Steeper lateral posterior tibial slope and greater lateral-medial slope asymmetry are associated with greater preoperative pivot-shift in anterior cruciate ligament injury

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COI Disclosure

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PTS and knee joint laxity in ACL injury

- **Pivot-shift test** is the **most commonly** used clinical examination to evaluate **anterolateral rotatory knee laxity**[1]

- The cause of the spectrum of anterolateral rotatory knee laxity is **multifactorial**; **Bony morphology** (i.e. **posterior tibial slope; PTS**) has been drawing attention[1-2]

Anterolateral rotatory knee laxity

- **Steeper** PTS correlated with **high-grade preoperative pivot-shift**[3-5]

Lateral-medial slope asymmetry

- **Lateral-medial PTS asymmetry** is risk factor for **concomitant posterolateral meniscal root tears** in ACL injuries[6]

However, association between PTS and preoperative pivot-shift has not been fully elucidated

Purpose

- ✓ To investigate the association between PTS and preoperative pivot-shift test by quantifying using an electromagnetic measurement system (EMS) in ACL-injured knees

Hypothesis

- ✓ Steeper lateral PTS and greater lateral-medial PTS asymmetry (lateral PTS > medial PTS) would be associated with greater tibial acceleration during the pivot-shift test in ACL-injured knees

Objectives

Retrospective analysis（Jan. 2017 - Mar. 2021）

Inclusion

- Primary ACL injury
- Underwent ACL reconstruction
- Evaluate the preoperative pivot-shift test using the EMS

Exclusion

- Age: 13 years or younger
- Previous injury to the ipsilateral knee joint
- Concomitant ligament injuries with ACL injury
- More than one-year period from injury to surgery

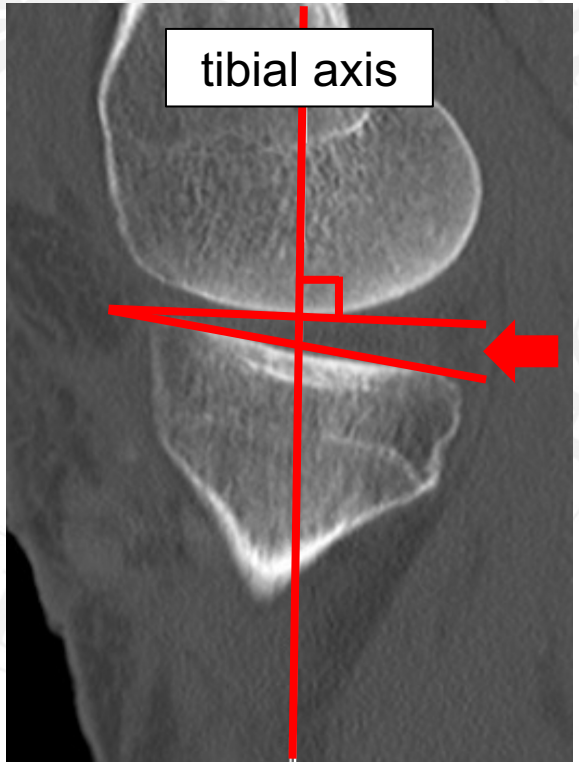
50 unilateral ACL-injured patients (male/female: 29/21)

Mean age: **28.0** ± 11.4 years (14 - 51)

Measurement of PTS

- High-resolution CT images were taken two weeks after the surgery
- Medial and lateral PTS were measured as previously reported[7-8]

