

Association of meniscal tears with cruciate ligament injuries

Sruthi Subramanian¹, Vignesh Kandasamy², Venkatesh Manchikanti^{3*}

¹Mediciti institute of medical sciences, Hyderabad, Telangana,

²Department of Radiology, Vardhman Mahavir Medical College, Delhi.

³Department of Radiology, Narayana medical college, Nellore, AP

*Corresponding author e-mail address: drvenki143@gmail.com

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Abstract

Aim: To find the association of meniscal tears with isolated and combined cruciate ligament injuries, grades of injury, time of injury and type of injury.

Method: Magnetic resonance (MR) imaging of 240 patients with knee pain who diagnosed with anterior cruciate ligament (ACL) and Posterior Cruciate Ligament (PCL) injury by arthroscopy were studied.

Results: Road and traffic accidents (RTA) caused in 80.4% of cases. A total of 192 patients (80%) with isolated ACL involvement, seven patients (2.9%) with isolated PCL involvement, and 41 patients (17%) with combined ACL and PCL involvement. In cases with ACL involvement (n=192), 17 patients (8.8%) had grade 1 injury: sprain, 82 patients (42.7%) had grade 2/3 injury: partial tear and 93 patients (48.4%) had grade 4 injury: complete tear. Among partial ACL tear, lateral meniscus involvement was predominant in 45 patients (54.8%), whereas medial meniscus was involved in 26 patients (31.7%) and normal meniscus was observed in 19 patients (23.1%). In lateral meniscus, the anterior horn was majorly involved 36 patients (80%) as compared to posterior horn in 15 patients (33.3%).

Conclusion: The present study indicates that the anterior horn of the lateral meniscus was predominantly involved in patients with isolated ACL and combined injury of ACL and PCL. The posterior horn of the medial meniscus was more commonly involved in chronic injury of ACL, whereas the posterior horn of the lateral meniscus was involved in acute ACL injury. Early ACL reconstruction is recommended for the prevention of secondary meniscal tears.

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Introduction

Magnetic resonance (MR) imaging, a non-invasive modality is commonly used to assess a wide spectrum of internal knee derangements and articular disorders (1). It has replaced conventional arthrography in the evaluation of menisci and cruciate ligaments, decreasing morbidity and costs associated with negative arthroscopic examinations (2). MR imaging enables the most comprehensive imaging assessment of knee joint when performed early after injury. MR imaging is widely used for assessing meniscal tears and helps for further course of treatment.

The knee joint is predisposed to trauma resulting in degeneration. Every structure is vital and plays a specific role. The anterior cruciate ligament and posterior cruciate ligament are intracapsular, extrasynovial ligaments of knee which help to maintain stability during rotational, accelerative and decelerative activities. Menisci play a very important role in shock absorption, joint stabilisation and possibly proprioception (3, 4). Approximately 70-90% of the axial load transmitted through each compartment is dissipated by its meniscus and helps in protection of the articular cartilage from injury (5). Reid et al states that activities like squatting, kneeling, crawling, driving, climbing stairs, lifting items and walking are all risk factors for meniscal tears (6).

There have been many studies which have shown the association of anterior cruciate ligament (ACL) tears with meniscal injuries. Approximately 70% of ACL tears are a result of non-contact injuries, whereas 30% caused by direct impact to the knee (7). Noyes and Barber-Westin observed an incidence of 65% of meniscal tears to be associated with ACL injury (8). The mechanism behind meniscal tears was due to the knee laxity and potentially unstable knee during dynamic movements. Magnussen et al. documented the development and progression of knee osteoarthritis in patient with ACL injury and concomitant meniscal tears.

There is relatively little literature regarding MR imaging appearance of posterior cruciate ligament (PCL) tears. In isolated PCL tears which account for 4% of all injuries (9). The highest incidence of PCL injuries is seen in road traffic accidents, followed by athletic injuries, like football, soccer and skiing. Meniscal tears are seen almost in 30% with higher incidence of tearing of anterior horn of lateral meniscus (10).

The aim of the study is to find an association of meniscal tears with isolated and combined cruciate ligament injuries, grades of injury, time of injury and type of injury.

Materials and methods

Study design

A retrospective study was conducted on patients with knee pain and those with cruciate ligament injuries referred from the Orthopaedics clinic. The study collected the data from the department of radio-diagnostics during January 2018 to March 2021.

Sampling method

Inclusion Criteria: All patients with confirmed diagnosis of ACL and PCL injury.

Exclusion Criteria: Patients with previous history of surgery on ipsilateral knee and ACL grafting were excluded from the study.

