The Effect of Patellar Tendinopathy in Autografts Used for ACL Reconstruction on Postoperative Outcomes

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INTRODUCTION:
The bone-patellar tendon-bone (BTB) autograft is a common graft choices for ACL reconstruction. Some patients requiring ACL reconstruction have underlying patellar tendinopathy, which could affect graft quality and postoperative patient-reported outcomes (PROs). The purpose of this study was to investigate if evidence of patellar tendinopathy on preoperative magnetic resonance imaging (MRI) in patients undergoing ACL reconstruction with BTB autograft has an effect on retears, subsequent surgeries, and postoperative PROs.

METHODS: Patients at our institution who underwent primary or revision ACL reconstruction with BTB autograft between January 2012 – June 2021 and had minimum two-year follow-up and record of a preoperative knee MRI were identified through retrospective review. Patients who underwent multi-ligament reconstruction, meniscus transplantation, or cartilage restoration procedures were excluded. Concomitant meniscus repair, meniscectomy, or lateral extra-articular tenodesis (LET) procedures were documented. Other variables collected include patient demographic information (age, sex, laterality), retears, and subsequent surgeries on the ipsilateral knee. Axial and sagittal sections of the proximal central third of the patellar tendon were evaluated on all preoperative MRIs for tendinopathic changes (increased signal intensity in the patellar tendon on fat-suppressed proton density or T2-weighted sequences). Classification was as follows based on signal intensity of the axial cross-sectional width of the patellar tendon: Grade 1 (none) – 0% to <25%; Grade 2 (moderate) - 25% to 50%; Grade 3 (severe) - >50% or partial patellar tendon tearing <50%; and Grade 4 - partial patellar tendon tearing >50% (Figure 1). MRIs were graded by two independent reviewers. PRO questionnaires were sent to all included patients excluding those without email addresses on file and bilateral ACL reconstructions. Inter-rater reliability for tendinopathy grading was determined using Cohen's kappa. Multivariable logistic regression evaluated odds of retear and reoperation between groups, and multivariable linear regression evaluated PROs between tendinopathy grades. For each outcome, final covariates were selected using a backward selection model to allow for identification of the most optimal model without overfitting. A p-value of < 0.05 was set as significant.

RESULTS: 909 knees (795 primary, 114 revision; 63% male, 37% female; 44.4% grade 1, 42.7% grade 2, 11.7% grade 3, and 1.2% grade 4 tendinopathy) met inclusion criteria (Table 1). The inter-rater reliability for MRI grading of tendinopathy showed an overall agreement rate of 66%, with a Cohen's kappa of 0.42, demonstrating moderate agreement. There were 89 subsequent surgeries at a mean of 1.6 years (SD 1.4) after ACL reconstruction, with 16 revisions due to graft failure. After controlling for relevant covariates, there were no significant associations between odds of retear and the presence of grade 2 (OR 2.2 [0.8 – 7.3]; $p = 0.15$), grade 3 (OR 0.9 [0.05 – 5.9]; $p = 0.93$), or grade 4 ($p = 0.99$) tendinopathy compared to no tendinopathy. There were no statistically significant associations between odds of having a subsequent surgery and the presence of grade 2 (OR 1.4 [0.8 – 2.2]; $p = 0.22$), grade 3 (OR 1.2 [0.6 – 2.5]; $p = 0.55$), or grade 4 (OR 1.9 [0.3 – 8.1]; $p = 0.43$) tendinopathy compared to no tendinopathy. The presence of concomitant medial meniscus repair at index procedure was significantly associated with increased odds of subsequent surgeries (OR 2.9 [1.8 – 4.6]; $p < 0.001$). There were 158 of 690 eligible patients that completed postoperative PROs, with a mean follow-up of 6.5 years (SD 2.4) after initial ACL reconstruction (Table 2). No significant differences were detected in all PROs between grades 2 and 3 tendinopathy compared to grade 1, except for a 5.2 point higher SANE for grade 2 versus grade 1 ($p = 0.03$; Table 3). Regardless of tendinopathy status, patients with a subsequent surgery scored significantly worse on all PROs measured except for the total KOOS.

DISCUSSION AND CONCLUSION: Patients with evidence of moderate to severe patellar tendinopathy on MRI prior to undergoing ACL reconstruction with BTB autograft have no significant differences in odds of ACL retear or subsequent ipsilateral knee surgery. No significant differences in the majority of postoperative PROs were seen between patients with and without patellar tendinopathy, regardless of patellar tendinopathy severity. Preoperative tendinopathic changes in the patellar tendon should not deter surgeons from selecting BTB autografts for ACL reconstruction.

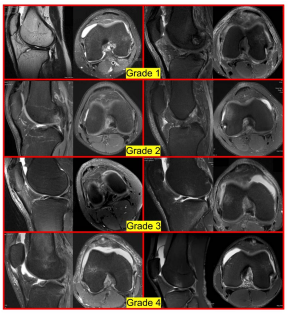

Figure 1. Axial and sagittal fat suppressed magnetic resonance imaging (MRI) images of patellar tendinopathy grading used for this cohort.

