Positive pivot-shift phenomenon in the contralateral uninjured knee is associated with greater preoperative pivot-shift in anterior cruciate ligament injured knee: quantitative evaluation using an electromagnetic measurement system

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INTRODUCTION: In patients with anterior cruciate ligament (ACL) injury, pivot-shift phenomenon is sometimes observed in the contralateral uninjured knee during the pivot-shift test in clinical setting. This contralateral physiological pivot-shift phenomenon may be related to greater pivot-shift in ACL-injured knee, however, this phenomenon or relationship has not been fully elucidated and there is a paucity of data in the literature. Thus, the purpose of the present study was (1) to quantify the pivot-shift phenomenon in the contralateral uninjured knee, and (2) to investigate the association between positive pivot-shift in uninjured knee and degree of preoperative pivot-shift in ACL-injured knee. The hypotheses were that pivot-shift phenomenon in contralateral uninjured knee could be quantified using a three-dimensional electromagnetic measurement system (EMS) [1, 2], and that positive pivot-shift in contralateral uninjured knee would be associated with greater pivot-shift in ACL-injured knee.
METHODS: A total of 197 unilateral ACL-injured patients (mean age: 28.8±14.0 years, male/female: 102/95) who underwent primary ACL reconstruction were included in the present study. The patients with a history of contralateral knee injury were excluded. Under general anesthesia prior to the surgery, Lachman test and pivot-shift test were performed in the both knees and quantified using the EMS as previously reported [1,2]. Posterior tibial translation (PTT, mm) as well as posterior tibial acceleration (PTA, m/s^2) during the pivot-shift test were measured, and anterior tibial translation (ATT, mm) during Lachman test was measured using the EMS. Positive pivot-shift phenomenon in contralateral uninjured knee was defined as the presence of the wave of posterior tibial translation around 30 to 50 degrees of knee flexion during the pivot-shift test (Figure 1). The patients were allocated into "positive group" and "negative group" according to the presence of pivot-shift phenomenon in the contralateral uninjured knee. Fisher's exact test was used to compare patient's demographics and pivot shift grade between positive and negative group. The Wilcoxon's signed rank test was used to compare PTT/PTA during pivot-shift test and ATT during Lachman test between contralateral and injured knees in the positive group. Mann-Whitney U test was used to compare PTT/PTA during the pivot-shift test and ATT during the Lachman test between positive and negative group.
RESULTS: Pivot-shift phenomenon in the contralateral uninjured knee was observed in 57 patients (28.9%) (positive group), and the negative group consisted of 140 patients (71.1%). There was no significant difference in the patient's demographics and pivot shift grade between positive and negative group (Table1). In comparison between the positive and negative groups, the positive group showed significantly greater PTT during the pivot-shift test on the injured side (positive group: 6.0 ± 5.1 mm, negative group: 4.4 ± 4.4 mm), but no significant differences were observed for other parameters.
In the positive group, the PTT/PTA during the pivot-shift test (2.1 ± 1.8 mm, 0.9 ± 0.6 m/s^2) in uninjured knee were significantly smaller than those in injured knee (6.0 ± 5.1 mm, 1.6 ± 1.2 m/s^2). Similarly, ATT during the Lachman test were significantly smaller in uninjured knee (14.1 ± 4.3 mm) than the injured knee (20.2 ± 4.5 mm) (Table2).
DISCUSSION: The main findings of the present study was that pivot-shift phenomenon was quantified in the contralateral uninjured knee using the EMS, and positive pivot-shift phenomenon was observed in about 30% of the subjects. Posterior tibial translation and acceleration during the pivot-shift test was significantly smaller in uninjured knee than ACL-injured knee, which is considered as reasonable values. Moreover, the positive group had greater posterior tibial translation during the pivot-shift test in ACL-injured knee, suggesting that physiological anterolateral rotatory knee laxity appears to be related to preoperative knee instability in ACL-injured knees.
SIGNIFICANCE/CLINICAL RELEVANCE: Positive pivot-shift phenomenon in the contralateral uninjured knee is associated with greater anterolateral rotatory knee laxity in ACL-injured knee.
REFERENCES: 1. Hoshino Y, et al. Am J Sports Med 2007; 2. Nagai K, et al. Knee Surg Sports Traumatol Arthrosc 2015.

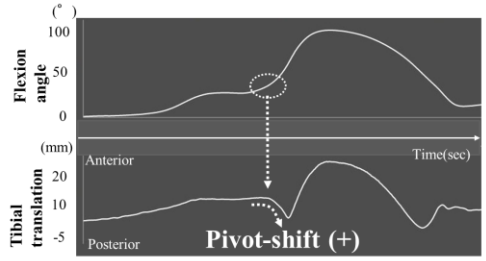

Figure 1. Example of positive pivot-shift phenomenon in contralateral uninjured knee using the EMS.

Table1. Patient demographics in positive and negative groups.

	Positive group	Negative group	P value
Patients	57 (28.9%)	140 (71.1%)	-
Sex (male / female)	34 / 23	68 / 72	0.21
Age	28.9 ± 13.1	28.8 ± 14.3	0.75
BMI (kg/m^2)	24.1 ± 4.6	23.6 ± 4.8	0.34

Table 2. Results of pivot-shift and Lachman tests using EMS. P_1 = uninjured vs injured knees in the positive group; P_2 = positive vs negative groups in the injured knee; P_3 = positive vs negative groups in the uninjured knee. PTT, posterior tibial translation; PTA, posterior tibial acceleration; ATT, anterior tibial translation.

EMS evaluation	Positive group(57)		Negative group(140)		P value		
	Uninjured knee	Injured knee	Uninjured knee	Injured knee	P_1	P_2	P_3
Pivot-shift test							
PTT (mm)	2.1 ± 1.8	6.0 ± 5.1	-	4.4 ± 4.4	<0.001	0.02	
PTA (m/s^2)	0.9 ± 0.6	1.6 ± 1.2	-	1.9 ± 1.1	<0.001	0.07	
Lachman test							
ATT (mm)	14.1 ± 4.3	20.2 ± 4.5	14.3 ± 4.3	20.3 ± 5.2	<0.001	0.87	0.94