MRI MEASUREMENTS OF SAGITTAL TROCHLEAR MORPHOLOGY IN PATIENTS WITH PATELLAR INSTABILITY

Marc Tompkins MD
Thomas Johnstone BS
Raimundo Vial MD
Jaren LaGreca MD
Elizabeth A. Arendt MD

Background

- There are multiple described techniques to measure trochlear dysplasia, however, there remains no consensus regarding which are best to diagnose or guide treatment
- There is a relative deficiency in measurements assessing the sagittal trochlear morphology

Goals of the Study

- Primary Study Aim
  - Compare the trochlear morphology of patients with patellar instability vs. controls on sagittal based MRI measurements
- Clinical Significance
  - Improved understanding of sagittal trochlear morphology may provide additional insight into anatomical factors that contribute to patellar instability

Hypothesis

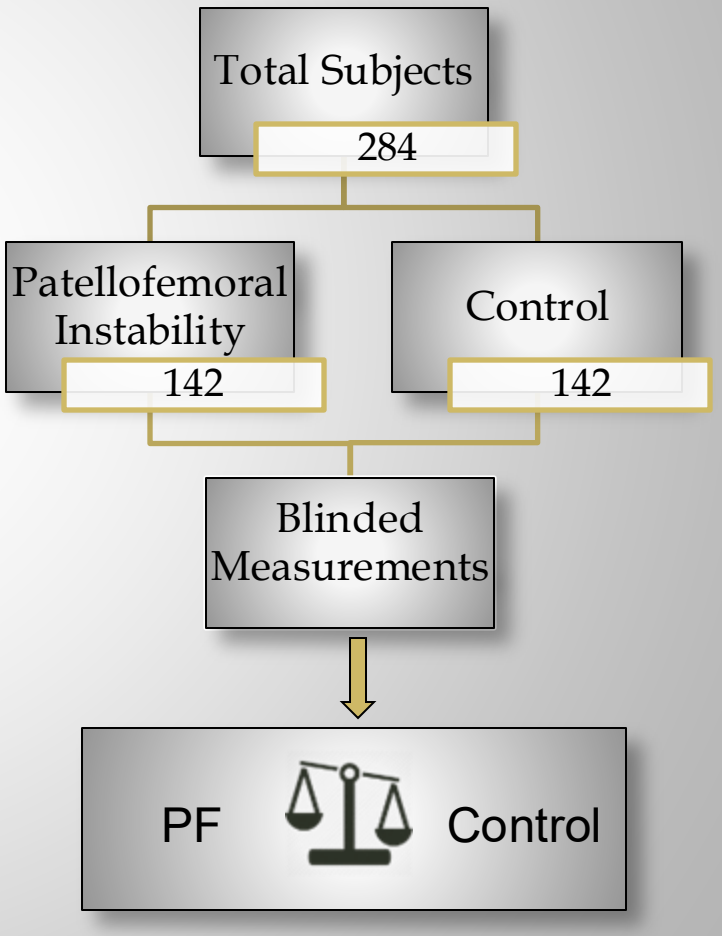
- Patients with patellar instability have significant differences in sagittal trochlear morphology as compared to controls

Methodology

Retrospective case-control study

Prognostic Level III study

Inclusion	Consecutive patients with primary patellar dislocations over 4 years from single institution
	Age- and sex-matched control patients (ACL patients)
Exclusion	PF patients with prior instability events or prior knee surgery
	Patients without knee MRI

