Original Article

Morphometry and Significance of Collodiaphyseal Angle among Bini Tribe in Southern Nigeria

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Abstract

Introduction: The collodiaphyseal angle (CDA) is an angle formed between the femoral neck and femoral shaft axes. It is a vital determinant of femoral neck fracture as narrower angle is often used as a predictor of stress fracture. It is also important in orthopedic treatment planning, especially hip replacement surgery. **Aim:** This study was carried out to evaluate the CDA values among the Bini tribe and elucidate its significance. **Methodology:** This study employed 200 anterior-posterior pelvic radiographs of the Bini tribe (100 males and 100 females) aged between 25 and 55 years obtained from selected radiological diagnostic centers in Benin City, Nigeria, after obtaining the Institutional Ethical Approval. They were used to evaluate the right and left CDA as an angle formed by intersection of the femoral neck and shaft axes and measured using the goniometer. Data were statistically analyzed using IBM-SPSS (version 20) with the mean, standard deviation, and range evaluated, and side and gender comparisons were done using *t*-test, and $P < 0.05$ was set as statistically significant level. **Results:** The average CDA was 135.56° ± 5.75° and 131.67° ± 6.15° in males and females, respectively. This angle showed significant gender differences bilaterally ($P < 0.05$). However, the bilateral differences in the CDA were not statistically significant among either male or female Binis ($P > 0.05$). **Conclusion:** The CDA can be employed as a morphometric indicator of sexual differences and for other clinical applications.

Keywords: Bini tribe, collodiaphyseal angle, human morphometry, Nigeria

Introduction

Physical anthropometry has been widely described as a branch of anthropology that entails morphometric study of different parts of the human body. It can be further described as the study of physical dimensions of distinct parts or the whole of the human body.[1-3] In general, human body dimensions are influenced by various factors such as age, gender, racial affiliation, and environmental conditions.[4,5] In essence, anthropometric studies are often conducted to determine the standard values of different bodily structures including skeletal, dental, or soft tissues in different populations.[6,7] In addition, anthropometric parameters have been vitally applied in different medical procedures such as clinical diagnosis, treatment planning, reconstructive surgery, and forensic medicine.[8]

One of such anthropometric parameters is the collodiaphyseal angle (CDA) which is the angle formed between the femoral neck and shaft longitudinal axes. The CDA is also referred to as neck-shaft angle, diaphysio-femoral neck angle, angle of the neck of femur, angle of inclination, collum-diaphyseal angle, or cervicodiaphyseal angle.[9,10] It is a vital determinant of femoral neck fracture as narrower angles are often used as a predictor of stress fractures.[11] It is therefore crucial in orthopedic treatment planning, particularly in hip replacement surgery, and determining the choice of implants for proximal femoral or transtrochanteric fractures.[12,13]

These important roles of CDA necessitated this study among the Bini tribe in the southern part of Nigeria. The objectives of this study were to determine the CDA using radiographs of patients from the Bini tribe in southern Nigeria and to elucidate its significance.

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Methodology

Study design and population

This is a retrospective descriptive cross-sectional study that used 200 anterior-posterior physical pelvic radiographs accessed from two radiological diagnostic centers in Benin City, Nigeria (6° 20′ 17.34″ N and 5° 37′ 32.70″ E). The study involved participants of Bini descent (100 males and 100 females) aged between 25 and 55 years (based on available records of patients), who were referred for pelvic imaging between 2013 and 2017. The names and biodata on selected radiographs were used as an indicator of their Bini descent.

Method of data collection

The CDA was measured as the angle formed by intersection of longitudinal axis of femoral neck and longitudinal axis of femoral shaft on the right and left sides using the goniometer [Figure 1]. The longitudinal axis of femoral neck was determined by joining two midpoints of femoral neck diameters with the femoral head, while the longitudinal axis of the femoral shaft was determined by joining two midpoints of the proximal femoral shaft distal to lesser trochanter.[14,15] All measurements for the right and left sides were recorded, and the average values were evaluated.

Inclusion and exclusion criteria

Only radiographs showing the right and left hip joints with normal articulation of the femoral head within the acetabulum of the hip bones bilaterally were included in this study. All radiographs showing only unilateral hip joint or fracture of the proximal and middle parts of the femur were excluded from this study.

Ethical approval

The study was approved by the Research and Ethical Committee, School of Basic Medical Sciences, College of Health Sciences, Igbinedion University, Okada, Edo State, Nigeria (08/009965/HSC).

