Lower Preoperative Patellar Tilt on MRI is Associated with Improved 2-Year Banff Patellofemoral Instability Instrument 2.0 Scores Following Medial Patellofemoral Ligament Reconstruction

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INTRODUCTION: Patients with patellofemoral instability (PFI) typically demonstrate good to excellent postoperative improvements in subjective knee function following medial patellofemoral ligament (MPFL) reconstruction, as measured by patient-reported outcome measures (PROMs). Prior studies have characterized the association of increased patellar height and a highly lateralized tibial tubercle as risk factors for adverse PROMs; however, there is a paucity of literature evaluating the associations between radiographic measures of patellar tilt and PROMs. Importantly, the lateral patellofemoral angle (LPFA) and sulcus angle have been demonstrated to be most sensitive in diagnosing PFI in the pediatric population. The aim of this study was therefore to identify whether patellar tilt, as measured by the lateral patellofemoral angle (LPFA), and other radiographic and clinical risk factors are associated with 2-year PROMs following reconstruction of the medial patellofemoral ligament (MPFL).

METHODS: This was a retrospective query from January 2017 to January 2022 of a consecutive series of patients ≤ 18 years old who underwent MPFL reconstruction by a single surgeon. Patients with preoperative and 2-year postoperative PROMs, and preoperative magnetic resonance imaging (MRI) studies were included in the study. PROMs of interest included the Banff Patellofemoral Instability Instrument 2.0 (BPII 2.0), Pedi-International Knee Documentation Committee (Pedi-IKDC), Kujala score, and Knee Injury and Osteoarthritis Outcome Score (KOOS) Quality of Life (QoL). Two independent examiners independently performed 4 measures of patellofemoral morphology, including the cartilaginous sulcus angle, LPFA, tibial tubercle to trochlear groove (TT-TG) distance, and Caton-Deschamps Index (CDI). These measures were chosen as prior work has shown these measurements to be the most sensitive in diagnosing PFI in the pediatric population. The ICCs for all measurements were excellent (ICC > 0.80). Standard descriptive statistics were used to report the mean, standard deviation (SD), median, interquartile range (IQR), and range of continuous variables. Independent samples t-tests or Mann-Whitney U tests were utilized to compare preoperative and postoperative PROMs, as appropriate to the normality of the distributions. Univariable regression was performed to determine variables associated with 2-year postoperative PROMs, which included age, sex, preoperative PROM, preoperative radiographic characteristics (sulcus angle, LPFA, TT-TG, and CDI) and surgical characteristics (autograft versus allograft, concomitant tibial tubercle osteotomy, and contralateral procedure within 2 years). Variables with $p < 0.20$ on univariable analysis were selected for the multivariable regression, which controlled for age, sex, and preoperative PROMs. A P-value < 0.05 was designated as the threshold for statistical significance. All analyses were conducted in SPSS (IBM Corporation, Armonk, NY).

RESULTS:

A final cohort of 82 patients who received MPFL reconstruction with and without TTO were identified, of which 74 (90.2%), 78 (95.1%), 76 (92.7%), and 74 (90.2%) had available 2-year postoperative BPII 2.0, Pedi-IKDC, Kujala, and KOOS QoL scores, respectively. Patients who underwent MPFL reconstruction had significantly improved 2-year PROMs compared to preoperative PROMs (BPII 2.0: 40.2 ± 18.1 vs. 70.2 ± 26.7; Pedi-IKDC: 44.8 ± 20.4 vs. 82.4 ± 19.4; Kujala: 52.4 ± 24.6 vs. 86.5 ± 17.0; KOOS QoL: 30.1 ± 24.0 vs. 71.3 ± 25.4; all, $p < 0.001$) (Table 1). Univariable analysis showed that less patellar tilt, as measured by an increasing LPFA, was associated with increased 2-year BPII 2.0 ($\beta = 1.0$, 95% CI: 0.4 to 1.6, $p = 0.001$), Pedi-IKDC ($\beta = 0.5$, 95% CI: 0.004 to 1.0, $p = 0.049$), and KOOS QoL ($\beta = 0.9$, 95% CI: 0.2 to 1.5, $p = 0.010$). Multivariable regression showed that each degree increase in the LPFA (lower patellar tilt) was associated with a 0.7 increase in the BPII 2.0 ($\beta = 0.7$, 95% CI: 0.1 to 1.4, $p = 0.034$) score (Table 2).

DISCUSSION AND CONCLUSION:

An increased preoperative patellar tilt, as measured by a more negative LPFA (worse patellar tilt), is associated with adverse BPII2.0 following MPFL reconstruction. These findings suggest a novel preoperative radiographic risk factor for adverse subjective outcomes following surgery for PFI. Clinicians may utilize this information for more informed physician-patient conversations for expected outcomes following MPFL reconstruction.

