Influence of Injury to the Kaplan Fibers of the Iliotibial Band on Anterolateral Rotatory Knee Laxity in Anterior Cruciate Ligament Injury: A Retrospective Cohort Study

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Influence of the injury to the Kaplan fibers of the iliotibial band on anterolateral rotatory knee laxity in the anterior cruciate ligament injury -a retrospective cohort study-

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Abstract

Background: Biomechanical cadaveric studies have shown that Kaplan fibers (KF) of the iliotibial band play a role in controlling anterolateral rotatory knee laxity in anterior cruciate ligament (ACL) injury. However, in the clinical setting, the contribution of injury to KF on anterolateral rotatory laxity remains unclear.

Purpose: To investigate the effect of MRI-detected concomitant injury to KF in ACL injured knees on anterolateral rotatory laxity measured by pivot-shift test in the clinical setting.

Study Design: Case-control study; Level of evidence, 3.

Methods: Ninety-one patients with primary ACL tears (age: 25 ± 11 years, 46 male/45 female) whose MRI was taken within 90 days after injury, were enrolled. KF injury was assessed by MRI according to the previously reported criteria, and the subjects were allocated into KF injury group and non-KF injury group. At the time of ACL reconstruction, the pivot-shift test was performed under anesthesia and quantitatively evaluated by tibial acceleration using an electromagnetic measurement system. Manual grading of the pivot-shift test was also assessed according to the IKDC guidelines. These were statistically compared between two groups using Mann-Whitney U test and Fisher's exact test ($p < 0.05$).

Results: KF was identified in 85 patients (93.4%), and KF injury was detected in twenty patients out of

85 patients (23.5%). No significant differences were observed between KF injury group (n = 20) and non-KF injury group (n = 65) in demographic data, the period from injury to MRI (8.0 ± 14.0 vs. 8.9 ± 12.1 days), the rate of meniscal injury (50.0% vs. 53.8%), or the rate of anterolateral ligament injury (45.0% vs. 44.6%). Regarding the pivot-shift test, no significant differences were observed in tibial acceleration (1.2 [interquartile range, IQR: 0.5-2.1] m/s^2 vs. 1.0 [IQR: 0.6-1.7] m/s^2) or manual grading between two groups.

Conclusion: Concomitant KF injury did not significantly affect the pivot-shift phenomenon in acute ACL-injured knees. The findings suggest that the contribution of KF injury to anterolateral rotatory knee laxity may be limited in the clinical setting.

Key terms: anterior cruciate ligament; anterolateral complex; iliotibial band; Kaplan fibers; magnetic resonance imaging; pivot-shift; anterolateral rotatory knee laxity

What is known about the subject: Biomechanical studies have shown contribution of the Kaplan fibers to anterolateral rotatory laxity while one recent clinical study has reported that KF injury was not associated with higher-grade pivot-shift test assessed by manual grading in ACL injury.

What this study adds to existing knowledge: The present study showed that concomitant KF injury did not significantly affect the pivot-shift phenomenon in acute ACL-injured knees by quantifying the pivot-shift test using an electromagnetic measurement system. The present findings suggest that the contribution of KF injury to anterolateral rotatory knee laxity may be limited in the clinical setting.

Introduction

Recently, much debate ensued regarding the biomechanical function of the anterolateral complex (ALC) of the knee in anterior cruciate ligament (ACL) injured knees after potential impact of ALC injury on anterolateral rotatory laxity has been extensively discussed in the setting of ACL injury.[12,37,41,51] The ALC consists of the superficial and deep aspects of the iliotibial band (ITB) with its Kaplan fiber attachments on the distal femur, along with the anterolateral ligament (ALL), a capsular structure within the anterolateral capsule, according to the statements from the International ALC Consensus Group Meeting.[21] The distal femoral attachment of the ITB was originally identified by Kaplan in 1958[34] and later known as the 'Kaplan fibers (KF)'.[9] Anatomic studies found that KF were the transverse fibers attached to the femoral metaphysis and in close proximity to the branches of the superior genicular artery, and in recent years, it has been reported that the KF have two distinct bundles attached proximally and distally.[23,26] KF and their injuries can be identified on MRI,[8,9] and the rate of the concomitant KF injury in ACL tear has been reported to be 17.6–60%.[9,10,13,15,40,45] Recent biomechanical studies have indicated that KF may function as a secondary restraint in the ACL-deficient knees,[27,36] and one cadaveric study reported that KF played a greater role in tibial internal rotation at higher flexion angle than the ALL.[20] These biomechanical studies[20,27,36] using cadaveric knees have shown the contribution of KF to anterolateral rotatory laxity in the ACL-injured knees. However, one recent clinical study has shown that KF injuries were not associated with a higher-grade pivot-shift in acute ACL injuries;[13] thus the role of KF in controlling anterolateral rotatory knee laxity remains uncertain. ACL reconstruction combined with either ALL reconstruction or lateral extra-articular tenodesis may better restore anterolateral rotatory knee laxity and decrease the failure rate,[6,22,43,48] but there is not such evidence for KF repair/reconstruction so far.

