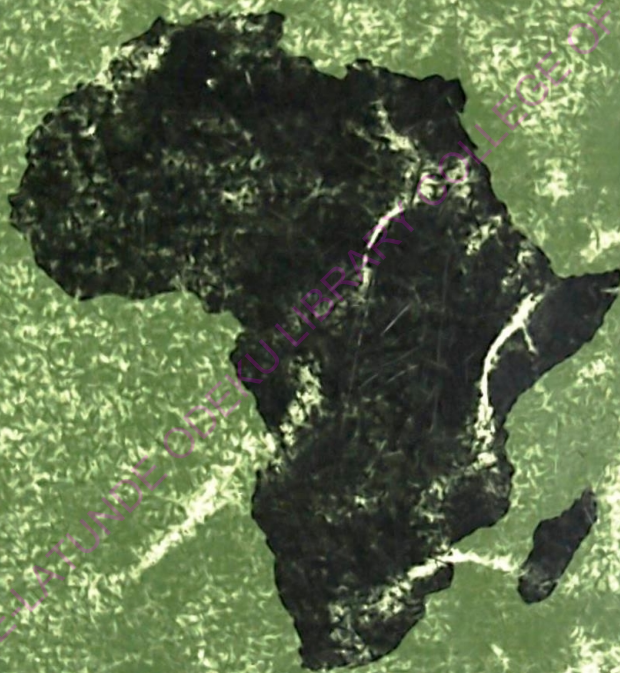


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# The collodiaphyseal angle of the femur in adult Nigerians

P. U. NWOHA

Department of Anatomy and Cell Biology, Obafemi Awolowo University, Ile-Ife, Nigeria

## Summary

An investigation was conducted on 256 people, consisting of 138 men and 118 women in Ile-Ife, Oyo State, Nigeria, to determine the variation of collodiaphyseal angle (CDA) of the femur with the transverse and vertical diameters of the head of the femur, with the neck, upper shaft diameter and lower shaft diameter of the femur. The effects of sex and geographical location on CDA were also considered. It was observed that the mean CDA of the men was greater than that of the women. The mean CDA of the right femur is generally greater than of the left femur in each sex. CDA significantly correlates negatively with the diameters of the head of the femur and with the diameters of the shaft, but positively with the neck. CDA exhibited regional variation in the female Nigerian population. Mean CDA of females in Ile-Ife, South-West Nigeria seemed greater than that of females in Calabar, South-East Nigeria. But mean CDA in the males is not different. CDA in Nigerians seemed greater than the CDA reported for the other countries and races. This might be due to different cultural habits or physique exhibited by the different races.

## Résumé

On a fait une enquête sur 256 adultes (138 hommes et 118 femmes) résidant à Ile-Ife, état d'Oyo au Nigéria, pour déterminer la variation entre l'angle du cou de fémur — 'collodiaphyseal angle' (CDA) — et les diamètres vertical et transverse de la tête de fémur, le cou, les diamètres de hampe supérieure et inférieure du

Correspondence: Dr P. U. Nwoha, Department of Anatomy and Cell Biology, Obafemi Awolowo University, Ile-Ife, Nigeria.

fémur. Les effets de sexe et lieu géographique sur CDA ont été considéré. On a observé que CDA était plus grand chez les hommes que chez les femmes. Dans chaque sexe, CDA de droit est plus grand que cela de gauche. Il n'y a aucune correspondance entre CDA, les diamètres de la tête fémorale et la hampe. Mais il y a une correspondance entre CDA et le cou ( $P < 0.05$ ). CDA a montré une variation régionale chez femmes les nigériennes. La moyenne CDA des femmes à Ile-Ife (Sud-Ouest de Nigéria) semble plus grand que cela des femmes à Calabar (Sud-Est de Nigéria). Mais CDA chez les hommes n'est pas différent. CDA rapporté pour les Nigériens semble plus grand que cela rapporté pour les gens d'autres pays et races. On constate que les physiques et l'habitude culturelle ont eu un influence sur cela.

