Is There an Association between Chronicity of Patellar Instability and Patellofemoral Cartilage Lesions? An Arthroscopic Assessment of Chondral Injury

Jeanne M. Franzone, M.D.[1] Mark A. Vitale, M.D., M.P.H.[1] Beth E. Shubin Stein, M.D.[2] Christopher S. Ahmad, M.D.[1]

[1] Department of Orthopaedics, Columbia University, New York, New York
[2] Department of Orthopaedics, Hospital for Special Surgery, New York, New York

Address for correspondence and reprint requests Christopher S. Ahmad, M.D., Department of Orthopaedics, Columbia University, 622 W. 168th Street, PH11C, New York, NY 10032 (e-mail: csa4@columbia.edu; mr2646@columbia.edu).

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Abstract

The purpose of this study was to investigate the association between chronicity of patellar instability on the prevalence, grade, and location of chondral lesions in patients with recurrent patellar instability. Patellofemoral chondral status was documented and graded according to the Outerbridge classification in 38 patients who underwent arthroscopic examination at the time of a medial patellofemoral ligament reconstruction procedure. Chondral lesions of any location were observed in 63.2% of patients. Patellar and trochlear lesions were observed in 57.9 and 13.2% of patients, respectively. There was a significantly higher duration of patellar instability in patients with a trochlear lesion versus those without a trochlear lesion ($p < 0.01$), and in patients with combined patellar and trochlear lesions versus those without both patellar and trochlear lesions ($p < 0.01$). There was a significant correlation between chronicity of patellar instability and Outerbridge grade of trochlear chondral injury ($p = 0.01$). Chi-squared analysis revealed that chronicity of patellar instability greater than 5 years was significantly associated with the likelihood of trochlear lesions ($p < 0.05$). We conclude that patients with increasing chronicity of patellar instability may have a higher likelihood of and higher grade of patellofemoral chondral injuries, specifically for trochlear lesions.

Keywords
- chronic patellofemoral instability
- chondral injury
- articular cartilage

Several studies have documented radiographic articular changes in the context of lateral patellar dislocation ranging from osteochondral fractures to contusions on the medial facet of the patella and the lateral trochlea.[1–3] These radiographic findings of osteochondral injury in the context of lateral patellar dislocation have been corroborated by operative findings.[4–6] While radiographic and operative findings have clearly established the link between patellar instability and subsequent patellofemoral chondral injury, it is less clear how the duration of patellar instability contributes to patellofemoral cartilage status. While it has been documented in the setting of anterior cruciate ligament (ACL) injuries that increasing duration of ACL instability and delay to surgery increase the likelihood of having secondary chondral lesions and meniscal injuries, such a relationship between chronicity of patellar instability and subsequent patellofemoral chondral injury has not been investigated.[7,8] Furthermore, although previous research has shown that recurrent patellar

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dislocations are more common among females and patients with a previous episode of instability, patella alta, trochlear dysplasia, and generalized ligamentous laxity[9–14] the relationship between these risk factors for recurrent patellar dislocation and subsequent patellofemoral cartilage injury have not been well studied.

The purpose of this study was to investigate the association between chronicity of patellar dislocation and prevalence, location, and grade of chondral lesions observed during arthroscopic evaluation in patients with chronic patellofemoral instability. The hypothesis was that increasing chronicity of patellar instability would be associated with increasing prevalence and grade of patellofemoral chondral injury.

Materials and Methods

Patient Study Group

The study group consisted of patients with recurrent patellar instability who underwent an open medial patellofemoral ligament (MPFL) reconstruction[15] by the two senior authors from January 2005 to March 2010. This study was approved by the institutional review boards at both institutions at which patients were treated. Inclusion criteria were: (1) a history of symptomatic recurrent patellar instability (i.e., two or more episodes of patellar dislocation with associated symptoms), (2) positive moving patellar apprehension test for patellar instability,[16] and (3) positive finding for patellar dislocation during examination under anesthesia. This yielded a total of 48 patients. Exclusion criteria included: (1) previous knee surgery ($n = 3$), and history of subluxation in the absence of frank dislocation ($n = 7$). Patellar subluxation was defined as a sensation of lateral patella translation that did not require a reduction maneuver to resolve, in contrast to patellar dislocation which was defined as a fixed laterally translated patella requiring a reduction maneuver to resolve. This yielded a final sample size of 38 patients.

