An In Vitro Analysis of an Anatomic Medial Knee Reconstruction

2009 Excellence In Research Award

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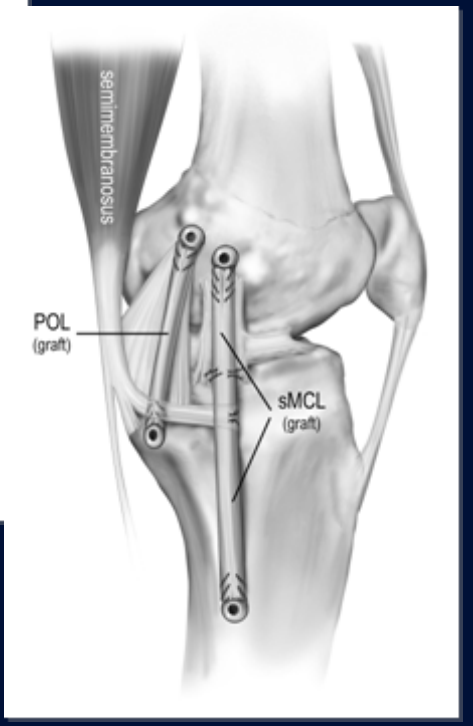
LaPrade RF *et al. J Bone Joint Surg Am, 2007*



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Disclosure

We have no relevant financial relationships to be discussed, directly or indirectly, referred to or illustrated with or without recognition within the presentation.

Background

- sMCL and POL provide primary and secondary stability to the medial knee.
- Injuries to the medial knee structures are common; some acute and chronic injuries may require surgery.
- No biomechanically validated anatomic medial knee reconstruction technique has been described.

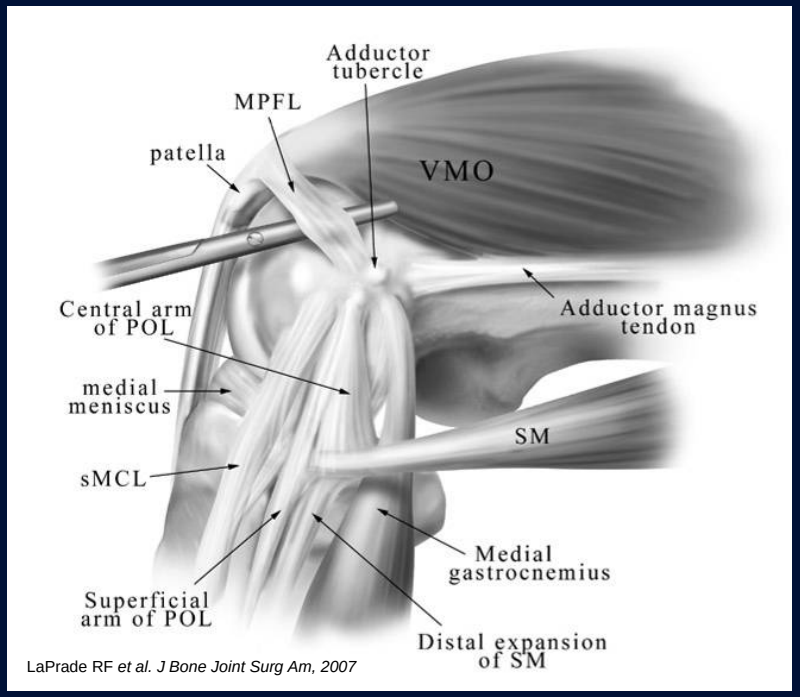
Warren LA et al. *J Bone Joint Surg Am.* 1974
Griffith et al. *Am J Sports Med.* 2009

The Anatomy of the Medial Part of the Knee

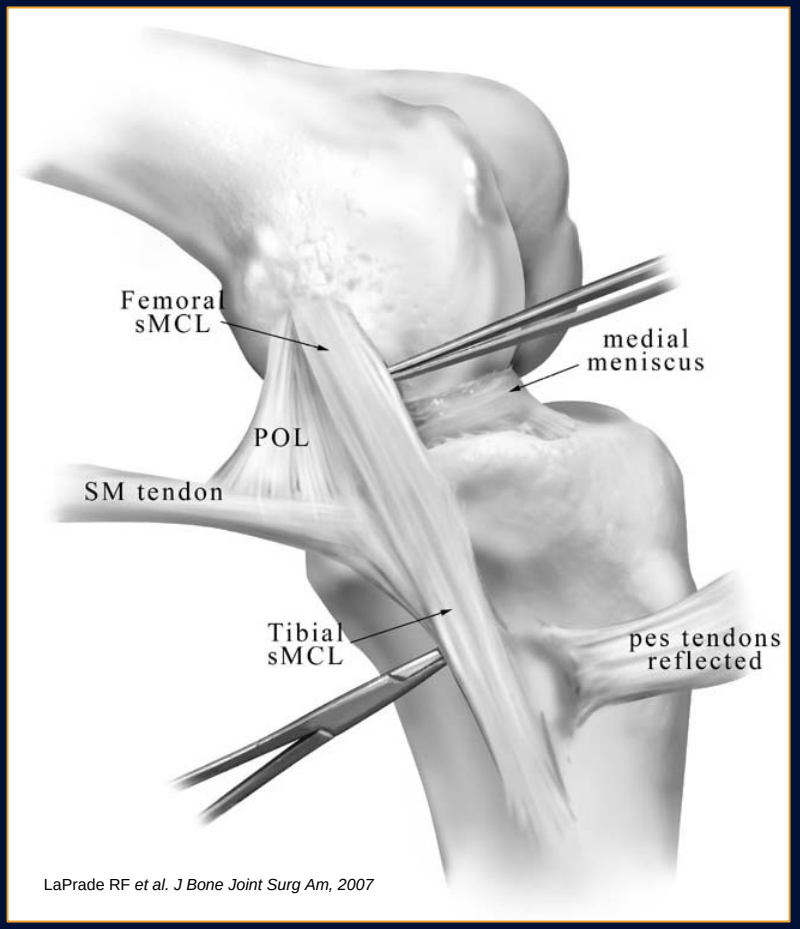
By Robert F. LaPrade, MD, PhD, Anders Hauge Engebretsen, Medical Student, Thuan V. Ly, MD, Steinar Johansen, MD, Fred A. Wentorf, MS, and Lars Engebretsen, MD, PhD

