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Review Article

Cross sectional analytical study – Analytical morphometric study of dry femur in South Gujarat

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ABSTRACT

Background: The femur is the longest, heaviest, and strongest bone in the human body. Morphometric study of femur can be useful for estimation of stature, prediction of femur fractures/pathologies, operative management as well as for determination of congenital anomalies.
Materials and Methods: 250 dry femur bones collected from bone Store, Government Medical College, Surat, Gujarat with study done over a period of 6 months. Total length of each femur and the Foraminal Index (FI) for each nutrient foramina were obtained.
Results: The mean total length of femur obtained was 41.22 cms. Torsion angle for both right sided as well as left sided femurs was most common in the range 11 - 14. 39.7% (48) of the total right sided femurs (121) had a torsion angle in the range 11 - 14 while 41.9% (54) of the total left sided femurs (129) also had a torsion angle in the range 11 - 14. Maximum number had a neck shaft angle in the range of 123 - 127 which constitutes 41.6% (104) of total sample size. Nutrient foramina was most commonly (48.8%) along linea aspera with most had a size corresponding to 22 gauge, which constitutes 45.7% (119) of total sample size.
Conclusion: Morphometric study of femur helps us to determine various factors which could be helpful for prediction, prevention and diagnosis of a certain pathology as well as for its management and treatment.

1. Introduction

The femur is the longest, heaviest, and strongest bone in the human body. There are also 2 prominent bony protrusions, the greater trochanter and lesser trochanter at the proximal end and two condyles which are weight transmitters to tibia in the distal end with two tiny projections called epicondyles hip joint is synovial joint[1] holding the femoral head within the acetabulum of the pelvis.

The usefulness of measurement of length of long bones in estimation of stature[2] and also helpful for the clinicians in the treatment of proximal and distal femur fractures. Different aspects of clinical disease conditions and fracture, congenital anomalies and changes in osteoporosis as well as medico-legal cases can be understood by the study of femur bone

The angle of the femur formed by the longitudinal axis of the neck and the longitudinal axis of the shaft of femur bone is termed as neck shaft or collodiaphysial angle which facilitates the mobility of hip joint.

The neck - shaft generally ranges from the angle of 115 to 140 degrees at an average of 126 in adults.

Nutrient foramen is an opening in the bone shaft which gives passage to the blood vessels of the medullary cavity of a bone for its nourishment and growth.[3] The topographical knowledge of these nutrient foramina is useful in operative procedures to preserve the circulation.[4–6]

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The nutrient foramen (NF) is defined as the largest of the foramen present on the shaft of long bone.

The present study deals with the co- relation between different anthropometric parameters of proximal and distal femur. Some of these parameters like neck shaft angle and neck length have been found to be useful as predictors for a risk of fracture neck femur.[7–9]

Angle of femoral torsion is a normal torsion or twist present in femur that plays an important role in stability and function of the hip joint. The angle of femoral torsion can be defined as the angle formed by femoral condyle's plane (bicondylar plane) and a plane passing through centre of neck and femoral head. Abnormal angle of femoral torsion has been implicated in the etiology of hip osteoarthritis and developmental dysplasia of hip joint.

The acute tear of anterior cruciate ligament (A.C.L.) is common in sports requiring frequent that rotational movements, rough stops or jumps. It is a belief that the morphology of the femoral intercondylar notch can predispose the injuries of A.C.L., and its morphometry analysis could provide important data to be used in the prevention and prognostic of these injuries.

2. Materials and Methods

Cross sectional analytical study – "Analytical morphometric study of dry femur in South Gujarat" was done on 250 dry femur bones collected from bone Store, Government Medical College, Surat, Gujarat with study done over a period of 6 months.

2.1. Data collection

250 dry femur bones collected from bone Store, Government Medical College, Surat.

Total length of each femur was measured with help of osteometric board Figure 1 by taking the measurement between superior aspect of head of femur and most distal aspect of medial condyle.[10]

The diaphyseal nutrient foramina Figure 2 were observed with a hand lens

Distance from upper end of bone was measured using vernier callipers and recorded as DNF.

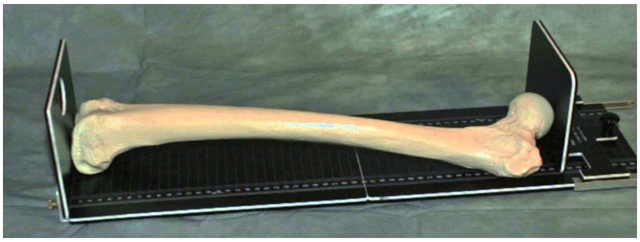

Fig. 1: Osteometric board (for measuring length of femur)

Fig. 2: Diaphyseal nutrient foramina

The Foraminal Index (FI) for each nutrient foramina will be obtained Hughes formula:

FI=DNF/TL X 100 [4.5]

DNF = Distance from proximal end of femur to nurient foramina

TL= Total length of bone

Caliber of foramina

Hypodermic needles of 18 to 24 gauge were used to assess the caliber of foramina.

