ISAKOS CONGRESS 2025 | MUNICH GERMANY June 8–11

A 3D anatomical study of the quadriceps mechanism, its association with femoral torsion and their relationship to patellofemoral instability

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Faculty Disclosure Information

Dr Sheanna Maine

- Nil relating to this topic

Dr Martina Barzan

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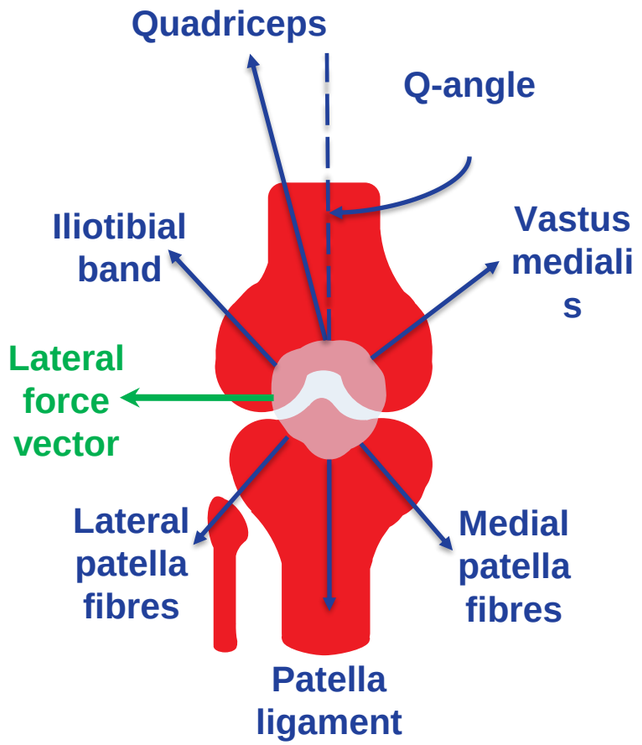
Patellofemoral Joint (PFJ) instability

Incidence: 147.7/100,000 person years[1].

Mechanism: Bony and soft tissue patella restraints overcome by lateral force vector exerted by the quadriceps mechanism



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Rotational Malalignment of the Knee Extensor Mechanism

Defining Rotation of the Quadriceps and Its Role in the Spectrum of Patellofemoral Joint Instability

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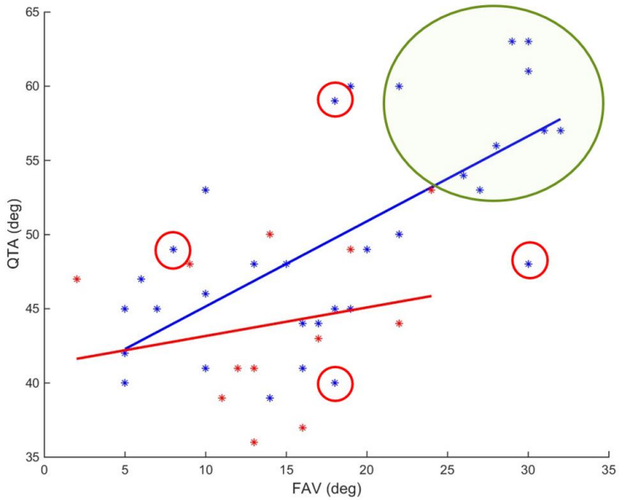
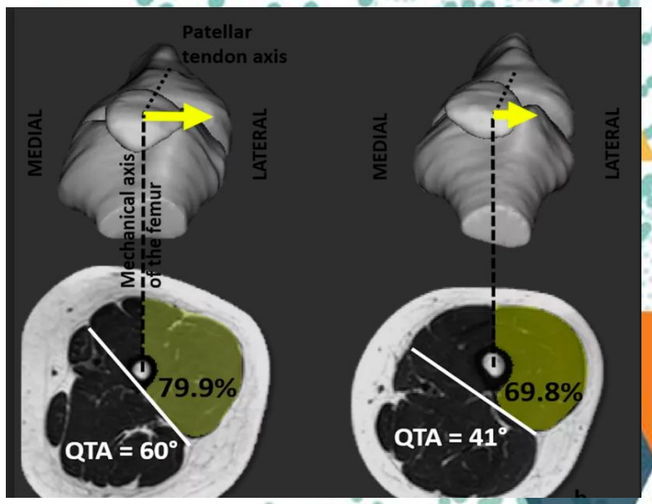
Investigation performed at the Department of Orthopaedics, Children's Health Queensland, Queensland Children's Hospital, Brisbane, Queensland, Australia





