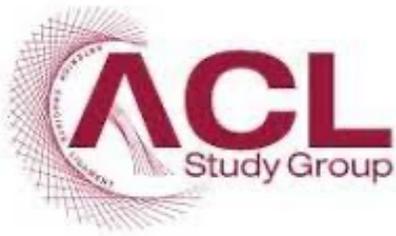


# Impact of Lateral Tibial Slope and Lateral Meniscal Root Lesions on Rotational Kinematics of the Knee

Tim Lording, Anna-Katharina Calek, Zefanya  
Hartanto, Ashen Fernando, David Ackland

ACL Study Group Meeting  
Iguasu Falls 2026

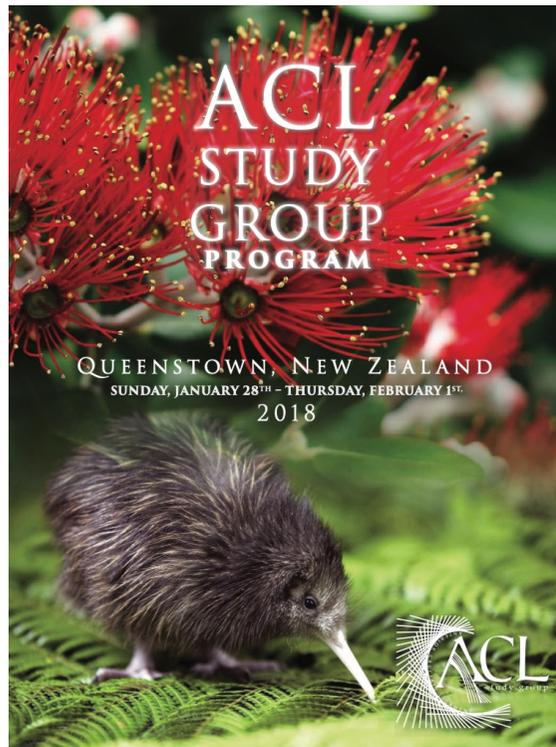




# Disclosures

- I declare that in the past three years I have:
- held shares in: Nil
- received royalties from: Nil
- done consulting work for: Smith & Nephew, Medacta
- given paid presentations for: Smith & Nephew, Arthrex
- received institutional support from: Smith & Nephew, Arthrex

# Background



## TIBIAL SLOPE

**9:54 - 10:01**

**Mark Clatworthy**

(61) The Effect of Lateral Tibial Posterior Slope on ACL Graft Failure Risk Depending on ACLR Technique Related Graft Isometry

**10:02 - 10:09**

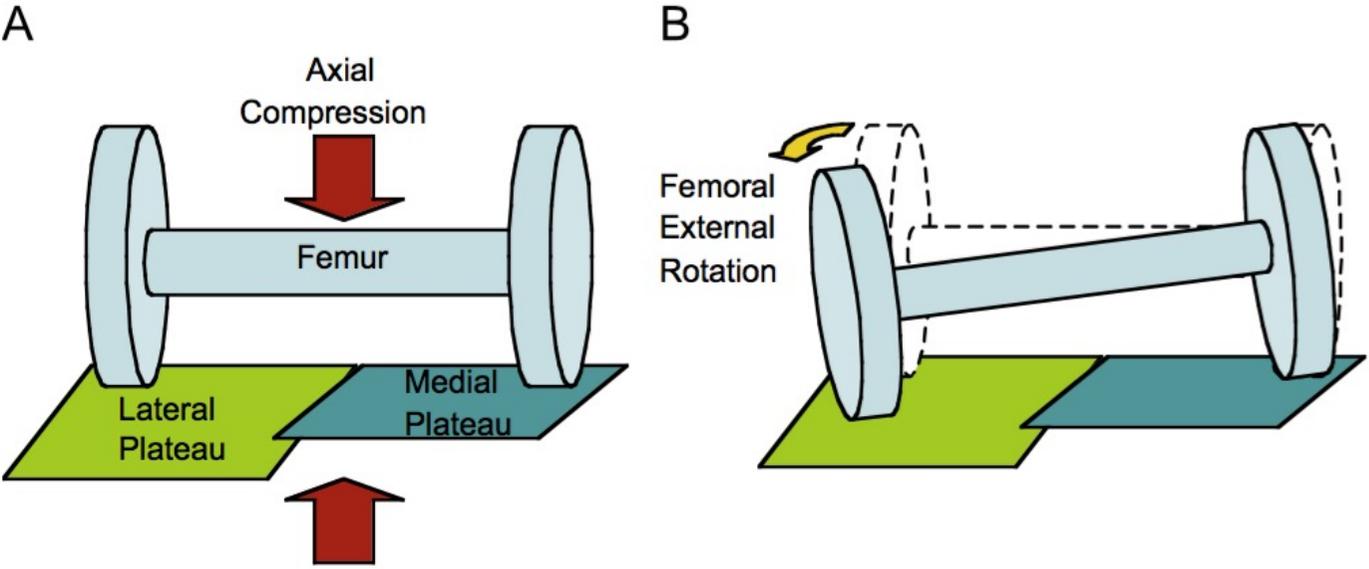
***Elmar Herbst (Guest of Andreas Imhoff)***

(62) *In-Vivo Internal Tibial Rotation and it's Association with Tibial Articulating Surface Morphology*