If 18 G is passed, then labelled as large foramina, 20 to 22 G labelled as medium foramina and 24 G as small foramina.

The bone was first held in its anatomic position, then the two limbs of the goniometerFigure 3 were made to align along axis of neck and shaft. The angle between the two gave the neck shaft angle.[11]

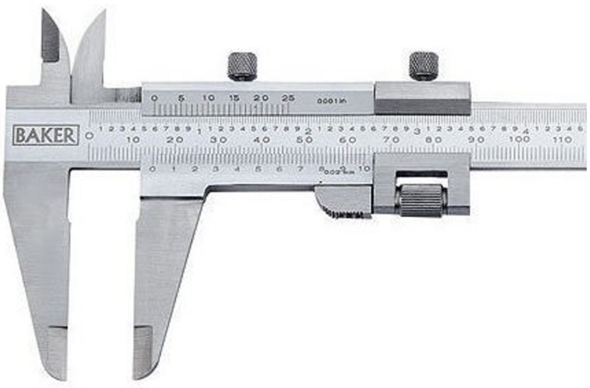

Fig. 3: Goniometer

Angle was measured using Kingsley Olmsted method.[12,13] The specimen was placed at the edge of glass horizontal surface so that femoral condyles rest on surface. The horizontal limb of goniometer is fixed at edge of table. The vertical head is held parallel along the axis of head and neck of femur.

The horizontal surface represents retrocondylar axis against which angle is measured with help of axis of head and neck of femur.

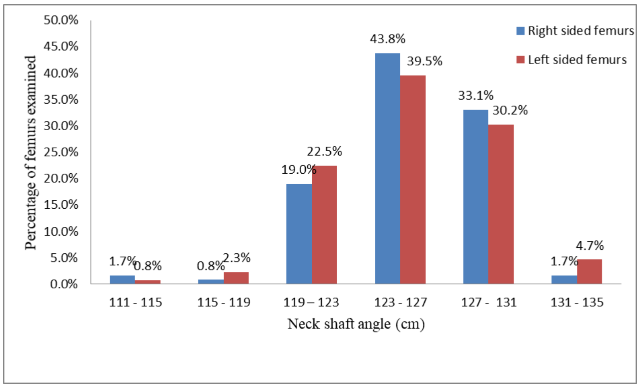

Fig. 4: Graph shows percentage of different neck shaft among femurs examined

The depth of intercondylar notch is identified as its height at the maximum with help of callipers.

3. Results

Out of 250 femur bones that were assessed, maximum number (40.8%) had a torsion angle in the range of 11 - 14 degrees Torsion angle of 11 - 14 degrees was most common in this range on both sides ($\chi 2$=0.12, p = 0.82).

Out of 250 femur bones that were assessed, maximum number had a neck shaft angle in the range of 123 – 127 degrees which constitutes 41.6% (104) of total sample size. Neck shaft angle in both right sided as well as left sided femurs was most common in the range 123 - 127 cm. This was comparable statistically ($\chi 2$=0.46, p= 0.49).

In 250 femur bones, a total of 260 foramina were noticed, most commonly (48.8%) along linea aspera. In right sided femurs, nutrient foramina were not noted in any other positions, while in one left sided femur, it was located elsewhere. Out of the 250 femoral bones studied, 4.4% (11) femurs had no nutrient foraminas, 86.6% (219) femur bones had single nutrient foramina, 7.6% (19) had double nutrient foraminas and 0.4% (1) had triple nutrient foraminas.

Out of 250 foramina that assessed, most had a size corresponding to 22 gauge, which constitutes 45.7% (119) of total sample size. More nutrient foraminas on right sided femurs were sized 24 gauge whereas in left sided femurs, most were of 22 gauge.

Out of 250 femur bones that were assessed, maximum number had a Intercondylar length in the range of 1.5 - 2.0 which constitutes 57.2% (143) of total sample size.

Intercondylar length was most common in the range 1.5 - 2 cm in both right and left femurs ($\chi 2$=0.002, p= 0.95).

Out of 250 femur bones that were assessed, maximum number had an intercondylar depth in the range of 2.6 - 3.0 cm which constitutes 42.4% (106) of total sample size.

Intercondylar depth in both right sided as well as left sided femurs was most common in the range 2.6 - 3.0 cm ($\chi 2$=0.7, p= 0.39).

4. Discussion

The diameter of the femoral head plays a significant role in determining the achievable range of motion of the hip joint and its stability against dislocation. The natural size of the femoral head usually ranges from 40 to 54 mm, with smaller sizes usually found in females and male femur head diameter is more than female average head diameter.

In our study the average diameter of 250 femurs is 42.7mm.

