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Measurement of Normal Patellar Ligament and Anterior Cruciate Ligament by MRI: A Record Based Study at Tertiary Care Hospital in Mandya

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ABSTRACT

Background
Anatomical knowledge of the anterior cruciate ligament (ACL) and patellar ligament (PL) is critical for surgical planning, particularly in ligament reconstruction procedures. This study aimed to measure normative lengths of ACL and PL using MRI among individuals without knee pathology in a tertiary care setting.
Methods
This retrospective, record-based observational study analysed knee MRI scans of 112 patients aged >18 years, selected from data archives at a tertiary hospital. Patients with known ligament injuries, degenerative disease, or prior surgery were excluded. ACL and PL lengths were measured in the sagittal plane using standardized radiological protocols. Data were analyzed for side- and gender-wise variation.
Results
The mean ACL length was 36.89 ± 1.00 mm on the right and 36.89 ± 0.95 mm on the left knee. The mean PL length was 45.24 ± 1.27 mm on the right and 45.34 ± 1.10 mm on the left knee. No statistically significant differences were found between right and left sides or between genders. The ligament lengths remained highly consistent across the population studied.
Conclusion
The study establishes MRI-based normative values for ACL and PL lengths in a healthy South Indian population, with minimal inter-individual or gender-related variation. These values may serve as reliable references for preoperative planning in ACL reconstruction and graft selection. Further studies with larger sample size are necessary to confirm these findings.
Keywords: Patellar ligament, Anterior cruciate ligament.

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INTRODUCTION

Knee joint is a highly complex and weight-bearing synovial joint that is critically stabilized by a set of ligamentous structures, of which the anterior cruciate ligament (ACL) and patellar ligament (PL) play pivotal roles. The ACL is essential for anteroposterior and rotational stability of the knee, while the PL, acting as the distal continuation of the quadriceps tendon, anchors the patella to the tibial tuberosity and is vital in knee extension mechanisms. Injuries to these ligaments are common, particularly among physically active individuals, and necessitate precise anatomical knowledge for diagnosis, surgical planning, and post-operative evaluation.[1–3]

Magnetic Resonance Imaging (MRI) has revolutionized musculoskeletal imaging by offering detailed visualization of soft tissue structures without ionizing radiation. It serves as the gold standard modality for evaluating intra-articular ligaments of the knee, including the ACL and PL.[4,5] Morphometric parameters of these ligaments-such as length, width, thickness, and signal characteristics-can be effectively assessed through MRI. This is especially crucial in ligament reconstruction surgeries where graft dimensions must approximate native ligament size for optimal biomechanical outcomes.[6]

Normative data on ACL and PL morphometry, however, exhibit notable inter-population variability, likely influenced by ethnicity, genetic factors, sex, age, and physical activity.[7–9] Indian populations are underrepresented in global databases, and even within India, region-specific studies are sparse. There is a growing need to establish normative MRI-based morphometric profiles for these ligaments in different Indian subpopulations to aid in surgical precision and anthropological comparison.

Previous studies have assessed ACL and PL dimensions, yet most have focused on Western or East Asian populations.[10–12] Moreover, studies specific to South Indian populations-especially from Karnataka-are minimal. The tertiary care centre in Mandya offers datasets of knee MRIs, and analysis of such records can yield valuable insights into regional ligamentous anatomy.

This study aims to bridge this gap by evaluating MRI-based morphometric parameters of the ACL and PL in individuals with normal knees, based on archived radiological records. The generated data might provide baseline reference values and may serve as a guide for clinical practitioners. Furthermore, it will contribute to the growing body of literature advocating for population-specific anatomical databases.

MATERIALS & METHODS

This was a retrospective, record-based descriptive study conducted in the Department of Orthopaedics and Department of Radiology, Mandya Institute of Medical Sciences, Mandya. The data extraction & analysis was done between January 2024 and July 2024 after approval from institutional ethics committee. The main objective of the study was to determine the measurements of normal patellar ligament and anterior cruciate ligament among adult population of Mandya, & to compare the length of ACL and PL in men and women.

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Patients of either gender, aged >18 years, who have undergone radiograph and MRI at Mandya were included in the study & patients with pathological ACL or PL ligament or traumatic ACL or PL ligament tear were excluded from the study.

Data collection was started after approval from the Institutional Ethics Committee of Mandya Institute of medical sciences, Mandya. A specially designed proforma was used to transcribe data from medical records. The measurement of ACL and PL were made from pre-existing database of MRI scan of knee done for unrelated reasons.

PL and ACL measurement: PL length in the oblique sagittal position is from the lower edge of the patella to the tibial tubercle. ACL length measurement, the starting point is from the top of the lateral intercondylar notch in the femoral attachment and the end was the front facies ossea of the eminentia intercondylaris in the tibial attachment point. The ratio of L1 and L2 will be calculated.

