Section: Anatomy

Original Research Article

MORPHOMETRY OF THE ARTICULAR FACETS ON THE POSTERIOR SURFACE OF PATELLA

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ABSTRACT

Background: The patella, commonly referred to as the *kneecap*, is the largest sesamoid bone in the human body. It develops within the tendon of the quadriceps femoris muscle and plays a crucial role in knee joint biomechanics. Positioned subcutaneously on the anterior aspect of the knee joint, the patella is particularly vulnerable to trauma due to its exposure. Additionally, it is subjected to varying mechanical stresses due to different squatting and sitting postures, particularly in populations where deep flexion of the knee is common. Functionally, the patella acts as a protective shield over the femoral condyles, enhancing joint stability and preventing excessive wear of the articular cartilage. Understanding the morphometric characteristics of the patellar articular facets is essential for orthopedic surgeons, as these dimensions directly influence surgical approaches in patellar fractures, knee arthroplasty, and prosthesis design. Furthermore, such anatomical knowledge is vital in forensic sciences for skeletal identification and medico-legal investigations. **Aim:** The present study aims to measure and analyze the morphometric parameters—including length and width—of the medial and lateral articular facets on the posterior surface of the patella. The findings will provide critical insights into the anatomical variations that may impact orthopedic procedures, prosthesis development, and forensic applications.

Materials and Methods: This study was conducted in the Department of Anatomy, SKIMS Medical College, Bemina, Srinagar, using a total of **45 dry human patellae**. Among these, **24 were from the right side** and **21 from the left side**. The dimensions of the medial and lateral articular facets were measured using a **digital Vernier caliper** with an accuracy of 0.01 mm. The mean values and standard deviations for each parameter were calculated and analyzed statistically to determine variations between right and left patellae.

Results: The morphometric analysis of the patellar articular facets yielded the following findings: **Lateral Articular Facet:** Mean length on the **right side**: **28.6 mm** ± 1.6 mm, Mean length on the **left side**: **28.2 mm** ± 1.7 mm, Mean width on the **right side**: **23.5 mm** ± 1.8 mm, Mean width on the **left side**: **23.1 mm** ± 1.5 mm **Medial Articular Facet:** Mean length on the **right side**: **23.8 mm** ± 2.1 mm, Mean length on the **left side**: **23.3 mm** ± 1.9 mm, Mean width on the **right side**: **21.1 mm** ± 1.9 mm, Mean width on the **left side**: **20.2 mm** ± 1.8 mm.

Conclusion: The present study provides valuable morphometric data on the medial and lateral articular facets of the patella, contributing to the anatomical and clinical understanding of the knee joint. These findings have significant applications in: **Orthopedic Surgery** – Assisting in patellar reconstruction, fixation of patellar fractures, and surgical planning for knee injuries. 1. **Prosthesis Design** – Enhancing the accuracy of patellar implants used in total

knee replacement (TKR) and patellofemoral unit prostheses. 2. **Forensic Anthropology** – Aiding in skeletal identification and comparative anatomical studies for medico-legal cases. A precise understanding of these dimensions can optimize surgical outcomes and improve the durability and functionality of knee implants. Future research with a larger sample size and diverse population groups is recommended to further validate and expand upon these findings.

Keywords: Patella, Sesamoid Bone, Quadriceps Femoris, Total Knee Replacement, Patellofemoral Prosthesis, Morphometry, Orthopedic Surgery.

INTRODUCTION

The patella, commonly referred to as the kneecap, is the largest sesamoid bone in the human body, developing within the tendon of the quadriceps femoris muscle.[1] It plays a crucial biomechanical role in knee joint function by enhancing the leverage of the quadriceps muscle, thereby increasing the mechanical efficiency of knee extension. The patella achieves this by altering the angle of pull of the quadriceps tendon, reducing friction between the tendon and the femoral condyles, and distributing compressive forces across the patellofemoral joint.[2] Anatomically, the patella is positioned anteriorly at the distal end of the femur, just superior to the knee joint line. It contributes significantly to the formation of the patellofemoral joint, which is integral to load transmission during weight-bearing and locomotion. Its unique anatomical features provide stability to the knee joint while facilitating smooth articulation between the quadriceps mechanism and the tibia.

Unlike most bones, the patella lacks a periosteum due to its sesamoid nature, making it distinct in terms of vascularization, healing potential, and surgical considerations. This property renders patellectomy a viable treatment option for complex patellar fractures when reconstructive surgery is unfeasible. Structurally, the patella exhibits a distinct morphology, with two primary surfaces—anterior and posterior—three borders (superior, medial, and lateral), and an inferiorly pointed apex.[1,3,4] The apex serves as the attachment site for the ligamentum patellae, which anchors the patella to the tibial tuberosity, playing a vital role in knee extension.

