
Investigation of the Effect of Anterior Cruciate Ligament Injury on the Axial Rotation of the Knee Joint

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COI Disclosure Information

Presenter : Kenjiro Okimura

I have no financial relationships to disclose.



Background

- ✓ Anterior cruciate ligament (ACL) injury induces an anterolateral rotatory instability (ALRI: pivot-shift), a combined movement of abnormal anterior-posterior translation and axial rotation.
- ✓ Tibial anterior translation during the pivot-shift in ACL-injured knees is evaluated independently and is heavily used for diagnosis and follow-up. [1, 2, 3]
- ✓ However, **the effect of the ACL injury on axial rotation is still controversial**, mainly due to lack of in-vivo evaluation system.

Does ACL injury affect axial rotation?

Previously....

ACL injury is associated
with abnormal axial rotation [4, 5]



ACL injury is not associated
with abnormal axial rotation [6, 7]

There is **no consensus** as to whether ACL injury
results in abnormal knee joint axial rotation

Purpose

To evaluate

- the effect of ACL injury on the angle of axial rotation for simple axial rotation stress
- the relationship between axial rotation angle and manual testing and clinical scores

Patients

Retrospective analysis (2017-2021)

Inclusion

- Acute primary ACL tear
- Underwent Anatomic Double Bundle ACLR
- More than one year follow-up
- Preop evaluation using the electromagnetic system

Exclusion

- Combined other ligament procedures
- Concomitant meniscal injury
- Incomplete data

Patients(n): **31** (14 males/17 females)

Mean age at injury: **27.5** (14~54)

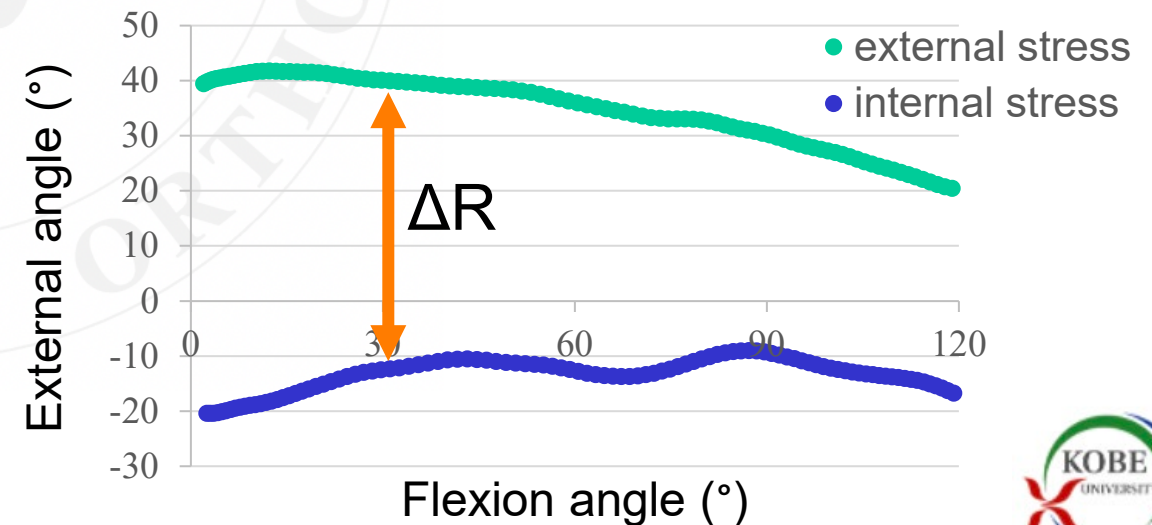
Rotation measurement using an electromagnetic system

- Flexion movement under simple external/internal rotation stress before the surgery under general anesthesia
- Measure 6 degrees of freedom of the knee using an electromagnetic system (EMS: JIMI 神戸) [8]
- The difference between the external and internal rotation angles was defined as ΔR



External stress

Internal stress



Evaluation

Preoperative EMS measurements

- ΔR ($^{\circ}$) at 30° , 60° and 90° flexion
- Anterior tibial translation under internal/external rotation stress (mm)
- Anterior tibial translation during Lachman test (mm)
- Tibial acceleration during pivot shift test (m/s^2)

