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Original Research Article

ESTIMATION OF COLLO-DIAPHYSEAL ANGLE OF FEMUR BY MARTIN'S DIOPTROGRAPH: A COMPARATIVE STUDY

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ABSTRACT

Background: The collo-diaphyseal angle (CDA) of femora appeared between the axis of neck and long axis of the femur having a great importance in complete understanding of the mechanics of the hip joint and serves as a basis for the treatment of pathological conditions of the hip and femur.

Materials and Methods: For the present study the collo-diaphyseal angle was measured in 152 normal south Indian femora, out of which 83 are random unknown sex femora, 42 are known males and 27 are known females.

Results: In this series, recorded minimum angle is 111.0^0 and the recorded maximum angle is 146.0^0 and the average being 128.09^0 in random femora. In the present series 42 known normal male femora are measured in which the lowest angle is 115.0^0 and the highest angle is 141.0^0, the average being 128.04^0. Among 27 known normal female femora the minimum angle recorded is 112.0^0 and maximum angle recorded is 139.0, the average being 127.20^0.

Conclusion: The above findings revealed that the neck shaft angle of femur is greater in males than in females.

KEY WORDS: Collo-diaphyseal angle (CAD), Martin's dioptrograph, Femur.

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INTRODUCTION

The neck-shaft angle and angle of inclination also known as collo-diaphyseal angle (CDA) of femur is defined as the angle made by the long axis of shaft and the long axis of the upper anterior column.

The angle is widest at birth and diminishes steadily until the adult condition is reached. It is less in female than in male, owing to the increased breadth of the lesser pelvis and greater obliquity of the shaft of the femur [1].

The cranial end of the femur has been the object of great attention. Knowledge of CDA of femur throws light on better understandings, about the mechanics of hip joint. This constitutes, thereby, basis for the treatment of different pathological conditions of the hip and femur. For instance, the determination of the said angle is of immense value, while planning osteotomies in coxa-plana and congenital

dislocations of the hip joint, moreover relevant information regarding secondary changes of the hip, due to the conditions like cerebral paresis and myelomeningocele can sometimes be obtained. According to Carme et al. any femoral measurement was likely to serve as a useful source to estimate sub-adult age in both archeological and forensic samples [2].

Despite many methods to measure the angle are mentioned in the literature lack of their precision differences among them and variations between the populations account for significant difference in values obtained. This renders almost impossible to determine the biological variation. Hence the reliability of such studies is hard for evaluation.

Extensive studies of normal neck angles have been carried out. The values differ considerably in the reports available. Differences in methods used, differing anatomical definitions and variations between populations may account for this. The principal objectives of the present study was to evaluate the range of the normal angles of femora and their sex differences.

MATERIALS AND METHODS

This work is under taken by collecting 152 femur bones, from the department of anatomy, in various Medical colleges of Telangana and Karnataka. Among these 152 femora, the known sex bones were labeled by using a pencil from 1-152.

We are measured the carrying angle with the help of an instrument called martin's dioptrograph (Fig no.1). This is an anthropometric instrument having four sliding bars in a rectangular form fixed in a movable form in each corner and a sliding central bar in the middle. This central bar is fixed in the central position by a pivot (P). On each side of the sliding bars have a pointer on the side and a visualizing scope on the diagonally opposite side. This entire sliding bar frame with pointer and scope rests on either side on a wooden platform of 2 pieces which has:

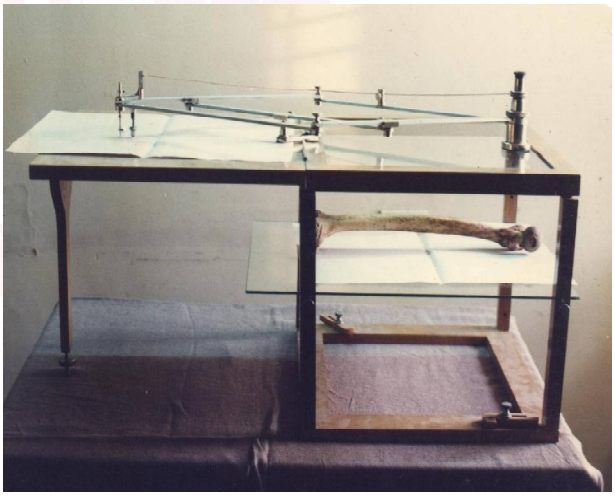
1. The half of the dioptrograph having the scope rests on wooden framed glass platform,

2. The other half with the pointer rests on a plane wooden platform on which the Drawing sheets can be fixed by using drawing board clips.

