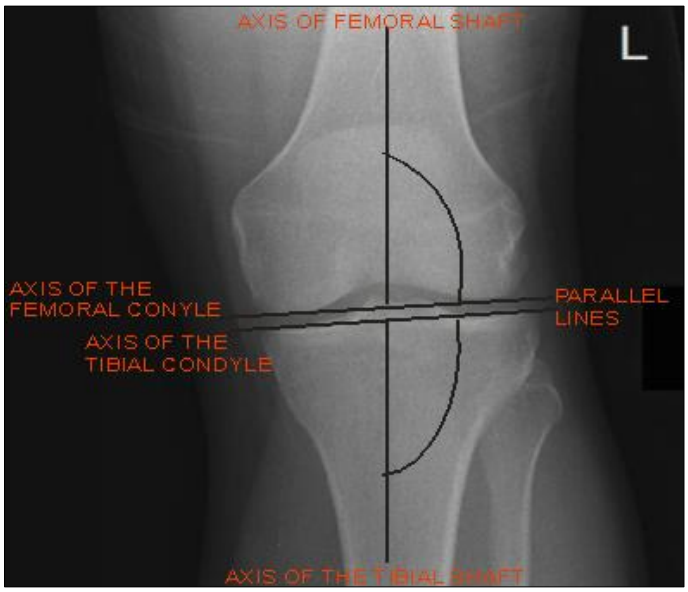

Fig 1: Femoral and Tibia Condyle angle

The name, age and sex of each subject on the x-ray together with the measured parameters were recorded. The age range for the individuals was 20-64. The radiographs for males and females were classified separately into nine (9) age groups spanned five (5) years interval (table 4.1 and 4.2). S.P.S.S (Statistical package for social sciences) 20.0 version was used for statistics. Data was presented as mean ± standard deviation. Z-test was used to test the difference between male and female values. The data was analyzed with statistical acceptance at p =0.05. A probability level of p<0.05 (as been significant).

The index of sexual dimorphism was calculated as follows:

$$\text{Index of sexual dimorphism (ISD)} = \frac{\text{Mean value of male}}{\text{Mean value of female}} \times 100$$

This index indicates the level of difference between sees. Values close to hundred indicate low level of sexual difference and conversely the level of sexual difference increases with the increase of the distance from hundred [7].

3. Results

The Result is presented in Tables 1-6.

Table 1: Age distribution, Mean Femoral condyle and Tibia condyle angles of Nigerian males

Age group	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
Frequency	20	50	55	45	35	25	15	10	5
Femur condyle angle	84.3	83.8	82.8	82.5	81.5	81.3	81.2	81.2	81.0
Tibia condyle angle	97.8	95.8	94.9	94.8	94.2	93.7	92.9	92.6	91.1

Table 2: Age distribution, Mean Femoral condyle and Tibia condyle angles of Nigerian Females

Age group	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64
Frequency	20	50	55	45	35	25	15	10	5
Femur condyle angle	83.5	83.4	82.5	81.9	81.8	81.7	80.8	80.6	80.2
Tibia condyle angle	96.0	95.2	94.2	94.4	93.6	93.4	92.4	91.2	90.1

Table 3: Mean Values of Femoral and Tibia condyle angle and test of significance of Nigerian males and females

Parameter measured	Males (n=250) Mean± SD	Females (n=250) Mean± SD	*p* value	Inference P=0.05
Femoral condyle angle	82.94 ± 0.6	81.60 ± 0.8	*P*< 0.05	Significant
Tibia condyle angle	94.69 ± 1.03	93.47 ± 1.35	*P*< 0.05	Significant

Table 4: Mean, SD, and the Index of Sexual Dimorphism (ISD) of the Parameters

Parameters (CM)	Male	Female	Index of sexual dimorphism (ISD)
Femoral condyle angle **(°)**	82.94±0.6	81.60±0.8	101.6
Tibia Condyle angle **(°)**	94.69±1.03	93.47±1.35	101.4