Evaluation and Documentation

All patients underwent arthroscopic examination before MPFL reconstruction. Chondral lesions visualized arthroscopically were documented in a systematic fashion using the Outerbridge[17] classification scheme as well as a simple descriptive classification of lesion location (patellar, trochlear, or combined patellar and trochlear).

Charts were retrospectively reviewed for clinical details including demographic data, history of knee surgery, concurrent knee injuries, time of first episode of patellar instability, number of episodes of patellar instability, and diagnosis of general ligamentous laxity.

Chronicity of instability was defined as the number of years from the initial episode of instability reported by the patient to arthroscopic evaluation at the time of MPFL reconstruction. The number of episodes of patellar dislocation was determined as documented in the medical records. Patellar dislocation was documented as reported by patients as not all such episodes were radiographically documented.

Clinical assessment of generalized ligamentous laxity relied upon the Beighton and Horan[18] modification of the Carter and Wilkinson[19] criteria. This scale of hypermobility uses five maneuvers to assess laxity: (1) passive dorsiflexion of the little fingers beyond 90 degrees with the forearm flat on the table, (2) passive apposition of the thumbs to the flexor aspects of the forearms, (3) hyperextension of the elbows beyond 10 degrees, (4) hyperextension of the knees beyond 10 degrees, and (5) forward flexion of the trunk, with the knees straight, so that the palms of the hands rest easily on the floor. One point is assigned for the ability to perform each of these actions and generalized ligamentous laxity is defined as a score $\geq$4 points.

Preoperative radiographs were reviewed to assess patella alta and trochlear dysplasia. Patella alta was defined as a Blackburne and Peel index greater than 1.0 measured on a standard preoperative lateral knee radiograph with the knee flexed to 30 degrees.[20] The same preoperative lateral knee radiographs were qualitatively assessed for trochlear dysplasia according to the presence or absence of the Dejour crossing sign.[14]

Statistical analyses were performed using independent sample *t* tests to determine the association between chronicity of patellar instability and the presence of chondral lesions and Pearson correlation analyses to determine the association between chronicity of patellar instability and grade of chondral lesions. Both univariate and multivariate analyses were performed to investigate the influence of other selected factors on the presence of patellofemoral chondral lesions, the dependent variable. The variables that were examined as potential predictors (independent factors) were age at time of first dislocation, gender, chronicity of instability, number of dislocations, ligamentous laxity, patella alta, and trochlear dysplasia. Univariate chi-square analyses were performed to test for a significant association between each of these risk factors and the presence of either patellar lesions, trochlear lesions, or combined patellar and trochlear lesions. To build logistic regression models which could be interpreted statistically, the continuous variable of age at time of first dislocation was recoded as a dichotomous variable above 10 years of age (as we postulated that there would be a difference in the prevalence and grade of chondral lesions at this age when patellar ossification is complete in females, corresponding to the average age of onset of 10[21]), the continuous variable of chronicity of instability was recoded as a dichotomous variable of instability greater than 5 years (based on the mean interval of instability before arthroscopic assessment in this cohort which was 5.1 years), and the continuous variable of number of dislocations was recoded as a dichotomous variable of more than four dislocations (based on the mean number of patellar dislocations before arthroscopic assessment which was 4.4 episodes). Three separate multivariate regression models were created to look at the influence of these risk factors on the likelihood of a trochlear lesion, a patellar lesion, and both trochlear and patellar lesions. Variables were eligible for entry into the model if they were significantly associated with a chondral lesion in the univariate analysis. Statistical analyses were performed using SPSS 17.0 (IBM Corporation, Armonk, NY), with a p value of 0.05 required for statistical significance. All tests were two-tailed.

Table 1 Demographic and Injury Characteristics

	Percentage	Mean (SD)
Age at first dislocation (y)		16.0 (±6.6)
Age at arthroscopic assessment (y)		21.0 (±7.4)
Gender (% female)	65.8%	
Laterality (% right)	55.3%	
Previous knee surgery (%)	21.1%	
Number of preoperative patellar dislocations (N)		4.4 (±4.8)
Ligamentous laxity (%)	28.9%	
Patella alta (%)	43.5%	
Trochlear dysplasia (%)	39.5%	
Duration of patellar instability (y)		5.1 (±6.7)

SD, standard deviation.

