

Original article:

Morphometric study of Cruciate ligaments of Knee joints: A cadaveric study in Eastern Indian population

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Abstract:

Introduction : This study is an effort to determine the accurate morphometric data pertaining to the Anterior and Posterior cruciate ligaments in relation to the native eastern Indian population.

Aims And Objectives : To study the following parameters of Anterior and Posterior Cruciate Ligaments of the knee joint : Length and Width of Anterior and Posterior Cruciate Ligaments at their middle 3rd as well as the extent of their variation.

Methods & Materials : The study was carried out in the Department of Anatomy of our institute in cadavers donated to the department during a period of one year. Subjects having no obvious macroscopic deformities of their knee joints and ages ranging between 30 years to 60 years of both sexes were only chosen . 50 knee joints belonging to 25 cadavers matching the above criteria were dissected for the study.

Result &Analysis : The mean length of the ACL of left side was recorded to be 20.02mm and the mean width of the ACL in its middle third was recorded to be 6.54mm .The mean length of the ACL for the right side was found to be 20.06mm and mean width of the ACL in its middle third on the right side was found to be 6.23mm.The mean length and width of the PCL in left side, in the present study were recorded to be 20.10mm and 6.22mm respectively. For the right side, the mean length and width (middle third) of the PCL were found to be 20.08mm and 5.90mm respectively.

Conclusion : This study will provide valuable information to the orthopaedicians from which they can choose the exact sized grafts for cruciate ligament reconstruction, which is the preferred mode of treatment for injuries to the cruciate ligaments, now a days.

Keywords: :Morphometry, cruciate ligaments, knee joint

Introduction:

Cruciate ligaments are very strong ligaments of knee joint. There are two cruciate ligaments, one being Anterior (ACL) and the other being Posterior (PCL) in par with their attachments to the tibia . Cruciate ligaments play an equally important role in providing stability to the knee joint. The ACL of knee is the most commonly injured ligament, representing about 60% of all knee injuries¹. ACL tear is usually associated with other injuries like medial collateral ligament and meniscal injuries of the knee (Unhappy triad of O'Donoghue), which causes functional instability of that joint . ACL injuries show long term effects on knee joint such as degenerative joint diseases like secondary osteoarthritis. So, reconstruction of ACL is essential in injured cases. For planning reconstruction surgery by using Patellar Tendon Allograft or Hamstring Tendon Allograft techniques, it is essential to know the detailed anatomy and morphometric measurements of ACL.² PCL injuries are more common than initially thought, comprising 3% of all knee injuries and being present in 37% of trauma patients with acute haemarthroses³. This incidence is dependent on the patient population reported, with PCL tears occurring more frequently in trauma patients than in athletic injury patients. Classification into isolated versus multi-ligament injured knees is important for taking decision during treatment . Isolated injuries to the PCL may have good results with non operative treatment, whereas multi-ligament injured knees have better outcomes with surgical intervention as it represents a complex problem in orthopaedic surgery⁴. Henceforth for the surgical repair of cruciate ligaments it is mandatory that orthopaedic surgeons should have detailed anatomical knowledge about various morphometric data of cruciate

ligaments, which will guide them in determining the appropriate size of the allograft to be utilized in the procedure of such reconstruction^{5,6}.

Aims & Objectives

1. To study the following parameters of Anterior and Posterior Cruciate Ligaments of the knee joint -

a) Length of Anterior and Posterior Cruciate Ligaments.

b) Width of Anterior and Posterior Cruciate Ligaments at their middle 3rd.

2. To document the extent of variation in the above parameters.

Materials & Methods

The study was carried out in the Department of Anatomy of our institute in cadavers donated to the department during a period of one year. Subjects having no obvious macroscopic deformities of their knee joints and ages ranging between 30 years to 60 years of both sexes were only chosen . 50 knee joints belonging to 25 cadavers matching the above criteria were dissected for the study. Knee joints of both sides were dissected . After dissecting the skin, soft tissues and muscles, the menisci were approached anteriorly by a longitudinal incision on each side of the joint capsule, cutting the patellar ligament and the collateral ligaments transversely. The anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL) were dissected after removing the intra - articular fat and other soft tissues, so that their femoral as well as tibial attachments can be clearly denoted . The ACL was measured for its length & width (at middle 3rd) from the anterior aspect of the joint . The PCL was measured for the same parameters from the posterior aspect of the knee joint . The above was done by means of a digital Vernier Calliper .