The anterior surface of the patella is subcutaneous and is separated from the overlying skin by the prepatellar bursa, which minimizes friction and allows unrestricted mobility.[5,6] The posterior surface, which articulates with the femur, is divided into two distinct regions: a superior articulating surface and an inferior non-articulating surface. The superior articulating region is further subdivided by a prominent vertical ridge into a larger lateral facet and a smaller medial facet.[6] This ridge aligns with the patellar groove of the femoral lower end during knee extension, ensuring stability and congruency in joint articulation.[1] The lateral facet remains in continuous contact with the lateral femoral condyle in all knee positions, while the medial facet is functionally divided into a medial area and a medial strip by an additional vertical ridge. The medial area articulates with the medial femoral condyle during knee extension, whereas the medial strip engages with the condyle during full flexion of the knee.[1]

Anthropometric studies have emphasized the importance of patellar morphology in relation to postural adaptations, such as squatting, kneeling, and other functional movements that vary across different ethnic and cultural groups.[7] The shape, size, and surface area of the patellar facets significantly influence the distribution of forces within the patellofemoral joint, impacting susceptibility to degenerative conditions like osteoarthritis and patellofemoral pain syndrome. Given the patella's superficial location, it is highly prone to traumatic injuries, such as fractures and dislocations, which necessitate precise surgical management strategies.

The selection of an appropriate patellar implant is crucial in total knee arthroplasty and patellofemoral arthroplasty, where the restoration of native patellar dimensions is essential for optimizing functional outcomes.[8] Morphometric evaluations of the patella assist in the customization of prosthetic designs, ensuring anatomic compatibility and biomechanical efficiency in surgical interventions.

Aim

The objective of this study is to provide essential morphometric data by measuring the mean values of the length and width of the medial and lateral articular facets on the posterior surface of the patella. These findings aim to facilitate clinical and orthopedic applications, including the design of patellar implants, surgical planning, and biomechanical analysis of knee joint function.

MATERIALS AND METHODS

This study was conducted in the Department of Anatomy, SKIMS Medical College, Bemina. A total of 45 human patellae were examined, comprising 24 right-sided and 21 left-sided specimens. The inclusion criteria for the selection of patellae included well-preserved, undamaged specimens obtained from cadaveric dissections. Specimens exhibiting pathological changes such as osteophytes, fractures, or degenerative erosion were excluded from the study to maintain accuracy in morphometric analysis.

The morphometric parameters measured for each patella included the maximum length and width of the medial and lateral articular facets on the posterior surface. A high-precision vernier caliper with an accuracy of 0.01 mm was used for all measurements to ensure precision and reproducibility. Each measurement was taken thrice, and the mean value was recorded to minimize observer bias and enhance reliability.

The data obtained from this study will contribute to a comprehensive understanding of patellar morphology, which is critical for multiple clinical applications. Accurate morphometric knowledge of the patella will aid orthopedic surgeons in refining surgical techniques, improving the design of patellar implants, and advancing the treatment of patellofemoral disorders. Furthermore, this data will serve as a reference for anthropological and forensic studies that examine variations in skeletal morphology across different populations.

This study also holds significance for sports medicine, where a detailed knowledge of patellar dimensions can assist in developing individualized rehabilitation programs for athletes recovering from patellar injuries. By correlating patellar morphometry with functional biomechanics, future research can further explore its implications in joint kinematics and kinetic modeling.