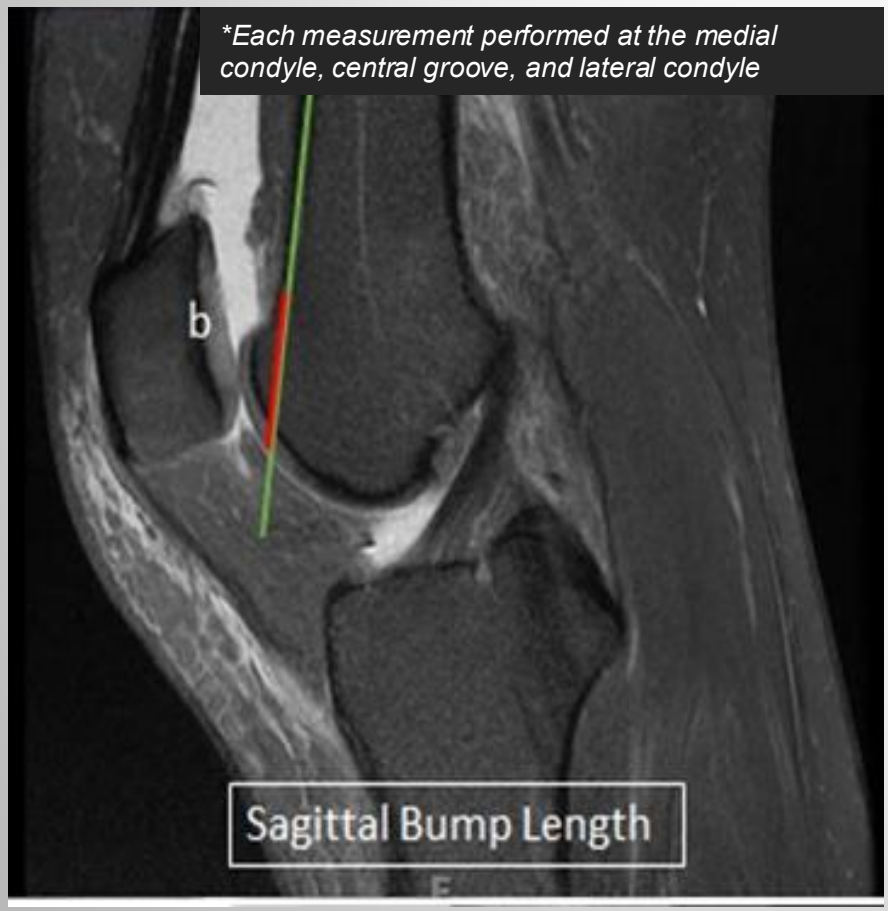


Sagittal Bump Height

- Line a (red) perpendicular to the anterior femoral cortex line (green)
- Point along the bump where there is the greatest length of line a

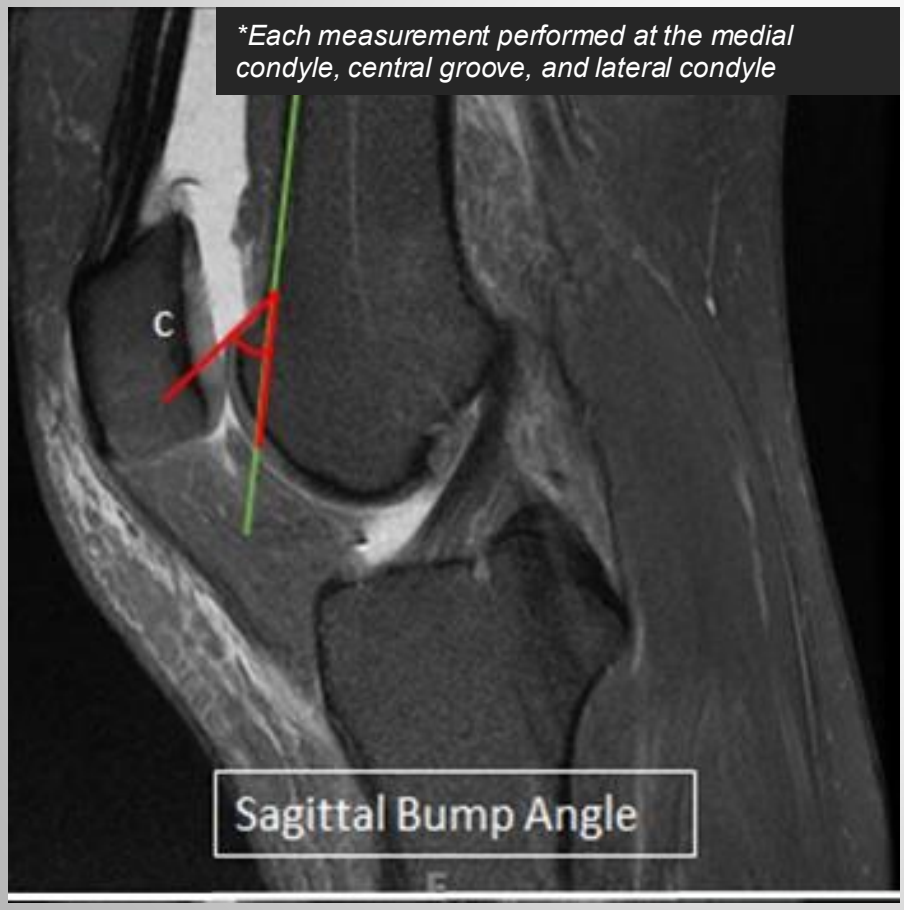
- All measurements were normalized to epicondylar width to standardize for size, in addition to the raw numbers

