

Cartilage Degradation Associated with Patellofemoral Pain for Adolescents

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INTRODUCTION: Patellofemoral pain is a common musculoskeletal disorder for adolescents. Weak cartilage causing overloading of subchondral bone is a potential instigator of idiopathic onset of patellofemoral pain. Cartilage degradation associated with patellofemoral pain can also potentially develop into patellofemoral osteoarthritis (OA) [1]. The current study used quantitative MRI to compare cartilage properties between adolescents with patellofemoral pain and healthy controls and identify demographic characteristics associated with cartilage degradation.

METHODS: Adolescents being treated for patellofemoral pain participated in quantitative MRI. Subjects with bilateral patellofemoral pain participated twice, separated by six months, with one analysis focused on each knee. Knees were included based on conservative treatment for patellofemoral pain without a patellar dislocation or other traumatic knee injury. The population included 17 knees from 11 subjects. Demographic characteristics at the time of evaluation were: age = 17.4 ± 2.2 years, body mass index (BMI) = 20.2 ± 4.3 kg/m², 9 females, and 8 males. Time since first onset of pain ranged from approximately 2 months to 6 years. The control population of healthy knees included 16 subjects with the following characteristics: age = 16.4 ± 1.8 years, body mass index (BMI) = 22.2 ± 2.4 kg/m², 10 females, and 6 males. The study was approved by the IRB.

Cartilage was assessed from MRI T1ρ relaxation times. Long T1ρ relaxation times indicate a relatively weak cartilage matrix due to a low concentration of proteoglycans. Mapping T1ρ relaxation times to patellofemoral and tibiofemoral cartilage has been described in detail previously [2]. Cartilage was segmented from a 3D fat saturated Dual Echo Steady State (DESS) MRI scan. Cartilage was separated into regions representing the patella, trochlear groove, medial and lateral femoral condyles, and medial and lateral tibial plateaus. The patella and trochlear groove were further divided into medial, central and lateral regions. Cartilage T1ρ relaxation times were quantified from fat saturated Magnetization-prepared Angle-modulated Partitioned-k-space Spoiled gradient-echo Snapshots (MAPSS) scans. T1ρ relaxation times were mapped to the cartilage regions from the DESS scans and averaged within each region.

T1ρ relaxation times were compared between the patellofemoral pain and control populations with t-tests, accounting for equality of variances, or Mann-Whitney U tests if the data was not normally distributed. For both groups, multivariable linear regressions correlated T1ρ relaxation times against age and BMI for all regions. Non-normally distributed residuals were addressed with Spearman correlations, while heteroscedasticity was addressed with weighted least squares regressions. Comparisons were also made between males and females with t-tests. Statistical significance was set at p < 0.05.

RESULTS SECTION: T1ρ relaxation times were significantly larger for the patellofemoral pain group than the control group for all regions of patellofemoral cartilage (p ≤ 0.004, Table 1), plus the medial and lateral tibial plateaus (p < 0.04). For the control group, significant correlations related increasing age to long T1ρ relaxation times for four of the six regions of patellofemoral cartilage (Table 2). On the contrary, youth was related to long patellofemoral (3 regions) and tibiofemoral (1 region) cartilage relaxation times for the patellofemoral pain group (Fig. 1). High BMI was related to long relaxation times for 3 tibiofemoral regions for the patellofemoral pain group. No significant differences were identified for males vs. females for the knees with pain (p > 0.1).

DISCUSSION: The results associate patellofemoral cartilage degradation with patellofemoral pain. Prior studies have not consistently identified elevated cartilage relaxation times for patellofemoral pain, likely due to populations including older subjects [3,4]. Significant differences between groups for the current study were primarily due to the youngest subjects. The results also associated tibiofemoral cartilage degradation with patellofemoral pain, identifying patellofemoral pain as a disorder of the whole knee. The significant correlations with age for the patellofemoral pain group could indicate cartilage recovers with time following onset of patellofemoral pain at a young age. Another interpretation is that age of onset of pain is a determinant of cartilage degradation. Follow up studies with a shorter time from onset of pain or longitudinal evaluation are needed to better interpret the results.

SIGNIFICANCE/CLINICAL RELEVANCE: Relatively weak cartilage is a potential instigator of patellofemoral pain for young adolescents. Onset of patellofemoral pain at a young age may also increase the risk of long term patellofemoral OA.

REFERENCES: 1. Conchie et al. Knee 23:708-11. 2. Elias et al. Cartilage 13:19476035221102570. 3. Thuillier et al. Am J Sports Med 41:1813-8. 4. van der Heijden et al. Am J Sports Med 44:1172-8.

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Table 1: T1ρ relaxation times (msec) for the patellofemoral pain and control groups

Region	Pain	Controls	p-value
Patella			
Lateral	44.8±3.5	39.3±5.4	0.002
Central	44.5±3.1	39.0±5.3	0.002
Medial	43.7±4.5	36.7±5.0	<0.001
Trochlear Groove			
Lateral	47.8±3.5	43.4±3.8	0.002
Central	47.4±2.6	43.7±3.4	0.004
Medial	45.9±2.3	42.5±3.2	0.001
Femoral Condyle			
Lateral	43.6±2.9	41.4±4.3	0.10
Medial	45.8±2.6	43.5±3.7	0.051
Tibial Plateau			
Lateral	40.7±3.0	37.8±3.8	0.031
Medial	44.5±3.7	40.7±4.5	0.011

Table 2: Parameters significantly correlated with T1ρ relaxation times (msec)

Group	Region	Parameter	r ²	β	p-value
Control	Cen Pat	Age	0.67	0.82	<0.001
Control	Lat Pat	Age	0.86	0.93	<0.001
Control	Med Troch	Age	0.41	0.64	0.007
Control	Lat Troch	Age	0.28	0.53	0.036
Patellofemoral Pain	Cen Pat	Age	0.54	-0.74	<0.001
Patellofemoral Pain	Lat Pat	Age	0.53 [#]		0.001
Patellofemoral Pain	Lat Troch	Age	0.41	-0.64	0.005
Patellofemoral Pain	Med Fem	BMI	0.31	0.56	0.021
Patellofemoral Pain	Lat Fem	BMI	0.41	0.64	0.006
Patellofemoral Pain	Lat Tib	BMI	0.67*	0.57	0.007
Patellofemoral Pain	Lat Tib	Age		-0.97	<0.001

Pat: Patella, Troch: Trochlear Groove, Fem: Femoral Condyle, Tib: Tibial Plateau, Med: Medial, Cen: Central, Lat: Lateral, BMI: body mass index, β: Standardized beta coefficient

*r² for the multivariable regression including two significant variables

[#]Spearman correlation

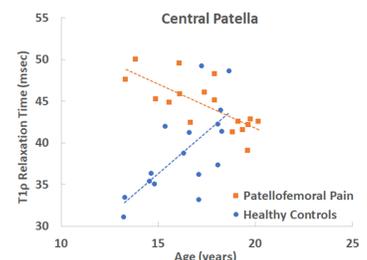


Figure 1: T1ρ relaxation times at the central patella vs. age for both groups.