

Anthropometric Analysis of Human Adult Dry Patella for Construction of Patellar Prosthesis: A Pilot Study

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ABSTRACT

Introduction: The pathobiology of patella related illnesses are multifactorial and the postoperative failure of total knee arthroplasty leads to the implant designing. Currently in India, based on the western anthropometry measurements, patellar prosthesis is available which is not perfectly suitable for Indian ethnic population. Creating a patellar bone prosthesis by incorporating the Indian ethnic anthropometric dimensions will give much better postoperative result and will help in designing new surgical techniques.

Aim: To obtain anthropometric measurements of patella in Indian Ethnic population for construction of patellar prosthesis.

Materials and Methods: An osteological study was carried out in which 66 non-pathological human dry adult patella bone was collected from southern and western ethnic Konkan tribal populations of India. The primary objective of the present study was to measure the anthropometric dimensions of dry Indian human

patella bone and to compare the anthropometry dimensions of various ethnic populations in and around the world. Measurements like height, breadth, thickness of articular surface of patella were measured and recorded. Various measurements were done using scientific digital Vernier calliper, digital protractor. Statistical analysis was done by using Graph pad prism version 8.2.1.

Results: The maximum mean height of right and left patella was 38.7 ± 5 mm and 40.006 ± 7 mm, respectively. Maximum mean breadth of right and left patella was 40.1 ± 5 mm and 40.2 ± 6 mm, respectively and all other parameters were statistically significant. When right and left side patella values were compared, all the parameters was statistically significant and more for left side except for maximum height of medial facet and maximum breadth of lateral facet.

Conclusion: The present study provides basic knowledge of patellar dimension to orthopedician which will help in designing the patellar prosthesis involving the knee.

Keywords: Articular facet, Dimensions of patella, Knee cap, Sesamoid bone

INTRODUCTION

Patella is the largest sesamoid bone in human body, developed from the tendon of quadriceps femoris; it is triangular in shape having two surfaces and three borders. Anterior surface is rough covered by the tendon of quadriceps femoris, posterior articular surface is smooth and divided into medial and lateral articular facet by median ridge. Patella has three borders superior border, lateral border, and medial border, converging inferiorly to form its apex [1]. The patella, also called as knee cap does not have morphological sex determination, however it is one of the few bones in human bone that is resistant to post-mortem changes [2]. Anthropometric dimensions of patella are clinically very important for the determination of patellar prosthesis, improper size of patellar implants after total knee arthroplasty will lead to excessive anterior knee pain, joint congruence, and patellar clunk syndrome and limitation of movements [3,4]. Generally, there are two methods to measure the anthropometry of any bone: 1) Dry bone with Vernier calliper; 2) Recording the anthropometry data in X-ray, MRI and Computed tomography with the help of Picture Archiving Communication System (PACS). Various research reviews states that average age for Total knee Arthroplasty is 60.5 years in male and 56.1 in female, when the age progresses, the postoperative complications exponentially increases [5]. However, the present study uses dry bone with digital Vernier calliper. Currently there were few prosthesis designs available in the market, but they were based on the western ethnic population and more over there is anthropometric dissimilarity between the Asian ethnic and western ethnic population [6,7]. Currently, in Indian population, there is lack of anthropometric patellar measurements, the data pertaining to the anthropometric dimensions can aid in development of patellar prosthesis and implants in total knee arthroplasty.

MATERIALS AND METHODS

A pilot osteological study was conducted on 66 non-fractured and non-pathological dry patellar bone of right and left samples for duration of two months. The dry patella samples were collected from Department of Anatomy, BKL Walawakar Rural Medical College, Ratnagiri, Maharashtra, India, Department of Anatomy, Rajas Dental College and Hospital, Tirunelveli, Tamilnadu, India, Department of Anatomy, Vinayaka Mission Kirupananda Variyar Medical College and Hospital, Salem, Tamil Nadu, India.

Inclusion Criteria

Patella which were included for the present study were irrespective of sex and age.

