

THE ASSOCIATED MENISCAL TEARS AND ASSOCIATED RISK FACTORS IN CONCOMITANT ACL INJURIES OF THE KNEE: A RETROSPECTIVE ANALYSIS

Kalawar RPS,^{1*} Pokharel B,¹ Chaudhary P,² Rijal R²

Affiliation

1. Associate Professor, Department of Orthopaedics, B.P. Koirala Institute of Health Sciences, Dharan, Nepal
2. Professor, Department of Orthopaedics, BP Koirala Institute of Health Sciences, Dharan, Nepal

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* Corresponding Author

Dr. Rosan Prasad Shah Kalawar

Associate Professor

Department of Orthopaedics

B.P. Koirala Institute of Health Science, Dharan

Email: docrosan@gmail.com

ORCID ID: <https://orcid.org/0000-0002-3633-2360>

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ABSTRACT

Introduction

The pattern of meniscus tear has significant impact on subsequent rehabilitation and functional outcome as they are usually associated with ACL injury. Knowledge about associated meniscus tear helps to identify patients in the early post-traumatic phase.

Objectives

To study meniscus tear patterns and association between different tear patterns of meniscus in ACL injured subjects and to identify potential demographic and other associated risk factors.

Methodology

Routine arthroscopic findings database of 54 patients operated for primary ACL reconstruction from January 2017 to December 2018 was used to study associated tear of meniscus. Based on arthroscopic evaluation, cases were grouped into meniscus having no tear, minor tear and major tear. Major tear included complete radial tears, root tears and unstable longitudinal tears including bucket-handle tears.

Result

Total arthroscopy cases in the study duration were 124. Of those, 43% (n=54) underwent ACL reconstruction (ACLR) for torn ACL. Among the patients who underwent ACLR, 58% had no tear, 26% had minor tears, and 16% had major tears of the meniscus. There were significant differences between three groups for gender, age groups and mechanism of injury. Risk factors for major tears were male gender and age <30 years. Minor and major tears were associated with a contact injury.

Conclusion

Male, age <30 years and history of contact injury have high risks for having an associated meniscus tear. Early referral to magnetic resonance imaging and/or arthroscopy is recommended to allow meniscus repair in a timely manner.

KEYWORDS

Arthroscopy, anterior cruciate ligament, ACL, contact injury, meniscus.



INTRODUCTION

Anterior cruciate ligament (ACL) injuries are commonly associated with meniscus tears with a prevalence rate of approximately 55% to 65%. Associated meniscal tears are strong predictors for the development and progression of osteoarthritis (OA) of knee and worse patient reported outcomes in ACL reconstructed patients, especially if total or partial meniscectomy has been performed.⁶ Thus, preservation of meniscal tissue as much as possible and meniscus repair if indicated is increasingly preferred over meniscectomy combined with ACL reconstruction.⁷

Medial meniscus tears are more common with chronic ACL insufficiency while lateral meniscus tears are more prevalent in acute ACL injuries.⁸ The complexity of meniscus tears increases in the chronic stage and the tears become less repairable.^{9,10} The significance of meniscus repair is that the preservation of meniscus is associated with decreased risk for osteoarthritis compared to meniscectomy.⁶

Meniscus tears pattern observed in ACL-injured patients varies greatly and guides subsequent management and rehabilitation. Incomplete longitudinal tears and complete stable longitudinal tears affect minimally on knee joint health, thus can be left in situ.¹¹⁻¹³ Bucket-handle tear, root tear, complete radial tear patterns are associated with major biomechanical bearings on knee health; so they should be repaired at the earliest possible to prevent accelerated joint degeneration.¹⁴⁻¹⁶

Tear patterns of the meniscus in ACL-injured subjects may be associated with variations in demographic and other risk factors such as gender, age, body weight, and injury mechanism. Study of such risk factors may help to identify major meniscal tears early. Very few studies have analyzed risk factors for different tear patterns of the meniscus in ACL-injured candidates. Thus, this study was conducted to refine current knowledge of risk factors for associated meniscus tears in ACL-injured candidates.

