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Shelby T. Desroches (presenter),
Nancy Park, David B. Frumberg, John
P. Fulkerson, Johannes M. Sieberer

Yale University, United States



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Shelby T. Desroches ^a , Nancy Park ^a, David B. Frumberg ^a, John P. Fulkerson ^a,
Johannes M. Sieberer ^{a b}

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High tibiofemoral rotations and patellar instability

- **High tibiofemoral rotation** (lateral/external rotation of the tibia with respect to the femur) is one of the many risk factors for **patellofemoral instability** (PFI). [1,2]
- This rotation dynamically increases the distance between the tibial tuberosity and the trochlear groove (TT-TG) inserting a lateral force vector on the patella. [3] (**Figure 1**)
- Treatment approaches for high tibiofemoral rotations are highly invasive. [4]

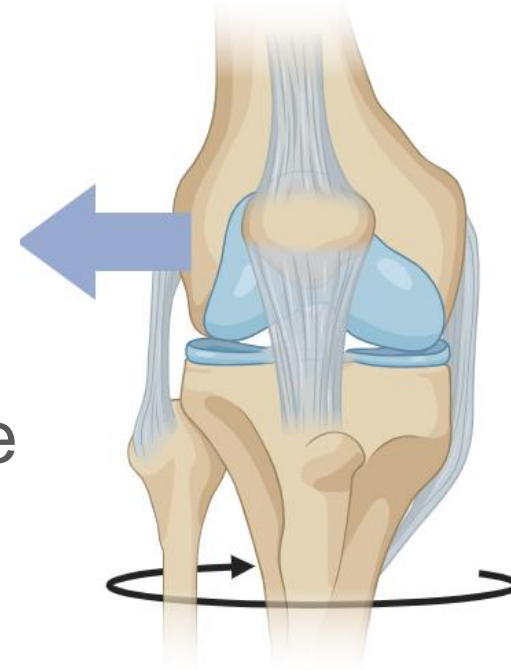


Figure 1: Lateral force vector on the patella during cases of high tibiofemoral rotations (Biorender.com)



Popliteus musculotendinous complex and high tibiofemoral rotations

- The **popliteus musculotendinous complex** runs from the lateral femoral condyle to the posterior medial tibial surface. [5] **(Figure 2)**
- The popliteus has the primary role of **resisting the lateral/external rotation of the tibia** with respect to the femur during early degrees of flexion. [5]