The glass platform is fixed to a wooden framed quadrangular shelf which has another glass platform (GP) on which the bone to be measured has to be placed. The distance between scope and glass platform can be adjusted by using the adjustable screws provided at 4 corners. The bone to be measured is kept on a thin transparent white sheet fastened, on the glass platform. This is illuminated with 60 watts bulb placed beneath the glass platform. When in use the drawing sheet, to receive the impressions of the bone.

Then looking through the scope, the scope is moved in such a way that the black spot in the lens runs along the margin of the femur kept on the glass platform. Simultaneously it should be checked to see the corresponding marking of this, on the drawing sheet. Thus the replica of the femur itself is obtained on the drawing sheet in the same manner the replica 152 femora were obtained on the drawing sheets.

Fig. 1: Martin's Dioptrograph.



The neck shaft angle of the femur was measured by marking axis of shaft and axis of neck. The axis of neck was drawn by taking two points one at the centre of the head and other at the midpoint of the narrowest part of the neck (highest constriction at the neck). Then the 2 points were joined, this represents the axis of the neck. Then the axis of the shaft was marked by taking two points of midpoint at the upper end of shaft and other at the lower end of the shaft, the two points were joined and the same line was extended at the upper end, as such, to cut the axis of the neck. Then the angle was measured, using a protractors and the angle was noted down.

RESULTS

The neck shaft angle of the femur is measured in 152 femora. Among these 42 were of known male, 27 are of known female and 83 are random unknown sex specimens.

In the random specimens minimum angle recorded is 111.0^0 and maximum as 146.0^0 with average angle 128.09^0. In known male sex bones the minimum angle is 115^0 and maximum as 141^0 with average angle 128.04^0. In known female sex bones the minimum angle is 112^0 and maximum as 139^0 with average angle 127.20^0. In case of female bones the angle is slightly lesser than the males. The difference of angle between male and female bones was not significant.

Table 1: Showing sex wise mean values of angle neck of femur.

Specimens	Number	Minimum (degree)	Maximum (degree)	Average
Random	83	111	146	128.09
Male	42	115	141	128.04
Female	27	112	139	127.2

Table 2: Showing distribution of frequency in 152 femora.

Range (degree)	Percentage
111-120	9.21
121-130	46.71
131-140	40.13
141-150	3.94

DISCUSSION AND CONCLUSION

Studies on neck shaft angle of femur showed variations with regard to age, sex and races. The neck shaft angle of femur in early fetal life was highest (3). The head and neck deviates from the shaft very earliest [4].

The angle varies from 160^0 in the child to 125^0 in the adult and is widest at birth and diminishes steadily until the adult condition is reaches [5].The angle in new born was nearly equal to the adult average being 126.5^0 and ranged 106^0-151^0. According to Kate B R. [6] Angulation renders stability during weight transmission. Mechanically the width of the pelvis should not influence the angle of the neck even to the slight degree [7]. The femur with a long neck was accompanied by high angulations of neck shaft and that with a short neck was associated with low angulations. The necks above average length have on each side a winder angle by 2^o then average necks or below average [8]. The inclination increases approximately by 0.04^o for every mm increase in total length of shaft [9].

According to Sitarama Rao measured angles taken at random, it was 132^0 to 205. The average neck shaft angle was found to be 127.7^0 [10]. According to the present study the neck shaft angles at random were found to be from 111^0 to 146^0. The average is being 128.09^0.

The neck shaft angle is of no value to determine sex and in females bones there is no difference in the angle due to the presence of either long or short necks. There was no significant difference in the angle between the sexes. The mean values of the male and female neck angles were 128.3^0 and 127^0 respectively.

According to martin that made studies on the female subjects of the Japanese, French, Negroes, Egyptians and bantu mentioned greater angles in females being 127.1^0 to 128^0 over their male counter parts being 124.3^0 to 128^0. According to Lavelle the neck shaft angle is greater in females than males [11]. According to Humphrey's conclusions the angle in the adult females the average was slightly smaller than males the average in males being 127^0. According to gray's the angle is less in the female than in the male due to the increased breadth of the lesser pelvis and greater obliquity of the femur [1,3]. In the present study the angle in the female was slightly lesser than the male. Being 112^0-139^0 average being 127.2^0 and 115^0 to 141^0 average being 128.04^0 respectively (Table 1).

Greater degrees of the angle in south Indians 135^0-205^0 may possibly be due to their habit of squatting when compared to Europeans 125^0. The angle was found to be larger in south Indians and west Indians being 129.6^0 to 133.1^0 highest being 151^0 at Madura [12]. According to studies done by Kate the angles were lowest in Formosan and highest in Andaman femur average 125.6^0 and 134^0. The results of present study comparing it with the data furnished by Kate the average angle was found to 128.09^0 in comparison to Kate being 128.5^0 (Table 3).