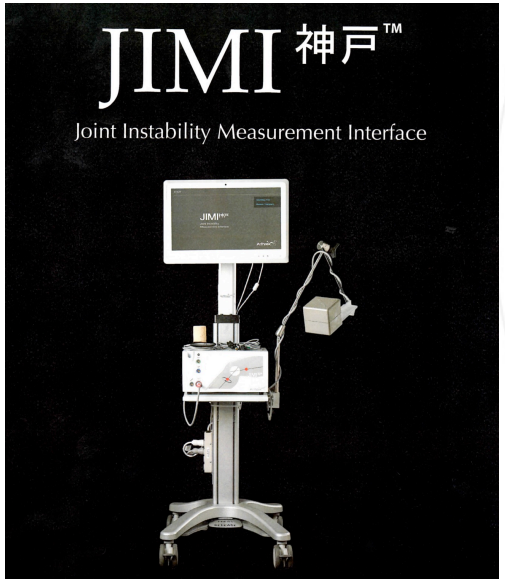
Define tibial axis

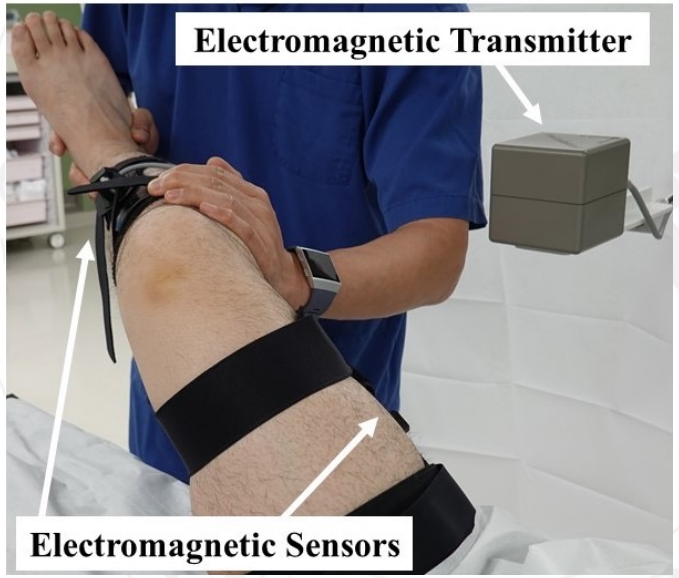


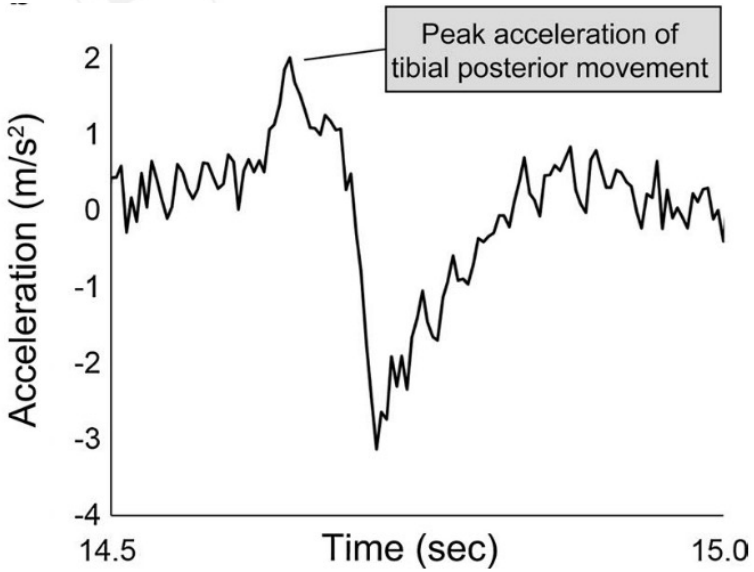
Measure medial and lateral PTS

Quantitative evaluation of pivot-shift test

- The pivot-shift test was performed preoperatively under general anesthesia using the EMS (JIMI神戸, Arthrex Japan Inc., Japan)
- **Tibial acceleration** (m/s^2) during the posterior reduction of the tibia was measured[9, 10]







Statistical analysis

The normality test: Shapiro-Wilk normality test ($p < 0.05$)
Correlation analysis: Pearson correlation coefficient ($p < 0.05$)