Investigation performed at the University of Minnesota, Minneapolis, Minnesota

A recent quantitative anatomical study improved our understanding of medial knee anatomy



LaPrade RF *et al. J Bone Joint Surg Am, 2007*

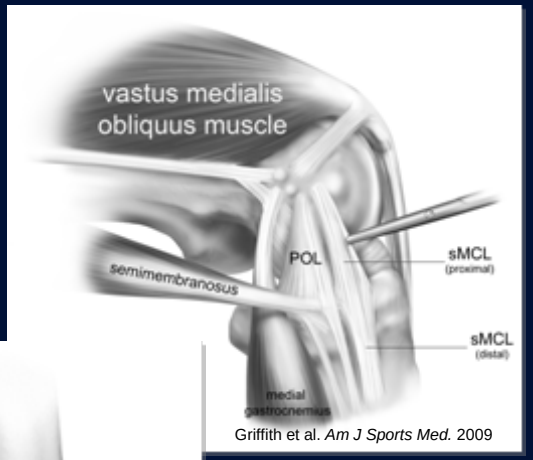


LaPrade RF *et al. J Bone Joint Surg Am, 2007*

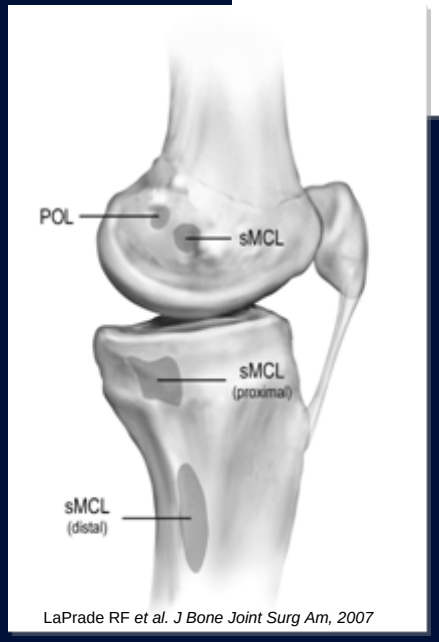
LaPrade RF *et al. J Bone Joint Surg Am;89(9), 2007*

Biomechanics

- Differences exist between the proximal and distal divisions of the sMCL.
  - psMCL - primary valgus stabilizer
  - dsMCL - primary rotational stabilizer
- POL is a primary internal rotation stabilizer near extension.
- Inverse relationship between POL and sMCL with restricting internal rotation.
- Important to reconstruct all structures to restore native biomechanics.



Griffith et al. *Am J Sports Med.* 2009



LaPrade RF *et al. J Bone Joint Surg Am, 2007*

Griffith et al. *Am J Sports Med.* 2009
Griffith et al. *Am J Sports Med.* 2009
Wijdicks et al. *Am J Sports Med.* 2009

Purpose

- Develop an anatomic medial knee reconstruction based on quantitative anatomic and biomechanical studies.
- Restore native knee stability.
- Avoid overconstraint of the reconstructed ligaments.

LaPrade RF *et al. J Bone Joint Surg Am, 2007*

Materials & Methods

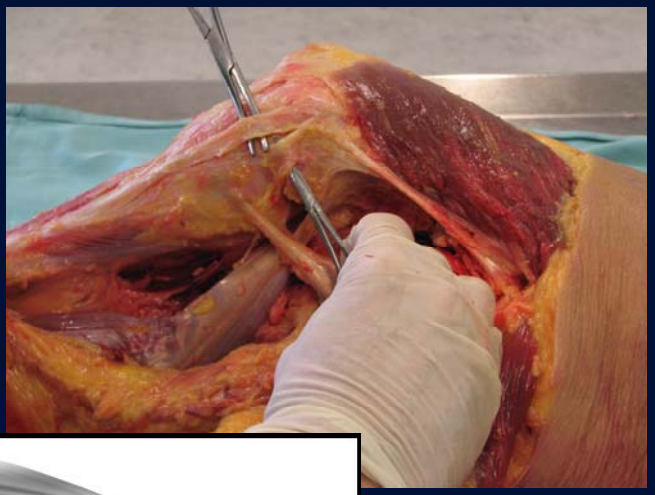
- 11 pilot knees to develop surgical technique (summary: one femoral tunnel did not work).
- 10 non-paired cadaveric knees.
- Intact, sMCL and POL sectioned, and anatomic reconstructed states.
- Tested at 0°, 20°, 30°, 60°, and 90° of knee flexion.
- Applied loads:
  - 10 Nm valgus moment
  - 5 Nm external and internal rotation torques
  - 88 Nm anterior and posterior drawer loads

