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MRI analysis of Incidences And Patterns Of Meniscal Tears Accompanying The Anterior Cruciate Ligament Injury, A Retrospective Study In Bone And Joint Hospital Barzulla Srinagar

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Abstract

Introduction: The pattern of lateral meniscus tears observed in anterior cruciate ligament (ACL)-injured subjects varies greatly and determines subsequent management. Certain tear patterns with major biomechanical consequences should be repaired in a timely manner. Injury to the anterior cruciate ligament (ACL) is frequently accompanied by tears of the menisci. Some of these tears occur at the time of injury, but others develop over time in the ACL-deficient knee.Knowledge about risk factors for such tears may help to identify patients in the early post-traumatic phase and subsequently may improve clinical results.

Aim and objectives: The aim of this study was to evaluate the effects of the patient characteristics, time from injury (TFI), and posterior tibial slope (PTS) on meniscal tear patterns. Our hypothesis was that meniscal tears would occur more frequently in ACL-deficient knees with increasing age, weight, TFI, PTS, and in male patients.

Materials and methods: This study was conducted at Govt. Bone and Joint Hospital Barzulla Srinagar. In this study 116 patients with ACL injury were enrolled. Details of meniscal lesions were collected. The medial and lateral tibial slopes (MTS, LTS) were measured and were correlated with the diagnosed meniscal tears.

Results: The median TFI (Time from injury) for patients with MM tears was 5.10 months while that for patients with LM tears was 4.30 months. The median MTS and LTS for patients with MM tears were 6.9° and 8.4° respectively while those for patients with LM tears were 6.3° and 7.8° respectively. There were 39 (33.62%) of patients with an isolated MM tear, 17 (16.66%) patients with an isolated LM tear, 8 (6.90%) patients with tears of both menisci, and 52 (44.82%) patients with no meniscal tear. The most common tear location of the MM was the posterior horn 26 (55.32%) followed by tears of the whole AH, PH and body 9 (19.14%). Similarly, tears of the LM tended to be distributed more posteriorly and involve mainly the PH 13 (52%). In MM tears, the most common tear type was a vertical tear 15(31.91%), followed by complex tears 7(14.89%) and in LM tears, the most common tear types were vertical and horizontal tears 5(20%) each, followed by peripheral tears 4(16%).

Conclusion: This study was able to demonstrate that the Incidence of Meniscal injury increased over time in ACL deficient knees. Older age, male sex, increased BMI and prolonged TFI were significant factors for the development of MM tears. An increase in the tibial slope, especially of the lateral plateau, seems to increase the risk of tear of the LM and of both menisci. Therefore, it may be suggested that tibial slope could be one parameter to consider in ACL injured patients for recommending early reconstruction, in order to prevent secondary meniscal tears. Hence an early Acl reconstruction within two months of injury followed by structured rehabilitation was a good option for patients as it prevented further meniscal damage

Keywords: Knee, ACL injury, Meniscus tear, Tibial slope, Time from injury

Introduction

The anterior cruciate ligament (ACL) is an important structure in maintaining the normal biomechanics of the knee and is the primary restraint to anterior tibial translation (ATT), providing 85% of the total restraining force to anterior drawer [1]. The anterior cruciate ligament (ACL) is the most commonly injured knee ligament. Injuries to the anterior cruciate ligament (ACL) are increasing over time, with younger women at elevated risk.

The menisci are important structures within the knee, with complex biomechanical functions. They are thought to carry 40–70% of the load across the knee, and they have a role in shock absorption, proprioception, and enhancement of stability [2].

Meniscal tears are also a significant source of morbidity in both the younger and older populations. Isolated ACL tears are uncommon, with approximately 50% accompanied by meniscal tears due to the close anatomic and functional relationships of these structures [3]. Meniscus tears are commonly observed in patients with anterior cruciate ligament (ACL) injuries, with a reported prevalence of approximately 55% to 65% [4-9]. With ACL injury the Tibia translates anteriorly with associated external rotation of femur entrapping the meniscus and also the tensile forces generated from the attachment with posterior capsular structures of the knee resulting in a meniscal tear [10].3 ACL tear results in functional instability, which manifests as giving way symptoms, swelling of the knee and pain, especially during strenuous activity [11, 12]. The ACL-deficient patients develop significant intra-articular damage with meniscal tears [13, 14] and ultimately (OA) osteoarthritis of the knee [12, 15]. Several studies have shown that associated meniscal tears are strong predictors for the development and progression of knee osteoarthritis (OA) as well as worse patient reported outcomes after ACL reconstruction, especially if a partial or total meniscectomy is performed [16- 20] . This observation has led to efforts to preserve as much meniscal tissue as possible, and meniscus repair combined with ACL reconstruction is increasingly preferred over meniscectomy [21, 22].

