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Prevalence of Pathologic Plica Following Anterior Cruciate Ligament Injury

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BACKGROUND/AIMS
The present study was designed to determine the relationship between the time from anterior cruciate ligament injury to operation as well as the presence of pathologic plica. We also assessed the relationship between the presence of pathologic plica and plica-associated cartilage injury as well as preoperative anterior knee pain.

MATERIAL and METHODS
All the data for this retrospective observational study was obtained from hospital records and arthroscopy videos. Preoperative complaints, such as giving-way episodes, anterior knee pain, and knee locking, and intraoperative findings, such as the presence and absence of the pathologic plica, cartilage injury, and meniscus lesion were evaluated. Patients operated within 3 mon of the injury and those operated ≥ 3 mon after the injury were classified into Group I and Group 2, respectively.

RESULTS
We enrolled 76 patients; group I included 46 patients, and group 2 comprised 30 patients; all the patients underwent anterior cruciate ligament reconstruction. The rate of preoperative anterior knee pain and pathologic plica formation was significantly higher in group 2 ($p<0.05$) as compared to that in group I. The reported preoperative anterior knee pain and cartilage injury in the pathologic plica positive group was significantly higher than that in the plica negative group ($p<0.05$).

CONCLUSION
Pathologic plica formation rate increases as the time period from anterior cruciate ligament injury to reconstruction increased. Preoperative anterior knee pain and intraoperative knee cartilage damage were more common in patients with pathologic plica. We recommend that pathologic plica investigation and resection be considered during anterior cruciate ligament reconstruction surgeries.

Keywords: Anterior cruciate ligament, reconstruction, anterior knee pain, suprapatellar plica, medial plica

INTRODUCTION

Synovial plica is a term that is used to define intraarticular folds that are remnants of the embryonic membranous septation of the joint and are accepted as normal structures of the knee joint that are observed incidentally during routine arthroscopy (1). Plica is classified into the following four distinct types. Infrapatellar plica is the most common plica; medial patellar plica has the highest potential to cause knee symptoms followed by suprapatellar plica; lateral patellar plica is very rare (2). As the plica is a remnant, plica of some size may exist in all knees. In most arthroscopic studies, the incidence of some kind of synovial plica was reported to be 70%–91% (2). Synovial plica rarely becomes symptomatic, usually following a knee trauma (1). In normal knees with no trauma, plica is thin, elastic, and harmless (3, 4). They could accommodate knee motions with no injury to the surrounding structures. Repetitive knee movements, trauma, and surgical knee interventions can cause irritation of the synovial plica. In this case, inflammation and hemarthrosis cause fibrosis and thickening of the plica (3). Impingement of the thickened plica may cause plica-related symptoms, such as anterior knee pain, recurrent knee effusion, giving way, clicking, and locking (5).

Diagnosis of plica syndrome can be challenging. The symptoms and clinical findings of plica syndrome have poor specificity and are similar to more common intraarticular pathologies, such as meniscal lesions and articular cartilage injuries (2).

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Imaging modalities are insufficient for diagnosis in most cases. Magnetic resonance imaging is able to demonstrate plica; however, this modality is ineffective for determining whether the plica is pathologic (6). The gold standard for the diagnosis of plica syndrome is knee arthroscopy because surgical treatment and further evaluation of the associated cartilage pathologies are possible during the same surgery.

Anterior cruciate ligament (ACL) injuries are common, and surgical reconstruction is the accepted treatment in young, active patients. During diagnostic arthroscopy that is performed to make a decision regarding reconstruction, plica structures are generally not evaluated in detail. We hypothesized that in some patients with ACL injury, the normal plical structures that existed before the trauma may become thicker and inelastic after a latent period, and plica-related mechanisms may be responsible for anterior knee pain. This study aimed to determine the relationship between the time from ACL injury to operation and the presence of pathologic plica. Moreover, the relationship between the presence of pathologic plica and plica-associated cartilage injury and preoperative anterior knee pain was assessed.

MATERIAL and METHODS

We obtained ethical approval for this study from the Institutional Review Board of the Near East University Medical Faculty (Reference No. 58-598). All the patients provided written informed consent for the publication of their individual data.

