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Evaluation of The Human Patellar Morphometry

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Abstract

Introduction: Patella is the widest sesamoid bone of the body. Extension mechanism occurs between the quadriceps and the patellar tendon. Surface of the patella joint has medial and lateral facets. Medial joint surface smaller and lighter convex than lateral joint surface. This study was undertaken to assess the patellar morphometry.

Material and Methods: Measurements were taken from 33 (16 right, 17 left) Anatolian patellae of unknown age or sex. The type of patella was assessed according to shape as type I, type II, type III and type IV. Patellar height, width and thickness, width and length of patellar facets were also measured.

Results: The frequency of different types of patellae were type I (18.2%), type II (75.8%), type IV (6%). Patellar height was 39,04±4,32 mm, patellar width was 41,63±3,81 mm, patellar thickness 19,49±1,6 mm. Width and length of medial articular facet were 18,72±3,43 mm and 23,13±3,35 mm, respectively. Width and length of lateral articular facet were 23,86±2,84 mm and 27,43±2,72 mm, respectively.

Conclusion: The patella is an important component in the extensor mechanism of knee joint. It increases the efficiency of quadriceps muscle by acting as a lever. The data obtained from this study were compared with those from previous studies. There are very few studies on morphology and dimensions of patella. An understanding of the association between the anatomic structures of the patella and morphometric measurements is clinically important. The data obtained from this study are extremely valuable in the design of prosthesis, development of surgical techniques and sex determination, biomedical applications, orthopedic surgery, degenerative diseases and anthropological records.

Keywords: patella height, patellar width, patellar thickness, patellar morphomety.

Introduction

Patella is a large, flat, triangular sesamoid bone located at the anterior of the knee joint, placed within the tendon of the quadriceps femoris muscle and it provides a central point of attachment for the quadriceps tendon and patellar ligament [1]. The lowest point of the patella is 1cm over the knee joint space and this position changes with

movements of the knee joint. Apex patella is located downwards whereas basis patella is located upwards and the patella therefore looks like an inverted triangle with faces looking anterior and posterior. The anterior surface is subcutaneous, convex and longitudinally ridged that is separated from the skin by a prepatellar bursa, and covered with the tendon expansion of quadriceps femoris. The posterior surface has a proximal smooth, oval articular area, fitting into the intercondylar groove on the femoral patellar surface and divides the patellar articular area into medial and lateral facets; with lateral is being usually larger [2]. The medial facet is subdivided into the medial facet proper and the odd facet (a much smaller facet) along the medial border of the patella. The lateral articular surface is concave in both vertical and transverse planes [1].

The bonificaiton of patella may last until the sixth year of life from a single center or may sometimes occur from two adjacent centers [3,1]. The shape of the patella can vary, and certain configurations are associated with patellar instability [2,4].

The extensor mechanism of the knee consists of the quadriceps muscle group and tendon, the patella, the patellar ligament, the tibial tubercle, and the patellar retinaculum [1,5]. The primary biomechanical function of the patella is to improve quadriceps efficiency by increasing the lever arm of the extensor mechanism. Patella rotates the forces of quadriceps femoris component to the patellar ligament and protects deeper knee structures, protects the tendon of quadriceps from friction effects and keeps stability of the knee joint. Understanding the pathogenesis of disordes involving the knee calls for a detailed knowledge of the normal anatomy and biomechanics of the patella [1]. The role of patella in the normal mechanical structure of the knee and in human identification procedures is studied extensively. In addition, morphometric data obtained from the patella and patellar ligament are crucial in the diagnoses and surgical corrections of knee-related injuries or disorders. Other studies have provided informative prognostic factors for patellofemoral joint disorders. 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 [6,7]. Dimensions and classification of patellae, as well as determining the relationship between the patella and patellar ligament in different population groups, are important anthropologically as well as clinically for the determination of the size of a patellar implant [2,7,8,9,10]. Patellae has been categorised into three types based on the dimensions of the widths of medial articular facet (MAF) and lateral articular facets (LAF) as well as the curvature of the facets [11]. In another study on the classification of the patellae of foetal cadavers, Koyuncu et al.2011 reported that 20% of patellae was Class A (the widths of MAF and LAF are equal). In addition, 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 was Class C (the width of MAF was greater than the width of the LAF) [7].

This study was undertaken to assess the types of patella after classifying them according to Wiberg and Baumgartl descriptions and obtain morphometric measurements.

Materials and Methods

In this study, 33 patella (16 right, 17 left) dried of Anatolian adults of unknown gender from the collection of the Department of Anatomy, Faculty of Medicine Cukurova University were used. There was no apparent sign of physical or pathological damage in any of the bones.

