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Anatomical Examination of The Ligamentum Cruciatum Posterior in Human Fetus

İnsan Fetuslarinda Ligamentum Cruciatum Posterior'un Anatomik İncelemesi

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ABSTRACT

Objective: The aim of this study is to determine the presence, differentiation and morphological features of the anterolateral band (ALB) and posteromedial bands (PMB) of the ligamentum cruciatum posterior (PCL) in human fetuses and to map PCL.

Materials and Methods: The study was carried out on 40 fetal knees with gestational ages ranging from 13 to 25 weeks of gestation without any external pathology or anomaly. ALB and PMB distinction was made when the knees were in full flexion position, and morphometric measurements of origo and insertio, mid width and length of PCL, ALB and PMB were made. Data were analyzed with both descriptive and quantitative statistical methods.

Results: When the right and left side parameters were evaluated in all fetuses in the measurements of ALB, it was determined that there was a significant difference in the proximal width measurement of ALB ($p<0.05$). There was a strong correlation between right and left sides of PCL, distal width ($r=0.668$; $p=0.001$), proximal width ($r=0.849$; $p<0.001$) and length measurements ($r=0.795$; $p<0.001$). A strong correlation was found between the right and left sides and the proximal width of the ALB ($r=0.758$; $p<0.001$), midpoint width ($r=0.832$; $p<0.001$) and length ($r=0.691$; $p=0.001$) measurements ($p=0.001$). In addition, a strong correlation was found between the measurements of the proximal width ($r=0.645$; $p=0.005$) and length ($r=0.675$; $p=0.001$) of the PMB between the right and left sides.

Conclusion: A broad mapping was obtained about the characteristics of PCL and its bands in the fetal period.

Keywords: Ligamentum Cruciatum Posterior, Anterolateral Band, Posteromedial Band, Knee Joint, Fetus

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ÖZET

Amaç: Bu çalışmanın amacı insan fetüslerinde ligamentum cruciatum posterior (PCL) anterolateral bant (ALB) ve posteromedial bantlarının (PMB) varlığını, ayrımını ve morfolojik özelliklerini belirlemek ve PCL'nin haritalamasını yapmaktır.

Materyal ve Yöntemler: Çalışma gestasyonel yaşları 13-25 gebelik haftası arasında değişen, harici patolojisi ve anomalisi olmayan 40 fetal diz üzerinde gerçekleştirildi. Dizler tam fleksiyon pozisyonunda iken ALB ve PMB ayrımı yapılarak; PCL, ALB ve PMB'ın origo ve insertioları, orta genişlikleri ve uzunluklarının morfometrik ölçümleri yapıldı. Veriler hem tanımlayıcı hem de nicel istatistiksel yöntemlerle analiz edildi.

Bulgular: ALB'ye ait ölçümlerde sağ ve sol taraf parametreleri tüm fetüslerde değerlendirildiğinde ALB'nin proksimal genişlik ölçümünde anlamlı farklılık olduğu belirlendi ($p<0.05$). PCL'nin sağ ve sol taraflar arasında; distal genişlik ($r=0,668$; $p=0,001$), proksimal genişlik ($r=0,849$; $p<0.001$) ve uzunluk ölçümleri ($r=0,795$; $p<0.001$) arasında güçlü bir korelasyon saptandı. Sağ ve sol taraflar arasında, ALB'nin proksimal genişliği ($r=0,758$; $p<0,001$), orta nokta genişliği ($r=0,832$; $p<0,001$) ve uzunluk ($r=0,691$; $p=0,001$) dahil tüm ALB ölçümleri arasında güçlü bir korelasyon bulundu ($p=0,001$). Ayrıca sağ ve sol taraflar arasında PMB'nin proksimal genişliği ($r=0,645$; $p=0,005$) ve uzunluk ($r=0,675$; $p=0,001$) ölçümleri arasında güçlü bir korelasyon saptandı.

Sonuç: Fetal dönemde PCL'nin ve bantlarının özellikleri hakkında geniş bir haritalama elde edilmiştir.