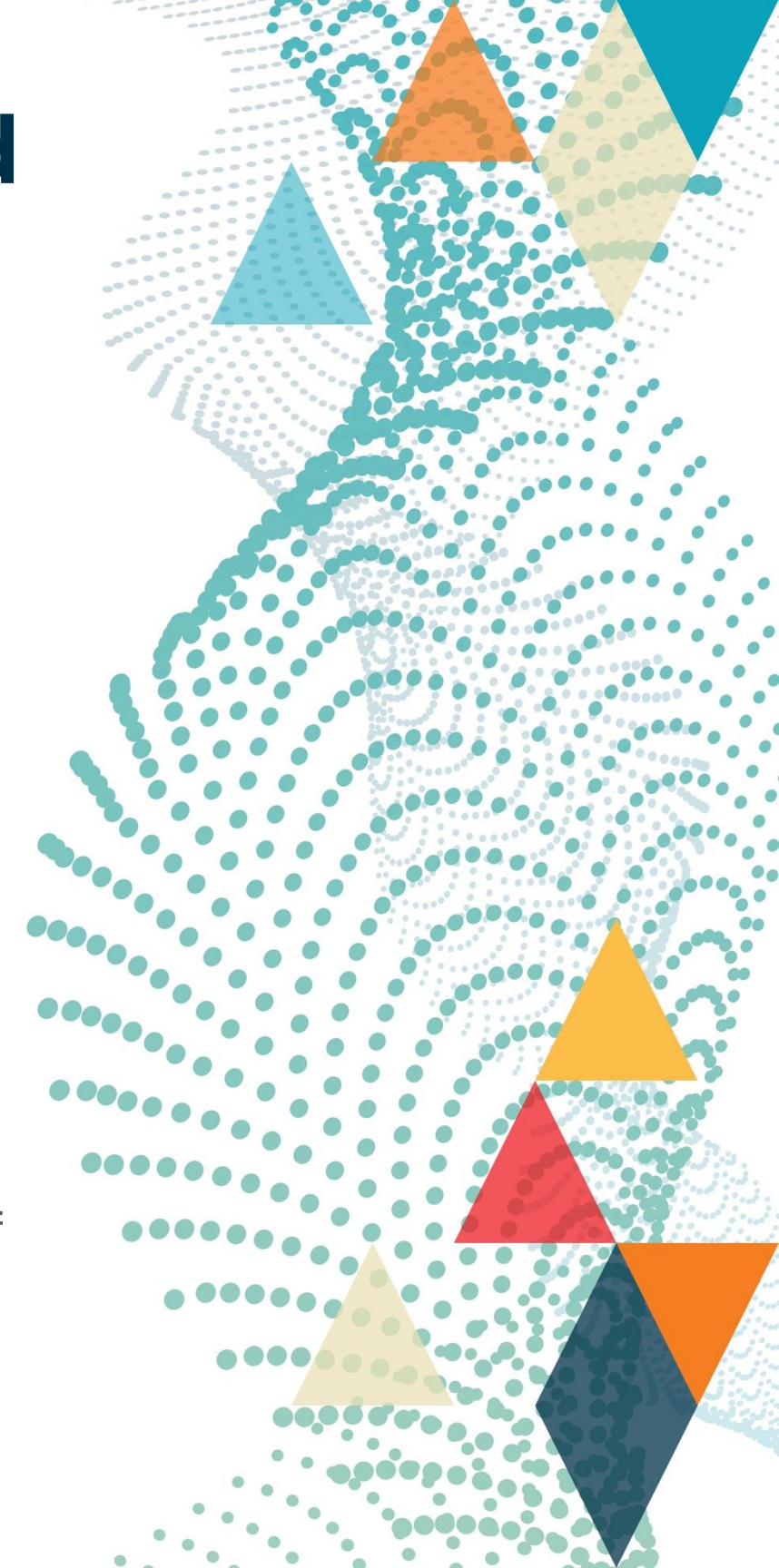
Figure 2: The trajectory of the popliteus on the tibiofemoral joint
(Bodyworksprime.com)



