Original Research Paper

Anatomy

EVALUATION OF MORPHOMETRIC PARAMETERS OF POSTERIOR CRUCIATE LIGAMENT AN MRI BASED STUDY.

Jain Ravi	Associate Professor, R.D. Gardi Medical College, Ujjain, M.P.
Chaturvedi Manish	Associate Professor, Designate, G.R.Medical College, Gwalior, M.P.
Parmar Narayan	Associate Professor, Amaltas Institute of Medical Science, Dewas, M.P.
Chouhan Vijay*	Assistant Professor, Government Medical College, Ratlam, M.P. *Corresponding Author

ABSTRACT **Aim of the Study:** To study the morphometric parameters of posterior cruciate ligament with respect to age, gender, side. **Method:** This study was carried out at 600 bedded private tertiary care teaching hospital Chandrikaben Rashmikan tGardi hospital and Ruxmaniben Deepchand Gardi Medical College Ujjain, Madhy Pradesh, India. Total 100 patients include in this retrospective study. Patient's data collected at minimum, a sagittal and coronal intermediate – or T2- weighted series that adequately depicted the posterior cruciate ligament (PCL).MRI machine used is of 1.5 tesla sigma HDE GEHC. The measurement of parameters is done by mechanical calculation. **Result:** The PCL length is significantly more in males as compare to females and there is significant difference between male (SD-3.43) and female(SD-3.99)length(p-0.046). The mean PCL length is 36.8mm and that of female is 35.2. The PCL width is significantly more in males(SD-1.24) as compare to females(SD-1.31)and there is significant difference between male and female (p-0.026)width. The mean PCL width in male is 6.9mm and that of female is 6.3mm. The PCL length is significantly more in left (SD-3.23) as compare to right (SD-3.99) (p-0.078). The PCL width is significantly more in left (SD-1.26) as compare to right (SD-1.28)(p-0.035). **Conclusion:** To conclude with the topic that Magnetic resonance imaging (MRI) findings of normal Posterior cruciate ligament (PCL) alignment and morphology in the knees of adults are documented in our research.The purpose of our study would be cross-sectional compile normative data on the PCL in young adults and elderly people.

INTRODUCTION:

Although the human knee joint may look like a simple joint but it is one of the most complex. However the knee is more likely to be injured than is any other joint in body. We tend to ignore our knee until something happens to them that causes pain. As the saying goes "one ounce of prevention is worth a pound cure". When the knee moves, it does not just bent and straighten, or medically termed flexion and extension but there is slight rotational component in this motion. These components recognized within last fifty years, which may be part of reason people have so many injuries. An internet based literature review using the catalog of national library of medicine for the keyword "Cruciate ligament" results in more than thousands of hits, thus reflecting high importance of basic and clinical research.As cruciate ligament injury is now one of the most common injuries found in general population specially in sports person and with the evolution of more advance orthopedic surgeries it is paramount important to learn normal anatomical parameters of the ligaments. The best tool for the dimensional study of posterior cruciate ligament is the MRI.As not many studies were conducted on PCL parameter using MRI in Indian Population we prefer to study in our institution. Magnetic resonance imaging (MRI) findings of normal posterior cruciate ligament (PCL) alignment and morphology in the knees of adults are documented[1, 2]. This difference may affect the reliability of using alterations in the normal anatomy described in adults such as bulking of PCL as a secondary sign of anterior cruciate ligament disruption, for evaluate the knees of children. The PCL plays important and integral role in knee joint stability. PCL primary restraint to posterior translocation of the proximal tibia and is a secondary restraint to varus, valgus and external rotation force. The PCL has shown higher tensile strength than the anterior cruciate ligament although exact measurement is debated[3]. The PCL named so because it's posterior insertion on tibia[4, 5]. The PCL was found to have a wide variation in shape and size of its femoral attachments, whereas the tibial attachment pattern was consistent[6].