This study was planned as a retrospective observational study. We enrolled 87 patients who had undergone arthroscopic ACL reconstruction surgery with quadrupled hamstring tendon grafts in the authors' clinic from January 2015 to October 2017. Patients who had undergone arthroscopic ACL reconstruction surgery and had agreed to participate in the study were included in our analyses. Arthroscopy videos are routinely recorded for all ACL reconstruction surgeries. In this context, eight of the patients whose arthroscopic video qualities were insufficient for investigation were excluded. Furthermore, three of the patients who did not consent to participate within the study were also excluded. Thus, finally, 76 patients who met the inclusion criteria were enrolled.

The hospital records and interviews with patients were used to collect information about their demographic characteristics and initial complaints. Trauma mechanism, time from trauma to operation, and preoperative complaints, such as giving-way episodes, anterior knee pain, and knee locking were recorded. Anterior knee pain was positively accepted when the patient experienced pain while performing one or more of the following daily activities: walking, running, jumping, climbing stairs, squatting, and sitting with bent knees for a prolonged period. Arthroscopy videos and operation reports were evaluated by two researchers independently for the determination of intraarticular pathologies. The patients were evaluated as per the presence or absence of pathologic plica formation, cartilage, and meniscus related pathologies. Descriptions of the investigated pathologies are presented below.

Main Points:

- Pathologic plica formation rate increases with increase in the duration from anterior cruciate ligament injury to reconstruction.
- Pathologic plica is related to anterior knee pain and knee cartilage damage.
- In delayed reconstruction cases, pathologic plica existence should be evaluated in detail to prevent further cartilage damage and postoperative anterior knee pain.

Pathologic Plica: Hypertrophic, non-transparent, tight, and inelastic plica was recorded as pathologic (Figure I-3). They were classified as medial and/or suprapatellar as per the location of the pathologic plica.

Cartilage injury: Cartilage injuries were graded as follows: Grade I, focal areas of softening with normal contour of the cartilage surface. Grade II, damage compromising <50% of the thickness of the cartilage. Grade III, damage compromising>50% of the thickness of the cartilage, but not extending to the subchondral bone tissue. Grade IV, total cartilage wearing with exposed subchondral bone. Cartilage injury was considered to be present when there was cartilage damage in any location of the knee of Grade 2 or more.

Meniscal Lesion: A meniscal lesion was considered when any of the following types of tears were present and treatment was required: parrot beak tear, radial tear, longitudinal tear, horizontal tear, bucket-handle, and complex tear.

Our patients were divided into two groups as per the duration between the injury and operation. Patients operated within 3 mon of the injury and those operated ≥ 3 mon after the injury were classified into group I and group 2, respectively. We compared the demographic characteristics, preoperative complaints, and intraoperative findings of these two patients groups. Accordingly, the relationship between the presence of pathologic plica and plica-associated cartilage damage and preoperative anterior knee pain was analyzed.

Statistical Analysis

In the descriptive statistics of the data, mean, standard deviation, median lowest, highest, frequency, and ratio values were used. The distribution of the variables was measured using the Kolmogorov-Smirnov test. Independent samples t-test and Mann–Whitney U test were used for the analysis of quantitative independent data. The chi-square test was used for analyzing qualitative independent data, and Fischer test was used when the chi-square test was not suitable. All the statistical analyses were performed using the Statistical Package for Social Sciences software version 22.0 (IBM SPSS Corp.; Armonk, NY, USA). Two authors analyzed the operation video of each patient independently. The examiners were blinded to the group information of the subject. In case of disagreement between the examiners, the data were re-evaluated until a consensus was reached. Interobserver reliabilities of the operation findings were assessed using the 'κ' statistical test. A kappa value of 0.8–I was considered to indicate perfect agreement.