Understanding of the pathogenesis, associated findings, and appearance of these injuries on all imaging modalities is critical to their accurate diagnosis and timely treatment. Radiographs may show indirect signs of ACL and meniscal injuries. Ultrasonography is being utilized more often in the workup of these conditions as an adjunct to physical exam and as an initial screening tool. MRI is widely considered the best modality for evaluating the ACL in the acutely injured, chronically injured, and reconstructed states [23] and is a well-established modality for diagnosing meniscal injuries. Multiple meta-analyses have been performed on the diagnostic accuracy of MRI in suspected ACL injuries, with sensitivity of 86.5-94.5% and specificity of 93-95.3% [24] and to have a pooled sensitivity and specificity for diagnosing meniscal injury of 91-93% and 81-88%, respectively, for medial meniscus tears and 76-79% and 93- 95%, respectively, for lateral meniscus tears [25-27]. Magnetic resonance imaging (MRI) is well suited for evaluation of these lesions, though somewhat limited by cost and access for MRI. ACL and meniscal tears can also be graded and classified according to their appearance on imaging which helps guide the surgeon during arthroscopy. The incidence, location and pattern of meniscal injury are time dependent in relation to the injury. In acute ACL injury there was a greater incidence of lateral meniscus tears than medial [6, 28]. In chronic ACL-deficiency, tears more often involve the medial meniscus. The incidence of tears occurring in both menisci increased as the instability became chronic [14]. Since the complexity of meniscus tears increase in the chronic stage, and tears are less amenable to repair as time passes, particularly lateral meniscus tears identified in the early posttraumatic phase may be best suitable for repair. The importance of lateral meniscus repair is emphasized by the fact that lateral meniscectomy is associated with a higher risk for osteoarthritis compared to medial meniscectomy [16, 18].

The purpose of this study was to document the incidence and distribution of meniscal lesions accompanying Acl tear based on injury to reconstruction time and to ascertain pattern of meniscal injury in the Acute (Reconstruction within 2 months of injury), Subacute (Reconstruction within

2-6 months of injury), Chronic (Reconstruction within 6- 12 Months of injury) phases. We also hypothesised that meniscal lesions would be significantly more in patients who had a prolonged time from injury.

Materials And Methods

Study Design:

A retrospective cohort study was performed to examine the association between different patterns of meniscal tears in ACL-injured subjects, and potential demographic and historical risk factors.

Patient's Selection:

All patients undergoing ACL reconstruction in our institution Govt. Bone and Joint Hospital Barzulla Srinagar between May 2017 and April 2020 were recruited to this study. A total of 116 patients with partial or complete rupture of ACL injury were included, and were divided into 4 groups according to the involved meniscus; Group 1 with medial meniscal (MM) tear, Group 2 with lateral meniscal (LM) tear, Group 3 with tears of both menisci, and Group 4 with no meniscal tear. Patient selection was performed after reviewing the preoperative clinical notes to collect data regarding preoperative physical examination, Operative technique, and subjective reports of pain dysfunction or limp were noted. Diagnosis was confirmed with an MRI in all Patients and also included patients in whom the diagnosis was made by arthroscopy. The clinical notes included documentation of the findings of the knee examination at the time of surgery with the patient under anesthesia and the findings of the diagnostic arthroscopy prior to ligament reconstruction.

Inclusion Criteria:

1. Both males and females between
2. Age >18 years
3. Patients who underwent primary ACL reconstruction with or without associated meniscal injury
4. Patients with either partial or complete ACL rupture in the affected knee, as established by arthroscopy

Exclusion Criteria:

1. Age <18 years
2. Patients with revision ACL surgeries were excluded

Demography Of Patients:

A total of 116 patients were included in the present study. The mean age was 33.21 years. 102 (87.93%) of the included patients were males and 14 (12.07%) were females. In this study the majority of the patients were between age group of 36-45 years (Table 1).