Out of 354 patients, 240 cases with ACL and PCL injury were included in the study. MRI knee studies from January 2018 to March 2021 were evaluated.

The grading of ACL injury was done by the 4-point system based on MR imaging, grade 1- intact (sprain), grade 2 -low grade partial tear, grade 3 – high grade partial tear and grade 4- complete tear (11). For purpose of simplicity grade 2 and grade 3 injuries were included under partial ACL tears.

PCL tears were classified according to their extension into, interstitial, partial or complete. Grade 1 - sprain; intraligamentous injury without joint laxity, grade 2- partial tear; moderate tear of some fibres while others are intact, grade 3 - complete tear; full thickness disruption of PCL fibres with or without bony injuries (12).

MR imaging

The examination was carried out in Philips 1.5 Tesla whole body MRI scanner with dedicated knee coil

Table 1. Scan Parameters MR imaging: Sequence, TE, TR and FOV

	SEQUENCE	TE	TR	FOV
1.	PD AXIAL	30 ms	3000-6000ms(mostly 3000 used)	A-P 180 mm R-L 180 mm
2.	FFE	9.2 ms ,in phase	short	A-P 180 mm R-L 180 mm
3.	STIR CORONAL	30 ms	short	R-L 180 mm H-F 180 mm A-P 100 mm
	Inversion recovery	150 ms	short	
4.	PD SPIR SAG	20 ms	short	R-L 100 mm H-F 180 mm A-P 180 mm
5.	T1 SAG	17 ms	MIN 400, Max 550	R-L 100 mm H-F 180 mm A-P 180 mm
6.	T2 SAG	100 ms	short	R-L 100 mm H-F 180 mm A-P 180 mm
7.	PD SPIR COR	30 ms	short	R-L 100 mm H-F 180 mm A-P 180 mm
8.	FFE SAG	9.2 ms	short	R-L 100 mm H-F 180 mm A-P 180 mm
9.	3D FFE	9.2 ms	short	H-F 180 mm R-L 160 mm A-P 94 mm

T2W (sagittal), PD SPIR (corona, axial and sagittal) and T1 W (axial) images were acquired and evaluated with surface knee coil (flex coil with two channels). Coil used for MR imaging includes; 2 coil elements Elliptical, loop size 14 cm x 17 cm, opening 11 cm x 14 cm [Sense Flex-M]. The scanning was done with the limb positioned in slight external rotation of the leg by 10-15° which makes it possible to visualize entire course of ACL on sagittal images. No contrast agent was used in the study.

Every subject was reviewed for identification of meniscal tear and grading of the tear. They were further classified into acute and chronic ligament injuries based on duration from the time of trauma. A statistical analysis was performed with frequency and percentage as variables.

Ethics Concern

The current study protocol was approved by Institutional Ethics Committee, and each included patient given approval of the Consent form. Each patient was explained about the procedure of MR imaging procedure and its diagnostic specificities for further clinical management of the patient. Informed consent was detailed in their language, by the concern Clinician, or Radiologist of concern.

Results

A total of 240 patients with cruciate ligament injuries were evaluated. Most of the patients were male, with the mean age of patients was 33 years ranged from 20 to 60 years. The most common cause of injury was due to road traffic accidents, followed by cases with no history of trauma (atraumatic), and non-contact sports injury.

Majority cases have isolated ACL involvement, followed by combined ACL and PCL involvement, and isolated PCL involvement.

Among isolated ACL involvement, lateral meniscus involvement was predominant followed by medial meniscus, combined meniscal involvement and normal meniscus.

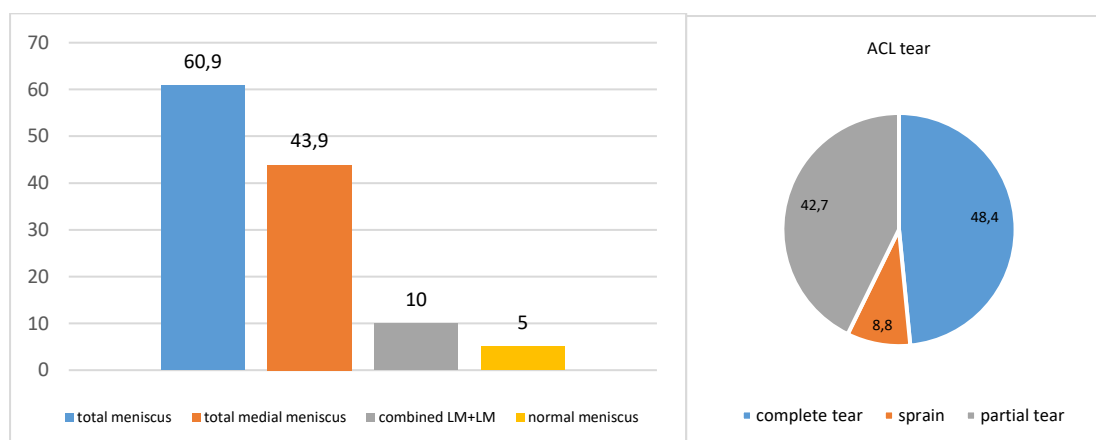


Figure 1. Bar graph showing type of meniscus and pie graph showing ACL tear.