Anahtar Kelimeler: Ligamentum Cruciatum Posterior, Anterolateral Band, Posteromedial Band, Diz Eklemi, Fetus

1. Introduction

The ligamentum cruciatum posterior (PCL) originates from the area intercondylaris posterior in the tibia and posterior horn of the meniscus lateralis, and extends and attaches to the anterior part of the outer surface of the medial condylus in the femur [1–4]. PCL is the structure that stabilizes the femur, especially when weight is placed on the flexed knee (climbing stairs, going uphill). Its primary function is to resist the posterior translation of the tibia on the femur, and its secondary role is to limit external varus and valgus rotations [1]. It prevents excessive flexion of the knee [5]. The PCL consists of two independent bundles that function in a common relationship to fulfill its role in providing resistance to posterior tibial translation relative to the femur. These bundles are named as anterolateral band (ALB) and posteromedial band (PMB) according to the attachment site in the femur. ALB has a more vertical orientation compared to PMB [6]. ALB is stretched in flexion, while PMB is stretched in extension. In addition, ALB has a relatively larger role in restricting translation throughout flexion, while PMB resists internal rotation at flexion angles greater than 90 degrees [7].

PCL injuries are relatively rare, especially in the pediatric population. However, due to their asymptomatic nature, PCL tears may be more common than previously thought [8]. Today, isolated PCL injuries account for 3% to 16% of all knee injuries [9]. 45% of these injuries are caused by traffic accidents and 40% by sportive activities. Football and ski sports have the highest incidence of sports injuries [10]. The most common isolated injury mechanisms are PCL injuries that develop after direct posterior displacement of the tibia in a 90° flexed knee. 84-95% of the loads in this position are met by the PCL. Rarely, PCL ruptures caused by excessive hyperflexion loads have been reported [11].

PCL, one of the primary ligaments forming the knee central complex, has been studied in detail recently. Most studies of PCL have been conducted in adults and mostly involve the elderly due to the availability of anatomical samples [11-16]. Therefore, information on the anatomy of PCL in young patients is limited, and there is little data, particularly on the fetal presence of the ALB and PMB parts of PCL [17,18]. Obtaining the normal values of the parameters related to the fetus in fetal development according to the gestational age is of great importance. Each community determines its own normal values for its populations, thus obtaining the fetal growth curve.

In the light of this information, the main purpose of the study is to evaluate PCL from the fetal period and to determine the detailed morphological features of PMB and ALB.

2. Material and Method

This study was approved by the local ethics committee (decision number: 2015/195) and all study procedures were performed in September-December 2015 in accordance with the requirements of the Declaration of Helsinki. This study was conducted on the 40 knees of a total of 20 aborted fetuses, 11 (55%) male and 9 (45%) female, with no external pathology or anomaly, aged between 13-25 weeks of gestation (assuming the fertilization time to start) in the fetus collection created in the Necmettin Erbakan University Anatomy Department. Fetuses were fixed in 10% formalin solution by immersion method.

In the study, dissections of the bilateral knee regions of all fetuses were performed in such a way that the places to be measured were clearly visible. The widths and lengths of the origo (attachments in the femur) and insertio (attachments in the tibia) of the ALB and PMB parts of the PCL were measured using microdissection instruments, 0.01mm precision digital caliper (Stainless hardened), surgical microscope (Karl Kaps SOM 62, Germany), measurement module and photographs were taken using the camera (Canon D1000) (Figure 1-3).