Table 1: Demography of patients

Parameters		No. of patients	Percentage
Sex	Male	102	87.93
	Female	14	12.07
Age group	< 25 Years	29	25.00
	25-35 Years	32	27.58
	36-45 Years	37	31.90
	46-55 Years	14	12.07
	56-65 Years	3	2.59
	> 65 Years	1	0.86

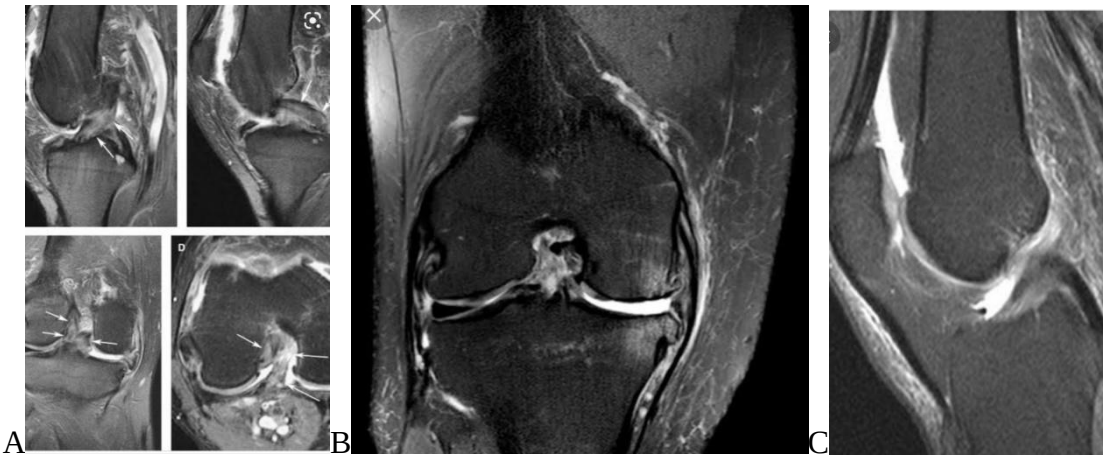
Data Collection:

The pre-operative clinical and radiological examination findings, as well as the intra-operative findings, were reviewed and recorded. The age at diagnosis, gender, presenting complaints with duration and symptoms, the side involved, the presence or absence of meniscal tear, type and location of meniscal tear, Duration between ACL rupture and reconstruction and also family history was collected. Mode of injury was documented and Road traffic accidents constituted more than 53% of the injury. Another 36% of the patients had a history of contact sports and in the remaining 20% the cause could not be ascertained but were included in the study as they satisfied the inclusion criteria.

Meniscal Tear Classification:

In all patients, meniscal lesions were confirmed arthroscopically using a standard probe and documented according to the ISAKOS classification. Tears were documented occurring in the medial or lateral meniscus. In addition, each meniscus was subdivided into three parts: the anterior horn, the body and the posterior horn. We further categorized the type of meniscal tear as Vertical, Horizontal, Peripheral, Oblique, Flap, Radial or Complex. Other variations such as bucket-handle and degenerative tears were also recorded (Figure 1).

Figure 1: MRI of knee, A: ACL with lateral meniscal (LM) tear, B: ACL with medial meniscal (MM) tear and C: ACL tear



Tibial slope measurement

The archived MRI scan images were analyzed and morphometric measurements were performed using a picture archiving and communication system . The MTS and the LTS were measured by radiologist. Three sagittal slices were selected corresponding to the midsagittal, the mid-medial compartment sagittal (B), and the midlateral compartment sagittal cut (C). All sagittal slices were selected manually, and digital measurements were performed twice for each patient two weeks apart to assess the intra-observer reliability.

The proximal tibial anatomical axis (PTAA) was selected to establish the PTS. This axis has been shown to have the best correlation with the tibial shaft anatomic axis and reflect most accurately the mechanical axis of the tibia. The PTAA was established on the mid-sagittal cut by a line joining the midpoint between the anterior and posterior tibial cortices at the level of the tibial tuberosity and at another level 5 cm more distal. The angle subtended between the tibial axis to the horizontal was then calculated (PTTA-H Angle). This angle was then used to transfer the calculated tibial axis to the medial and lateral sagittal cuts to assess the MTS and LTS respectively. The tibial slope in each compartment were measured as the angle between a line perpendicular to PTAA and a line connecting the superior points of the anterior and posterior corresponding tibial plateau. A posterior inclination was assigned a positive value, while an anterior inclination was assigned a negative value.