Maine et al., 2019, JBJS Open Access

Aims

- Define the 3D relationship between femur and quadriceps mechanism
- Create a subject-specific coordinate system to compute the centroid of vastus medialis (VM) and vastus lateralis (VL) relative to the mechanical axis of the femur in all 3 planes.
- Assess relative distributions of VM and VL in controls vs dislocators with and without torsion

Methods

17 knees were assessed in 17 participants

Combined demographics:

Mean age (yrs) = 14.7

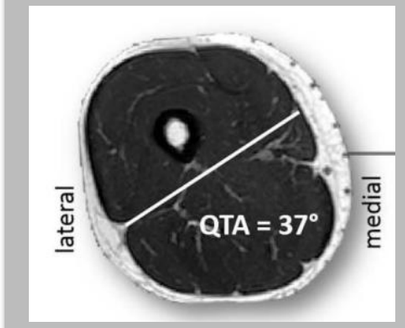
Mean height (m) = 1.64

Mean weight (kg) = 60.3

3 Groups

Group 1 Dislocators (6)

Femoral torsion <15°
QTA <50°



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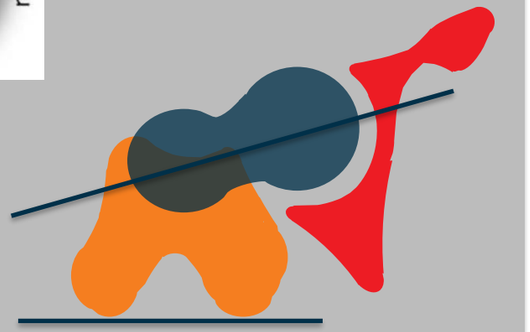
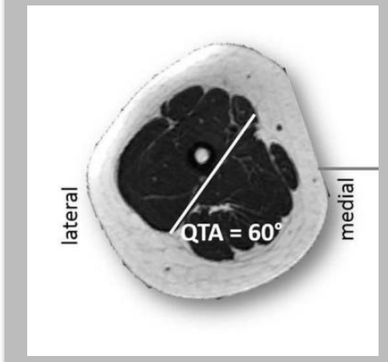


Group 2 Dislocators (6)

Femoral torsion >25°
QTA >50°



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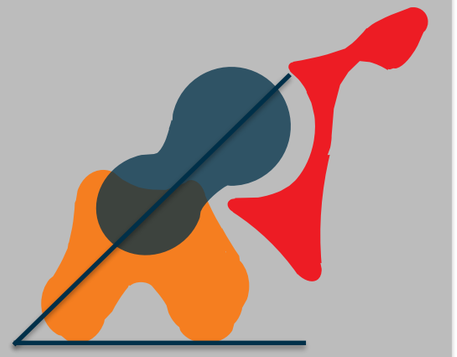
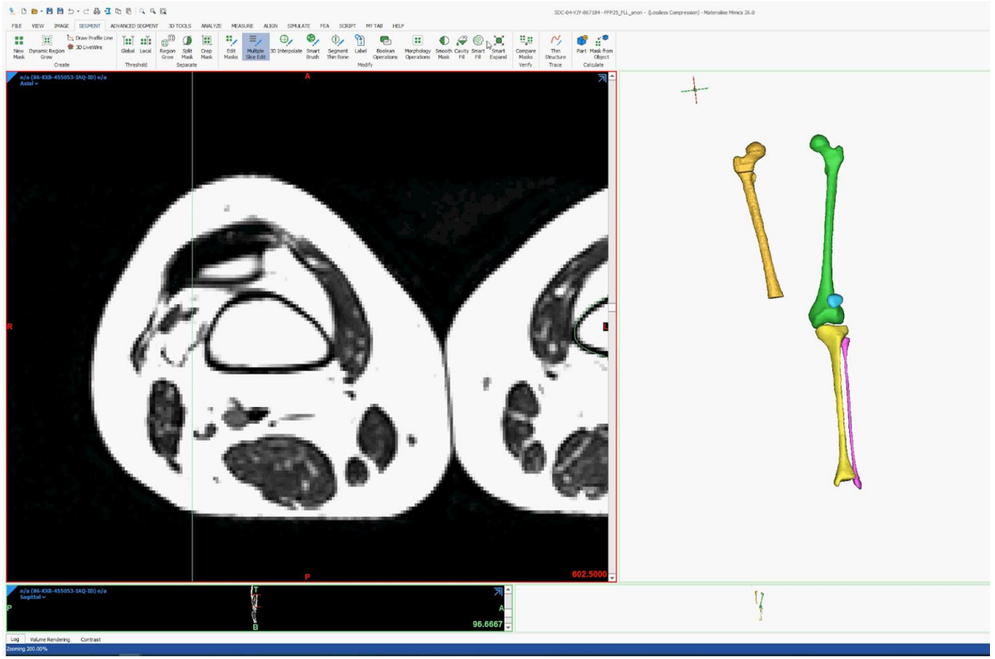