RESULTS

Primary ACL reconstruction was performed for 76 patients, including 65 men and II women. The average age of the study

subjects was 29.8 y (range, 18–46 y). Surgery was performed on the right knee of 48 patients and the left knee of 28 patients. Reported trauma mechanisms were related to football in 43 patients, sprain in 14, basketball in 11, skiing in 4, traffic accident in 3, and kickboxing in 1 patient. The rate of investigated preoperative complaints were giving-way episodes in 67 (88.2%) patients, clicking or locking in 39 (51.3%), and anterior knee pain in 15 (19.7%) patients. Pathologic plica formation was noted in 30 (39.5%) of the patients. Of these pathologic plica, 15 were suprapatellar, 8 were medial, and 7 were both. Meniscal lesions were observed in 35 (46.1%) of the patients, where 21 of the lesions were medial, nine were lateral, and five were both-sided meniscal tears. Cartilage injury was observed in 22 (28.9%) of the patients, and their distribution was as follows: 11 patients had medial condyle, 11 patients had patella, 5 patients had lateral condyle, and 2 patients had trochlea cartilage injuries.

There were 46 patients in the first group and 30 in the second group. The average duration from the time of injury to the time of operation was 7.2 wk (range, 4–11 wk) in group 1 and 16.5 mon (range, 3–48) mon in group 2. A comparison of the demographic features, preoperative complaints, and arthroscopic findings of these two groups has been presented in Table 1. The rates of recurrent giving-way episodes, preoperative clicking, and locking were not significantly different ($p>0.05$) between group 1 and group 2. The rate of preoperative anterior knee pain was significantly higher in group 2 as compared to that in group 1 ($p<0.05$). In addition, the pathologic plica formation rate was significantly higher in group 2 than in group 1 ($p<0.05$). The medial pathologic plica existence ratio did not differ significantly ($p>0.05$) between group 1 and group 2s. However, suprapatellar pathologic plica formation was significantly higher in group 2 as compared to that in group 1 ($p<0.05$). The rate of meniscus lesions was not

TABLE 1. Comparison of the demographic features, preoperative complaints, and arthroscopic findings of the two groups

		Group 1		Group II			
		Mean ± sd/n-%	Median	Mean ± sd/n-%	Median	p	
Age		29.0±7.3	28.5	30.9±6.8	31.0	0.250	t
Sex	Female	10 21.7%		1 3.3%		0.026	X^2
	Male	36 78.3%		29 96.7%			
Side	Right	32 69.6%		16 53.3%		0.152	X^2
	Left	14 30.4%		14 46.7%			
Plica	(-)	37 80.4%		9 30.0%		0.000	X^2
	(+)	9 19.6%		21 70.0%			
Medial Plica		6 13.0%		9 30.0%		0.069	X^2
Suprapatellar Plica		5 10.9%		17 56.7%		0.000	X^2
Meniscus Lesion	(-)	26 56.5%		15 50.0%		0.577	X^2
	(+)	20 43.5%		15 50.0%			
Medial		12 26.1%		14 46.7%		0.065	X^2
Lateral		12 26.1%		2 6.7%		0.033	X^2
Cartilage İnjury	(-)	40 87.0%		14 46.7%		0.000	X^2
	(+)	6 13.0%		16 53.3%			
Patellar		0 0.0%		11 36.7%		0.000	X^2
Medial Condyle		2 4.3%		9 30.0%		0.002	X^2
Lateral Condyle		3 6.5%		2 6.7%		0.980	X^2
Trochlea		2 4.3%		0 0.0%		0.516	X^2
Preop Ant Knee Pain	(-)	43 93.5%		18 60.0%		0.000	X^2
	(+)	3 6.5%		12 40.0%			
Injury Mechanism	Basketball	8 17.4%		3 10.0%		0.574	X^2
	Football	26 56.5%		17 56.7%		0.822	X^2
	Kick Box	0 0.0%		1 3.3%		0.394	X^2
	Ski Sport	1 2.2%		3 10.0%		0.333	X^2
	Sprain	9 19.6%		5 16.7%		0.987	X^2
	Traffic Accident	2 4.3%		1 3.3%		0.703	X^2
Recurrent Giving-Way Episodes	(-)	7 15.2%		2 6.7%		0.259	X^2
	(+)	39 84.8%		28 93.3%			
Preoperative Clicking And Locking	(-)	24 52.2%		13 43.3%		0.451	X^2