Table 5: Range of measurement for the parameters measured

Parameters measured	Range of measurement
Femoral condyle angle	79- 85 Degrees males 78- 84 Degrees females
Tibia condyle angle	90- 99 Degrees males 89- 97 Degrees females

Table 6: Comparison of Mean values of femoral and tibia condyle angles in Adult Nigerians with data on Caucasian found in listed literature

***p* = 0.05**	**Present study**		**Caucasians**		**Authors**
Femoral condyle angle	82.94 ± 0.6	81.60 ± 0.8	81.0 ± 1.6	80.5 ± 1.5	Keats et al (1966
Tibia condyle angle	94.69 ± 1.03	93.47 ± 1.35	93.0 ± 2.5	92.5 ± 2.0	Keats et al (1966)

It was observed in table 1 and 2 that the age range of 20-24 had the highest Mean Values in the Femoral Condyle and Tibia Condyle Angles. While the least values were recorded for the 60-64 years age group. Males had greater values in all parameters than females in all age groups. Statistical analysis from table 3 shows that males had significantly greater values than females showing sexual dimorphism ($p<0.05$). In table 4 showing the Index of sexual dimorphism which is used to ascertain the level of sexual difference between sexes, both the femoral condyle angle and the tibia condyle angle gave values further than 100.

Values further than 100 indicate high level of sexual difference between sexes. Table 5 gives the ranges of measurements taken for each parameter. In table 6 values from this study were greater than those of Caucasians as recorded by Keats *et al.*, (1966) [2].

4. Discussion

The study was directed towards investigating the normal mean values of the femoral condyle and tibia condyle angles of the normal knee joint of Nigerians.

From the study, mean femoral condyle and tibia condyle angle for Nigerian male was 82.94± 0.6 and 94.69± 1.03 respectively. Mean femoral condyle and tibia condyle angle for Nigerian female was 81.60± 0.8 and 93.47± 1.35 respectively. There was a significant difference in the mean femoral condyle angle and tibia condyle angle between Nigerian male and female ($p< 0.05$). This could be as a result of genetic makeup and inheritance which manifest as sexual dimorphism as reported by previous authors on most anthropometric parameters [8, 9, 10]. This agrees with the study of (Udoaka *et al*.,) [1] which found sexual dimorphism with these parameters. It has been suggested that genetic factors exert a substantial influence on the individual differences in body shape and configuration and therefore should be considered in developing standards for various populationsv [11].

The index of sexual dimorphism gave values further than 100, an indication of the high level of sexual difference in these parameters.

The result of this study showed ethnic differences from Caucasian values (often quoted in standard textbooks of anatomy and orthopedics) and showed the sexual dimorphism seen in Caucasian subjects. It showed higher values than those of Caucasians. Previous studies have shown that whites have more anterior bowing and shorter femur than blacks [12, 13, 14], a fact that could explain for the racial differences reported here.

The clinical importance of the femoral condyle and tibia condyle angle in the diagnosis and management of fractures as well as in knee osteoarthritis is stressed for practicing orthopedic surgeons [15]. Also, the tibia condyle and femoral condyle angles are useful as forensic tools in sexual and racial identification which is paramount in forensic and medico legal cases [13]. This Study has provided a reference standard for the Nigerian Adult population.

5. Conclusion

This study has been able to establish the mean femoral and tibia condyle angles of the normal knee joint of Nigerians. As in other population femoral condyle angle and tibia condyle angle are sexually dimorphic among Nigerians and therefore can be used to identify sex. The values for Nigerian males were greater than those of females ($p < 0.05$). Comparison with those of Caucasians showed ethnic differences. Knowledge of these values is important in evaluation of sex, racial differences and in clinical applications. Thus, radiologist and orthopedic surgeons should utilize this knowledge in diagnosing knee joint pathologies and in corrective surgery involving the knee.

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