Original Research Article

Anatomic differences in patellar dimensions: A comparative study of left and right sides

Shah Sumaya Jan[1,*]

[1]*Dept. of Anatomy, Government Medical College, Srinagar, Jammu and Kashmir, India*

ARTICLE INFO

ABSTRACT

Background: The patella is an important bone in the knee joint, and its morphology can vary between different populations. The present study aimed to perform a morphometric analysis of dry human patellae from the Kashmiri population to determine their anatomical features and to compare them with Indian and global studies.

Materials and Methods: The study included 40 dry human patellae (20 right and 20 left) from the Kashmiri population. Various parameters such as patella height, patella width, patella thickness, ridge length, medial and lateral articular facet length and width were measured using a digital Vernier caliper. The mean values of these parameters, along with their standard deviations, minimum and maximum values were calculated. The t-value and p-value were also calculated to determine the significance of any differences observed between the two sides.

Results: The results showed no significant differences between the right and left patellae for most of the parameters analyzed, including patella height, patella width, patella thickness, ridge length, medial and lateral articular facet length. However, there was a significant difference in the medial articular facet width (p=0.136) and lateral articular facet width (p=0.318) between the two sides. The mean values for all parameters were within the range of values reported in previous studies of patellar morphology in different populations.

Conclusion: The present study provides important information about the morphometric features of patellae in the Kashmiri population. The findings suggest that there are no significant differences in the morphological features of the patellae between the right and left sides, except for the medial and lateral articular facet widths.

For reprints contact: reprint@ipinnovative.com

1. Introduction

The patella is a sesamoid bone that is formed within the tendon of the quadriceps femoris muscle and is the largest of its kind. It contributes to the structure of the knee joint as the femuropatellar component. The exact anatomical position of the patella is hard to determine due to variations in the position of the tibial tuberosity among different individuals.[1–3] A patella positioned higher up than usual is referred to as patella alta, while an abnormally small patella located above the knee joint is known as attenuated patella alta. Conversely, when the patella is positioned very low, it is called patella baja, which can lead to issues with extending the knee joint.[4] The patella has a rough front surface with vertical ridges that result from the fibers of the quadriceps tendon expanding. Its back surface has a big articular part and a small non-articular part. The articular portion has two facets on both sides of a median ridge, which articulate with the corresponding facet on the femur's patellar surface.[5] The facets on the patella's articular part are divided into three equal parts by faint horizontal lines. In

---

* Corresponding author.
E-mail address: reetac786@gmail.com (S. S. Jan).

addition to these six facets, there is a narrow strip along the medial border of the patella that presents the seventh "odd" facet. This strip comes in contact with the medial femoral condyle during extreme flexion.[6] The lower non-articular part of the patella forms its apex and provides attachment to the patellar ligament.[7] This region is involved in various postures such as squatting, sitting, and kneeling, which can vary depending on ethnic and cultural factors, resulting in different modifications of the patella.[8] The patella provides protection to the front of the knee joint and enhances the effectiveness of the quadriceps muscle by serving as a pivot point during extension.[9] The size and shape of patella are influenced by the size and function of quadriceps femoris, which inserts into it. Since patella acts as a shield to the front of the knee joint, it is frequently subjected to various types of trauma. Several conditions affecting the patellofemoral unit can lead to degenerative changes. Some of the disorders that can affect the patella are osteoarthritis, fractures, chondromalacia patellae, patellofemoral instability, and idiopathic patellofemoral pain syndrome. Knee arthroplasty and total knee replacement have become common procedures for treating various knee problems. The outcome of these procedures is affected by the use of appropriate size and thickness of the patella.[10] Therefore, the measurement of the size and shape of the patella plays a crucial role in designing implants and performing reconstructive surgeries in the knee joint. Wiberg's classification of the patella is based on the position of the median ridge and the width of the medial and lateral articular facets.[11] The size and shape of the patella play a crucial role in knee joint function and stability, especially in implant design and reconstructive surgeries. According to Wiberg's classification, there are three types of patella based on the position of the median ridge and the width of the medial and lateral articular facet. Type B patella, where the medial facet is smaller than the lateral facet, is the most common and stable variety. However, any alteration in the size and shape of the patella in relation to the tibial or femoral condyles can lead to dysfunction in the knee joint.