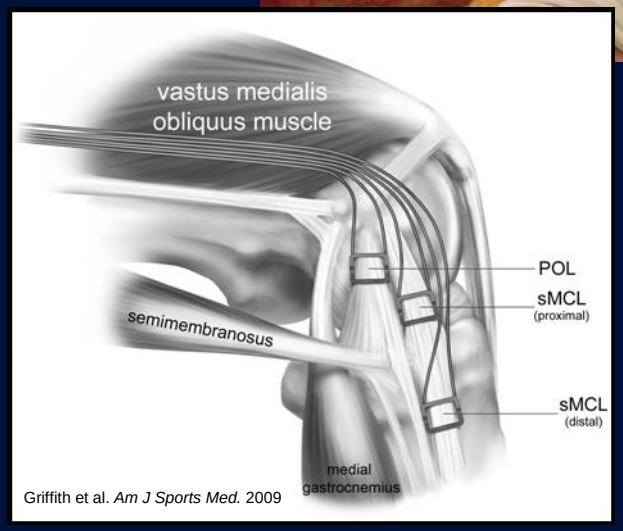
LaPrade RF *et al. J Bone Joint Surg Am, 2007*

Griffith et al. *Am J Sports Med.* 2009

Materials & Methods

- Electromagnetic tracking system (Polhemus) monitored knee motion.
- Buckle transducers measured ligament tensile load.

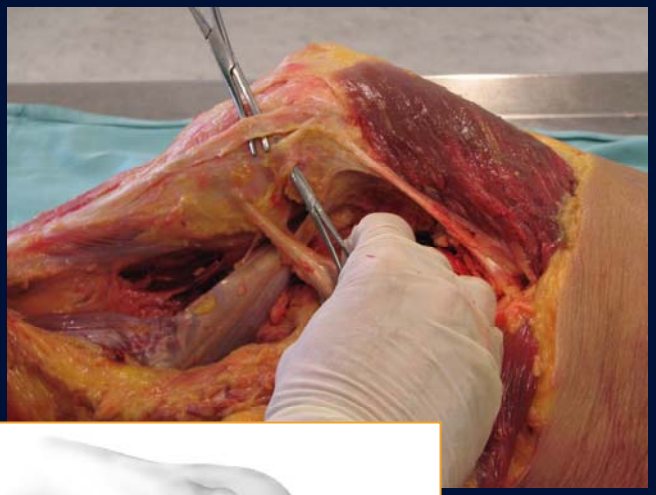




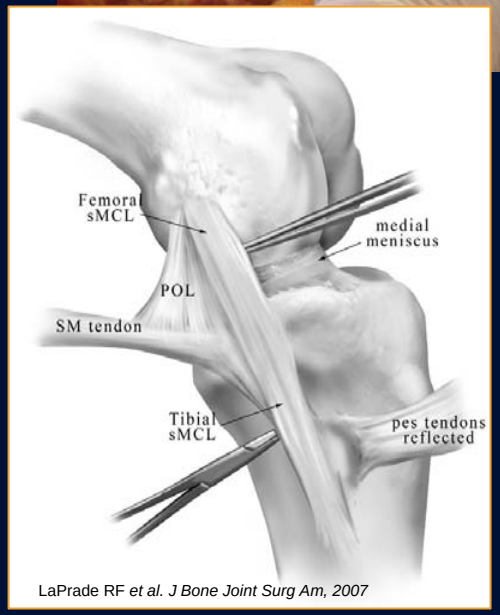
An et al. *J Biomechanics*. 1988.
Lewis et al. *J Biomech Eng.* 1982.
Griffith et al. *Am J Sports Med.* 2009
Wijdicks et al. *Am J Sports Med.* 2009

Clinically Important Anatomy

- sMCL
  - Femoral sMCL attachment is slightly postero-proximal to the medial epicondyle.
  - Distal sMCL attaches 6 cm distal to the joint-line.
  - Proximal sMCL attachment is mainly to soft tissues.



- POL
  - Femoral attachment is antero-distal to the gastrocnemius tubercle.
  - Central arm of POL attaches to the posteromedial tibia near the direct arm of the semimembranosus tendon.