Exclusion Criteria

Fractured patella, patella already undergone patellar re-surfacing, skeletally immature patella, patella in cadaver.

Total of eight anthropometry data were collected with the help of scientific digital Vernier calliper with the error value of 0.001 mm [Table/Fig-1,2].

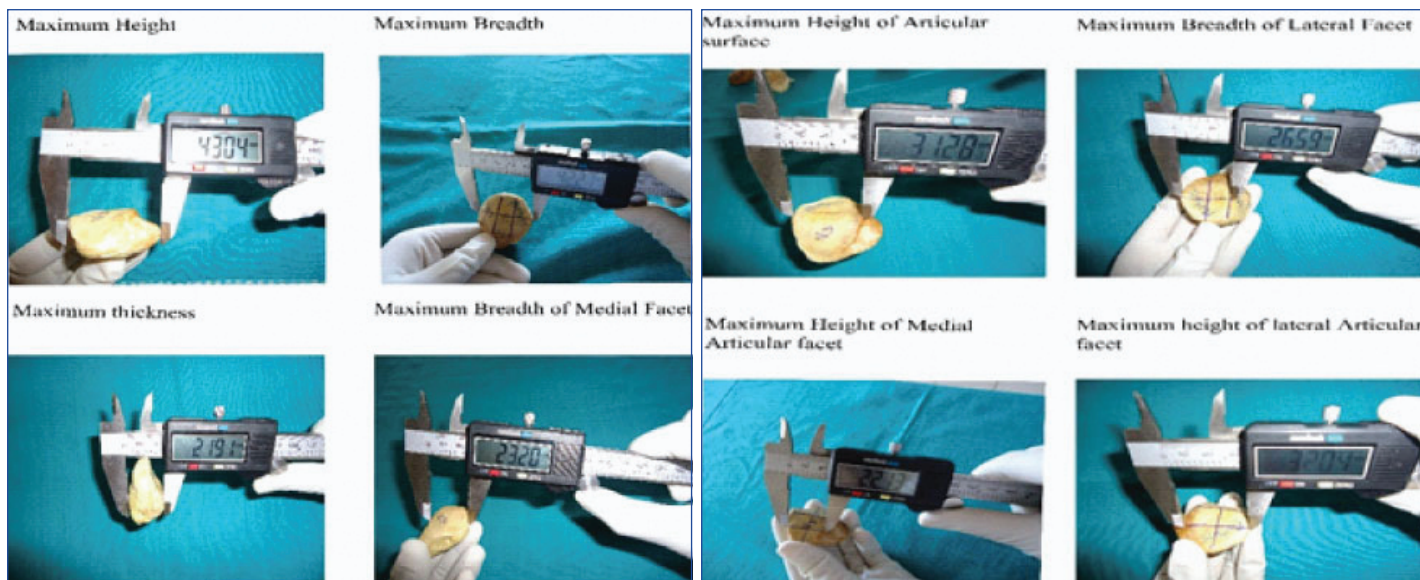
Maximum height- Maximum vertical distance between the apex and base of the patella

Maximum breadth- Maximum distance present between the medial and lateral border of the patella.

Maximum thickness- Maximum distance present between the anterior and posterior surface of patella.

Maximum breadth of the medial facet- Maximum horizontal distance between median ridge and medial border of patella [8].

Maximum height of articular surface- Maximum vertical articular smooth surface between the superior and distal end of median ridge.



[Table/Fig-1,2]: Various anthropometric measurements of Patella. (Images from left to right)

Maximum breadth of lateral facet- Maximum horizontal distance between the median ridge and the medial border of the patella.

Maximum height of medial articular facet- Maximum horizontal distance between the superior and inferior border of patella

Maximum height of lateral articular facet- Maximum horizontal distance between the superior and inferior border of patella [8,9].

All the osteological sample measurement taken in Research lab, Department of Anatomy and the data was electronically stored.

STATISTICAL ANALYSIS

The statistical work was done using GraphPad prism Software package version 8.2.1. The statistical analysis includes Mean, median, standard deviation, one-way Anova was used for Right and Left Patella bones.

