

# Increasing Rotatory Instability Caused by Combined Secondary Stabilizer Injuries in ACL-Deficient Knees: Quantitative Assessment Using Inertial Sensor

Jiro Kato<sup>1</sup>, Masahiro Nozaki<sup>1</sup>, Hiroaki Fukushima<sup>1</sup>, Syunta Hanaki<sup>1</sup>

<sup>1</sup>Nagoya City University, 1 Kawasumi, Mizuho-cho, Mizuho-ku, Nagoya city, Aichi, Japan.  
ktjiro@gmail.com

**Disclosures:** Jiro Kato(N), Masahiro Nozaki(N), Hiroaki Fukushima(N), Syunta Hanaki(N)

**Introduction:** Medial meniscus ramp lesion (MMRL), lateral meniscus posterior root tear (LMPRT), and anterolateral complex injury (ALCI) are specific injuries to anterior cruciate ligament (ACL) injury and each injury is regarded as secondary stabilizer of ACL<sup>2</sup>. However, the influence of their combination to knee stability was unknown. The purpose of this case-control study was to investigate the effect of the number of concomitant secondary stabilizer injuries on knee instability in patients undergoing ACL reconstruction.

**Methods:** Of 552 ACL reconstruction surgeries performed within 1 year of injury between January 2017 and April 2023, 321 patients who underwent quantitative assessment of knee instability under anesthesia were included. Patients with other ligament injury, knee joint laxity, history of contralateral knee injury, and meniscus injuries other than MMRL and LMPRT were excluded (Figure 1). Age, gender, BMI, and Tegner activity scale were investigated from medical record data, and imaging data and surgical findings were investigated retrospectively. MMRL and LMPRT were diagnosed with systematic arthroscopic investigation of the posterior compartment<sup>3,5</sup>, and ALCI that defined as anterolateral ligament injury and/or Kaplan fiber injury<sup>1,4</sup>, were diagnosed with magnetic resonance imaging. Patients were divided into four groups according to the number of concomitant injuries (single: isolated ACL injury, dual: one concomitant injury with ACL injury, triad: two concomitant injuries with ACL injury, tetrad: three concomitant injuries with ACL injury). Comparisons between each group were made for subjective pivot-shift grade (0-3), quantitative evaluations of pivot-shift test using the inertial sensor [side to side difference of tibial external rotation angular velocity (AVER; deg/s) and composite acceleration (CA; mm/s<sup>2</sup>)], and anterior tibial translation (ATT; mm). Statistical analysis was performed using the Kruskal-Wallis test for continuous variables and Fisher's exact test for categorical variables, with a significance level of  $p < 0.05$ .

**Results:** Finally, one hundred forty-two patients were included in this study (mean age: 25.6 years old, male 55%). MMRLs were found in 52 knees (36.6%), LMPRTs in 22 knees (15.5%), and ALCIs in 81 knees (57.0%). Isolated ACL injury was 37 patients (26.1%), dual was 63 patients (44.4%), 34 triad knees (23.9%), and 8 tetrad knees (5.6%). There were no significant differences in age, gender, BMI, Tegner activity scale, time from injury to surgery, or time from injury to MRI among the four groups. The percentage of High-grade pivot-shift increased as the number of complicating injuries increased (Figure2). Quantitative evaluations with the inertial sensor, AVER had a significant difference between single and tetrad (single 201.4[95% CI: 192.0-269.5], dual 361.7[95% CI:278.9-528.1],  $p=0.033$ ), and CA was significantly lower in the isolated ACL injury than in all other groups (Figure3). There was no significant difference in the amount of ATT between the groups.

**Discussion:** The most important finding in this study is that as the number of the secondary stabilizer injuries increase, rotatory instability in ACL-deficient knee was increased. To put it another way, Patients with high-grade pivot-shift had an increased probability of concomitant secondary stabilizer injury. Other studies have reported that Secondary stabilizer also affects ATT, but no association was found in this study.

**Significance/Clinical Relevance:** Although many previous studies have examined the individual effects of ALCI, MMRL, and LMPRT on ACL-injured and reconstructed knees, this study is a significant study of their combined effects. Patients with severe preoperative rotational instability should be treated for possible complicating **multiple** secondary stabilizer injuries.

**REFERENCES:**

- Batty L, Murgier J, O'Sullivan R, et al. The Kaplan Fibers of the Iliotibial Band Can Be Identified on Routine Knee Magnetic Resonance Imaging. *Am J Sports Med.* 2019;47(12):2895-2903.
- Gracia G, Cavaignac M, Marot V, et al. Epidemiology of Combined Injuries of the Secondary Stabilizers in ACL-Deficient Knees: Medial Meniscal Ramp Lesion, Lateral Meniscus Root Tear, and ALL Tear: A Prospective Case Series of 602 Patients With ACL Tears From the SANTI Study Group. *Am J Sports Med.* 2022;50(7):1843-1849.
- LaPrade CM, James EW, Cram TR, et al. Meniscal root tears: a classification system based on tear morphology. *Am J Sports Med.* 2015;43(2):363-369.
- Runer A, Dammerer D, Kranewitter C, et al. Injuries to the anterolateral ligament are observed more frequently compared to lesions to the deep iliotibial tract (Kaplan fibers) in anterior cruciate ligament deficient knees using magnetic resonance imaging. *Knee Surg Sports Traumatol Arthrosc.* 2022;30(1):309-318.
- Sonnery-Cottet B, Conteduca J, Thunat M, Gunepin FX, Seil R. Hidden lesions of the posterior horn of the medial meniscus: a systematic arthroscopic exploration of the concealed portion of the knee. *Am J Sports Med.* 2014;42(4):921-926.

**ACKNOWLEDGEMENTS:** None

**IMAGES AND TABLES:**

