Medial patellofemoral ligament length change patterns in asymptomatic knees of patients with contralateral patellar instability

Miho J. Tanaka, MD
Karina Mirochnik
F. Joseph Simeone, MD
Eric M. Berkson, MD
Kartik Mangudi Varadarajan, PhD

HARVARD
MEDICAL SCHOOL

MGH 1811
MASSACHUSETTS
GENERAL HOSPITAL
ORTHOPAEDICS

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MPFL Reconstruction

- Anisometry and inappropriate graft length have been associated with
  - Abnormal patellar kinematics and contact pressures
  - Increased graft strain
  - Increased risk of failure

- Reconstructive surgical techniques have focused on assessing and minimizing length changes during knee range of motion to recreate the isometric function of the MPFL.
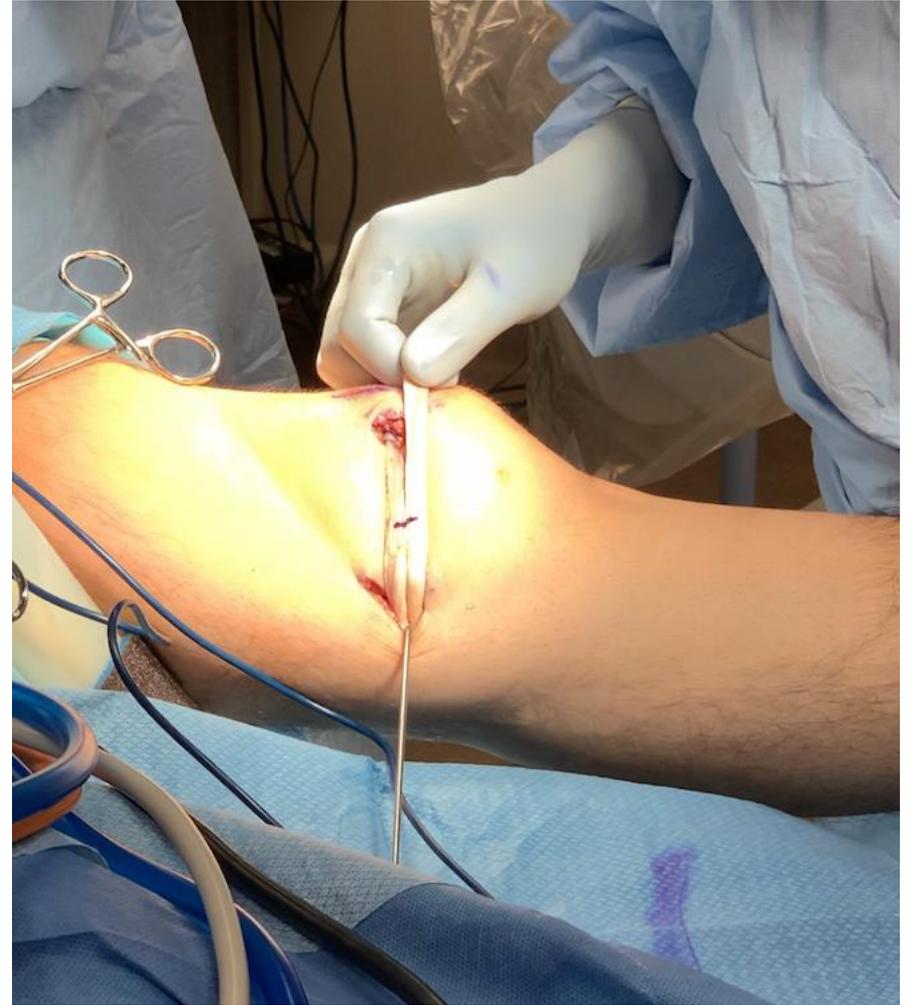
MPFL Reconstruction

- The native MPFL has been shown to remain constant in length from 0-60° knee flexion in biomechanical studies.

