



Morphogenesis of Anterior Cruciate Ligaments on Both the Knee Joints in Adult Indian Population and Its Surgical Approaches: A Patient based Study

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ABSTRACT:

Background: The strongest ligament in the knee joint, the anterior cruciate ligament aids in standing, rotational stability, and the avoidance of joint hyperextensibility. Collagen fibres connect it to the tibial and femoral insertions. Its anatomy differs depending on the race and is difficult to repair if it is ruptured. Its anatomy is essential for recognising their footprints, and this article analyses its relationship to the long bones of the lower leg to comprehend ligament reconstruction and restoration.

Obejectives : The purpose of this study is to compare the overall length of the ACLs in both knee joints and connect them with the lengths of the tibia and femur. Materials and Procedures: Observation and surgical procedures on 20 patients were observed in the study. The length of the ACL was measured using a digital calliper, and the femur and tibia were measured using a measuring tape. Result : The mean \pm standard deviation of the total length of the ACL in the right and left knees is 29.42 ± 5.48 and 29.78 ± 4.07 , respectively, and ranges from 19.5 - 37.1 and 22.5 - 34.7. The parametric distribution of femur length on the right and left sides is 42.97 ± 2.42 , with ranges of 39 - 45.6, respectively, while the mean \pm standard deviation of tibia length on both lower limb sides is 36.55 ± 1.87 , with ranges of 34 - 37.8, respectively. All of the parametric distributions show a positive connection at the $p < 0.05$ level of significance. In conclusion, the current study gives orthopedic surgeons the information they need to undertake surgery and grafting.

Introduction

First, the knee joint begins to grow in the fourth week of pregnancy and gives way in the sixth week [1]. The centre of the knee joint or its outlying regions show cavitation blueprints [2,3,4,5,6]. Two collateral ligaments on the sides of the knee and two cruciate ligaments, such as the Anterior Cruciate Ligament (ACL) and Posterior Cruciate Ligament (PCL), inside the knee, create the ligaments that primarily link the joint cavity of the knee [7,8]. The ACL attaches to the tibia's anterior condylar region, which is partially connected to the lateral meniscus. The

ACL measures 11 mm in width and 38 mm in length [9].

The ACL prevents the knee joint from being overextended [12], stabilises the knee joint, and serves as a passive restraint for the tibia with regard to the femur [10, 11]. As a result, the ACL is more likely to sustain damage [13] than the other knee ligaments [14,15,16]. Congenital ACL agenesis occurs in 0.017 out of 1000 births [17,18,19,20].



Material and Methods

The investigation was conducted on 20 patients attending MDBASMC, Deoria (UP) compare with some cadaveric study. Simple Random Sampling was the sampling strategy employed to obtain the data and carried out the observational study design. The study

did not include knees that had undergone surgery or suffered trauma. In this investigation, the parameters were observed twice. A digital caliper was used for all ACL measurements, and a measurement tape was used for the tibial and femur measurements. Between the femoral and tibial insertions, the ACL's overall length was measured [21].

Table1: Showing the parameters of total length ACL of both the knee and length of Femur and Tibia of both the sides

No. of Patients	Parameters	Min–Max (mm)	Mean ± SD	p-Value*
20	Total length ACL- Right Knee	19.5- 37.1	29.42 ± 5.48	= 0.4373
	Total length ACL- Left Knee	22.5- 34.7	29.78 ± 4.07	
	Length of Rt. Femur	39- 45.6	42.98 ± 2.34	= 0.4920
	Length of Lt. Femur	39- 45.6	42.97 ± 2.42	
	Length of Rt. Tibia	34–37.8	36.55 ± 1.77	= 0.5
	Length of Lt. Tibia	34–37.8	36.55 ± 1.87	

*Independent T-test (p<0.05)

Table 2 : Correlation Matrix for length of ACL of both knees, Length of Femur and Tibia of Right and Left side

		ACL Tot Length Rt. Knee	ACL Tot Length Lt. Knee	Length of Rt. Femur	Length of Lt. Femur	Length of Rt. Tibia	Length of Lt. Tibia
ACL Tot Length Rt. Knee	Pearson’s Correlation Coefficient	1					
	Sign(2-tailed)	-					
ACL Tot Length Lt. Knee	Pearson’s Correlation Coefficient	0.376	1				



	Sign(2-tailed)	0.282	-				
Length of Rt. Femur	Pearson's Correlation Coefficient	0.037	-	1			
	Sign(2-tailed)	0.943	-	-			
Length of Lt. Femur	Pearson's Correlation Coefficient	-	-0.279	-	1		
	Sign(2-tailed)	-	0.492	-	-		
	Pearson's Correlation Coefficient	-0.028	-	-	-	1	
	Sign(2-tailed)	0.936	-	-	-	-	
	Pearson's Correlation Coefficient	-	-0.208	-	-	-	1
	Sign(2-tailed)	-	0.567	-	-	-	-
**.Correlation is significant at the 0.01 level (2-tailed).							
*.Correlation is significant at the 0.05 level (2-tailed).							