In the clinical setting, the pivot-shift test is a valuable manual examination to detect anterolateral rotatory knee laxity[19,39] although this assessment is subjective and widely variable. Additionally, the pivot-shift test is multifactorial, and can be influenced by ALC lesions, meniscal tears, posterior tibial slope and other osseous parameters.[18] Importantly, the pivot-shift has been shown to correlate with functional outcomes after ACL reconstruction[7] although there is not always a complete correlation between biomechanical instability and clinical inferior outcomes. Recently, there are some clinically usable and validated quantitative evaluation systems for assessing rotatory knee laxity during the pivot-shift test,[29,31,42,44] and the electromagnetic measurement system (EMS) has been shown to have high diagnostic reliability for the pivot-shift test.[44] The pivot-shift phenomenon can be quantitatively measured as tibial acceleration (m/s^2) using the EMS.

Thus, the purpose of the present study was to investigate the effect of MRI-detected concomitant injury to KF in acute ACL-injured knees on pivot-shift test measured by the EMS in the clinical setting. It was hypothesized that the acute ACL-injured knees with concomitant KF injury would increase tibial acceleration and have higher grade of manual pivot-shift test compared to the ACL-injured knees without concomitant KF injury.

Materials and methods

Subjects

The present retrospective analysis of prospectively collected data included a total of 91 patients (46 males/45 females; mean age 25 ± 11 years) with unilateral acute primary ACL tear, who underwent primary ACL reconstruction in one institution. The diagnosis of the ACL tears was made based on clinical findings and MRI, which was confirmed arthroscopically. The inclusion criteria were as follows; unilateral acute primary ACL tears; time from injury to MRI < 90 days;[9] preoperative evaluation using the EMS. The exclusion criteria were as follows: concomitant ligament procedures (medial collateral ligament, posterior cruciate ligament, and/or posterolateral complex) or realignment procedures; contralateral knee injury; previous injury or surgery in ipsilateral knee; more than one-year period from MRI to the surgery; MRI quality was less than 1.5-T; insufficient data of the EMS measurement. Originally, 239 patients were identified from the medical records from March 2013 to September 2020. After reviewing inclusion and exclusion criteria, a total of 91 patients were enrolled in the present study (**Figure 1**). The study was approved by the Institutional Review Board of Kobe University (ID No. B190055).