METHODOLOGY

Study design

Our study is a retrospective cohort design to study meniscus tear patterns and aims to identify the association between different tear patterns of the meniscus in ACL injured subjects and also to evaluate potential demographic and other risk factors associated.

The study protocol was approved by the institutional review committee of B.P. Koirala Institute of Health Sciences, Nepal (IRC number: IRC/1487/018). Patient record file and arthroscopy finding record proforma of all patient who had undergone arthroscopic ACL reconstruction from January 2017 to December 2018 was retrieved from medical record section of hospital. The relevant data was collected and organized to a masterchart.

Study subjects having isolated meniscal injury, multi-ligamentous injuries or a history of previous surgery at the index knee were excluded from study.

Meniscus tear was grouped into three groups namely 'no tear,' 'minor tear,' and 'major tear.' Minor meniscal tear

included incomplete longitudinal tears or complete stable longitudinal tears not extending further than 1 cm in front of the popliteus tendon and radial or flap tears involving less than 75% of the meniscal width.^{11-13,16} Major tear included root tear (defined as avulsion of the meniscus root or complete radial tears within 1 cm from the bony insertion of the lateral meniscus), complete radial tears with transection of the meniscus ('radial split tears'), and unstable longitudinal tears including bucket-handle tears.¹⁴⁻¹⁷

The records were used to obtain demographic data and injury history with proper duration. Gender, age at surgery, height, weight, body mass index (BMI), type of injury, and mechanism of injury were considered for present study. Patient age was further analyzed by dividing the cohort into two age groups: <30 years and >30 years. Patients were divided into three BMI groups based on the classification of the World Health Organization: <24.9 kg/m² (normal), 25–29.9 kg/m² (overweight), and >30 kg/m² (obese).¹⁸ The circumstance in which the injury occurred was used to define the type of injury and was classified as high-impact sports-related, low-impact sports-related, and not sports-related injuries. Hunt Valley II (2005) definition was used to classify the mechanism of injury as non-contact mechanism or contact mechanism.¹⁹ When the forces applied to the knee joint resulted from the patients' own movements and did not involve contact with another person or object, the mechanism was assumed to be non-contact. A contact mechanism was assumed if an external force was directly applied to the knee joint or if an external force was applied to the patient but not directly to the injured knee.

Statistical analysis

SPSS software version 21.0 (IBM-SPSS, New York, USA) was used for Statistical analysis. The level of significance was set at $p < .05$. Mean \pm standard deviation was used for continuous variables and confidence interval (CI) was set at 95%. Categorical variables were reported as count and percentages.

Univariate analysis was performed by comparing the three study groups with regard to gender, age, age groups, height, weight, BMI, BMI groups, type of injury (high-impact sports, low-impact sports, and not sports related), and mechanism of injury (non-contact and contact). Level of significance, odds ratios (OR), and 95% CIs were calculated for each variable.

Sample size estimation

This study considers 95% confidence interval (CI) and 80% power to estimate the sample size. For this purpose, we had considered study by Michalitsis et al. in which 63% cases had meniscus injury in ACL deficient knee.⁵ The corrected sample size was 41. However, we considered all cases of ACL injury (total number 54) during last year.

RESULTS

A total of 124 knee arthroscopic procedures had been performed in the study. Of these, 54 (43%) patients who underwent primary ACL reconstruction met our inclusion



criteria and were included in the study. Our study population comprised of Thirty-six percent females and sixty four percent were males. Mean age was 29 (19-39) years, mean height was 175 ± 9 cm, mean weight was 75 ± 15 kg, and mean BMI was 25 ± 5 kg/m². Sixty-seven percent of the patients were aged <30 years and the BMI was normal in 65%. Most patients (67%) injured their ACL during high-impact sports and a non-contact mechanism was found in 79%.

