

Correlation of Detachment of Proximal Tibia Superficial Medial Collateral Ligament and Medial Meniscus Extrusion with Knee Osteoarthritis

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Learning Point of the Article:

Proximal Tibial sMCL detachment and Medial Meniscus extrusion can be used as prognostic factors for the progression of knee Osteoarthritis.

Abstract

Introduction: The aim of the study is to assess the correlation of detachment of proximal tibia superficial medial collateral ligament (sMCL) and medial meniscus (MM) extrusion with knee osteoarthritis (OA) and its progression.

Materials and Methods: This is a prospective study where 165 knees were evaluated using radiographs and magnetic resonance imaging for the severity of OA knee according to Kellgren-Lawrence grading, MM extrusion, and status of proximal tibia attachment of sMCL. Chi-square test of Independence and Pearson's correlation test were used to assess any correlation among the variables.

Results: The study population had a mean age of 52.93 + 19.46 years. 106 (64.24%) were males and 59 (35.75 were females). There were 83 (50.30%) left knees and 82 (49.70%) right knees in the study. The percentage of proximal tibia sMCL detachment was more in patients with knee OA than those without OA (85–88.89%). Similarly, the percentage of MM extrusion was maximum in advanced arthritis patients (95%). Both these variables were lowest in non-arthritic group (2.56% and 6.41%, respectively). Statistical analysis showed a significantly positive correlation of detachment of proximal tibia attachment of sMCL as well as MM extrusion with grades of OA of knee ($P < 0.001$ for both).

Conclusion: A detached proximal tibia sMCL and an extruded MM were individually found to have a strong association (Chi-square test) and a positive linear correlation (Pearson's test) with the arthritic condition of the knee. This would suggest a role of both these variables in the progression of knee OA. They can thus be used as prognostic markers for knee OA as well as an important target in the management of knee OA.

Keywords: Meniscus extrusion, superficial medial collateral ligament, osteoarthritis knee, superficial medial collateral ligament, medial meniscus, prognostic factors, OA progression.

Introduction

Knee osteoarthritis (OA) is the most common chronic joint disease in the world, affecting the articular cartilage and exposing the subchondral bone [1]. There is progressive pain, stiffness, and reduced mobility, eventually deteriorating the joint function [2]. Along with affecting the quality of life of the patients, OA also poses a burden on global public health [3]. Depending on

the grade of OA, there is a battery of treatments available, namely conservative treatment with medications and physiotherapy; minor interventions such as intra-articular steroids, platelet-rich plasma, prolotherapy, and viscosupplementation; and surgical interventions such as chondroplasty, osteotomies, and lastly partial or total knee replacement. Most of the times, orthopedicians are required to make these judgments based on

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Table 1: Study demographics

Variables	Values (%)	
Age	Mean–52.93	Standard deviation–19.46
Gender	Males–106 (64.24)	Females–59 (35.75)
Side	Right–82 (49.69)	Left–83 (50.30)
Detached sMCL	77 (46.67)	
MM extrusion	79 (47.87)	
OA	No OA group	78 (47.27)
	K-L Grade 1 and 2	27 (16.36)
	K-L Grade 3 and 4	60 (36.36)

sMCL: Superficial medial collateral ligament, MM: Medial meniscus, OA: osteoarthritis, K-L: Kellgren- Lawrence

Table 2: Observed values according to groups

Groups	Detached sMCL (%)	MM extrusion (%)
No OA	2.56	6.41
Grade 1 and 2 OA	88.89	62.96
Grade 3 and 4 OA	85	95

sMCL: Superficial medial collateral ligament, MM: Medial meniscus, OA: osteoarthritis

Table 3: Statistical analysis

Variables	Tests	Result	Interpretation
Proximal tibia sMCL detachment and grades of OA	Chi-square test of independence	P<0.001	Detachment of sMCL from proximal tibia has a statistically significant association with knee OA progression. There is a strongly positive linear correlation between the two.
	Pearson correlation	R=0.7938	
MM extrusion and grades of OA	Chi-square test of independence	P<0.001	MM extrusion has a statistically significant association with knee OA progression. There is a strongly positive linear correlation between the two.
	Pearson correlation	R=0.8713	
MM extrusion and proximal tibia sMCL detachment	Pearson correlation	R=0.7494	MM extrusion has a moderately positive linear correlation with the detachment of proximal tibia sMCL.

sMCL: Superficial medial collateral ligament, MM: Medial meniscus, OA: osteoarthritis

analysis of risk factors, symptoms, signs, and results of imaging and laboratory examinations [4]. However, there are instances where selection of adequate treatment becomes dilemmatic due to factors such as clinic-radiological mismatch, borderline age group, and obesity. [5]. Therefore, identifying specific diagnostic and prognostic parameters for knee OA has become the need of the hour. In literature, many parameters such as hyaluronic acid level, baseline radiographic reduction in joint space, quadriceps strength, gender, general activity level, and previous knee injury have been associated with OA prognosis [6]. It is often observed that magnetic resonance imaging (MRI) showing arthritic changes in the knee also shows concomitant morphological changes in the proximal tibial attachment of superficial medial collateral ligament (sMCL) and medial meniscus (MM) extrusion to some extent. However, there is no substantial research that links non-traumatic changes in proximal tibia sMCL with knee OA. Similarly, more studies are needed to establish a linear relationship between MM extrusion and generalized knee OA.