Comparison of ACL
intact and deficient

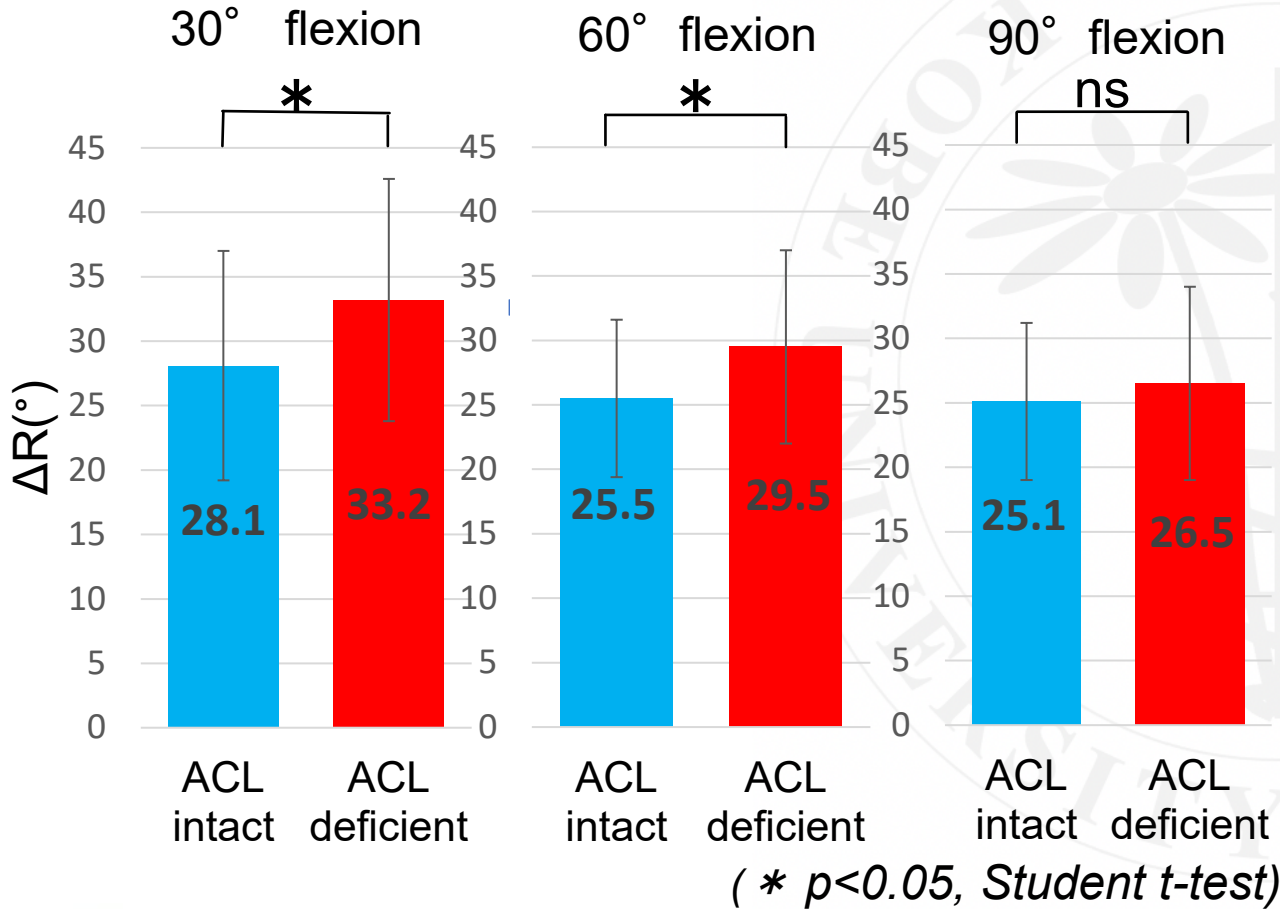
Postoperative clinical evaluation

- IKDC subjective score at one year postoperatively