Results & Analysis

Amongst the 50 cadaveric knee joints dissected (in 25 cadavers) for the purpose of this present study, 13 were males and 12 were females. The mean age of the cadavers were found to be 56.32 with a Standard Deviation (SD) of 3.755. The maximum age was recorded to be 60 yrs. and minimum to be 49yrs. In the present study, the mean length of the ACL of left side was recorded to be 20.02mm with SD of 1.222 and the mean width of the ACL in its middle third was recorded to be 6.54mm with SD of 0.759.

The mean length of the ACL for the right side was found to be 20.06mm with SD of 1.414 and mean width of the ACL in its middle third on the right side was found to be 6.23mm with SD of 0.784. The mean length and width of the PCL in left side, in the present study were recorded to be 20.10mm with SD of 1.126 and 6.22mm with SD of 0.851 respectively. For the right side, the mean length and width (middle third) of the PCL were found to be 20.08mm with SD of 1.130 and 5.90mm with SD of 0.777 respectively.

Table 1. Descriptive statistics of numerical variables –left side

	n	mean	95%CI UL	95%CI LL	median	min	max	Lower quartile	Upper quartile	Std.Dev
Age	50	56.32	55.25	57.39	58.00	49.00	60.00	52.00	59.00	3.755
ACL length	50	20.02	19.67	20.37	20.07	18.32	21.73	18.91	21.24	1.222
ACL Width mid 1/3 rd	50	6.54	6.32	6.75	6.88	5.39	7.77	5.86	7.19	0.759
PCL length	50	20.10	19.78	20.42	20.28	18.34	21.67	19.01	21.09	1.126
PCL Width mid 1/3 rd	50	6.22	5.98	6.46	6.56	4.80	7.35	5.39	6.98	0.851

Table 2. Descriptive statistics of numerical variables –Right side

	n	mean	95%CI UL	95%CI LL	median	min	max	Lower quartile	Upper quartile	Std.Dev
ACL length	50	20.06	19.66	20.46	20.45	17.98	22.21	18.71	21.28	1.414
ACL Width mid 1/3 rd	50	6.23	6.00	6.45	6.41	4.89	7.76	5.60	6.88	0.784
PCL length	50	20.08	19.76	20.40	20.66	18.52	21.76	18.93	20.98	1.130
PCL Width mid 1/3 rd	50	5.90	5.68	6.12	5.99	4.77	7.02	5.09	6.64	0.777

Table 3: Comparison of numerical variables between Male and Female – Student’s unpaired t test.—left side.

	Male Mean	Female Mean	t-value	df	p	Valid N (M)	Valid N (F)	Std.Dev M.	Std.Dev. F
Age	56.30	56.35	-0.0479	48	0.962	27	23	3.709	3.892
ACL length	21.07	18.78	20.2718	48	0.000	27	23	0.484	0.267
ACL Width mid 1/3 rd	7.19	5.77	19.8887	48	0.000	27	23	0.266	0.235
PCL length	21.08	18.95	21.8929	48	0.000	27	23	0.427	0.203
PCL Width	6.96	5.35	21.7070	48	0.000	27	23	0.223	0.300

mid 1/3 rd									
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Table 4: Comparison of numerical variables between Male and Female – Student’s unpaired t test.—Right side

	Male Mean	Female Mean	t-value	df	p	Valid N (M)	Valid N (F)	Std.Dev M.	Std.Dev. F
ACL length	21.27	18.64	18.2196	48	0.000	27	23	0.606	0.359
ACL Width mid 1/3 rd	6.88	5.46	15.6385	48	0.000	27	23	0.335	0.302
PCL length	21.08	18.90	28.6628	48	0.000	27	23	0.328	0.174
PCL Width mid 1/3 rd	6.56	5.13	16.9443	48	0.000	27	23	0.307	0.286

Table 4:

Comparisons between anterior and posterior cruciate ligaments – paired t test

In males

Parameter	2-sided p value	
	Left side	Right side
ACL_Len vs PCL_len	0.981	0.091
ACL_WidthMid vs PCL_WidthMid	0.001	0.000

In females

Parameter	2-sided p value	
	Left side	Right side
ACL_Len vs PCL_len	0.035	0.005
ACL_WidthMid vs PCL_WidthMid	0.000	0.003

Figure 1. – Bar Diagram showing comparison of mean length of ACL and PCL of the right and left sides.

