Short-term Patellofemoral Chondrosis Following Anterior Cruciate Ligament Reconstruction: Does Graft Type Matter?

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INTRODUCTION:

The exact etiology of patellofemoral chondrosis following anterior cruciate ligament reconstruction (ACLR) is unknown. It is posited that iatrogenic injury to the extensor mechanism during harvest of bone-patellar tendon-bone (BPTB) or quadriceps autograft may predispose patients to patellofemoral disease. The purpose of this study was to determine the association between ACLR graft type and the development of postoperative patellofemoral chondrosis. Our hypothesis is that extensor autograft-based ACL reconstruction predisposes patients to progression of patellofemoral chondrosis.

METHODS:

A consecutive series of primary ACLR between January 2018-December 2021 performed by seven fellowship trained sports medicine surgeons at a single large health care institution was retrospectively reviewed with a minimum follow-up of six months. Inclusion criteria was presence of a follow-up MRI after ACLR. Exclusion criteria were any multiligamentous knee surgery and age <14 years at surgery. Patients were grouped depending on the involvement of the extensor mechanism in the graft type: BPTB autograft and quadriceps tendon autograft (extensor group), or hamstring and allograft (non-extensor group). A validated scoring instrument – the Anterior Cruciate Ligament OsteoArthritis Score (ACLOAS) – was used to assess subchondral bone marrow lesions (BMLs; graded 0-3) and cartilage injury (graded 0-6) in the patellofemoral joint (PFJ) before and after surgery. Signal intensity of the BML was recorded as the ratio of the mean signal intensity of a bone bruise to the mean signal intensity of a normal metaphyseal area. The number of new cartilage lesions and increased lesions in the PFJ as graded by the ACLOAS were recorded and compared between groups. Statistical analyses included Chi square and Fisher's exact tests for categorical variables, and Mann-Whitney or unpaired t-tests for nonparametric and parametric data. Spearman's rank assessed correlations between postoperative PFJ cartilage scores and preoperative BML/cartilage scores. Regression analysis was identified risk factors for PFJ cartilage progression after ACLR. Statistical significance was defined as $p < 0.05$.

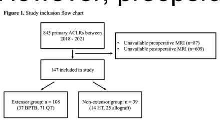
RESULTS:

Out of 843 primary ACLRs initially identified, 147 met inclusion and exclusion criteria (mean age 25 ± 10 years, 73 (50%) female) (**Table 1**). In the included 147 ACLRs, there were 37 BPTB autografts (25%), 71 quadriceps tendon autografts (48%), 14 hamstring tendon autografts (10%), and 25 allografts (17%). The mean follow-up length of postoperative MRI was 21 ± 16 months. The number of patients with worsening PFJ cartilage grade from pre- to post-op MRI did not differ significantly between the extensor group (n = 27, 25%), compared to the non-extensor group (n = 9, 23%); $p > 0.22$) (**Figure 2a**). Similarly, no significant difference in the mean progression of patellofemoral chondrosis was observed: extensor group (average 0.5 grade increase), non-extensor group (average 0.4 grade increase); $p > 0.62$ (**Table 2**). Similarly, in regards to subchondral bone marrow lesion progression, the number of patients with worsening PFJ BML grade from pre- to post-op MRI did not differ significantly between the extensor group (n = 30, 28%) and non-extensor group ((n = 21, 54%); $p > 0.51$) (**Figure 2b**). Also, no significant difference in the progression of BML development was observed: extensor group (0.4 grade increase), non-extensor group (0.1 grade increase; $p > 0.28$) (**Table 2**). Overall, graft type was not associated with increased odds of PFJ cartilage grade worsening from pre- to post-op ($p = 0.57$). Higher postoperative PFJ grade did correlate with higher preoperative BML ($p < 0.001$) and cartilage ($p = 0.01$) gradings in the PFJ (**Table 3**). The presence of preoperative PFJ BML is significantly associated with worsening PFJ cartilage grade at final follow-up (OR 4.0, 95% CI: 1.5–10.2; $p = 0.01$).