In patients with combined ACL and PCL involvement, majority were lateral meniscus involvement, followed by medial meniscus involvement and normal meniscus.

In patients with isolated PCL injury, equal involvement of medial meniscus and normal meniscus was seen in three patients (42.8%) whereas lateral meniscus was involved in one patient (14.2%). Posterior horn tear was observed in patients with medial meniscus involvement and anterior horn tear was seen in the patient with lateral meniscus involvement.

In cases with sprain of ACL (n=17), medial meniscus showed slightly increased incidence in seven patients (41.1%), whereas equal frequency of normal meniscus and lateral meniscus involvement was seen in six patients (35.2%). In patients with medial meniscus involvement, posterior horn tear was seen more commonly in five patients (71.4%) as compared to anterior horn two patients (28.5%).

Table 2. Baseline characteristics of patients with cruciate ligament injuries

Characteristics	Frequency
Sex	
Male	198 (82.5%)
Female	42 (17.5%)
Mode of injury	
Road traffic accidents, n(%)	193 (80.4%)
Sports injury	17 (7%)
Atramausic	30 (12.5%)
Ligament involved	
ACL	192 (80%)
PCL	7 (2.916 %)
ACL+PCL	41 (17.08%)
Meniscus involvement: ACL+PCL(n=41)	
lateral meniscus	25 (60.9%)
medial meniscus	18 (43.9%)
normal meniscus	5(12.1%)
ACL+PCL- lateral meniscus (n=25)	
Anterior horn tear	22 (88%)
posterior horn	10 (40%)
ACL+PCL- medial meniscus (n=18)	
posterior horn tear	14 (77.7%)
anterior horn tear	3(16%)

Table 3. Characteristic features of ACL ligament Meniscus involvement

Meniscus involvement: ACL cases (n=192)	
lateral meniscus	118 (61.4%)
medial meniscus	101 (52.6%)
combined meniscal	55 (28.6%)
Normal meniscus	44 (22.9%)
ACL- lateral meniscus involvement (n=118)	
anterior horn tear	79 (66.9%)
posterior horn tear	57 (48.3%)
ACL- medial involvement (101)	
posterior horn tear	79 (78.2%)
anterior horn tear	28 (27.7%)
ACL -Grading of injury	
grade 1 injury: sprain	17 (8.8%)
grade 2/3 injury: partial tear	82 (42.7%)
grade 4 injury: complete tear	93 (48.4%)
partial ACL tear (n=93)	
lateral meniscus involvement	45 (54.8%)
medial meniscus	26 (31.7%)
normal meniscus	19 (23.1%)
partial ACL tear -lateral meniscus (n=45)	
anterior horn	36 (80%)
posterior horn	15 (33.3%)
complete tear of ACL (n=93)	
lateral meniscus	43 (46.2%)
medial meniscus	43 (46.2%)
normal meniscus	23 (24.7%)
complete tear of ACL- lateral meniscus (n=43)	
Posterior horn tear	34 (79%)
anterior horn	23 (53.4%)
complete tear of ACL- medial meniscus(n=43)	
Posterior horn tear	38 (88.3%)
anterior horn tear	15 (34.8%)

Table 4. Characteristic features of PCL ligament Meniscus involvement

Involvement	Frequency, n(%)
Meniscus involvement: PCL(n=7)	
medial meniscus	3 (42.8%)
normal meniscus	3 (42.8%)
lateral meniscus	1(14.2%)
Grading of injury	
grade 1 injury: sprain	1(14.2%)
grade 2/3 injury: partial tear	4(57.1%)
grade 4 injury: complete tear	2 (28.5%)
grade 1 injury: sprain (n=1)	
Normal meniscus	1(14.2%)
grade 2/3 injury: partial tear (n=4)	
posterior horn of medial meniscus	2
normal meniscus	2
grade 4 injury: complete tear	
anterior horn of lateral meniscus	1
posterior horn of medial meniscus	1

