Original Article

Study of Sexual dimorphism of human patella by measuring maximum height, width, thickness

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ABSTRACT

Background

Largest sesamoid bone in our body is patella which develops within the tendon of the quadriceps femoris muscle. Therefore, its morphology is dependent on the strain generated by the quadriceps muscle and can be modified by several cultural-ethnic factors. Males have comparatively larger muscle build compared to females, so this small bone would show a remarkable degree of sexual dimorphism.

Methods

Cross sectional, analytical type of study carried out in the Department of Anatomy, Dhaka Medical College, Dhaka, from January 2018 to June 2019. One hundred and fifty (150) dry adult human left patella of unknown sex were collected. The study samples were grouped into male and female by discriminant function analysis and 92 male and 58 female bones were found. Maximum patellar height, width, thickness were measured by digital slide calipers.

Results

The mean ± SD of maximum patellar height, width, thickness, were significantly higher in male than female.

Conclusion

The morphometric measurements of the left patella showed that Significant difference exists between male and female patellae. The maximum height, width and thickness of patellae were significantly higher in male than female.

Keywords

Height of patella; width of patella; thickness of patella.

INTRODUCTION

The patella is embedded in the tendon of quadriceps femoris, anterior to the distal femur (femoral condyles). It is flat, distally tapered, proximally curved, and has anterior and posterior surfaces, three borders and an apex which is the distal end of the bone. With the knee in extension, the apex is just proximal to the line of the knee joint. The subcutaneous, convex anterior surface is perforated by nutrient vessels. It is longitudinally ridged, separated from the skin by a prepatellar bursa, and covered by an expansion from the tendon of quadriceps femoris, which blends distally with superficial fibres of the patellar tendon (patellar ligament), the continuation of the tendon of quadriceps.[1]

Human skeletal parts are highly crucial in many anthropological cases and traumatic events (e.g. mass disaster, murder, road traffic accidents, etc.) for determination of sex and stature.[2] Estimation of sex is further trustworthy

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if the complete skeleton is available for analysis but in forensic cases human skeletal remains are often incomplete or damaged. The skull, pelvis and long bones are frequently absent or fragmented so that sex prediction must be attempted from other parts of the skeleton. However the accuracy of sex estimation from other skeletal elements depends on the degree of sexual dimorphism exhibited by the skeleton.[3] The patella although does not have any distinct morphological features for determining sex or race but still it is used for personal identification purposes because of its resistant to post-mortem changes.[4]

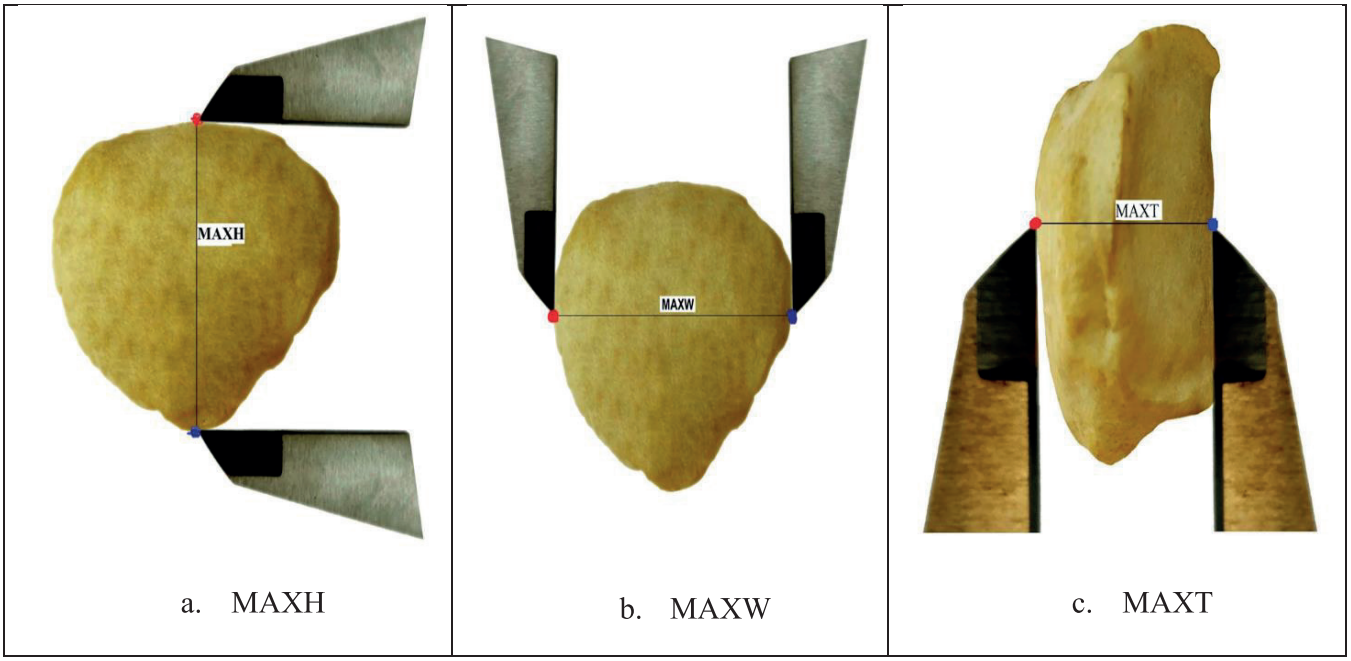
Knee instability due to decreased neuromuscular strength and coordination or increased ligamentous laxity may be the possible cause of increased incidence of knee injury in females in addition to female sex hormones (i.e. estrogen, progesterone and relaxin).[5]