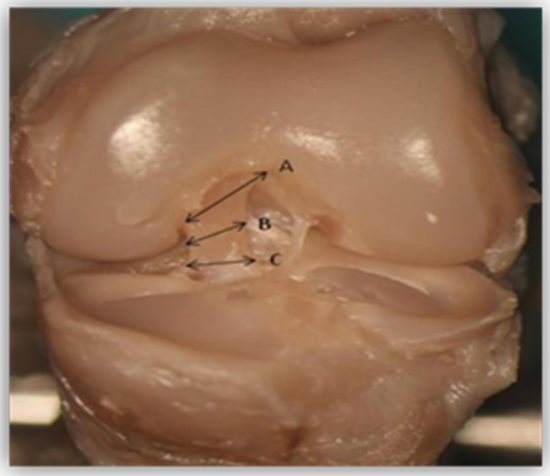

Figure 1. Proximal, midpoint and distal width measurements of the left posterior cruciate ligament on a 14-week old male fetus. (A: Proximal width of the PCL, B: Midpoint width of the PCL, C: Distal width of the PCL)

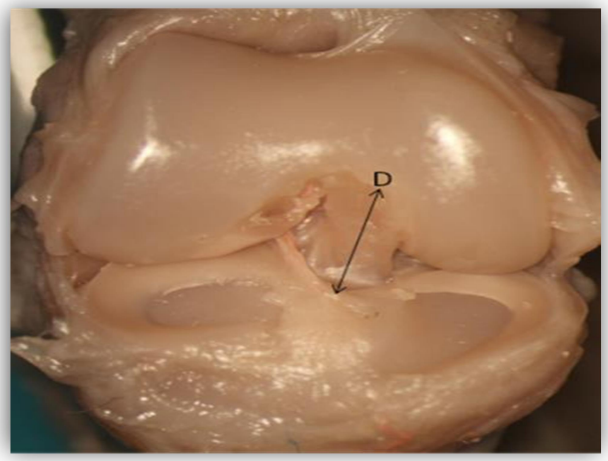

Figure 2. Length measurements of the right posterior cruciate ligament on a 14-week old male fetus. (D: PCL length).

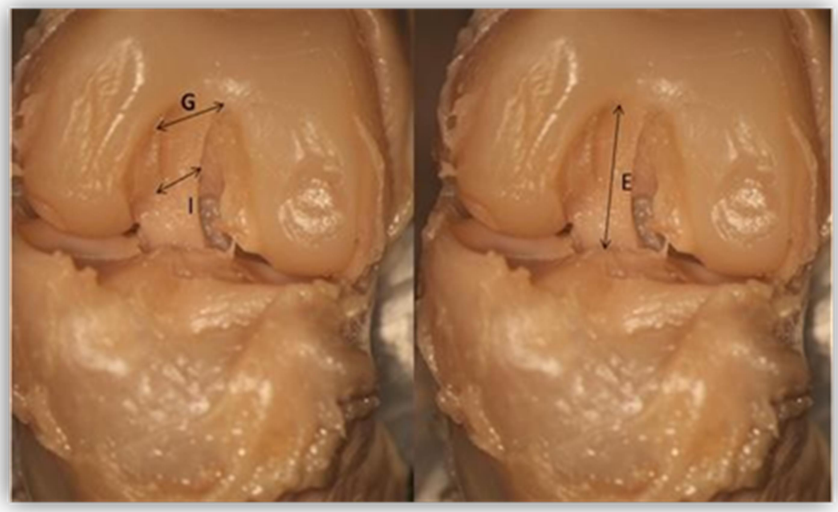

Figure 3. Proximal width (G), midpoint width (I) and length (E) of the ALB on a 22-week old male fetus. (G: Proximal width of the ALB, I: Midpoint width of the ALB, E: ALB length

