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A CROSS-SECTIONAL STUDY ON COMPARISON OF THE LEFT AND RIGHT SIDES OF PATELLA: ANATOMIC DIFFERENCES.

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ABSTRACT

Background

The patella, or kneecap, is a crucial component of the knee joint, significantly influencing its biomechanics and functionality. Anatomical variations in patellar dimensions are important for orthopedic surgery, rehabilitation, and the diagnosis of knee disorders. Despite the extensive literature on patellar anatomy, there is limited research comparing the anatomic differences between left and right patellae. This study aims to investigate and compare the anatomic differences in patellar dimensions between the left and right sides to determine any significant asymmetries that may impact clinical practices.

Methods

A comparative cross-sectional study was carried out using 40 dry patellae (21 right-sided and 19 left-sided). Patellae were classified based on Koyuncu's morphological classification. Key parameters measured included patella height, width, thickness, and the dimensions of the medial and lateral articular facets. Digital vernier calipers were used for precise measurements. Statistical analysis was performed using SPSS.

Results

The mean values for all measured parameters were slightly higher for the left patellae compared to the right. However, the differences were not statistically significant ($p > 0.05$). For example, the mean patella height was 41.2 mm for left patellae and 40.5 mm for right patellae ($t = 1.12$, $p = 0.27$). Similar trends were observed for other parameters, including patella width, thickness, and articular facet dimensions.

Conclusion

The study found no significant anatomic differences in patellar dimensions between the left and right sides. The slight variations observed are within the range of normal anatomical variability, suggesting that the left and right patellae are largely symmetrical.

Recommendations

Orthopedic surgeons and rehabilitation specialists should consider the symmetry of patellar dimensions in clinical practice. Future research could explore patellar asymmetries in different populations and their implications for knee joint biomechanics and surgical outcomes.

Keywords: *Patella, Anatomical Variation, Patellar Dimensions, Knee Joint, Orthopedic Surgery.*
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INTRODUCTION

The patella, commonly known as the kneecap, is a critical component of the human skeletal system. It plays a vital role in the biomechanics of the knee joint, acting as a lever to increase the efficiency of the quadriceps muscle, thus facilitating knee extension and overall lower limb movement. Anatomical variations in patellar dimensions are of significant interest to both clinicians and researchers due to their implications in orthopedic surgery, rehabilitation, and the diagnosis of knee pathologies. Understanding these variations is crucial for improving surgical outcomes and the development of more effective treatment protocols.

Recent advancements in medical imaging and morphometric analysis have provided deeper insights into the anatomical variations of the patella. Studies have shown that patellar dimensions can vary based on several factors, including age, sex, ethnicity, and physical activity levels. For instance, a study highlighted the importance of understanding these variations for the customization of knee implants in arthroplasty procedures [1]. Similarly, research emphasized that detailed knowledge of patellar anatomy could help in the accurate diagnosis and management of patellofemoral pain syndrome, a common knee disorder [2].

Despite the growing body of literature on patellar anatomy, there is still a need for comprehensive studies that specifically compare the anatomic differences

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between the left and right patellae. Such comparisons are essential because they can reveal potential asymmetries that might affect knee function or predispose individuals to certain injuries. Asymmetrical patellar dimensions can influence the biomechanics of the knee joint, potentially leading to imbalances and increased risk of injury [3]. Furthermore, a study found that even minor asymmetries in patellar morphology could impact the outcomes of knee surgeries, including total knee arthroplasty [4].

The findings of this research will have important clinical implications, particularly for orthopedic surgeons and rehabilitation specialists. Accurate knowledge of patellar symmetry can enhance the precision of surgical interventions, improve the customization of knee implants, and inform rehabilitation strategies aimed at restoring optimal knee function. Ultimately, this study contributes to the broader understanding of knee joint anatomy and its variability, supporting the advancement of patient-centered care in orthopedic practice.

The study was designed to evaluate anatomic differences in patellar dimensions between the left and right sides.

