Original article

The femoral collodiaphyseal angle amongst selected Kenyan ethnic groups

Otsianyi, WK.*, Naipanoi, AP. and Koech, A.

University of Nairobi (Human Anatomy), Nairobi, Quénia
*E-mail: wyksa2000@uonbi.ac.ke

Abstract

Background: There is evidence suggesting that there is inter-populational differences of the femoral neck-shaft angle which has been attributed to disparity in the economic and physical activity levels. As knowledge of the collodiaphyseal angle (CDA) is important to orthopaedic surgeons, there is need to elucidate whether there is significant variation of this angle among the diverse ethnic groups in Kenya. Objectives: Describe the variability of the CDA among the different ethnic groups (whose economic and physical activity differ) in the Kenyan population. Setting: The study was conducted at the radiology department of Kenyatta National Hospital. Materials and methods: Normal pelvic radiographs of patients seen at Kenyatta National Hospital were grouped into five major ethnic groups and were used in this study. Three readings of the CDA were then measured using goniometry and the average recorded. Results: Four hundred and thirty-two femora were studied, 133 were female while 299 were male, and the age ranged from 16-95 years. The average CDA angle was found to be 127.56° + 3.75 (the range being 104-145°, the mode 130°). The CDA was 126.11° + 3.22 and 128.21 + 3.79 in females and males respectively. This angle was largest among the nomadic group (129.72 + 4.76) and smallest (127.25 + 4.15) among the highland Bantu (ANOVA revealed an F of 2.022, level of significance of 0.09). Conclusions: The average CDA described here is lower compared to what has been presented in other populations. Interethnic differences were observed and these differences could be explained by the varying activities of the different groups in their day to day life.

Keywords: collo-diaphyseal angle, ethnic variations, femur, neck-shaft angle.

1 Introduction

The collo-diaphyseal angle made by the long axis of the femoral shaft with the axis of the femoral neck, is important in lateral balance control, an important factor in normal walking and in hip stability (GULAN, MATOVINOVIC, NEMEC et al., 2000). It has been reported to display populational variations by several authors (ANDERSON and TRINKAUS, 1998; IGBIGBI and MSAMATI 2002; IGBIGBI, 2003). In a study on East Africans the average value of the CDA was found to be different among Kenyans, Ugandans and Malawians (IGBIGBI and MSAMATI, 2002; IGBIGBI 2003). Such inter-populational difference of the CDA has been attributed to varying activity levels (IGBIGBI and MSAMATI, 2002) and genetics(QURESHI, MCGUIGAN, SEYMOUR et al., 2001). Other factors like diet and lifestyle have also been implicated (IRDESEL and ARI, 2006). Knowledge of this angle is important in some orthorpaedic procedures such as dynamic hip screw fixation and hip replacement surgery (PAJARINEN, LINDAHL, SAVOLAINEN et al., 2004). In addition a narrower angle is said to predispose to stress fractures (VOO and ARMAND, 2003). This study therefore aims at extending the findings of Igbigbi as concerns the femoral shaft-neck angle and its variation among the different ethnic groups in the Kenyan population (IGBIGBI, 2003).

2 Material and methods

The study was conducted at the radiology department of KNH. Ethical approval was obtained from the Kenyatta National Hospital Ethical Review Committee. All Antero-posterior (AP) pelvic radiographs (showing both the left and right sides) in which CDA was identifiable and which contained data/information identifying age, gender and ethnicity of the subjects were included in the study. Radiographs with obvious pathologies that interfere with measurement of CDA were excluded. The angle was be taken between the long axis of the femoral shaft (drawn from the centre of the shaft) and the axis of the neck (drawn from the midpoint of the head of the femur towards the base of the neck). The angle so formed was measured using a goniometre. Three recordings were done and an average recorded. This was done on both the left and the right sides.

The name on each radiograph and demographic data from the files were used for categorization into the 5 ethnic groups to be studied: highland Bantu comprising of the Kikuyu, Meru and Embu whose main activity of these ethnic groups is farming; coastal bantu comprising the Mijikenda and Taita whose main activity is weaving and cooking; highland nilotes comprising of the Kalenjin who are pastoralists and well known for long distance running; River-lake nilotes, the Dholuo who practice fishing and the nomadic groups, which include the Maasai, Somali, Turkana and Samburu involved in long distance walking(MARHOUM A and SAMPER, 2010).

3 Results

Four hundred and thirty-two femora were studied, 133 were female while 299 were male, and the age ranged

from 16-95 years. The average CDA angle was found to be 127.56° + 3.75 (the range being 104-145°, the mode 130°). The CDA was 126.11° + 3.22 and 128.21 + 3.79 in females and males respectively. There was no statistical difference between the male and female angles. P = 0.06. This angle was largest among the nomadic group (129.72 + 4.76) and smallest (127.25 + 4.15) among the highland Bantu (ANOVA revealed an F of 2.022, level of significance of 0.09). This was considered to be statistically significant as the F value is not close to 1 and therefore the null hypothesis was rejected (Table 1).

The side differences are as depicted in the Table 2.

Table 1. CDA measurements in various Kenyan ethnic groups.

Ethnic Group	CDA
Highland Bantu	127.25 + 4.15
Coastal Bantu	127.50 + 3.29
Highland Nilotes	127.90 + 3.28
Riverlake Nilotes	127.94 + 3.42
Nomadic groups	129.72 + 4.76
F value(ANOVA)	2.022

Table 2. CDA measurement right versus left.

Side	CDA
Right	127 + 3.55
Left	127.15 + 3.90
p-value	0.49

Where a p-value less than 0.05 was considered statistically significant.