- Cadaveric studies have demonstrated that morphological abnormalities such as patella alta and lateralization of the tibial tuberosity can lead to anisometry of the graft.

- Length changes in the intact MPFL in patients with morphological risk factors have not been described.

Aim

- To assess MPFL length change patterns in knees of patients with contralateral patellar instability

- To assess the influence of morphologic risk factors on these changes

- Hypothesis: MPFL length would differ between different knee flexion angles, and that the amount of length change would correlate with the severity of morphological abnormalities present.

Methods

- Patients with unilateral recurrent patellar instability who underwent dynamic computed tomography (CT) imaging as part of routine workup for patellar stabilization surgery were included in this study.

- Dynamic CT imaging of the bilateral knees was performed as has been previously described by Elias and Cosgarea, with active knee extension in a sitting position performed over 10 seconds

- All scans were performed on the GE Revolution computed tomography (CT) scanner in Cine Mode.

Methods

- Inclusion criteria :
    - Patients with a history of unilateral recurrent patellar instability
    - Between the ages of 12 and 40
    - No symptoms on the contralateral knee

- Exclusion criteria:
    - Bilateral knee symptoms
    - History of injury or prior surgery in the nonoperative knee
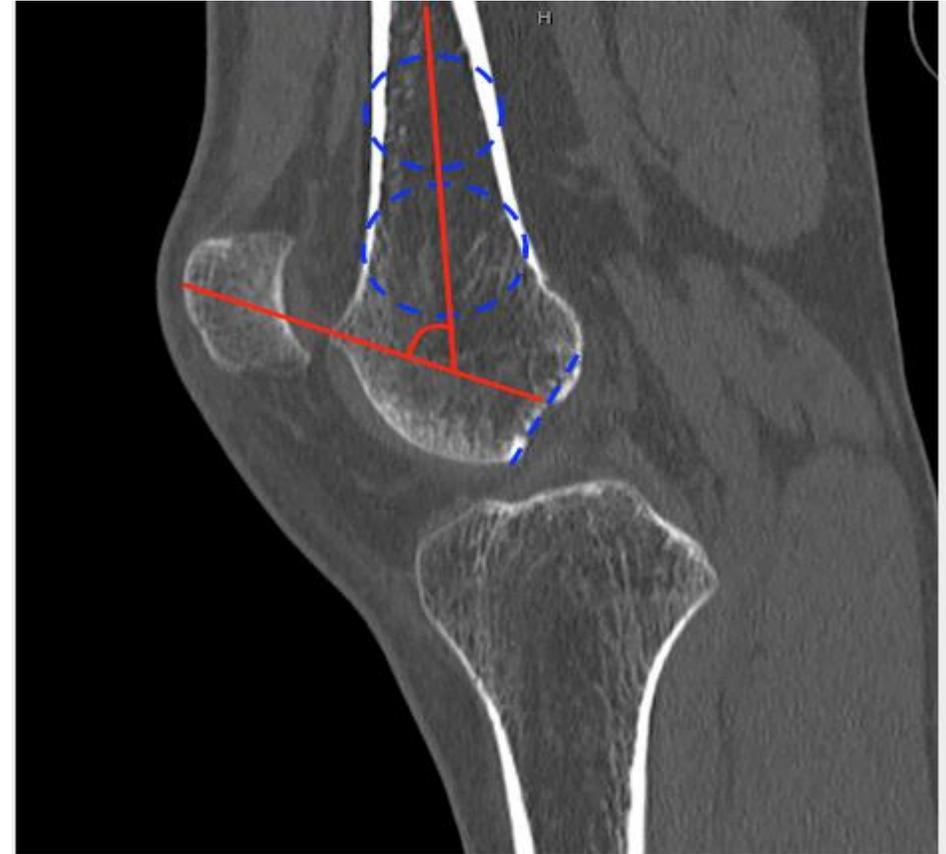
2D measurements