RESULTS

The maximum mean height of right and left patella was 38.7 ± 5 mm and 40.006 ± 7 mm respectively. The values for all other parameters are depicted in [Table/Fig-3].

Parameters (mm)	Right side mean (mm)	Left side mean (mm)	Significance (p-value)
Maximum height of patella	38.7 ± 5	40.006 ± 7	$p < 0.0001^{****}$
Maximum breadth of patella	40.1 ± 5	40.2 ± 6	$p < 0.0001^{****}$
Maximum thickness of patella	20.7 ± 4	21.3 ± 5	$p < 0.0001^{****}$
Maximum height of articular surface of patella	28.6 ± 4	29.6 ± 5	$p < 0.0001^{****}$
Maximum breadth of medial facet	21.3 ± 3	21.7 ± 8	$p < 0.0001^{****}$
Maximum height of medial facet	25.6 ± 7	24.5 ± 6	$p < 0.0001^{****}$
Maximum breadth of lateral facet	28.4 ± 2	24.3 ± 4	$p < 0.0001^{****}$
Maximum height of the lateral facet	28.04 ± 3	29.8 ± 5	$p < 0.0001^{****}$

[Table/Fig-3]: Anthropometric dimensions of patella right and left side.

One-way anova; ****highly significant

DISCUSSION

The mean breadth and mean thickness of Indian ethnic patella is smaller in comparison with the study done by Baldwin JL and House CK [11]. Comparison of anthropometric measurements with other published studies is shown in [Table/Fig-4] [8,10-13].

Mean breadth of medial articular facet was 19.03 mm and mean breadth of lateral articular facet of south Chinese ethnic study was 25.1 mm [14]. However, the present study mean breadth of medial and lateral articular facet was significantly larger in dimensions. The maximum mean height and maximum breadth of North Indian ethnic patella anthropometry values almost matches the present study

Study	Type of sample	Mean height (mm)	Mean breadth (mm)	Mean thickness (mm)
Olateju Ol et al., [10] (South africa population) n=46	Human adult cadaver of male and female	43.73 ± 3.65	45.14 ± 3.96	23.85 ± 2.18
Baldwin JL and House CK, [11] (USA population) n=35	Human Adult patella Total knee arthroplasty	38.60 ± 2.47	50.30 ± 5.65	23.90 ± 2.30
Iranpour F et al., [12] (British population) n=37	3-Dimensional Computed tomography	34.3 ± 3.8	44.8 ± 4.8	22.4 ± 2.3
Jain R et al., [13] North Indian population N=200	Normal X ray	41.67 ± 4.1	43.35 ± 4.10	19.22 ± 2.19
Agnihotri G et al., [8] North Indians n=200	Human adult dry patellae from male cadavers	35.8	37	16.95
Current study India N=66	Human adult Dry patella bone of both sex	40.006 ± 7	40.2 ± 6	21.3 ± 5

[Table/Fig-4]: Comparison of anthropometric dimensions of patella in various ethnic populations [8,10-13].

[13]. The results of the present study showed that the mean height, breadth, thickness of Indian anthropometric measurements was significantly smaller than the western as well as African ethnic [9,10] and larger than Chinese ethnic [14]. This might be due to races, genetic, environment, lifestyle, and age. Most of the prosthesis available in India are designed and developed, based on western anthropometry data which is anatomically not suitable for the Indian ethnic population. The current analysis shows that anthropometry data of Indians are smaller in all parameters than the western and African ethnic population and larger than the North Indian population.

LIMITATION

The major limitation of the present study was that the thickness of patellar articular cartilage was not measured since the study was based on anthropometry of dry patella and it was very hard to determine sex of patella bone.

CONCLUSION

The present study showed that Indian ethnics have smaller patella compared to the other ethnic population around the world. However, the present study gives basic anthropometry knowledge of patella which will help forensic anthropometry studies. Further studies of patella in magnetic resonance imaging and computed tomography may reveal the cartilage thickness of male and female patella and help to design the patellar prosthesis for Indian ethnic population.

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