Patella is prone to trauma due to its subcutaneous placement and can be affected by any systemic skeletal disorder. The success of total knee arthroplasty or patellofemoral arthroplasty depends on obtaining the suitable patellar implant. There are very few studies on morphology of patella and the knowledge of morphological dimensions of patella performs very important role in the design of prosthesis and development of surgical techniques.[6]

An appropriate size and thickness of a patellar implant is important in ensuring success in the functionality of arthroplasty. A disproportional implant of the patellofemoral joint would result in an ineffective lever support, limitation of motion, excessive wear and instability of the patella with associated knee pain.[7] The dimensions of the patella in this study provide more precise information about the true anatomic morphometry that can be used in reconstruction of the patella during total knee arthroplasty. The present study was done with an aim to increase knowledge about the measurement of different dimensions of adult human patella and to develop a baseline data regarding these dimensions.

METHODS

A cross-sectional analytical study was done on 150 dry adult human left patella bones of unknown sex. The samples were collected from Dhaka Medical College, Dhaka and Northern International Medical College, Dhaka. Any fracture of patella, presence of deformity, part of bone is missing or incomplete were excluded.



a. MAXH b. MAXW c. MAXT

Photograph 1: a) measurement of maximum height of patella, b) measurement of maximum width of patella c) measurement of maximum thickness of patella

Digital slide caliper, and digital camera were used for the measurements. Sexes of the collected patellae were determined by stepwise discriminant function analysis technique and grouped into male and female. Maximum patellar height (MAXH) was measured by the linear distance between the upper most point on the superior border and the lower most point on the apex of the patella.[8] Maximum width (MAXW) of patella was measured by the linear distance between the outer most point of the medial border and the outer most point of the lateral border of the patella.[8] Maximum thickness (MAXT) of patella was measured as the distance between the anterior most point of the anterior surface and the midpoint of the facetal ridge of the patella.[8] Maximum height of patella [MAXH], Maximum width of patella [MAXW] and Maximum thickness [MAXT] were measured three times, then the average value of each variable was taken and recorded in millimeter.

Ethical clearance

The study was approved by the Ethical Review Committee of Dhaka Medical College, Dhaka Number 233/2018, dated 06.10.2018.

RESULTS

The study was conducted on 150 adult human left patellae. Out of 150 patellae, 92 were male and 58 were female. After collection of data, statistical analysis was done by the software SPSS (Statistical Package for Social Sciences) for Windows, Version 22.0.