Table 5. Group of injuries and predominant meniscus and horn involvement

	Predominant meniscus	Predominant horn involvement
ACL sprain	Medial meniscus 41.1%	Posterior horn=71.4
Partial ACL sprain	Lateral meniscus 54.8%	Anterior horn=80
Complete ACL tear	Lateral= medial meniscus 42.6%	Posterior horn more common in both menisci

Among 106 patients with acute ACL injury, predominant lateral meniscus involvement was seen in 62 patients (62.2%), compared to medial meniscus in 25 patients (23.5%) and normal meniscus in 31 patients (29.2%). In lateral meniscus, predominant anterior horn tear was observed in 43 patients (65.1%) compared to posterior horn in 32 patients (48.4%) whilst, posterior horn tear was more common in 20 patients (80%) than anterior horn, 6 patients (24%) of medial meniscal injury.

Table 6. distribution of meniscus in Acute and chronic ACL injury

	Acute ACL injury	Chronic ACL injury
Medial meniscus	23.5%	77%
Lateral meniscus	62.2%	32.7%
Normal	29.2%	11.4%

Chronic ACL injury was seen in a total of 61 patients wherein, predominant medial meniscus involvement was seen in 47 patients (77%) compared to lateral meniscus in 20 patients (32.7%) and normal meniscus in seven patients (11.4%). Posterior horn tear was predominant 39 patients (82.9%) as compared to anterior horn 14 (29.7%) in medial meniscus, whilst anterior and posterior horn tear were equal in 13 patients of lateral meniscus injury.

Among thirty patients with no history of trauma (atraumatic), lateral meniscus involvement showed slightly higher predominance in 15 patients (50%) as compared to medial meniscus in 13 patients (43.3%) and normal meniscus in five patients (16.6%). Anterior horn tear was more common twelve patients (80%) than posterior horn in six patients (40%), in lateral meniscus injury, whereas posterior horn tear was predominant in 11 patients (84.6%) compared to anterior horn in three patients (23%) with medial meniscus injury.

Among 17 patients with history of non-contact sports injury, lateral meniscus showed predominant involvement in nine patients (52.9%) compared to medial meniscus in 8 patients (47%) and normal meniscus was seen in two patients (11.7%). Anterior horn tear was more common eight patients (88.8%) of lateral meniscus as compared to posterior horn in four patients (44.4%). Medial meniscus showed posterior horn tear in all eight patients, whereas anterior horn tear was seen in four patients (50%).