Trochlear Dysplasia:
- Sulcus angle
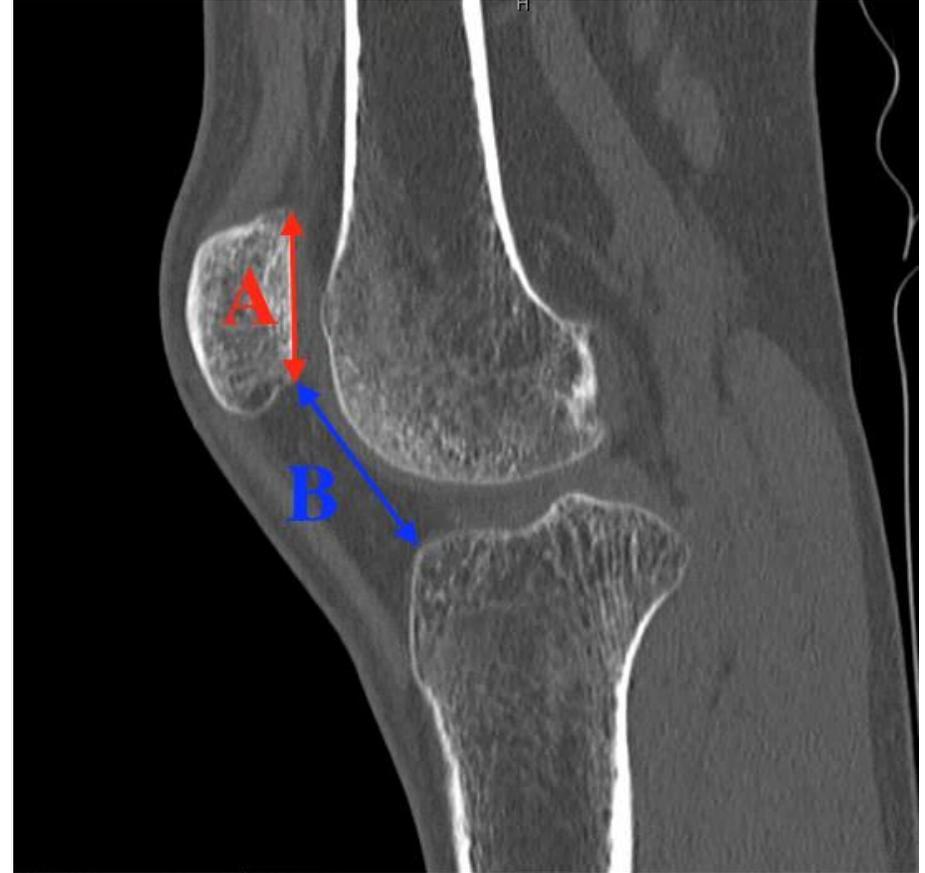- Lateral trochlear inclination (LTI)
- Trochlear depth
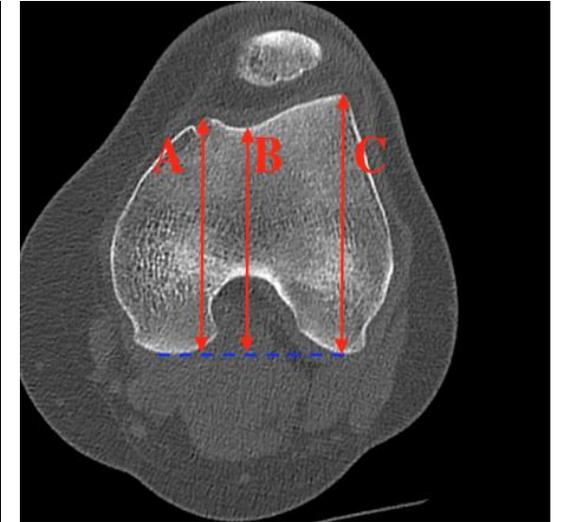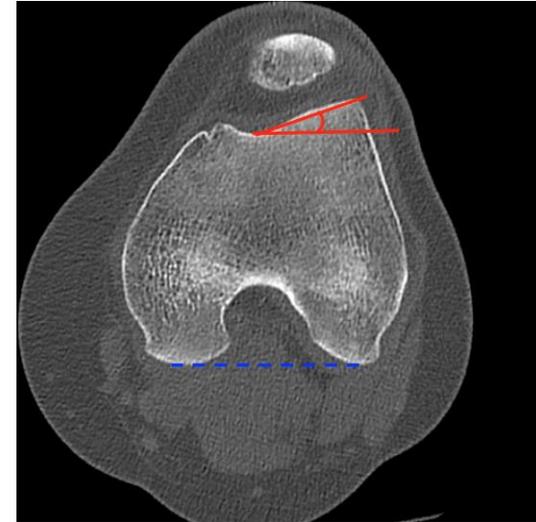
2D measurements