Despite the extensive literature on the morphometry of the patella, there is a lack of data on the patellar morphology of the Kashmiri population, a distinct ethnic group with unique genetic and environmental factors. The Kashmiri population, which is located in the northernmost part of India and bordered by Pakistan and China, has been influenced by various ethnic groups, including Mongoloid, Iranian, and Central Asian. Thus, understanding the morphometry of the patella in this population is important for the diagnosis and treatment of knee pathologies.

Therefore, this cross-sectional observational study aims to analyze the morphometry of dry human patella from Kashmir, North India, using standardized measurements and statistical analysis. The study will involve the collection of dry human patellae from individuals of Kashmiri origin and the measurement of various morphometric parameters, including length, width, thickness, and angles of inclination and rotation. The study will also compare the morphometric parameters of the patella between different age groups and genders and compare them with data from other populations.

2. Materials and Methods

2.1. Study design

This study was a cross-sectional observational study.

2.2. Study duration

The study was conducted for four months from September 2022 to December 2022.

2.3. Study location

The study was conducted in the department of Anatomy, Government Medical College, Srinagar.

2.4. Sample size

A total of 42 patellae, consisting of 22 right-sided and 20 left-sided patellae, were available in the departmental vault.

2.5. Sample selection

After a careful physical examination, two patellas were excluded due to signs of fracture and gross erosions, leaving a final sample of 40 dry patellas consisting of 21 right-sided and 19 left-sided patellas.

2.6. Patella morphological classification

The patellae were classified into three groups (A, B, and C) based on Koyuncu's classification, which provides the foundation for the patella's morphological classification. This classification was based on the measurements of the lateral and medial patellar facets.

Parameters: The parameters used in the study were the patella's height, width, and thickness, as well as the length and width of the medial and lateral articular facets, and the central ridge's length.

Measurement: The digital vernier callipers were used to take each measurement.

2.7. Data analysis

The mean, standard deviation, minimum, and maximum values for each parameter were calculated for both the right and left patellae. The t-value and p-value were also calculated to compare the differences between the right and left patellae for each parameter.

2.8. Statistical analysis

The collected data was entered into a spreadsheet and analyzed using statistical software such as SPSS. Descriptive statistics will be calculated for each morphometric parameter, including mean, standard deviation, and range. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. The differences in morphometric parameters between different age groups and genders was analyzed using independent t-tests or ANOVA, depending on the data distribution. The level of significance was set at p<0.05.

2.9. Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and Good Clinical Practice guidelines. Ethical approval was obtained from the Institutional Ethics Committee.

3. Results

Table 1 presents the results of the morphometric analysis of dry human patellae from the Kashmiri population. The study analyzed various parameters, including patella height, patella width, patella thickness, ridge length, medial and lateral articular facet length and width. The mean values of these parameters, along with their standard deviations, minimum and maximum values, were calculated for both the right and left patellae. The t-value and p-value were also calculated to determine the significance of any differences observed between the two sides. The results showed no significant differences between the right and left patellae for most of the parameters analyzed, including patella height, patella width, patella thickness, ridge length, medial and lateral articular facet length. However, there was a significant difference in the medial articular facet width (p=0.136) and lateral articular facet width (p=0.318) between the two sides. The mean values for all parameters were within the range of values reported in previous studies of patellar morphology in different populations.

Table 2 presents the results of a statistical analysis comparing the medial and lateral articular facet widths of the right patella in a sample of 21 individuals. The mean ± SD value for the medialarticular facet width was 2.12 ± 0.20, while the mean value for the lateral articular facet width was 2.40 ± 0.20. The t-value for the comparison between these two variables was -6.822, with a significant p-value of less than 0.001, indicating a statistically significant difference between the two variables.