Sagittal Bump Length



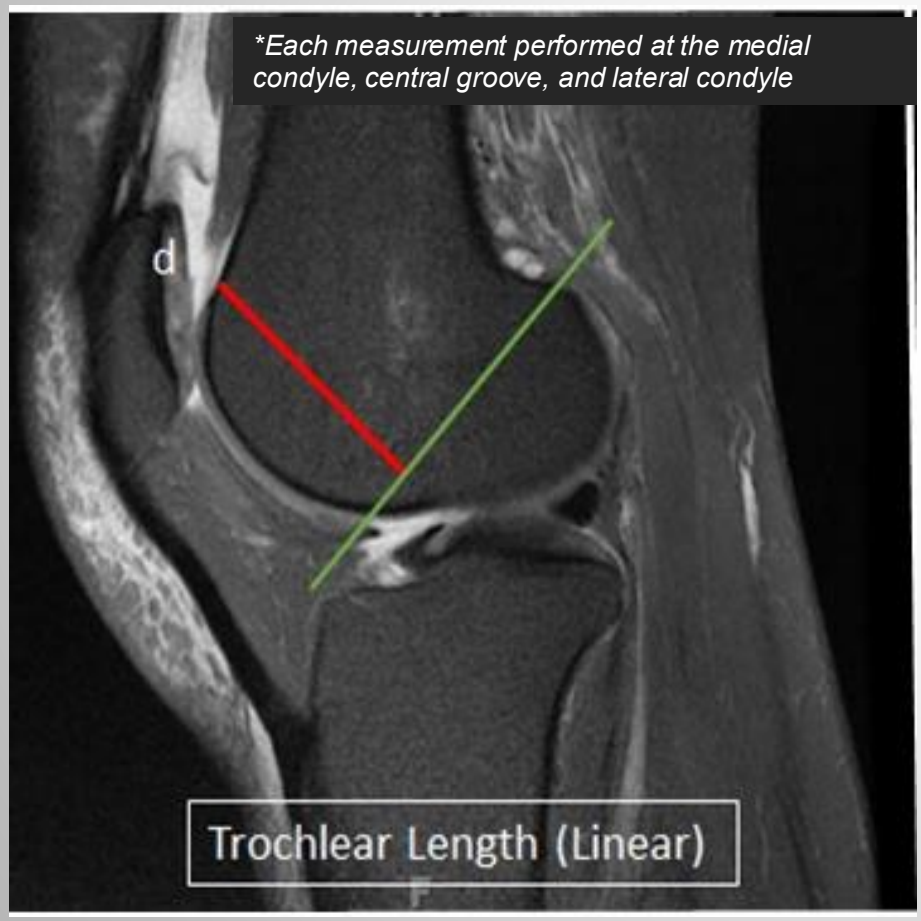
- Line b (red) parallel to the anterior femoral cortex line (green)
- Length of line b from point at which the bump rises anterior to the green line and then dips below