Correlation
analysis with ΔR

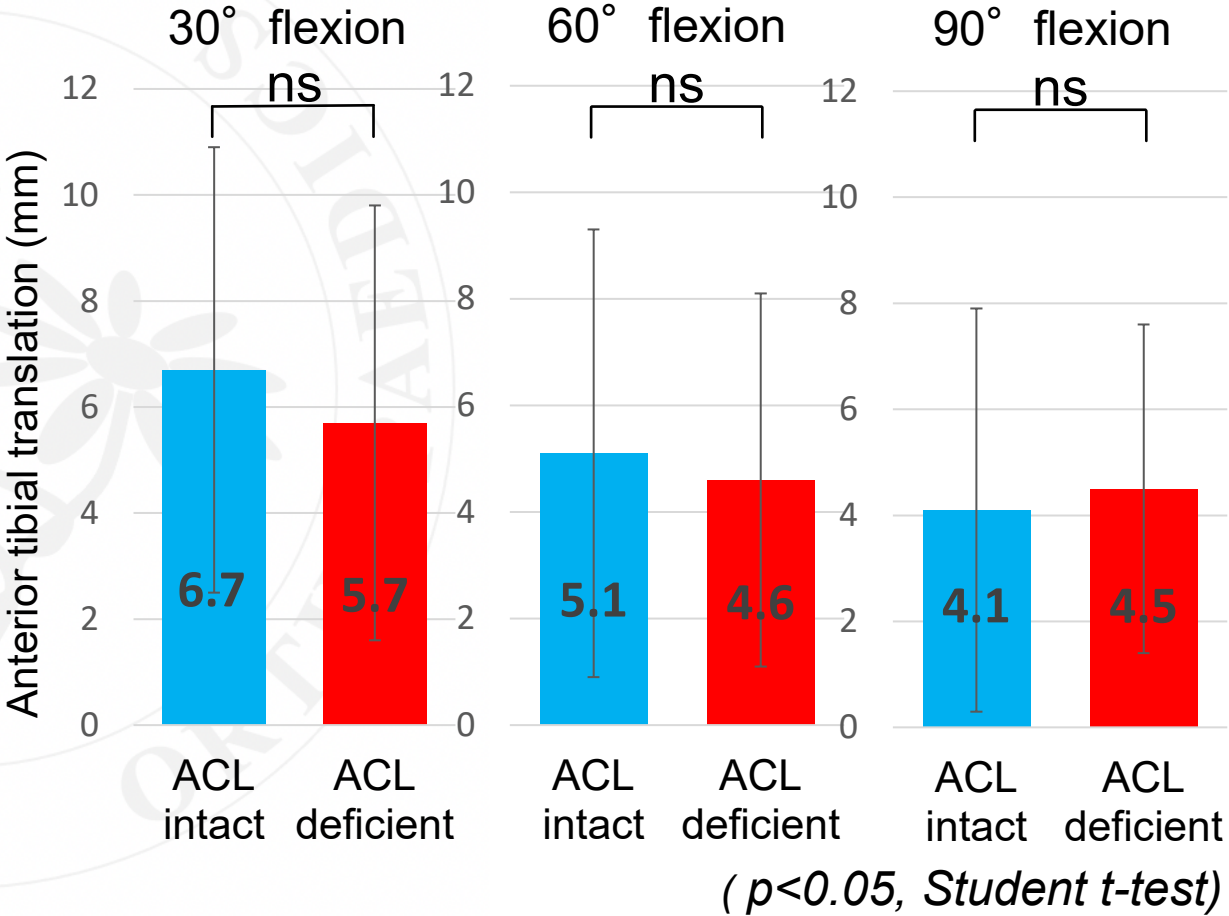
Results

ΔR at each flexion angle



Increased axial rotation in ACL deficient knees

ΔR at each flexion angle

