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Epidemiology of Chondral and Meniscal Lesions in Multiligament Knee Injuries: A Retrospective Analysis in a Single Tertiary Center

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Abstract

Background: Multiligament knee injuries (MLKI) are complex injuries often associated with intra-articular pathologies such as meniscal and chondral lesions. Timely diagnosis and treatment are crucial to prevent long-term joint deterioration. **Objective:** To determine the prevalence and associated factors of meniscal and chondral injuries in patients with MLKI at a tertiary center. **Methods:** This retrospective study reviewed data of 65 patients who underwent surgery for MLKI. Demographic information, mechanism of injury, number of ligaments injured, and time to surgery were analyzed. The presence of meniscal and chondral lesions was assessed and correlated with clinical factors. **Results:** Meniscal and chondral injuries were present in 86.2% and 84.6% of patients, respectively. Most patients (75.4%) sustained injuries due to road traffic accidents. Surgical intervention was delayed beyond one year in 78.5% of cases. A significant association was found between time to surgery and presence of chondral lesions ($p = 0.002$). **Conclusion:** There is a high prevalence of intra-articular injuries in MLKI, especially in delayed presentations. Early referral and timely surgical management are crucial in reducing the risk of cartilage damage and improving outcomes.

Keywords

Multiligaments Knee Injuries, Meniscus, Cartilage

1. Introduction

Multiligament knee injuries (MLKIs) represent a rare but devastating type of knee trauma characterized by the disruption of two or more major ligaments of the knee joint. These injuries may involve the anterior cruciate ligament (ACL), pos-

terior cruciate ligament (PCL), medial collateral ligament (MCL), lateral collateral ligament (LCL), or posterolateral corner (PLC). MLKIs are typically caused by high-energy mechanisms such as motor vehicle accidents, falls from height, or direct impact during contact sports [1] [2]. Despite their low incidence, estimated between 0.02% and 0.2% of all orthopedic injuries, MLKIs are clinically significant due to their complexity and the potential for long-term disability [3] [4].

The severity of these injuries lies not only in the ligamentous damage but also in the frequent involvement of intra-articular structures such as the menisci and articular cartilage. Studies have demonstrated that meniscal tears are present in up to 80% of MLKI cases, while chondral lesions are seen in up to 75% [5]-[7]. These associated injuries can lead to joint instability, chronic pain, and accelerated osteoarthritis if not addressed promptly [8] [9]. The presence of these lesions often correlates with the mechanism of injury and the delay in surgical intervention [10] [11].

Menisci play a vital role in knee biomechanics, aiding in load transmission, shock absorption, and joint congruity. Damage to these structures, especially when accompanied by ligament rupture, significantly compromises joint stability. Similarly, articular cartilage is crucial for smooth joint articulation. Once damaged, cartilage has limited healing potential, and untreated lesions may progress to osteoarthritis [12]-[14]. MRI can help detect these injuries preoperatively, but their true extent is often revealed only during arthroscopy [15].

Timely surgical management is a key factor influencing outcomes in MLKIs. Early reconstruction is generally associated with better functional recovery and reduced risk of secondary intra-articular damage. However, early surgery must be balanced against the risk of arthrofibrosis. Hence, the optimal window for surgical intervention is often considered to be within three to six weeks post-injury [16]-[18]. Delayed surgery, particularly beyond six months, has been associated with a higher incidence of chondral injuries and inferior patient-reported outcomes [19] [20].

The mechanism of injury varies by population and region. In high-income countries, sports are the leading cause of MLKIs, particularly among young, active individuals. In contrast, in low- and middle-income countries, motor vehicle accidents remain the predominant mechanism due to differences in transportation systems and safety practices [21] [22]. These regional variations not only influence injury patterns but also impact treatment timelines. Delayed referral, inadequate access to orthopedic care, and socioeconomic factors contribute significantly to the delay in definitive treatment in resource-limited settings [23] [24].

Although numerous studies have examined MLKIs, much of the literature originates from Western nations with well-established trauma systems. There remains a paucity of regional data from Southeast Asia, where delayed presentation is common. In Malaysia, the healthcare burden from RTA-related knee trauma is significant, and understanding the epidemiology of associated intra-articular lesions can help improve clinical management.

This study aims to evaluate the prevalence of meniscal and chondral injuries in

MLKIs at a tertiary center in Malaysia and assess the relationship between these injuries and demographic variables, injury mechanism, number of ligaments involved, and timing of surgical intervention.

2. Objectives

The general objective of this study is to assess the occurrence of chondral & meniscus lesions in multiligament knee injuries (MLKI) in a single tertiary center. The specific objective is to evaluate associations between intra-articular lesions and demographic factors, mechanism of injury, number of ligaments involved, and time to surgery.

