



Original Research Article

Patellar dimensions in south Indian population-An aid to implant design in total knee arthroplasty

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ABSTRACT

Introduction: For a successful knee arthroplasty it is imperative to measure patellar thickness intraoperatively to guide the depth of resection. Width thickness ratio of patella is a useful indicator for assessing pre-morbid patellar thickness. Patellar implants for total knee arthroplasty rely mostly on data from Western population as data from Indian population is sparse.

Aim of the study: To study the dimensions of patella in South Indian population and to compare it with the previous literature. To estimate the commonest variant of patella in Indian population as per the Weibergs classification.

Materials and Methods: 101 dry patella from the Department of Anatomy of MVJ Medical College and Research Hospital were used for this study following approval from Institutional ethical committee. The dimensions of patella i.e Patellar height, width, thickness, width of medial and lateral articular facet were measured using Digital Vernier calipers.

Results: The results of various statistical parameters (Length, Width, Thickness, MAF and LAF) on the right and left side and combined were expressed in terms of mean and standard deviations along with minimum and maximum values. (Table 1) The mean height, width and thickness of patella was 39.07mm, 42.56mm and 22.7mm respectively. The values of all the variables of both sides were compared. There was no statistical difference between the variables on right and left sides. Width of MAF in the present study was 19.8 ± 2.82 mm while Width of LAF was 24.6 ± 1.88 mm. Ratio of width to thickness of patella was 1.8mm. There was no correlation between the two variables.

Patella was classified according to Wiberg classification on the basis of dimensions of the width of medial articular and lateral articular facet as well as curvature of the facets. The most common variant observed was Type 2.

Conclusion: The knowledge of patellar morphometry will aid the orthopedic surgeons in designing prosthesis. Morphometric data of patella on Indian population will also act as guide for forensic experts and anthropologists in sex determination.

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1. Introduction

Patella is the largest sesamoid bone develops in the tendon of the quadriceps femoris. Patella is triangular in shape with apex directed downwards. It is flat bone tapering distally with anterior and posterior surfaces. Patella has base, medial

border and lateral border. The anterior surface is rough and non articular with longitudinal ridges covered by an expansion from the quadriceps femoris. The upper part of posterior surface is articular with larger lateral facet and smaller medial facet which are separated by median ridge. The lower non articular part on the posterior surface is rough for the attachment of ligamentum patella. The most medial part of patella articulates with the medial condyles of femur

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during full flexion at the knee joint.¹

Patellar dimensions have an evolutionary and forensic importance. Patellar morphometry is affected by environment, culture and ethnicity. It is also of utmost importance in developing patellofemoral implants for total knee arthroplasty. A disproportionate implant will result in limitation of movement in knee joint and unstable patellofemoral knee complex.² This study aimed at analysing of morphometry of patella and classifying patella according to Wieberg's classification in South Indian population as variation in shape of patella can result in unstable patella.³ A thorough knowledge of the morphometry of patella and its biomechanics will aid in understanding the pathologies associated with knee.⁴

2. Materials and Methods

101 dry patella of both sexes were taken for the study from the Department of Anatomy MVJMC & RH, Bangalore. Bones with fractures, loss of bone density or bone erosion were excluded from the study. Measurements of patella namely patella height, width, thickness, width of medial articular facet and lateral articular facet were studied using digital Vernier calipers as follows.



Fig. 1: Patella Thickness measurement

1. Patella height / length – distance between superior border and apex.
2. Patella width – distance between medial and lateral border
3. Patella thickness – distance between anterior surface and median ridge on posterior surface



Fig. 2: Patella Bone

4. Width of medial articular facet – maximum width from medial border to the median ridge.
5. Width of lateral articular facet – maximum width from lateral border to the median ridge.
6. The measurement of variables was tabulated and statistically analyzed.