The diagnosis was confirmed in the operating room by examination under anaesthesia and by arthroscopy. Acl Tears and the associated meniscal injury were identified by the operating surgeon. Meniscal injury location and grade of injury was noted. All patients were treated with Arthroscopic ACL Reconstruction and Grade II and III meniscal tears were treated with menisctomy or repair. The impact of age on meniscal tears was also taken into consideration and was one of the variables that was statistically analysed in addition to the duration between ACL rupture and reconstruction.

Results

The median TFI (Time from injury) for patients with MM tears was 5.10 months while that for patients with LM tears was 4.30 months. TFI had a significant effect on the incidence of meniscus tears, with patients having a longer time to surgery. TFI did not influence tear site or type, with the exception of MM tear types.

The median BMI for the patients with MM tears was 26.3 while that of patients with LM tears was 24.7. BMI had a significant effect on the incidence of MM tears, with higher BMI having higher incidence. Conversely, no effect of the BMI on the incidence of meniscus tears in the other groups. BMI did not affect the tear sites or types in any groups.

The median MTS and LTS for patients with MM tears were 6.9° and 8.4° respectively while those for patients with LM tears were 6.3° and 7.8° respectively. The LTS has a significant effect on the incidence of LM tears. Patients with LM tears demonstrated greater LTS (median= 8.9˚) compared to that of patients without tears (6.8˚). Similarly, the LTS has a significant effect on the incidence of both MM and LM tears, with patients in this group demonstrating greater LTS (9.1˚) compared to that of the patients without tears (6.8˚). The MTS did not influence the incidence of meniscus tears in any groups. Neither the MTS nor the LTS had an effect on the tear site or type in any group.

There were 39 (33.62%) of patients with an isolated MM tear, 17 (16.66%) patients with an isolated LM tear, 8 (6.90%) patients with tears of both menisci, and 52 (44.82%) patients with no meniscal tear (Table 2).

Table 2: Incidence of meniscal tears

Group	Parameters	No. of patients	Percentage
I	MM tear	39	33.62
II	LM tear	17	16.66
III	Both MM and LM	8	6.90
IV	No tear	52	44.82

The most common tear location of the MM was the posterior horn 26 (55.32%) followed by tears of the whole AH, PH and body 9 (19.14%). We noted an equal proportion of AH and body tears 2 (4.26%) each, while the AH and body tears represented the least common 1 (2.13%). Similarly, tears of the LM tended to be distributed more posteriorly and involve mainly the PH 13 (52%), followed by the tears involving both the PH and body 5 (20%). No tears were seen of AH and body (Table 3).

Table 3: Distribution of meniscal tears according to their location

Location	Medial meniscus (MM)		Longitudinal meniscus (LM)	
	No. of patients	Percentage	No. of patients	Percentage
AH	2	4.26	1	4
PH	26	55.32	13	52

Body	2	4.26	4	16
AH+ Body	1	2.13	0	0
PH + Body	7	14.89	5	20
AH+ PH+ Body	9	19.14	2	8
Total	47	100.00	25	100
AH: Anterior horn, PH: Posterior horn				

After evaluating all 47 MM tears, the most common tear type was a vertical tear 15(31.91%), followed by complex tears 7(14.89%). The flap tears represented the least common type 1 (2.13%). We noted an equal proportion of 4 (8.51%) in radial and bucket-handle tears each (Table 4).

In 25 LM tears, the most common tear types were vertical and horizontal tears 5(20%) each, followed by peripheral tears 4(16%). In comparison with MM tears, there were less of degenerative and oblique tears 1(4%), but horizontal tears had the same distribution for both sides 5 (20%). We noted an equal proportion in flap, radial, complex and degenerative, oblique as 2 (8%) in each and 1 (4%) in each respectively (Table 4).