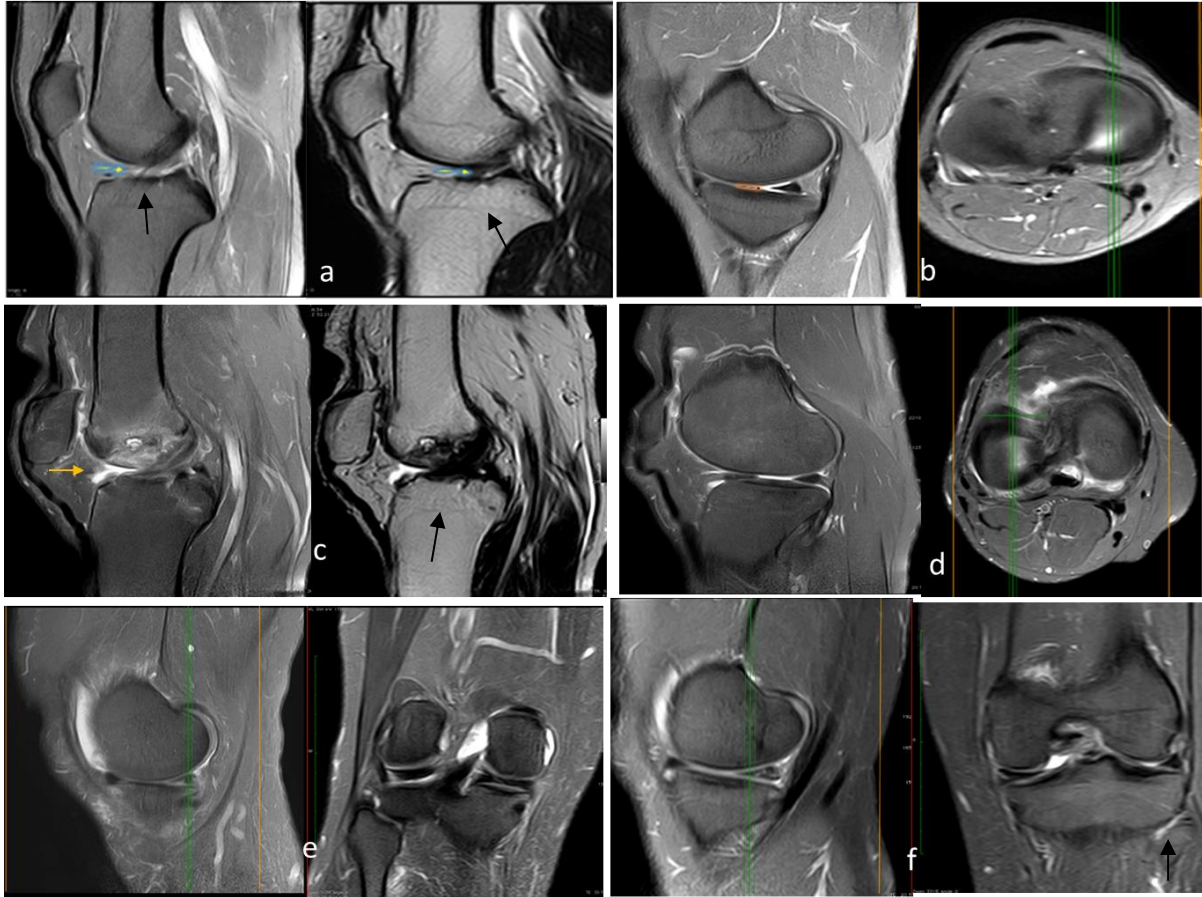


Figure 2. A. Sagittal T2/PD SPIR image demonstrates partial ACL tear. B. Tear of the posterior horn of the medial meniscus. C. sprain of ACL and partial tear of ACL. D. associated tear of anterior horn of lateral meniscus. E. associated tear of anterior horn of medial meniscus. F. anterior horn of lateral meniscus.

Discussion

The purpose of this study was to analyse the association of meniscal tears with cruciate ligament injuries, where various variables like the ligament injured, grade of injury, duration from time of trauma and aetiology of injury were considered and a statistical analysis was done to exhibit the association of meniscal tear with the above variables.

The differentiation of acute and chronic ACL injury was made based on the time interval between MR examination and time of injury. Examination done within 8 weeks of injury was included under acute and above eight weeks as chronic injury.

Meniscal tears are known to occur commonly with ACL injury. When an injury to ACL occurs, tibia most commonly translates anteriorly with external rotation relative to the femur (13). Meniscal tears mainly occur due to entrapment and rotational forces between tibia and femur, the tensile forces result from the attached points with the posterior joint capsular structures and ligaments (14). Our study similarly shows an increase in association of anterior horn of lateral meniscus tear with ACL injury.

It has been demonstrated that incidence of medial meniscal tears increased with delay in surgery whereas the incidence of lateral meniscus tears was independent of time interval from the time of injury to ACL reconstruction (15,16,17). This finding implies that lateral meniscal tears typically emerge during the acute stages of injury and various other factors like increase in chronicity of injury (time after initial insult) or delay in surgery may be responsible for medial meniscus tears.

Association between meniscal tear accompanying ACL injury and its aetiology, time gap from history of injury, activity level after initial trauma and BMI was analysed in 239 cases (18). The authors found that an increase in time from injury, active daily life and re-injury to be risk factors for medial meniscus tear. Similarly, medial meniscus tear was seen to be predominant than lateral meniscus tear with an increase in time gap from injury to examination (chronic injury) in our study.

This study also tried to show the predominant meniscal involvement in patients with no history of trauma (atraumatic) and in those with non-contact injury (sports injury), which revealed that anterior horn of lateral meniscus was predominantly involved in the above aetiologies. This finding was seen to be similar to high risk of lateral meniscus tear during contact injury, explained by high forces applied to the knee joint (19).

Limitation of the study include it was a retrospective study with a total of 240 patients, therefore, validity of our findings is limited due to a smaller sample size. The mechanism of injury was self-reported by the patients which might have introduced an information bias. Finally, the patterns of meniscal tear were not included in the study.

Conclusion

Analysis of the present study indicates that the anterior horn of lateral meniscus was predominantly involved in patients with isolated ACL and combined injury of ACL and PCL. Posterior horn of medial meniscus was more commonly involved in chronic Injury of ACL, whereas posterior horn of lateral meniscus was involved in acute ACL injury. Both menisci were equally involved in patients with complete ACL tear, lateral meniscus showed higher incidence of tear in partial ACL injury and medial meniscus showed slightly higher percentage of tear in ACL sprain. Patients with no history of trauma (atraumatic) and sports Injury (non-contact) showed predominant lateral meniscus involvement.

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