**10:10 - 10:17**

**Tim Lording**

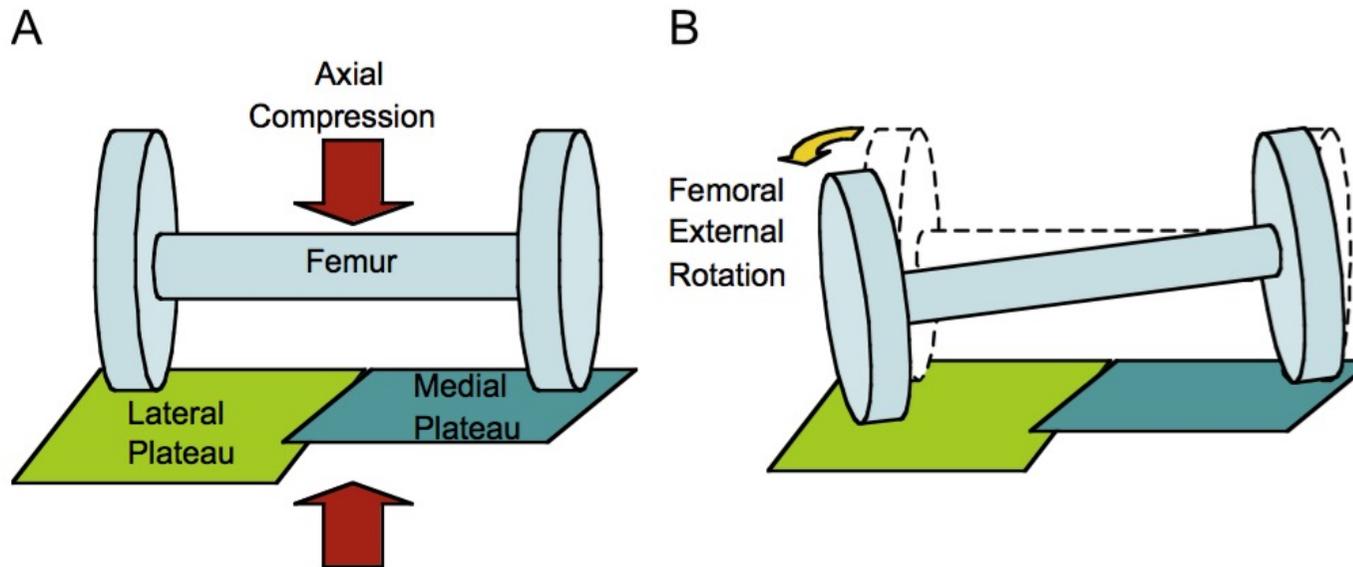
(63) Proximal Tibial Bony and Meniscal Slopes are Higher in ACL Injured Subjects Than Controls: A Comparative MRI Study





## A case-control study of anterior cruciate ligament volume, tibial plateau slopes and intercondylar notch dimensions in ACL-injured knees<sup>☆</sup>

R.A. Simon<sup>a</sup>, J.S. Everhart<sup>a</sup>, H.N. Nagaraja<sup>b</sup>, A.M. Chaudhari<sup>c,\*</sup>

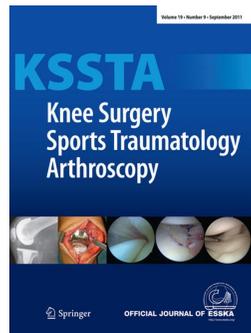


# Background



David Ackland

# Background



## **Influence of soft tissues on the proximal bony tibial slope measured with two-dimensional MRI**

**Sébastien Lustig · Corey J. Scholes ·  
Sean P. M. Leo · Myles Coolican · David A. Parker**



## **Is Noncontact ACL Injury Associated with the Posterior Tibial and Meniscal Slope?**

**R. Hudek MD, B. Fuchs MD, PhD, F. Regenfelder MD,  
P. P. Koch MD**

# Aim

- To evaluate the impact of increased lateral tibial plateau slope and lateral meniscal posterior root lesions on rotational kinematics of the knee under axial loading

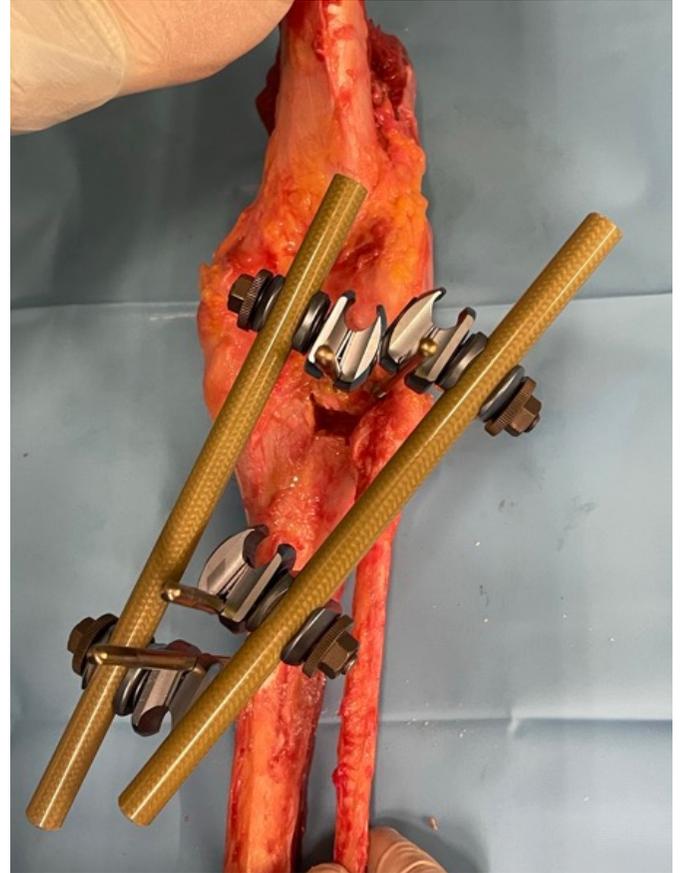
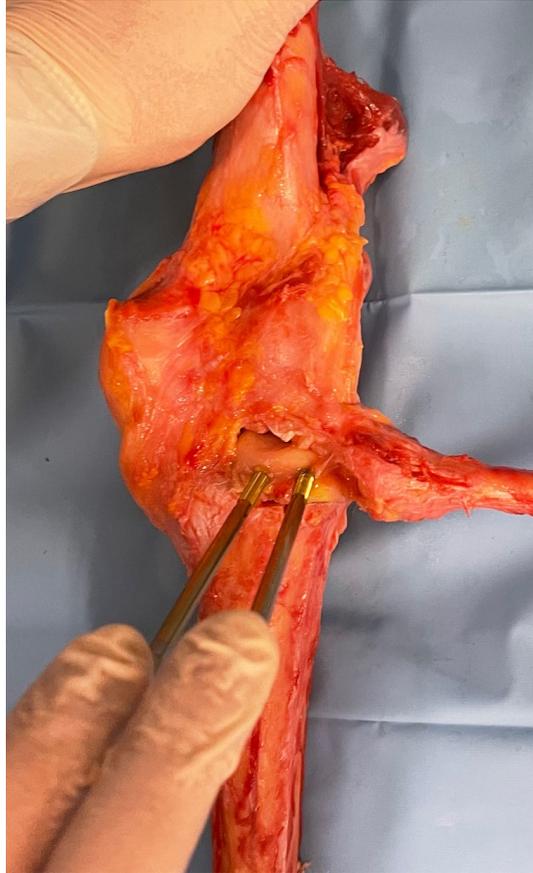
# Hypothesis