Moorman et alin human cadaveric knee dissections find that thoseligamentfibers inserting along PCL fossa compose the majority of ligament, and those fibers that attach along the posterior cortex are less than 0.5mm thick[7]. They measured the anterior edge of the PCL to be 15.6 ± 1.1mm anterior to the posterior tibial cortex. Takahashiet al indicated the location of anterior lateral bundle insertion was virtually on the articular surface in the PCL fossa, whereas the posterior medial bundle insertion is around 4.6mm distal from articular surface[8]. Girgis et al inhuman cadaveric fresh knee dissections that the PCL averaged 38mmin length[9]. The PCL is thinnest at midsubstance averaging 11mm. in addition the cross sectional area of PCL is tapering from 32mm from its femoral origin to 13.4mm at the tibial insertion[10].

Approval of institutional Ethical committee:
The research protocol was approved by institutional ethics committee

METHOD:
This is a retrospective study. Data from picture archiving and communication systems (PACS) computer records of all patients who will undergo knee MR imaging examinations will be extracted.The study was carried for 1.5 years after permission of Institutional ethical committee on 100 patient's data.MRI sequences used in the study included 1) T1 and T2 sequences in sagittal plane 2) Axial T2 sequence 3) Coronal T1 sequence 4) STIR sequence in Sag and Coronal views.

All examinations included, at minimum, the following sequences performed at 1.5 tesla sigma HDE GEHC: sagittal and coronal intermediate- or T2-weighted fast spin-echo or turbo spin-echo sequences (2500 – 4500/17–34 [repetition time{TR}msec/echo time{TE} msec] and/or 2500 – 4500/68 –102 [effective], echo train length of six to eight, two signals acquired), conventional spin-echo intermediate- and T2-weighted sequences (2000 –3000/12–15 and 2000 –3000/64 – 80, one signal acquired), or a fast inversion recovery sequence (3500 – 4500/34/155 [repetition time msec/echo time msec/inversion time msec], echo train length of six to eight, two signals acquired). For all sequences, the section thickness

was 3–5 mm with an intersection gap of 0.5–1.5 mm and a matrix of (256 –512) _ (192–256) was used, depending on the patient's size. Sagittal and coronal sequences were prescribed from an axial sequence.

Inclusion criteria: Patient age ranged more than 20.

Exclusion Criteria:
Patients with history of complete disruption of the PCL, previous reparative surgery, distal femoral or proximal tibial fractures, congenital structural anomalies, developmental delay, non–weight-bearing states, syndromes, a femoral-tibial angle larger than 5° of hyperextension or larger than 15° of flexion will also be excluded

The 100 examinations were performed in which 31 knees of female patients and in 69 knees of male patients. Among 100% cases 50% belongs to age group 21-30 years, 25% belongs to 31-40 years age group, 14% belongs to 41-50 years age group, 11% belongs to >50 years age group. As we had retrospectively taken the data of patient we have taken either side of the knee whose data is available after excluding the exclusion criteria. The right knee frequency is 49% and the left knee frequency is 51% of total.
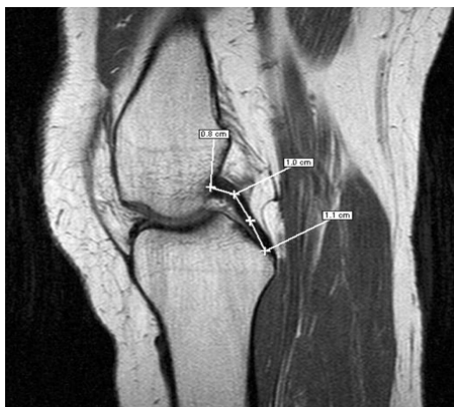

Figure-01 Diagram showing how to measure length of Posterior cruciate ligament.

As posterior cruciate ligament is bent posteriorly we measure length in two fragments and then add both.