	All Patients (n = 908)		Grade 1 (n = 404)		Grade 2 (n = 388)		Grade 3 (n = 106)		Grade 4 (n = 11)	
	n	%	n	%	n	%	n	%	n	%
Laterality										
Left	457	50.3%	197	48.8%	206	53.1%	49	46.2%	5	45.5%
Right	452	49.7%	207	51.2%	182	46.9%	57	53.8%	6	54.5%
Sex										
Male	573	63.0%	212	52.5%	275	70.9%	80	75.5%	6	54.5%
Female	336	37.0%	192	47.5%	113	29.1%	26	24.5%	5	45.5%
Revision Case	114	12.5%	43	10.6%	54	13.9%	17	16.0%	0	0.0%
Mean Age (SD)	24.7 (7.2)		24.1 (7.3)		25.0 (7.1)		26.3 (7.1)		20.1 (4.8)	
MM Repair	218	24.0%	85	21.0%	98	25.3%	30	28.3%	5	45.5%
LM Repair	162	17.8%	70	17.3%	69	17.8%	19	17.9%	4	36.4%
Medial Meniscectomy	98	10.8%	31	7.7%	51	13.1%	16	15.1%	0	0.0%
Lateral Meniscectomy	239	26.3%	86	21.3%	116	29.9%	35	33.0%	2	18.2%
LET	15	1.7%	5	1.2%	6	1.5%	4	3.8%	0	0.0%
Retear	16	1.8%	5	1.2%	10	2.6%	1	0.9%	0	0.0%
Subsequent Surgery	89	9.8%	33	8.2%	43	11.1%	11	10.4%	2	18.2%

Table 1. Demographic and surgical information for all included patients based on tendinopathy grade. BTB – Bone-patellar tendon-bone; QT – Quadriceps tendon; SD – Standard deviation; MM – medial meniscus; LM – Lateral meniscus; LET – Lateral extra-articular tenodesis.

	All Patients (n = 152)		Grade 1 (n = 69)		Grade 2 (n = 70)		Grade ¾ (n = 13)	
	n	%	n	%	n	%	n	%
Laterality								
Left	73	48.0%	33	47.8%	37	52.9%	3	23.1%
Right	79	52.0%	36	52.2%	33	47.1%	10	76.9%
Sex								
Male	83	54.6%	27	39.1%	48	68.6%	8	61.5%
Female	69	45.4%	42	60.9%	22	31.4%	5	38.5%
Revision Case	25	16.4%	11	15.9%	12	17.1%	2	15.4%
Mean Age (SD)	26.4 (7.0)		25.4 (6.4)		27.2 (7.4)		26.9 (7.4)	
Mean FU, years (SD)	6.5 (2.4)		6.1 (2.3)		6.8 (7.2)		7.2 (2.7)	
MM Repair	36	23.7%	15	21.7%	20	28.6%	1	7.7%
LM Repair	27	17.8%	13	18.8%	11	15.7%	3	23.1%
Medial Meniscectomy	11	7.2%	2	2.9%	8	11.4%	1	7.7%
Lateral Meniscectomy	48	31.6%	15	21.7%	30	42.9%	3	23.1%
LET	2	1.3%	1	1.4%	0	0.0%	1	7.7%
Re-tear	1	0.7%	1	1.4%	0	0.0%	0	0.0%
Re-operation	10	6.6%	3	4.3%	6	8.6%	1	7.7%

Table 2. Demographic and surgical information for included patients who completed patient-reported outcomes questionnaires based on tendinopathy grade. BTB – Bone-patellar tendon-bone; QT – Quadriceps tendon; SD – Standard deviation; FU – Follow-up; MM – medial meniscus; LM – Lateral meniscus; LET – Lateral extra-articular tenodesis.

	Grade 1 (n = 69)		Grade 2 (n = 70)			Grade ¾ (n = 13)			Significant covariates from backwards selection model
	mean	SD	mean	SD	P-value*	mean	SD	P-value*	
PROMIS PF	58.1	8.9	58.5	9.2	0.93	50.3	7.7	0.8	reoperation (p = 0.02)
PROMIS PI	45.1	7.1	45.4	7.3	0.87	43.1	6.6	0.5	reoperation (p = 0.02)
SANE	82.8	16.1	86.8	11.5	**0.03**	88.2	9.4	0.22	reoperation (p = 0.02)
IKDC	84.6	14.0	85.3	12.5	0.63	85.6	13.9	0.73	reoperation (p = 0.004)
KOOS Sx	84.9	13.2	86.7	11.1	0.37	84.3	13.0	0.7	reoperation (p = 0.002), revision (p = 0.002)
KOOS pain	92.9	8.0	92.4	7.7	0.96	91.4	6.6	0.84	reoperation (p = 0.007)
KOOS ADL	97.4	4.4	97.6	4.2	0.48	96.5	3.0	0.31	reoperation (p = 0.003), LM repair (p = 0.03)
KOOS Sports	82	17.2	80.7	18.1	0.81	83.8	15.4	0.66	reoperation (p < 0.001)
KOOS QoL	72.8	21.5	73.7	21.3	0.89	74.5	24.1	0.85	reoperation (p < 0.001), revision (p = 0.02)
KOOS total	79.4	20.9	78.8	24.6	0.92	56.9	10.1	0.25	None

Table 3. Mean and standard deviation (SD) of patient-reported outcomes for included patients by tendinopathy grade. Bolded values indicate statistically significant predictors ($p < 0.05$). *p-values are comparing Grade 2 vs Grade 1 and Grade 3 versus Grade 1 tendinopathy. PROMIS – Patient-reported outcomes measurement information system; PF – Physical function; PI – Pain interference; SANE – Single assessment numeric evaluation; IKDC – International knee documentation committee; KOOS – Knee injury and osteoarthritis outcome score; Sx – Symptoms; ADL – Activities of daily living; QoL – Quality of life; MM – Medial meniscus; LM – Lateral meniscus.