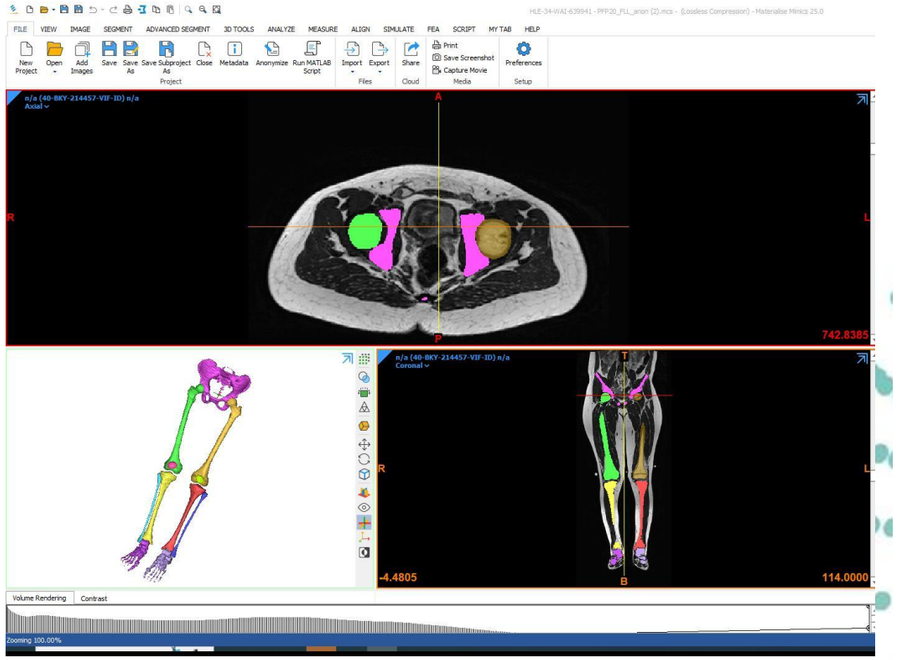
Controls (5)