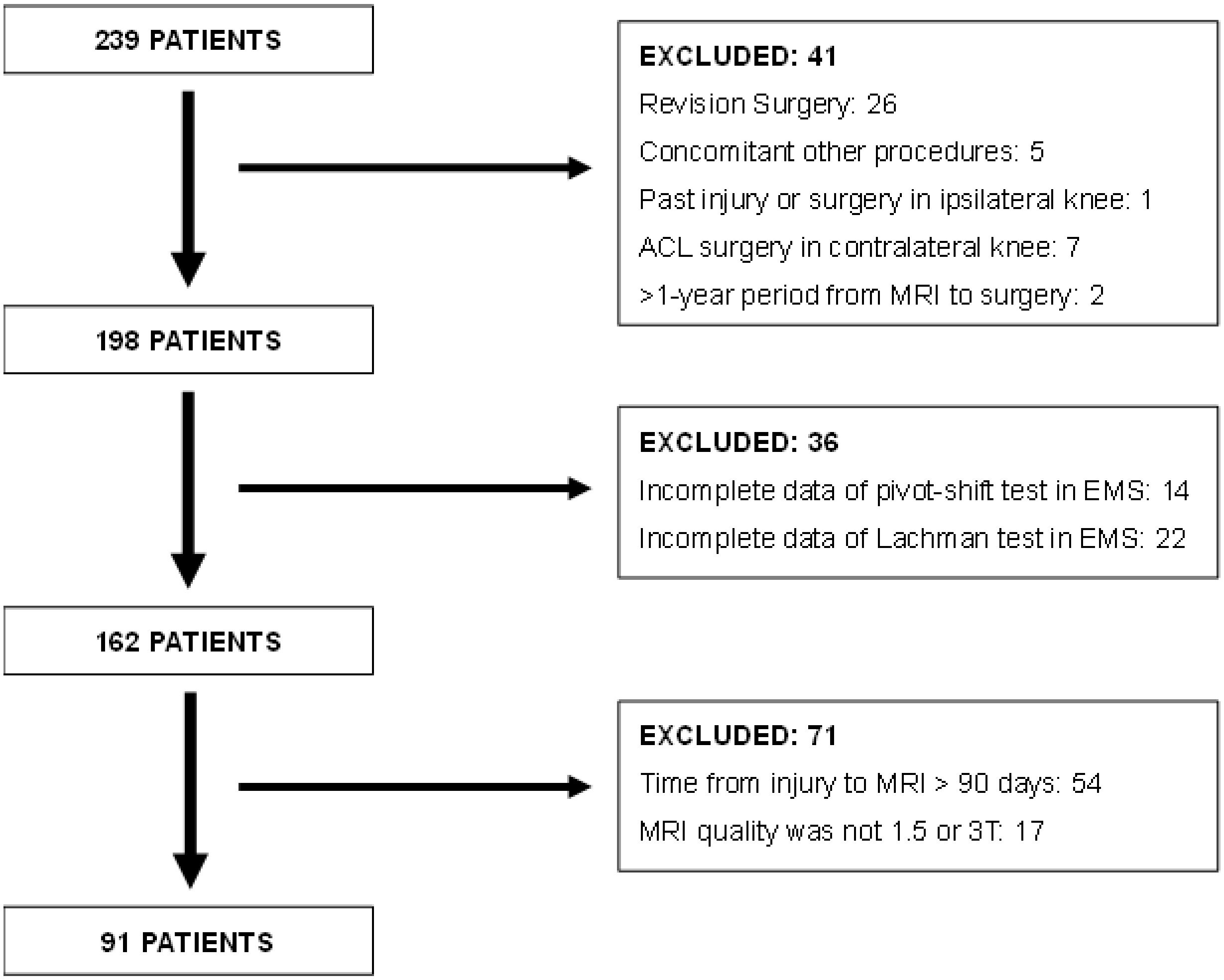

Figure 1. Flowchart of the inclusion/exclusion process for the present study

ACL, anterior cruciate ligament; MRI, magnetic resonance imaging; EMS, electromagnetic measurement system; KF, Kaplan fibers.

Identification of concomitant KF injury

Concomitant KF injury was identified using 1.5-T or 3.0-T MRI which was taken for the diagnosis of ACL injury. Knee MRI was performed in the supine position with the leg extended. Three-plane (sagittal, coronal and axial) sequences using both proton-density-weighted images and fat-suppressed proton-density-weighted images were obtained. KF injury was assessed according to the previous report by Batty et al.[9] by a single examiner (an orthopaedic surgeon) after confirming the inter-rater reliability. Briefly, the diagnosis of injury to the KF required at least 1 direct sign of injury or at least 2 indirect signs in any plane. The direct signs included (1) discontinuity of the KF and (2) femoral avulsion of the KF; Indirect signs included (1) thickening and/or intrasubstance signal change of the KF, (2) focal bone marrow edema at KF insertion site (posterolateral femur), (3) localized soft tissue edema in the region of the KF, and/or (4) wavy appearance to the KF.[9]

The examiner was blinded to the results of the pivot-shift evaluations. Based on the MRI findings, the patients were allocated into two groups: KF injury group and the non-KF injury group. The manual grading and the quantitative evaluations of the pivot-shift test were compared between two groups.

Assessment of the concomitant injury of meniscus, collateral ligament and ALL

The meniscal injury was diagnosed by MRI and arthroscopy during the surgery, and the collateral ligament injuries were diagnosed based on MRI and clinical examination. The ALL injury was assessed by MRI using the previously reported method.[14] All results were blinded at the time of pivot-shift evaluation.