Figure 1: Shows the method of measurement of Length of Lateral Facet

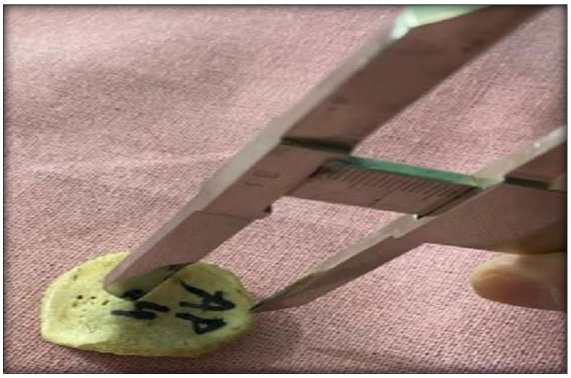

Figure 2: Shows the method of measurement of width of lateral facet

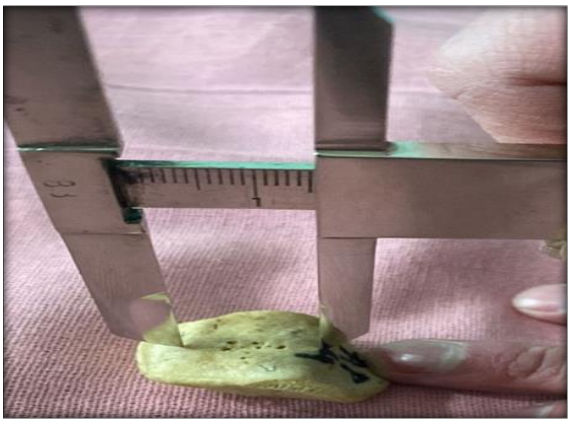

Figure 3: Shows the method of measurement of Width of Medial Facet

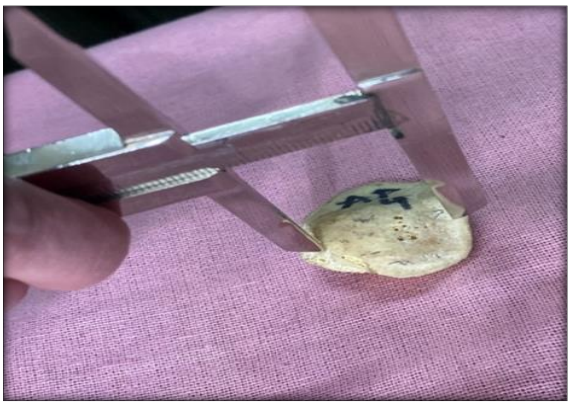

Figure 4: Shows the method of measurement of Length of Medial Facet

RESULTS

Table 1: Side distribution of patellae

TOTAL NUMBER OF PATELLAE	RIGHT	LEFT
45	24	21

The above table shows the total of 45 patellae were used for the study, out of which 24 belong to right side and 21 belong to left side.

Table 2: Mean length and width of lateral articular facets

DIMENSIONS(mm)	RIGHT	LEFT
length	28.6 ± 1.6	28.2 ± 1.7
width	23.5 ± 1.8	23.1 ± 1.5

The above table shows the mean of the length of the lateral articular facet on the right side was found to be 28.6mm with the standard deviation of 1.6mm, while on the left it was found to be 28.2mm with the standard deviation of 1.7 mm. Similarly the width of lateral articular facet on the right side was found to be 23.5 mm with the standard deviation of 1.8 mm, while on left side it was found to be 23.1 millimetres with standard deviation of 1.5 mm.

Table 3: Mean length and width of medial articular facets of patellae

DIMENSIONS (mm)	RIGHT	LEFT
length	28.6 ± 1.6	28.2 ± 1.7
width	23.5 ± 1.8	23.1 ± 1.5

The mean length of medial articular facet on right side was found to be 23.8 mm with standard deviation of 2.1 mm. While on the left side it was found to be 23.3 mm with the standard deviation of 1.9 mm. On the right side the width was found to be 21.1 mm with the standard deviation of 1.9 mm. Similarily on the left side the width of the medial articular facet was found to be 20. 2mm with the standard deviation of 1.8 mm.

DISCUSSIONS

The morphometric analysis of the articular facets on the posterior surface of the patella holds significant clinical and anatomical importance. This study provides valuable data on the dimensions of the medial and lateral articular facets, which can assist in orthopedic procedures, prosthetic design, and forensic investigations.

Our findings indicate that the lateral articular facet is consistently larger than the medial facet, a result that aligns with previous studies.[1,2] This anatomical variation may be attributed to the increased biomechanical load borne by the lateral facet due to the normal valgus alignment of the knee joint. Studies suggest that the lateral facet plays a more dominant role in weight transmission and patellofemoral articulation.[3]

The mean length of the lateral facet was 28.6 mm on the right side and 28.2 mm on the left, with respective widths of 23.5 mm and 23.1 mm. These measurements are consistent with previous morphometric studies conducted on different populations.[4,5] Conversely, the medial articular facet exhibited smaller dimensions, with a mean length of 23.8 mm on the right and 23.3 mm on the left. The width was 21.1 mm on the right and 20.2 mm on the left. These variations may be influenced by genetic, ethnic, and mechanical factors affecting patellar morphology.[6]

The clinical implications of these findings are considerable. In total knee replacement (TKR) and patellofemoral arthroplasty, a precise understanding of patellar morphometry is crucial for optimizing implant design and ensuring joint function longevity.[7] Additionally, these data may aid forensic identification, where patellar measurements contribute to demographic profiling.[8]

CONCLUSION

This study provides essential morphometric data on the medial and lateral articular facets of the patella, emphasizing their clinical and surgical significance. Our findings confirm that the lateral facet is larger than the medial facet, a characteristic attributed to the biomechanical demands of the knee joint. These results have direct applications in orthopedic surgery, prosthetic development, and forensic investigations. Future studies with larger sample sizes and diverse populations will further enhance the understanding of patellar morphometry.

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