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MORPHOMETRIC STUDY OF THE ANGLE OF THE PATELLAR FACET

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ABSTRACT:

INTRODUCTION: The possible association between disorders of the femoro-patellar joint and geometrical anatomical variations in the patellar facet and femoral sulcus motivated us to conduct a morphometric study on the angle of the patellar facet and to correlate this with possible variation factors, such as: length,width at the midpoint of the femur, femur inclination angle, distance between condyles and depth of the patellar facet. Significance of the study in that obtained results would be useful for clinicians dealing with case of pathologic alterations in the sulcus angle and malignant of the patella femoral joint.

AIMS AND OBJECTIVES: To measure the angle formed by the patellar facet in relation to the length of femur, the width at the midpoint of the femur, the femur inclination angle and many more.

MATERIAL AND METHODS: The study was conducted in the department of Anatomy, Sardar Patel Medical College, Bikaner, Rajasthan on 200 dry human femur bones of both sides (including 95 right and 105 left) of unknown sex and age and also having no deformity.

RESULT: Present study shows that range for patellar facet angle at the end point (PFAe) of the femoral sulcus from whole sample was observed 116^0 to 146^0, for right side as 117^0 to 146^0 and for left side as 116^0 to 146^0 found.

CONCLUSION: The results obtained as follows:- a) angle of the patellar facet: mean for start level of the patellar facet=142.8^0; mean for midpoint level =131.5^0 and mean for end level = 131.6^0 b) mean distance between condyles = 46.6mm c) mean depth of the patellar facet = 7.1 mm d) mean for Ficat and Bizou's condylar depth index = 6.8 e) Inclination angle=125.5^0

KEY WORDS: Patellar Facet, Patello Femoral Joint, Femoral sulcus, Femoral inclination angle.

INTRODUCTION

The anatomy of the patella femoral joint is complex. The patella is the largest sessamoid bone in the body and its articular surface is covered by thick cartilage. The length of the patella is somewhat longer than its articular surface, with the ratio being normally about 1.2 to 1.5. In full extension, the patella lies just proximal to the trochlea, often with a slight lateral position. The patella engages the trochlea at about 10 to 15 degrees of flexion, and stays engaged throughout flexion above 15 degrees. The sulcus angle is the angle of indentation and is an important factor in patella-femoral jointstability[1].

As a pulley, the patella redirects the quadriceps force as it undergoes normal lateral tracking during flexion. The lateral trochlear facet, which is normally 1 cm higher than the medical, it provides a buttress to lateral patellar subluxation and helps maintain the patella's centered position in the trochlea[2].The trochlear groove plays a major role in the mechanic and pathomechanics of the patella-femoral joint. After knee arthroplasty, one of the determinates in the patella-femoral mechanism is the design of the prosthetic trochlear groove. In the natural and prosthetic knees the position, shape, and orientation of the trochlea groove are three of the key determinants of function and dysfunction, yet the rules governing these three features remain elusive. Ben cornell et al[3] mentioned that patellar stability is dependent upon two components: bony components: bony component (trochlear groove) and soft tissue structures.

A higher incidence of patellar dislocation occur females age 10 to 17 years and the athletically active, with less incidence over age 30 year. Lateral dislocations are very common as compared to medial side. The location and configuration the intercondylar of the distal femur is clinically significant in the mechanism and patho mechanism of the patella-femoral articulation [4,5,6]. The location of the femoral sulcus, the deepest depression of the intercondylar groove, relative to the condyles or its orientation relative to the anatomical and mechanical axis of the femur was defined by walmsle[7]. The shape of the sulcus in the patellar surface of the femur is an important factor in the patella femoral congruence[8,9]. Its depth has been recorded as the osseous angle seen on axial radiographs[10,11] and in computed tomographic scans and magnetic resonance imaging of the patella femoral joint[8,9].

AMIS AND OBJECTIVE

The aim of study is to measure the angle formed by the patellar facet in relation to the length of femur, the width at the midpoint of the femur, the femur inclination angle, distance between condyles, depth of the patellar facet and to compare present study data to the other studies.

MATERIAL AND METHODS

The study was conducted in the department of Anatomy, Sardar Patel Medical College, Bikaner, Rajasthan and F H Medical College, Tundla, Firozabad U.P. on 200 dry human femur bones of both sides (including 95 right and 105 left) of unknown sex and age and also having no deformity. Completely preserved femurs wereselected, in order to rule out the

possibility of interference due to wear and tear that could affect the measurements. The materials required for the study were:-

- 200 dry human femur bones of the unknown sex and age
- Vernier Calipers
- Metallic scale/Ruler
- Protractor
- Osetometric Board
- Photographic Camera
- Depth Gauge

METHODOLOGY

The patellar facet were photographed at three positions:

a) At start level
b) At middle level
c) At end level

For the start level, the camera was centered on the anterior start of the patellar facet (Figure 1), for the middle level, camera was focused on the midpoint between the start and end points of the patellar facet (figure-2), and for the level camera was centered on the transition between the patellar facet and the intercondylar notch, hence the last point of the patellar facet that is still visible (Figure 3)

Fig.1 PFAs- Angle at the start of the patellar facet

Fig.2PFAm- Angle At the midpoint of the patellar facet.