Of the 54 included patients, 58% patients had isolated ACL tears, 26% had an associated minor meniscus tear, and 16% had an associated major meniscus tear. Table 1 shows detailed distribution of meniscus tear patterns and Table 2 shows patient characteristics of each group and the results of the univariate group comparison. Statistically significant differences between the 'no tear' and 'minor tear' groups were found for the mechanism of injury, with a higher proportion of contact injuries in the minor tear group (p<0.05). Compared to patients with no tear, a significantly higher proportion of male patients (p<0.001), patients <30 years (p<0.01), and contact injuries (p<0.001) were found in patients with major tears. In addition, contact injuries were significantly more common in patients with major tears as compared to patients with minor tears (p<0.05).

Table 1: Distribution of meniscus tear patterns (n=54)

Group	Percentage (%)
No tear	58%
Minor tear	26%
Incomplete/Complete stable longitudinal tear extending <1cm in front of the popliteus tendon	20%
Radial or flap tear involving <75% of the meniscal width	6%
Major tear	16%
Root tear	9%
Radial split tear	4%
Unstable longitudinal/bucket handle tear	3%

Table 2: Univariate analysis (n=54)

Variable	Group			P value
	No tear	Minor tear	Major tear	
Gender				<0.05
Female	42%	39%	11%	
Male	58%	61%	89%	
Age (years)		28±10	25±9	>0.05
Age groups (years)				<0.05
<30	59%	73%	82%	
>30	41%	27%	18%	
BMI (Kg/m²)				>0.05
<24.9	62%	71%	58%	
25-29.9	30%	23%	34%	
>30	8%	6%	8%	
Type of injury				>0.05
High-impact sports	65%	64%	77%	
Low-impact sports	11%	9%	8%	
Not sports related	24%	27%	15%	
Mechanism of injury				<0.001
Non-contact	92%	73%	43%	
Contact	8%	27%	57%	

Table 3 shows the results of the multivariate logistic regression analysis. The sole independent risk factor for a minor tear was a contact mechanism with an OR of 4.3 (95% CI, 1.7–10.6). Independent risk factors for major tears were male gender (OR, 7.4; 95% CI, 1.9–27.6), age <30 years (OR, 5.8; 95% CI, 1.7–19.9), and a contact mechanism (OR, 18.5; 95% CI, 5.9–57.4).

Table 3: Multivariate logistic regression (n=54)

	Minor Tear			Major Tear		
	OR	95% CI	P value	OR	95% CI	P value
Gender						
Female	<i>Referent</i>			<i>Referent</i>		
Male	1.4	0.5-3.7	>0.05	7.4	1.9-27.6	<0.05
Age (years)	0.9	0.9-1.0	>0.05	0.9	0.9-1.1	>0.05
Age groups (years)						
<30	1.8	0.9-3.6	>0.05	5.8	1.7-19.9	<0.05
>30	<i>Referent</i>			<i>Referent</i>		
BMI (Kg/m²)						
<24.9	<i>Referent</i>			<i>Referent</i>		
25-29.9	0.3	0.1-1.4	>0.05	1.5	0.1-4.4	>0.05
>30	0.5	0.1-2.2	>0.05	1.4	0.1-2.8	>0.05
Type of injury						
High-impact sports	1.5	0.6-3.5	>0.05	0.6	0.2-2.3	>0.05
Low-impact sports	1.1	0.3-4.2	>0.05	0.6	0.1-4.0	>0.05
Not sports related	<i>Referent</i>			<i>Referent</i>		
Mechanism of injury						
Non-contact	<i>Referent</i>			<i>Referent</i>		
Contact	4.3	1.7-10.6	<0.05	18.5	5.9-57.4	<0.001

DISCUSSION

Identified risk factors for major meniscal tear were male gender (OR= 7.4) and age of <30 years (OR=5.8) in this study. The strongest predictor for a major meniscal tear, however, was a contact injury mechanism with an OR of 18.5. Similarly, the sole risk factor for a minor meniscal tear was a contact injury mechanism with an OR of 4.3.