Sagittal Bump Angle



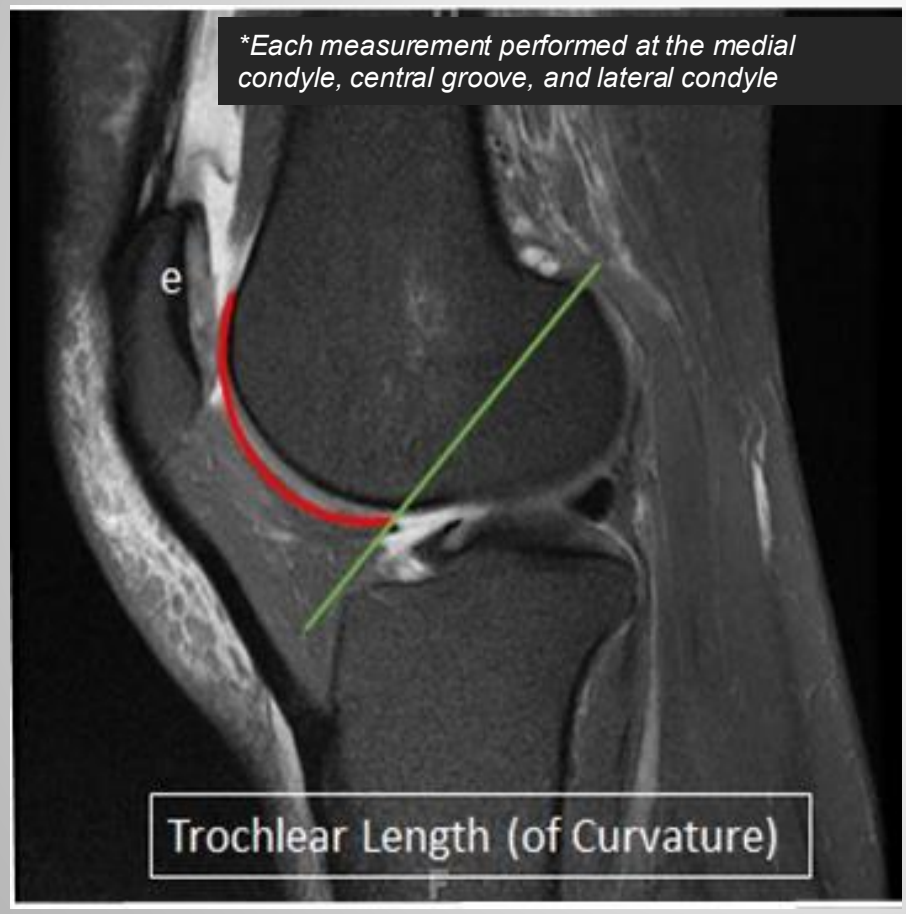
- Angle c (red) which follows the cartilage as it is leaves the anterior femoral cortex line (green)

Linear (Direct) Trochlear Length



- Line d (red) perpendicular to Blumensaat's line (green)
- Ends at proximal most aspect of the trochlear articular cartilage

Curvilinear Trochlear Length



- Line e (red) which follows curvilinear shape of trochlea to Blumensaat's line (green)
- Ends at proximal most aspect of the trochlear articular cartilage

Univariate Analysis of Differences Between Sagittal Markers in Control and PF Instability Groups