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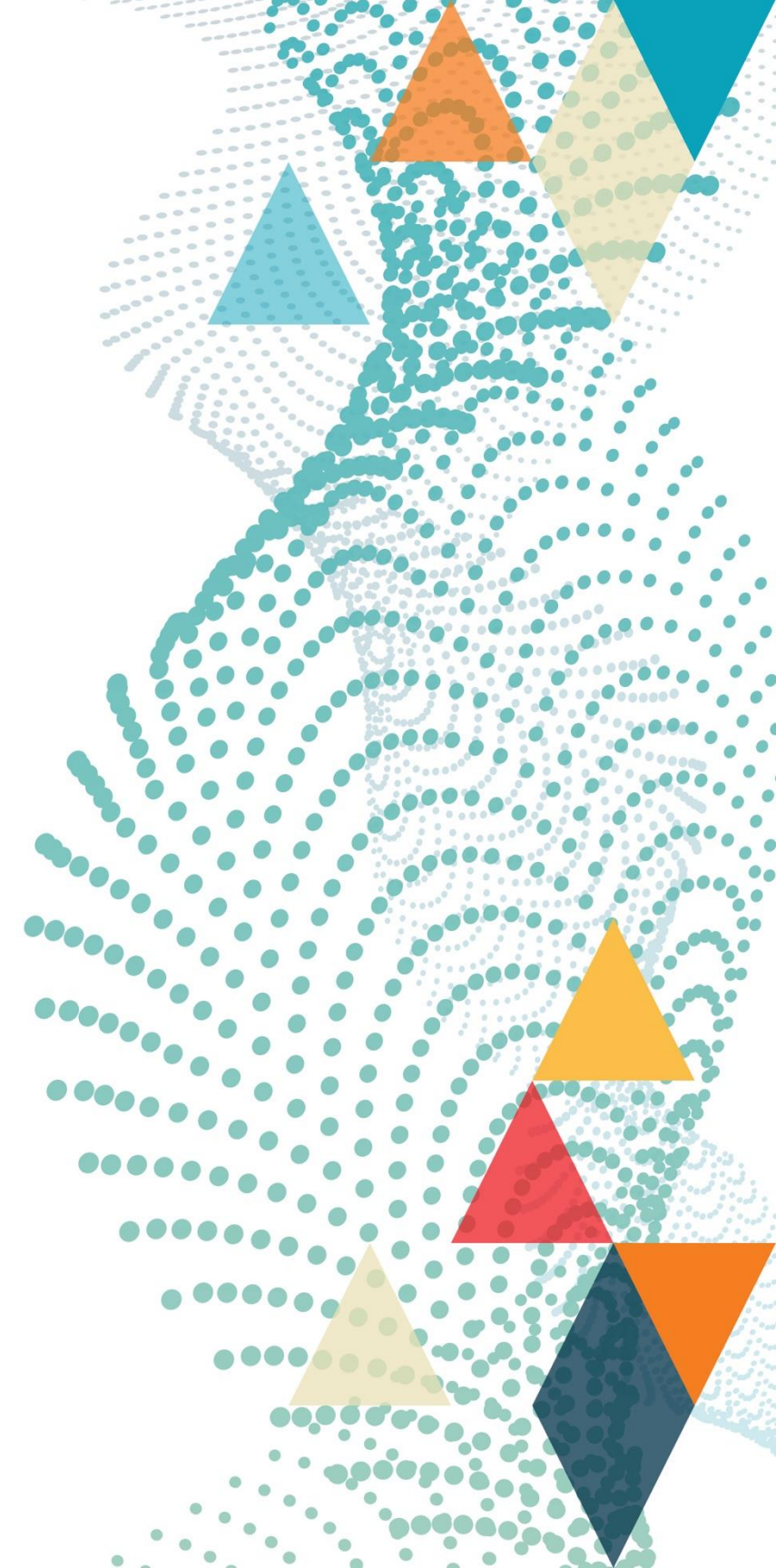


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Study Purpose

- The purpose of this study was to determine the relationship between the length of the popliteus musculotendinous complex and tibiofemoral rotation in PFI and control populations.
- This was done to better inform the possibility for **less-invasive treatment approaches** that involve the popliteus for those with high tibiofemoral rotations and patellar instability.



Methods

- **Population:** 35 PFI and 35 control non-weight bearing MRIs
- **Measurements:**
 - Tibiofemoral rotation: Angle between the femoral condylar and tibial condylar lines on axial slices [6]
 - Popliteus length: Popliteus sulcus to femoral condyle distance *minus* sulcus to the end of the tibia distance on a sagittal view
- **Statistical Analysis:**
 - Mann Whitney U-Test: To compare rotation between patients and controls and length between patients and controls
 - Simple Linear Regression Analysis: To understand the relationship between rotation and length



Significant differences seen between PFI patients and controls for rotation and length

- Tibiofemoral rotation was significantly larger (greater external rotation of the tibia with respect to the femur) in the PFI patient group ($p < .001$)
- Popliteus length was significantly larger in the PFI group ($p = .002$)