Many available studies evaluate risk factors for meniscus tears in ACL injuries. However, most evaluate mainly the association of timing of surgery and meniscal tears. It has been shown 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.^{5,9,10,20,24-27} This result confirms that lateral meniscus tears occur at the time of initial injury and other factors than surgical delay must be responsible for lateral meniscus tears in ACL-injured subjects. However, only few studies have analyzed the association between different demographic and historical factors and meniscal tears.¹⁸ Kluczynski et al. examined the predictors of meniscal tears in 541 patients undergoing ACL.¹⁸ The analyzed predictors included age, sex, BMI, mechanism of injury, type of injury, interval from injury to surgery, and instability episodes. The authors found that male sex predicted more lateral and medial meniscus tears, sports-related injuries predicted fewer medial meniscal tears, and more instability episodes predicted more medial meniscus tears.¹⁸ In a similar study, the association between meniscal injuries accompanying ACL tears and the mechanism of injury, time from injury, activity level after the initial trauma, reinjury after the initial trauma, and BMI was analyzed in 293 patients.²⁸ The authors concluded increasing time from injury, active daily life, and reinjury to be risk factors for



meniscal injuries.²⁸ A limitation of both studies is that meniscus tears were considered a binary finding (meniscus tear vs. no meniscus tear). No differentiation was made between different patterns of meniscus tears. However, the pattern of meniscus tears observed in ACL-injured subjects varies greatly and a differentiated perspective seems to be necessary because of their potential prognostic value.^{4,8} This study analyzed the association of different tear patterns of the meniscus and patient specific risk factors. Meniscus tear patterns regarded as major within this study were root tears, radial split tears, and unstable longitudinal tears including bucket-handle tears. These tear patterns dramatically alter the loading profile of the knee joint in biomechanical studies and are thought to promote the onset and rapid progression of OA.¹⁴⁻¹⁷ Repair of major meniscal tears at the time of ACL reconstruction should therefore be preferred over meniscectomy, since meniscus repair is associated with less cartilage degeneration and better clinical results.^{6,7} Unfortunately, meniscectomy was the most common method of treatment. Lateral meniscus tears were treated by meniscectomy in 71%, by repair in 14%, and left in situ in 14%. Interestingly, performing surgery within 6 weeks was predictive of more lateral meniscal repairs.¹ It is also found that higher meniscus healing rates occur in patients who underwent acute meniscus repair in conjunction with ACL reconstruction compared to delayed meniscus repair.²⁹ These findings underline the importance of early identification of patients with major meniscal tears if repair is attempted. The findings of our present study imply that male patients, patients under the age of 30, and especially patients who sustained a contact injury are at high risk for an associated major lateral meniscus tear. We therefore recommend early referral of those patients to magnetic resonance imaging (MRI) and/or arthroscopy in order to allow meniscus repair in a timely manner.

Similar to our study, other studies have also found an association between male sex and an increased prevalence of concomitant meniscus tears.^{3,18,20,21,23} However, these studies did not differentiate between different meniscus tear patterns. In the present study, male sex was only predictive for major meniscal tears whereas gender distribution was similar among patients with no tear or a minor tear. This association may be explained by a lesser degree of ACL resilience in females, leading to ACL rupture

at smaller forces and thus less associated meniscal damage.²¹ A higher failure load of the ACL may also explain the observed higher risk for associated major lateral meniscus tears in younger patients.

There are several limitations of our study. This is a retrospective study so the validity of our findings is limited. The small sample size of 54 patients is relatively low for conducting an epidemiologic study. Only patients undergone ACL reconstruction were evaluated and therefore the results may not allow generalization to all patients with an ACL tear. Differences in knee morphology, stratification according to medial or lateral meniscus or material properties of the meniscus were not examined which were many among many other factors that may predict the tear pattern.

CONCLUSION

Male sex, age <30 years, and a contact injury mechanism are independent risk factors for concomitant major meniscal tears among patients with a tear of the ACL. Patients with a contact injury mechanism have an approximately 18-fold increased risk for a major meniscus tear and is therefore necessary for an early referral to magnetic resonance imaging and /or arthroscopy in order to allow meniscus repair in a timely manner and avoid the outcomes of a late repair or missed meniscal tear.

LIMITATIONS OF THE STUDY

This study doesn't classify medial or lateral meniscus injury.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest regarding this study.

FINANCIAL DISCLOSURE

The authors have not received financial grant from any company or pharmaceuticals. They have done this study voluntarily as a part of their academic career and interest.

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