Measurement of the pivot-shift test and Lachman test

Pivot-shift test and Lachman test were performed under general anesthesia just prior to ACL reconstruction. The standardized pivot-shift test was performed by experienced surgeons as previously reported.[28] For the quantitative evaluation of pivot-shift test, tibial acceleration was measured using the originally developed EMS (JIMI Kobe, Arthrex Japan, Tokyo, Japan) as previously described[2,30,31,44] (**Figure 2**). In addition, Lachman test was also measured using the EMS, and side-to-side difference (SSD) in anterior tibial translation (mm) was calculated by subtracting the value in the contralateral knee from the value in the injured knee as previously reported. [3]

Briefly, two electromagnetic sensors were secured on the thigh and shank with plastic straps. Seven anatomic bony landmarks of the femur and tibia (greater trochanter, medial and lateral epicondyles, the crossing point of medial joint line and the medial collateral ligament, fibular head and the medial and lateral malleoli) were digitized with a probe with a sensor to register three-dimensional positions of the landmarks in relation to the two sensors. The positions of the femur and tibia were then recognized based on the spatial relationship between the anatomic bony landmarks and sensors. The anatomic coordinates of the knee were set according to the system proposed by Grood and Suntay.[24] The six degree-of-freedom knee kinematics were recorded during the pivot-shift test with a sampling rate of 240 Hz. Tibial acceleration (m/s^2) at the time of posterior reduction of the tibia was then calculated from the data of the tibial anteroposterior translation. For the accuracy of this measurement, it is reported that the average standard deviation of three repeated measurements was 0.2 ± 0.1 m/s^2.[30,31,44]

At the same time, manual grade of the pivot-shift test was assessed according to the International Knee Documentation Committee (IKDC) guidelines[33], and categorized as low grade (IKDC grade 0 and 1) and high grade (IKDC grade 2 and 3). The manual grading was performed blinded to the quantitative evaluation result.

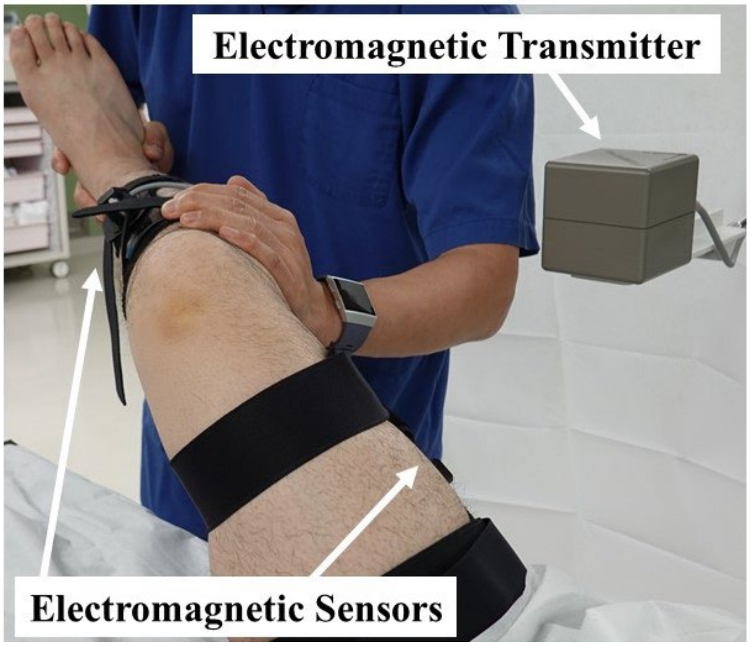

Figure 2. The electromagnetic measurement system for the pivot-shift test. Two electromagnetic sensors were secured on the thigh and shank with plastic straps. The anatomic coordinates of the knee were set via electromagnetic transmitter. The acceleration of tibial reduction (m/s^2) was calculated.

Statistical Analysis

All analyses were performed using StatView 5.0 (Abacus Concepts Inc.,Berkeley, CA, USA). Shapiro-

Wilk test was used to assess normal distribution of each parameter. Mann-Whitney U test was used to compare tibial acceleration between KF injury group and non-KF injury group. Fisher's exact test was used to compare the manual grading of the pivot-shift test between the two groups. Statistical significance was set at $p < 0.05$. The mean ± standard deviation (SD) was reported for the data with normal distribution. The median and interquartile range (IQR) was reported when the data was not normally distributed.

Inter-rater reliability of the KF injury diagnosed by MRI was assessed using complete cohorts by two orthopaedic surgeons. The Cohen's κ coefficient for categorical variables was calculated.[38] Agreement rate (percentage of all inter-observer comparisons with agreement/disagreement on a parameter) was also reported. κ values were classified as described by Landis and Koch, with values of 0–0.20, slight agreement; 0.21–0.40: fair agreement; 0.41–0.60: moderate agreement; 0.61–0.80: substantial agreement; and 0.80–1.00: excellent agreement.[38]