Figure-02 Diagram showing how to measure width of Posterior cruciate ligament.

Width is measured in mid third of the posterior cruciate ligament.

OBSERVATION AND RESULTS:
Statistical analysis was performed by using appropriate software. We use statistical tools like mean, SD, t-test, diagrams and one way variance for comparing different parameters of posterior cruciate ligament with respect to side, sex, and age group.

Table-01 Descriptive table showing right and left side frequency.

Side		Frequency	Percent
	Right	49	49.0
	Left	51	51.0
	Total	100	100.0

The right knee frequency is 49% and the left knee frequency is 51% of total.

Table-02 Frequency distribution for different age groups.

Age group	Frequency	Percent
21-30	50	50.0
31-40	25	25.0
41-50	14	14.0
more than 50	11	11.0
Total	100	100.0

Among 100% cases, 50% belongs to age group 21 - 30 years, 25% belongs to 31 – 40years age group, and 14% belongs to 41- 50 years age group, 11% belongs to > 50 years age group.

Table- 03 Descriptive statistics of parameter of PCL length for different age groups.

Age group	N	Mean	S.D.
21-30 (1st)	50	36.4880	3.65070
31-40 (2nd)	25	35.2320	3.59058
41-50 (3rd)	14	36.8357	3.96322
>50 (4th)	11	37.5273	3.40796

The mean PCL length decreases from 1st age group to 2nd age group then it increases gradually from 2nd to 4th age group but this is not significant.

Table-04 Descriptive statistics of parameter of PCL width for different age groups.

Age group	N	Mean	S.D.
21-30 (1st)	50	6.47802	1.24512
31-40 (2nd)	25	7.1160	1.00734
41-50 (3rd)	14	6.8000	1.06193
>50 (4th)	11	7.0727	2.06063

The mean PCL width increases from 1st to 2nd age group then it decreases from 2nd to 3rd age group and then it increases from 3rd to 4th age group.

Table-05 Descriptive statistics and p value of different parameter for male and female.

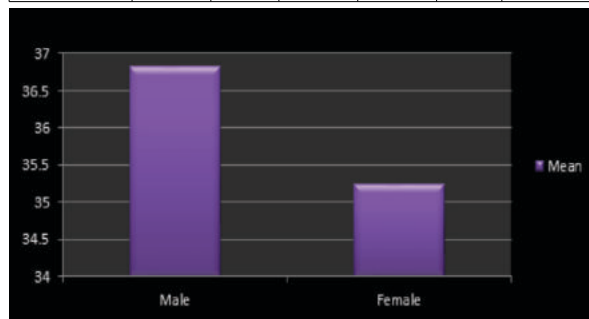| Parameter	Sex	N	Mean	SD	t	P
Length PCL	Male	69	36.8275	3.43112	2.025	0.046
	Female	31	35.2452	3.99765		
Width PCL	Male	69	6.9406	1.24491	2.267	0.026
	Female	31	6.3194	1.31692		

Figure-03 Simple bar diagram showing PCL length for male and female.

The PCL length is significantly more in males as compare to females and there is significant difference between male and female (p< 0.05) length.
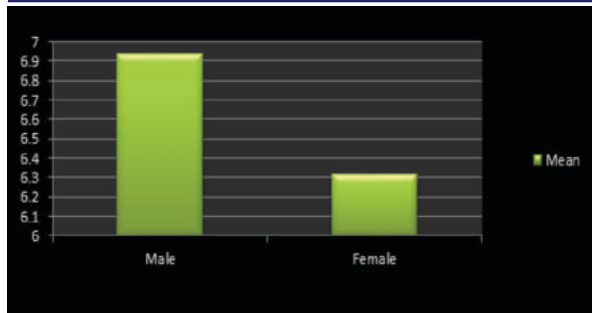
Figure-04 Simple bar diagram showing PCL width for male and female.

The PCL width is significantly more in males as compare to females and there is significant difference between male and female (p< 0.05) width.