Table 4: Distribution of meniscal tears according to their type

Type	Medial meniscus (MM)		Longitudinal meniscus (LM)	
	No. of patients	Percentage	No. of patients	Percentage
Vertical	15	31.91	5	20
Peripheral	6	12.77	4	16
Horizontal	5	10.64	5	20
Flap	1	2.13	2	8
Bucket-handle	4	8.51	3	12
Degenerative	2	4.26	1	4
Oblique	3	6.38	1	4
Radial	4	8.51	2	8
Complex	7	14.89	2	8
Total	47	100.00	25	100

Discussion

The purpose of this study was to identify incidences and patterns of meniscal tears in ACL injured subjects who underwent surgery within 6 months after injury. Identified risk factors for major meniscal tears were male gender and age of <45 years. Other authors, however, have found no such association [29]. Male patients had a higher incidence of injury in the body and posterior horn of both menisci and show more vertical, peripheral tears than females. This observed injury pattern may be explained by a lesser degree of ACL resilience in women, leading to ACL rupture at smaller forces with less associated meniscal injury [30].

Time from injury to surgery has also been shown to increase the frequency and severity of meniscal injuries. Most of the studies, however, focused on the association between the timing of surgery and meniscal tears. It has been clearly demonstrated that the incidence of medial meniscus tears increases with delayed surgery whereas the incidence of lateral meniscus tears is independent of the time interval

from injury to ACL reconstruction. Our study confirms that a delay in surgical treatment is associated with a higher incidence of MM tears. Our results are in accordance with the results of other studies that reported an increased incidence of MM tears [31-33] and LM tears remain fairly constant in respect to TFI [34]. These finding implies that lateral meniscus tears typically emerge during the initial injury and other factors than surgical delay must be responsible for lateral meniscus tears in ACL-injured subjects.

In our study, increased BMI was also associated with an increased incidence of MM tears. The median BMI for the patients with MM tears was 26.3 while that of patients with LM tears was 24.7. BMI had a significant effect on the incidence of MM tears, with higher BMI having higher incidence. Conversely, no effect of the BMI on the incidence of meniscus tears in the other groups. BMI did not affect the tear sites or types in any groups. Generally, obesity has an unfavorable effect on the knee joint, and previously BMI and weight equally predicted meniscal injury [35]. Consequently, Ford et al. [36] reported a significant correlation between meniscal tear and increasing BMI.

In this study the LTS shows a significant effect on the incidence of both MM and LM tears as compared to that of the patients without tears. Patients with LM tears demonstrated greater LTS (median= 8.9˚) compared to that of patients without tears (6.8˚). Our study reveals that the MTS did not influence the incidence of meniscus tears. Neither the MTS nor the LTS had an effect on the tear site or type in any group. We suggest that PTS is one of the considerations in ACL injury to prevent secondary meniscal tears in patients with ACL injury. Increased slope, particularly in the lateral compartment, is a risk factor for lateral and both menisci tears, and when identified should prompt the clinical to consider early ACL reconstruction to prevent further meniscal injury.

In this study, there were 39 (33.62%), 17 (16.66%) and 8 (6.90%) of patients with MM tears, LM tears and both menisci respectively and the overall incidence of meniscal tears was 64 (57.18%) which is near about equivalent with rates in the literature [8, 9, 37]. Various mechanisms affect the frequency of medial and lateral meniscal tears, including lower limb alignment**,** load distribution, and delay of intervention. The incidence of LM tears remained relatively unchanged with time, while MM tears increased with time.

In our study the most common tear location in the MM was the posterior horn 26 (55.32%) with the most common tear types being vertical tears was vertical tear 15(31.91%), followed by tears of the whole AH, PH and body 9 (19.14%), findings in accordance with the current literature [6]. We noted an equal proportion of AH and body tears 2 (4.26%) each, while the AH and body tears represented the least common 1 (2.13%). Similarly, tears in the LM tended to be distributed more posteriorly and involve mainly the PH 13 (52%), followed by the tears involving both the PH and body 5 (20%). The most common tear types were vertical and horizontal tears 5(20%) each, followed by peripheral tears 4(16%). In comparison with MM tears, there were less of degenerative and oblique tears 1(4%), but horizontal tears had the same distribution for both sides 5 (20%).

Conclusion

This study was able to demonstrate that the Incidence of Meniscal injury increased over time in ACL deficient knees. Older age, male sex, increased BMI and prolonged TFI were significant factors for the development of MM tears. An increase in the tibial slope, especially of the lateral plateau, seems to increase the risk of tear of the LM and of both menisci. Therefore, it may be suggested that tibial slope could be one parameter to consider in ACL injured patients for recommending early reconstruction, in order to prevent secondary meniscal tears. Hence an early Acl reconstruction within two months of injury followed by structured rehabilitation was a good option for patients as it prevented further meniscal damage.

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