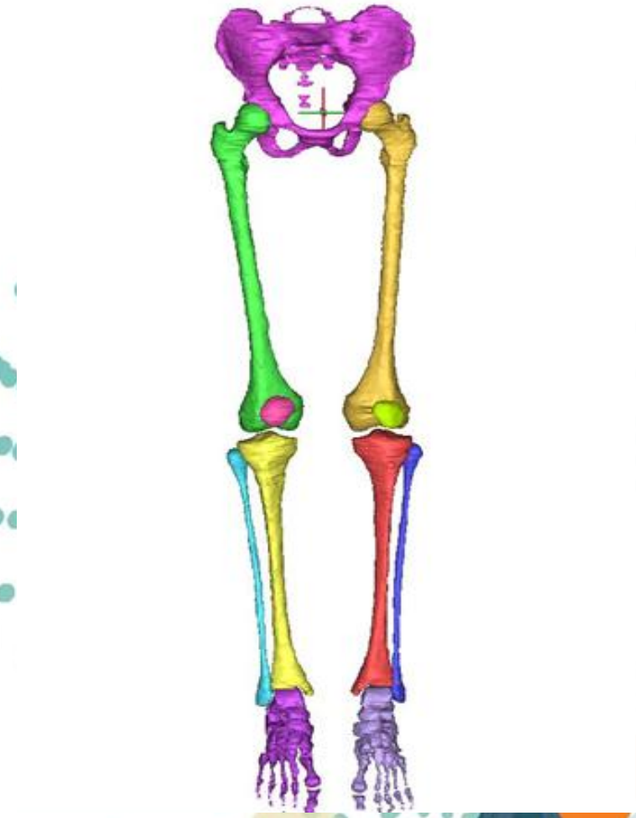
No history of PFJ dislocation

Segmentation

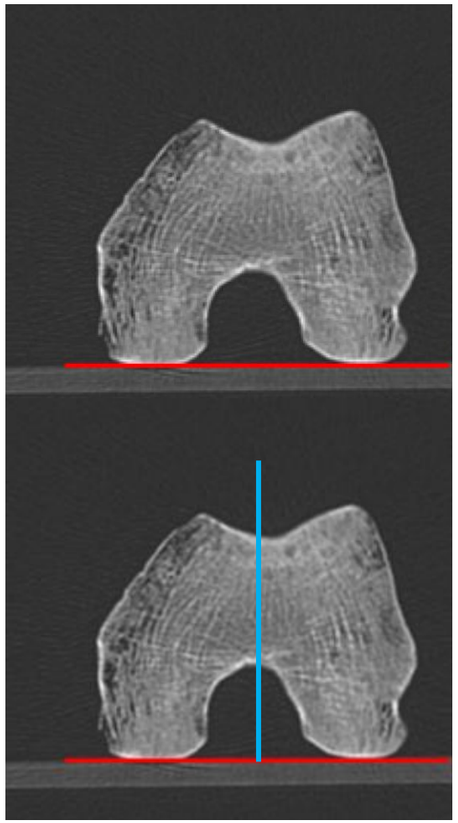
The Femur, Vastus Medialis and Lateralis were segmented for all participants