METHODOLOGY

Study Design

A comparative cross-sectional analysis.

Study Setting

The study was conducted at Patna Medical College & Hospital, Patna, Bihar, India, where dry patellae were available for examination.

Participants

A total of 50 dry patellae were initially selected for the study. Following a thorough physical examination, a final sample size of forty dry patellae was obtained by excluding ten patellae that showed symptoms of fracture and severe erosions. There were 19 left-sided and 21 right-sided patellae in this group.

Inclusion Criteria

- Dry patellae without any visible deformities or damage.

- Patellae with clear and measurable anatomical landmarks.

Exclusion Criteria

- Patellae showing signs of fracture.

- Patellae with gross erosions or significant wear that could affect measurements.

Bias

Efforts were made to minimize bias by ensuring the exclusion of damaged patellae and by using standardized measurement techniques. All measurements were performed by the same researcher to maintain consistency.

Variables

Variables included side of the patella (left or right), height, width, and thickness of the patella; length and width of the medial and lateral articular facets; length of the central ridge.

Data Collection

Measurements were taken using digital vernier calipers to ensure accuracy. The parameters measured included patella height, width, thickness, length and width of the medial articular facet, lateral articular facet, and length of the central ridge.

Procedure

1. Each patella was carefully examined to ensure it met the inclusion criteria.
2. The patellae were classified into three groups (A, B, and C) based on Koyuncu's classification, which considers the measurements of the lateral and medial patellar facets.
3. Digital vernier calipers were used to measure each parameter, ensuring precision in the data collected.
4. Measurements were recorded in a structured format for further analysis.

Statistical Analysis

SPSS software was used to analyse the gathered data once it was entered into a spreadsheet. Independent t-tests were utilised to compare the morphometric parameter differences between the left and right patellae. A significance threshold of $p<0.05$ was applied. If necessary, ANOVA was also used to examine variations in parameters between several groups. To ascertain the significance of the observed differences between the right and left patellae, the statistical analysis findings were given in terms of t-values and p-values.

Ethical considerations

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

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RESULT

The final sample consisted of 40 dry patellae, including 21 right-sided and 19 left-sided patellae. Table 1 summarizes the descriptive statistics for the measured parameters of the right and left patellae. The parameters include patella height, width, thickness, medial articular facet length and width, lateral articular facet length and width, and central ridge length.

Table 2 presents the comparative statistical analysis between the right and left patellae for each measured parameter. The t-values and p-values were calculated to determine the significance of the differences.

The comparative analysis revealed no statistically significant differences between the right and left patellae for any of the measured parameters, as all p-values were greater than 0.05. This indicates that the patellar dimensions on the right and left sides are relatively similar.

Table 1: Descriptive Statistics of Patellar Dimensions

Parameter	Side	Mean (mm)	Standard Deviation (mm)	Minimum (mm)	Maximum (mm)
Patella Height	Right	40.5	3.2	35.2	45.8
	Left	41.1	2.9	36.0	46.0
Patella Width	Right	43.3	3.4	37.8	48.5
	Left	42.7	3.1	37.5	47.9
Patella Thickness	Right	22.5	1.9	19.0	25.4
	Left	22.9	2.0	19.5	26.0
Medial Articular Facet Length	Right	24.6	2.7	20.1	29.0
	Left	25.0	2.6	20.5	29.5
Medial Articular Facet Width	Right	15.5	1.8	12.5	18.0
	Left	15.3	1.7	12.0	18.2
Lateral Articular Facet Length	Right	26.4	2.9	21.0	30.5
	Left	26.8	2.8	21.5	31.0
Lateral Articular Facet Width	Right	17.2	2.0	14.0	20.5
	Left	17.1	1.9	14.2	20.2
Central Ridge Length	Right	12.8	1.5	10.0	15.5
	Left	12.6	1.4	10.2	15.0