DISCUSSION AND CONCLUSION:

Postoperative PFJ degeneration was not found to vary based on graft type following primary ACL reconstruction. However, preoperative subchondral BMLs in the PFJ are associated with progression of chondral injury following surgery.

Figure 1. Study inclusion flow chart



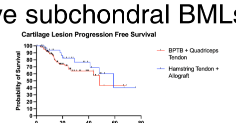


Figure 2a
Kaplan-Meier curve demonstrating cartilage lesion progression free survival of extensor (bone-patellar tendon-bone (BPTB) autograft and quadriceps tendon autograft) versus non-extensor (hamstring tendon autograft and allograft). No significant differences were found between the two groups (p>0.22).

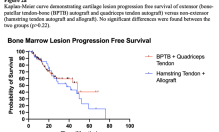


Figure 2b
Kaplan-Meier curve demonstrating bone marrow lesion progression free survival of extensor (bone-patellar tendon-bone (BPTB) autograft and quadriceps tendon autograft) versus non-extensor (hamstring tendon autograft and allograft). No significant differences were found between the two groups (p>0.51).

Table 1. Demographics of cohort meeting inclusions criteria

	BPTB autograft (n=37) + Quadriceps Tendon autograft (n=71)	Hamstring Tendon Autograft (n=14) + Allograft (n=25)	P value
Demographics			
Age at time of ACLR (years)	22.0 (14.6 – 49.3)	32.2 (15.4–66.0)	**<0.001**
Female sex, n (%)	46 (43)	27 (69)	**0.004**
Laterality left, n (%)	49 (45)	21 (56)	0.24
BMI	25.8 (18.3 – 44.1)	26.7 (18.0 – 41.2)	0.31
Mean follow-up (months)	18.9 (0.5 – 68.6)	26.2 (4.0 – 76.2)	0.06
Surgical timing			
Days from injury to ACLR, mean (IQR)	83 (22 – 52)	1256 (33 – 81)	**0.003**
ACLR within 6 weeks after injury, n (%)	36 (33)	23 (59)	**0.005**
Concomitant meniscus procedures, n (%)			
Any meniscus surgery[a]	72 (66)	23 (59)	0.39
Any meniscus repair	24 (22)	12 (31)	0.29
Lateral	17 (16)	7 (18)	0.75
Medial	7 (6)	6 (15)	0.09
Any meniscectomy	24 (22)	12 (31)	**0.28**
Lateral	17 (16)	7 (18)	0.75
Medial	7 (6)	6	**0.09**

[a] *Includes ramp lesion repair, root repair*

Table 2. BML and cartilage progression in the PFJ by graft type

	BPTB + Quadriceps Tendon		Hamstring Tendon + Allograft		
	Preoperative MRI	**Postoperative MRI**	**Preoperative MRI**	**Postoperative MRI**	**P value**
BML grade					
Grade 0	83 (76)	69 (64)	28 (72)	26 (67)	0.28
Grade 1	16 (15)	12 (11)	7 (18)	5 (13)	
Grade 2	6 (6)	16 (15)	0 (0)	5 (13)	
Grade 3	3 (3)	11 (10)	4 (10)	3 (8)	
Cartilage grade					
Grade 0	89 (82)	75 (70)	20 (51)	17 (44)	0.62
Grade 2.0/2.5 (Focal)	13 (12)	15 (14)	10 (26)	8 (20)	
Grade 3/4 (Superficial wide-spread)	6 (6)	10 (9)	8 (20)	11 (28)	
Grade 5/6 (Full thickness wide-spread)	0 (0)	8 (7)	1 (3)	3 (8)	

Table 3. Spearman's rank correlation between postoperative PFJ cartilage score and preoperative scores

	BPTB group (n=37)	
	Spearman's rho	**P value**
Preoperative score		
PFJ BML	0.53	**<0.01***
PFJ cartilage	0.43	**0.01***
BML signal intensity ratio	-0.15	0.17