Results

Demographics and Injury Characteristics

Demographic data are summarized in ►**Table 1**. All patients underwent an arthroscopic assessment of chondral status before open MPFL reconstruction, but several patients underwent additional concurrent procedures at the time of surgery, including lateral releases (65.8%) as well as chondroplasty to the patella (36.8%), trochlea (5.3%), tibial plateau (5.3%), and femoral condyles (5.3%). Graft choices for MPFL reconstruction included semitendinosus autograft (60.5%), gracilis autograft (23.7%), semitendinosus allograft (13.2%), and tibialis anterior allograft (2.6%).

Arthroscopic Findings

There was a high rate of chondral lesions overall, with 24 of 38 patients (63.2%) having a patellofemoral chondral lesion of any location observed at the time of arthroscopy at an average of 5.1 years (standard deviation [SD] = 6.5, range = 0.1 to 26.9 years) from initial episode of instability to arthroscopic evaluation at time of MPFL reconstruction. Lesions of the patella were most common; 57.9% of all patients had patellar chondral lesions, 13.2% had lesions of the trochlea, and 10.5% had combined patellar and trochlear lesions. With respect to the 57.9% of patients with lesions of the patella, 72.7% of those lesions were on the medial facet, 9.1% on the central dome, 9.1% on the lateral facet, and 9.1% were diffuse patellar lesions. The mean Outerbridge grades of patellar and trochlear lesions were 1.6 ± 1.5 and 0.4 ± 1.1, respectively.

Chronicity of Instability and Presence of Patellofemoral Lesions

There was no significant difference in the mean number of years of patellar instability in those with a patellar chondral injury versus those without a patellar chondral injury ($p = 0.660$). Independent sample t test analyses revealed a significantly higher number of years of patellar instability in those patients with trochlear lesions (mean = 12.6 years, SD = 9.8) versus those without trochlear lesions (mean = 3.9 years, SD = 5.1) ($p = 0.004$), as well as in patients with combined trochlear and patellar lesions (mean = 14.1 years, SD = 9.7) versus those without combined trochlear and patellar lesions (mean = 4.0 years, SD = 5.2) ($p = 0.002$).

Chronicity of Instability and Grade of Chondral Lesion

Pearson correlation analyses revealed no correlation between chronicity of patellar instability and Outerbridge grade of patellar chondral injury ($r = 0.10$, $p = 0.545$). There was a significant correlation between chronicity of patellar instability and Outerbridge grade of trochlear chondral injury ($r = 0.41$, $p = 0.012$).

Chi-Square Univariate Analysis

The results of the univariate chi-square analysis are summarized in ►**Table 2**. These analyses indicated that age at time of first dislocation greater than 10 years was significantly associated with the likelihood of trochlear and combined trochlear and patellar lesions, but not with the likelihood of patellar lesions. Furthermore, chronicity of patellar instability greater than 5 years was significantly associated with the likelihood of trochlear, but not patellar or combined trochlear and patellar lesions. A Pearson correlation analysis indicated a poor correlation between the number of years of chronicity of patellar instability and age in years at time of first dislocation ($r = -0.36$), therefore these two factors were entered into the multivariate regression analyses as independent factors for all three models of patellofemoral chondral injury.

Multivariate Regression Analysis

The model for patellar chondral lesions indicated that neither age at time of first dislocation nor chronicity of patellar instability predicted the likelihood of patellar chondral lesions. This model had a Nagelkerke R^2 of 0.018. The model for trochlear chondral lesion likewise indicated that neither age at time of first dislocation nor chronicity of patellar instability predicted the likelihood of trochlear lesions. This model had a Nagelkerke R^2 of 0.261. Lastly, the model for combined patellar and trochlear lesions indicated that neither age at time of first dislocation nor chronicity of patellar instability

Table 2 Univariate Chi-Square Analysis (Relationship of Variables with Presence of Patellofemoral Chondral Lesions)[a]