Table 3: Showing Comparison of present work with another works [13].

S.NO	Workers	Male angle (in degree)	Female (in degree)
1	Parsons – 1914	125	127
2	Pearson- 1919	130.4	131.47
3	Gross berg- 1924	123.95	124.35
4	Ingalls- 1924	129.64	127.1
5	Hasimoto- 1938	128.5	128.5
6	Pick et al – 1941	126.4	126.4
7	Lofgren – 1956	125.2	125.1
8	Schofield G – 1959	136.3	137.1
9	Kate B R – 1967	127.05	127.61
10	Reikera's et al -1982	128.3	127
11	Gnudi S et al- 1999	-	122.64
12	Nagar .M et al – 2002	11.32	11.02
13	RC Siwach et al – 2003	13.68	-
14	Maini PS et al2005	16.31	-
15	Nissen et al – 2005	131	129
15	Shrikant Rokade, et al - 2009	18.68	16.34
16	Jain AK et al– 2009	8.9	-
17	Ankur Zalawadia et al– 2010	10.9	13.6
18	Srimiahi T et al– 2011	9.78	10.13
19	Present work	128.04	127.2

A.I. Udoaka and C.E. Agi were aimed to find the CDA in 252 antero-posterior radiographs of pelvis in both males and females. Results showed a decrease in the values of the collo-diaphyseal angles as age advances, the least was recorded for the old age group of 70-79years. The males in all the age groups had larger collo-diaphyseal angles though only significant at the age ranges of 20-29 years and 40-49years ($p<0.05$). The least recorded angles were 127^0 for the elderly females. [14] This study has shown a tendency towards coxa-vara in the elderly population and it is Imperative to emphasize the possibility of applying this finding in orthopedic practice in relation to the risk of fracture of the neck of the femur.

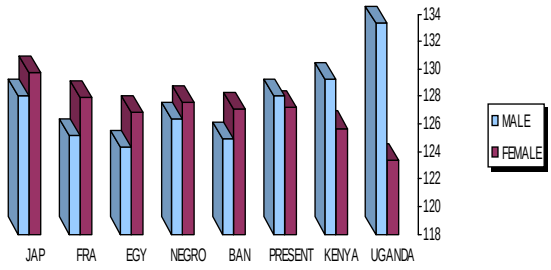
The evidence suggesting that there is inter-population differences of the femoral neck-shaft angle which has been attributed to disparity in the economic and physical activity levels. 432 femora were studied, 133 were female while 299 were male, and the age ranged from 16-95 years. The average CDA angle 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 [15].

The collo-diaphyseal angle of East African subjects was investigated using 860 unilateral antero-posterior radiographs of the hip from 400 Ugandan and 460 Kenyan subjects. The angle ranged from 125^0–144° with a mean of 133.3° and a standard deviation (SD) of 5.3° for Ugandan males and 119^0–139°, mean 123.4°, SD 5.8° for Ugandan females. The Kenyan values were 125^0–159°, mean 129.2°, SD 6.2° for males; and 117^0–134°, mean 125.7°, SD 5.1° for females, respectively. There were significant differences between males and females in both groups as well as between Ugandan and Kenyan males ($P < 0.05$). (16) (Table .4)

Table 4: Showing comparison of present work results with different regional results.

S.NO	Country	Male angle (in degree)	Female angle (in degree)
1	Japan	128	129.7
2	France	125.1	127.9
3	Egypt	124.3	126.8
4	Negro	126.4	127.6
5	Bantu	124.9	127.1
6	Kenya	129.2	125.7
7	Uganda	133.3	123.4
6	Present work	128.04	127.2

Graph 1: Showing comparison of present work results with different regional results Conclusion.



That the angle formed by the neck of the thigh-bone with the shaft varies considerably in different persons at any given period of life. That it is smaller in short bones than in long bones; and that it is also most likely to be small when the pelvis is wide; the combination of these two conditions rendering it usually smaller in women than in men. That the angle decreases during the period of growth; but that after growth hasbeen completed it does not usually undergo

any change, even if life be continued to extreme old age. Some change may take place in exceptional cases, but as a rule the angle remains the same from the adult period till death, at whatever age that may occur. That, if during growth the limb be relieved of the weight of the body, as in the bedridden state, in paralysis or in a stump the angle of the neck with the shaft usually retains the open form of early life or even may become wider. The above findings revealed that the neck shaft angle of femur is greater in males than in females.

Conflicts of Interests: None

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