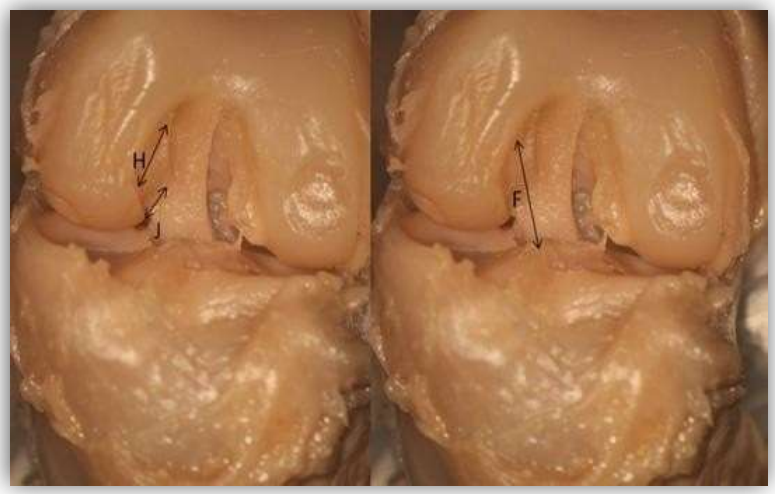

Figure 4. Proximal width (H), midpoint width (J) and length (F) of the PMB on a 22-week old male fetüs.
(H: Proximal width of the PMB, J: Midpoint width of the PMB, F: PMB length)

In order to minimize the error that may occur in the measurements, PCL measurements were made by the same person and the averages of the obtained data were taken. The arithmetic mean and standard deviations of the parameters in the second trimester were determined by using the SPSS 21.0 statistical program (IBM-Statistics software, USA) with the help of the data obtained from the fetuses. Student-t test was used to compare parametric data between genders and parties. Significance level was accepted as $p<0.05$. The reference intervals determined by the correlation coefficient Cohen(1988), were taken. The direction of correlation was determined as negative and positive, and the correlation coefficient was defined as low between r=0.10-0.29, moderate between r=0.30-0.49, and high between r=0.50-1 [19].

3. Results

In our study, the proximal widths of PCL, ALB and PMB were measured as 2.75±0.95mm, 1.70±0.52mm, 1.52±1.13mm on the right side and 2.94±0.79mm, 1.88±0.48mm, 1.50±0.68mm on the left side on average. The mean point widths of PCL, ALB and PMB on the right side were measured on average as 1.57±0.76mm, 0.98±0.32mm, 1.01±0.32mm and 1.56±0.40mm, 0.98±0.32mm and 0.90±0.25mm on the left side, respectively. The mean lengths of PCL, ALB and PMB were measured as 5.13±1.46mm, 4.90±1.30mm, 4.70±1.38mm on the right side and 5.19±1.53mm, 5.32±1.48mm and 4.83±1.50mm on the left side, respectively (Table 1)

Table 1: According to all and gender fetus maximum (max), minimum (min), mean values and standard deviations (Mean±SD) of parameters (mm).

	All fetuses				Male				Female				p
P	n	Min	Max	Mean±SD	n	Max.	Min.	Mean±SD	n	Max.	Min.	Mean±SD	
rPCLpw	40	1.29	5.52	2.75±0.95	22	5.52	1.29	2.74±1.14	18	3.82	1.55	2.76±0.71	0.095
lPCLpw	40	1.75	4.64	2.94±0.79	22	4.64	1.97	3.03±0.91	18	3.82	1.75	2.84±0.66	0.006
rPCLmw	40	0.72	4.35	1.57±0.76	22	4.35	1.02	1.69±0.96	18	1.95	0.72	1.43±0.40	0.044
lPCLmw	40	0.96	2.31	1.56±0.40	22	2.31	1.02	1.60±0.45	18	2.09	0.96	1.51±0.35	0.064
rPCLdw	40	0.83	2.94	1.58±0.51	22	2.94	1.04	1.60±0.56	18	2.15	0.83	1.56±0.46	0.083
lPCLdw	40	0.97	5.12	1.84±0.88	22	2.49	1.15	1.71±0.50	18	5.12	0.97	2.00±1.22	0.053
rPCLl	40	2.48	7.64	5.13±1.46	22	7.35	2.96	5.32±1.50	18	7.64	2.48	4.91±1.46	0.054
lPCLl	40	2.07	9.21	5.19±1.53	22	7.67	2.97	5.25±1.25	18	9.21	2.07	5.11±1.89	0.085
rALBpw	34	0.74	2.73	1.70±0.52	18	2.41	0.74	1.54±0.57	16	2.73	1.3	1.87±0.43	0.019
lALBpw	34	1.1	2.73	1.88±0.48	18	2.65	1.1	1.80±0.54	16	2.73	1.37	1.97±0.43	0.047
rALBmw	34	0.58	1.66	0.98±0.32	18	1.66	0.67	1.05±0.37	16	1.23	0.58	0.90±0.25	0.035
lALBmw	34	0.61	1.54	0.92±0.24	18	1.54	0.67	0.99±0.29	16	1.14	0.61	0.85±0.15	0.021
rALBl	40	2.5	7.99	4.90±1.30	22	7.99	3.16	4.94±1.48	18	5.91	2.5	4.87±1.14	0.009
lALBl	40	3	9.7	5.32±1.48	22	7.76	3	5.25±1.32	18	9.7	3.54	5.41±1.74	0.082
rPMBpw	34	0.76	5.52	1.52±1.13	18	5.52	0.76	1.79±1.47	16	2.3	0.8	1.22±0.52	0.003
lPMBpw	34	0.76	3.03	1.50±0.68	18	3.03	0.76	1.67±0.77	16	2.12	0.83	1.30±0.53	0.026
rPMBmw	32	0.48	1.71	1.01±0.32	16	1.71	0.48	1.10±0.37	16	1.34	0.53	0.91±0.26	0.025
lPMBmw	32	0.48	1.34	0.90±0.25	16	1.3	0.48	0.89±0.24	16	1.34	0.53	0.91±0.27	0.088
rPMBl	40	2.48	7.86	4.70±1.38	22	7.86	2.62	4.79±1.60	18	6.21	2.48	4.59±1.15	0.074
lPMBl	40	2.95	9.51	4.83±1.50	22	7.52	2.95	4.72±1.22	18	9.51	3.2	4.97±1.86	0.073