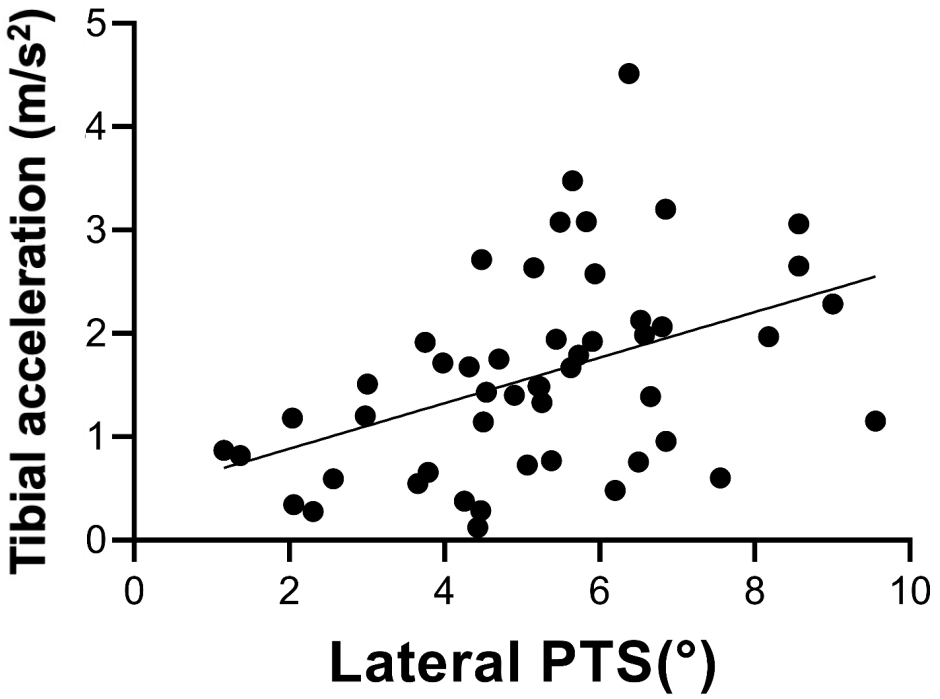
Result: Patient demographics

・50 ACL-injured knees (male/female 29/21)

	Mean (95% CI, range)
Mean age（years）	28.0 (24.8 - 31.2, 14 - 51)
Mean period from injury to surgery (days)	81.8 (62.5 – 101.1, 13 - 326)
Lateral PTS (°)	**5.2** (4.7 – 5.7, **1.2 – 9.6**)
Medial PTS (°)	**4.9** (4.3 – 5.5, **0.9 – 9.6**)
Lateral-medial slope asymmetry (°)	**0.3** (-0.2 – 0.8, **-2.9 – 3.8**)
Tibial acceleration (m/s^2)	**1.6** (1.3 – 1.9, 0.1 – 4.5)

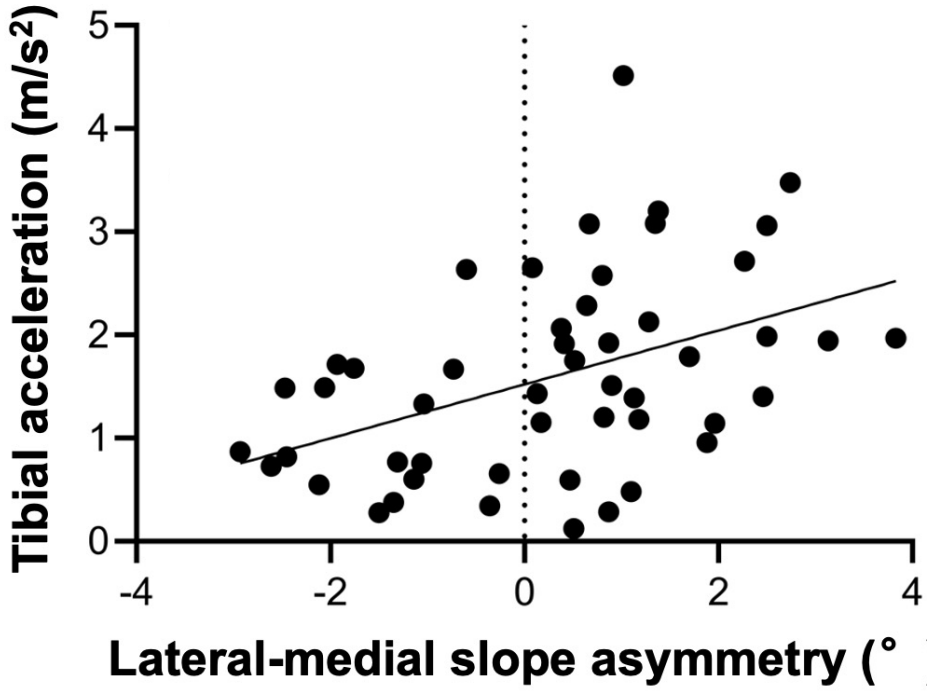
Correlation between PTS and tibial acceleration

Lateral



Significant positive correlation
r = **0.436**, p < 0.01

Lateral-medial slope asymmetry



Significant positive correlation
r = **0.443**, p < 0.01

No significant correlation was observed between medial PTS and tibial acceleration

Discussion: PTS and anterolateral rotatory knee laxity

The previous studies

- Preoperative pivot-shift was quantified using iPad image analysis[3]
  Lateral PTS (MRI): High laxity group (**9.3°**) > Low laxity group (**6.1°**)