The type of patella was assessed according to shape as type I, type II, type III and type IV. Patellar height, width and thickness, width and length of patellar facets were also measured. Each patella was classified according to its shape, using the descriptions of Wiberg and Baumgartl:

Type I: The facets are concave, symmetrical and of equal size;

Type II: The medial facet is rather smaller than the lateral facet and the lateral facet is concave;

Type III: The medial facet is markedly smaller than the lateral facet.

Type IV: No medial facet or central rim (Fig. 1)[11,12,13].

Patellar height, width and thickness, width and length of patellar facets were measured using a digital sliding caliper accurate to 0.01 mm (Figure 1-C).

The following distances were measured:

Patellar height: Linear distance between superior border and apex.

Patellar width: Linear distance between medial and lateral border.

Patellar thickness: Linear distance between anterior surface and median ridge on posterior surface.

Medial articular facet width: Maximum width from the medial border to the median ridge.

Medial articular facet lenght:

Lateral articular facet width: Maximum width from the lateral border to the median ridge.

Results

The frequency of different types of patellae were type I (18.2%), type II (75.8%), type IV (6%) No type III was observed. (Table 1). Morphometric measurements show that; left, right and total patellar height was 40,35±3,45 mm; 37,65±4,81 mm; 39,04±4,32 mm; left, right and total patellar width was 41,81±3,22 mm, 41,43±4,45 mm, 41,63±3,81 mm; left, right and total patellar thickness 19,99±1,77 mm, 18,96±1,24 mm, 19,49±1,6 mm. Left, right and total width and length of medial articular facet were 19,93±3,57 mm, 17,44±2,84 mm, 18,72±3,43 mm and 23,43±3,42 mm, 22,82±3,36 mm, 23,13±3,35 mm, respectively. Left, right and total width and length of lateral articular facet were 24,36±3,40 mm, 23,34±2,08 mm, 23,86±2,84 mm and 27,33±3,05 mm, 27,55±2,43 mm, 27,43±2,72 mm, respectively. (Table 2).

Discussion

It is known that morphometric variations are often observed in measurements even within the same population group and that the variation could be more striking across different groups. Reasons for these variations are not explained clearly but differences in measuring methods, gender, age and stature could be contributing factors. The measurements of the patella, patellar ligament and articular facets were higher in the male cadavers than in the female cadavers which indicates that the patella, the patellar ligament and the width of articular facets are sexually dimorphic [14-17].

In the present study the mean height, width and thickness of the patella of were 39,04 ± 4,32 mm; 41,63 ± 3,81 mm and 19,49 ±1,60 mm, respectively. In addition, the mean width and length of medial articular facet were 18,72±3,43 mm and 23,13±3,35 mm, respectively. width and length of lateral articular facet were, 23,86±2,84 mm and 27,43±2,72 mm, respectively.

Baldwin and House (2005) have found mean patella thickness to be 22,6 mm on adult patella during arthroplasty, compared to our 19,49 mm. In 2007 Yoo et al in their study on magnetic resonance image patients have reported mean patellar height as 44,6 mm and mean patella thickness to be 22,3 mm compared to our measurements of 39,04 mm and 19,49 mm. Iranpour et al in 2008 found mean patellar height to be 34,3 mm and mean patella thickness to be 22,4 mm in 3D constructed CT scans compared to our 39,04 mm and 19,49 mm.

Oleteju et al in 2013 in fresh human cadaveric patella have found the patellar height to be 43,7 mm and mean patella thickness 23,97 mm. In our study those values were 39,04 mm and 19,49 mm. Those measurements were reported as 39,9 mm and 22.72 mm by Shang Pen from CT scan in a group of Chinese volunteers in 2014.

In fresh human cadaveric patellas; Schlenzke and Schwezinger in 2014 found mean patella height to be 54,4 mm which was 39,04 in our study. On dry adult patellas those measurements were 38,0 mm (39,04 mm for us) and 18,29 mm (19,49 mm for us) by Murugan Magi in 2017 and finally axial magnetic resonance imaging of 140 adults by Muhammed et al have reported the mean patealla width to be 39,14 mm and mean patellar thickness to be 18,27 compared to our 41,63 mm of mean patellar width and 19,49 mean patellar thickness.

This study is rare in literature by measuring patellar width and medial and lateral articular facet of a population group. There is a moderate to strong correlation between paired measurements of the patella in the current study. The width of the patella has been suggested to be a dependable factor for predicting the normal size of patella thickness, as well as for helping surgeons to decide on the thickness of the patella prosthesis during arthroplasty.