- Trochlear Length was measured as the angle between:
  - Femoral shaft axis
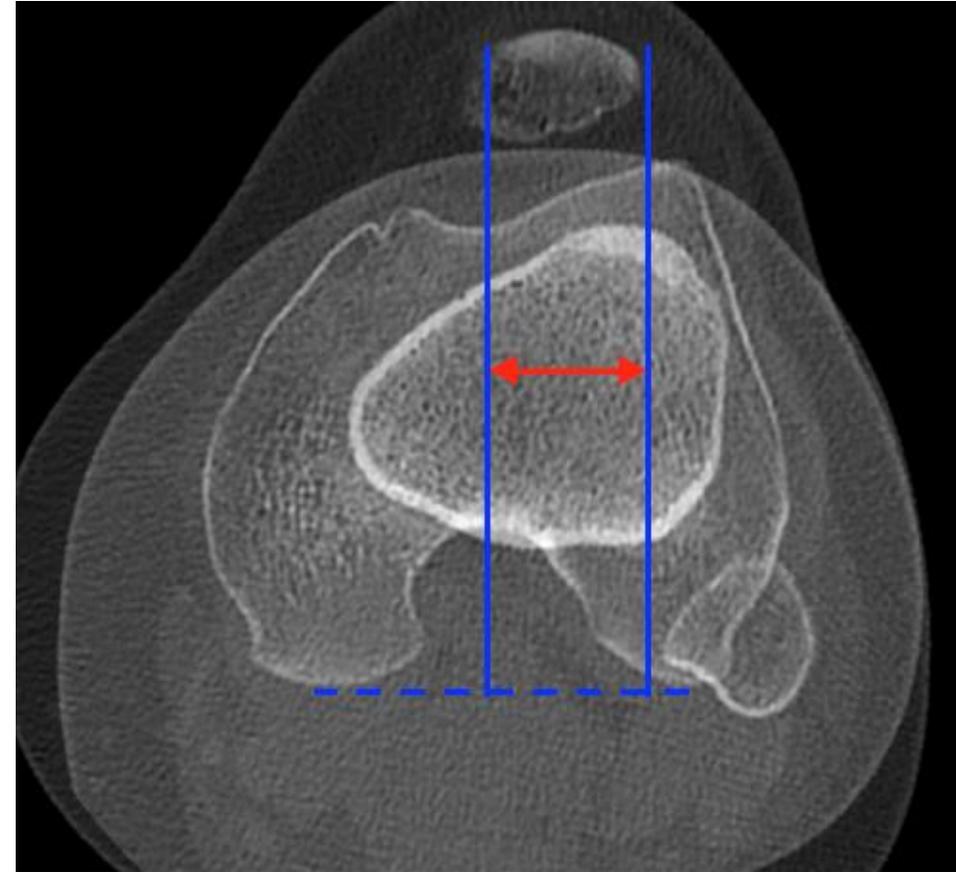 - Midpoint of Blumensaat line to proximal aspect of trochlea