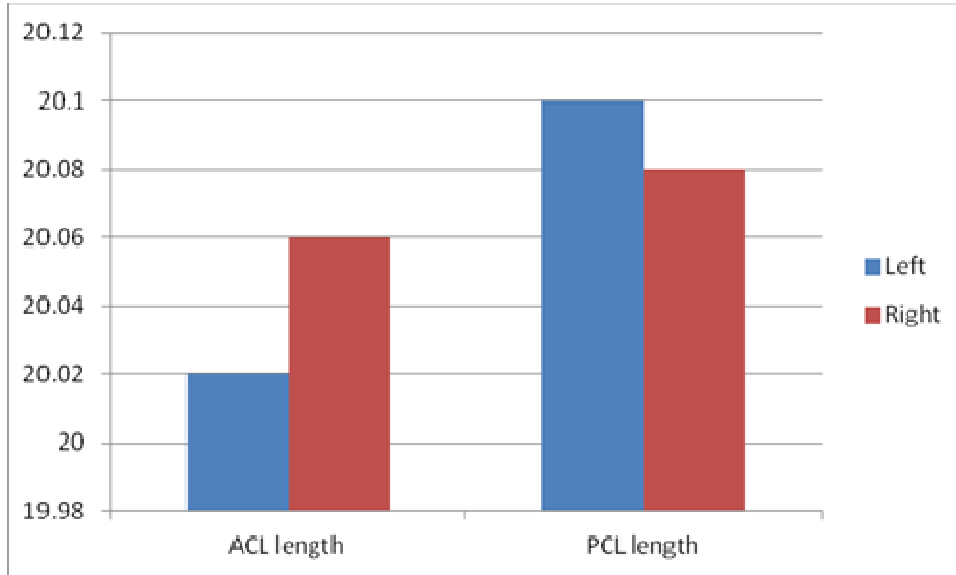
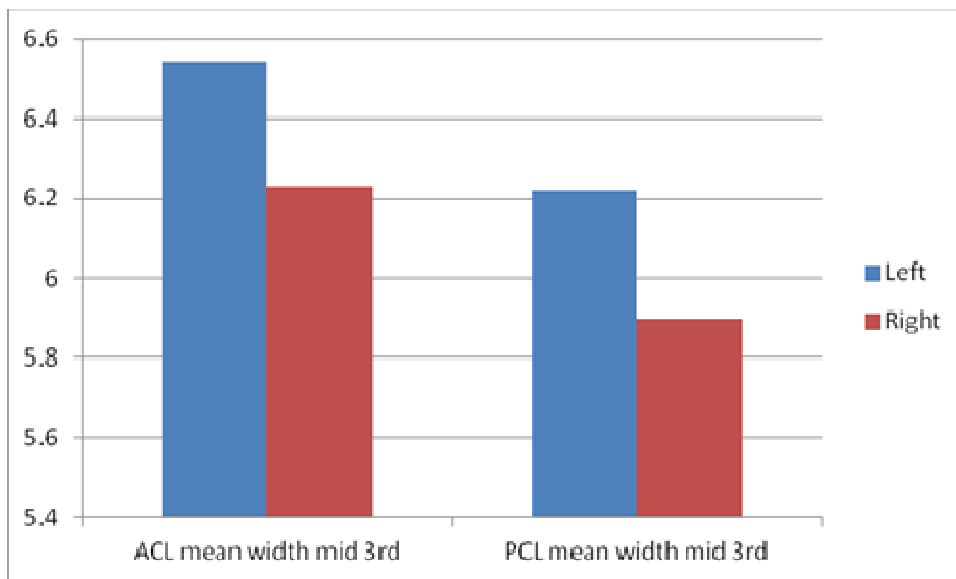