The mean ± SD of maximum height was 42.10 ± 1.99 mm with the range of 37.50 to 46.70 mm in male and 36.16 ± 2.31 mm with the range of 31.30 to 40.45 mm in female. The mean maximum patellar height was found higher ((p<0.001) in male than in female. (Table I). The mean ± SD of maximum width was 42.87 ± 1.80 mm with the range of 39.20 to 46.35 mm in male and 36.94 ± 1.58 mm with the range of 33.35 to 40.35 mm in female. Mean maximum width was significantly higher (p<0.001) in male than female (Table I). The mean ± SD of maximum thickness was 20.73 ± 1.25 mm with the range of 17.27 to 26.60 mm in male and 18.69 ± 1.39 mm with the range of 16.10 to 22.12 mm in female. Mean maximum thickness was significantly higher (p<0.001) in male than female (Table I).

Table 1: Maximum height, maximum width and maximum thickness of patella in male and female

Variables	Male (n=92) Mean±SD	Female (n=58) Mean±SD	p value
Maximum height of patella (mm)	42.10 ±1.99 (37.50 - 46.70)	36.16 ± 2.31 (31.30 - 40.45)	<0.001***
Maximum width of patella (mm)	42.8 7± 1.80 (39.20 - 46.35)	36.94 ± 1.58 (33.35 - 40.35)	<0.001***
Maximum thickness of patella (mm)	20.73 ± 1.25 (17.27 – 26.60)	18.69 ± 1.39 (16.10 – 22.12)	<0.001***

Figures in parentheses indicate range. SD = Standard Deviation.
Comparison of values between male and female was done by Unpaired Student's 't' test
***= significant at p<0.001 n= sample size

DISCUSSION

Findings of the present study were suggestively higher (p<0.001) in male than in female. The highest values were found in male due to fact that male bones are sturdy and longer than female bones. Men are involved in most physical activities and exercise that enhance and restore the growth of bone. Other factors that affect bone growth are genetic factors, environmental factors, dietary pattern, occupation, hormonal factors.[9]

Sex hormones maintain skeletal probity and skeletal homeostasis because they add bone during adolescence both in men and women. In addition to sex steroids, other hormones such as GH and insulin like growth factor 1(IGF1) may bestow to the development of the skeletal sexual dimorphism. However, during adolescence gender differences in bone growth become manifest, with men reaching higher peak bone mass, greater bone size and ultimately, a stronger skeleton compared to women.[10]

Sexual dimorphism of patella has been studied in India[6,11-14] and other population groups.[15-20] Phoophalee et al.[4] analyzed patella using six measurements and described an overall accuracy of 90.5% using a linear

discriminant analysis, 83% accuracy stated by Bidmos et al[19], 85% accuracy stated by Dayal and Bidmos[20].

In the present study the mean (±SD) of maximum height, maximum width and maximum thickness of patella were similar ($p<0.001$) with the findings of Akhlagi et al.[3] acted on Iranian population, Phoophalee et al.[4] carried out study on Thai population, Olateju, Philander and Bidmos[7] acted on South African population, Vohra P[11] carried out study on Indian population, Kayalvizhi et al.[14] acted on north Indian population, Peckman and Fisher[15] acted on American population, Sakau[16] on Japanese population, Peckmann et al.[17] on 106 patella of contemporary Spanish population, Kim et al.[18] acted on Korean population. They all found higher values in male than in female ($p<0.001$).

CONCLUSION

The present study was an attempt to construct data on different dimensions of dry adult human left patella. Statistically significant difference was found between male and female patella. The maximum height, maximum width and maximum thickness were found suggestively higher in male than female ($p<0.001$). These data may be useful for orthopedic surgery, anthropology, comparative anatomy, evolutionary biology and forensic evaluation and can be compared with data obtaining foreign researchers.

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Authors contribution

Data gathering and idea owner of this study: Dr.Mustafezur Rahman, Dr.Nusrat Rumman Mowtoshee.

Study design: Dr.Mustafezur Rahman, Dr.Rebeka Shahin.

Data gathering: Dr.Nusrat Rumman Mowtoshee, Dr.Mustafezur Rahman.

Writing and submitting the manuscript: Dr.Mustafezur Rahman, Dr.Dilruba siddiqua, Dr.Mahmuda Khatoon.

Editing and approval of final draft: Dr.Mustafezur Rahman, Dr.Dilruba Siddiqua, Dr.Mahmuda Khatoon.

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