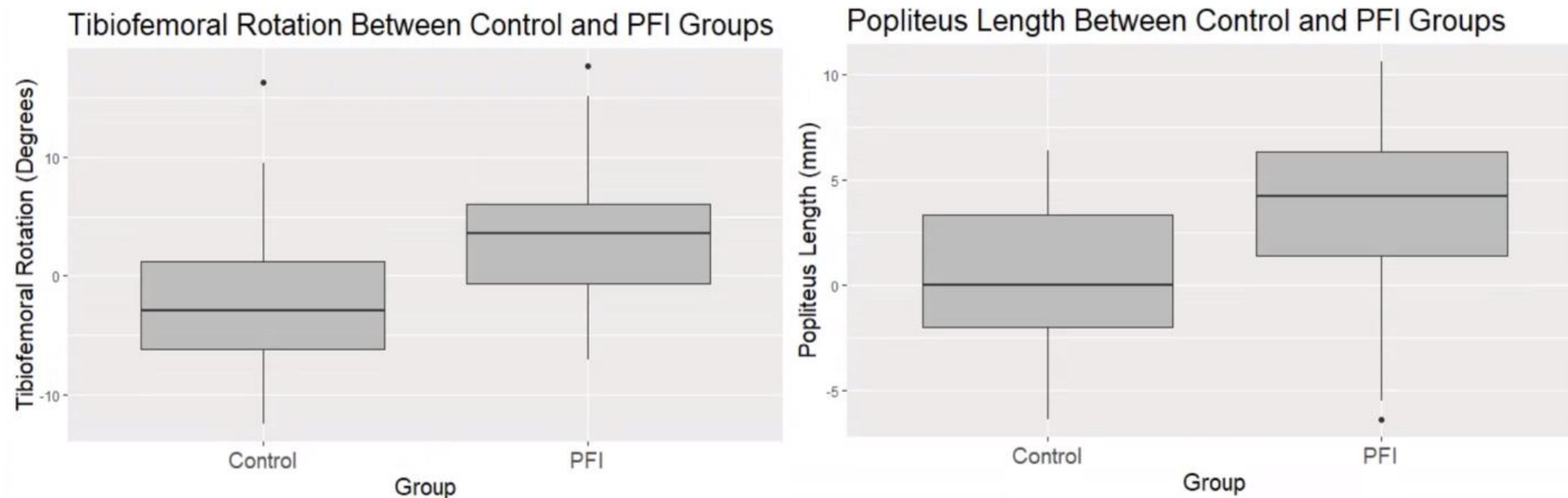


Figure 3: Difference in tibiofemoral rotation and popliteus length between controls and PFI patients



Significant positive relationship between tibiofemoral rotation and length

- Tibiofemoral rotation and popliteus length had a statistically significant positive relationship for the control group, PFI group, and overall:

- Control $r^2 = .52$ ($p < .001$)
- PFI $r^2 = .35$ ($p < .001$)
- Overall $r^2 = .49$ ($p < .001$)