An a priori power calculation was performed using G*Power 3.1.9.4 (Franz Paul, Kiel, Germany) based on the past studies that used the EMS to quantify the pivot-shift test.[44] A prior power analysis showed that a total sample size of 84 knees was required to detect a difference in acceleration of the tibia of 0.5 m/s^2 during pivot shift using Mann-Whitney U test (effect size $d = 0.80$) at a power and significance level of 0.80 and 0.05, respectively (**Supplemental Figure 1, 2**). A difference of 0.9 m/s^2 in acceleration was assumed to be clinically significant as previously reported.[44]

Results

KF was identified in 93.4% (85/91 cases) of the cases. In six cases, KF was not entirely visualized in the MRI. No significant difference was observed in the rate of KF identification between 3.0-T MRI (93.5%, 29/31 cases) and 1.5-T MRI (93.3%, 56/60 cases) (Pearson's chi-squared test, $p = 0.78$). Twenty of 85 patients (23.5%) were diagnosed with KF injury by MRI. Typical images of KF injury are shown in **Figure 3**. In KF injury group ($n = 20$), eleven cases (55%) fulfilled one direct sign and nine cases (45%) fulfilled two indirect signs.

The rate of KF injury was not significantly different between 3.0-T and 1.5-T MRI (24.1% vs 23.2%, $p = 0.92$). In terms of inter-rater reliability of KF injury diagnosis, the agreement rate of the presence of KF injury between two examiners was 92.9% and Cohen's κ coefficient was 0.797, which is considered to be substantial agreement[38] (**Table 1**).

Patient demographics of KF injury group ($n = 20$) and non-KF injury group ($n = 65$) are summarized in **Table 2**. There were no significant differences in age, sex, the period from injury to MRI (8.0 ± 14.0 days vs. 8.9 ± 12.1 days, $p = 0.78$), injury pattern (contact or non-contact), medial meniscus injury rate (30.0% vs. 32.3%, $p = 0.85$), lateral meniscus injury rate (35.0% vs. 40.0%, $p = 0.69$), medial collateral ligament injury, lateral collateral ligament injury, and ALL.

No significant difference was observed in tibial acceleration during the pivot-shift test between KF injury group (median 1.2 m/s^2, IQR: 0.5–2.1) and non-KF injury group (median 1.0 m/s^2, IQR: 0.6–

1.7) (p = 0.73, **Figure 4**). In addition, there was no significant difference in manual grading of the pivot-shift test between the two groups (**Table 3**, p = 0.06). No significant difference was also observed in SSD in anterior tibial translation during the Lachman test between KF injury group (median 4.3 mm, IQR: 0.8–7.4) and non-KF injury group (median 6.4 mm, IQR: 4.4–9.6, p = 0.06).

Table 1. Inter-rater agreement on diagnosing Kaplan fibers injury with all subjects

		Examiner 1		
		Kaplan fibers injury +	Kaplan fibers injury −	Total
Examiner 2	Kaplan fibers injury +	16	2	18
	Kaplan fibers injury −	4	63	67
	Total	20	65	85

Table 2. Patient demographics and baseline characteristics[a]

	KF injury group (n=20)	non-KF injury group (n=65)	p value[b]
Age at time of injury (years)	27.6 ± 12.6 (range, 13–55)	25.0 ± 11.3 (range, 11–59)	0.41
Sex (male / female)	9 / 11	35 / 30	0.49
Period from injury to MRI (days)	8.0 ± 14.0 (range, 1–63)	8.9 ± 12.1 (range, 0–50)	0.78
Period from MRI to surgery (days)	67.3 ± 49.5	69.1± 55.7	0.83
Injury pattern (contact / non-contact)	5 / 15	16 / 49	0.97
Medial meniscal injury (yes / no)	6 / 14	21 / 44	0.85
Lateral meniscal injury (yes / no)	7 / 13	26 / 39	0.69
Medial collateral ligament injury	4 (20.0%)	11 (16.9%)	0.54
(Grade 1/2/3)	3 / 1 / 0	5 / 6 / 0	
Lateral collateral ligament injury	1 (5.0%)	0 (0%)	0.07
(Grade 1/2/3)	1 / 0 / 0	0 / 0 / 0	
Anterolateral ligament injury	9 (45.0%)	29 (44.6%)	0.98

[a] KF, Kaplan fibers. MRI, magnetic resonance imaging.

[b] Statistical significance: $p < 0.05$.