2D measurements

- Caton Deschamps Index
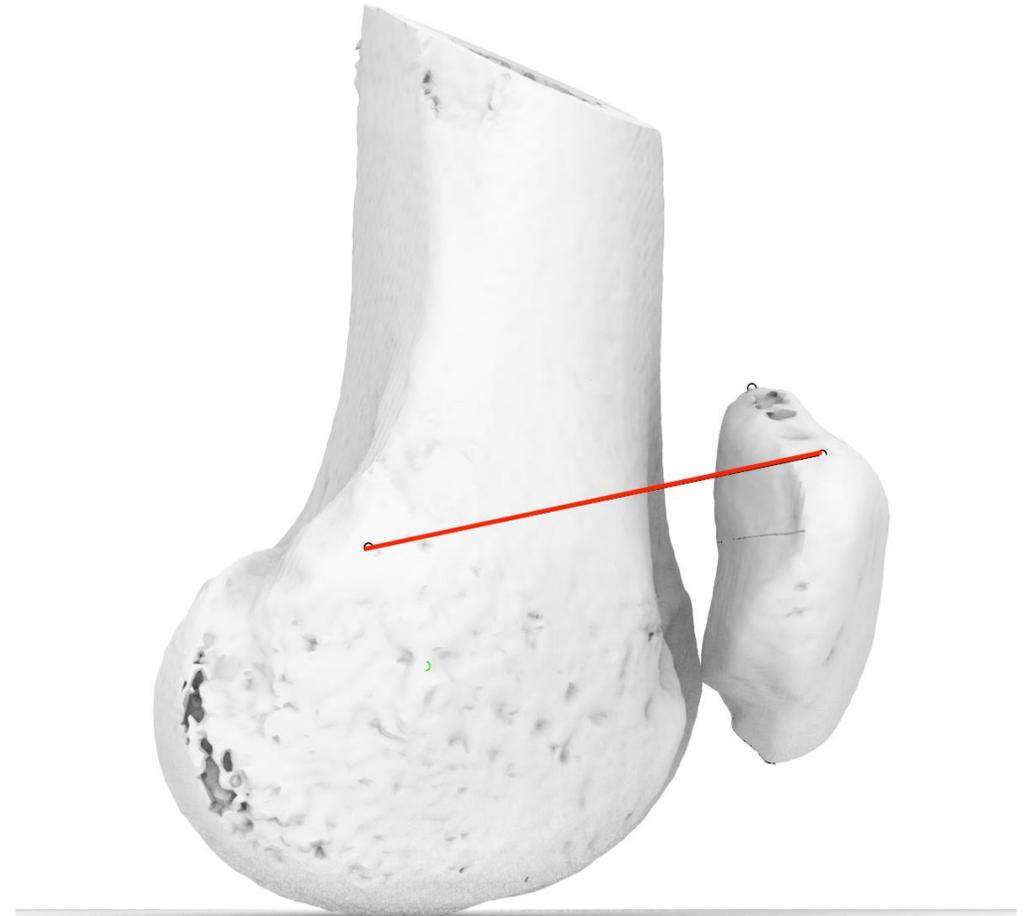
2D measurements

- TTTG distance

3D Measurements

- Volume rendered 3D digital knee models were derived from each frame of the dynamic CT
- Knees were grouped into 10° intervals of knee flexion
- At each flexion angle, MPFL length was calculated based on the distance between the known anatomic attachment points on the patella and femur

3D Measurements

- On the medial border of the patella, a point was identified 19% of the patellar articular length from the superior pole, representing the radiographic midpoint of the anterior attachment
- On the femur, a point 1cm distal to the prominence of the adductor tubercle was identified

