Morphometric Study of Patellar Measurement: An Overview from Eastern Zone of India

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ABSTRACT

Introduction: Morphometric analysis of the patella has been reported to be important in forensic identification, implant design and in some reconstructive procedures of the knee. Longevity and success of knee replacement depends also in proper implant dimensions. The size and shape of articular surface of patella, width, height, thickness and width of medial and lateral facets of patella are the important parameters that can determine the stability of patellofemoral joint and implant design. This study aimed at the morphometric and comparative analysis of patella in eastern part of India.

Material and Methods: 89 dry bones were collected from the students and the departmental bone bank. Measurements were taken by using Vernier Callipers.

Results: Bony features and abnormalities if any were noted. Classification of patella, based on the dimensions of the articular facets and dimensions of the patella and articular facets were also noted.

Conclusion: This type of morphometric study on patella may help in implant designing and forensic measurements

Keywords: Classification of patella, Patellar stability, Knee Replacement.

INTRODUCTION

The patella is the largest sesamoid bone and is embedded in the tendon of quadriceps femoris. It is placed anterior to the distal femur (femoral condyles). It is flat, distally tapered, proximally curved. Patella has anterior and posterior surfaces, three borders and a distally placed apex. The anterior surface has vertical ridges. The posterior surface has proximal smooth and oval articular area, crossed by a smooth vertical ridge. Patellar articular area has medial and lateral facets; the lateral being usually larger. Each facet is divided by faint horizontal lines into equal thirds. A seventh 'odd' facet is presented by a narrow strip along the medial border of the patella which comes in contact with the medial femoral condyle in extreme flexion.[1] Posterior surface is articular in upper three fourths and non articular in its lower one fourth.

Dye[2] has noted that amphibians and some reptiles do not have osseous patellae. However, lizards, birds, and mammals bear patella leading into speculation that a bony patella is important for terrestrial existence.

The patella forms part of the knee joint and is situated in front of lower end of femur approximately 1 cm above the knee joint. When patella lies higher, it is called patella alta and if it is lower, it is called patella baja.[3]

Wiberg proposed three shapes based on position of vertical ridge[4]

- Type I: there are roughly equal medial and lateral facets
- Type II: most common: medial facet is only 1/2 size of lateral facet;
- Type III: medial facet is so far medial that the central ridge is barely noticable;

The superior border (surface) slopes in front and below. The medial and lateral borders are thinner and gives attachment to medial and lateral patellar retinacula respectively. The lateral retinaculum receives contributions from the iliotibial tract also.

There is variability in respect to shape of the patella which can determine patellar stability . The bone may appear in two parts (a bipartite patella), usually with a smaller supero-lateral fragment, in radiograph. This kind of appearance may be due to the presence of a separate ossification centre or failed union after stress fracture

Rough markings of attachment of Quadriceps femoris can be seen on superior surface, extending to the anterior surface up to the apex. Along the lateral and medial borders and apex, vastus lateralis, medialis, and the patellar tendon are attached.

There is a natural tendency of patella to get displaced laterally. This is because of the difference in alignment of the femoral and tibial shafts that pull the quadriceps on the patella resulting in a superolateral force on it.

Apart from the natural tendency there are a lot of causes of patellar Instability like, small patella, very highly placed patella above the trochlea or shallow trochlear groove.

Therefore it appears that dynamic muscular control is important for the stability of the bone. The most distal part of vastus medialis has transverse fibres that are attached directly to the medial border of the patella. The natural tendency to lateral displacement is counteracted by the pull of these transverse fibres medially.

Therefore, patella is of great clinical importance from anatomical and surgical point of view. Any deviation in shape, size or position of the bone in respect to femoral and

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tibial shafts may change the normal behaviour of the knee joint and may hamper the patello-femoral mechanism. In this study we tried to find out some measurements of patella in respect to size and shape that may have great importance for patellar stability.

Yoo et al. (2007)[5] said that the geometry of the patella and patellar tendon was significantly larger in males. Other demographic factors including weight, height, body mass index correlates well with patellar thickness, but poorly with the patellar tendon length.[6]

Study on southern Chinese population showed that males have larger patellae, and there was no statistically significant difference between sides (i.e. right vs left patellae). Compared with Western population, these patellae were smaller.[7] A study in northern Indian population, used patellar morphometry for sex determination, with high accuracy of up to 80.5%.[8]

Quadriceps tendon thickness also showed significant correlation with patellar height.[9]

This study aimed at the morphometric and comparative analysis of patella in eastern part of India.