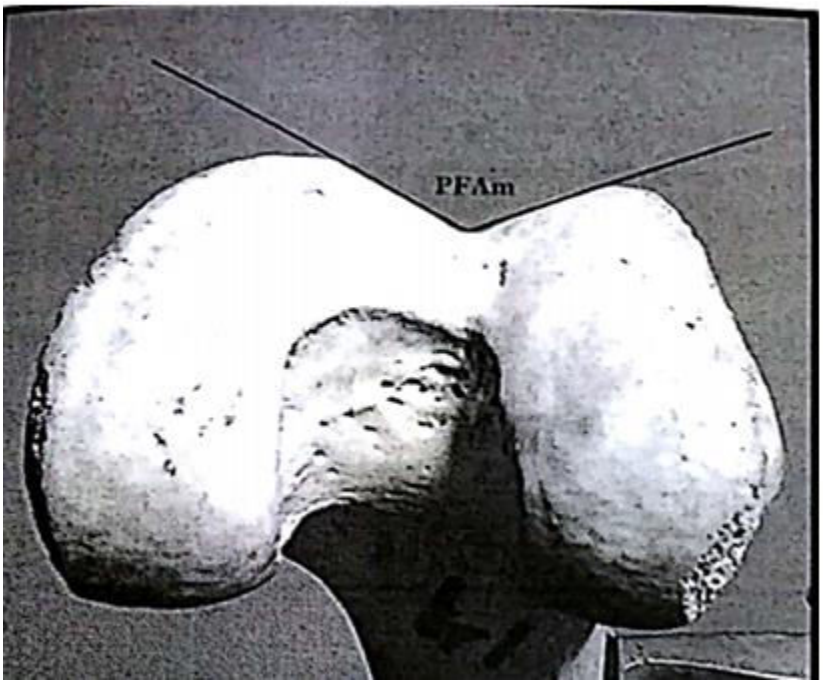
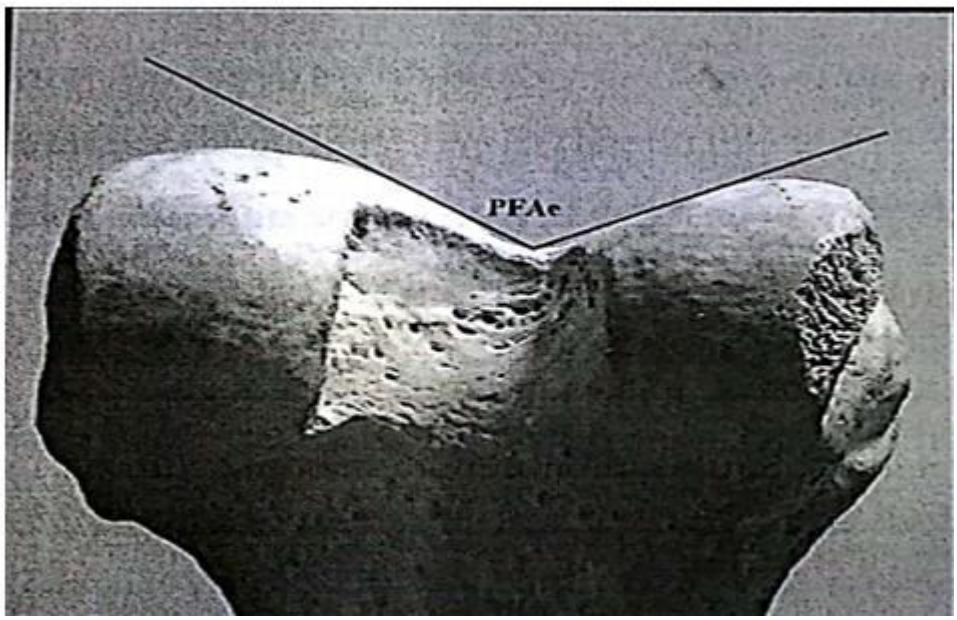


Fig.3 PFAe- Angle at the end of the patellar facet.



To obtained measurements, we were taken the following reference points:

- Length, from the apex of the greater trochanter to the start of the patellar facet.
- Width of femur shaft (side to side) from the midpoint of the length.
- Inclination angle, formed by the meeting point between straight lines traced out from the center of the body of the bone shaft and the center of the anatomical neck.
- Distance between the lowest points on each condyle.
- Depth of the patellar facet, measured directly.