(n: total number of knees, min.: Minimum, max. Maximum:, Mean±SD: mean±standard deviation, (rPCLpw: right posterior cruciate ligamentof proximal width, lPCLpw:left posterior cruciate ligament of proximal width, rPCLdw: right posterior cruciate ligament of distal width, lPCLdw:left posterior cruciate ligament of distal width, rPCLmw:right posterior cruciate ligament of midpoint width, lPCLmw: left posterior cruciate ligament of midpoint width, rPCLl:right posterior cruciate ligament of length, lPCLl: left posterior cruciate ligament of length, rALBpw: right anterolateral band of proximal width, lALBpw:left anterolateral band of proximal width, rALBmw: right anterolateral band of midpoint width, lALBmw: left anterolateral band of midpoint width, rALBl:right anterolateral band of length, lALBl:left anterolateral band of length, rPMBpw: right posteromedial band of proximal width, lPMBpw: left posteromedial band of proximal width, rPMBmw: right posteromedial band of midpoint width, lPMBmw: left posteromedial band of midpoint width, rPMBl: right posteromedial band of lenght, lPMBl: left posteromedial band of lenght, ($p<0.05$))

The means and standard deviations of the measurements were determined. When comparing the length and width parameters of PCL, ALB and PMB, there was no statistically significant difference between the genders (p>0.05) (Table 1).

When the right and left side parameters of PCL and PMB measurements were compared in all fetuses, there was no statistically significant difference between the sides, but when the right and left side parameters were evaluated in all fetuses in ALB measurements, there was a significant difference in the proximal width measurement of ALB (p>0.05) (Table 2).

When the right and left side parameters of PCL, PMB and ALB measurements were compared separately in female and male fetuses, no statistically significant difference was found between the parties (p<0.05) (Table 2)

Table 2. P values of parameters on the left, right sides and without sex discrimination.