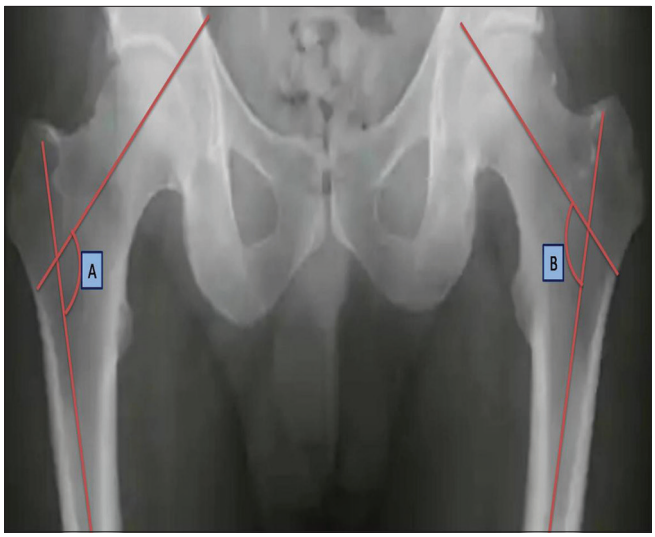

Figure 1: Plain anteroposterior pelvic radiograph showing the right CDA (A) and left CDA (B) formed by intersection of the longitudinal axes of the femoral neck and shaft on the right and left sides. CDA: Collodiaphyseal angle

Participants' consent

The study was explained to all the participants, and their informed consent was obtained before the study.

Statistical analysis

All measured and recorded values were statistically analyzed using IBM-SPSS (version 20, IBM Corp, NY, USA) software for Windows. The mean, standard deviation (SD), and range were evaluated. Statistical comparisons were done using *t*-test, and $P < 0.05$ was considered statistical level of significance.

Results

In this study, the average age of the male participants was 45.53 years, while that of the female participants was 47.37 years. The males had significantly higher CDA than the females bilaterally ($P < 0.05$). The average CDA on the right and left sides of both male and female radiographs is provided in Tables 1 and 2. The mean ± SD of the CDA was 135.56° ± 5.75° in males and 131.67° ± 6.15° in females [Table 3].

In both males and females, the right CDA was higher than the left. However, this was not statistically significant ($P > 0.05$) [Tables 1 and 2]. These results also showed that the mean CDA was significantly higher ($P < 0.05$) among males than females [Table 3]. The normal range of CDA for both male and female Bini Tribe was 135.56° ± 5.75° and 131.67° ± 6.15°, respectively.

Table 1: The right and left collodiaphyseal angle among male Bini adults in southern Nigeria

Variables	Right	Left
Number of participants (*n*)	100	100
Mean (°)	136.56	134.67
SD (°)	6.55	5.35
Minimum (°)	119	118
Maximum (°)	142	140
Range (°)	122.5-145.5	120.5-142.5
P	0.195	

SD: Standard deviation

Table 2: The right and left collodiaphyseal angle among female Bini adults in southern Nigeria

Variables	Right	Left
Number of participants (*n*)	100	100
Mean (°)	132.43	130.66
SD (°)	5.98	6.75
Minimum (°)	116	115
Maximum (°)	138	135
Range (°)	119.5-141.5	120.0-140.0
P	0.135	

SD: Standard deviation

Discussion

Human morphometric measurements are veritable indicators of variation within a given human population or different populations either in the same or across different gender.[16] They are also applied as determinants of physical fitness, health status, and performance levels of different individuals.[17-19]

According to the findings of this study [Tables 1 and 2], the side differences in the CDA were not statistically significant in both gender groups. This was similar to the findings of Vinay *et al*. and Smriti *et al*., wherein no significant side differences were observed in the CDA.[20,21] However, the results of this study showed that the right CDA was nonsignificantly larger than the left CDA in both male and female participants. Based on the findings of Gilligan *et al*. and Nwoha, the dominance of the right lower limb could account for the higher right CDA value.[22,23]

The average CDA values in the males and females of the Bini tribe evaluated in this study were higher than the values reported in South-Western Nigeria [Tables 3 and 4]. The significant sexual difference in the CDA observed in this study showed the CDA as a potential morphometric indicator of sexual difference. This sex-linked variation showed consistency with the findings of Abiodun *et al*.[29] and Benard *et al*.[24] among some South-Western and North-Western Nigerians, respectively. On the contrary, Adekoya-Cole *et al*.[15] and Iyidobi *et al*.[30] did not observe significant sexual differences in the CDA among South-Eastern and some other South-Western Nigerians, respectively.