- That increased lateral plateau slope and lateral meniscal posterior root lesions would lead to increased internal tibial rotation under axial loading

# Methods

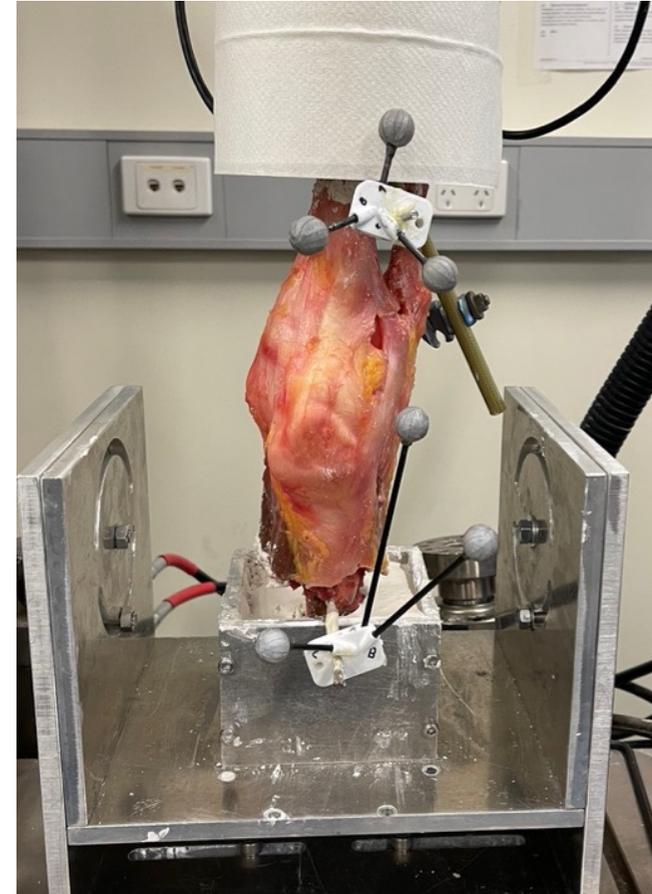
- 10 Cadaveric knee specimens
- Posterior CWO under lateral compartment
  - Allowing adjustable slope increase of  $10^{\circ}$
  - Fixed with external fixateur





# Methods

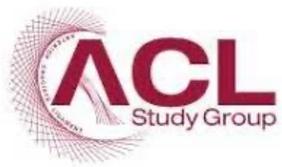
- Mounted in Instrom machine
  - Tibia in free rotating mount
  - Femur in mobile mount allowing flexion to 30°
- Infra-red arrays affixed to femur and tibia