Table-06 Descriptive statistics and p value of different parameter for right and left side.

Parameter	Side	N	Mean	SD	t	P
LENGTH-PCL	Right	49	35.6776	3.99741	-1.780	0.078
	Left	51	36.9706	3.23959		
WIDTH-PCL	Right	49	6.4714	1.28095	-2.133	0.035
	Left	51	7.0137	1.26143		

There is no significant difference between PCL length between right and left knee irrespective of sex (p>0.05). Significant difference between PCL width of right and left sided knee (p<0.05).
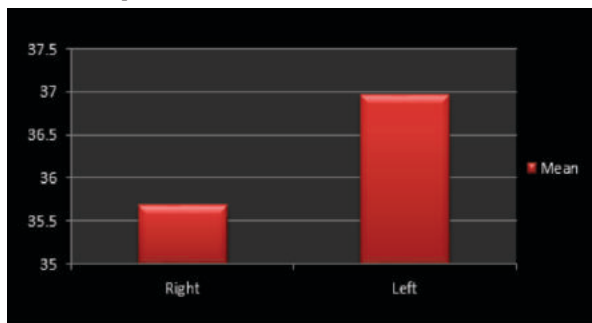

Figure-05 Simple bar diagram showing PCL length of right and left side.

The PCL length is significantly more in left as compare to right and there is no significant difference between left and right (p> 0.05) length
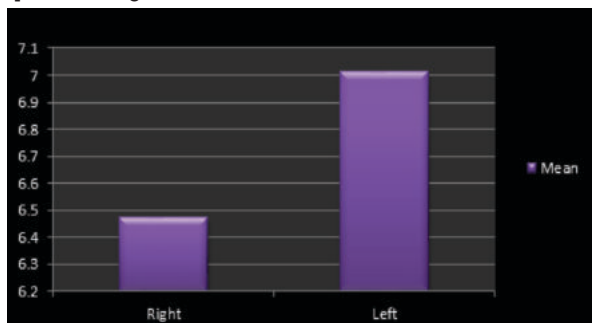

Figure-06 Simple bar diagram showing PCL width of right and left side.

The PCL width is significantly more in left as compare to right and there is significant difference between left and right (p< 0.05) width.

DISCUSSION:
Most probably this study is the only study which evaluates the morphometric parameters on living subjects with the help of radio-imaging (MRI scan).Girgis et al in cadaver and fresh knee dissections that the PCL averaged 38mmin length[9]. The PCL is narrowest at midsubstance averaging 11mm. The PCL length is significantly more in males as compare to females and there is significant difference between male and female (p<0.05) length. The mean PCL length is 36.8mm and that of female is 35.2. The PCL width is significantly more in males as compare to females and there is significant difference between male and female (p<0.05) width. The mean PCL width in male is 6.9mm and that of female is 6.3mm. The PCL length is significantly more in left as compare to right and there is no significant difference between left and right (p<0.05) length. The mean PCL length in right knee is 35.6mm and that of left is 36.9mm. The PCL width is significantly more in left as compare to right and there is significant difference between left and right (p<0.05) width. The mean PCL width in right knee is 6.4mm and that of left knee is 7.0mm. The mean PCL length is maximum at more than 50 years of age group and mean PCL width is maximum at 31 – 40 years of age group.

SUMMARY AND CONCLUSION:
To conclude that Magnetic resonance imaging (MRI) findings of normal posterior cruciate ligament (PCL) alignment and morphology in the knees of adults are documented in our research.. There is significant difference between PCL length and width between male and female irrespective of side. There is significant difference between PCL width of right and left sided knee. We don't have a common consensus about its parameters with age, sex and side in human being. Most probably the present study is the only study which evaluates the morphometric parameters on living subjects with the help of radio-imaging (MRI scan) in India.

Conflict of interest:
The authors declared that there is no conflict of interest.

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