Table 1. Baseline vs. 2-Year Postoperative Patient-Reported Outcome Measures

	Baseline	**2-year postop**	**P value**
Banff	40.2 ± 18.1	70.2 ± 26.7	<0.001
Pedi-IKDC	44.8 ± 20.4	82.4 ± 19.4	<0.001
Kujala	52.4 ± 24.6	86.5 ± 17.0	<0.001
KOOS QoL	30.1 ± 24.0	71.3 ± 25.4	<0.001

Table 2. Univariable and Multivariable Regression of Demographic, Preoperative MRI, and Surgical Characteristics with 2-year Patient Reported Outcome Measures

	Banff (N = 74)				**Pedi-IKDC (N = 78)**				**Kujala (N = 76)**				**KOOS QoL (N = 74)**			
	Univariable β (95% CI)	P-value	Multivariable β (95% CI)	P-value	Univariable β (95% CI)	P-value	Multivariable β (95% CI)	P-value	Univariable β (95% CI)	P-value	Multivariable β (95% CI)	P-value	Univariable β (95% CI)	P-value	Multivariable β (95% CI)	P-value
Age	0.61 (-2.1 to 3.3)	0.648	0.6 (-1.6 to 3.3)	0.495	0.6 (-1.6 to 2.8)	0.582	0.6 (-1.4 to 2.7)	0.615	1.1 (-0.7 to 3.0)	0.229	0.9 (-0.9 to 2.8)	0.322	1.6 (-1.3 to 4.4)	0.278	1.7 (-1.0 to 4.4)	0.215
Sex (male vs. female)	12.1 (-1.4 to 25.6)	**0.028**	10.6 (0.6 to 20.7)	**0.039**	7.2 (-1.6 to 16.0)	0.106	5.4 (-3.2 to 14.0)	0.215	5.2 (-2.7 to 13.0)	0.197	4.3 (-3.4 to 11.9)	0.269	11.9 (0.03 to 23.8)	**0.049**	9.5 (-1.6 to 20.7)	0.097
Pre-operative PROM	0.16 (-0.19 to 0.47)	0.394	0.1 (-0.2 to 0.4)	0.435	0.2 (-0.1 to 0.4)	0.157	0.1 (-0.1 to 0.3)	0.305	0.04 (-0.1 to 0.2)	0.658	0.001 (-0.2 to 0.2)	0.993	0.3 (0.02 to 0.5)	**0.034**	0.2 (-0.01 to 0.4)	0.105
Preoperative MRI variables																
Sulcus Angle	-1.1 (-1.9 to -0.4)	**0.002**	-0.7 (-1.5 to 0.1)	0.084	-0.8 (-1.4 to -0.2)	**0.007**	-0.6 (-1.2 to 0.1)	0.090	-0.7 (-1.3 to -0.2)	**0.005**	-0.6 (-1.2 to -0.1)	**0.032**	-1.0 (-1.8 to -0.2)	**0.011**	-0.6 (-1.4 to 0.3)	0.182
TT-PCL	1.6 (0.4 to 3.4)	**0.010**	0.7 (0.1 to 1.4)	**0.014**	0.5 (0.0 to 1.0)	**0.049**	0.3 (-0.3 to 0.8)	0.333	0.4 (-0.3 to 0.9)	0.303	0.5 (-0.3 to 0.7)	0.371	0.9 (0.7 to 1.5)	**0.010**	0.6 (-0.1 to 1.3)	0.087
TT-TG	-0.1 (-1.6 to 1.4)	0.849	–	–	0.6 (-0.5 to 1.8)	0.297	–	–	0.6 (-0.8 to 1.8)	0.223	–	–	0.2 (-1.3 to 1.8)	0.785	–	–
CDI	-14.2 (-68.3 to 11.9)	0.201	–	–	-1.8 (-25.1 to 19.4)	0.864	–	–	-2.3 (-21.7 to 17.2)	0.818	–	–	-1.8 (-28.2 to 27.5)	0.947	–	–
Surgical Characteristics																
Autograft vs. Allograft	-4.1 (-17.2 to 7.1)	0.410	–	–	-1.1 (-18.8 to 8.5)	0.815	–	–	-1.5 (-10.1 to 7.2)	0.738	–	–	-3.2 (-16.3 to 9.9)	0.631	–	–
TTO	-6.4 (-25.2 to 11.4)	0.300	–	–	5.8 (-8.6 to 26.3)	0.418	–	–	4.8 (-8.7 to 18.3)	0.481	–	–	-6.4 (-25.4 to 13.0)	0.507	–	–
Contralateral procedure within 2 years	2.6 (-9.5 to 13.4)	0.732	–	–	1.2 (-7.9 to 10.3)	0.791	–	–	-1.7 (-9.9 to 6.6)	0.669	–	–	-9.5 (-15.1 to 12.2)	0.842	–	–

95% CI = 95% Confidence Interval, Beta coefficient (β) represents the change in 2-year PROM per unit of demographic, preoperative MRI, or surgical characteristic for continuous variables. Categorical variables were sex (reference group: female), autograft versus allograft (reference group: allograft), TTO (reference group: no TTO), and contralateral procedure within 2 years (reference group: no contralateral procedure). For multivariable regression of 2-year BPS-2.0 score, the β associated with LPFA was 0.7, suggesting that every degree increase of preoperative LPFA (towards a less negative/improved preoperative patellar tilt) was associated with an increase of 0.7 in the 2-year BPS-2.0 score.