Result

The Mean \pm Standard deviation of the total length of the ACL in the right and left knees is 29.42 ± 5.48 and 29.78 ± 4.07 , respectively, whereas the min-max ranges are $19.5 - 37.1$ and $22.5 - 34.7$. The parametric distribution of the femur length on the right and left sides of the lower limbs falls between 39 and 45.6, with mean \pm standard deviation of 42.98 ± 2.34 . In contrast, the length of the tibia on both lower limb sides measures 36.55 ± 1.87 , falling between 34 and 37.8, respectively. All parametric distributions show a positive association, however at the $p < 0.05$ threshold of significance, this connection is statistically not significant (Table 1). Our bivariate analysis (Table 2) revealed a substantial association between the total length of the ACL of the right knee and the lengths of the femur and tibia on both sides. connected to the left knee's whole length ACL. The length of the right femur

is insignificantly positively correlated with the total length of the ACL of both knees, while the length of the left femur and the length of both tibia sides are insignificantly correlated with each other.

Discussion

Due to its clinical use in many different domains, ACL has a very long history [22]. Because of surgical techniques, it can occasionally be absent, which is noteworthy. For information on the precise grafting of this ligament, its attachments serve as a diagnostic tool. The current study offers useful information about the ACL, and an attempt has been made to determine the relationship between the tibia and femur.



Table 3 : Comparison of parameters of total length of ACL with previous studies

S. No	Authors	Total Length ACL	
		Right Knee (Mean \pm SD)	Left Knee (Mean \pm SD)
1.	Rajarshi Dutta et al. ²³	20.06 \pm 1.41	20.02 \pm 1.22
2.	Sakkarai Jaya Gandhi et al. ²⁴	32.25 \pm 2.25	32.28 \pm 2.45
3.	AD Sampath et al. ²⁵	28.06 \pm 1.57	28.53 \pm 1.69
4.	Present study	29.42 \pm 5.48	29.78 \pm 4.07

The average total length of the ACL in both knee joints in this study was 29.43 and 29.77, respectively, which was comparable to the study conducted in the Tamilnadu region by AD Sampath et al. [25] Sakkarai Jayagandhi [24] had discovered the same values in the Pondicherry region, although they were higher than those observed in this study. In contrast, Rajarshi Dutta's [23] study in the West Bengal region was often lower than any of the aforementioned investigations (Table 3). While Odenstein et al. [27] reported their parametric mean of ACL was 32, which is somewhat similar with the study by Iriuchishima T et al. [28], Chandrashekhar Naveen et al. [25] showed some similarities with this study and found their mean data as 29.82 in males and 26.85 in females. In the Karnatka region, B.G. Rani Geetha et al. [29] observed a mean of 37.14, which was greater than earlier research.

Conclusion

The current study comes to the conclusion that precise information regarding the ACL's parameters is required for surgical procedures and in the event of agenesis, which directs orthopaedic surgeons to actually restore the ligament during grafting. Additionally, it offers useful information regarding the relationship between the lengths of the tibia and femur on both sides.