Parameters	All fetuses	Male	Female
rPCLpw - lPCLpw	0.106	0.144	0.540
rPCLdw - lPCLdw	0.921	0.679	0.573
rPCLmw - lPCLmw	0.165	0.382	0.272
rPCLl - lPCLl	0.797	0.803	0.598
rALBpw - lALBpw	**0.046**	0.131	0.113
rALBmw - lALBmw	0.211	0.395	0.403
rALBl - lALBl	0.107	0.192	0.301
rPMBpw - lPMBpw	0.915	0.777	0.330
rPMBmw - lPMBmw	0.151	0.138	0.975
rPMBl - lPMBl	0.628	0.771	0.468

(rPCLpw: right posterior cruciate ligament of proximal width, lPCLpw:left posterior cruciate ligament of proximal width, rPCLdw: right posterior cruciate ligament of distal width, lPCLdw:left posterior cruciate ligament of distal width, rPCLmw:right posterior cruciate ligament of midpoint width, lPCLmw: left posterior cruciate ligament of midpoint width, rPCLl:right posterior cruciate ligament of length, lPCLl: left posterior cruciate ligament of length, rALBpw: right anterolateral band of proximal width, lALBpw:left anterolateral band of proximal width, rALBmw: right anterolateral band of midpoint width, lALBmw: left anterolateral band of midpoint width, rALBl:right anterolateral band of length, lALBl:left anterolateral band of length, rPMBpw: right posteromedial band of proximal width, lPMBpw: left posteromedial band of proximal width, rPMBmw: right posteromedial band of midpoint width, lPMBmw: left posteromedial band of midpoint width, rPMBl: right posteromedial band of lenght, lPMBl: left posteromedial band of lenght)

A strong correlation was found between distal width (r=0.668; p=0.001), proximal width (r=0.849; p<0.001) and length measurements (r=0.795; p<0.001) for the right and left sides of the PLC. A weak correlation was found between the right and left sides in terms of midpoint width measurements of PCL(r=0.454; p=0.044) (Table 3).

A strong correlation (p<0.001) was found between proximal width (r=0.758; p<0.001), midpoint width (r=0.832; p<0.001) and length measurements (r=0.691; p=0.001) of ALB in all measurements of ALB for right and left sides (Table 3). In addition, a strong correlation was found between the measurementsof the proximal width (r=0.645; p=0.005) and length (r=0.675; p=0.001) of the PMB for the right and left sides (Table 3).

Table 3. Correlation between all parameters.