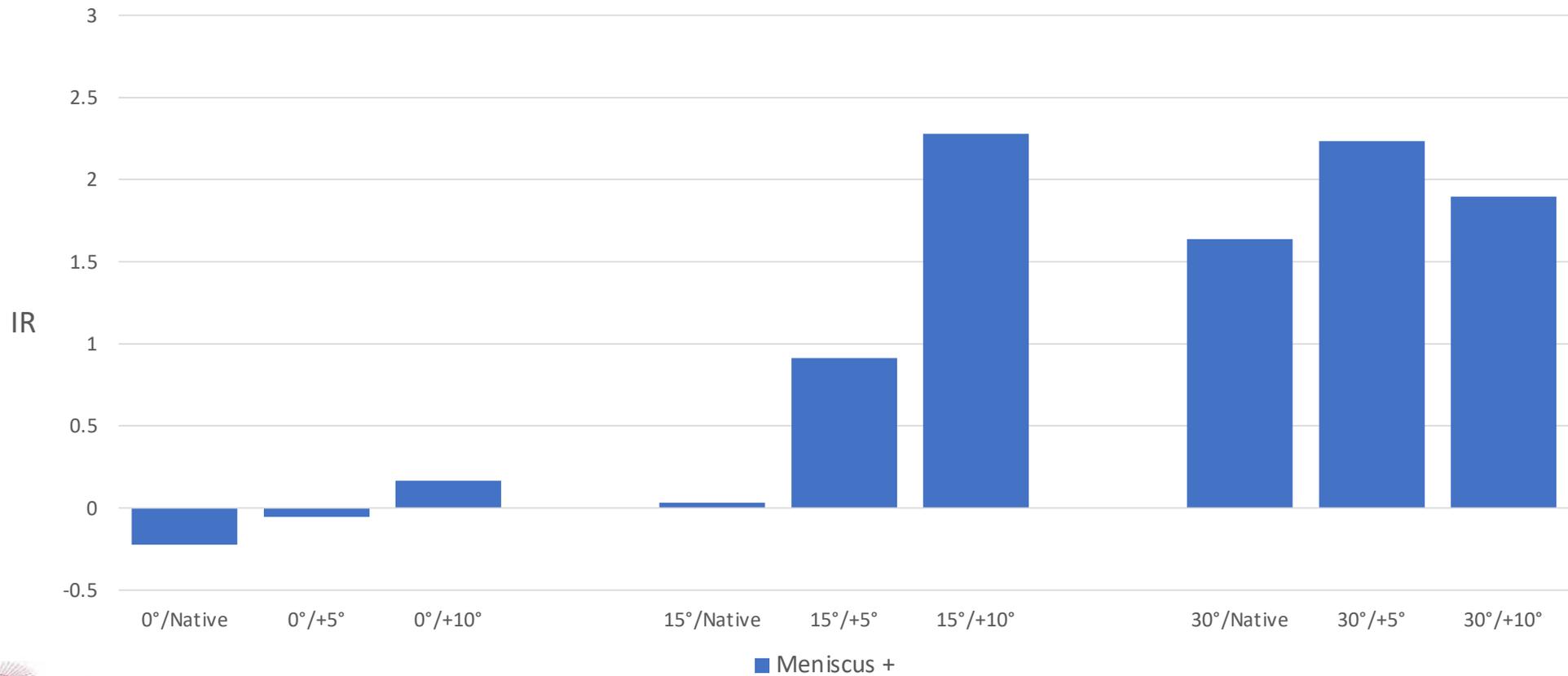
# Methods

- Testing protocol
  - 0 °/15 °/30° knee flexion
  - Native/+5°/+10° tibial slope
  - +/- posterior lateral meniscal root lesion
- Compression 300N
  - Rate 10mm/min
  - Hold 20 seconds
- Force and positional data continuously recorded