The mean, maximum, minimum and standard deviation of all the variables was calculated and tabulated. Pearson's correlation coefficient was used to study the association between height, width and thickness, Mean width to thickness ratio was graphed. Statistical analysis was performed with Microsoft excel.

3. Results

Table 1: Patella Bone Measurements (COMBINED) right and left side

Variable	Mean $\pm$ SD	Max	MIN	P-value
Length	39.07723 $\pm$ 4.454456	62	29.6	0.267308
Width	42.56733 $\pm$ 3.079127	51.1	35.5	0.698506
Thickness	22.7099 $\pm$ 2.796516	28.9	16	0.801724
MAF(Width)	19.86139 $\pm$ 2.828532	29	14	0.584311
LAF(Width)	24.64356 $\pm$ 1.88989	30	21	0.428569

The results of various statistical parameters (Length, Width, Thickness, MAF and LAF) on the right & left side and combined were expressed in terms of mean and standard deviations along with minimum and maximum

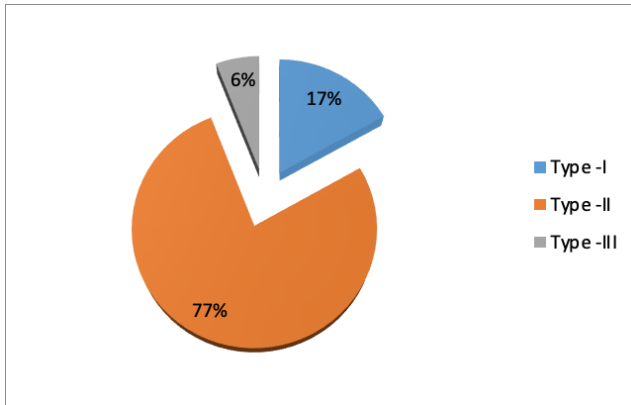


Fig. 3: Pie chart for different types of patella based on wiberg classification

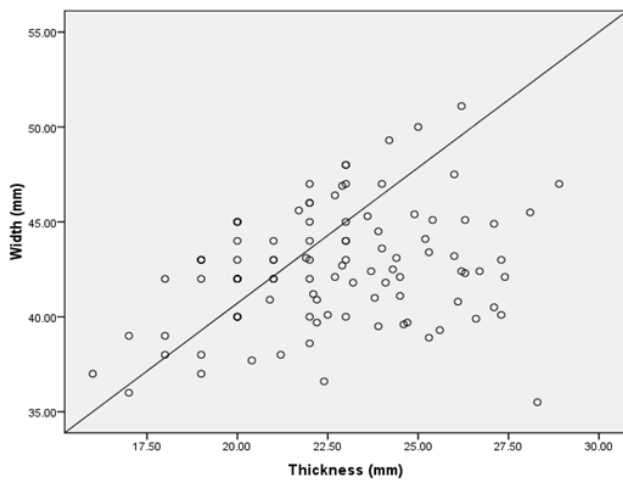


Fig. 4: Correlation between width and thickness of patella (combined)

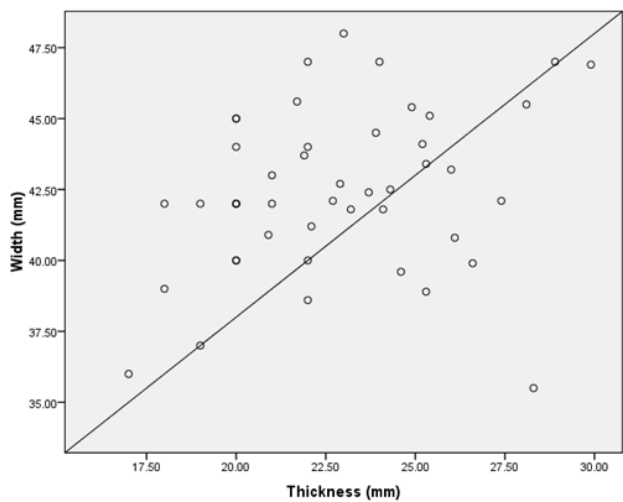


Fig. 5: Correlation between width and thickness of patella (Right)