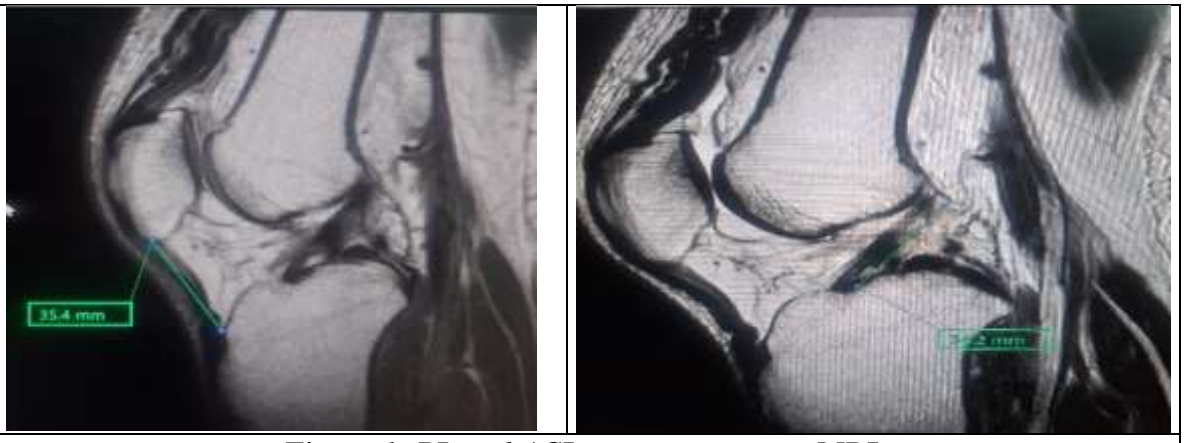

Figure 1: PL and ACL measurement on MRI

Statistical Analysis

All data were recorded in a preformatted excel sheet. Data was presented using descriptive statistics including mean, standard deviation, frequencies & percentages.

RESULTS

A total of 112 patients were included in the study, consisting of 71 males (63.4%) and 41 females (36.6%), with the average age being 34.9 ± 11.7 years for males and 46.0 ± 12.2 years for females. Complete details of side of knees assessed, mean length of ACL & PL are mentioned in Table 1.

Age (yrs), mean ± SD	Male	34.9 ± 11.7
	Female	46 ± 12.2
Gender, n (%)	Male	71 (63.4)
	Female	41 (36.6)
Side of measurement, n (%)	Right	59 (52.7)
	Left	53 (47.3)
Mean ACL length (mm)	Right	36.89 ± 10
	Left	36.89 ± 0.95

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Mean Patellar length (mm)	Right	45.24 ± 1.27
	Left	45.34 ± 1.10

Table 1: Patient demographics & mean ACL & PL measurements

When stratified by gender, male participants demonstrated ACL lengths of 36.9 ± 1.00 mm (right) and 36.87 ± 1.02 mm (left), whereas female participants showed corresponding values of 36.8 ± 1.02 mm (right) and 36.92 ± 0.95 mm (left). For the PL, males had measurements of 45.28 ± 1.20 mm (right) and 45.27 ± 1.19 mm (left), while females exhibited 45.26 ± 1.18 mm (right) and 45.29 ± 1.14 mm (left) (Table 2).

		n	Male (n=71)	n	Female (n=41)
ACL	Right	36	36.9 ± 1.0	23	36.8 ± 1.02
	Left	35	36.87 ± 1.02	18	36.92 ± 0.95
PL	Right	36	45.28 ± 1.20	23	45.26 ± 1.18
	Left	35	45.27 ± 1.19	18	45.29 ± 1.14

Table 2: Gender & Side based stratification of ACL & PL measurements

No statistically significant differences were found between genders or between the right and left sides for both ACL and PL measurements. Overall, the ACL and PL lengths in this study appear highly consistent, with very low inter-individual and side-to-side variation.

DISCUSSION

This MRI-based retrospective study yielded a mean ACL length of 36.89 mm and a mean PL length of 45.29 mm, with negligible variation across sides and between genders. These consistent findings support the hypothesis that anatomical dimensions of these ligaments are largely conserved in healthy individuals.

When compared to previously published literature, the findings align well with normative data reported in other regional and international studies. For example, Tameem et al. (2018) evaluated MRI-based ACL and PL lengths in an Indian cohort and reported an average ACL length of 38.3 ± 2.2 mm and PL length of 45.7 ± 3.1 mm, values that closely mirror those observed in the present study.[13] Similarly, Uhorchak et al. (2003) described average ACL lengths ranging from 35 mm to 39 mm, affirming the general anatomical range for these structures among healthy adults.[14]

The absence of gender-based variation in ligament lengths in our study corroborates the findings of Chandrashekar et al. (2006), who also reported minimal differences in ACL morphology between males and females despite differences in biomechanical injury risk profiles.[8] This suggests that ligament length alone may not be a decisive factor in gender-based susceptibility to ACL injuries, emphasizing the importance of other anatomical or neuromuscular factors.

In terms of clinical relevance, knowing the expected lengths of ACL and PL is critical for ACL reconstruction, especially when using autografts harvested from the patellar ligament. Mariscalco et al. (2013) emphasized that graft length and thickness are directly associated with surgical outcomes, especially graft fixation strength and tunnel positioning.[15] The PL measurements from our study were consistent across patients & offer valuable reference values to guide graft selection and surgical planning. Furthermore, by demonstrating consistency

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between right and left knees, this study supports the use of the contralateral limb as a reference standard during reconstructive procedures, a practice recommended in various orthopedic guidelines.

Strengths of this study were, it provides baseline anatomical data for ACL and PL in a previously underrepresented South Indian population. Measurements were taken using high-resolution MRI, ensuring anatomical accuracy. Limitations of the study were, retrospective design may introduce selection bias, lack of correlation with body morphometry such as height, weight, or limb length. Absence of data on dynamic variables such as muscle strength or joint loading may limit biomechanical interpretations.

CONCLUSION

This MRI-based observational study establishes normative reference values for the anterior cruciate and patellar ligaments. The near-identical measurements across both limbs and genders enhance confidence in using these values for preoperative planning and graft sizing in ligament reconstruction surgeries. These findings are consistent with historical data and contribute valuable regional insights for orthopedic and radiological practice. Further largescale studies will be helpful in reinforcing these results

Sponsor: None
Conflicts of Interest: None

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