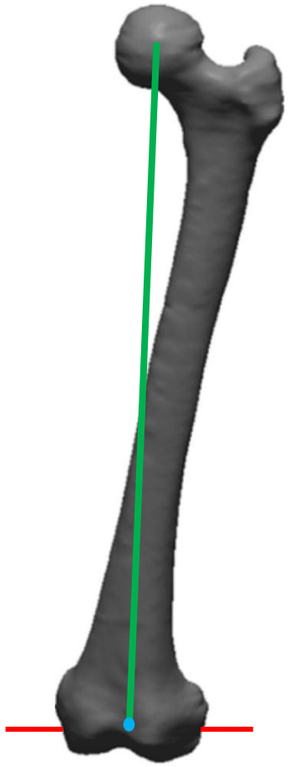


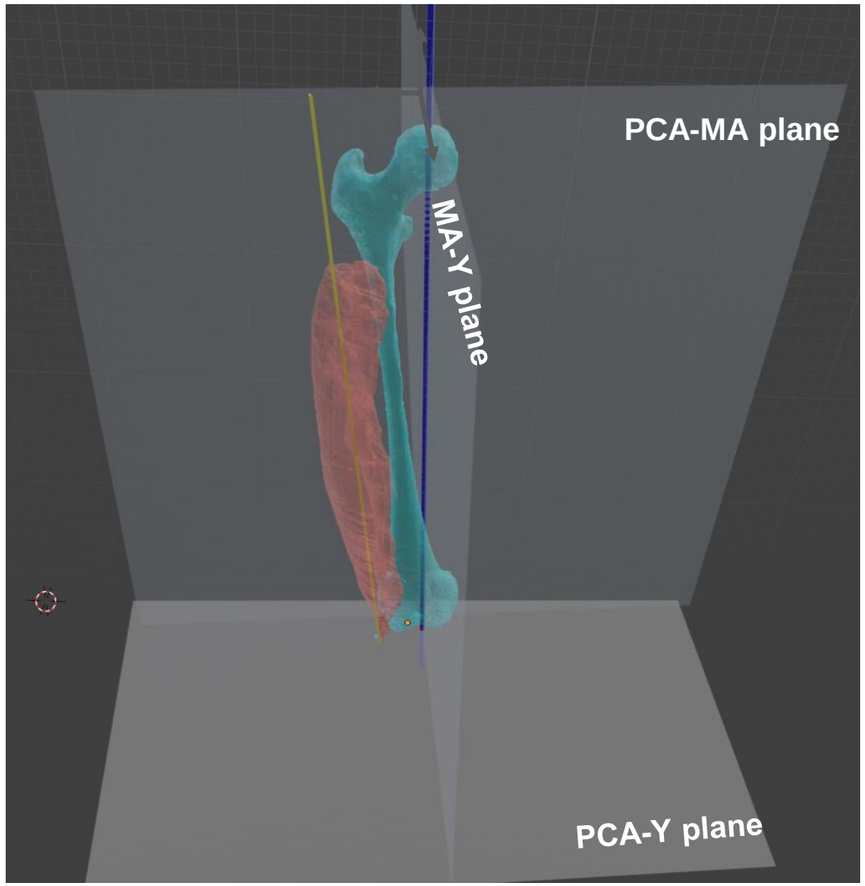




A Subject-Specific Coordinate System was created to provide a consistent femoral reference system





