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ORIGINAL ARTICLE

Dimension of normal anterior cruciate ligament on MRI in our population.

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ABSTRACT… Objective: The present study will help us in establishing local statistics in our population. **Study Design:** Descriptive study. **Setting:** Department of Orthopedic Surgery at Khyber Teaching Hospital in Peshawar. **Period:** June 2023 to December 2023. **Methods:** Seventy MRI of knee were collected. Knee MR images sagittal and coronal plane (T2-Weighted Images) were reviewed by radiologist and only knees with an intact cruciate ligament were included in the study. All the measurement (length and width) were made with electronic caliper. **Results:** Regarding radiological length of ACL on sagittal view on MRI, the minimum length was 28mm and maximum was 46mm and mean length was 34mm and standard deviation of 4.49, Regarding width of ACL on sagittal view it was found that the minimum length was 8mm and maximum was 16mm and its mean length was 10.4mm with standard deviation of 2.02. While the width of ACL on coronal plane was such that the minimum length was 6mm maximum was 16mm its mean was 11.34 and standard deviation of 2.48. By applying one sample T-Test and compare with Kowen parameter the p value was 0.00 for both length and width showing statistically highly significant. **Conclusion:** In conclusion in our population ACL is shorter and thicker then westerns population. Further studies should be done arthroscopically and on cadaveric to establish our local statistics of anthropometric measurements of anterior cruciate ligament.

Key words: Anterior Cruciate Ligament, MRI, Measurement.

INTRODUCTION

The anterior cruciate ligament (ACL) serves as the principal kinematic ligament of the knee. Positioned extra-synovially and intracapsularly, it extends in a caudal direction from the medial surface of the lateral condyle of the femur to the anterior section of the proximal tibial plateau.[1]

The ACL is composed of multiple fiber bundles. Initially, it was categorized into two primary bundles: the anteromedial (AM) bundle and the posterolateral (PL) bundle. However, subsequent research revealed a more nuanced structure, indicating that the anterior cruciate ligament is, in fact, divided into three distinct fiber bundles.[2]

Magnetic Resonance Imaging (MRI) stands out as an exceptional imaging modality that enables the qualitative assessment of intra-articular soft tissue anatomy. This capability allows for the checking of both complete and partial ruptures of the ACL. With the continual advancement of MRI technology, there has been a concurrent improvement in image quality, resulting in higher resolution images. This enhanced image quality, in turn, facilitates the quantitative measurement of anatomical structures.[3]

An estimated 200,000 cases of ACL tears occur annually, with approximately 100,000 undergoing ACL reconstruction procedures in the United States.[4]

Measurements taken from cadaveric specimens indicate that the anteromedial (AM) bundle is approximately 38mm in length, while the posterolateral (PL) bundle measures around 18mm in length. In terms of mid-substance diameter, both the AM and PL bundles exhibit similarity, with average sizes of 7.1mm and 6.7mm, respectively.[5] In a study involving fifty MRI scans of the knees, the measurements of the ACL

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bundles were examined. The AM bundle exhibited an average length of 36.9+/-2.8 mm and a width of 5.1+/-0.7 mm. In contrast, the PL bundle had an average length of 20.5+/-2.4 mm and a width of 4.4+/-0.8 mm. In coronal view, the width of the AM bundle averaged 4.2+/-0.8 mm, while the PL bundle averaged 3.7+/-0.8 mm. Additionally, a pilot study was conducted involving arthroscopic measurements in ten knees that underwent both MRI and arthroscopy. The results of the pilot study showed average lengths and widths for the anteromedial (AM) and posterolateral (PL) bundles, namely 35.3mm and 6.5mm for AM, and 19.1mm and 5.4mm for PL, respectively. When compared to the MRI measurements, the differences between these values were not found to be statistically significant.[6]