3. Materials and Methodology

We retrospectively did a cross-sectional study in Hospital Kuala Lumpur. Medical records of patients who underwent MLK reconstruction surgery for the period 1 October 2021 to 30 September 2024 of selected subjects who met the eligibility criteria were reviewed.

The inclusion criteria include all patients aged 16 - 50 years old who underwent multi-ligament knee reconstruction surgery in Hospitals Kuala Lumpur during the period 1 October 2021 till 30 September 2024 with complete documentation and clinical data. The exclusion criteria include patients aged more than 50 years old or less than 16 years old who underwent multi-ligament knee reconstruction surgery, patients with MLKI who were treated conservatively and revision surgery of multi-ligament knee reconstruction surgery.

The data were extracted from the patient's medical records, including demographics (age, gender & ethnicity), injury characteristics (mechanism & number of ligaments torn), associated intra-articular injuries (meniscus and cartilage involvement) and time interval (duration between injury and surgery). Descriptive statistics were used for demographic data. The data were analysed using IBM SPSS Statistics, Version 29.0. Fisher's exact test and Mann-Whitney U test were applied to evaluate associations between variables. A p-value <0.05 was considered statistically significant.

4. Results

A total of 65 patients with multiligament knee injuries (MLKI) were included in this study. Table 1 shows that the mean age was 31.66 years (SD = 6.82), with a range from 19 to 50 years.

The majority of patients were male (83.1%), with Malay ethnicity (86.2%) being the predominant group. Other ethnic groups included Indian (9.2%), Chinese (1.5%), and Others (3.1%).

In terms of intra-articular damage, meniscal tears were present in 56 patients (86.2%). While chondral lesions were found in 55 patients (84.6%). With regard to injury complexity, most patients had two ligaments involved (66.2%), while 33.8% had injuries involving three ligaments.

The mechanism of injury was predominantly road traffic accidents (RTA), accounting for 75.4%, while 24.6% were sports-related injuries. The median time from injury to surgical intervention was 22.0 months, with an interquartile range (IQR) of 13.0 to 50.0 months.

Table 1. Demographic characteristics and distribution of chondral and meniscal lesions among patients with multiligament knee injuries (N = 65).

Variables	n (%)
Age	
Mean (SD)	31.66 (6.82)
Minimum	19
Maximum	50
Gender	
Female	11 (16.9)
Male	54 (83.1)
Ethnicity	
Malay	56 (86.2)
Chinese	1 (1.5)
Indian	6 (9.2)
Others	2 (3.1)
Presence of Meniscus Tear	
Yes	56 (86.2)
No	9 (13.8)
Presence of Cartilage Injury	
Yes	55 (84.6)
No	10 (15.4)
Number of Ligaments Involved	
2	43 (66.2)
3	22 (33.8)
Mechanism of Injury	
RTA	49 (75.4)
Sport	16 (24.6)
Time Interval from Injury to Surgery	
Median (IQR)	22.0 (37.0)
25th Percentile	13.0
75th Percentile	50.0

Table 2 summarizes the bivariate analysis comparing patient demographics, injury factors, and timing of surgery with the presence of meniscal and chondral lesions.

Table 2. Association between patient factors and intra-articular knee lesions.

Factors	Meniscus Lesion		p value
	Present (N = 56) n (%)	Absent (N = 9) n (%)	
Age			
Below 35	37 (66.1)	6 (66.7)	[a]1.000
Above 35	19 (33.9)	3 (33.3)	
Ethnicity			
Malay	49 (87.5)	7 (77.8)	
Chinese	0	1 (11.1)	[a]0.167
Indian	5 (8.9)	1 (11.1)	
Others	2 (3.6)	0	
Gender			
Male	45 (80.4)	9 (100)	[a]0.337
Female	11 (19.6)	0	
Number of Ligaments Involved			
2	37 (66.1)	6 (66.7)	[a]1.000
3	19 (33.9)	3 (33.3)	
Mechanism of Injury			
RTA	41 (73.2)	8 (88.9)	[a]0.433
Sport	15 (26.8)	1 (11.1)	
Time from injury to surgery (months)			[b]0.447
Median (IQR)	22.0 (35.0)	42.0 (45.0)	
Factors	**Chondral Lesion (N = 65)**		**p value**
	Present (N = 55) n (%)	**Absent (N = 10) n (%)**	
Age			
Below 35	36 (65.5)	7 (70.0)	[a]1.000
Above 35	19 (34.5)	3 (30.0)	
Ethnicity			
Malay	47 (85.5)	9 (77.8)	
Chinese	1 (1.8)	0	[a]0.333
Indian	6 (10.9)	0	
Others	1 (1.8)	0	
Gender			
Male	44 (80.0)	10 (100)	[a]0.190
Female	11 (20.0)	0	
Number of Ligaments Involved			
2	34 (61.8)	9 (90.0)	[a]0.145
3	21 (38.2)	1 (10.0)	