Table 2: Patella Boneright side measurements

Variable	Mean $\pm$ SD	Max	Min
Length	39.50741 $\pm$ 3.51073	47	31.4
Width	42.68148 $\pm$ 3.282491	51.1	36.6
Thickness	22.70926 $\pm$ 2.758607	27.3	16
MAF (Width)	19.96296 $\pm$ 2.719343	29	15
LAF (Width)	24.48148 $\pm$ 1.997553	30	21

Table 3: Patellabone left side measurements

Variable	Mean $\pm$ SD	Max	Min
Length	38.5087 $\pm$ 5.369826	62	29.6
Width	42.43913 $\pm$ 2.891941	48	35.5
Thickness	22.85652 $\pm$ 3.088736	29.9	17
MAF(Width)	19.65217 $\pm$ 2.938007	29	14
LAF(Width)	24.78261 $\pm$ 1.750086	30	21

Table 4: Correlation between patellar width and thickness

Patellar bone width	Patellar bone thickness	
	Correlation (r value)	P value
Combined	0.286	0.004
Right	0.342	0.011
Left	0.281	0.049

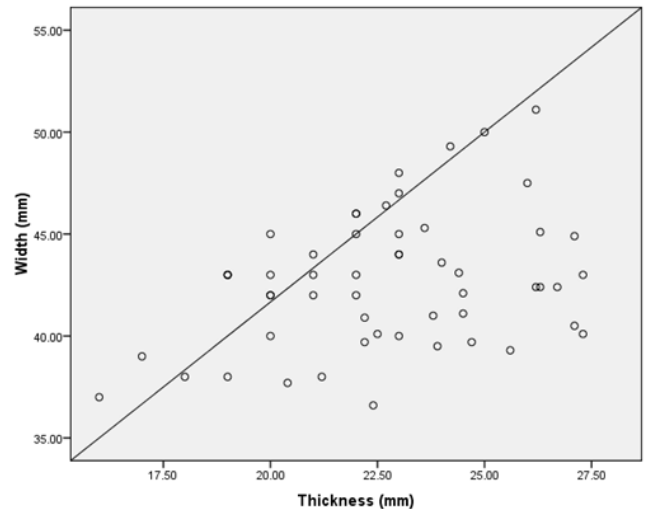


Fig. 6: Correlation between width and thickness of patella (Left)

values.(Table 1) The mean height, width and thickness of patella was 39.07mm, 42.56mm and 22.7mm. The values of all the variables of both sides were compared. There was no statistical difference between the variables on right and left sides. Width of MAF in the present study was 19.8 ± 2.82 mm while Width of LAF was 24.6 ± 1.88 mm. Ratio of width to thickness of patella was 1.8mm. There was positive correlation between the width and thickness of patella on both right, left sides and combined.(Table 4)

Patella was classified according to Wiberg classification on the basis of dimensions of the width of medial articular and lateral articular facet as well as curvature of the facets.

Table 5:

Study	Study Sample	Patella Height(mm)		Patella Width(mm)		Patella Thickness(mm)	
		Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Schlenzka and Schwesinger(2014)	50 fresh human cadaveric patella	54.4	3.5	50.3	4	-	-
Iranpour.et.al (2008)	30 Reconstructed CT scans	44.3	4.8	44.8	4.8	22.4	2.3
Shang peng (2014)	CT Scan	39.94	3.68	-	-	22.72	1.81
Poonam Vohra et.al(2017)	60 Dry bones	41.55	2.84	40.17	2.59	19.29	1.52
Present study	Dry bones	39.07	4.45	42.56	3.07	22.70	2.79
Magi Murugan et al	65 adult dry patella	38.07	3.70	-	-	18.29	
Baldwin &House	92 patella during total knee arthroplasty	-	-	-	-	22.6	1.73

Each patella was classified into three categories as Type-1 where WMAF=WLAF, Type-2 where WMAF>WLAF and type-3 in which WMAF<WLAF. Out of 101 patella studied, 78 patella belonged to Type-2, 17 patella were type-1 and 06 patella were classified as Type-3.