Characteristic	Control	Patellofemoral Instability	P Value
Sample Size	142	142	
Sagittal Bump Height Lateral (mm) (mean (SD))	6.85 (1.83)	5.45 (1.17)	<0.001
Normalized - Sagittal Bump Height Lateral (mm) (mean (SD))	8.76 (2.41)	6.67 (1.50)	<0.001
Sagittal Bump Height Central (mm) (mean (SD))	5.43 (1.10)	5.41 (1.17)	0.853
Normalized - Sagittal Bump Height Central (mm) (mean (SD))	6.96 (1.47)	6.61 (1.49)	0.052
Sagittal Bump Height Medial (mm) (mean (SD))	5.27 (1.55)	4.32 (1.18)	<0.001
Normalized - Sagittal Bump Height Medial (mm) (mean (SD))	6.72 (1.93)	5.27 (1.44)	<0.001
Sagittal Bump Length Lateral (mm) (mean (SD))	30.80 (5.24)	27.68 (4.08)	<0.001
Normalized - Sagittal Bump Length Lateral (mm) (mean (SD))	39.34 (6.64)	33.79 (5.04)	<0.001
Sagittal Bump Length Central (mm) (mean (SD))	23.27 (3.45)	23.10 (3.11)	0.656
Normalized - Sagittal Bump Length Central (mm) (mean (SD))	29.76 (4.64)	28.21 (3.99)	0.003
Sagittal Bump Length Medial (mm) (mean (SD))	23.75 (5.49)	20.94 (4.65)	<0.001
Normalized - Sagittal Bump Length Medial (mm) (mean (SD))	30.31 (6.81)	25.57 (5.73)	<0.001
Sagittal Bump Angle Lateral (deg) (mean (SD))	23.84 (4.59)	20.40 (3.92)	<0.001
Sagittal Bump Angle Central (deg) (mean (SD))	30.43 (6.48)	30.27 (6.53)	0.84
Sagittal Bump Angle Medial (deg) (mean (SD))	24.72 (6.99)	22.00 (6.04)	0.001
Trochlear Length (Direct) Lateral (mm) (mean (SD))	38.80 (3.31)	40.17 (12.38)	0.205
Normalized - Trochlear Length (Direct) Lateral (mm) (mean (SD))	49.51 (3.43)	49.02 (16.09)	0.726
Trochlear Length (Direct) Central (mm) (mean (SD))	33.93 (2.84)	37.14 (3.47)	<0.001
Normalized - Trochlear Length (Direct) Central (mm) (mean (SD))	43.32 (3.35)	45.27 (3.68)	<0.001
Trochlear Length (Direct) Medial (mm) (mean (SD))	31.56 (3.19)	31.99 (3.78)	0.299
Normalized - Trochlear Length (Direct) Medial (mm) (mean (SD))	40.31 (4.00)	38.95 (3.88)	0.004
Trochlear Length (Curved) Lateral (mean (SD))	47.91 (4.22)	47.89 (5.31)	0.97
Normalized - Trochlear Length (Curved) Lateral (mean (SD))	61.16 (4.86)	58.37 (5.95)	<0.001
Trochlear Length (Curved) Central (mean (SD))	42.70 (4.11)	46.81 (6.69)	<0.001
Normalized - Trochlear Length (Curved) Central (mean (SD))	54.55 (5.38)	57.05 (7.44)	0.001
Trochlear Length (Curved) Medial (mean (SD))	39.81 (15.60)	38.73 (6.42)	0.445
Normalized - Trochlear Length (Curved) Medial (mean (SD))	50.94 (21.30)	47.14 (7.05)	0.044