MATERIAL AND METHODS

89 dry patella were procured from the students and the departmental bone bank of ESI-PGIMSR & ESIC Medical College, Joka, Kolkata. Broken patella and patella with patello femoral diseases were excluded from the study. Necessary permission from the ethical board had been obtained.

Following measurements of the patella were taken using a Vernier calliper,

1. maximum patella height (PH),
2. maximum patella width (PW)
3. maximum patella thickness (PT)
4. The maximum widths of the medial articular facets (WMAF)
5. Ridge thickness
6. The maximum widths of the lateral articular facets (WLAF)
7. Height of upper articular facet
8. Height of lower articular facet
9. Angle of apex

In Table 1, the description of various terms related to measurement are shown

Each patella was classified into one of 3 categories Type A (WMAF=WLAF), Type B (WMAF <WLAF), Type C (WMAF >WLAF). (Based on the dimension of WMAF in relation to WLAF,)

After getting the bones over all examination was done and then picked up for taking further measurement according to the descriptions shown in Table 1.

After taking the necessary measurements all data are tabulated and analyzed statistically. Statistical data were calculated using the *Statistical Package for Social Sciences* (SPSS version 20.0),

RESULTS

Total 89 intact bones were collected (Right = 48, Left = 41). All measurements were taken in the Department of Anatomy of ESIC Medical College, Kolkata, using electronic Vernier callipers. In Table 2, the detail

Pic-1: Vernier Callipers and a set of bones to be measured

Measurements	Description
Height of Patella PH	Linear distance between superior border and apex
width of Patella PW	Linear distance between medial and lateral border
thickness of Patella PT	Linear distance between anterior surface and median ridge on posterior surface
Width of medial articular facet WMAF	Maximum width from the medial border to the median ridge
Width of lateral articular facet WLAF	Maximum width from the lateral border to the median ridge
Table-1: Various measurements of patella and their descriptions	

	Left				Right			
	N	Mean	Std. Deviation	Std. Error Mean	N	Mean	Std. Deviation	Std. Error Mean
Maximum height or Length	41	40.5349	3.66576	.57250	48	39.4506	3.52595	.50893
Maximum breadth	41	41.2161	4.05390	.63311	48	40.5340	3.73572	.53920
Maximum thickness	41	19.7912	1.64953	.25761	48	19.3969	1.68804	.24365
Medial facet width	41	15.6005	2.56663	.40084	48	14.7806	2.15662	.31128
Ridge thickness	41	5.4551	1.08541	.16951	48	6.0367	1.38405	.19977
Lateral facet width	41	20.1602	2.30055	.35929	48	19.7583	2.50093	.36098
Height of upper articular facet	41	31.0246	2.87478	.44896	48	30.5681	3.25657	.47005
Height of lower articular facet	41	9.5100	2.91096	.45462	48	8.9242	2.95140	.42600
Angle of apex	41	118.05	14.003	2.187	48	117.19	13.165	1.900
Table-2: Statistical data of different parameters patella.								

Classification	Total(%)
Wiberg type I	5.78
Wiberg type II	91.73
Wiberg type III	2.47
Table-3: Classification of Patella	