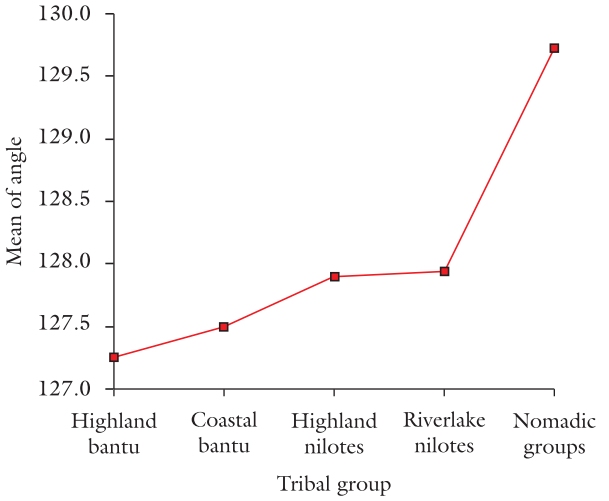

Figure 1. line graph showing the distribution of the CDA in the various ethnic groups.

4 Discussion

We present a mean CDA of 127.56° (the range being 104°-145° among the 432 femora studied. A radiographic study done on the same at another Hospital in Kenya presented a range of 117–159° (IGBIGBI, 2003). Our exploration of the various ethnic groups in Kenya revealed the largest CDA among the nomadic group (129.72 + 4.76) and smallest (127.25 + 4.15) among the highland Bantu (Figure 1).

These varying ranges suggest inter-populational and individual differences which have been proposed by several authors (ANDERSON and TRINKAUS, 1998; IGBIGBI, 2003; IRDESEL, 2006; NWOHA, 1991; TAHIR, 2001). Nwoha (1991) and Tahir (2001) studied the collo-diaphyseal angle of the femur in adult Nigerians. The angle demonstrated regional differences among the Nigerian population especially among females. The mean CDA of females in Ile-Ife, South-West Nigeria seemed greater than that of females in Calabar, South-East Nigeria. They attributed this to different cultural habits and physique exhibited by the different groups. We also propose differing activity types and levels as the reason of the variations; the highland Bantu (comprising of the Kikuyu, Meru and Embu) whose main activity is farming), coastal bantu (Mijikenda and Taita whose main activity is weaving and cooking) highland nilotes (Kalenjin who are known for long distance running), River-lake nilotes (Dholuo who practice fishing commonly) and the nomadic groups, which include the Maasai, Somali, Turkana and Samburu involved in long distance walking(MARHOUM and SAMPER, 2010).

These differences are attributable to genetic and environmental factors. Anderson and Trinkaus compared collo-diaphyseal angles across different populations from modern, historic and prehistoric human population samples (ANDERSON and TRINKAUS, 1998). They found that larger angles were more common in modern industrialized societies with an increasingly sedentary lifestyle and mechanization. Lower values of the angle were more common in non-industrialised populations. There was a strong correlation between economic levels and average size of the angle which was explained by effects of differences in activity levels and hence habitual load levels on the hip region. Geography, climate and race however did not appear to affect patterns of femoral collo-diaphyseal angles. Other factors that may explain inter-population variation include genetics (QURESHI, McGUIGAN, SEYMOUR et al., 2001) and dietary factors (IRDESEL, 2006). Qureshi, McGuigan, Seymour et al. (2001) demonstrated significant relationship between the size of the neck-shaft angle and various alleles of the COLIA1 genotype. The neck-shaft angle was increased in the Ss/ss genotype groups compared to SS homozygotes.

As observed in earlier studies the size of the CDA was smaller in females126.11° + 3.22 and larger 128.21 + 3.79 in males in this study (ANDERSON and TRINKAUS, 1998; IGBIGBI, 2003; NWOHA, 1991; TAHIR, 2001). The small angle in women is as a result of their wider pelvis, greater bicondylar angle (obliquity of the shaft of the femur), and shorter length of the femora (SINGH, 1986.). In our study side differences of the CDA was not statistically significant. Some authors have demonstrated considerable asymmetry in the neck shaft angle (NWOHA, 1991; MACHO, 1990) but the findings have been inconsistent as to the degree of asymmetry and the direction of the asymmetry (ANDERSON and TRINKAUS, 1998). In some studies the left limb had larger angles than the right (ANDERSON and TRINKAUS, 1998) while in others the right had larger angles than the left (NWOHA, 1991; MACHO, 1990).

Determination of the CDA is of clinical relevance mostly in association with femoral neck fractures. A change in the size of the angle is used in the detection of fractures of the neck of the femur (TIAN, CHEN, LEOW et al., 2003). The angle size is also used in the prediction of fracture risk among different subjects (GNUDI, RIPAMONTI, GUALTIERI et al., 1999; GOMEZ, 1994). Gnudi, Ripamonti, Gualtieri et al. (1999) in a study on white postmenopausal women determined that the neck shaft angle could be used to discriminate between healthy and osteoporotic fractured femurs. Subjects with fractures had greater neck-shaft angles. Other authors have however found no association between the angle and fracture risk (FAULKNER, CUMMINGS, BLACK et al., 1993; MIKHAIL, VASWANI and ALOIA, 1996).

Population differences in the geometry of the proximal femur have also been used to explain differences in the incidence of fractures of the neck of the femur in different populations (NAKAMURA, TURNER, YOSHIKAWA et al., 1994). Nakamura, Turner, Yoshikawa et al. (1994) compared proximal femoral morphometric characteristics in Japanese and white American women. They found that Japanese women had smaller neck-shaft angles than American women. This, along with other differences in femoral morphometry, could be used to explain the differences in hip fracture risk between the two populations. Japanese have a lower incidence of hip fracture despite having lower femoral neck mass. Further studies are required for assessment of inter-ethnic variations for femoral neck fractures as an extension of this study.

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Received July 17, 2010
Accepted March 23, 2011