[t] t test / m Mann-Whitney u test / X^2 Chi-square test (Fischer exact)

TABLE 2. Relationship between the presence of pathologic plica and plica-associated cartilage injury and preoperative anterior knee pain

		Plica (-)		Plica (+)		
		n	%	n	%	p
Cartilage Injury	(-)	44	95.7%	10	33.3%	0.000 X^2
	(+)	2	4.3%	20	66.7%	
Preoperative Anterior Knee Pain	(-)	45	97.8%	16	53.3%	0.000 X^2
	(+)	1	2.2%	14	46.7%	

X^2 Chi-square test

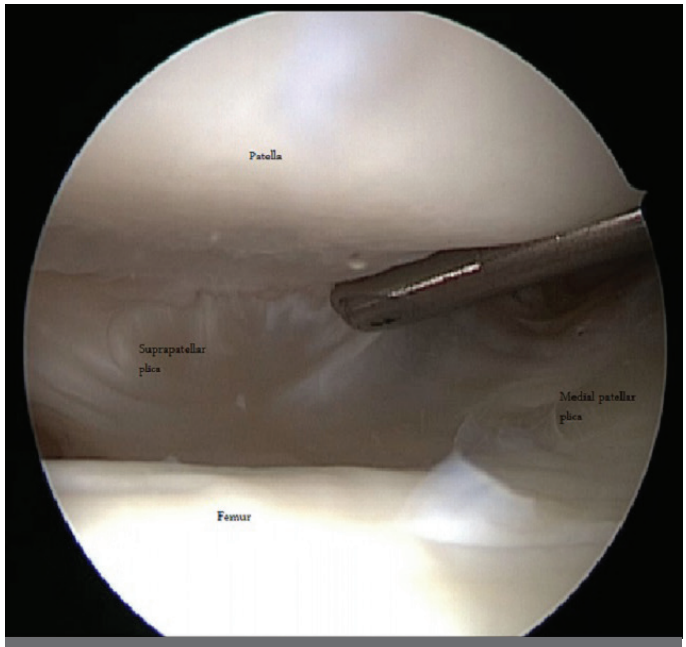

FIGURE I. Hypertrophic and non-transparent appearance of pathologic suprapatellar and medial patellar plica