Continued

Mechanism of Injury			
RTA	41 (74.5)	8 (80.0)	[a]1.000
Sport	14 (25.5)	2 (20.0)	
Time from injury to surgery (months)			[b]0.002
Median (IQR)	25.0 (40.0)	12.0 (18.0)	

[a]Fisher Exact Test, [b]Mann-Whitney Test.

For meniscus lesions, out of the 65 patients in the study, 56 (86.2%) were found to have meniscal lesions, while 9 patients (13.8%) did not. Analysis of demographic and clinical factors revealed no statistically significant differences in the presence of meniscal lesions. Age did not appear to influence lesion occurrence, with no significant difference observed between patients younger and older than 35 years ($p = 1.000$). While a higher proportion of lesions was noted among males (80.4%), this finding was not statistically significant ($p = 0.337$). Ethnicity also showed no significant association with the presence of meniscal lesions ($p = 0.167$), although Malay patients comprised the majority of the cohort. Similarly, the number of ligaments involved—whether two (66.1%) or three (33.9%)—did not significantly affect the rate of meniscal injury ($p = 1.000$). Meniscal tears were more frequently seen in patients whose injuries resulted from road traffic accidents (73.2%), yet this trend was not statistically significant ($p = 0.433$). Lastly, the median time from injury to surgery was longer among those without meniscal lesions (42.0 months) compared to those with lesions (22.0 months), but the difference did not reach statistical significance ($p = 0.447$).

Chondral lesions were identified in 55 patients (84.6%), while 10 patients (15.4%) showed no such damage. Analysis of age, gender, and ethnicity revealed no statistically significant differences in the occurrence of chondral lesions among these demographic groups. Although a higher proportion of chondral injuries was observed in patients with three-ligament injuries (38.2%), this was not statistically significant ($p = 0.145$). The mechanism of injury also showed no significant correlation with chondral damage ($p = 1.000$). However, a significant association was found between the time from injury to surgery and the presence of chondral lesions. Patients with chondral damage had a median delay of 25 months before undergoing surgery, significantly longer than the 12-month median delay observed in patients without chondral lesions ($p = 0.002$). This finding suggests that delayed surgical intervention may contribute to an increased risk of chondral deterioration.

These results show that meniscal lesions were common but not significantly influenced by demographic or surgical timing factors. In contrast, chondral lesions were significantly associated with longer delays from injury to surgery, emphasizing the importance of timely surgical intervention to prevent progressive cartilage damage. These results align with previous studies indicating meniscal tears are prevalent in multiligament knee injuries regardless of mechanism [1] and

chondral injuries correlate strongly with delayed treatment due to ongoing mechanical instability and cartilage wear [2] [24].

Figure 1 shows that among patients with multiligament knee injuries, a substantial proportion exhibited associated intra-articular pathology. Isolated meniscal tears were observed in 10.8% of cases, while 9.2% had isolated chondral lesions. Notably, 75.4% of patients sustained both meniscal and chondral damage, highlighting the high incidence of combined intra-articular injuries in this population. Only a small minority (4.6%) showed no evidence of intra-articular involvement. These findings reflect a significant burden of joint pathology in multiligament knee injuries, with the majority of patients experiencing combined lesions. This pattern is consistent with existing literature, which suggests that the high-energy mechanisms typically responsible for multiligament injuries often result in extensive intra-articular trauma [1] [24]. The predominance of combined injuries underscores the importance of thorough arthroscopic evaluation during surgical planning to ensure comprehensive management of all associated intra-articular lesions.

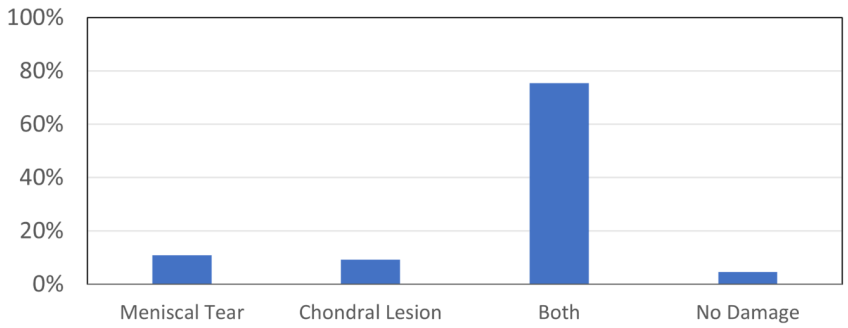

Figure 1. Percentage of associated injuries.

