Combined graft augmentation for medial collateral ligament repair may improve knee kinematics

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MCL injury

- Grade I: microscopic injury, conservative
- Grade II: partially torn, no clinical instability
- **Grade III:** completely torn, surgery
  
  (Associated ligament injury 78% - ACL 95%)

**Treatment strategy for ACL + Grade III MCL injury – still controversial**

- Concomitant ACL + MCL surgery in acute phase

**Risk of arthrofibrosis**

- Acute phase: conservative, reduce swelling, ROM recovery
- Chronic phase: simultaneous ACLR + MCL repair or reconstruction

**Valgus instability**

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*Fetto JF, CORR 1978*

*Westermann RW, Arthroscopy 2019*
Successful restoration of MCL function in the case of ACL + MCL grade 3 injury

- Contributes to ACL graft healing
- Appropriate force distribution

**ACLR failure rate in MCL malfunction:** 31%

Wright RW, AJSM 2010

Reliable MCL surgery would be needed for successful outcome in ACL + grade 3 MCL injury cases
MCL surgery?
- Repair
- Reconstruction
- Repair + augmentation

Lack of biomechanical studies
Purpose

- Compare the kinematics of isolated MCL repair and MCL repair + graft augmentation in the setting of ACLR

Hypothesis

- Isolated MCL repair is insufficient in knee kinematics
- Adding graft augmentation better restores knee kinematics in the setting of concomitant ACLR
Methods

- Fresh frozen human cadaver knees, n=12
- **ACLR**
  - SB-ACLR with Ø8mm Semitendinosus tendon graft
  - F: endobutton, T: post screw, 40N at 20° knee flexion

- **MCL treatment**
  - **Suture**: sutures in MCL/POL, lift it up and post tie
  - **Augmentation**: 3 strand Gracilis graft (MCL-DB + POL)
  - d+s MCL: 30° knee flexion, POL: FE, manual max
MCL repair

Surgical procedures

Femur

Tibia

MCL grade 3 injury

Krackow suture x2
Surgical procedures

MCL repair + augmentation

Femur

Screw

Tibia

Post tie at MFC

s+d MCL DB

POL
Graft augmentation

Gracilis autograft

s+dMCL DB

POL
**Knee States Tested**
- ACLR + MCL intact
- ACLR + MCL deficient
- ACLR + MCL suture
- ACLR + MCL suture + graft

**Robotic Test Loads**
- ATT 89N (FE, 15°, 30°, 60°, 90°)
- Valgus 10Nm (FE, 15°, 30°)
- Simulated PS (FE, 15°, 30°)
  7Nm valgus + 5Nm IR

**Evaluate kinematics**
Results

Anterior Tibial Translation - ATT

Knee Flexion Angle (deg.)

* p < 0.05 compared to MCL intact
-- p < 0.05 within groups
Results

Knee Flexion Angle (deg.)

FE  15°  30°

* p < 0.05 compared to MCL intact  -- p < 0.05 within groups
Results

Coupled ATT

Knee Flexion Angle (deg.)
- FE
- 15°
- 30°

Displacement (mm)

- ACLR/MCL intact
- ACLR/MCL deficient
- ACLR/MCL suture
- ACLR/MCL suture + graft

No significant differences
Results Summary

**ATT at lower flexion angles**

- No significance between ACLR/MCL intact and ACLR/MCL suture + graft augmentation
- Significantly larger displacement in ACLR/MCL suture than ACLR/MCL intact

**Valgus**

- ACLR/MCL suture + graft augmentation restores better than ACLR/MCL suture state
MCL repair itself cannot restore the MCL function consistently

The knee kinematics become more similar to intact state by adding graft augmentation

Hypothesis was validated
Accelerated postoperative rehabilitation is needed for sufficient functional recovery after ACL (and MCL) surgery.  

ACL graft has higher tension in lower flexion angle.

MCL suture + graft augmentation improves the knee kinematics - in lower flexion angles at time zero.

Concomitant augmentation is clinically recommended.
Discussion

Kinematics in pivot shift loading

- Displacement was higher than deficient/suture state
- Measuring lateral displacement
- MCL is fulcrum

Anterior translation of whole tibia in MCL deficiency

Relative displacement of lateral tibia decreases

Tanaka M, KSSTA 2012
Conclusion

Combined graft augmentation with MCL suturing can better restore intact MCL kinematics than isolated MCL suturing in the setting of ACL with MCL grade 3 injury.