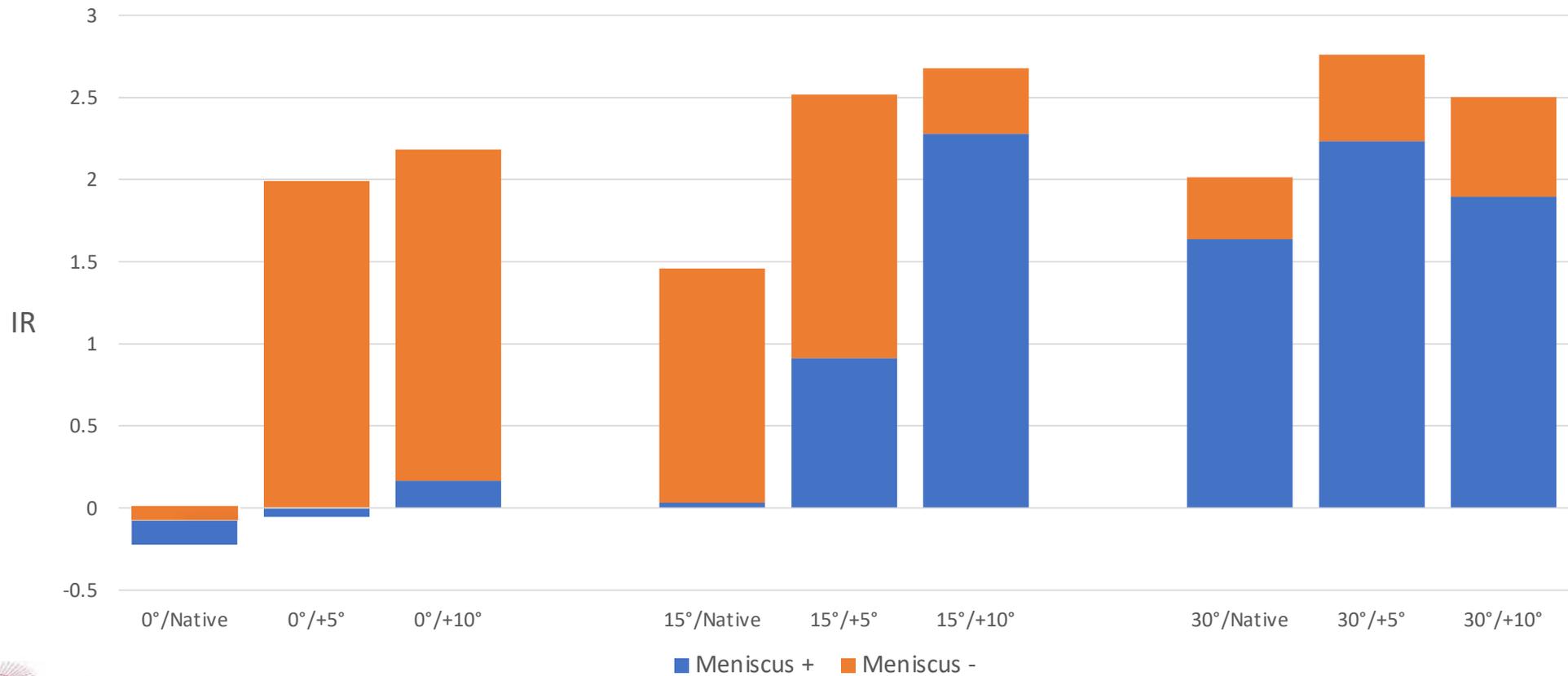
# Results



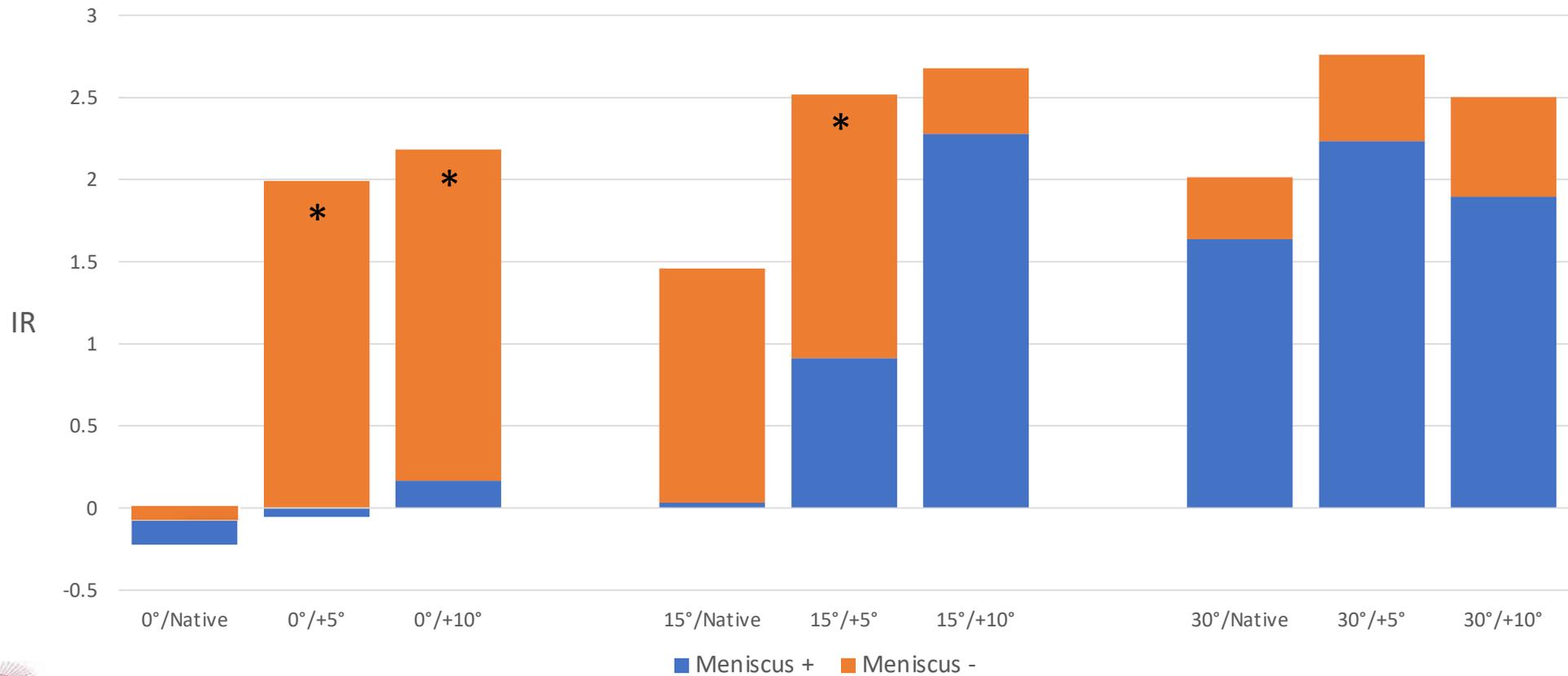
# Results- Meniscus Intact



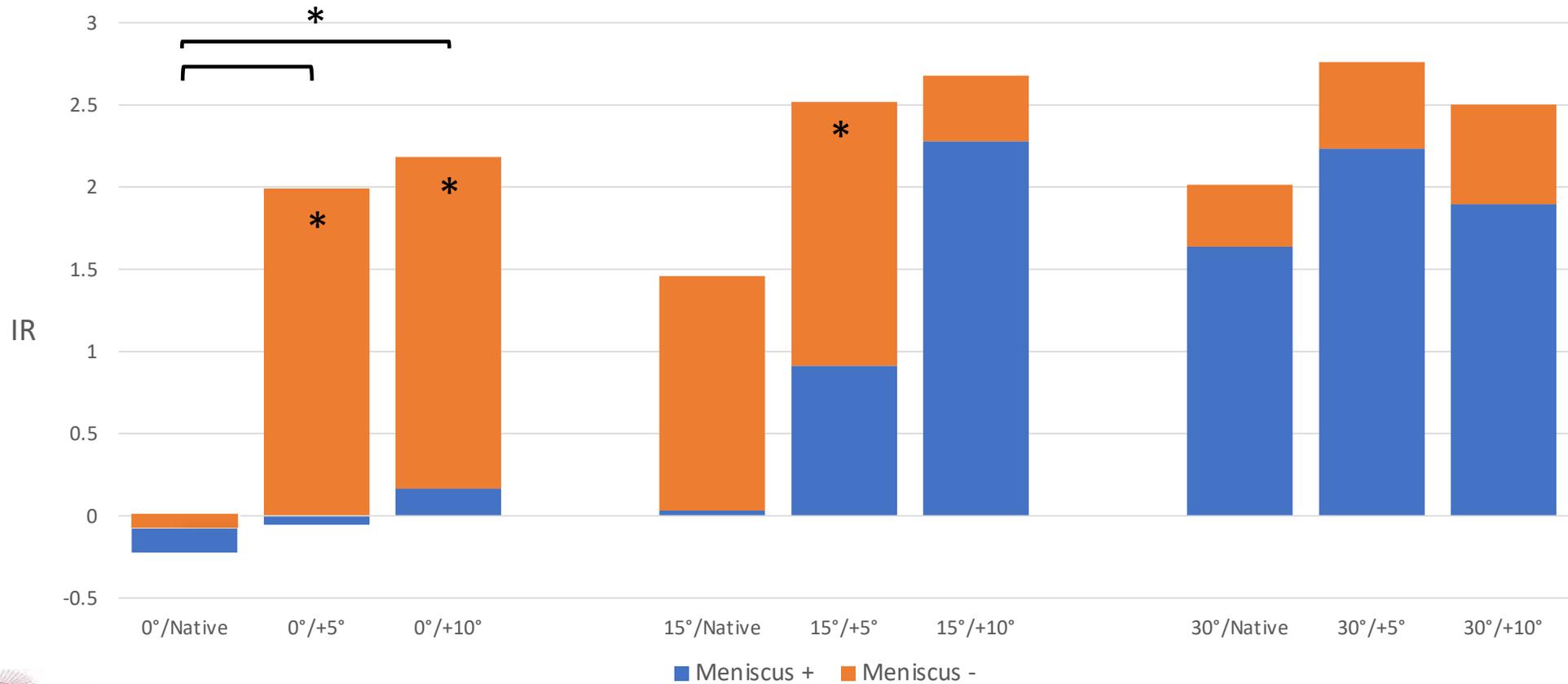
# Results- Meniscus Released



# Results- Meniscus Released



# Results- Meniscus Released



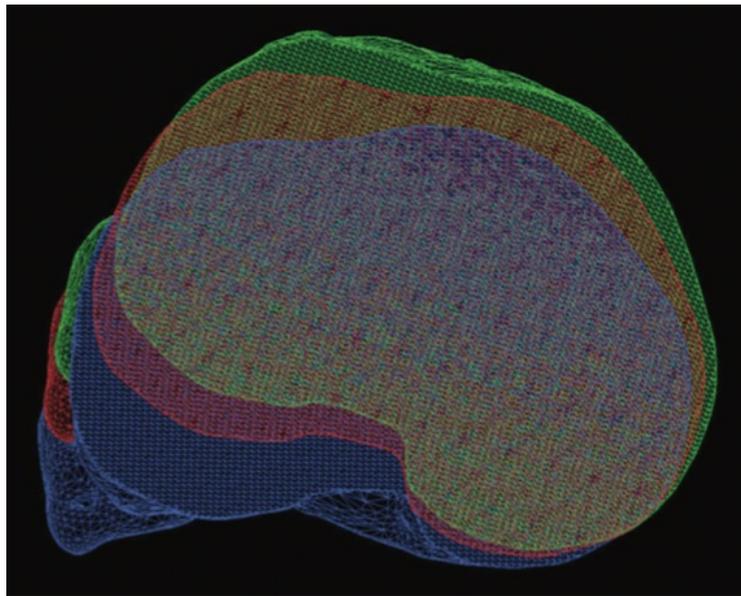
# Discussion

- Interplay between slope and meniscus is complex
  - Isolated  $\uparrow$ slope  $\neq$   $\uparrow$ IR\*
  - Lateral meniscal root lesion =  $\uparrow$  IR at 0° and 15° with  $\uparrow$ slope
  - $\uparrow$ slope =  $\uparrow$ IR with lateral root lesion in extension