## Introduction

The upper end of the femur consists of a rounded head, a neck and two trochanters. The neck runs downwards and laterally to join the shaft. The angle that the long axis of the neck makes with the long axis of the shaft is the collodiaphyseal angle (CDA). According to Hollinshead [1], the CDA is a device to allow for the greater mobility of the hip joint. The study of the CDA has fascinated several researchers. The magnitude of CDA in such studies has varied. Some reported CDA of 120° [2], some 125° [3,4], while others have reported 126° [1] and over 130 [5,6]. Such is the variation exhibited in the reported values of CDA that more studies on it are necessary in order to provide a wider view of the extent of variation of this angle in man. According to previous reports, this angle varies among sexes, being greater in the male than in the female [7-10],

varies with age, diminishing from birth to puberty [4,11], with stature of the individual [12] and from one region of a country to the other [5,10].

Singh *et al.* [6] conducted studies of CDA of people in Calabar, South-East Nigeria, but, with reported regional variation in CDA, further studies conducted in Nigeria are advisable to compare and complement this earlier study. The outcome of the study will also help in guiding the construction of femoral neck implants for Nigerians, because the values presently in use in orthopaedic departments in Nigeria are those mostly reported for the other countries and races, and these could be significantly larger or smaller than actual Nigerian values, thus creating problems for the orthopaedic management.

Considerable interest has been shown by previous authors in the study of CDA in Caucasians [13-16], and in the Mongoloids [5,10,17] but very little interest has been shown on the Black population. The impact of racial variation on the value of CDA would be much better understood if more studies were carried out on the Black population. Furthermore, very little is known about the relationship of CDA with the diameters of the head, neck, upper and lower shafts of the femur. The knowledge of the relationship of CDA with some of these parameters would increase our understanding of CDA and perhaps be of importance in the clinical diagnosis of some bone diseases of the head, neck or shaft of the femur.

The present investigation, which is a retrospective one, therefore sets out to:

- (i) complement the work of Singh *et al.* [6] in Nigerians;
- (ii) provide more information on CDA in the Black population;
- (iii) correlate CDA with diameters of the head, neck and shaft of femur.

### Materials and methods

X-ray films belonging to 138 male patients, giving a total of 138 left femora and 138 right femora, and 118 female patients, giving a total of 118 left femora and 118 right femora, were utilized for this study. The patients had reported at the Casualty Unit of the Obafemi Awolowo University Hospitals Complex, Ile-

Ife, Nigeria, between 1983 and 1987, for suspected injury to the pelvis, and their ages ranged from 25 to 85 years.

X-ray films of the pelvis without pathological injury were selected for this study by a trained radiologist. The X-ray films were taken from an anode-film distance of 100 cm, the patient's position was anteroposterior, with the feet parallel to each other such that the medial sides of the big toes touched; this antero-posterior method was used for all the films in this work. The following measurements were taken directly on the films (Fig. 1):

- (i) vertical diameter of the head — VD (H-B in Fig. 1): from the topmost point vertically