Head size is a critical determinant of range of joint motion, and larger heads are reported to be associated with reduced risk of dislocation compared with smaller head sizes by reducing impingement between prosthetic components.[14]

It has been hypothesized that the anterior cruciate ligament may be stretched over the posterior cruciate ligament or the lateral condyle by internal or external rotation in knees with a stenotic notch and thus acts as a predisposing factor for anterior cruciate ligament injuries.[15]

In our study the average intercondylar distance (ICD) is 29.4mm and intercondylar length is 17.1mm which is above the range given by Hdkon Lund-Hanssen in their study.[16]

It was reported that, in femoral diaphysis transplant surgeries, the profunda femoris artery can be used.

So the number and location of nutrient artery has to be considered in the case of graft surgeries. A graft with good vascular supply will have better results.

Although newer methods using CT scan have been shown to be ±1° accurate, there is no universal consensus for locating the femoral neck axis and the femoral condylar axis. Hence, estimation of the AFT on dry bones is still considered to be the most accurate method. In our study Torsion angle for both right sided as well as left sided femurs was most common in the range 11 - 14 degrees.

39.7% (48) of the total right sided femurs (121) had a torsion angle in the range 11 - 14 while 41.9% (54) of the total left sided femurs (129) also had a torsion angle in the range 11 - 14. Hence, there is no significant difference in torsional angle based on laterality.

Femoral neck-shaft angle is an important parameter of proximal femoral geometry. Not only it has an anthropological value but also it gives an insight into possible underlying hip pathology.[17]

Out of 250 femur bones that were assessed, maximum number had a neck shaft angle in the range of 123 - 127 which constitutes 41.6% (104) of total sample size.

Neck shaft angle for both right sided as well as left sided femurs was most common in the range 123 - 127 .43.8% (53) of the total right sided femurs (121) had neck shaft angle in the range 123 - 127 while 39.5% (51) of the total left sided femurs (129) also had a neck shaft angle in the range 123 - 127.

In our study there is no significant relationship between number of nutrient foramina and length of femurs. The

Table 1: Torsion angle of femurs

Ranges (in cm)	Right sided femurs (%)	Left sided femurs (%)	Total
8 – 11	15 (12.4)	3 (2.3)	18 (7.2)
11 – 14	48 (39.7)	54(41.9)	102 (40.8)
14 – 17	41 (33.9)	37(28.7)	78 (31.2)
17 – 20	16 (13.2)	33(25.6)	49 (19.6)
20 – 23	1 (0.8)	1 (0.7)	2(0.8)
23 – 26	0 (0)	1 (0.7)	1(0.4)
Total	121	129	250

Table 2: Position of nutrient foraminas in femurs

Position	Right sided femurs(%)	Left sided femurs(%)	Total
Along linea aspera	56(46.3)	71(51.1)	127
Medial lip of linea aspera	36(29.8)	37(26.6)	73
Medial to linea aspera	13(10.7)	19(13.7)	32
Lateral lip of linea aspera	8(6.6)	7(5.0)	15
Lateral to linea aspera	8(6.6)	4(2.9)	12
Others	0(0)	1(0.7)	1
Total	121	139	260

Table 3:

Foraminal index	Right sided femurs(%)	Left sided femurs(%)	Total femurs(%)
0 – 33.33	15(13.2)	18(14.4)	33(13.8)
33.34–66.66	99(86.8)	107(85.6)	206((86.2)
>66.67	0	0	0
Total	114	125	239

Table 4: Relationship between length of femur and nutrient foraminas

Femoral length (in cm)	Side (Right/Left)	Number of nutrient foramina					Total
		None	One	Two	Three	Subtotal	
35-40	Right	1	9	1	0	11	24
	Left	0	11	2	0	13	
40-45	Right	5	62	5	1	73	150
	Left	4	68	5	0	77	
45-50	Right	1	32	3	0	36	74
	Left	0	35	3	0	38	
50-55	Right	0	1	0	0	1	2
	Left	0	1	0	0	1	
Total		11	119	19	1	250	250

Table 5: Inter-condylar depth of femurs (n=250)

Range (in cm)	Right sided femurs(%)	Left sided femurs(%)	Total
1.8 – 2.2	3(2.5)	1(0.8)	4
2.2 – 2.6	19(15.7)	18(14)	37
2.6 – 3.0	48(39.7)	58(45)	106
3.0 – 3.4	44(36.4)	45(34.9)	89
3.4- 3.8	7(5.8)	7(5.4)	14
Total	121	129	250

mean total length of femur obtained was 41.22 cms. Femur was found to have variable number of nutrient foramina, ranging from 1 to 3, on a single bone which shows no relationship with length of femur.

In our study as the femoral length increases that is going towards positive end the interconylar length values also shows a positive shift, thus establishing the relationship between them.

Out of 250 femur bones that were assessed, maximum number had a neck shaft angle in the range of 123 - 127 which constitutes 41.6% (104) of total sample size.

Neck shaft angle for both right sided as well as left sided femurs was most common in the range 123 - 127.

43.8% (53) of the total right sided femurs (121) had neck shaft angle in the range 123 - 127 while 39.5% (51) of the total left sided femurs (129) also had a neck shaft angle in the range 123 - 127.

5. Source of Funding

None.

6. Conflict of Interest

None.

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