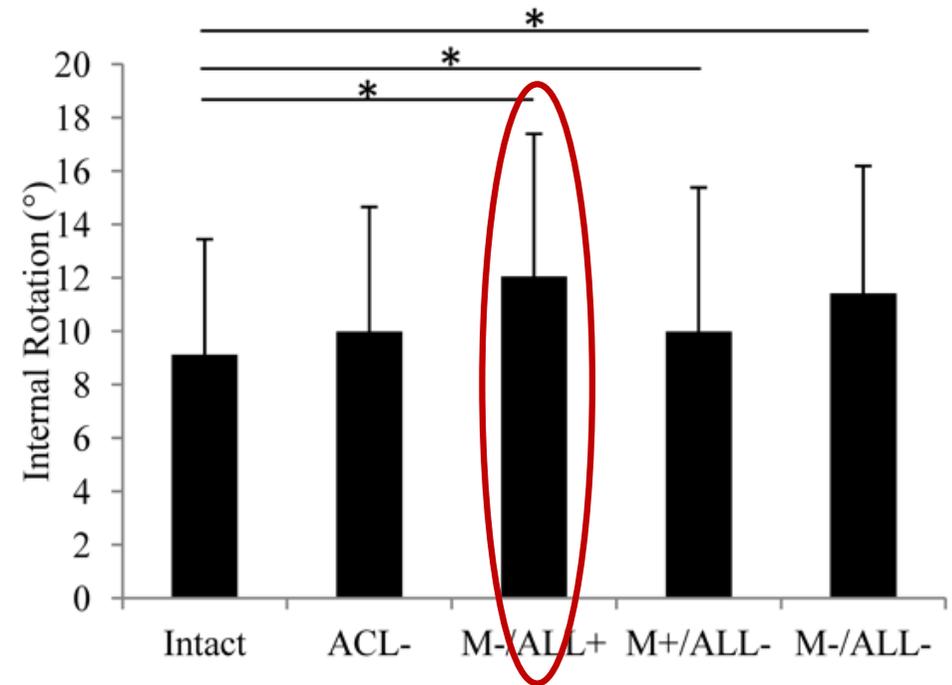
# Discussion

- Interplay between slope and meniscus is complex
  - Isolated  $\uparrow$ slope  $\neq$   $\uparrow$ IR\*
  - Lateral meniscal root lesion =  $\uparrow$  IR at 0° and 15° with  $\uparrow$ slope
  - $\uparrow$ slope =  $\uparrow$ IR with lateral root lesion in extension
- Is the meniscus a restraint or part of the slope?

# Discussion



Shybut T, AJSM 2015

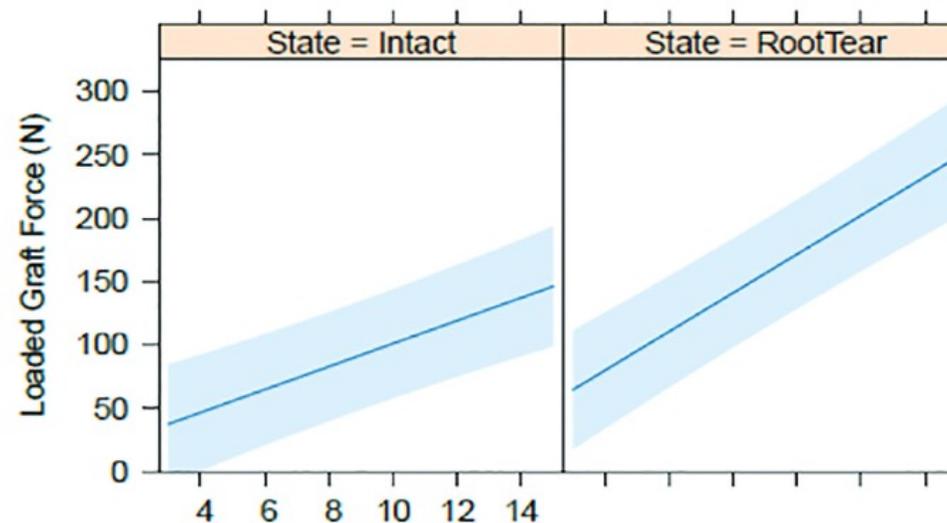


Lording T, CORR 2017

# Discussion



## Posterior Medial Meniscus Root Tears Potentiate the Effect of Increased Tibial Slope on Anterior Cruciate Ligament Graft Forces

