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Muroran City General Hospital

Accuracy and reliability of the ultrasound-assisted Lachman test in diagnosing anterior cruciate ligament injuries

Authors: Yuzuru Sakakibara, MD, PhD[1, 4]; Vasundhara Mathur, MD[1]; David O Osei-Hwedieh, MD[1], Rohan Bhimani; MD[1]; Soheil Ashkani-Esfahani, MD[1,2] ; Miho Jean Tanaka, MD PhD[3] .

Affiliations:
1- Foot & Ankle Research and Innovation Lab (FARIL), Massachusetts General Hospital, Harvard Medical School, Boston, MA
2- FARIL-SORG Collaborative, Massachusetts General Hospital, Harvard Medical School, Boston, MA
3-Department of Orthopaedic Surgery, Massachusetts General Hospital, Harvard Medical School, Boston, MA
4-Department of Orthopaedic Surgery, Muroran City General Hospital, Hokkaido, Japan

Background

Dynamic examination is the primary method for detecting the presence of anterior cruciate ligament (ACL) insufficiency.

The Lachman test has been reported to be the most sensitive clinical examination to assess ACL injuries.

Ultrasound imaging has been shown to be **highly accurate**, **affordable**, and **accessible** for orthopaedic care settings, specifically for assessment of soft tissue injuries.

Conflict of Interest: This study was funded by a research grant from Fujifilm Co.

Purpose

However, Whether dynamic ultrasound imaging has sufficient precision in evaluating ACL injuries has not been studied.

Purpose of this study

To detect and quantify the instability of ACL-deficient knee joint using portable handheld ultrasound.

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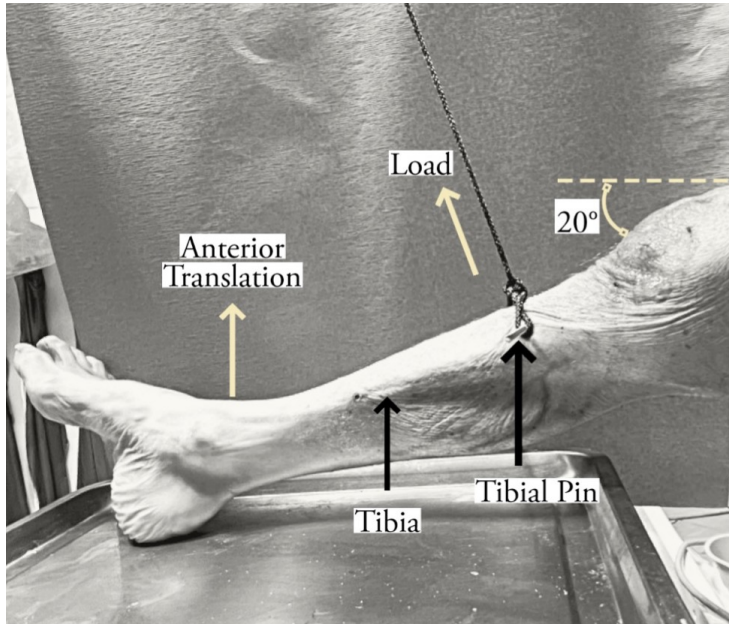
Materials & Tests

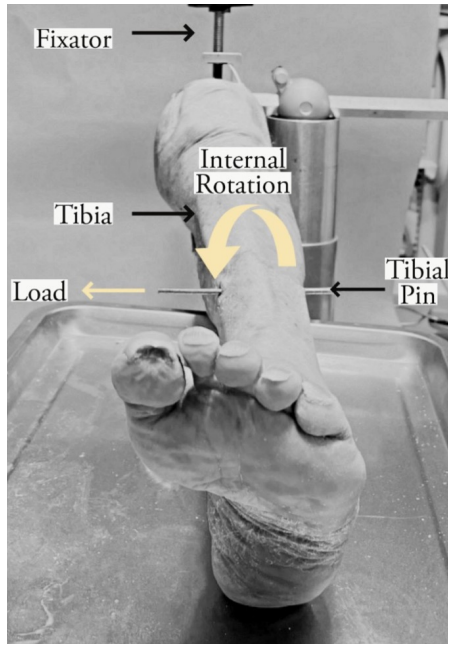
Ten fresh-frozen cadaveric knee specimens were evaluated in three conditions:
(1) **intact ACL**, (2) **complete ACL deficient**, and (3) **ACL and Anterolateral ligament (ALL) deficient**.

Dynamic testing was performed while simulating the Lachman test (anterior translation of the tibia with 100N) and pivot shift test (internal rotation (IR) torque with 10Nm). (Fig1)
Portable handheld ultrasound device (iViz Air wireless handheld ultrasound, Fujifilm Co, Japan).