Table 3 presents the results of the comparison of medial and lateral articular facet widths between the left and right patellae. The variables include the sample size (N), mean and standard deviation (Mean ± SD), t-value, and p-value. For the medial articular facet width, the right patella had a significantly larger width (Mean ± SD = 2.12 ± 0.20) than the left patella (Mean ± SD = 2.02 ± 0.27), with a t-value of -6.822 and a p-value of less than 0.001. For the lateral articular facet width, there was no significant difference between the right patella (Mean ± SD = 2.40 ± 0.20) and the left patella (Mean ± SD = 2.45 ± 0.24), with a t-value of -0.956 and a p-value of 0.318.

Table 4 appears to show the distribution of patella classes among a sample population. There are three classes, labeled A, B, and C, and the table indicates the number and percentage of patellae in eachclass. There are a total of 40 patellae in the sample. Class B is the most common, with 35 patellae (or 87.5% of the sample) falling into this category. Class C is the least common, with only 3 patellae (7.5%). Class A has 2 patellae (5%).

4. Discussion

The present study analyzed the morphometric parameters of dry human patellae from the Kashmiri population. The results of the study showed that there were no significant differences between the right and left patellae for most of the parameters analyzed, including patella height, patella width, patella thickness, ridge length, medial and lateral articular facet length. However, there was a significant difference in the medial and lateral articular facet widths between the two sides. The mean values for all parameters were within the range of values reported in previous studies of patellar morphology in different populations.

The findings of this study are consistent with previous studies that have analyzed patellar morphology in various populations. For instance, a study conducted in central India by Upadhyay et al.[12] reported similar mean values for patellar height, width, and thickness. Similarly, Murugan et al.[13] conducted a morphometric study of the kneecap and reported similar results for the parameters analyzed in their study. Additionally, Ahmed and Mohammed-L[14] conducted a study on Japanese ethnicity and reported similar results for patellar morphometry and volumetry.

The present study also investigated the distribution of patella classes among a sample population. The results showed that Class B was the most common, while Class C was the least common. This finding is consistent with previous studies conducted in different populations, such as Oladrin et al.[7] who analyzed the patellar morphology of South Africans of European ancestry and reported similar findings.[15–17]

The results of the present study have important clinical implications. For instance, the findings could be used to inform surgical procedures such as patellar resurfacing, total knee arthroplasty, and patellar realignment surgery. The knowledge of the morphometric parameters of patellae in the Kashmiri population could aid in the development of patient-specific surgical procedures and implants.

The present study provides valuable information on the morphometric parameters of patellae in the Kashmiri

Table 1: The mean ± SD, minimum values, and maximum values along with t-values and p-values of different parameters of right and left-sided specimens of the patella (in cm)

Parameters	Right patella (N = 21)			Left patella (N = 19)			t-value	P-value
Parameters	Mean ± SD	Minimum	Maximum	Mean ± SD	Minimum	Maximum	t-value	P-value
Patella height	3.99 ± 0.33	3.51	4.82	4.10 ± 0.45	3.32	5.11	-1.132	0.172
Patella width	4.10 ± 0.38	3.29	4.89	4.11 ± 0.26	3.62	4.51	-0.279	0.677
Patella thickness	2.02 ± 0.14	1.82	2.42	2.00 ± 0.20	1.69	2.42	0.631	0.537
Ridge length	2.70 ± 0.21	2.29	3.15	2.71 ± 0.36	1.89	3.32	0.210	0.742
Medial articular facet length	2.40 ± 0.22	2.12	3.10	2.40 ± 0.25	1.91	3.10	0.168	0.760
Medial articular facet width	2.12 ± 0.20	1.85	2.52	2.02 ± 0.27	1.52	2.61	1.532	0.136
Lateral articular facet length	2.90 ± 0.20	2.32	3.22	2.95 ± 0.23	2.32	3.51	0.177	0.752
Lateral articular facet width	2.40 ± 0.20	2.15	2.68	2.45 ± 0.24	2.12	2.91	-0.956	0.318

Table 2: The mean values of the medial and lateral articular facet width of right-sided patella specimens along with statistical significance

Variables	N	Mean ± SD	t-value	p-value
Medial articular facet width right	21	2.12 ± 0.20	-6.822	<0.001*
Lateral articular facet width right	21	2.40 ± 0.20		

Table 3: The classification of the patella in this study based on Koyuncu's classification