Ficat and Bizou's condylar depth index which is ration of the distance between the condyles devidedby the depth the patellar facet at the deepest point considered.

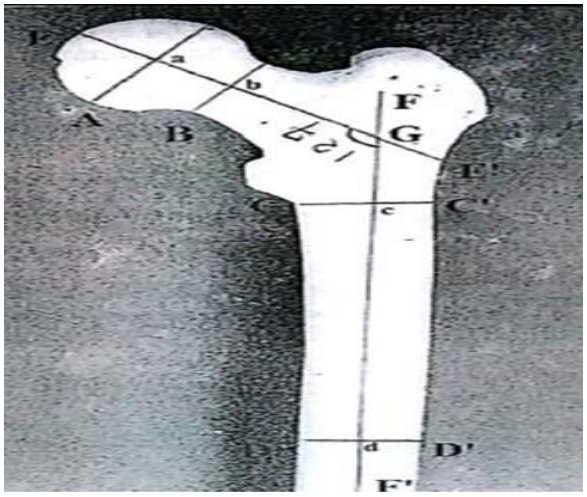
These measurements were taken as follows:

- Femur length, using a Osteometric board graduated in millimeters.
- Width, using a vernier Calipers.
- Inclination angle, measured by using photographs.
- Distance between condyles obtained by placing both condyles on an ink pad and then again placing ink stained condyles on aplain white paper to get two intercondylar points followed by measuring minimum distance between these two points.
- Depth of the patellar facet, was measured by using depth gauge.

Measurements of inclination angle were taken by placing each photograph with a ruler and marker then mark out the longitudinal axis of the neck and shaft of the femur as well as protractor was used to measure the angle obtained at intersection. The method adopted was that of Tahir et al[12] (2001):-

1. Axis of the neck of femur: Measurement of the maximum diameter of the head of the femur was by drawing a line joining the two most lateral points of the head of femur (AA). The minimum diameter of the neck (BB') which was the line joining the two lateral point of the neck of the femur that are closed then a line was drawn joining the mid points of the line AA' and BB' and extend. This line (EE') is the axis of the neck of femur.
2. Axis of the shaft of femur: This was determined by drawing transverse lines across the shaft of the femur just below the lesser.Trochanter (CC') and away from its distal end DD'. The mid points of both lines noted as c' and d' respectively. These two points were joined by a line is the axis of the shaft of the femur (FF'). collo-diaphyseal angle:- The angle formed by the intersection of the axis of the neck of the femur and the axis of the shaft of femur is the collo- the neck femur and the axis of the shaft of femur is the collo-diaphyseal angle (EGF') as seen in figure.

Fig.4 Measurement of Inclination angle (adopted from Tahir et al[12] 2001)



- AA' Maximum diameter of the head of the femur.
- BB' Minimum diameter of the neck of the femur.
- A' Midpoint of AA^1.
- B' Midpoint of BB^1.
- CC' Maximum diameter of the shaft of the femur just below the lesser trochanter.
- C' Midpoint of CC^1.
- DD' Maximum diameter of the shaft of the femur away from its distal end.
- D' Midpoint of DD^1.
- EE' Axis of the shaft of the femur
- FF' Axis of the neck of the femur
- G; Intersect of line EE'and FF'
- EGF' collo-diaphyseal angle of the femur.

OBSERVATIONS AND RESULS

The study was conducted on 200 dry human femur bones of both side (including 95 rights and 105 left) of unknown sex and age. SPSS version 17.0 was used for Statistical analysis of all the parameters for right and left side of femurs and then compared. Student T- test was applied for assessment of significance level. All observation found with the present study is depicted in **TABLE 01.**

Table 1 Descriptive statistic of all the measured parameters

Parameters	Right Side				Left side				Total			
	Mini	Max	Mean	S.D	Mini	Max	Mean	S.D	Mini	Max	Mean	S.D
PFAs (degree)	120.0	156.0	142.3	6.2	128.0	154.0	143.3	5.8	120.0	165.0	142.8	6.0
PFAm (degree)	118.0	148.0	131.1	6.3	119.0	148.0	131.8	6.0	118.0	148.0	131.5	6.1
PFAe (degree)	117.0	146.0	132.1	6.3	116.0	146.0	131.1	6.2	116.0	146.0	131.6	6.3
Inclination angle (degree)	110.0	137.0	123.2	5.8	114.0	140.0	127.7	5.1	110.0	140.0	125.5	5.9
ID (mm)	35.0	63.0	47.2	5.5	35.0	60.0	46.1	5.1	35.0	63.0	46.6	5.3
PFD (mm)	4.0	11.3	7.2	1.4	4.3	10.3	6.9	1.2	4.0	11.3	7.1	1.3
Index	4.2	14.0	6.8	1.7	4.3	11.3	6.9	1.4	4.2	14.0	6.8	1.6
Length (cm)	35.5	44.6	40.1	2.0	33.6	45.8	40.3	2.4	33.6	45.8	40.2	2.2
Shaft width at mid point of femur (cm)	2.1	3.2	2.6	0.2	2.0	3.1	2.6	0.2	2.0	3.2	2.6	0.2