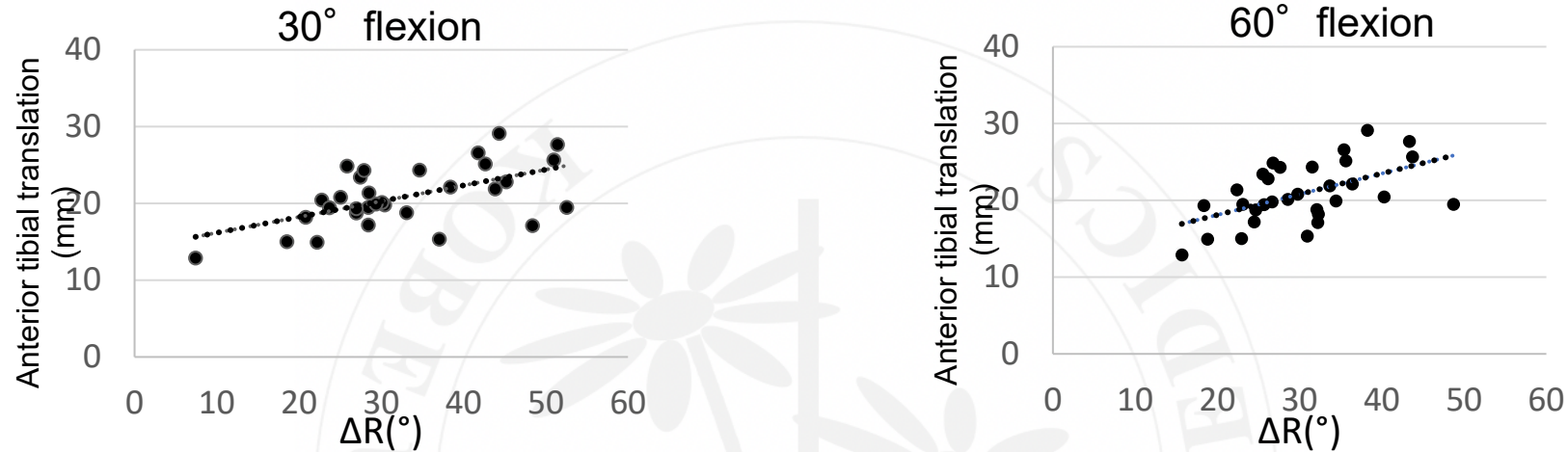


No effect on AP translation



Results

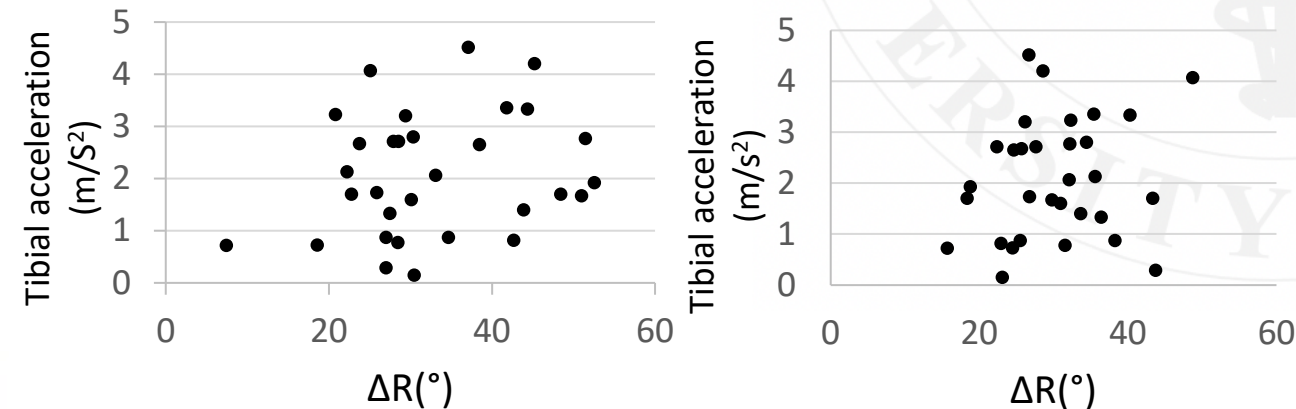
Correlation between ΔR and anterior laxity