3D Measurements

- The distance between the two points were calculated
- Straight line representation of the fibers was allowed to wrap around the femoral condyle to ensure accurate length measurement between the selected patellar and femoral points
- Measurements were performed at each flexion angle
- All 3D measurements and analyses were performed using Rhinoceros 3D Software Version 6
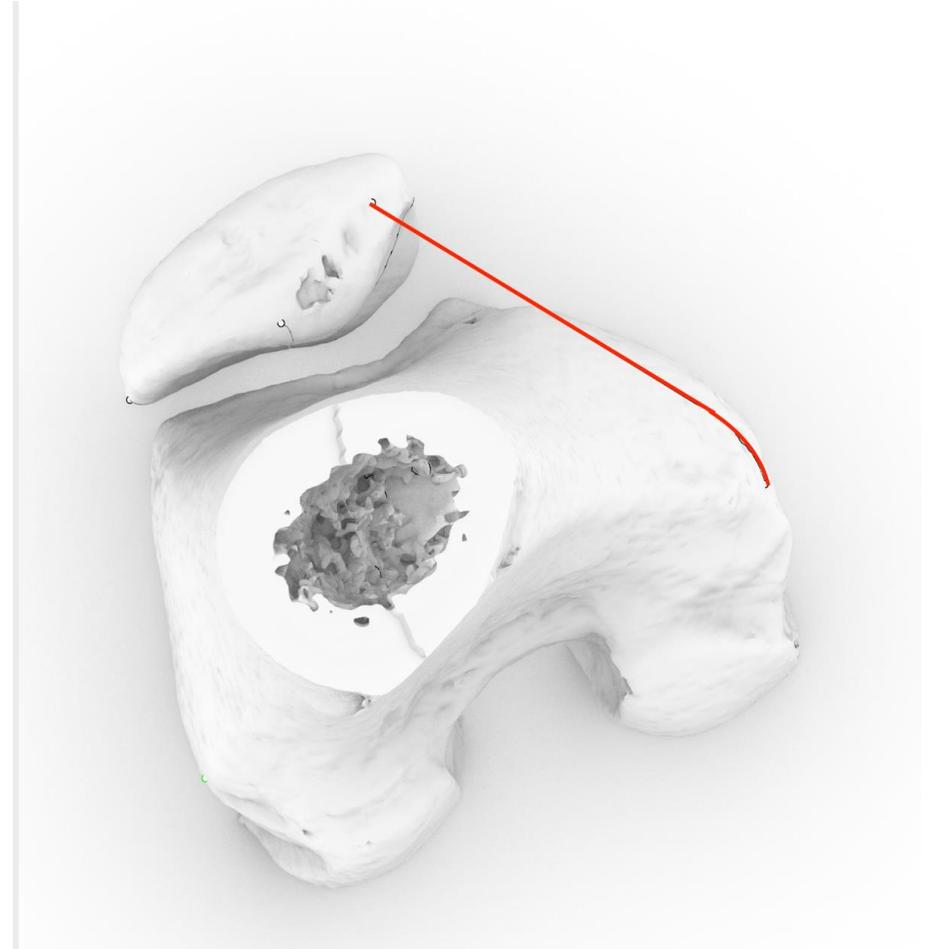
Analyses

- Descriptive statistics were used to describe MPFL length at each knee flexion angle
- One way ANOVA testing with post hoc Tukey HSD was performed to assess for significant differences in MPFL length at each knee flexion angle
- Stepwise multiple linear regression was performed to identify a significant relationship between MPFL length changes and morphologic measurements of sulcus angle, LTI, trochlear depth, trochlear angle, CDI and TTTG distance

Analyses

- Knees were categorized by the number of morphologic risk factors present.
  - Trochlear dysplasia: trochlear depth =<4mm
  - Patella alta: CDI>=1.2
  - Malalignment: TTTG distance >=20mm
- The cumulative number of risk factors was used to categorize each knee from 0-3
- Linear regression analysis was performed to assess the relationship between % change in MPFL length and the number of morphologic risk factors present

Results

- 17 patients with unilateral patellar instability underwent dynamic CT imaging
- 6 knees were excluded for not having adequate images for analysis that reached full extension or 50° knee flexion
- 11 knees were included in this study (4M, 7F), with a mean patient age of 24.8+/-7.4 years