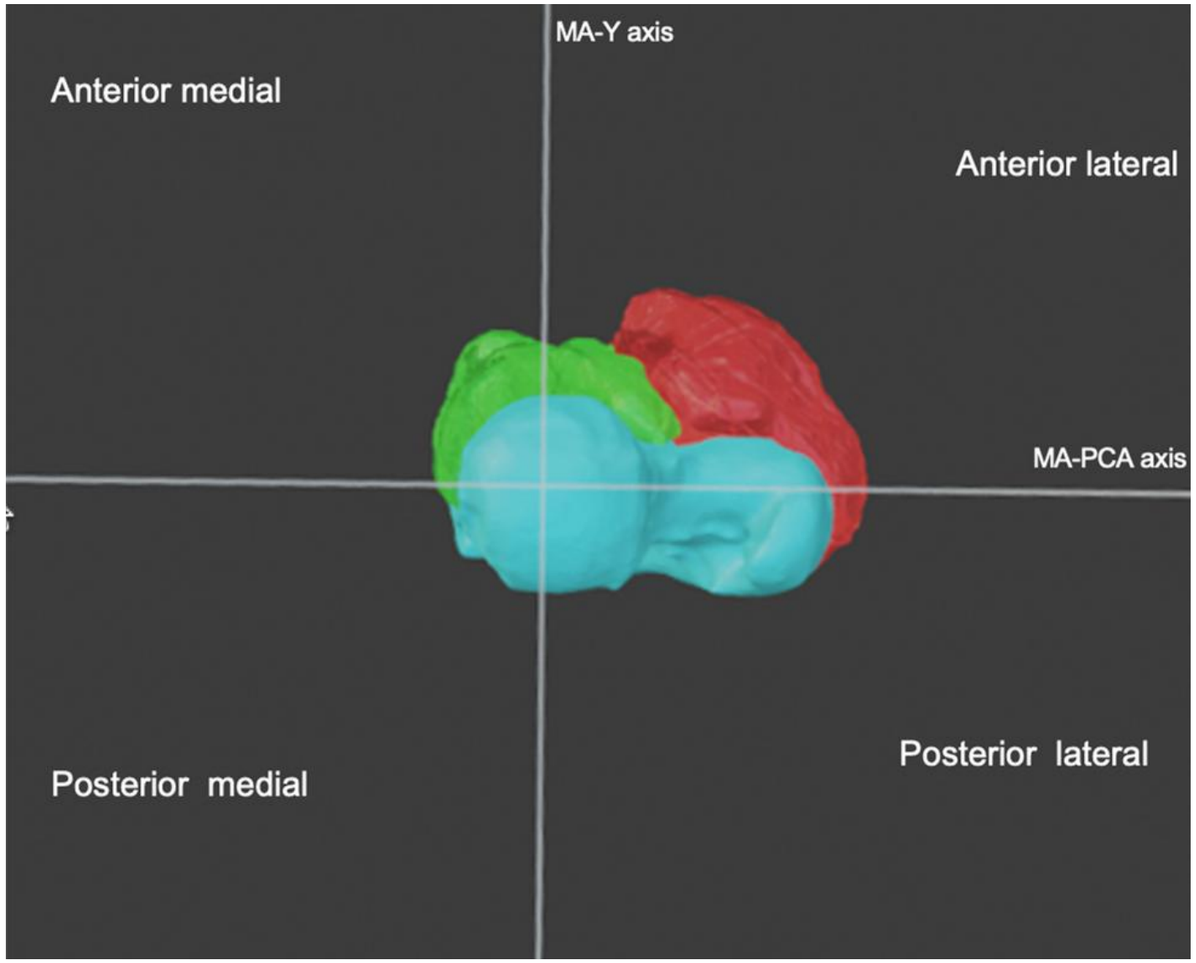


X-axis – Posterior Condylar Axis (PCA) red
Y-axis – Axis that is perpendicular to MA and PCA blue
Z-axis – Mechanical Axis of the Femur (MA) green

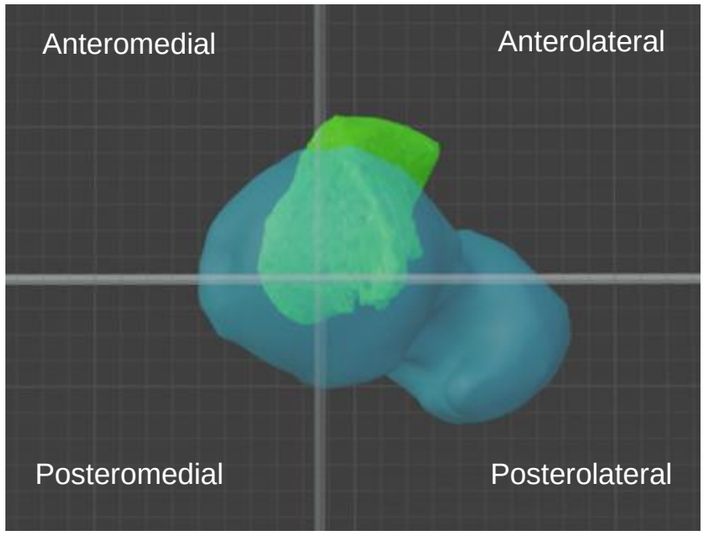
Yellow line – centroid line of the vastus lateralis