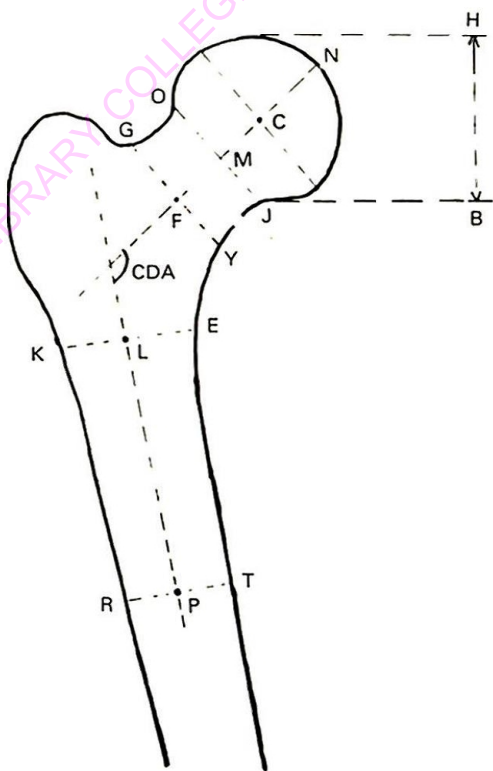


Fig. 1. A schematic diagram of the collodiaphyseal angle (CDA) of the femur: H-B = vertical diameter; M-N = transverse diameter; O-J = neck diameter; K-E = upper shaft diameter; R-T = lower shaft diameter; C-F = axis of the neck; and L-P = axis of the shaft.

to the lowest point on the head of the femur;

- (ii) transverse diameter — TD (M-N in Fig. 1): from a point near the fovea centralis transversely to the junction with the neck;
- (iii) neck diameter — ND (O-J in Fig. 1): diameter of the neck measured at its narrowest part;
- (iv) upper shaft diameter — USD (K-E in Fig. 1): measured at a point 8 cm from the top of the greater trochanter;
- (v) lower shaft diameter — LSD (R-T in Fig. 1): measured at a point on the shaft 16 cm from the top of the greater trochanter.

The following measurements were made on transparent paper superimposed directly on the X-ray film:

- (i) axis of the neck: formed by joining the midpoint of the head (C) and the midpoint of the base of the neck (F);
- (ii) axis of the shaft: formed by joining the midpoint of USD (L) and the midpoint of LSD (P);
- (iii) CDA: the angle formed by the axis of the neck with the axis of the shaft. The angle was measured with a protractor.

The values obtained from the measurements were analysed statistically. Student's *t*-test was used to compare the values of CDA between the males and females in the present work. The relationship of CDA with the diameters was analysed by Pearson's product of moment correlation coefficient. Identification points

(IP) were calculated for likely usage in sex, and perhaps in racial differentiation. An identification point is a point beyond which there is no overlap in the values recorded for the male and female bones. The *P* value for this work was fixed at  $P < 0.05$ .

## Results

In each of the sexes (Table 1) the mean CDA of the right femora is higher than that of the left femora, although not significant. Similarly, CDA of the male is greater than that of the female but not to a very significant degree ( $P < 0.08$ ). IP classified a small percentage of the bones. An upper IP of  $141^\circ$  identified 12% of male right bones while a lower IP of  $117^\circ$  classified 5% of female right bones. For the left femora a lower IP of  $118^\circ$  classified 5% of female bones and none of the male bones. In the male, CDA exhibits negative correlation with VD and TD and with USD and LSD and positive with ND. The correlation is significant for TD, and LSD ( $P < 0.05$ ), as shown in Table 2. In the female, CDA has negative correlation with VD and TD, and with USD and LSD, and positive correlation with ND. The correlation is also significant for VD, ND, USD, and LSD ( $P < 0.05$ ; Table 2). The mean CDA reported in males in the present study in Ile-Ife does not seem different from the mean CDA reported by Singh *et al.* [6] for males in Calabar, but in the female the mean CDA reported here seems

Table 1. Student's *t*-test for the significance of the difference between mean collodiaphyseal angle (CDA) in the right (R) and in the left (L) femora of each sex, and for the femora between the sexes

	Male	Female	<i>T</i> value	<i>P</i> value
No. of cases	138	118		
Range	$117^\circ$ - $146^\circ$	$114^\circ$ - $141^\circ$		
R mean CDA	133.7	131	1.74	0.08
± s.d.	5.91	7.80		
No. of cases	138	118		
Range	$118^\circ$ - $144^\circ$	$114^\circ$ - $144^\circ$		
L mean CDA	132.9	130.2	1.70	0.08
± s.d.	5.64	7.74		
<i>T</i> value	1.32	1.15		
<i>P</i> value	ns	ns		