Fig1



100N anterior drawer loading



10Nm internal rotation torque

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Ultrasound imaging

The probe was placed at the anterior medial (AM) and lateral (AL) joint line, and the difference between D1 and D2 was taken as a measure of translation of the tibia (ΔD): ΔD= D2 - D1 .

Tibial rotation = ΔD in AM view divided by ΔD in AL view. And anterior translation of the tibia (ΔD) relative to the femur was calculated. (Fig 2,3)

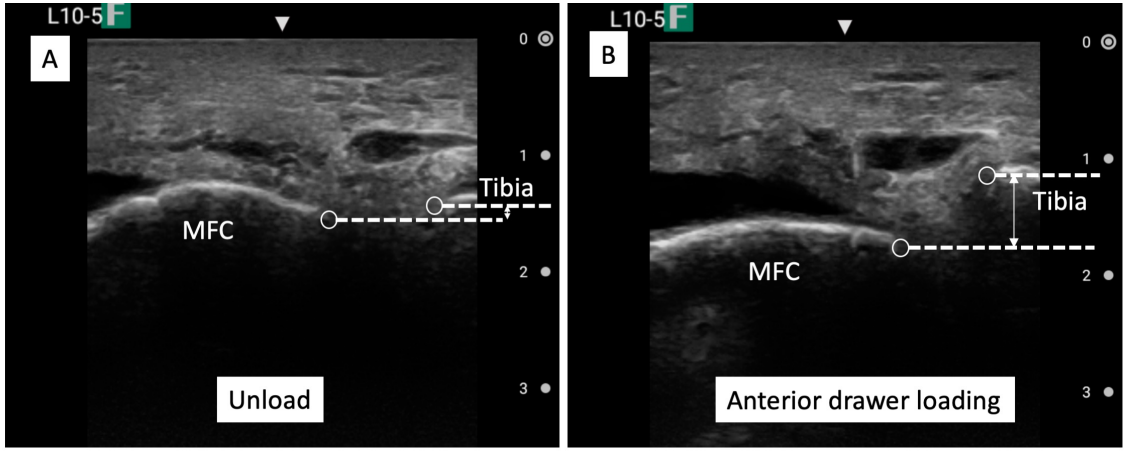

Fig2: AM view: result of ACL deficient condition.
A is the unload and B is anterior drawer loading.
MFC: Medial femoral condyle

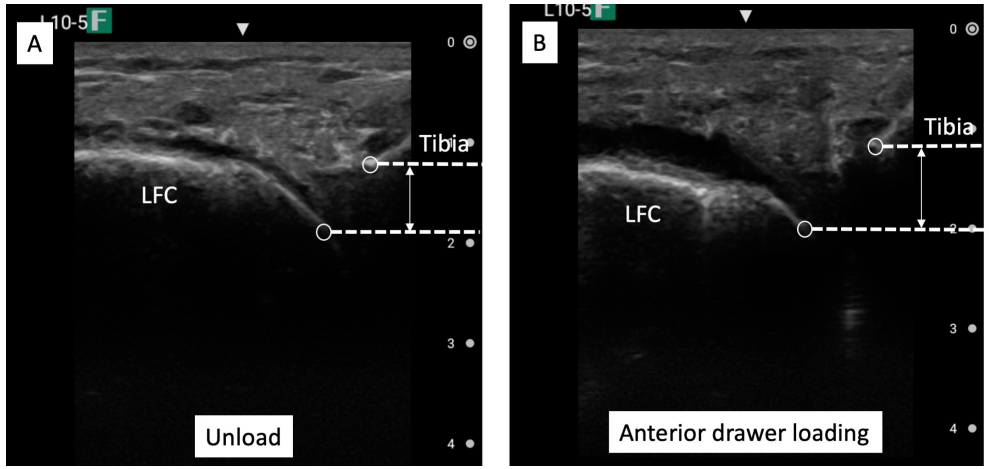

Fig3: AL view: result of ACL deficient condition.
A is the unload and B is anterior drawer loading.
LFC: Lateral femoral condyle

ROC curve analysis

Receiver operating characteristic (ROC) curve analysis was performed to calculate an ideal cutoff point for detecting instability of the ACL deficient and ACL+ALL deficient knees.

AUC for ACL deficiency

Table1: Summarized results demonstrate area under ROC curves (AUC) for ACL tear state with their respective cut off values, specificities, and sensitivities compared to the intact.