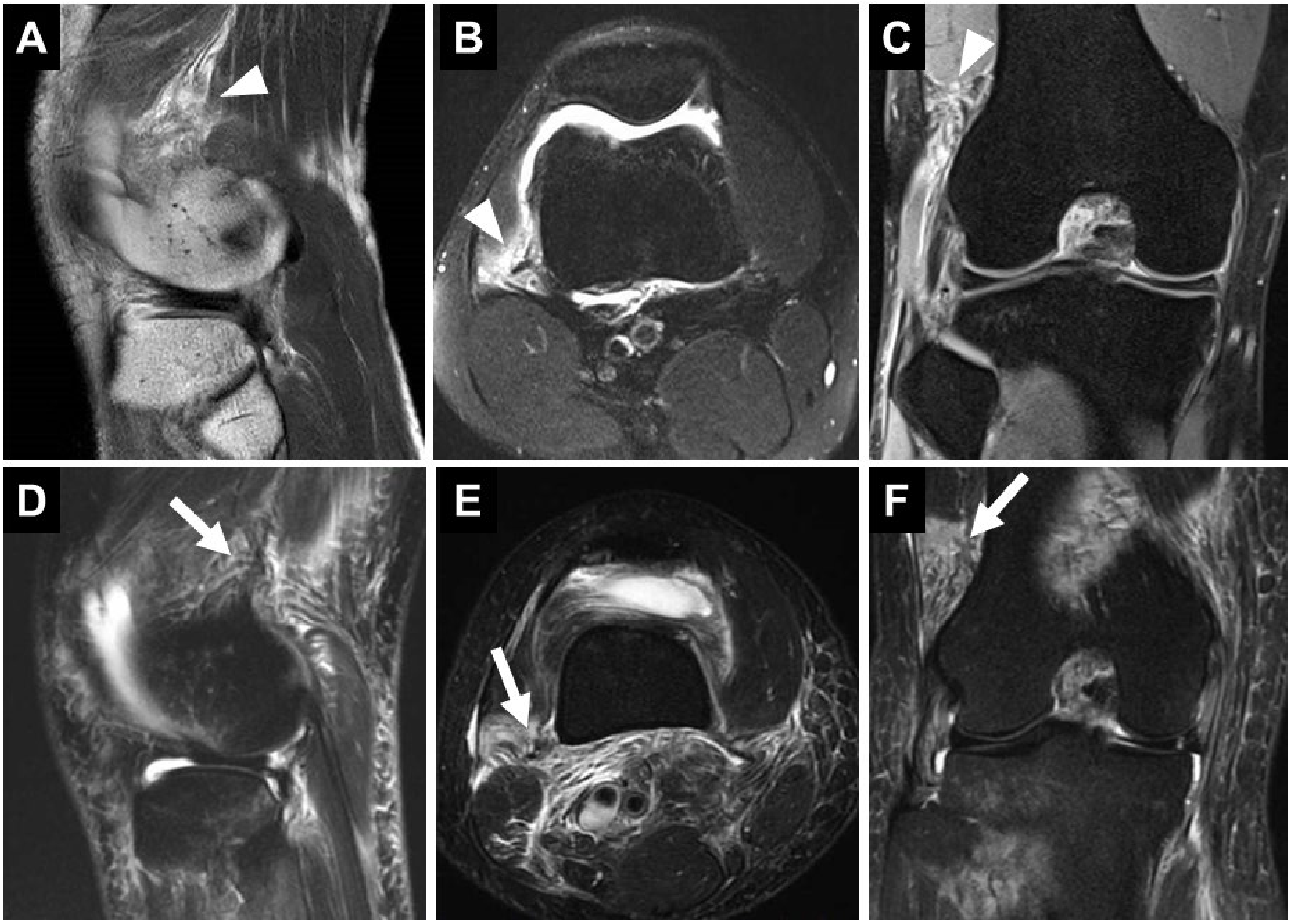

Figure 3. Typical images of KF injury. (A, B, C) There is discontinuity of KF (direct sign, white head). (D, E, F) There is diffuse edema around KF with signal changes and thickening (indirect signs, white arrow).

KF, Kaplan fibers; ACL, anterior cruciate ligament.

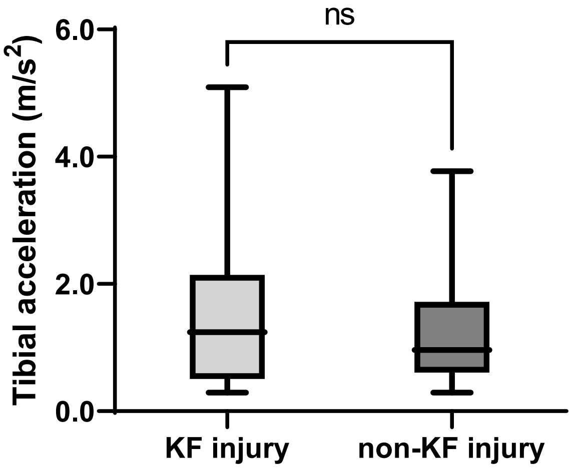

Figure 4. Comparison of tibial acceleration during the pivot-shift test between the KF injury and non-KF injury groups.