Figure 2 shows the distribution of patients based on time since injury to surgical intervention is as follows:

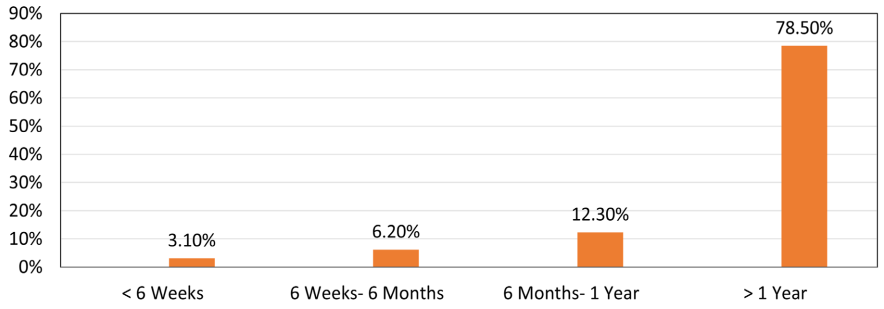

Figure 2. Percentage of patients by time since injury to surgery.

A significant proportion (78.5%) underwent surgery more than 1 year after injury, indicating substantial delays in treatment. Only 9.3% of patients had surgery within 6 months.

This delay may reflect healthcare system limitations, socioeconomic factors, or

delayed diagnosis/referral. Importantly, the earlier statistical analysis showed a direct correlation between surgical delay and increased incidence of chondral damage, supporting the concern that prolonged instability contributes to joint degeneration [2].

These results show that combined intra-articular damage (meniscus + cartilage) is the norm in multiligament injuries. The delay in surgery in >75% of patients is concerning, especially in view of the degenerative changes observed with longer intervals. These findings support early referral and definitive treatment to potentially reduce secondary damage.

5. Discussion

This study investigated the epidemiological patterns and associated intra-articular lesions, specifically meniscal and chondral injuries in patients with multiligament knee injuries (MLKIs) managed at a single tertiary center. Our findings reveal a high prevalence of associated meniscal and chondral damage, with a significant delay between injury and surgical intervention in the majority of patients.

Prevalence of Meniscal and Chondral Lesions

A strikingly high proportion of patients exhibited concomitant intra-articular pathology, with 86.2% presenting with meniscal tears and 84.6% with chondral lesions. Notably, 75.4% of patients had both types of injuries. These findings are consistent with prior studies that highlight the high rate of intra-articular injuries in MLKI cases due to the high-energy mechanisms involved [1] [24]. The high incidence of both meniscal and chondral injuries also supports previous findings that articular damage is common in MLKI due to mechanical overload and instability [24] [25].

Mook *et al*. [2] reported that meniscal injuries occur in up to 80% of MLKI patients, while chondral injuries may be found in more than 70%, particularly in chronic cases. The extent of articular damage is often underestimated on preoperative imaging, underscoring the importance of diagnostic arthroscopy during reconstruction [25].

Delayed Surgical Intervention

Several factors contributed to the delayed surgical intervention observed in this study. Firstly, the public healthcare system often faces constraints in operating theatre availability and specialist scheduling, leading to longer waiting times. Secondly, socioeconomic barriers such as limited transportation, employment commitments, and lack of insurance or financial resources may delay patients' access to definitive care. Thirdly, a lack of early recognition or referral from primary care settings can prolong the diagnostic pathway. These systemic and patient-level factors cumulatively result in treatment delays that may exacerbate cartilage degeneration.

A major finding in this cohort is the significant delay to surgery, with 78.5% of patients undergoing reconstruction more than one year post-injury. The median time to surgery was 22.0 months (IQR: 13.0 - 50.0). Delays were primarily attributable to late referrals, delayed diagnosis, and resource limitations—common issues

in public tertiary care systems in developing countries [17].

Prolonged delay from injury to surgery was significantly associated with the presence of chondral lesions ($p = 0.002$), highlighting the degenerative cascade that may occur in untreated knee instability. This statistical significance between delayed surgical intervention and chondral lesions aligns with research suggesting that prolonged joint instability exacerbates cartilage degeneration [15]. In contrast, time to surgery did not show a significant association with the presence of meniscal lesions ($p = 0.447$), which may reflect the acute nature of meniscal damage in multiligament trauma.