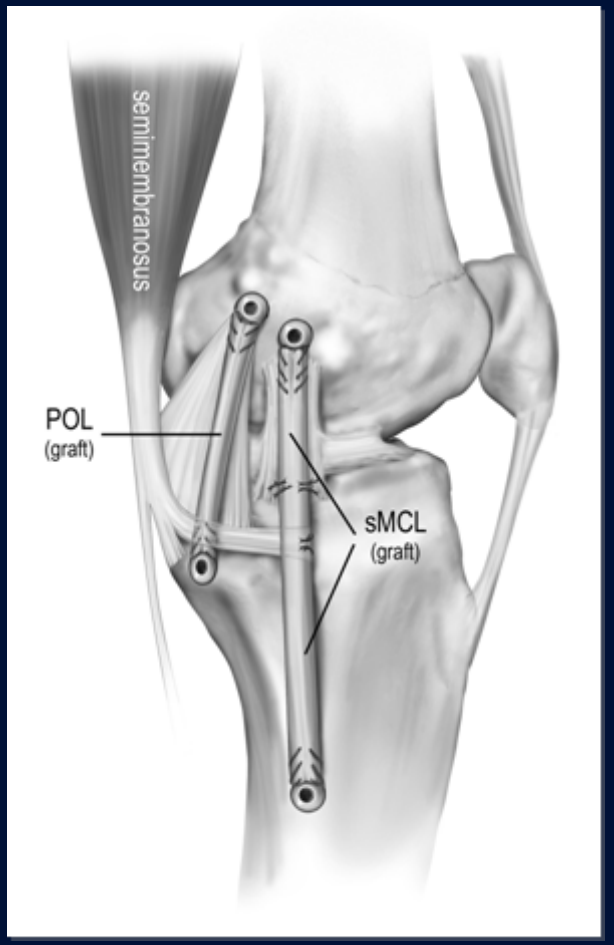


LaPrade RF *et al. J Bone Joint Surg Am, 2007*

LaPrade et al. *J Bone Joint Surg Am.* 2007

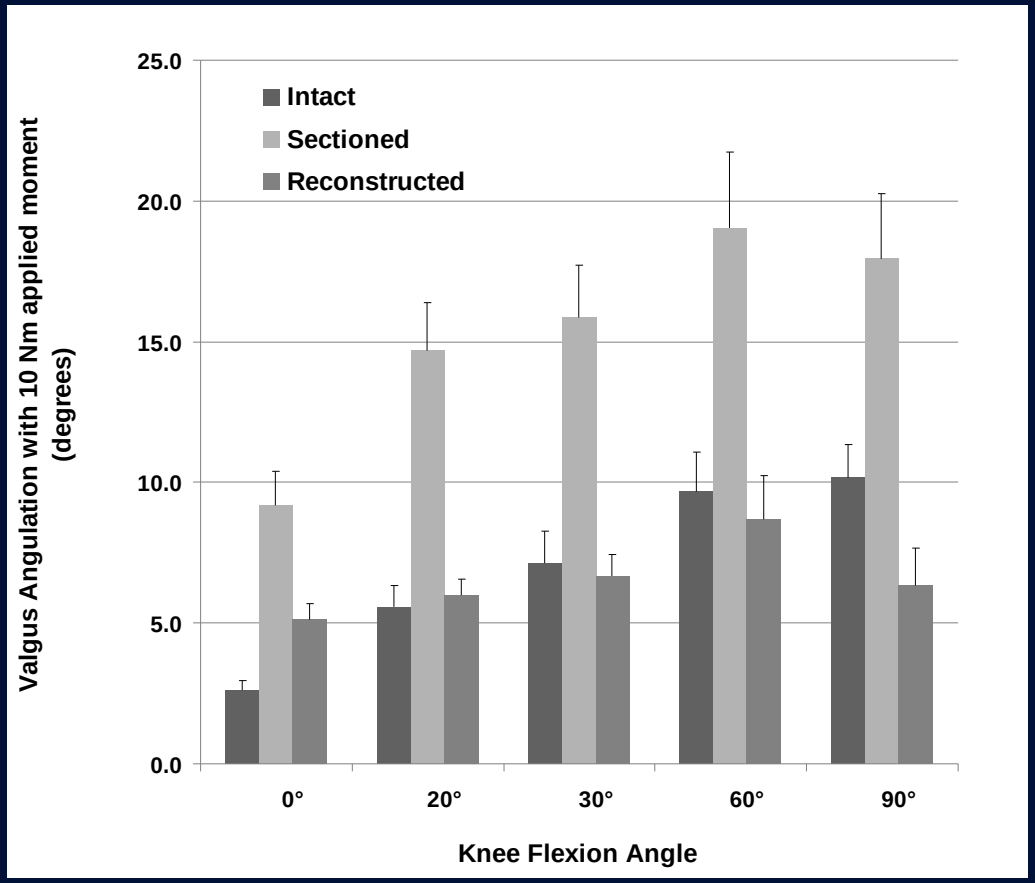
Reconstruction Technique

- Anatomic Reconstruction
  - 4 tunnels
  - 2 grafts
- Semitendinosus graft split into 16 cm (sMCL) and 12 cm (POL) lengths.
- sMCL tensioned at 30 degrees
- POL tensioned at 0 degrees