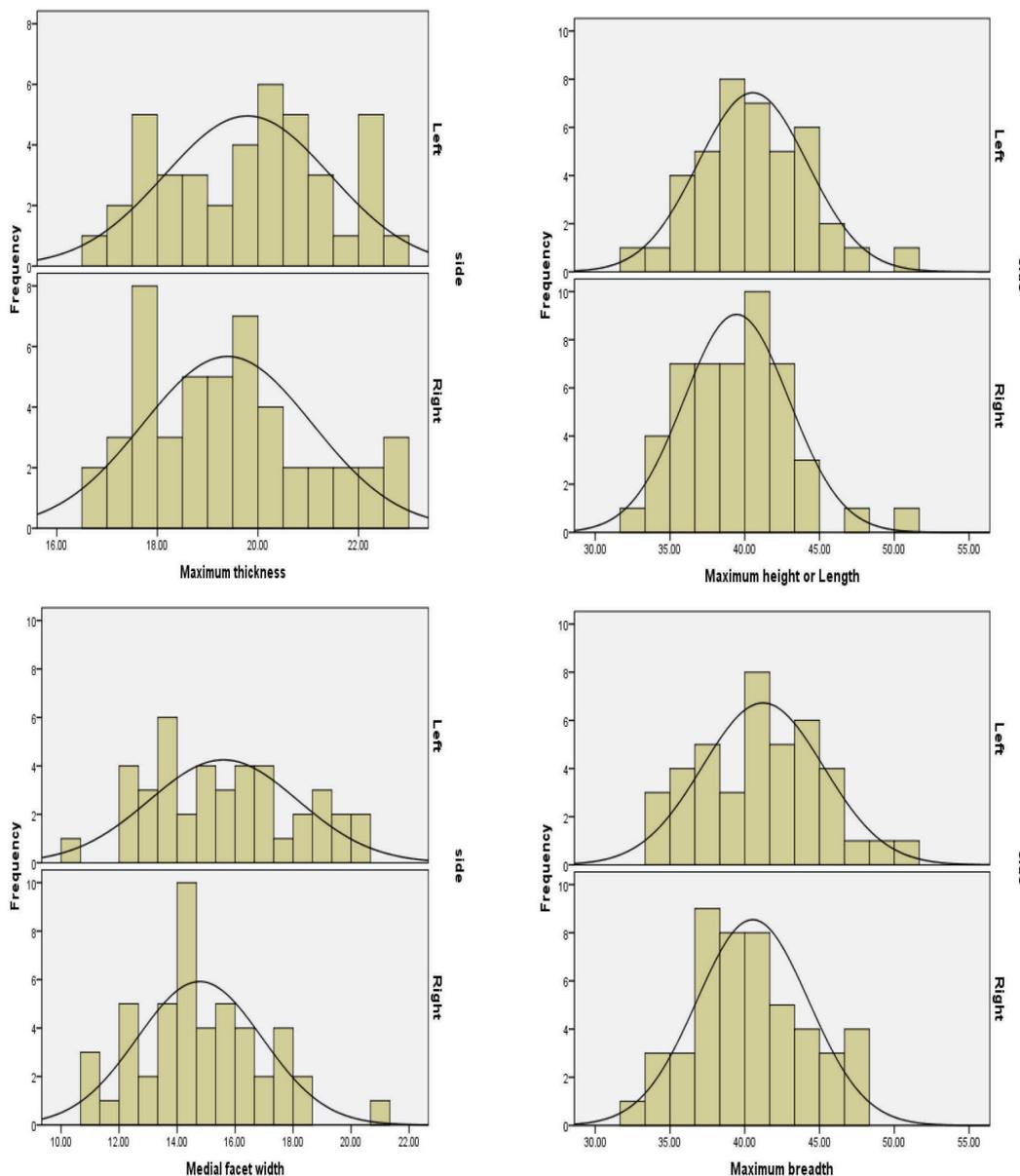|	N (Left side)	N (right side)	t-statistic	p-value
Maximum height or Length	41	48	1.420	.159
Maximum breadth	41	48	.826	.411
Maximum thickness	41	48	1.110	.270
Medial facet width	41	48	1.638	.105
Ridge thickness	41	48	-2.178	.032
Lateral facet width	41	48	.784	.435
Height of upper articular facet	41	48	.695	.489
Height of lower articular facet	41	48	.939	.350
Angle of apex	41	48	.299	.766
Table-4: Comparison between the measurements of the right and left patella using student's t-test.				