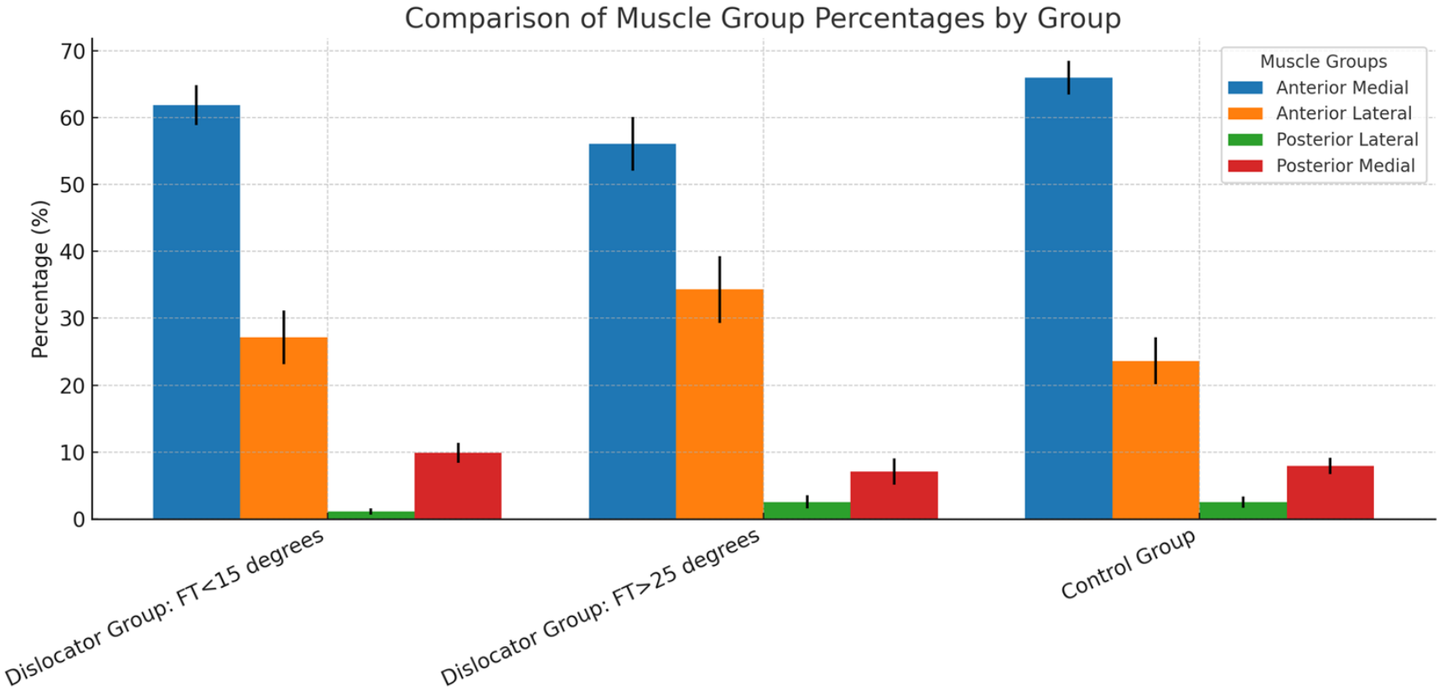
Blue line – mechanical axis of femur

The Axial Plane was divided into Quadrants

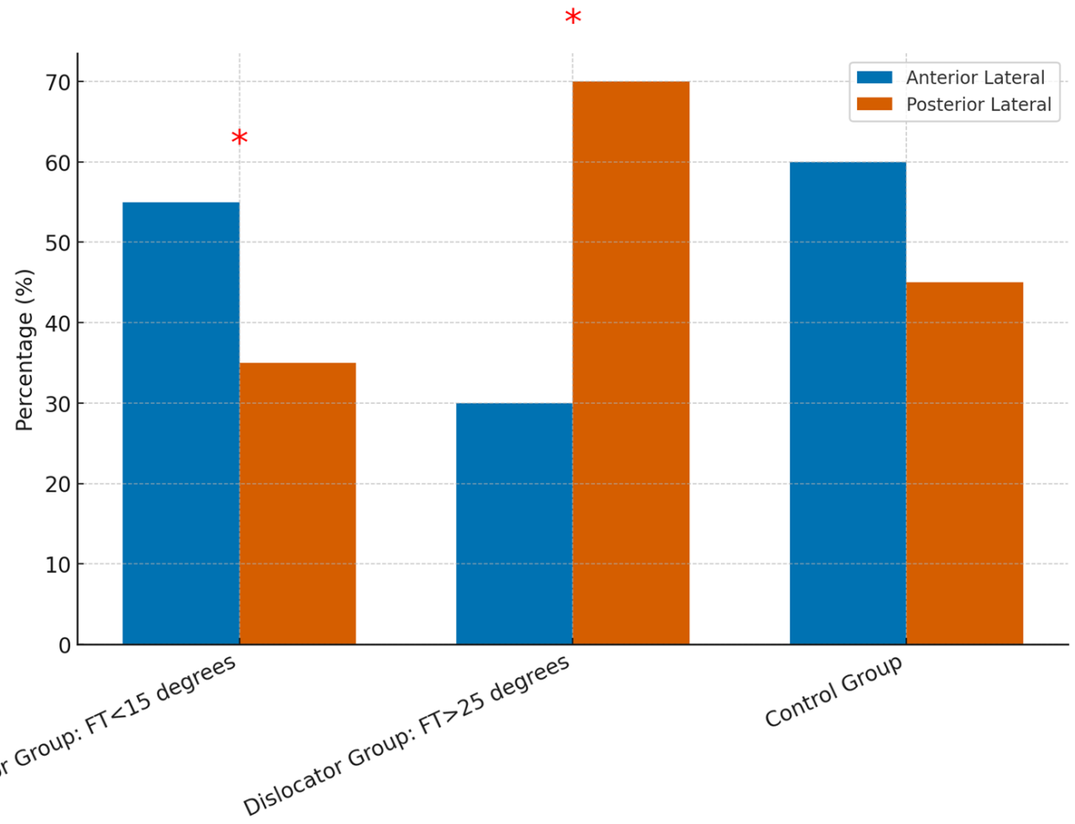


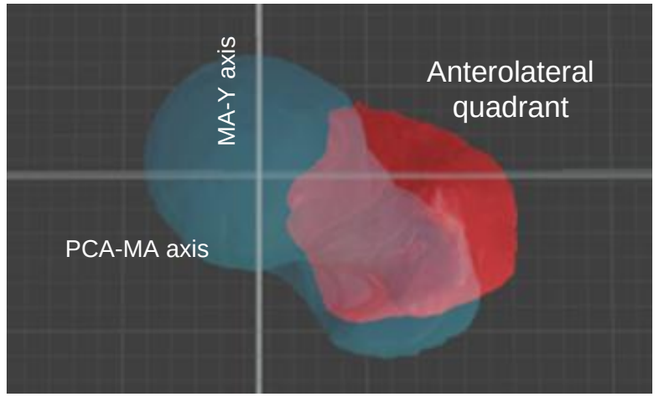
Results – Vastus Medialis



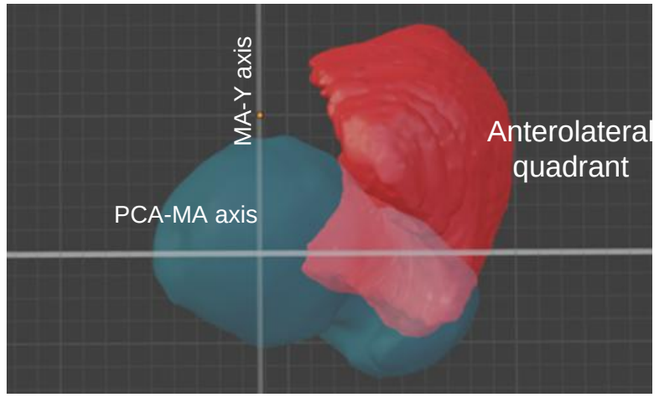


Results – Vastus Lateralis





Dislocator FT > 25 °



Dislocator FT < 15°

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Discussion

- Significant differences found in Quads anatomy in both coronal and axial planes
- VL muscle bulk in dislocators with torsion is located more posteriorly than in dislocators without torsion
- VM muscle bulk is similar across groups
- QTA does seem to reflect the overall position of vastus lateralis

Limitations

Limited participants

Vastus intermedius and rectus femoris still to be included

Can not predict activation or magnitude of force exerted by muscle

Conclusion

- Greater understanding of quads anatomy and its association with femoral torsion in PFJ instability may help to differentiate patients requiring more aggressive soft-tissue management
- May help determine if derotational osteotomies should be performed proximally or distally in the femur
- Future work to define influence of quads position on tibial tuberosity position and type of trochlear dysplasia

References

Sanders TL et al., Sports Health, 10(2):146-154, 2018

Maine ST, O'Gorman P, Barzan M, Stockton CA, Lloyd D, Carty CP. Rotational Malalignment of the Knee Extensor Mechanism: Defining Rotation of the Quadriceps and Its Role in the Spectrum of Patellofemoral Joint Instability. JBJS Open Access. 2019;4(4). doi:10.2106/JBJS.OA.19.00030.