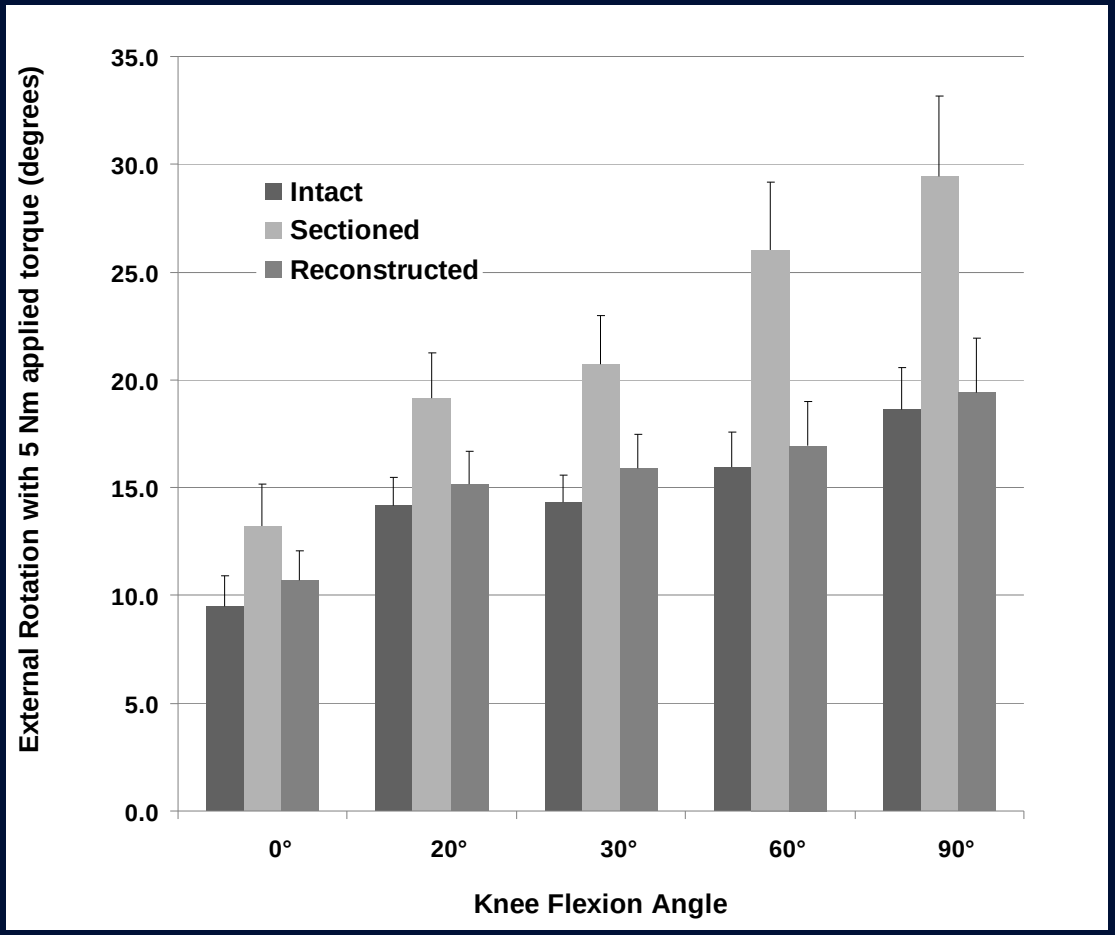
Results - Valgus Angulation

- Significantly increased valgus angulation occurred following sectioning of the sMCL and POL.
- Recovered following anatomic reconstruction.
- Small differences between intact and reconstructed at 0 and 90 degrees.