There was no significant difference between the groups.

ns, not significant; KF, Kaplan fibers.

Table 3. Manual grading of the pivot-shift test in KF-injury group and non-KF injury group[a]

		Kaplan fibers			
		Injury group	Non-injury group	Total	p value
Pivot-shift test	Low grade (0 / 1)	9 (45.0%) (0 / 9)	45 (69.2%) (1 / 44)	54 (63.5%) (1 / 53)	0.06
	High grade (2 / 3)	11 (55.0%) (11 / 0)	20 (30.8%) (18 / 2)	31 (36.5%) (29 / 2)	
	Total	20	65	85	

[a]KF, Kaplan fibers.

Discussion

The main finding of the present study was that concomitant injury to KF did not have a significant impact on anterolateral rotatory laxity measured by quantifying the pivot-shift test using the EMS in the acute ACL-injured knees. This finding is in line with the recent clinical study showing that KF injury was not associated with a higher-grade pivot-shift test, assessed by manual grading.[13] In addition, there were no differences in the injury patterns or in the existence of the concomitant injuries to collateral ligament, meniscus, and/or ALL between the KF injury group and non-KF injury group. Thus, in the clinical setting, the contribution of KF injury on anterolateral rotatory knee laxity may be limited in ACL injury in contrast to the previous biomechanical studies showing significant contribution of the KF on anterolateral rotatory knee laxity.[20,36]

Recently, potential impact of anterolateral complex (ALC) injury on anterolateral rotatory laxity has been extensively discussed in the setting of ACL injury.[4,5,12,16,22,25,26,35] The ALC consensus group meeting stated that the ALC consists of the superficial and deep aspects of the ITB with its KF attachments on the distal femur, along with the ALL, a capsular structure within the anterolateral capsule.[21] In 1958, Kaplan[34] originally described the layers and attachments of the ITB to the femur. In 1976, Hughston et al.[32] described “lateral capsular ligament”, and in 1986, Terry et al.[49] classified the ITB into the aponeurotic layer, the superficial layer, the middle layer, the deep layer and the capsule-osseous layer, and the KF has shown to be included in the deep layer. In 1993, they also reported that the injury to the capsule-osseous layer of the ITB in ACL-deficient knees was significantly correlated with the grading of the pivot-shift test.[50] Descriptions of the ALC anatomy are confused by overlapping nomenclature.[21] Vieira et al.[52] are often attributed to being the first to describe the ALL, although this was the same name that Terry et al. used to describe the capsule-osseous layer of the ITB.

One biomechanical study has shown that the deep and capsule-osseous layer of the ITB, which includes KF, contributed to the restraint of internal rotation in ACL-deficient knees at all range of motion (0˚, 30˚, 60˚, 90˚), and internal rotation in simulated pivot-shift test.[36] A different biomechanical study has shown that in ACL-deficient knees, the contribution of KF to internal rotation was greater than ALL, particularly at knee flexion deeper than 60˚.[20] However, the present clinical study did not show significant influence of KF injury on anterolateral rotatory knee laxity contrary to the hypothesis. One recent clinical study also showed that injury to KF did not result in a higher manual grade of the pivot-shift test with 267 patients with ACL-injured knees.[13] In contrast to the study by Devitt et al, the novelty of the present study was that the pivot-shift test was quantitatively evaluated using the EMS; despite precise assessment of the pivot-shift test, no significant differences were observed between KF injury and non-KF injury groups, which supports the previous report.[13] Moreover, the incidence of ALL injury was not significantly different between two groups, and confounding by ALL injury would be minimal in the present study.

Although MRI would be a useful tool in identifying the structure of the ALC, KF injury diagnosed by MRI may not be an indication for additional procedures such as lateral extra-articular tenodesis based on the current findings whereas some have reported inferior outcomes after ACL reconstructions with ALL injury diagnosed with preoperative MRI.[11,47] A discrepancy between biomechanical study and clinical study could include potential healing of the soft tissue structures in the interval between MRI and physical examination. Moreover, it is worth mentioning that in the biomechanical model of ALC injury including KF injury, an extensive cutting of not only anterolateral capsule and ALL but also the KF attachment of the ITB is performed to create the worst-case scenario of injury, and this might be at least one reason for the discrepancy between biomechanical findings and clinical findings.