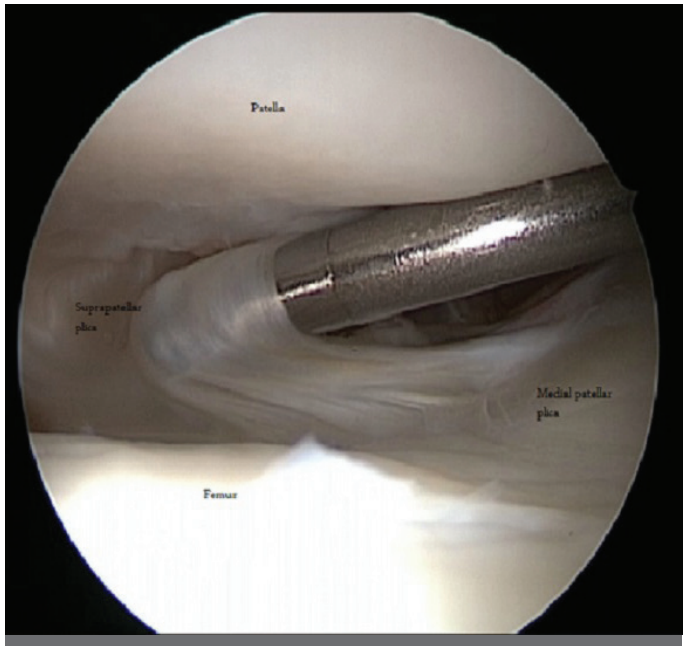

FIGURE 2. Inelastic and non-fragile structure of pathologic plica

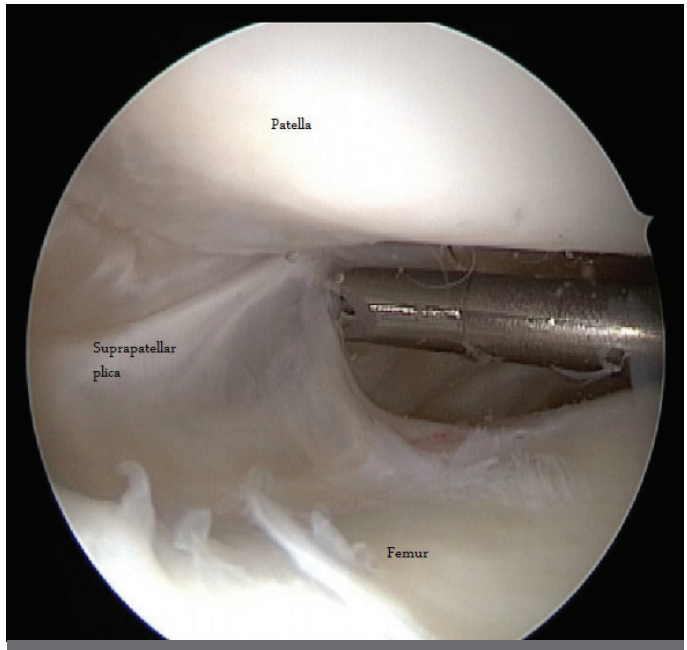

FIGURE 3. Resection of pathologic plica with an arthroscopic shaver

significantly different between the groups (p>0.05). The medial meniscus lesion ratio was similar between the two groups (p>0.05); however, the lateral meniscus lesion ratio was significantly higher in group I as compared to that in group 2 (p<0.05). The cartilage injury rate was significantly higher in group 2 than in group I (p<0.05). Patella and medial condyle cartilage injury was significantly higher in group I than in group 2 (p<0.05); however, there was no significant difference between the groups in terms of lateral condyle and trochlea cartilage injuries (p>0.05) (Table I). The reported anterior knee pain and cartilage injury in the pathologic plica positive group was significantly higher than that in the plica negative group (p<0.05) (Table 2). Interobserver agreement (k) values in the assessment of pathologic plica were 0.83 and 0.87, respectively, indicating perfect agreement.

DISCUSSION

The most important finding of this study was that the rate of pathologic plica increased as the duration between ACL injury and operation increased. We assumed that ACL injuries may cause pathologic transformation of the plica over time, and this could be an overlooked cause of anterior knee pain after this injury.

Some possible anterior knee pain pathologies following ACL injury are Hoffa syndrome, patellofemoral chondral injury, patellar tendinitis, quadriceps tendinitis, patellar bone bruise, anterior horn injuries of the meniscus, and synovial plica syndrome. Symptoms and clinical findings of these pathologies are generally indistinguishable for a certain disease (I).

In our study, the cause of statistically higher anterior knee pain rate in the second patient group was thought to be due to high patellar cartilage damage prevalence. However, in the subgroup analysis of patients with and without plica, the relationship between the presence of plica and anterior knee pain was significant. Therefore, this study showed that anterior knee pain after ACL injury may be related to pathologic plica. Imaging

modalities, such as radiography, ultrasonography, and magnetic resonance imaging have limited efficiency in diagnosing plica syndrome. Exclusion of other anterior knee pain pathologies with the suspicion of plica syndrome is necessary for diagnosis. Definitive diagnosis is performed using arthroscopy. However, it is easy to miss the existence of suprapatellar plica during arthroscopy. Medial plica is like a shelf on the medial synovial wall (7) that sometimes travels in front of the medial femoral condyle; however, suprapatellar plica resembles the roof of the knee joint, particularly if it is a complete type (8).