Recent literature also supports this, including a 2023 multicenter study published in the American Journal of Sports Medicine, which demonstrated that delays beyond 6 months were associated with significantly increased cartilage wear and lower postoperative IKDC scores [26].

Mechanism and Pattern of Injury

Road traffic accidents (RTAs), being high-energy events, often result in greater mechanical stress transmitted across the knee joint, leading to more complex injury patterns, including bicruciate ligament tears and extensive chondral damage. In contrast to sports-related trauma, RTAs are more likely to involve multiple impact vectors and higher velocity, contributing to the high rate of associated intra-articular lesions observed in our cohort. This reinforces the notion that the injury mechanism directly influences severity and surgical complexity.

The most common mechanism of injury in this study was road traffic accidents (RTA), accounting for 75.4%, followed by sports-related trauma (24.6%). These findings are consistent with other Asian and developing nation cohorts where RTAs remain a major cause of MLKIs [4]. Western studies, in contrast, often report sports as the leading cause, particularly in athletic populations [13].

Two ligaments were involved in **66.2%** of cases, and three ligaments in **33.8%**. This distribution aligns with studies suggesting that bicruciate ligament injury combined with a collateral ligament (e.g., ACL + PCL + MCL/LCL) represents the typical pattern in MLKIs [11].

Demographic Trends

Although no statistically significant differences were observed across ethnic groups, potential disparities in access to care, health-seeking behavior, and rehabilitation adherence may influence outcomes. Cultural beliefs about injury, socioeconomic status, and geographical proximity to tertiary centers can affect the timeliness of intervention and follow-up. Future studies with larger sample sizes are needed to evaluate these ethnic and sociocultural influences more robustly.

The study population was predominantly male (83.1%), with a mean age of 31.66 years, which is in line with other epidemiological studies of MLKI [12]. The male predominance likely reflects greater exposure to high-energy trauma through occupational and vehicular risks.

Age was dichotomized at 35 years based on prior orthopedic literature indicating that patients above 35 years tend to have a higher incidence of degenerative

joint changes, slower recovery, and different biological healing responses compared to younger individuals. Several studies in sports medicine and knee ligament reconstruction use 35 years as a practical threshold to distinguish between "younger athletic" and "older" patient cohorts due to differences in tissue quality, meniscal repair potential, and chondral health [12] [25].

While no statistically significant associations were found between gender, age, ethnicity, or the number of ligaments involved and the presence of intra-articular lesions, the small sample size limits statistical power. Nonetheless, the observed trends suggest potential demographic risk patterns that warrant further exploration in larger multicenter studies.

Rehabilitation Strategies and Outcomes

Postoperative rehabilitation plays a critical role in restoring function, range of motion, and strength following MLKI surgery. Typically, a phased protocol is followed, starting with early mobilization and progressing to strength and proprioceptive training. The absence of rehabilitation outcome data in this study is a limitation; however, existing literature suggests that structured rehabilitation is essential for optimal functional recovery and minimizing long-term complications such as stiffness or graft failure.

6. Conclusions

This study highlights the significant burden of intra-articular injuries, particularly meniscal and chondral lesions, in patients with multiligament knee injuries (MLKIs) treated at a tertiary center. The findings demonstrate that these associated lesions are highly prevalent, with over 85% of patients exhibiting meniscus or cartilage damage. Importantly, the data show a strong association between delayed surgical intervention and the incidence of chondral lesions, reinforcing the detrimental effects of prolonged joint instability.

The predominance of road traffic accidents as the primary mechanism of injury in this cohort reflects the socio-environmental context of the population studied. Additionally, the high percentage of patients undergoing surgery more than one year after injury underscores systemic healthcare delays that contribute to secondary joint degeneration.

The study's results emphasize the need for early recognition, appropriate referral, and timely surgical management in MLKI cases. A multidisciplinary approach involving primary care providers, orthopedic surgeons, and rehabilitation services is critical to optimize outcomes. Furthermore, policymakers and hospital administrators should recognize the long-term consequences of delayed care and invest in improving trauma care pathways and access to orthopedic services.

In conclusion, prompt surgical intervention following MLKI may help preserve joint structures and prevent irreversible degeneration. This study adds valuable regional data to the global understanding of MLKI and emphasizes the importance of healthcare system readiness in managing these complex injuries. Future prospective, multicenter studies are recommended to validate these findings and sup-

port evidence-based guidelines for MLKI management in Southeast Asia and similar healthcare settings.

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Ethical Clearance

Ethical clearance from NMRR and MREC. NMRR ID-24-03891-ZLP (IIR).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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