Regarding the identification of KF on MRI, Batty et al.[8] reported that intact KF could be identified in 96% of intact ACL knees on the sagittal slice of 3.0-T MRI, which was similar with the identification rate in the present study (93.4%). The rate of the KF injury varies among the previous reports ranging from 17.4% to 53.8% (**Table 4**).[9,10,13,15,40,45] Importantly, only one study investigated the association between KF injury and anterolateral rotatory knee laxity among these studies. The wide spectrum of the injury rate could be partially attributable to the different diagnosis criteria, different inclusion criteria, and/or different MRI protocol. This is similar to the reports related to ALL injury with the high variability in the identification of normal and injured ALL definition and the respective MRI findings.[1] The injury rate of the ALL has been reported to range from 11 to 88%.[1,17] It has been described that hemorrhage in the region of the KF can be observed during surgical exploration,[16,50] but these studies did not explicitly describe the disruption to the continuity of the KF. The present study used rigorous diagnostic criteria described by Batty et al,[9] in which the presence of soft tissue edema around the KF was only one factor, and it needed to be associated with at least one other direct or indirect sign of injury of the KF. Devitt et al.[13] emphasized that it is crucial not to assume that the presence of hemorrhage or edema alone on MRI heralds serious structural damage to the ALC of the knee. In terms of magnetic strength of MRI, no significant difference was observed in the identification rate of KF or the rate of KF injury between 1.5-T and 3.0-T MRI in the present study, suggesting that diagnosis of injury to KF is feasible with 1.5-T MRI.

There are several limitations in the present study. Firstly, the MRI scans in the present study were from various sources with differing protocols. However, we believe that this scenario does reflect the current realities for orthopaedic surgeons evaluating MRI scans in the day by day clinical practice. Secondly, the bony morphology, which might have affected the results of pivot-shift (i.e. posterior tibial slope), was not assessed and compared in the present study. Thirdly, the pivot-shift tests were performed by four surgeons. However, it was performed by experienced surgeons in a standardized technique, which reduced inter-examiner variability.[28] Thus, inter-examiner variability would have been minimized. Fourth, KF injury may have healed in some cases during the period between the MRI and clinical evaluations under anesthesia, which may have affected the results of the pivot-shift test. However, no significant correlations were found between the period from MRI to surgery and tibial acceleration during the pivot-shift test (single linear regression analysis, $R = 0.11$, $p = 0.30$), suggesting the influence of period from

MRI to surgery would be minimal. Moreover, healing potential of the KF is still unknown as the recent study has shown that the ALL has limited intrinsic healing potential.[46] Fifth, there is inherent bias from the retrospective nature of the methodological design in the present study. Lastly, a post hoc power analysis of Fisher's exact test showed that actual power was 0.52, which suggested the analysis of the manual grading of the pivot-shift test was underpowered, although the present comparison of tibial acceleration between two groups had sufficient power (**Supplemental Figure 2**).

The strength of the present study is that anterolateral rotatory knee laxity was quantitatively evaluated by using EMS during the pivot-shift test, and compared between KF injury and non-KF injury groups. The present findings showed that no significant effect of the KF injury on anterolateral rotatory knee laxity was observed in the clinical setting.

Table 4. Comparison between the present study and the previous studies in terms of Injury rate of KF in ACL tears[a]

Lead author	MRI	Period from injury to MRI	KF injury rate
Van Dyck P[15]	3.0-T	< 6 weeks	33%
Batty LM[9]	3.0-T	< 90 days	23.7%
Marom N[40]	3.0 or 1.5-T	< 6 weeks	Proximal KF: 50-58% Distal KF: 46-60%
Devitt BM[13]	3.0 or 1.5-T	< 60 days	17.6%
Runer A[45]	3.0-T	Not reported	21.3%
Berthold DP[10]	3.0 or 1.5-T	< 3 months	35.6-53.8%
The present study	3.0 or 1.5-T	< 90 days	22.0%

[a]KF, Kaplan fibers. ACL, anterior cruciate ligament. MRI, magnetic resonance imaging.

Conclusion

The KF injury was detected in 22.0% of acute ACL-injured knees using MRI. Concomitant KF injury did not significantly affect the pivot-shift phenomenon in acute ACL-injured knees. The findings suggest that the contribution of KF injury to anterolateral rotatory knee laxity may be limited in the clinical setting.

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