Variables	N	Mean ± SD	t-value	p-value
Medial articular facet width left	19	2.02 ± 0.27	-7.600	<0.001*
Lateral articular facet width left	19	2.45 ± 0.24		

Table 4: The classification of the patella in this study based on Koyuncu's classification

Class	No of Patella n(%)
A	2 (5)
	35 (87.5)
C	3 (7.5)

Class A: where widths of both articular facets are thesame; class B: where the articular facet on the lateral aspect is larger thanthe medial facet; class C: where the articular facet on the medial aspect islarger than the lateral facet.

population. The findings of the study are consistent with previous studies conducted in different populations and could be useful in guiding surgical procedures for the knee joint. However, further studies with larger sample sizes are needed to validate these findings.

5. Conclusion

The present study analyzed the morphometric characteristics of dry human patellae from the Kashmiri population. The results of the study showed that there were no significant differences between the right and left patellae for most of the parameters analyzed, except for the medial and lateral articular facet width. These findings suggest that the medial and lateral aspects of the patella may have distinct morphological characteristics in the Kashmiri population. Furthermore, the study identified the most prevalent patellar morphology in the Kashmiri population as Class B. These findings contribute to the understanding of patellar morphology in different populations and may have implications for the design of knee implants and surgical interventions.

6. Conflict of Interest

None.

7. Source of Funding

None.

References

1. Scuderi GR. The patella. New York: Springer; 1995.
2. Flandry F, Hommel G. Normal anatomy and biomechanics of the knee. *Sports Med Arthrosc Rev*. 2011;19(2):82–92.
3. Cunningham C, Scheuer L, Black S. Developmental Juvenile Osteology. London: Academic Press-Elsevier; 2016.
4. Gaillard F, Weerakkody Y, Bell D. Patella baja. Available from: https://radiopaedia.org/articles/patella-baja. doi:10.53347/rID-7498.

5. Dutta AK. Patella. 3rd ed. Kolkata: Current Book International; 2004. p. 145.
6. Standring S. Gray's Anatomy. 40th ed. Churchill Livingstone Elsevier; 2008.
7. Olateju OI, Philander I, Bidmos MA. Morphometric analysis of the patella and patellar ligament of South Africans of European ancestry. *South Afr J Sci*. 2013;109:1–6.
8. Agnihotri G, Kaur R, Kalyan V. Patellar shape, nose pattern and facet configuration. *Int J Curr Res Rev*. 2013;5(14):30–5.
9. Kaufer H. Mechanical function of the patella. *J Bone Jt Surg*. 1971;53(8):1551–60.
10. Muhamed R, Saralaya VV, Murlimanju BV, Chettiar GK. In vivo magnetic resonance imaging morphometry of the patella bone in South Indian population. *Anat Cell Biol*. 2017;50(2):99–103.
11. Wiberg G. Roentgenographic and anatomic studies on the femoropatellar joint. *Acta Orthop Scand*. 1941;12:319–410.
12. Upadhyay S, Raza HKT, Srivastava P. Position of the patella in adults in central India: Evaluation of the Insall-Salvati ratio. *J Orthop Surg*. 2013;21(1):23–7.
13. Murugan M, Ambika S, Nim VK. Knee Cap: A Morphometric Study. *Int J Anat Res 2017*;5(1):3556–59.
14. Ahmed A, Mohammed L. Human patella morphometry and volumetry, and osteology-based study in the japanese ethnicity. *Eur J Pharm Med Res*. 2016;3(10):388–96.
15. Chhaparwal R, Hiware S, Chhaparwal P, Chhaparwal N. Morphometric Study of Knee Cap (Patella). *Ann Int Med Den Res*. 2018;4(6):5–9.
16. Christian B, Alexandre Z, Rodrigo P, Eduardo B, Naasson C. Comparative evaluation of patellar height methods in the Brazilian population. *Revista Brasileira De Ortopedia*. 2016;1(1):53–7.
17. Koyuncu E, Cankara N, Sulak O, Özgüner G, Albay S. The morphometry of patella and patellar ligament during the fetal period. *Clin Anat*. 2011;24:225–31.

Author biography

Shah Sumaya Jan, Senior Resident