Significant positive correlation

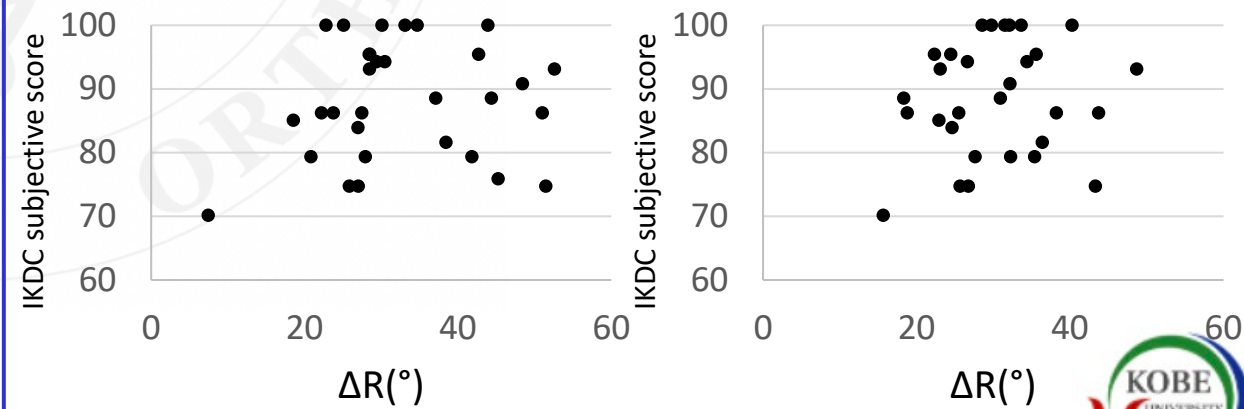
(Pearson correlation coefficient)

Correlation between ΔR and pivot-shift acceleration



No correlation

Correlation between ΔR and postoperative IKDC score



No correlation

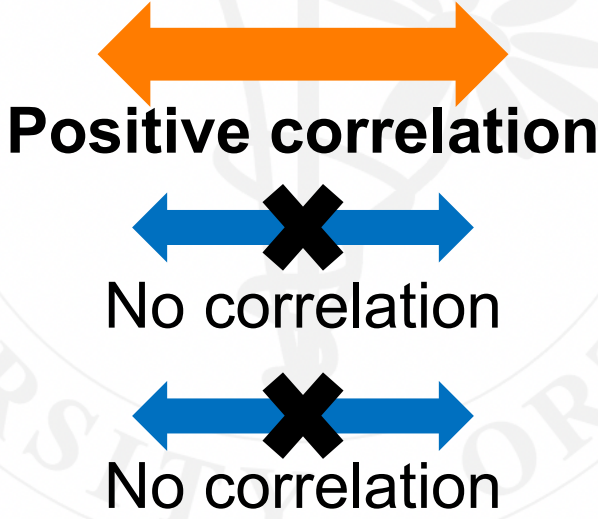


Discussion

This present study

ACL injury **increased axial rotation angle** without anterior-posterior translation

Increase of axial rotation angle



Anterior laxity

Anterolateral rotational instability

Postoperative IKDC score

Conclusion

- ACL injury increased the angle of axial rotation without anterior-posterior translation
- Axial rotation angle had little effect on anterolateral rotational instability

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- [2] Zaffagnini S, Signorelli C, Grassi A, et al. Anatomic anterior cruciate ligament reconstruction using hamstring tendons restores quantitative pivot shift. *Orthop J Sports Med.* 2018;6(12):2325967118812364.
- [3] Hong CK, Hoshino Y, Watanabe S, et al. The coronal lateral collateral ligament sign in the anterior cruciate ligament-injured knees was observed regardless of the knee laxity based on the quantitative measurements. *Knee Surg Sports Traumatol Arthrosc.* 2022;30:3508-3514.
- [4] Willinger L, Athwal KK, Williams A, et al. An anterior cruciate ligament in vitro rupture model based on clinical imaging. *Am J Sports Med.* 2021;49:2387–2395.
- [5] Oh YK, Kreinbrink JL, Ashton-Miller JA, et al. Effect of ACL transection on internal tibial rotation in an in vitro simulated pivot landing. *J Bone Joint Surg Am.* 2011;93(4):372-80.
- [6] Hemmerich A, van der Merwe W, Batterham M, et al. Knee rotational laxity in a randomized comparison of single- versus double-bundle anterior cruciate ligament reconstruction. *Am J Sports Med.* 2011;39:48–56.
- [7] Lane JG, Irby SE, Kaufman K, et al. The anterior cruciate ligament in controlling axial rotation an evaluation of its effect. *Am J Sports Med.* 1994;22:289–293.
- [8] Hoshino Y, Kuroda R, Nagamune K, et al. Optimal measurement of clinical rotational test for evaluating anterior cruciate ligament insufficiency. *Knee Surg Sports Traumatol Arthrosc.* 2012;20(7):1323-30.