Plica is normal structures commonly observed during routine knee arthroscopy. Plica syndrome is considered to occur because of structural changes of the plica following an inflammatory process (9). Inflammation and swelling of the plica is responsible for acute complaints, and long-term thickened plica may cause chondral damage. Christoforakis et al. reported increased incidence of articular cartilage wearing in knees with synovial plica, particularly in the patella and medial femoral condyle (5). Any factor that causes intraarticular hematoma and synovitis could cause pathologic transformation of the plica. Elastic tissues of the plica became fibrotic with prolonged inflammation. Occult trauma, mechanical irritation with repetitive knee movements, intraarticular pathologies (meniscal injury, loose body, osteochondritis dissecans, patella subluxation etc.), and surgical interventions are reported in the etiology (1). In our study, we investigated the presence of pathologic plica after ACL injury, the most common cause of traumatic hemarthrosis in the knee (10).

The criteria used to define plica as pathologic have not been well established. Plica causing anterior knee pain and recurrent knee effusion without associated intraarticular lesion should be classified as pathologic (3). Pathologic plica is diagnosed during arthroscopy if it is hypertrophic, has lost its transparency and fragile structure, and causes chondral damage with impingement. However, plica evaluation is subjective; some surgeons overlook it as the etiology of anterior knee pain, while others identify it as the cause in most cases. Further, there is no threshold for classifying plica as pathologic or normal. Pathologic plica is treated with arthroscopic resection. The investigation and resection of normal plica structures during routine knee arthroscopy may be associated with a longer surgical time and extra damage during the procedure. The necessity of normal plica resection is a controversial subject in the literature (2). To our knowledge, there are no data on the time required for pathologic plica transformation after intraarticular inflammation, such as ACL injury, in the literature. We determined a 3-month period as a threshold value in this retrospective study because in our clinical practice, we encountered more pathologic plica intraoperatively in patients who had been operated after 3 mon of ACL injury. In ACL injury cases, patients experience a period of hematoma and immediately after regression of the hematoma, they start daily activities; this may cause further inflammation in the synovial membranes. Chronic synovitis causes fibrotic transformation of the plica and may be the cause of anterior knee pain in patients who have experienced ACL injury.

The underlying mechanism by which suprapatellar plica becomes symptomatic remains controversial. It is assumed that complete type suprapatellar plica is more likely to manifest symptoms (11, 12). Different causal mechanisms have been reported for the symptoms. Inflammation of the plica caused by any reason leads to structural changes in the plica. Hypertrophic plica exerts increased forces on the articular surfaces and causes degenerative changes (13). Impingement of the hypertrophic plica between the extensor mechanism and the medial femoral condyle during knee flexion beyond 70° is another reported mechanism for symptoms (14, 15). Fibrotic suprapatellar plica acts on the superior patella and changes its dynamics during flexion and extension. Malalignment of the patella in this manner is also a reported cause of anterior knee pain (16). Intraarticular volume and joint fluid distribution may also be affected by a large suprapatellar plica; thus, increased pressure applies forces on the articular cartilage (13).

In this study, pathologic plica was detected in 9 (19.6%) of the 46 patients who underwent reconstruction within 3 mon of ACL injury, and pathologic plica was detected in 21 (70%) of the 30 patients who underwent reconstruction ≥ 3 mon after ACL injury. This significant difference showed that plica hypertrophy occurs after a latent period from the time of injury. It could be said that plica works as the gatekeeper of the knee joint because it is hypertrophied after intraarticular inflammation. In some cases, the plica structures will become hypertrophic and cause plica-related symptoms. In the present study, anterior knee pain and cartilage damage of the knee, especially in the patella and medial condyle, was significantly more common in patients with pathologic plica.

This study has certain limitations, including the relatively small sample size, retrospective study design, and the absence of a comparison group without plica resection. We believe that further research that compares patient satisfaction in ACL reconstructions with and without plica resection is warranted. Although this study proved that pathologic plica is associated with anterior knee pain and cartilage damage, long-term follow-up cohort studies are needed to improve the understanding regarding the significance of pathologic plica.

In conclusion, Pathologic plica formation rate increases with an increase in the duration between ACL injury and reconstruction. Preoperative anterior knee pain and intraoperative knee cartilage damage were more common in patients with pathologic plica. We recommend that pathologic plica investigation and resection be considered during ACL reconstruction surgeries.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Near East University Scientific Research (Reference No. 58-598).

Informed Consent: Written informed consent was obtained from the patients.

Peer-review: Externally peer-reviewed.

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