	Mean+/-SD
Age	24.7+/-7.4
Sulcus Angle	155.2+/-13.1
LTI	11.9+/-6.3
Trochlear depth	3.4+/-2.1
Trochlear length	66.1+/-4.6
CDI	1.1+/-0.1
TTTG distance	18.1+/-3.5

MPFL Length Changes

- MPFL length was greatest at 0°, with significant differences when compared to 20° (p=0.032), 30° (p=0.007), 40° (p=0.006), and 50° knee flexion (p=0.003)
- No significant length differences were noted between other combinations of knee flexion angles
- MPFL length varied from 74.0+/-7.8mm at 0° to 64.2+/-4.7mm at 50° knee flexion
  - Overall 15.5+/-11.7%, or 9.8+/-7.4mm change in length (p<0.001)

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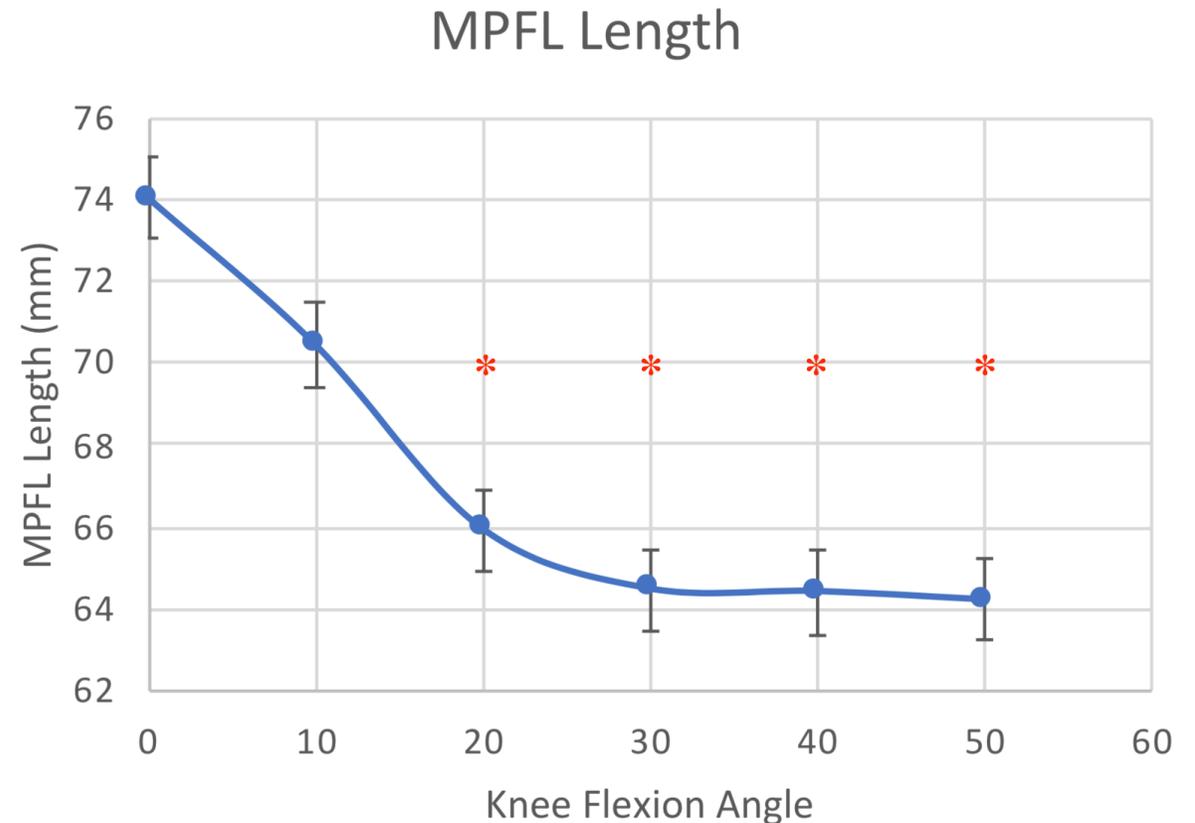
Regression analysis