SD - ± Standard Deviation

DISCUSSION

The bone structures at the lower extremity of the femur that are most cited in the literature that we have consulted the sulcus of the patellar facet of trochlea[13,14,15,16] and the intercondylar notch [17,18]. In all these reported studies morphometric abnormalities of lower extremity of femur level have been associated with knee disorders.

We have observed that the depth of the patellar facet and the distance between the condyles were the measurements with the largest dispersion in relation to their mean values. This suggests that these measurements vary greatly between individuals. Consequently, this gives rise to significant variation in Ficat and Bizou's condylar depth index since they are incorporated in this index. However, the angle of the patellar facet presented small dispersion in relation to their mean values, thus suggestion that these angles are less variable in relation to their mean values that are the measurements of the depth of the patellar facet and the distance between the condyles **(table 1).**

Numerical data such as Ficat and Bizou's index, Brattstrom's angle and the intercondylar width index are relative and must be regarded as reference at the point at which the measurements taken and they do not extend to the whole patellar facet and intercondylar notch Agreeing with Angelo, Costa, Galindo et al[19]. We have seen that in most cases, the mythology used did not specify the level of measurements, which further makes it difficult to compare values. The patellar facet angle cited by Brattstrom[15], which received his name, was obtained from radiographs on the knee and the level of the patellar facet at which it was measured is insufficiently clear.

Table 2 Comparison of Mean Patellar facet angle

Table 2 Comparison of Mean Patellar face angle	
Authors Name	**Mean Patellar facet angle (in degree)**
Present study	135.3^0
Nascimento et al[99]	130.8^0
Khalil et al[59] (MRI)	134^0
Kalil et al[59] (Dry femur)	141.7^0

Brattstorm et al[5]	142^0
Mearchant et al[18]	138.6^0
Buard et al[58]	144^0
Martino et al[17]	132^0
Mulligan et al[60]	138.6^0
Shih et al[52]	146.1^0
Gulman et al[73] (cadaver)	145.7^0
Gulman et al[13] (USG)	146^0
Andrew et al	141.5^0
Syid et al[112] (MRI)	173^{0*}
Salzmann et al[113] (X-Ray)	135.6^{0*}
Salzmann et al[17] (MRI)	180^{0*}
* Mean value of patellar facet angle in patients.	

Table 3 Comparison of Mean Patellar facet depth.

Table 3 Comparison of Mean Patellar facet depth	
Authors name	PDF (mm)
Present study	7.0
Nascimento et al[99]	9.5
Dejour et al[7]	7.8

Frrirman et al[114]	3.0*
*Mean value of patellar facet depth in patients	

Table 4 Comparison of Mean Inclination angle

Table 4 Comparison of Mean Inclination angle	
Authors name	Inclination angle (in degree)
Present study	125.5^0
Nascimento et al[99]	128.9^0
Benedito et al[96]	128.1^0
Putz& Palest et al[94]	150^0
Putz& Palest et al[94]	126^0
Mouro et al[92]	150^0
Dasalva et al[93]	126^0

Table 5 comparison of Inclination angle in right and left side

Table 5 comparison of Inclination angle in right and left side			
Authors name	IA Right	IA Left	IA Pool
Present study	123.2^0	127.7^0	125.5^0
Otsianyi et al[98]	127^0	127.2^0	127.1^0
Benedito et al[96]	128.2^0	128^0	128.1^0
Mauro et al[92]	111.2^0	114.2^0	150^0

Da salva et al[93]	122.5^0	125.6^0	126^0

SUMMARY AND CONCLUSION

Present study concluded that the angle of the femoral sulcus decreased from the start of the patellar facet toward its end. With the increment of Condylar depth index, it was seen that mean patellar facet angle also increased because patellar facet depth was incorporated as a denominator in the index. Patellar facet angle decreases as the facet increased, because angle was negatively correlated with depth especially at midpoint of facet and it was highly significant (p=0.000).

Patellar facet angle is variable, but this variability is weakly associated with the side of femora, length, width and inclination angle of the femur, as observed according to the t-test (significance level of 5%) for the correlation coefficients that were calculated. The results were found in present study, may be helpful to the clinicians dealing with patient of patellar facet angle alteration, mal alignment of patella femoral joint and dysplastic knees.

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