Conflicts of Interests: None

References

1. Satoshi Ogata and Hans K. Uthoff. The Development of Synovial Plicae in Human Knee Joints: An Embryologic Study. 1990; 4(6) : 315-321.
2. Gray, D.J., and E. Gardner 1950 Prenatal development of the human knee and superior tibiofibular joints. *Am. J. Anat.*, 86:235–287.
3. O' Rahilly, R. 1952 The development of the synovial joints in the chick. *Anat. Rec.*, 112:303–375.
4. Palacios, J. and M. Rhode. Embriología de la rodilla. In: IV Symposium Internacional de Traumatología Guille'n, P., ed. Fundación Mapfre, Madrid, 1980 : 3–25.
5. Ca'ceres, E., and V.L. Caja. Estudio de las cavidades intraarticulares de la rodilla en los períodos embrionario y fetal humano. *An. Desarr.* 1980 : 56:79–85.
6. Andersen, H. Histochemical studies on the histogenesis of the knee joint and superior tibio-fibular joint in human fetuses. *Acta Anat.* 1961; 46:279–303.
7. Standring S, editor. Gray's anatomy: the anatomical basis of clinical practice. Edinburgh: Elsevier Churchill Livingstone; 2005:1461.
8. Arnoczky SP. Anatomy of the anterior cruciate ligament. *Clin Orthop Relat Res* 1983; (172):19-25.
9. Standring S Gray's Anatomy: The Anatomical Basis of Clinical Practice. 40th edition. Elsevier; Churchill Livingstone. 2008:1401.
10. Butler DL, Noyes FR, Grood ES. Ligamentous restraints to anterior posterior drawer in the human knee. A biomechanical study. *J Bone Joint Surg Am.* 1980 ; 62(2) : 259-70.
11. Kiapour AM, Wordeman SC, Paterno MV, et al. Diagnostic value of knee arthroscopy in the prediction of anterior cruciate ligament strain during landing. *Am J Sports Med* 2013.
12. A. Ferretti, P. Papandrea, F. Conteduca, and P. P. Mariani. Knee ligament injuries in volleyball players. *Am J Sports Med.* 1992; 20(2):203–207.



13. Renstrom P, Ljungqvist A, Arendt E, et al.. Non-contact ACL injuries in female athletes: an International Olympic Committee current concepts statement. *Br J Sports Med.* 2008 ;42(6):394–412.
14. Shen W, Jordan S, Fu F. Review article : Anatomic double bundle anterior cruciate ligament reconstruction. *J Orthop Surg. Hong Kong* 2007.15(2) : 216-221.
15. Chetan SA, Johnson DL. Anatomic revision Anterior Cruciate Ligament reconstruction. *Sports Med Arthrosc.* 2010. 18(1) : 33-39.
16. Schreiber VM, Van Eck CF, Fu FH. Anatomic Double bundle ACL reconstruction. *Sports Med Arthrosc.* 2010 ; 18(1) : 27-32.
17. Johansson E, Aparisi T. Congenital absence of the cruciate ligaments : a case report and review of the literature. *Clin Orthop Relat Res* 1982;162:108–11.
18. Manner HM, Radler C, Ganger R, Grill F. Dysplasia of the cruciate ligaments: radiographic assessment and classification. *J Bone Joint Surg Am* 2006;88:130–7.
19. Berruto M, Gala L, Usellini E, Duci D, Marelli B. Congenital absence of the cruciate ligaments. *Knee Surg Sports Traumatol Arthrosc* 2012 ; 20 : 1622–5.
20. Abhinav Kumar Mishra et al. Comparative study between total length of Anterior Cruciate Ligament on both knees and correlates it with length of femur & tibia and its clinical application : A cadaveric study. 2022. 20 (8) : 3133-3139.
21. M.G. Antea et al. Long Bone (Humerus, Femur, Tibia) Measuring Procedures in Cadavers. *J Forensic Sci.* 2014. 5(9) : 1325-1329.
22. Strouhal E, Vachala B, Vymazalová H. The medicine of the ancient Egyptians. The American University in Cairo Press. 2014 : 30.
23. Rajarshi Dutta et al. Morphometric study of Cruciate ligaments of Knee joints: A cadaveric study in Eastern Indian population. *Indian Journal of Basic and Applied Medical Research*; 2017. 7(1) : 26-35.
24. Sakkarai Jayagandhi et al. The Morphometric Study of Anterior Cruciate Ligament: A Cadaveric Study. *Int J Anat Res* 2018, Vol 6(3.2) : 5581-86.
25. A. D. Sampath Kumar and M.R. Manimekalai. Cadaveric Study of Morphometric Analysis of Anterior Cruciate Ligament and its Significance. *International Journal Of Orthopaedics Traumatology & Surgical Sciences.* 2019. 5(1) : 232-235.
26. Naveen Chandrashekar et al. Sex-Based Differences in the Anthropometric Characteristics of the Anterior Cruciate Ligament and Its Relation to Intercondylar Notch Geometry. *The American Journal of Sports Medicine.* 2005 : 33(10) ; 1492-97.
27. Odensten M, Gillquist J. Functional anatomy of the anterior cruciate ligament and a rationale for reconstruction. *The Journal of bone and joint surgery.* 1985 : 67(2) ; 257-62.
28. Iriuchishima T et al. Size comparison of ACL footprint and reconstructed autograft. *Knee Surg Sports Traumatol Arthrosc.* 2013 : 21(4) ; 797-803.
29. Geetha Rani B.G. Morphometric Analysis of Cruciate Ligaments. *Int J Anat Res* 2019: 7(4.3) ;7149-54.