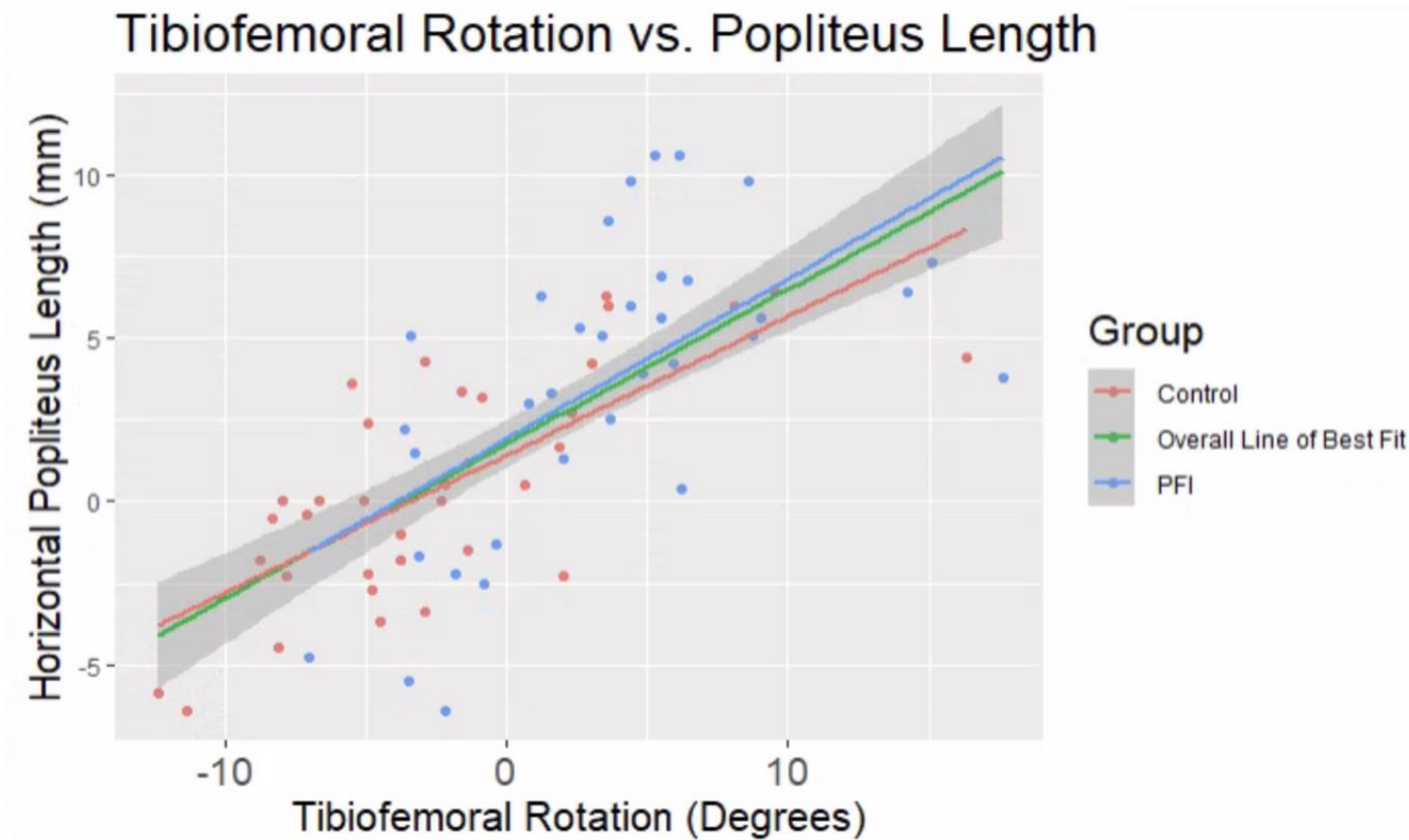


Figure 4: Relationship between tibiofemoral rotation and length

Discussion

- Smaller popliteus lengths are associated with smaller tibiofemoral rotation angles, suggesting that reduction of popliteus lengths could lead to reduction of rotation
 - Specifically, quantitative results suggest that an **advancement of the popliteus (thus reducing the popliteus length) by .473mm would reduce rotation by 1 degree**
 - Unexplained variance from the regression analysis suggests that the measured popliteus length is also impacted by at least one other factor in addition to rotation (such as anterior/posterior translation).