The observed strong positive correlation between the patella height and the patella width in this study supports the findings of Koyuncu et al. in which a linear relationship was demonstrated between the length and width of the patella throughout gestational age [10].

Conclusion

This study compares the patellar morphometric dimensions with population from other countries, continents and describes basic values and its deviation from normal values, so that orthopedic surgeons, clinicians, forensic experts, anthropologists and academicians in Asian continents can perform well handling of patella.

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Legends for Tables

Table 1. Number and percentages of the types of patella.

Parameters	Patella n=33	
	n	(%)
Type 1	6	18.2
Type 2	25	75.8
Type 3		
Type 4	2	6

Table 2. The means, standard deviations and range of the distances (mm) measured on the left, right and total patella.

Parameters (mm)	Left		Right		Total	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Patellar height	32,83-46,76	40,35±3,45	27,59-44,40	37,65±4,81	27,59-46,76	39,04±4,32
Patellar width	35,15-47,31	41,81±3,22	35,11-48,84	41,43±4,45	35,11-48,84	41,63±3,81
Patellar thickness	16,75-22,60	19,99±1,77	17,24-20,59	18,96±1,24	16,75-22,60	19,49±1,60
Medial articular facet width	11,58-25,45	19,93±3,57	10,68-21,32	17,44±2,84	10,68-25,45	18,72±3,43
Medial articular facet lenght	15,22-27,67	23,43±3,42	18,05-28,64	22,82±3,36	15,22-28,64	23,13±3,35
Lateral articular facet width	18,10-31,51	24,36±3,40	19,96-27,09	23,34±2,08	18,10-31,51	23,86±2,84
Lateral articular facet length	22,34-35,30	27,33±3,05	21,32-31,65	27,55±2,43	21,32-35,30	27,43±2,72

Table 3. The comparison between the our results with those of the other authors as regards with the morphometric measuremeds of the patella.

Authors	Sample and subjects	Patella height		Patella width		Patella thickness	
		Mean	SD	Mean	SD	Mean	SD
Yoo et al. (2007) [19]	Magnetic resonans imaging (n=163 adult)	**44.6**	**3.7**			**22.3**	**1.9**
Schlenzka and Schwesinger (2014) [8]	Fresh human cadaveric patellae (n=50)	**54.4**	**3.5**				
Iranpour et al. (2008) [20]	3D reconstructed CT scans (n=37 adults)	**34.3**	**4.8**			**22.4**	**2.3**
Baldwin and House (2005) [13]	Adult patellae during total knee arthroplasty (n=92)					**22.6**	
Shang Pen (2014) [21]	CT scan from Chinese volunters (n=40)	**39.94**	**3.68**			**22.72**	**1.81**
Murugan Magi et al. (2017) [2]	Dry adult patellae (n=65)	**38.07**	**3.7**			**18.29**	**1.73**
Olateju OI et al. (2013)	Fresh human	**43,73**	**3,65**			**23,97**	**2,12**

[7]	cadaveric patellae (n=46)						
Muhamed R et al. (2017) [22]	Axial Magnetic resonans imaging (n=140 adult)			**39,14**	**1,76**	**18,27**	**0,90**
Present study (2018)	Dry adult patella (n=33)	**39,04**	**4,32**	**41,63**	**3,81**	**19,49**	**1,60**

Legends for Figures

Figure 1. Morphometric measuremed of patellae. A:Patellar height, B: Patellar width

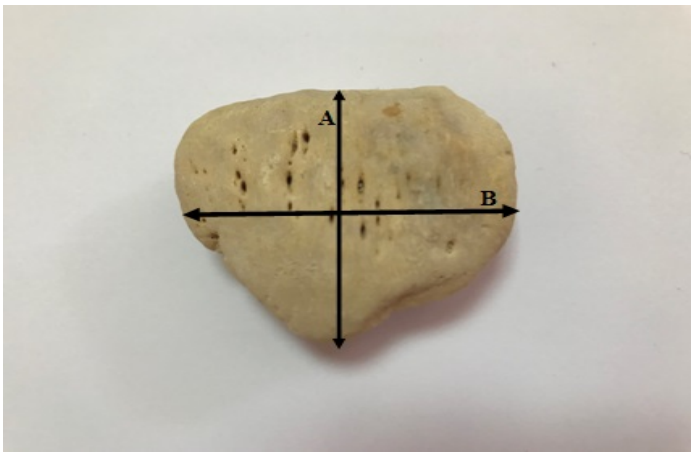

Figure 2. A:Lateral articular facet length; B: Lateral articular facet width; C:Medial articular facet lenght; D:Medial articular facet width.