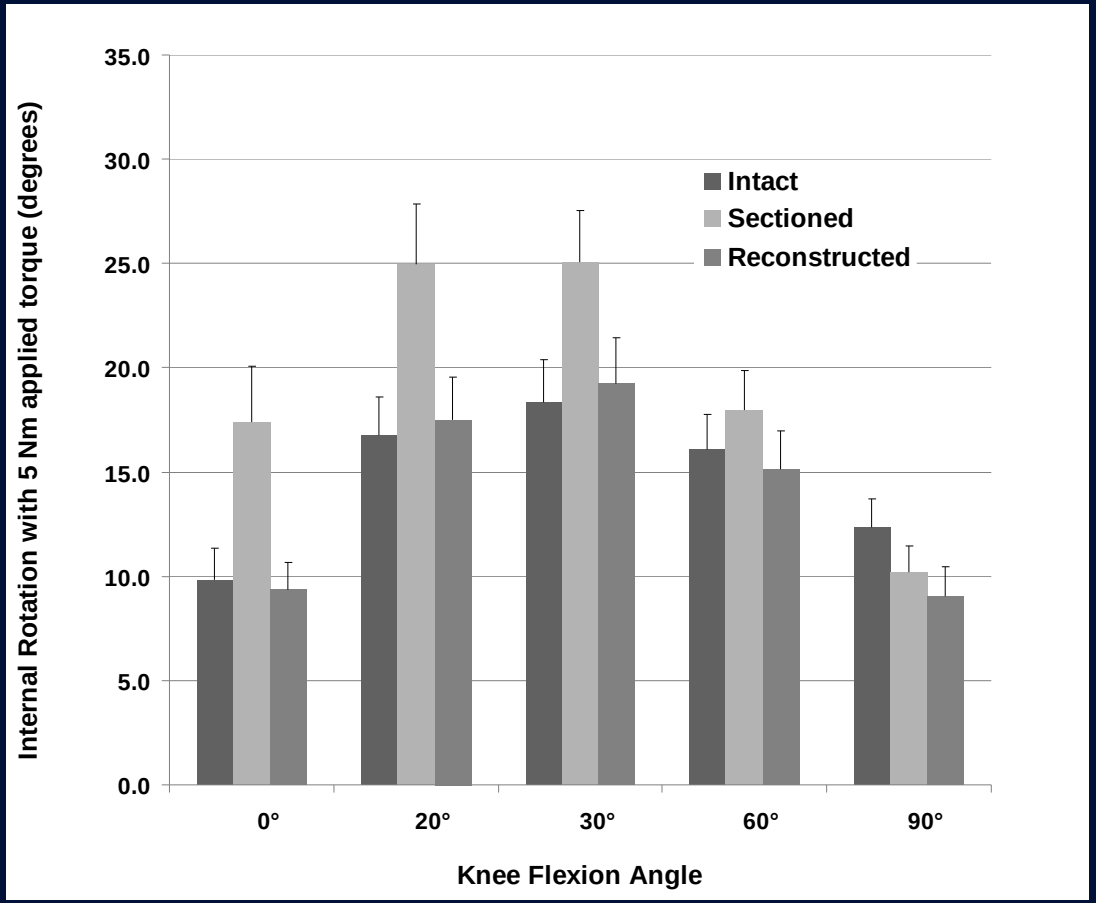
Results - External Rotation

- Significantly increased ER occurred following sectioning of the sMCL and POL.
- Recovered following anatomic reconstruction.