Medial collateral ligament (MCL) is the most commonly injured knee ligament [7]. The superficial layer of the MCL (sMCL), being the prime medial stabilizer, comprises anterior fibers that are oriented vertically and attach to proximal tibia at 12 mm distal to articular surface (proximal attachment) and 6 cm distal to articular surface (distal attachment) [8,9].

MM is a crescent-shaped fibrocartilage in the knee functioning toward balanced force transmission, joint stability, joint congruity and lubrication [10, 11]. The collagen fibers in the meniscus are specifically aligned in a circumferential manner (hoop structure), which creates a biomechanical resistant against hoop stresses during weight bearing [12, 13].

Our study aims to comprehensively investigate and find a possible correlation between proximal tibia sMCL detachment and MM extrusion with knee OA.

Materials and Methods

Patients with chronic as well as recent onset knee pain were included in the study with valid consents and evaluated with routine knee radiographs and MRI. Those with a history of trauma or previous invasive interventions in the knee were excluded. We managed to enroll 165 patients in our study. Routine radiographs comprised of standing antero-posterior and lateral views. These were evaluated for OA, if any, according to Kellgren-Lawrence (K-L) grading system. Knee MRI was evaluated for MM extrusion and status of proximal tibial attachment of sMCL (attached or detached).

MRI assessment

sMCL was assessed in coronal plane, and the proximal attachment (approximately 12 mm from joint line) was observed whether attached or detached (Fig. 1).

MM was assessed in a coronal plane on a slice with the widest tibial plateau. It was considered extruded if it was displaced beyond the outermost border of the tibial plateau in mid-





Figure 1: Proximal tibia superficial medial collateral ligament (red arrow) (a) attached, (b) detached. Green arrows show sMCL distal attachment.

coronal plane [14]. The authors have devised a novel classification for easier understanding of the severity of meniscus injuries (Fig. 2).

Grading of meniscal injury

Grade 0: No injury (intact meniscus)

Grade 1: Meniscus tear present without extrusion

Grade 2: Limited meniscal extrusion with or without tear

Grade 3: Definite meniscal extrusion (defined as complete extrusion of meniscus beyond the line joining ends of articular surface of femoral and tibial condyles).

Grades 2 and 3 were considered in the MM extrusion group during the statistical analysis. Subjects were divided into 3 groups – No OA (K-L grade 0), mild-to-moderate OA (K-L grade 1, 2), and advanced OA (K-L grade 3, 4). Each group was studied for MM extrusion and proximal tibia sMCL status. Chi-square test of independence and Pearson’s correlation test were

used to establish possible association of these 2 variables with OA knee.

Results

A total of 165 patients were studied. The mean age of the study population was 52.93 ± 19.46 years. 106 (64.24%) were males and 59 (35.75%) were females. There were 83 (50.30%) left knees and 82 (49.69%) right knees. 78 (47.27%) patients had no OA (K-L grade 0). 27 (16.36%) had mild-to-moderate OA (grade 1 or 2). 60 (36.36%) patients had advanced OA (Grade 3 or 4) (Table 1). It was observed that the incidence of proximal tibia sMCL detachment was significantly higher in arthritic knees (85–88.89%) than in non-arthritic ones (2.56%). Similarly, MM extrusion was seen to be more in higher grades of OA (62.96–95%) as compared to no OA group (6.41%) (Table 2).

Statistical analysis (Table 3)

1. According to Chi-square test of Independence and Pearson’s correlation test, detachment of proximal tibia sMCL had a high statistically significant association and a strong positive correlation with the severity of OA knee ($P < 0.001$ and $r = 0.7938$). In other words, knees with detached proximal tibia sMCL had more severe OA progression.

The Chi-square statistic was 115.7194 with degree of freedom 2 $\chi^2(2, n = 165) = 115.72, P < 0.001$

The coefficient of determination (r^2) was 0.6301 $r(163) = 0.79, P < 0.00001$

2. MM extrusion showed similar correlation with OA which was strongly positive and highly significant ($P < 0.001$ and $r = 0.8713$). This signifies that more the extrusion of MM, higher



Figure 2: Grading of meniscal injury. (a) Grade 1 (Intact Meniscus). (b) Grade 2 (Meniscal tear without extrusion). (c) Grade 3 (Limited Meniscal extrusion). (d) Grade 3 (Definite Meniscal extrusion).



would be the OA grades.