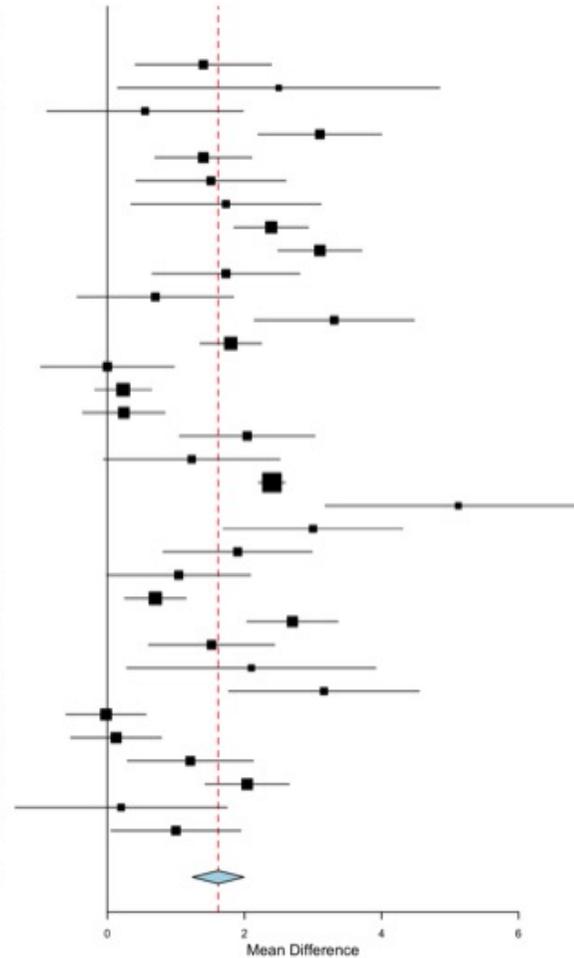


Samulesen B, AJSM 2019

# Discussion

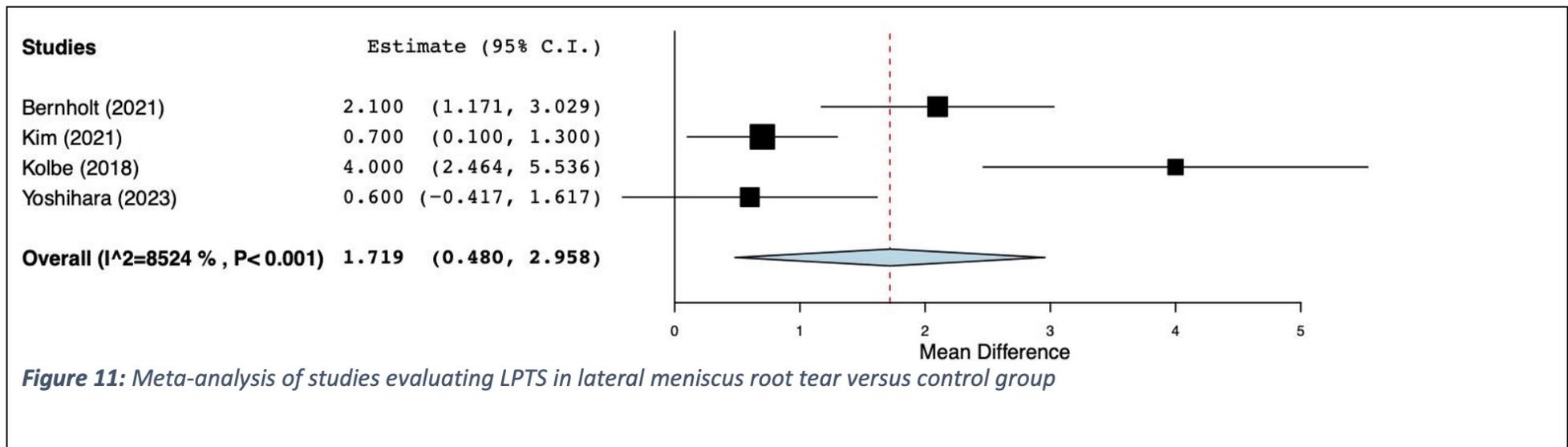
Lateral slope  
ACL vs Control

Studies	Estimate (95% C.I.)
Beynon 2014	1.400 (0.407, 2.393)
Bisson 2010	2.500 (0.150, 4.850)
Blanke 2016	0.550 (-0.881, 1.981)
Elmansori 2017	3.100 (2.198, 4.002)
Gultekin 2023	1.400 (0.693, 2.107)
Hashemi 2010	1.510 (0.416, 2.604)
He 2022	1.730 (0.343, 3.117)
Hohmann 2021	2.390 (1.847, 2.933)
Hohmann 2022	3.100 (2.487, 3.713)
Huang 2019	1.730 (0.652, 2.808)
Hudek 2011	0.700 (-0.441, 1.841)
Ikawa 2021	3.310 (2.143, 4.477)
Jagadeesh 2022	1.800 (1.352, 2.248)
Khan 2011	0.000 (-0.974, 0.974)
Kizilgoz 2018	0.230 (-0.184, 0.644)
Kzig.z 2019	0.240 (-0.360, 0.840)
KumarPanigrahi 2020	2.040 (1.052, 3.028)
Milani 2022	1.230 (-0.058, 2.518)
Misir 2022	2.400 (2.205, 2.595)
Mukherjee 2017	5.120 (3.178, 7.062)
Rahnemai-Azar 2016	3.000 (1.690, 4.310)
Raja 2019	1.900 (0.813, 2.987)
Ristic 2014	1.040 (-0.008, 2.088)
Sayit 2017	0.700 (0.252, 1.148)
Shen 2018	2.700 (2.035, 3.365)
Shen 2019	1.520 (0.603, 2.437)
Simon 2010	2.100 (0.283, 3.917)
Stijak 2007	3.160 (1.770, 4.550)
Sundar 2016	-0.020 (-0.603, 0.563)
Suprasanna 2019	0.127 (-0.535, 0.789)