		rPCLpw	lsPCLpw	rPCLdw	lPCLdw	rPCLmw	lPCLmw	rPCLu	LPCLu	rALBpw	lALBpw	rALBmw	lALBmw	rALBu	lALBu	rPMBpw	lPMBpw	rPMBmw	lPMBmw	rPMBu	lPMBu
lPMBu	r	0.431	0.594**	0.245	0.535*	0.497*	-0.030	0.760**	0.923**	0.298	0,445	0,439	0,400	0,583**	0,950**	0,327	0,557*	0,335	0,247	0,675**	1
	P	0.058	0.006	0.298	0.015	0.026	0.901	0.000	0.000	0.245	0.073	0,078	0,111	0,007	0,000	0,200	0,020	0,205	0,356	0,001	
rPMBu	r	0,811**	0,846**	0,586**	0,560*	0,743**	0,459*	0,896**	0,637**	0,243	0,581*	0,683**	0,542*	0,892**	0,747**	0,591*	0,727**	0,491	0,412	1	
	P	0,000	0,000	0,007	0,010	0,000	0,042	0,000	0,003	0,347	0,015	0,003	0,025	0,000	0,000	0,013	0,001	0,053	0,112		
lPMBmw	r	0,489	0,503*	0,385	0,390	0,652**	0,400	0,428	0,307	0,482	0,574*	0,595*	0,401	0,593*	0,446	0,219	0,337	0,574*	1		
	P	0,055	0,047	0,141	0,135	0,006	0,124	0,098	0,247	0,059	0,020	0,015	0,124	0,016	0,083	0,414	0,201	0,020			
rPMBmw	r	0,625**	0,629**	0,669**	0,647**	0,782**	0,287	0,559*	0,412	-0,082	0,376	0,583*	0,611*	0,460	0,501*	0,696**	0,529*	1			
	P	0,010	0,009	0,005	0,007	0,000	0,280	0,024	0,113	0,764	0,151	0,018	0,012	0,073	0,048	0,003	0,035				
lPMBpw	r	0,526*	0,748**	0,534*	0,651**	0,489*	0,160	0,867**	0,564*	0,211	0,463	0,672**	0,739**	0,572*	0,636**	0,645**	1				
	P	0,030	0,001	0,027	0,005	0,046	0,538	0,000	0,018	0,417	0,061	0,003	0,001	0,016	0,006	0,005					
rPMBpw	r	0,797**	0,675**	0,902**	0,702**	0,766**	0,179	0,629**	0,362	-0,260	0,233	0,606**	0,508*	0,437	0,425	1					
	P	0,000	0,003	0,000	0,002	0,000	0,493	0,007	0,153	0,313	0,369	0,010	0,037	0,080	0,089						
lALBl	r	0,570**	0,709**	0,358	0,566**	0,634**	0,116	0,833**	0,921**	0,309	0,547*	0,590*	0,464	0,691**	1						
	P	0,009	0,000	0,121	0,009	0,003	0,627	0,000	0,000	0,228	0,023	0,013	0,061	0,001							
rALBl	r	0,795**	0,857**	0,530*	0,396	0,756**	0,338	0,860**	0,641**	0,353	0,711**	0,660**	0,419	1							
	P	0,000	0,000	0,016	0,084	0,000	0,145	0,000	0,002	0,164	0,001	0,004	0,094								
lALBmw	r	0,326	0,521*	0,555*	0,624**	0,473	0,260	0,651**	0,367	0,265	0,489*	0,832**	1								
	P	0,202	0,032	0,021	0,007	0,055	0,313	0,005	0,147	0,304	0,046	0,000									
rALBmw	r	0,593*	0,673**	0,717**	0,643**	0,744**	0,390	0,681**	0,427	0,220	0,563*	1									
	P	0,012	0,003	0,001	0,005	0,001	0,122	0,003	0,088	0,395	0,019										
lALBpw	r	0,486*	0,686**	0,359	0,442	0,540*	0,148	0,670**	0,527*	0,758**	1										
	P	0,048	0,002	0,156	0,075	0,025	0,571	0,003	0,030	0,000											
rALBpw	r	0,038	0,214	-0,122	0,264	0,113	0,108	0,326	0,326	1											
	P	0,884	0,409	0,640	0,305	0,665	0,681	0,201	0,202												
lPCLl	r	0,490*	0,654**	0,271	0,544*	0,522*	-0,211	0,795**	1												
	P	0,028	0,002	0,248	0,013	0,018	0,372	0,000													
rPCLl	r	0,755**	0,861**	0,551*	0,568**	0,709**	0,234	1													
	P	0,000	0,000	0,012	0,009	0,000	0,320														
lPCLmw	r	0,417	0,255	0,367	0,245	0,454*	1														
	P	0,067	0,278	0,112	0,299	0,044															
rPCLmw	r	0,911**	0,814**	0,871**	0,675**	1															
	P	0,000	0,000	0,000	0,001																
lPCLdw	r	0,573**	0,565**	0,668**	1																
	P	0,008	0,009	0,001																	
rPCLdw	r	0,838**	0,716**	1																	
	P	0,000	0,000																		
lPCLpw	r	0,849**	1																		
	P	0,000																			
rPCLpw	r	1																			
	p																				

(rPCLpw: right posterior cruciate ligament of proximal width, lPCLpw:left posterior cruciate ligament of proximal width, rPCLdw: right posterior cruciate ligament of distal width, lPCLdw:left posterior cruciate ligament of distal width, rPCLmw:right posterior cruciate ligament of midpoint width, lPCLmw: left posterior cruciate ligament of midpoint width, rPCLl:right posterior cruciate ligament of length, lPCLl: left posterior cruciate ligament of length, rALBpw: right anterolateral band of proximal width, lALBpw:left anterolateral band of proximal width, rALBmw: right anterolateral band of midpoint width, lALBmw: left anterolateral band of midpoint width, rALBl:right anterolateral band of length, lALBl:left anterolateral band of length, rPMBpw: right posteromedial band of proximal width, lPMBpw: left posteromedial band of proximal width, rPMBmw: right posteromedial band of midpoint width, lPMBmw: left posteromedial band of midpoint width, rPMBl: right posteromedial band of lenght, lPMBl: left posteromedial band of lenght, *: Correlation is significant at the 0.05 level (2-tailed), **: Correlation is significant at the 0.01 level (2-tailed)).