Variable	Location of Lesion	Variable Absent	Variable Present	*p* Value
Age at first dislocation >10 y	Patellar	66.7% (6/9)	53.6% (15/28)	0.49
	Trochlear	33.3% (3/9)	7.1% (2/28)	0.05[b]
	Combined patellar and trochlear	33.3% (3/9)	3.6% (1/28)	0.01[b]
Male gender	Patellar	56% (14/25)	61.5% (8/13)	0.74
	Trochlear	12%(3/25)	15.4% (2/13)	0.77
	Combined patellar and trochlear	8% (2/25)	15.4% (2/13)	0.48
Chronicity of patellar instability >5 y	Patellar	54.2% (13/24)	61.5% (8/13)	0.67
	Trochlear	4.2% (1/24)	30.8% (4/13)	0.02[b]
	Combined patellar and trochlear	4.2% (1/24)	23.1% (3/13)	0.08
More than four patellar dislocations	Patellar	54.5% (12/22)	75.0% (9/12)	0.24
	Trochlear	9.1% (2/22)	16.7% (2/12)	0.51
	Combined patellar and trochlear	4.5% (1/22)	16.7% (2/12)	0.23
Ligamentous laxity	Patellar	55.6% (15/27)	63.6% (7/11)	0.65
	Trochlear	11.1% (3/27)	18.2% (2/11)	0.56
	Combined patellar and trochlear	11.1% (3/27)	9.1% (1/11)	0.85
Patella alta	Patellar	53.8% (7/13)	50% (5/10)	0.86
	Trochlear	23.1% (3/13)	10% (1/10)	0.41
	Combined patellar and trochlear	23.1% (3/13)	10% (1/10)	0.41
Trochlear dysplasia	Patellar	56.5% (13/23)	60% (9/15)	0.83
	Trochlear	17.4% (4/23)	66.7% (1/15)	0.34
	Combined patellar and trochlear	87% 2/23)	13.3% (2/15)	0.65

[a]Data reported as percentage (count).
[b]Statistically significant difference at $p < 0.05$ by chi-square test.

predicted the likelihood of combined patellar and trochlear chondral lesions. This model had a Nagelkerke R^2 of 0.286.

Discussion

This retrospective study investigated the influence of chronicity of patellofemoral instability and other possible risk factors on the incidence, location, and grade of patellofemoral chondral lesions in 38 patients with symptomatic recurrent patellar instability as observed arthroscopically at the time of surgical stabilization of the patella. The results of this study indicate a high overall rate of patellofemoral chondral injuries in patients with recurrent patellar instability affecting almost two-thirds of patients. Patellar chondral lesions were observed more frequently than trochlear chondral lesions. It must be noted that there was a mean interval of 5.1 years between initial episode of instability and surgery yielding relatively long period of time to develop chondral lesions in the setting of recurrent patellar instability.

These findings are consistent with previous research, although a wide range of rates and locations of articular chondral lesions have been reported. For instance, in an arthroscopic examination of 39 patients undergoing lateral retinacular release for recurrent patellar dislocation or subluxation Chen and Ramanathan[22] identified chondromalacia patellae and osteochondral fracture in 33 and 31% of patients evaluated, respectively. Dandy and Griffiths[23] similarly noted abnormalities on the articular cartilage of the patella at arthroscopy in 41.5% of 41 patients undergoing lateral release for recurrent patellar dislocation. More recently, Nomura and Inoue[5] in an investigation of 57 patients with recurrent patellar dislocation found patellar cartilage lesions in 96% of knees examined either arthroscopically or under direct visualization. Furthermore, Luhmann et al,[4] utilizing arthroscopic assessment at the time of patellar realignment surgery, identified patellar and femoral osteochondral lesions in 73 and 23% of 38 patients, respectively. Utting et al[24] performed 59 trochleoplasties on 54 patients with either patellofemoral instability or chronic patellar dislocation associated with trochlear dysplasia, with intraoperative findings of a macroscopically normal and abnormal patellofemoral articular surface in 19 and 37 knees, respectively. They found abnormal trochlear cartilage in 12 (20%) of the 59 knees.

Although the results need to be interpreted with caution in the appropriate context, the current investigation identified a modest association between chronicity of instability and likelihood and grade of patellofemoral chondral injury. Specifically, patients with both patellar and trochlear chondral lesions as well as those with isolated trochlear chondral lesions experienced a significantly longer duration of patellar

instability as measured by time from initial episode of instability to time of arthroscopic evaluation. There was a correlation between chronicity of instability and the grade of trochlear chondral injury as assessed by the Outerbridge grading system. Furthermore, univariate regression revealed that chronicity of instability greater than 5 years was associated with a significantly increased likelihood of trochlear lesions. It should be noted that the cutoff of 5 years was empirically based on the mean value of chronicity of instability for patients in this cohort, as there are no previously established clinical cutoffs for when chronicity of instability may impart an effect; these results do not imply that 5 years is a critical number per se in the increasing risk of chondral lesions, but it does provide further evidence that patients with patellar instability that is present for a greater number of years is associated with a greater likelihood of patellofemoral chondral lesions. Controlling for age at time of instability, the multivariate model failed to identify a significant association between chronicity of instability and presence of chondral lesions, and we speculate that the results may have been more robust with a larger sample size.