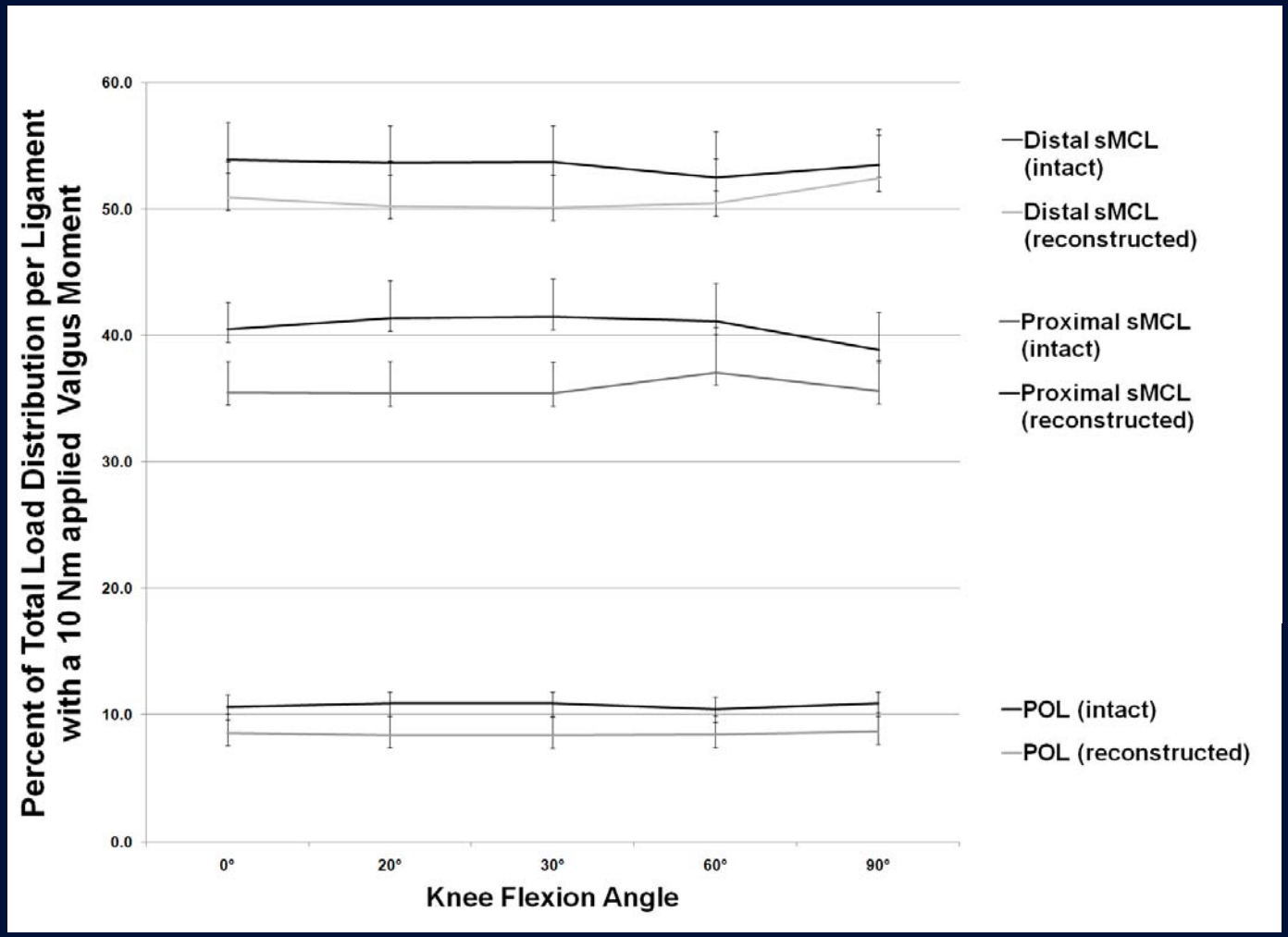


Results - Internal Rotation

- Significantly increased IR occurred at 0, 20, 30, and 60 degrees of knee flexion in sectioned state.
- Recovered following anatomic reconstruction.



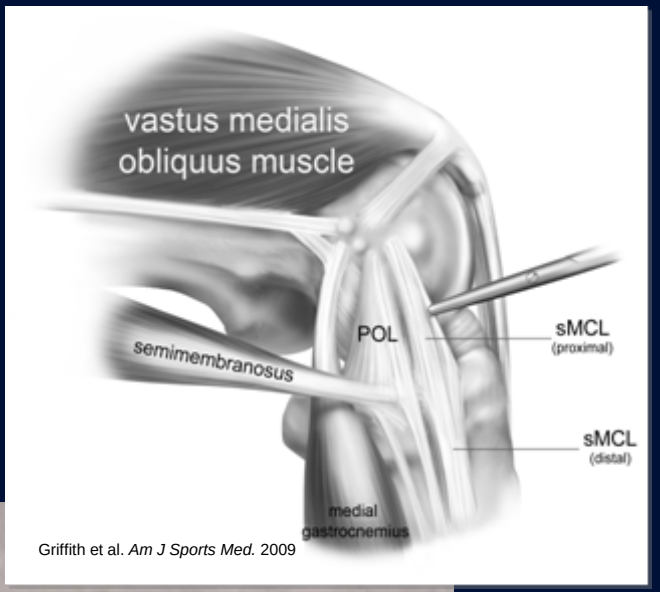
Results - Tensile loads



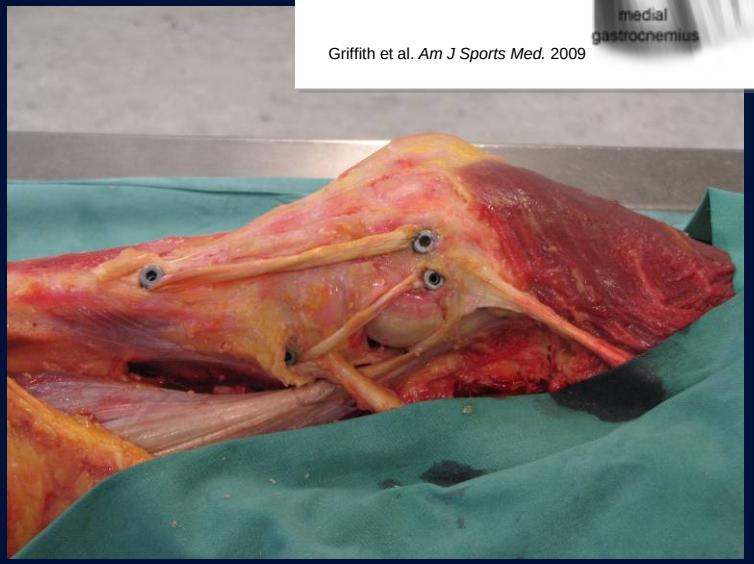
No significant differences were observed in the tensile loads experienced by the intact vs reconstructed ligaments.

Discussion

- Significant increases in valgus angulation, ER, and IR were found following sectioning of the medial knee structures.
- This instability was recovered to near-normal stability following our anatomic medial knee reconstruction.