4. Discussion and Conclusion

In recent years, studies on PCL in adults have taken a large place in the literature. It was observed thatmostly in adult cadaver studies, the femoral and tibial adhesion areas, the relationship of ALB and PMBto the surrounding structures, and the biomechanics of PCL were examined. However, within the framework of different approaches to PCL reconstruction, studies have been conducted on cadavers and patients with the help of preoperative and intraoperative radiological devices (4,20–26). At the same time, there are many cases of ACL ruptures in adults and children, isolated or with PCL, in the literature. Isolated PCL ruptures are extremely rare. PCL ruptures in adults are in the form of rupture of the bundle at the midline with a rate of 22%, while the remainder are avulsions from the bone. In children, midline rupture is rare and injuries are usually osteochondral or cartilaginous avulsion causing laxity. Even physical tests (eg, posterior drawer test) are often negative [27,28]. While the method of reconstruction in surgery gives rapid and positive results, it is controversial because it can damage growth plates in children [29].

While Ugutmen et al (2006) reported a case of pediatric PCL in the form of tibial avulsion, they recommend open surgery and screwing technique in such cases [30]. Sorensen et al (2017) consider single-bundle sparing surgery for symptomatic PCL in 6 children with a mean age of 9 years [31]. In another study examining cases of midline PCL tears in 3 children, they recommended iliotibial band-derived surgery [32].

Literature studies generally suggest that intact PCL is a general determinant of ACL graft size. Therefore, although isolated injury is rare, the size of an intact ligament has an importance in determining the graft size for frequently injured ACL. In the imaging study performed on 758 children aged 5-18 years, Heath et al. (2022) formulated that the thickness of the ACL in the coronal plane was 0.16 times and plus 6.23 (mm) of the thickness of the PCL in the coronal plane, and the thickness in the sagittal plane was 0.53 times and plus 5.85 (mm) of the thickness of the PCL in the same plane. They also calculated that the ACL/PCL height ratio increased with age [33]. In their study, Kim et al (2021) examined the relationship between PCL and ACL dimensions in 400 children aged 13-18 years. They found a positive correlation between ACL/PCL lengths, midline thicknesses, and insertion thicknesses.Ligament thicknesses and lengths increased with age [34]. Studies have linked the development of PCL dimensions to age during skeletal development [35]. In spite of the limitation of the fetal group used in our study to the second trimester, it was found that the width and length of the anterolateral and posteromedial bands of PCL at different points and PCL increased in direct proportion to age.

Knowing the developmental stages of PCL is important in terms of reconstruction surgeries in isolated injuries of PCL. In pediatric cases, surgeons can achieve maximum clinical results with minimum damage by knowing the average size of the bundles of this complex structure. In addition, the literature has suggested that PCL dimensions are a model for ACL grafts. In the growing knowledge of anatomy regarding the function of the knee joint, there are limited studies of PCL in the fetal period. For this reason, we think that it would be useful to know the developmental stages of PCL, especially in immature knees. Since our study is a rare study that examines the development of PCL from the mother's womb and detailed morphometric measurements of PCL during the fetal period are made, we think that it mayshed light on future studies in this area.

As a result, the findings of our study will provide a better understanding of the anatomy of the PCL from the fetal period to adulthood. It will also contribute to increasing the success of future pediatric PCL reconstructions and minimizing iatrogenic risks by emphasizing the characterization of PCL.

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Conflict of Interest: There is no conflict of interest between the authors.

Declaration of Ethical Code

In this study, we undertake that all the rules required to be followed within the scope of the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with, and that none of the actions stated under the heading "Actions Against Scientific Research and Publication Ethics" are not carried out.

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