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Conclusions & Limitations

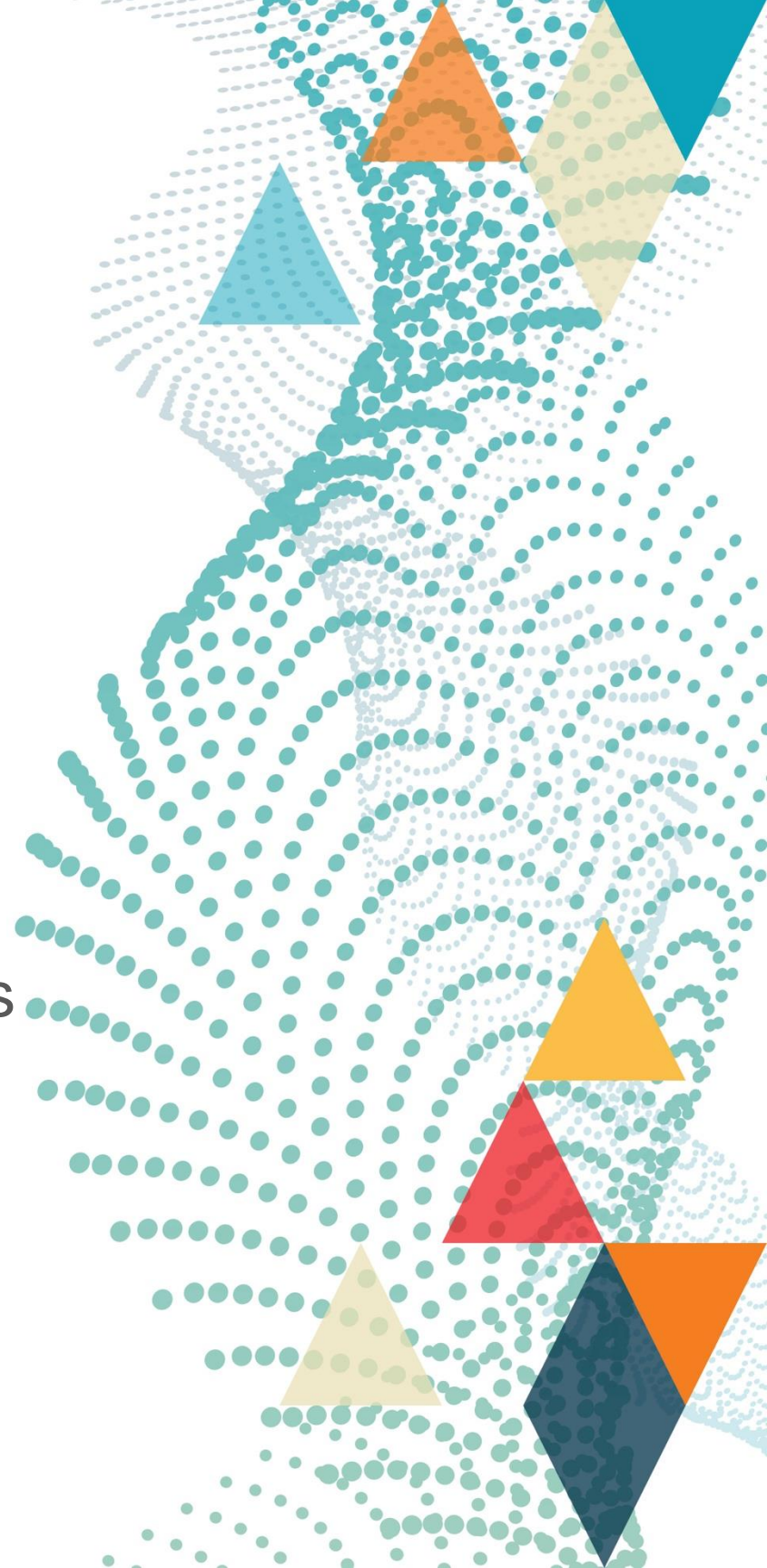
- **Conclusions:**
 - The findings in this study show a significant relationship between the length of the popliteus and tibiofemoral rotation, demonstrating the possibility of popliteus advancement for treatment of high rotations.
 - Further research should investigate this relationship through cadaver studies and/or through weight bearing MRI.
- **Limitations:**
 - Varying positions of the knee (degree of flexion) in the scanner during the scan may impact the tibiofemoral rotation and popliteus length measured [7]
 - This was mitigated as much as possible by exclusion of scans with visibly high flexion



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