4. Discussion

Patellar morphometry has significant role in implant design and surgical procedures like patella resurfacing for total knee arthroplasty.⁵ In the present study the measurement of bone was done on dry bones to avoid errors during measurement. The mean height, width and thickness of patella in this study were 39.07mm, 42.56mm and 22.70 mm respectively. The data obtained was compared with the previous studies and summarized in Table 3.

In the present study mean height of the patella was 39.07mm with standard deviation of 4.45 which was similar to the findings of Shang peng, Magi Murugan, Vohra et al but less compared to the previous study by Schlenzka and Schwesinger.⁶⁻⁹ Table 1 also shows that, the values of patellar height are comparable with previous studies irrespective of the methodology (CT, Dry bones/MRI). However, the width of patella in our study was also less compared to study by Schlenzka and schwesinger⁹ but almost similar to the study by Poonam Vohra et al and Iranpour et al.^{5,8} These variations could be because of racial differences, differences in methodology, sex etc.

Thickness of patella in our study also coincided with the findings of Iranpour et al, Shang peng, Baldwin & House.^{5,6,10} There was no significant difference between right and left side of patellar dimensions which was similar to that of the studies by previous authors. Width to thickness ratio on right side was 1.88mm and for the left side was 1.85mm. This was similar to the findings by Iranpour et al who studied the patellar dimensions through CT scan.⁵ Their study revealed a positive correlation coefficient

between width and thickness of patella similar to what we observed in this study.

Patella were also classified based on the dimensions of the articular facets. In our study, type B was most prevalent which support Wieberg et.al and Koyunchu et.al observations.^{11,12}

Width of MAF in the present study was 19.8 ± 2.82 mm which was similar to the studies done on other population. However, study by Biswas and Sharma reported lower values on eastern population of India.¹³ Width of LAF was 24.6 ± 1.88 mm comparable to studies in other population except Biswas & Sharma reporting slightly lower values.¹³ Ratio of width to thickness of patella was 1.8mm similar to that of Chinese population (1.94mm) average but less than the UK population (2.11mm average). This ratio is useful to create patellar prosthesis during knee arthroplasty.⁵ The ratio of LAF to MAF was 1.24mm similar to studies by Shang Peng (1.34mm) and Magi Murugan (1.21mm).^{6,7}

No significant differences in variable values were observed between the right and left side similar to previous studies. However, study by Olateju reported greater width and thickness of patella on the right in Europeans which he postulated was because of over use of one limb.¹⁴

We observed Type B patella as the most common variant based on Wibergs classification similar to Magi Murugan and Fucntese et.al.¹⁵

Koyuncu et al in his study on foetal patella reported that prevalence of Class-A patella (width of MAF is equal to LAF) as 20%, Class B patella (width of MAF less than LAF) as 50% and Class C patella (width of MAF more than LAF) as 30% which is different from Wibergs classification of adult patella.^{11,12}

5. Conclusion

In order to aim for optimum biomechanical integrity following Total Knee arthroplasty, ideal size of the implant

is imperative. Patellar size is one of the criteria used for patellar resurfacing. It is desirable to resect not more than one third of patellar thickness to prevent loss of bony structure. This study may add value to the existing data on Morphometry of patella in Indian population. Patellar morphometry can be used in sex determination with an accuracy of 80%. This study may also add values to existing literature on patellar morphometry which can be put to use in science of anthropology, forensic, anatomy and on designing prosthesis for reconstruction surgeries.

6. Conflict of Interest

None.

7. Source of Funding

None.

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