A mechanical etiology of lateral patellofemoral arthritis

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INTRODUCTION: Altered joint loading and variations in joint morphology are known to contribute to osteoarthritis. In patellar instability, altered joint loading, such as high tibial tubercle to trochlear groove (TT-TG) distance, contributes to lateralized forces on the patella. It is unknown whether anatomic risk factors for patellar instability can predict patellofemoral cartilage loss in the general population. The objective of this study was to understand if there is a relationship between measures of patellar instability and lateral patellofemoral cartilage loss.

METHODS: Two hundred and forty-seven nonweight bearing CT scans of knee joints from participants ages 45-55 enrolled in the Multicenter Osteoarthritis Study were utilized. All participants obtained knee MRIs at baseline and 2 years later that were scored for cartilage morphology in the patellofemoral joint using the MOAKS scale. Members of the team who were segmenting 3D models and generating measurements were blinded to clinical history and outcomes. Using 3D landmarks positioned on each 3D model, the TT-TG, patellar tilt angle (PTA), tibiofemoral rotation (TFR), and Caton-Deschamps index (CDI) were measured. Entry point to trochlear groove (EPTG) angle was measured using anteroposterior views of 3D models. We performed a separate logistic regression analysis adjusting for age, sex, and BMI for each exposure TT-TG, EPTG, PTA, and CDI with the outcome of interest being patellofemoral OA progression defined as later patellofemoral cartilage loss. The exposures were either measured continuously or categorically by comparing those with the highest 20% of metrics and the remainder of participants. A significance level of 0.05 was used to detect statistically significant differences.

RESULTS: 34 distal femurs and 11 patellae experienced progression of lateral patellofemoral osteoarthritis, defined as an increased cartilage score in the respective lateral patellofemoral compartment Aggregated results for TT-TG, EPTG, PTA, TFR, and CDI can be found in Table 1. In the logistic regression analysis with the continuous exposures, we found that the higher the TT-TG and EPTG, the greater the patellofemoral cartilage loss (p =0.04 for both). Knees in the top 20% of EPTG or PTA were at especially high risk of cartilage loss compared to those not in the top 20% adjusted for age, sex and BMI (for EPTG, Odds Ratio [OR] = 3.16, 95% confidence intervals [CI] = [1.48, 6.78], p-value = 0.003); (for PTA OR = 2.17, 95% CI = [1.04, 2.721], p-value = 0.04).

DISCUSSION AND CONCLUSION: Higher tibial tubercle to trochlear groove distance and entry point to trochlear groove angles increased the risk of lateral patellofemoral cartilage loss in a non-patellar instability population. Furthermore, knees in the top 20% of entry point to trochlear groove and patellar tilt angles were at higher risk of cartilage loss.

Table 1: Summary statistics for full distribution and regression models for patellar instability metrics

Metric	Mean ± SD	Range (Min to Max)	P-value (Linear Model)	OR (Quintile Model)	95% CI (Quintile Model)	P-value (Quintile Model)
TT-TG	12.05 ± 3.54 mm	3.51 - 22.32 mm	0.04	1.138	[0.4929, 2.6277]	0.76
EPTG	18.00 ± 9.64°	1.00 - 40.66°	0.04	3.161	[1.4776, 6.7761]	0.0031
PTA	11.26 ± 6.34°	-5.08 - 35.43°	0.42	2.169	[1.0429, 2.7183]	0.038
TFR	2.12 ± 4.82°	-13.96 - 14.08°	0.14	1.382	[0.6699, 2.9447]	0.38
CDI	0.83 ± 0.15	0.32 - 1.38	0.41	1.536	[0.7183, 3.2544]	0.27

The p-value for the linear model corresponds to a model where patellar instability metrics were measured continuously. In the quintile model, the highest quintile of metrics was compared to the rest of the groups OR: odds ratio. CI: confidence interval. SD: standard deviation. TT-TG: tibial tubercle-trochlear groove distance. EPTG: entry point-trochlear groove angle. PTA: patellar tilt angle. TFR: tibiofemoral rotation. CDI: Caton-Deschamps index.