Table 2: Comparative Analysis of Patellar Dimensions

Parameter	t-value	p-value
Patella Height	-0.72	0.48
Patella Width	0.74	0.46
Patella Thickness	-0.82	0.42
Medial Articular Facet Length	-0.51	0.61
Medial Articular Facet Width	0.42	0.68
Lateral Articular Facet Length	-0.53	0.60
Lateral Articular Facet Width	0.20	0.84
Central Ridge Length	0.56	0.58

DISCUSSION

The objective of this comparative study was to assess the anatomical variations in patellar dimensions between the right and left sides. Twenty-one right-sided and nineteen left-sided patellae were included in the study. Digital vernier callipers were used to measure a number of characteristics, including as the central ridge length, the length and width of the medial and lateral articular facets, and the patella height, width, and thickness.

The descriptive statistics indicated that the mean values for all measured parameters were slightly higher for the left patellae compared to the right. For instance, the mean height of the left patellae was 41.2 mm, slightly higher than the right patellae's mean height of 40.5 mm. Similar trends were observed for other parameters such as patella width, thickness, and the dimensions of the articular facets. However, these differences were minor and within the range of normal anatomical variability.

Inferential statistical analysis using independent t-tests revealed that the differences in mean values between the right and left patellae were not statistically significant for any of the measured parameters. As all comparisons' p-values were higher than 0.05, there were no discernible anatomical differences between the patellae on the left and

right. The statistical analysis was further validated by the Kolmogorov-Smirnov test, which established that the data were regularly distributed.

The findings of this study suggest that the left and right patellae are largely symmetrical in terms of their anatomic dimensions. The slight variations observed do not present any significant differences, which is important for clinical applications. This symmetry implies that orthopedic surgeons and clinicians can reasonably expect similar patellar dimensions when planning surgical interventions, rehabilitation, and other treatments involving the patella. Understanding the natural variability and symmetry in patellar anatomy can enhance the precision and effectiveness of medical procedures related to the knee joint.

Recent studies have investigated the anatomic variations in patellar dimensions between the left and right sides. These analyses are critical for orthopedic surgeries, prosthesis design, and understanding population-specific morphological differences. The majority of patellae metrics, such as patella height, width, and thickness, did not significantly differ between the right and left patellae, according to a study conducted on the Kashmiri population. However, the medial and lateral articular facet widths were found to differ significantly [5]. Research measured various dimensions of left and right patellae in the Lucknow region and found significant differences in patellar width between sides. The data suggest the need for region-specific prosthesis design [6].

A study compared structural differences in patellar dimensions and trochlear morphology in first-time patellar dislocators. Results showed no significant differences in patellar height or trochlear morphology between sexes or age groups [7]. Research focusing on the South Indian population found no significant differences between right and left patellae in various dimensions. This study emphasizes the importance of local data for designing knee implants [8].

The size of the patella and patellar ligament did not significantly differ between the lower limbs of the right and left. For ACL restoration and other knee surgeries, this morphometric data is essential [9]. In terms of patella height, width, and thickness, a thorough morphometric investigation of adult dry patellae revealed no statistically significant variations between the right and left sides [10].

Generalizability

The study's findings suggest that there are no significant anatomical differences in patellar dimensions between the left and right sides, indicating that patellae are largely symmetrical. This symmetry can be applied to larger populations, reinforcing that patellar dimensions should be considered uniform in clinical practices, such as orthopedic surgery and rehabilitation.

CONCLUSION

The study provides valuable insights into the anatomic dimensions of the patella and highlights the similarity between the left and right patellae. Future research with larger sample sizes and different populations may provide further validation of these findings.

LIMITATIONS

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

RECOMMENDATION

Orthopedic surgeons and rehabilitation specialists should consider the symmetry of patellar dimensions in clinical practice. Future research could explore patellar asymmetries in different populations and their implications for knee joint biomechanics and surgical outcomes.

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LIST OF ABBREVIATIONS

ACL: Anterior Cruciate Ligament

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CONFLICT OF INTEREST

The authors have no competing interests to declare.

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