Figure-1: Showing different parameters of patella (comparing both the sides)

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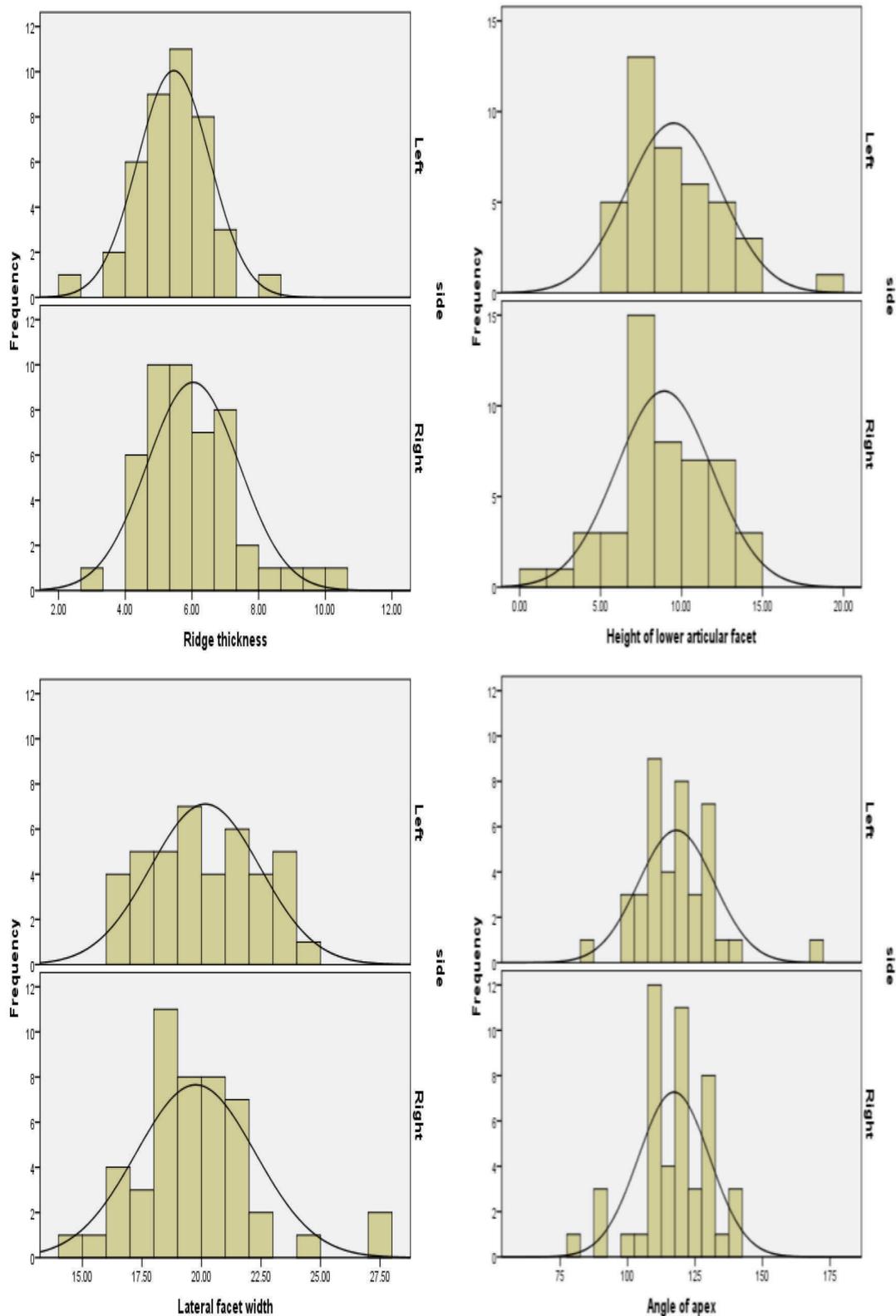
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Figure-2: Showing different parameters of patella (comparing both the sides)

statistical data of different parameters of patella are displayed.

In the present study the mean height, width and thickness of patella were 40.53, 41.21 and 19.79 mm respectively for left side and 39.45, 40.53 and 19.39 mm respectively for right side. Mean value of Medial facet width, Lateral facet width, Height of upper articular facet and Angle of apex in our study were found to be 15.60 mm, 20.16 mm, 31.02 mm and 118.05 on left side and the same on right side were 14.78 mm, 19.75 mm, 30.56 mm, and 117.19 respectively. Mean Ridge thickness was 5.45 mm and 6.03 mm on left and right side respectively.

According to Wiberg classification maximum number of patella belonged to type II variety.

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DISCUSSION

The importance of the patellar morphometry for human identification in forensic study and also its role in the mechanical design of the knee have been widely accepted. Measurements of the patella and patellar ligament are often used in implant design and certain surgical procedures such as patella resurfacing for total knee arthroplasty and the harvesting technique of patellar ligament grafts during the reconstruction of the anterior cruciate ligament/ posterior cruciate ligament.