Summary of Univariate Results

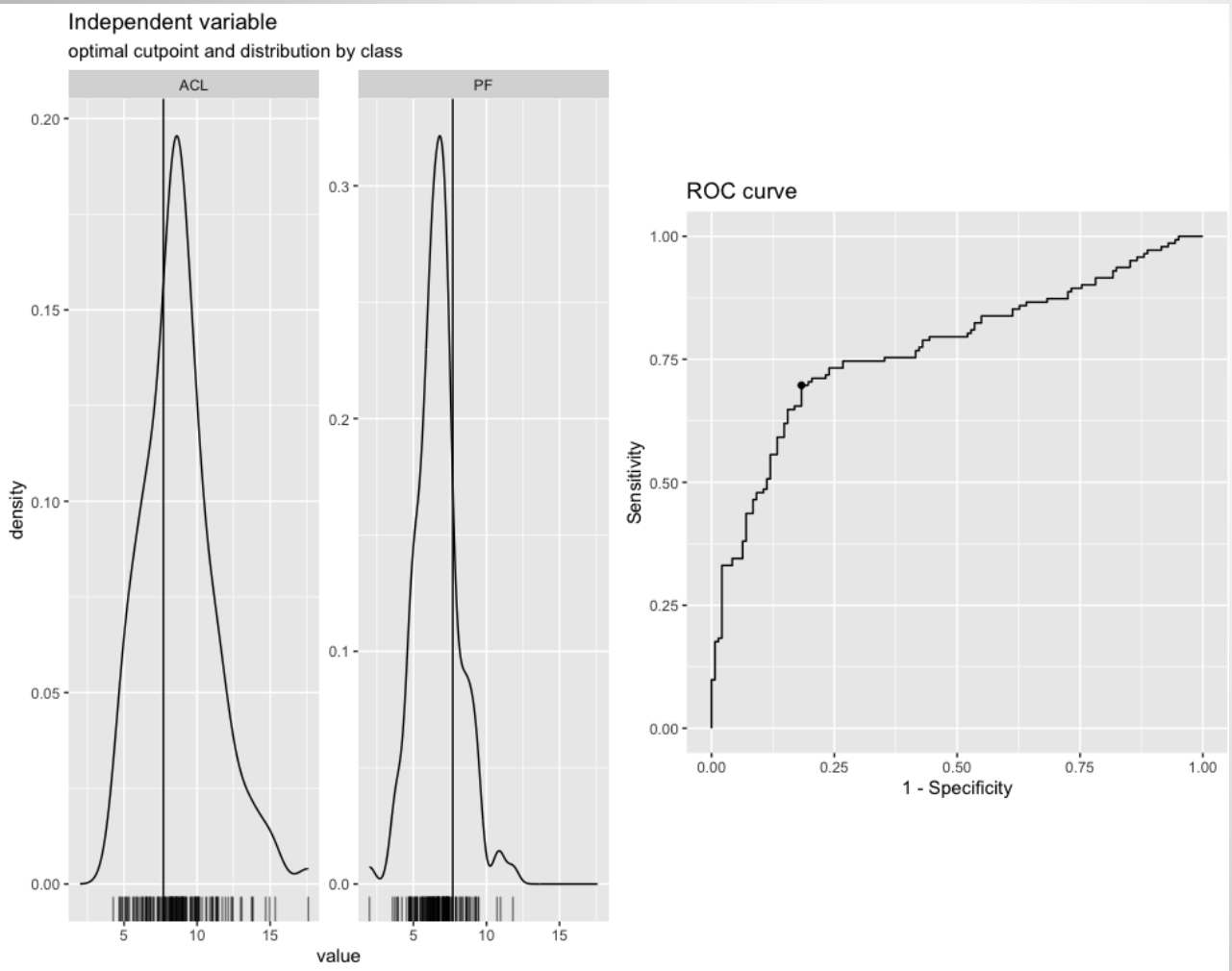
- Sagittal bump height
  - Lateral and Medial
- Sagittal bump length
  - Lateral and Medial
- Sagittal bump angle
  - Lateral and Medial
- Trochlear length direct
  - Central
- Trochlear length circumferential
  - Central

Sagittal Markers Ranked by Usefulness in Discriminating Between Control and PF Instability