Congruent with our findings, the East African males evaluated in Uganda and Kenya had significantly higher CDA than those of their females' counterpart [Table 4]. On the contrary, Vemavarapu *et al*.[25] and Sinha *et al*.[26] did not observe any significant sexual difference in the CDA assessed among some Indian population. However, Pathak *et al*.[27] documented the report of sexual differences in the CDA of some Indian population in conformity to the findings of this study.

The CDA varies in different population groups due to the differences in climatic factor, genetic factor, and lifestyle.[13,14,22] In particular, the nomadic lifestyle has been reported to predispose to wider CDA.[22] Furthermore, CDA variation within a specific population has been attributed to factors such as age, stature, sex, and physical activity.[20,27] Shrestha *et al*.[13] and Otsianyi *et al*.[14] reported that wider orientation of the pelvis and shorter lower limbs in females predispose them to smaller CDA values than in males. Otsianyi *et al*.[14] further reported that the physical activity levels which are often higher in males can be correlated with higher CDA values and vice versa.

Radha *et al*.[9] reported the clinical application of CDA as a predictor of femoral neck fracture and diagnosis of proximal femoral deformities. Akhlaghi *et al*.[10] further described its application in orthopedic treatment planning for hip and femoral fractures. This include the design and choice of implants, surgical repair of hip fractures, and restoration of normal hip morphology.[12] In the current study, the evaluation of the CDA among the study population [Tables 3 and 4] provided veritable parameters that would enable these clinical applications for the study population.

The clinical significance of the CDA also includes its application in the determination of coxa vara and coxa valga occurrences. Abiodun *et al*.[29] described the CDA as an important clinical diagnostic parameter useful in the diagnosis of coxa vara and coxa valga among some Nigerian population by the evaluation of the normal range of the CDA. Study among sickle cell children in North-West Nigerian reported that a gradual increase in CDA with increasing age leads to an increase in coxa valga tendency among the participants.[24] Udoaka and Agi reported that the CDA value decreases with increasing age from birth due to the development of bony pelvis; however, further CDA reduction would increase the coxa vara tendency leading to an increased risk of femoral neck fractures.[28]

The results obtained from this study [Tables 3 and 4] indicated the normal range of CDA for the study population. In

Table 3: The average collodiaphyseal angle among male and female Bini adults in southern Nigeria

Variables	Male	Female
Number of participants (*n*)	100	100
Mean (°)	135.56	131.67
SD (°)	5.75	6.15
Minimum (°)	118.5	115.5
Maximum (°)	141.5	136.5
Range (°)	124.50-147.50	120.0-141.0
P	0.035	

SD: Standard deviation

Table 4: Comparison between the collodiaphyseal angle in different study populations

Authors	Country	CDA (°)	
		Male	Female
Abiodun *et al*.[29]	Nigeria (South-West)	Right-133.2±7.6 Left-131±7.3	Right-125±6.9 Left-123±6.9
Iyidobi *et al*.[30]	Nigeria (South-East)	131.43	130.78
Adekoya-Cole *et al*.[15]	Nigeria (Lagos)	131.57±5.66	129.97±6.33
Otsianyi *et al*.[14]	Kenya	128.21±3.79	126.11±3.22
Vemavarapu *et al*.[25]	Indians	128.04	127.20
Sinha *et al*.[26]	Indians	130.28	131.42
Pathak *et al*.[27]	Indians	129.26	126.62
Shrestha *et al*.[13]	Nepal	Right-132.96±6.05 Left-131.54±13.66	Right-134±6.57 Left-132.98±6.23
Current study	Nigeria (Bini tribe)	135.56±5.75	131.67±6.15

CDA: Collodiaphyseal angle

conformity to the above studies, the CDA value that is lower or higher than the normal range among the study population would serve as an indicator of coxa vara or coxa valga predisposition or occurrence, respectively.

Conclusion

The CDA can serve as a morphometric indicator of sexual differences within the study population. This is evident from the higher CDA values among the Bini males than the Bini females. It can also be used for various clinical applications such as diagnosis and treatment of hip and proximal femoral deformities as well as the determination of coxa vara and valga occurrence.

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Conflicts of interest

There are no conflicts of interest.

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