The Chi-square statistic was 109.5972 with degree of freedom 2
 $\chi^2(2, n = 165) = 109.5972, P < 0.001$

The coefficient of determination (r^2) was 0.7592
 $r(163) = 0.87, P < 0.00001$

3. In addition, Pearson's correlation test also showed a moderately positive correlation of MM extrusion with proximal tibial sMCL detachment ($r = 0.7494$). In other words, proximal tibia sMCL detachment increases the chances of MM extrusion.

The coefficient of determination (r^2) was 0.5616
 $r(163) = 0.74, P < 0.00001$.

Discussion

The objective of this study is to establish proximal tibia sMCL detachment and MM extrusion as possible risk factors and prognostic variables for the progression of OA. The statistical analysis showed a significant and valid correlation supporting the above hypothesis. It is clear in the findings that higher grades of OA have higher chances of proximal tibia sMCL detachment and more MM extrusion. There are no previous studies linking detachment of proximal tibial sMCL directly to OA grades with such a remarkably positive correlation.

In 2015, Bastick et al. summarized numerous patient-related and disease-related prognostic factors such as bone marrow lesions, flexion contractures, subchondral cysts, and synovitis toward OA progression. However, proximal tibia sMCL detachment was not among them. Moreover, meniscal damage and extrusion could not be significantly associated with the disease [15].

Bierma-Zeinstra and Koes in their study found that there was a moderate to strong association of serum levels of hyaluronic acid with knee OA progression [16]. However, no other factors were found to have stronger evidence of being OA prognostic markers.

Heidari in his article in 2011 stated that joint laxity along with other factors could be considered for the prognosis of knee OA [17]. Similarly, another article by Sharma et al. found increased laxity as a strong prognostic factor for OA knee progression [18].

Lewek et al. stated that patients with significant medial knee laxity had high prevalence of OA than those with no laxity [19]. On the same lines, Conaghan et al. postulated that weak or damaged ligaments would lead to untoward laxity, causing abnormal weight distribution. This would ultimately damage the articular cartilage and cause OA [20]. The above examples make it clear that in the past, no research has been done to

specifically study the status of proximal tibia sMCL attachment along with MM extrusion and correlate them both to the progression of knee OA. The author has previously researched and published a study concluding that a detached sMCL proximal tibial attachment can be a strong predictor of OA knee progression [21]. This article studies a wider aspect and includes MM extrusion along with proximal tibia sMCL detachment to correlate with knee OA. This makes the study unique and gives researchers a vital thought to do further research upon.

Swamy et al. in 2018 stated that an extruded meniscus is not just a meniscal injury but can be an expression of other pathologies such as cartilage loss, ligament injuries, or OA [14]. Crema et al., in their article, concluded that meniscal extrusion could probably result from complex interactions between joint tissues and mechanical stresses in the OA process [22]. A recent prospective cohort study by Zeng et al. suggests that MM extrusion can be considered as a predictor of structural progression of knee OA [23].

In 2005, Kamekura et al., in their brilliant experiment, studied the direct effects of transection of various ligaments of the knee on knee cartilage in mice [24]. They found that the combination of MCL transection and medial meniscectomy caused cartilage destruction and osteophyte formation in the medial tibial plateau. Histological examination showed proliferation and shape change of chondrocytes at 2–4 weeks, cartilage destruction into the middle zone at 8 weeks, and osteophyte formation at 12 weeks. This article substantially supports our study and its results align with our finding that detachment of proximal tibial attachment of sMCL and MM extrusion contributes to progression of knee OA.

Limitations

Meniscus extrusion was studied in supine MRI which might be more on a weight-bearing study. Mechanical axis malalignment, which could be associated with OA knee progression, was not studied. Furthermore, MRI being an expensive modality, this evaluation would be costly and cumbersome.

Conclusion

Proximal tibial sMCL detachment and MM extrusion were statistically found to be significantly associated with knee OA and thus can be used as prognostic predictors for the progression of OA. Since these two variables are statistically interdependent, they can also be considered as medial meniscus-ligamentous complex failure, which can prognosticate about knee OA. A keen identification of the status of proximal tibia sMCL attachment might help us judge the laxity of the knee and

aid in decision-making while treating that knee conservatively as well as surgically. Similarly, correct diagnosis of MM extrusion and early repair of the associated lesion can slowdown OA progression and increase success rates of conservative treatments. As a future prospect, these measures in turn can lead to less number of prosthetic replacements and significantly benefit the quality of life of the patient and economy of the health system.

Clinical Message

A detached proximal tibia sMCL with extruded meniscus suggests an accelerated OA progression. Identifying these variables can help surgeons to decide about early interventions for preserving the knee, thus reducing the chances of future prosthetic replacements.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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