Figure 2: Bar Diagram showing comparison of mean width of ACL and PCL in the middle thirds of the right and left sides



Discussion

Not much studies had been done in the field of morphometric study of the ACL and PCL of the knee joints. In standard anatomical textbooks, the average length and width of the ACL is mentioned to be 38mm and 11mm respectively. This length and width in case of the PCL are mentioned to be 38mm and 13mm respectively ^{7,8}. So, ACL and PCL of the knee joints, though same in length, the

PCL has been mentioned to be thicker than the ACL in standard anatomical textbooks. Odensten et al ⁹, recorded the average length of the ACL in 33 cadaveric knee joints to be 31mm. Whereas, Gillquist et al ¹⁰, measured the length of the ACL in cadavers to be 32mm. However, the above mentioned studies did not specify any gender or side variations.

	Present study	Odensten et al	Gillquist et al
Mean length of ACL	20.02mm (Lt) 20.06mm (Rt)	31mm	32mm

Unpaired t test performed to compare the above values between males and females showed a p value of < 0.001, both in case of the length and width of the ACL, indicating significant gender variations between the two sides when compared. When compared to the values for the mean length and width of the ACL published in the standard anatomical textbooks, the mean length of the ACL of both the sides were recorded much less in this present study. This can perhaps be explained by the ethnic origins of the cadavers studied in this present study. Unpaired t test performed between the data obtained from the male and female cadavers showed p values both for the length and width (middle third) of the PCL to be < 0.001, thereby indicating significant gender differences

in those values of the PCL. Yelicherla et al ¹¹ in their study regarding the cruciate ligaments of the knee joints in cadavers, recorded the mean length and width of the ACL considerably greater in males when compared to that of the female (p < 0.05). This finding was consistent to that found in the present study (p < 0.001). Unlike this present study, the study done by Yelicherla et al showed the mean length of the ACL irrespective of the side, to be 43.5mm in males and 41.9mm in females. The mean width of the ACL in the same study was recorded to be 12.1mm in case of male cadavers and 11.0mm in case of the female cadavers. Thus, both these recorded values were significantly higher when compared to the same for the present study.

	Present study	Yelicherla et al
Mean width of ACL	7.19mm (males) 5.77 mm (females)	12.1 mm (males) 11.0mm (females)

Similar findings were observed for the mean length and width in the middle thirds for the PCL, when

compared between the study done by Yelicherla et al and the present study. Comparison between the ACL

and the PCL by means of paired t test showed, 2 sided p value for the mean length on the left side to be 0.981 in males and for the right side in males to be 0.091. For the width, p values in males for the left side was calculated to be 0.001 and that for the right side to be < 0.001 , which indicated significant differences in width of the ACL and PCL for both the sides. In case of females, p values for the length were calculated to be 0.035 on the left side and 0.005 on the right side, which showed not much difference in their values, when they are compared. For the width (middle thirds), p values were found to be < 0.001 in the right side and 0.003 in the left side. This on the other hand showed significant differences in width between the ACL and PCL also in females, both in the right as well as left sides. None of the studies mentioned previously in this discussion said anything regarding the

comparison between the data obtained for the ACL and PCL.

Conclusion

The present study will contribute to the literature regarding the morphometry of the cruciate ligaments of the knee joint. The study not only recorded those data but also compared those between the two sides and either sex. This will provide valuable information to the orthopaedicians from which they can choose the exact sized grafts for cruciate ligament reconstruction, which is the preferred mode of treatment for injuries to the cruciate ligaments, now a days. However, the study will be more informative if the sample size is more and may be more accurate if the study is done with Magnetic Resonance Imaging techniques, which can show the morphological features of the menisci and cruciate ligaments better.

Photograph 1 – Showing the left knee joint before dissection



Photograph 2 – Showing the length of Anterior Cruciate Ligament



Photograph 3 – Showing width of the Posterior Cruciate Ligament.



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