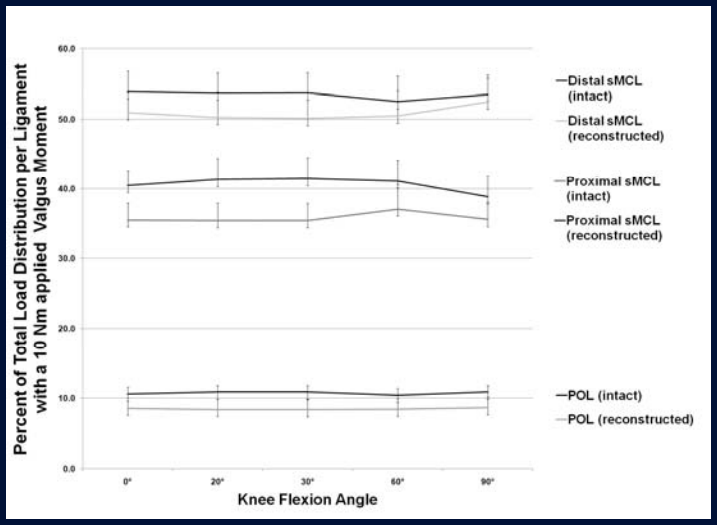


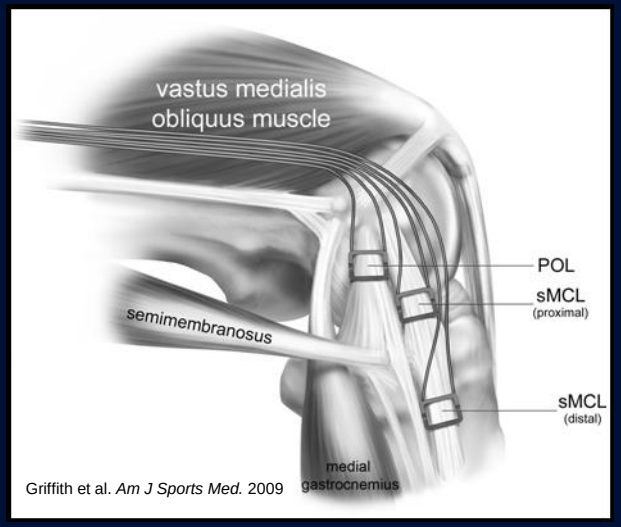
Griffith et al. *Am J Sports Med.* 2009



Discussion

- No increased tensile load was found in the reconstructed ligaments compared to the intact state.
- Confirms that no overconstraint occurred in our anatomic reconstruction technique.





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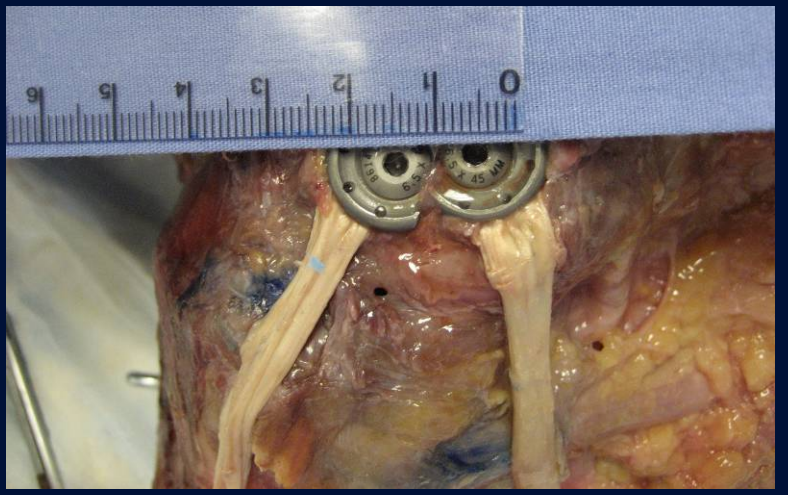
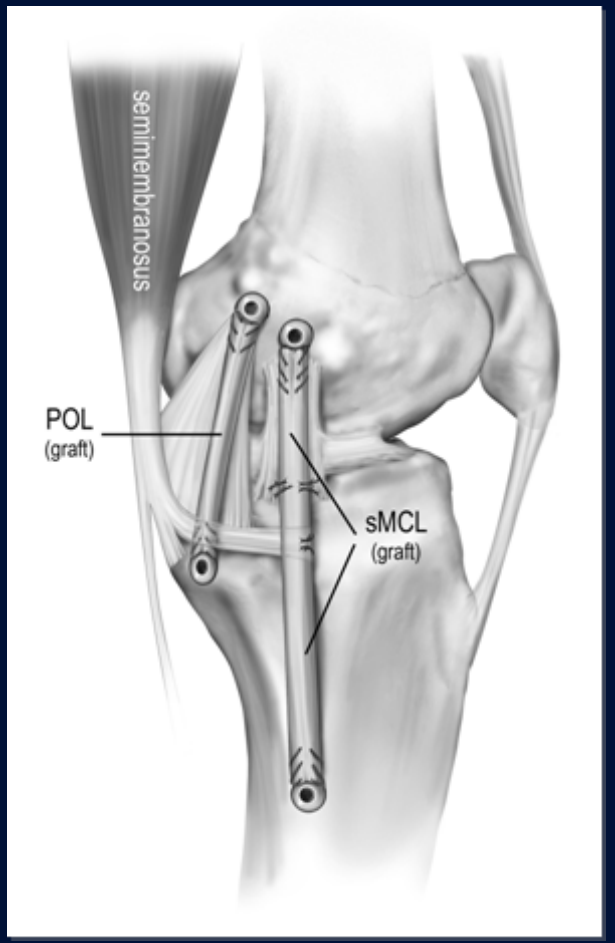
Discussion

- Pilot study – One single femoral tunnel (multiple fixation types) failed in all cases.
- Two femoral tunnels required.
- Clinical implication – Two tunnels may be necessary for early ROM.



Conclusions

- An anatomic medial knee reconstruction technique restores native stability to a knee with a severe acute or chronic medial knee injury without overconstraint.
- This reconstruction technique is a viable option when surgery is indicated.
- Two femoral tunnels may be necessary to allow for early ROM.
- Prospective outcome studies are ongoing.



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Medial Knee Research Team