Variable	Control	PF Instability	P Value	AUC
Normalized - Sagittal Bump Height Lateral (mm) (mean (SD))	8.76 (2.41)	6.67 (1.50)	<0.001	0.77
Trochlear Length (Direct) Central (mm) (mean (SD))	33.93 (2.84)	37.14 (3.47)	<0.001	0.77
Normalized - Sagittal Bump Length Lateral (mm) (mean (SD))	39.34 (6.64)	33.79 (5.04)	<0.001	0.75
Sagittal Bump Height Lateral (mm) (mean (SD))	6.85 (1.83)	5.45 (1.17)	<0.001	0.74
Normalized - Sagittal Bump Height Medial (mm) (mean (SD))	6.72 (1.93)	5.27 (1.44)	<0.001	0.73
Sagittal Bump Angle Lateral (deg) (mean (SD))	23.84 (4.59)	20.40 (3.92)	<0.001	0.72
Trochlear Length (Curved) Central (mean (SD))	42.70 (4.11)	46.81 (6.69)	<0.001	0.72
Normalized - Sagittal Bump Length Medial (mm) (mean (SD))	30.31 (6.81)	25.57 (5.73)	<0.001	0.7
Sagittal Bump Height Medial (mm) (mean (SD))	5.27 (1.55)	4.32 (1.18)	<0.001	0.69
Sagittal Bump Length Lateral (mm) (mean (SD))	30.80 (5.24)	27.68 (4.08)	<0.001	0.69
Normalized - Trochlear Length (Direct) Central (mm) (mean (SD))	43.32 (3.35)	45.27 (3.68)	<0.001	0.66
Sagittal Bump Length Medial (mm) (mean (SD))	23.75 (5.49)	20.94 (4.65)	<0.001	0.65
Normalized - Trochlear Length (Direct) Lateral (mm) (mean (SD))	49.51 (3.43)	49.02 (16.09)	0.726	0.64
Normalized - Trochlear Length (Curved) Lateral (mean (SD))	61.16 (4.86)	58.37 (5.95)	<0.001	0.64
Sagittal Bump Angle Medial (deg) (mean (SD))	24.72 (6.99)	22.00 (6.04)	0.001	0.63
Normalized - Trochlear Length (Curved) Medial (mean (SD))	50.94 (21.30)	47.14 (7.05)	0.044	0.63
Normalized - Trochlear Length (Curved) Central (mean (SD))	54.55 (5.38)	57.05 (7.44)	0.001	0.61
Normalized - Sagittal Bump Length Central (mm) (mean (SD))	29.76 (4.64)	28.21 (3.99)	0.003	0.59
Normalized - Trochlear Length (Direct) Medial (mm) (mean (SD))	40.31 (4.00)	38.95 (3.88)	0.004	0.59
Normalized - Sagittal Bump Height Central (mm) (mean (SD))	6.96 (1.47)	6.61 (1.49)	0.052	0.58
Trochlear Length (Direct) Lateral (mm) (mean (SD))	38.80 (3.31)	40.17 (12.38)	0.205	0.54
Sagittal Bump Height Central (mm) (mean (SD))	5.43 (1.10)	5.41 (1.17)	0.853	0.53
Sagittal Bump Length Central (mm) (mean (SD))	23.27 (3.45)	23.10 (3.11)	0.656	0.53
Sagittal Bump Angle Central (deg) (mean (SD))	30.43 (6.48)	30.27 (6.53)	0.84	0.53
Trochlear Length (Direct) Medial (mm) (mean (SD))	31.56 (3.19)	31.99 (3.78)	0.299	0.53
Trochlear Length (Curved) Lateral (mean (SD))	47.91 (4.22)	47.89 (5.31)	0.97	0.53
Trochlear Length (Curved) Medial (mean (SD))	39.81 (15.60)	38.73 (6.42)	0.445	0.53

- Top three:
- Lat Bump Height
- Direct Trochlear Length
- Lat Bump Length

Cutpoints for Univariate Predictors: Normalized Lateral Sagittal Bump Height (mm)



- Cutoff Point: 7.69
- AUC: 0.77
- Optimal Sensitivity: 0.70
- Optimal Specificity: 0.82
- Youden Index: 0.51

Conclusions

- There are differences in sagittal plane measurements between primary PF instability patients and controls (in this case isolated ACL tear patients)
  - It is likely that these sagittal plane measurements can improve understanding of trochlear morphology
- The sagittal bump is most different between PF and controls for the medial and lateral trochlea
  - Lower for PF patients than controls
- The trochlear length is most different between PF and controls for the central trochlea
  - Longer for PF than controls
- These two things remind us of the interesting question of whether this is more of a problem with central overgrowth or medial and lateral undergrowth