	Cut-off value (in mm)	AUC	95% CI	Overall Accuracy (%)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
AM-AD	2.6mm	0.89	0.66-0.97	85	80	90	88.9	81.8
AM-IR	0.7mm	0.65	0.42-0.85	70	50	90	83.3	64.3
AL-AD	1.6mm	0.72	0.47-0.89	75	80	70	72.7	77.8
AL-IR	2.4mm	0.66	0.42-0.85	65	60	80	66.7	63.6

ACL, anterior cruciate ligament; ALL, anterolateral ligament; AUC, area under the curve; CI, confidence interval; %, percentage; mm, millimeters;PPV, positive predictive value; NPV, negative predictive value. AM-AD: anterior medial view, anterior drawer loading, AM-IR: anterior medial view, internal rotation torque, AL-AD: anterior lateral view, anterior drawer loading, AL-IR: anterior lateral view, internal rotation torque.

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Translation of the tibia

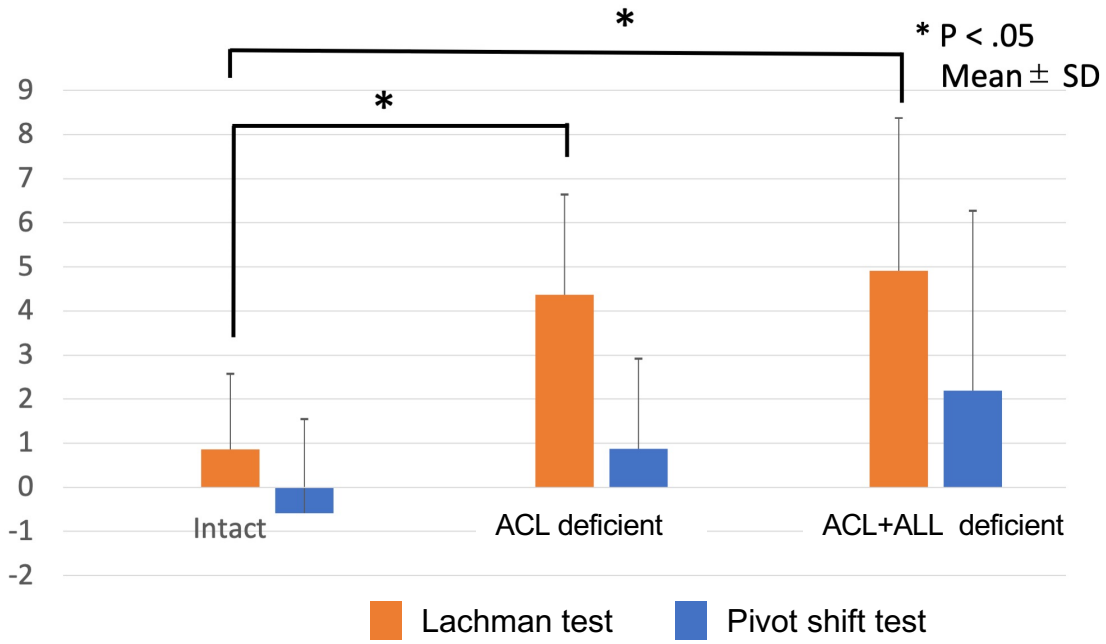


Fig4: Translation of the tibia in anterior medial view

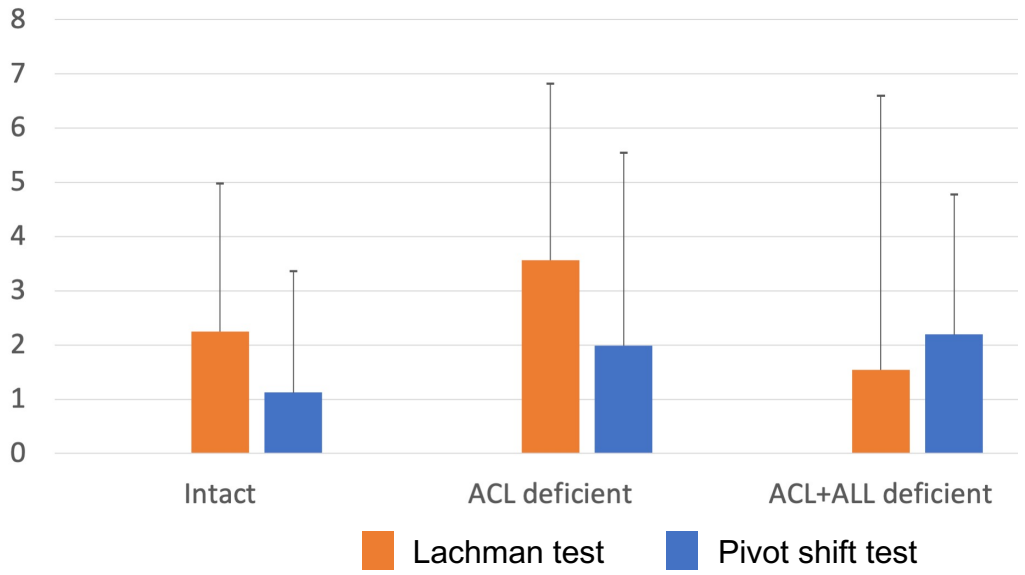
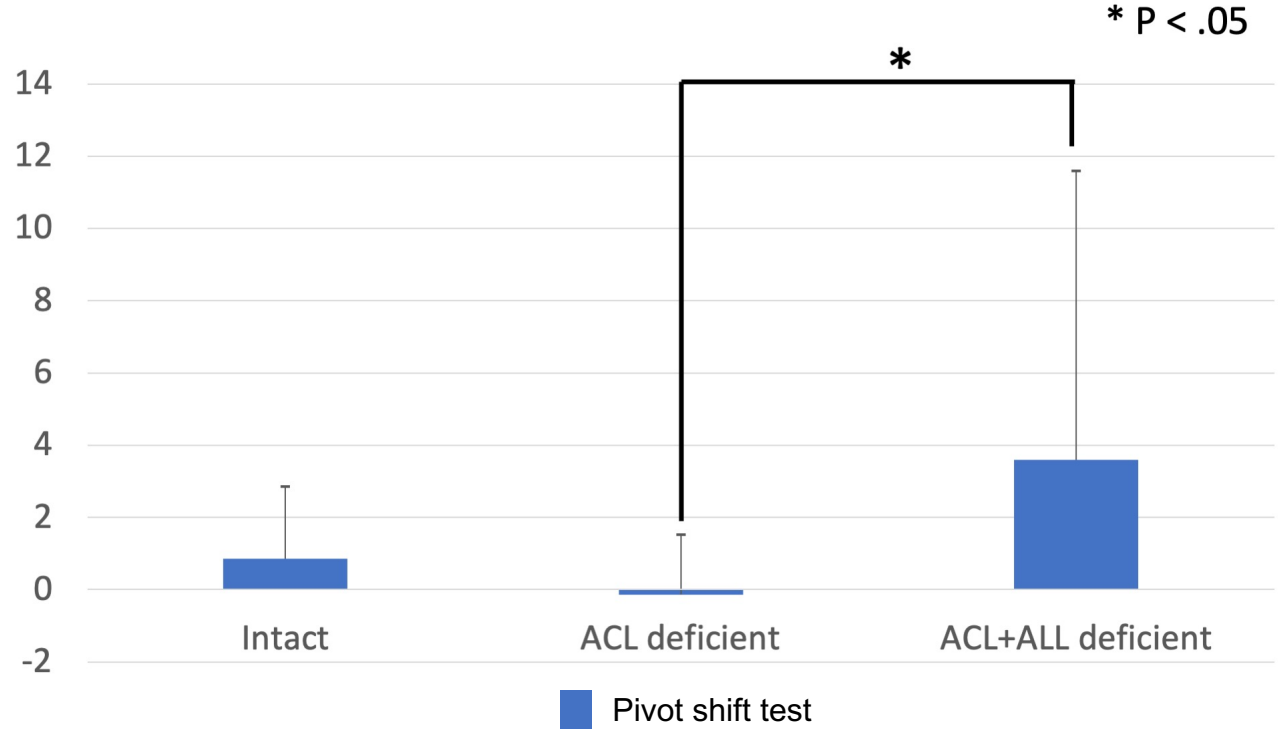


Fig5: Translation of the tibia in anterior lateral view

While simulating the Lachman test, translation of the tibia of ACL deficient and ACL+ALL deficient showed significant difference compared to that of Intact.

Δ distance of AM view divided by AL view

Fig6: Translation of the tibia viewed from anterior medial view divided by anterior lateral view



In pivot shift test, translation of the tibia showed significant difference between ACL deficient and ACL + ALL deficient condition. SD: Standard deviation. Values are presented as mean ± SD

Discussion

Dynamic ultrasound evaluation of ACL injury and knee instability from the anterior aspect of the knee is an effective and novel method with **high sensitivity and specificity**, **accuracy,** and **reproducibility**.

Additionally, pivot shift test was significantly different between ACL injury and ACL+ALL injury in our study.

Potential for beneficial clinical applications

- Ultrasound can evaluate instability quantitatively and can thus be used for postoperative follow-up and functional evaluation.
- In the outpatient and emergency departments, it may have use for accurate and early diagnosis of ACL injuries.
- The dynamic assessment of rotational instability on ultrasound may serve as a future direction for more accurate evaluation of ALL insufficiency.

CONCLUSION & CLINICAL RELEVANCE

Dynamic ultrasound evaluation from AM view is highly reproducible, with high sensitivity and specificity for diagnosing ACL insufficiency.

References

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