The findings of a prospective study aimed at examining the variability in ACL measurements between MRI samples and the Kowen parameter of the ACL reveal that the ACL exhibits a minimum length of 3.1 cm and a maximum length of 4 cm. The mean length is determined to be 3.7 cm, with a standard deviation (SD) of 0.42. In terms of thickness, the ACL demonstrates a minimum of 0.5 cm and a maximum of 1.2 cm, with a mean thickness of 0.8 cm and a SD of 0.18. The ratio of ACL length to thickness ranges from a minimum of 3.20 to a maximum of 7.17, with a mean ratio of 4.87 and a SD of 1.29.[7]

The current study is essential for establishing local statistics within our population, considering the variations reported by different authors and the absence of a specific study on this topic within our hospital. Offering accurate measurements of the ACL in our community through MRI can enhance our capacity to identify ACL damage post-injury. Additionally, it may assist in the selection of grafts and preparation for surgical reconstruction of the ACL.

The objective of our study is to evaluate the dimension of normal anterior cruciate ligament on MRI scan in our population.

METHODS

This descriptive study was conducted on seventy sample size from June 2023 to December 2023. MRI scans of the knee were acquired from the Department of Orthopedic Surgery at Khyber Teaching Hospital in Peshawar after taking ethical approval from hospital (754/DME/KMC) (24/1/2023). Sampling technique was through non probability consecutive sampling. These scans were selected specifically from individuals without any history of ACL injury or previous surgery, aiming to establish a baseline for normal anatomy. The sample size of 70 was determined using a mean ACL length of 3.7, a standard deviation of 0.42, a 95% confidence interval, and a 10% margin of error, following the WHO sample size calculation formula. The inclusion criteria for the study population encompassed individuals with completed growth (closed epiphyseal growth plate), irrespective of gender, without any prior injury or surgery, aged between 18 to 60 years. Knee magnetic resonance (MR) images in sagittal and coronal planes (T2-Weighted Images) were meticulously reviewed by a radiologist, and only knees demonstrating intact cruciate ligaments were incorporated into the study. While Patients with knee disorders, or anatomical abnormalities or with a history or evidence of injury, surgery, or disease in their ipsilateral knee or any contraindication to MRI were excluded from study. All measurements were conducted using electronic calipers. For each patient, information such as age, sex, and address was gathered and recorded. The midpoint of each bundle's thickness was measured, and the length was determined by measuring the distance between the femoral and tibial attachments' center points.

Statistical Analysis

This descriptive study aimed at exploring the variability in measurements of the anterior cruciate ligament and Kweon's[7] parameter of the ACL. The collected data underwent thorough revision, coding, tabulation, and were then entered and analyzed using SPSS version 17. Descriptive statistics, including mean, standard deviation (+/-SD), minimum, and maximum (range), were calculated for numerical data. Analytical statistics employed a one-sample T-Test to assess whether the mean of a single variable differed from a specified constant, with a significance level set at

a P value of 0.05.

RESULTS

In this study the total number of sample was 70, the frequency was such that there were 62 males and 8 females. (Table-I)

Male	62	88.6
Female	8	11.4
Total	70	100.0

Table-I. Frequency of male and female ratio

The rest of descriptive statistics was such that the minimum age was 18 year and maximum was 47 and mean age was 28 years. Regarding radiological length of ACL on sagittal view on MRI, the minimum length was 28mm and maximum was 46mm and mean length was 34mm and standard deviation of 4.49. Regarding width of ACL on sagittal view it was found that the minimum length was 8mm and maximum was 16mm and its mean length was 10.4mm with standard deviation of 2.02. While the width of ACL on coronal plane was such that the minimum length was 6mm maximum was 16mm its mean was 11.34 and standard deviation of 2.48. (Table-II)

The ratio of length of ACL and width of ACL is shown in (Table-III).

By applying one sample T–Test, radiological measurement shows that that the mean length of ACL was 34mm and that of Kowen parameter[7] was 37mm and its P value is 0.00 mean highly significant. (Table-IV).

Same for thickness of ACL, the mean radiological thickness was 10.47mm, compare with Kowen (7) Thickness which was 8mm and applying one sample T-test (Table-V).