Usually, measurements are taken during surgery and its thickness is a guide for the depth of resection in total knee replacement. However, in a pathological joint, the proper measurement may not be possible to take or may be altered. Studies on patellar thickness and various patellar dimensions on three-dimensional reconstructed computed tomographic scans have been done already.

We are taking in to consideration that the data obtained during surgery and the same from the dry bones do not have any statistically significant difference.

For all practical purposes dry bones are used to take the measurements, as they can give more or less accurate results and this type of studies are easy to conduct . Therefore, we took the measurements and compared them with the already available data.

Comparison in respect to sides(right and left) have also been done to know if there was any statistically significant difference (Table 4,Figures 1 and 2).

The assumption here is that there is no difference between either side and hence a p-value greater than 0.05 indicates that we cannot reject the null hypothesis(our assumption).

All the parameters studied here showed no statistically significant difference between right and left patella except for ridge thickness that may be further studied extensively to establish any conclusion (Table 4).

Koyuncu et al. in a study on fetal cadavers found that there was no significant differences between genders or sides (right or left patella).[10]

They found a significant correlation between gestational age and all studied morphometric parameters of patella. They also reported that 20% of patellae were Class A (the widths of MAF and LAF are equal). In Class B (the width of the MAF is smaller than the width of the LAF) was reported as the most prevalent (50%) while 30% of patellae were Class C (the width of MAF was greater than the width of the LAF.[10]

In another study by James L and Baldwin, it was found that the medial facet was slightly thicker than the lateral facet (18 vs 17 mm) and the lateral facet was 25% wider than the medial face.[11]

But in our study following results were found (Table 3),

Wiberg type I was 5.78%,

Wiberg type II was 91.73%,

Wiberg type III was 2.47% respectively.

As compared to the previous studies results were found different. In our study in more than 91% of the patellae, the width of medial articular facets were smaller than width of

lateral articular facets. The difference in results may be due to difference in ethnicity or difference in build and stature of eastern Indian populations that can be further explored.

CONCLUSION

All these data related to patellar morphometry found in this study are valuable for use in anthropology, comparative Anatomy, Forensic and Evolutionary Biology. These data can be of great help in prosthesis/implant designing and their use in biomedical applications like in replacement and reconstructive surgeries.

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REFERENCES

1. Susan Standring, Gray's Anatomy, 40th Edition, Churchill Livingstone Elsevier,2008
2. Dye SF. An evolutionary perspective of the knee. J Bone Joint Surg 1987;69:976.
3. Dr Arun Pal Singh. Anatomy of Patella. Published -August 15, 2015
4. Wiberg G. Roentgenographic and anatomic studies on the femoropatellar joint. Acta Orthop Scand. 1941;12:319-410.
5. Yoo JH, Yi SR, Kim JH. The geometry of patella and patellar tendon measured on knee MRI. Surg Radiol Anat. 2007;29: 623-8.
6. Miller TT, Staron RB, Feldman F. Patellar height on sagittal MR imaging of the knee. AJR Am J Roentgenol. 1996;167: 339-41.
7. Peng S, Linan Z, Zengtao H, Xueling B, Xin Y, Zhaobin X, Xu H. Morphometric measurement of the patella on 3D model reconstructed from CT scan images for the southern Chinese population. Chin. Med. J. 2014;127: 96-101.
8. Kayalvizhi I, Arora S, Dang B, Bansal S, Narayan RK. Sex Determination by Applying Discriminant Functional Analysis on Patellar Morphometry. MH; 42(4.8): 38-1.
9. Potage D, Duparc F, D'Utruy A, Courage O, Roussignol X. Mapping the quadriceps tendon: An anatomic and morphometric study to guide tendon harvesting. Surg Radiol Anat. 2015; 37:1063-7.
10. Koyuncu, E., Cankara, N., Sulak, O., Ozguner, G., Albay, S. The morphometry of patella and patellar ligament during the fetal period. Clin Anat, 2011;24:225-231.
11. James L. Baldwin, C. Ken House. Anatomic Dimensions of the Patella Measured During Total Knee Arthroplasty. The Journal of Arthroplasty 2005;20:250–257.