- Stepwise multiple regression analysis
  - Sulcus angle
  - LTI
  - Trochlear depth
  - Trochlear angle
  - CDI
  - TTTG distance
- Independent relationship between increasing MPFL length change and TTTG distance (R=0.62, R2 0.392, p=0.039)

Risk Factors

- A significant difference in length change was identified when comparing knees with 0 or 1 risk factors versus knees with 2 or 3 risk factors (7.4+/-8.9% vs 22.2+/-9.5%, p=0.027).
  - 4.9+/-5.6mm length change in knees with 0 or 1 morphological risk factor
  - 13.9+/-6.4mm length change with 2 or 3 morphological risk factors.
- The number of morphologic risk factors present in each knee demonstrated a strong relationship with % change in MPFC length between 0° and 50° knee flexion (R=0.81, R2=0.66, p=0.002).

Correlation between # Risk Factors and % MPFL Length Change

$y = 8.4455x + 3.2318$
$R^2 = 0.6628$

% Length Change

Risk Factors
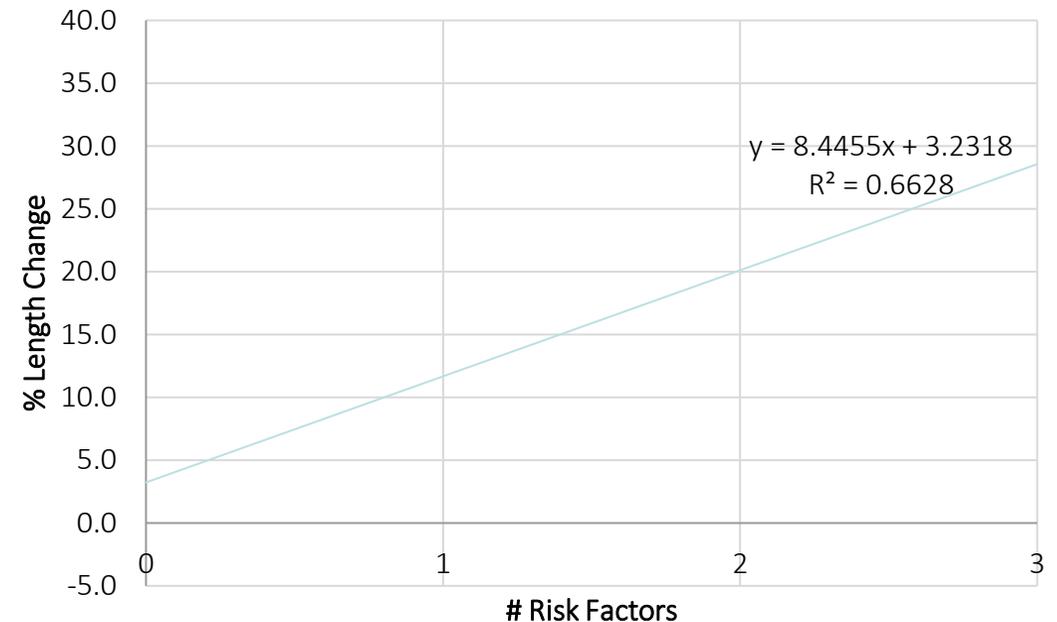
Conclusion

- In asymptomatic knees of patients with contralateral patellar instability, calculated MPFL length was significantly greater at 0° when compared to 20-50° knee flexion using standard attachment points on the patella and femur
- Furthermore, the number of morphological risk factors present in the knee was associated with greater anisometry of the MPFL
  - Up to 22.6mm greater at 0° than 50° flexion
- This suggests that the isometric function of the intact MPFL in these patients may not reflect previously described findings in anatomically normal patients
- Further studies are needed to understand the pathoanatomy related to these changes, as well as the implications for graft placement and assessment of isometry in MPFL reconstruction techniques

Thank you