**Table 2.** Pearson's product of moment correlation coefficient between collodiaphyseal angle (CDA) and diameters of the head, neck and shaft of the femur in the males and in the females in Ile-Ife, Nigeria

	CDA	
	Right	Left
<b>Male</b>		
Head transverse (TD)	-0.351*	-0.459*
Head vertical (VD)	-0.0183	-0.273
Neck (ND)	+0.025	+0.272
Upper shaft (USD)	-0.088	-0.101
Lower shaft (LSD)	-0.395*	-0.490*
<b>Female</b>		
Head transverse (TD)	-0.333	-0.253
Head vertical (VD)	-0.403*	-0.393
Neck (ND)	+0.363*	+0.414*
Upper shaft (USD)	-0.527*	-0.428*
Lower shaft (LSD)	-0.539*	-0.546*

\*Significant correlation at  $P < 0.05$ .

to be greater than that reported in Calabar (Table 3).

### Discussion

The reported higher value of CDA of the right femur compared with the left femur indicates that CDA is not of the same value for both limbs. In Ile-Ife, as was also earlier noted by

Singh *et al.* in Calabar [6], the CDA of men is higher than that of women and this might perhaps be as a result of the generally larger stature of men compared with women in Nigeria. The larger CDA of men compared with women has also been noted by Pick, Stack and Agson [7], Townsley [8] and Schofield [9].

In digitigrada, Bego and Zegiri [18] had indicated that CDA depended to a large extent on the weight borne on the back. Mean CDA of females in Ile-Ife was generally larger than that in Calabar, but in the males the mean CDA values are nearly the same. Although this observation needs to be further substantiated by work done by the same person in the two places, it does, nevertheless suggest some regional variation of CDA in female Nigerians. In other works, Singh and Singh [10] had also noted regional variation of CDA in the Indians. The negative correlation of CDA with the head and shaft diameters and positive with the neck diameter suggests that large CDA is associated with large femoral neck, narrow head and shaft diameters. Unduly large or small CDA values may be indicative of disease conditions of the head or shaft or neck of the femur. Manuel and Yusof [19] compared the CDA of Chinese, Japanese, Australian Aborigines, Maoris and white Americans and had noted that the reported CDA in Chinese was greater than in Australian Aborigines, Finns and white Americans. The work of Singh *et al.* [6], supported by the present work, has shown that the greatest mean CDA reported for Nigerians (134°) is

**Table 3.** Values of collodiaphyseal angle (CDA) reported in the present work and CDA values reported in the work of Singh *et al.* (1986) in Nigerians [6]

	Male		Female	
	Right	Left	Right	Left
<b>Present work</b>				
No. of cases	138	138	118	118
CDA range	117°-146°	118°-144°	114°-141°	114°-144°
CDA mean	133.7°	132.9°	131.7°	130.2°
± s.d.	5.91	5.64	6.81	6.74
<b>Singh <i>et al.</i> (1986)</b>				
No. of cases	101	101	50	50
CDA range	125°-142°	124°-144°	116°-131°	113°-130°
CDA mean	132.6°	133°	126.2°	126.3°
± s.d.	3.80	4.12	2.97	3.33

greater than that reported for Indians by Singh and Singh [10] ( $125^\circ$ ), for Whites by Sinclair [2] ( $120^\circ$ ), Hollinshead [1] ( $126^\circ$ ) and Hamilton [4] ( $125^\circ$ ), and for Chinese by Hashimoto [17] ( $130^\circ$ ). This suggests that the Black race, and Nigerians in particular, may have higher CDA than Caucasians and Mongoloids, and this is perhaps due to the generally larger physique of Blacks compared with other races, or due to some undetermined genetic factors. This observation calls for further work using similar subjects from different races and under the same research conditions. However, this work provides a preliminary basis. Identification points have limited use in sexual differentiation because a very small percentage of the bones were classified by their application in this work.

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