There have been no investigations to the best of our knowledge which have specifically investigated a relationship between chronicity of instability and likelihood and grade of patellofemoral chondral injury, although previous research by Nomura and Inoue documented a subset of chondral lesions worsening over time in the setting of patellar instability.[25] Second-look arthroscopic evaluation in patients with patellar instability led the authors to conclude the pathogenesis of cartilage lesions in the setting of recurrent patellar dislocation may be related to reparative reaction, degradation, and repeated trauma, and concluded "the continuation of patellar dislocation definitely makes the patellar cartilage lesions worse."

Our analysis examined the effects of several potential risk factors—including age at the time of first dislocation, gender, the number of dislocation episodes, ligamentous laxity, patella alta, and trochlear dysplasia—as possible confounders on the relationship between chronicity of instability and presence of lesions. These potential risk factors were selected either because of previous findings or because of clinical judgment suggesting that these factors may contribute to the likelihood of patellofemoral lesions in the setting of chronic patellar instability. For example, patella alta has been long associated with idiopathic symptomatic chondromalacia patellae, patellofemoral pain syndrome, and recurrent patellar dislocation.[10,13,26] Although generalized ligamentous laxity and trochlear dysplasia are considered risk factors for recurrent patellar dislocation,[12,14] it is possible that these conditions also simultaneously protect the patellofemoral articular surfaces because required forces to dislocate the patella are smaller. Furthermore, the shear forces of lateral patellar movement have been associated with patellofemoral cartilage degeneration in operative and animal studies,[27,28] suggesting that the number of dislocations may play a role in the development of patellofemoral chondral lesions. In our univariate analysis, however, only the variable of age at time of first dislocation had an effect on the likelihood of chondral lesions, as patients who had a first dislocation at the age of 10 years or younger were more likely to have a chondral lesion observed at time of arthroscopy. While we are unaware of previous studies that have found an increased risk of patellofemoral chondral injury in patients with younger age at time of first dislocation, it has been established that younger age among first-time dislocators is associated with a greater tendency to undergo recurrent dislocation.[29] Furthermore, we speculated that dislocation before physeal closure compared with after physeal closure may influence the result of chondral lesions.

There are several limitations in this study. First, the results of the study assessed a population of patients with recurrent symptomatic patellar instability electing to undergo MPFL reconstruction; as such these results cannot be generalized to patients with a single episode of patellar instability nor those who do not elect operative management. A second limitation is that as a retrospective study there may have been a recall bias for some risk factors, such as a patient's report of the first episode of instability or the number of patellar dislocations or subluxations experienced. However, patients were asked about their history of dislocations and subluxations at the time of each office visit as opposed to at the time of surgery or later, thus minimizing this potential bias. Another limitation is the relatively small sample size of this study. In fact, we hypothesized that chronicity of patellar instability would affect the likelihood of not only trochlear lesions but also patellar lesions, and while there was a trend for chronicity of instability to increase the likelihood of patellar lesions, the failure of this relationship to reach statistical significance may be a reflection of this small sample size resulting in insufficient power to detect such a difference. A further limitation is related to inadequacies with the current grading systems for patellofemoral cartilage damage in this cohort. The Outerbridge classification system,[17] initially designed to describe chondromalacia of the patella, is a descriptive system that is location-independent. The Fulkerson classification system[30] not used in this study is a qualitative system of patellar lesions only and does not describe the trochlear lesions that were present in this cohort. The Noyes articular cartilage grading system[31] also not used in this study offers both a qualitative and quantitative assessment of cartilage lesions of the knee and includes an assessment of cartilage injury location, but due to its weighting of lesions in the medial and lateral tibiofemoral compartments is not sufficiently sensitive for isolated patellofemoral lesions. The limitations of currently published knee cartilage injury grading systems highlight a need for a sensitive grading system that is both specific to patellofemoral lesions and also includes injury location. Lastly, while we have demonstrated a relationship between chronicity of patellar instability and number of episodes of instability on subsequent patellofemoral articular lesions, it is unclear how these lesions may affect health-related quality of life in these patients. While the current data suggest a causative role for increasing chronicity of patellar instability on the subsequent development of patellofemoral chondral lesions, future randomized prospective investigation would be warranted to further elucidate this relationship.

This retrospective investigation demonstrates a high rate of patellofemoral chondral injuries in patients with recurrent instability as well as an association between chronicity of instability and patellofemoral chondral injuries, particularly trochlear injuries.

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