- **Six factors** were associated with preoperative **high-grade** pivot-shift[2]
  PTS (radiograph)**>9°**, Beighton score≧4 points, male,
  medial and lateral meniscus posterior segment injury, chronicity (> 6months)

The present study

Steeper lateral PTS
Greater PTS asymmetry

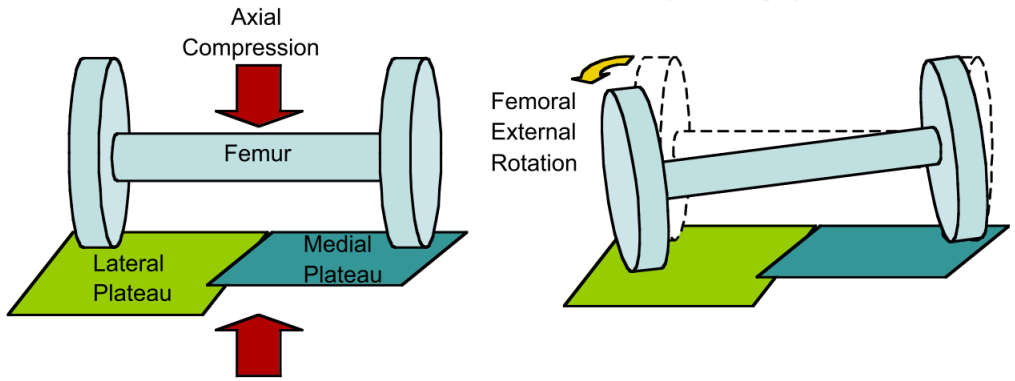
➡ **Greater Tibial acceleration**

PTS asymmetry and anterolateral rotatory knee laxity

The present study

Greater Lateral-medial PTS asymmetry (**Lat > Med PTS**): 0.3˚ (range: -2.9 – 3.8) ➡ Greater tibial acceleration

Proposed mechanism



The lateral side of the femur slides posteriorly off the steep lateral tibial plateau, using the flat medial tibial plateau as a pivot point[11]

Not only **lateral PTS** but also **PTS asymmetry** could be an important parameter related to anterolateral rotatory knee laxity

Factors associated with preoperative high-grade pivot-shift test

Previous studies

Quantitative evaluation of pivot-shift test using EMS (JIMI神戸™)

Lateral meniscus injury[10]

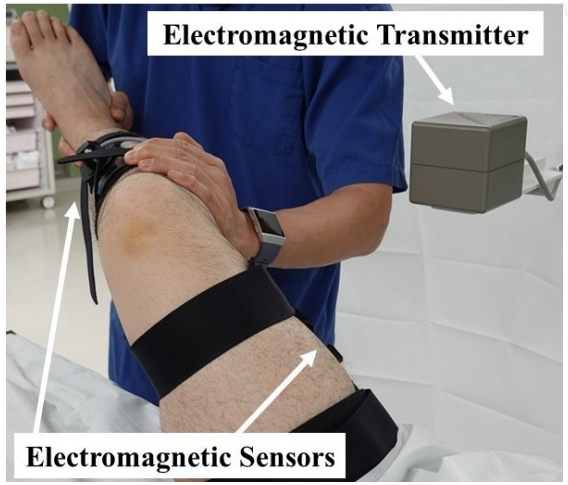
Chronicity (＞1 year)[12]

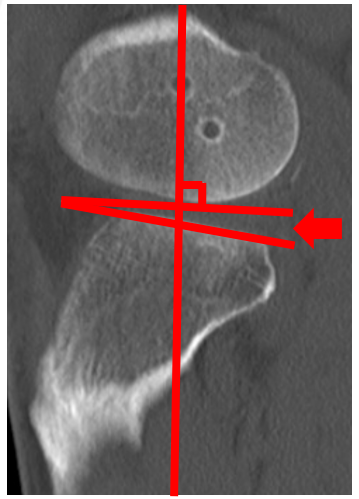
→ ACL-injured knees "**high-grade**" pivot-shift ← Anterolateral complex injury[13-15]

Present study

Bony morphology of tibial plateau

- **Lateral PTS**
- **PTS asymmetry**





Conclusions

- **Steeper lateral PTS** and **greater lateral-medial slope asymmetry** were associated with greater preoperative tibial acceleration during the pivot-shift test in ACL-injured knees
- Surgeons should be aware that lateral PTS, as well as lateral-medial slope asymmetry, may affect preoperative anterolateral rotatory knee laxity in ACL injury

Reference

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