TeixeiraGoncalvesAlves 2022	1.210 (0.292, 2.128)
Unal 2021	2.040 (1.427, 2.653)
vanDiek 2013	0.200 (-1.347, 1.747)
Waiwaiote 2016	1.000 (0.055, 1.945)
<b>Overall (I<sup>2</sup>=8888 % , P&lt; 0.001)</b>	<b>1.617 (1.240, 1.994)</b>



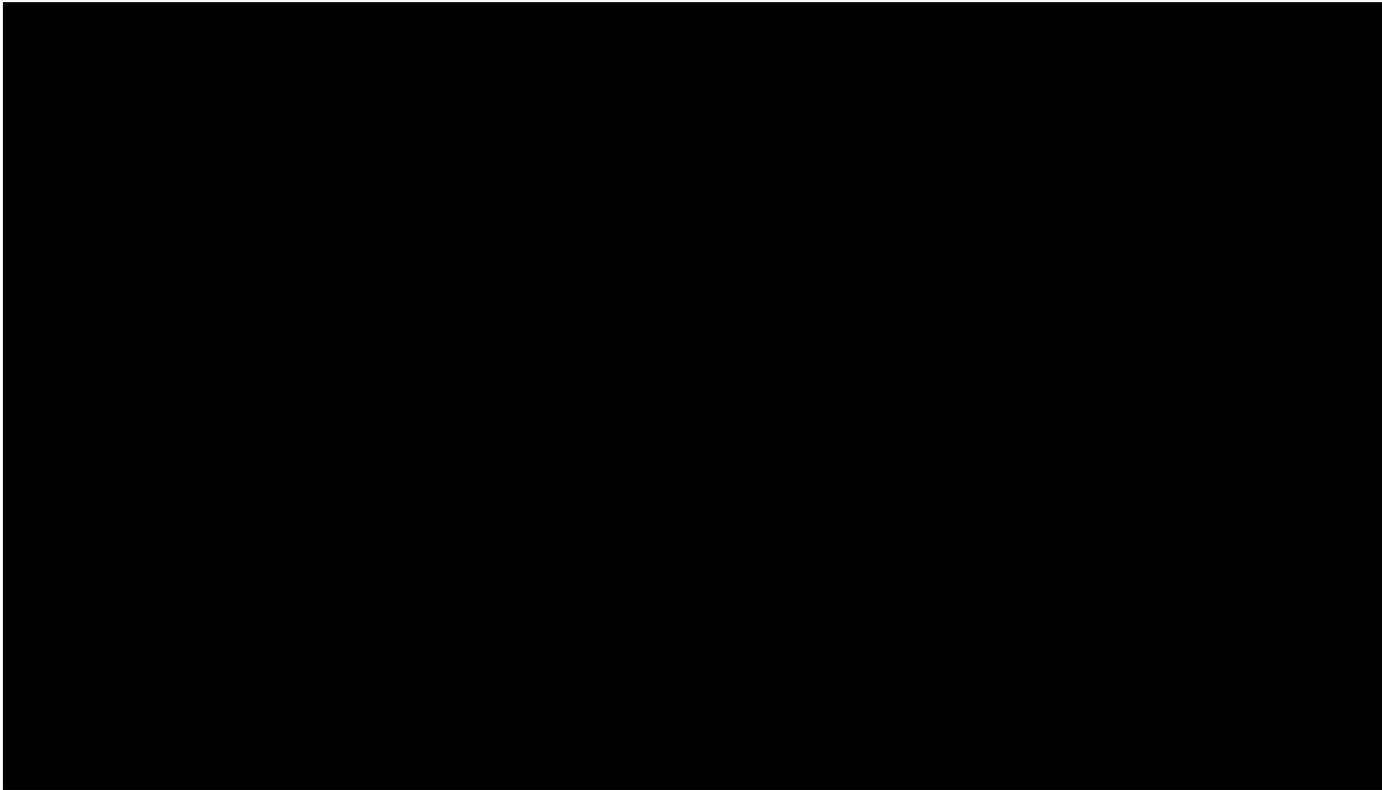
Zeng JISAKOS 2025

# Discussion



Zeng Under review

# Discussion



# Limitations

- Osteotomy model
  - Disruption of tib/fib joint
  - Meniscal roots not on mobile part
- Magnitude of axial force
  - To avoid overload of cadaver bone
- Sample size
  - Trends with large effect sizes did not reach significance

# Conclusion

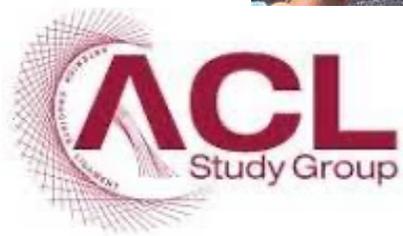
- Increased lateral tibial slope and loss of the lateral meniscal root causes increased internal rotation under axial loads at low flexion angles
- Increased lateral plateau bony slope causes increased internal rotation in the meniscal root deficient state in extension

# Conclusion

- These findings demonstrate a complex interplay between slope and meniscal integrity
- The lateral meniscus and meniscal root attachment should be preserved/repared where possible to protect the ACL



MONASH  
University



Thank-you



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