This shows that P value is .000 which is highly significant.

DISCUSSION

Athletes and individuals engaged in sports often necessitate ACL reconstruction, primarily utilizing autografts, frequently sourced from hamstring tendons. The reconstruction of a torn ACL has demonstrated enhanced knee stability in both daily and strenuous activities when compared to non-surgical treatment, particularly in active

	Minimum	Maximum	Std. Deviation	Mean
Age	18.00	47.00	6.96451	28.6000
Length of ACL on sagittal view	28.00	46.00	4.49451	34.7286
Width of ACL on sagittal view	8.00	16.00	2.20488	10.4714
Width ACL on coronal view	6.00	16.00	2.48407	11.3429

Table-II. Descriptive statistics

Price Related Differential	Coefficient of Dispersion	Coefficient of Dispersion
		Median Centered
1.027	.142	16.7%

Table-III. Ratio Statistics for Length of ACL on sagittal view / Width of ACL on sagittal view

	Test Value= 37					
	T	Df	Sig (2-tailed)	Mean Difference	95% Confidence Interval of Difference	
					Lower	Upper
Length of ACL on sagittal View	-4.228	69	.000	-2.27143	-3.3431	-1.1998

Table-IV. One-Sample Test

	Test Value= 8					
	T	Df	Sig (2-tailed)	Mean Difference	95% Confidence Interval of Difference	
					Lower	Upper
Width of ACL on sagittal view	9.378	69	.000	2.47143	1.9457	2.9972

Table-V. One-Sample Test

individuals. The outcomes of the ligament repair are contingent on the anatomy of the graft, emphasizing the importance of a well-matched graft for optimal results.[8] Zantop derived the conclusion from his study that an excessively long graft could result in the tibial plug protruding from the tunnel, while a graft that is too short would pose challenges in fixation.[9] Hence, the length and thickness of the native ACL are crucial factors in choosing the appropriate graft type and ensuring the graft is prepared properly for good results.

The imaging method employed played a significant role in obtaining precise data. Katahira[10] highlighted the importance of increased diagnostic accuracy by recommending the prescription of oblique coronal images aligned with the length of the ACL based on an oblique sagittal image acquired through a double oblique sequence. However, according to Aglietti[11], enhanced visualization of the ACL in the knee is achieved at a mild flexion angle (17-30°). This improvement is attributed, in part, to the reduced partial volume of the proximal ACL beneath the intercondylar roof. Recent advancements in radiological technology have ushered in a new era of effective cruciate ligament visualization. Hashemi was a pioneer in publishing an article on three-dimensional images of the ACL, and measurements obtained through this method were deemed acceptable.[12]

In this radiological study, the mean length of the anterior cruciate ligament (ACL) was determined to be 34mm. This demonstrates a notable variation compared to Kowen's[7] findings, possibly attributed to Tajima's[13] description of a range between 3.2-3.8 cm. Tajima further noted that The knee's mobility affected the separations between the ACL fiber attachment sites. In accordance with the tensioning pattern. it was noted that flexion increased the anteromedial bundle's distance. In contrast, the posterolateral bundle's length decrease at 90° of flexion as opposed to full extension. The mean thickness of the ACL in our population is 10mm, contrasting with Kowene's[7] reported ACL mean thickness of 8mm. These findings suggest that in our population, the ACL tends to be shorter and thicker than in Western populations. J.L. Tan[14] conducted a study revealing that the ACL in Singaporean Chinese individuals is narrower, shorter, and more vertically oriented when compared to Western populations.

CONCLUSION

In conclusion, our population exhibits a pattern where the anterior cruciate ligament (ACL) is shorter and thicker compared to Western populations. The utilization of preoperative MRI for assessing normal knee joint conditions may contribute to enhanced outcomes in knee ligament reconstruction procedures.

Further studies should be done arthroscopically and on cadaveric to establish our local statistics of anthropometric measurements of anterior cruciate ligament.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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