Preoperative ACL Tear Severity Correlates with Functional Deficits After BEAR but Not BTB or Quad Autograft Reconstruction

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INTRODUCTION:

The extent of anterior cruciate ligament (ACL) injury evaluated on pre-operative MRI or described intraoperatively is presumed to influence functional recovery, yet data across different reconstruction techniques are scarce. The ACL Severity Score is a 12-item scoring method previously described to incorporate associated injuries (meniscus, cartilage, bone bruising, concomitant ligamentous injuries) in a severity scale to allow reproducible comparisons in ACL injured patients. The current study sought to quantify the association between preoperative ACL severity scores and early functional outcomes after (1) bridge-enhanced ACL repair (BEAR), (2) bone–patellar-tendon–bone (BTB) autograft, and (3) quadriceps-tendon autograft (Quad).

METHODS:

Retrospective review of all patients undergoing ACL repair or reconstruction from January 2022 to December 2024 by a single surgeon was conducted, with 136 total patients identified that had at least one instance of functional testing at 6 months post-op. Of 136 patients, there were 46 BEAR, 45 BTB, and 45 Quad ACL reconstructions (Table 1). A fellowship-trained orthopaedic surgeon assigned total MRI severity scores for each case. Functional testing and patient-reported outcomes at 6 and 9 months included: IKDC, ACL-RSI, KT-1000, isokinetic quadriceps/hamstrings strength (percent body-weight, injured limb), LESS, and hop-test limb-symmetry indices. Spearman's ρ was calculated for each graft type, time-point, and outcome, with $|\rho| < 0.30$ considered weak, 0.30–0.49 moderate, and ≥ 0.50 strong.

RESULTS:

Patients undergoing BEAR had a significantly lower median MRI severity score (2.0) compared to Quad (4.0) or BTB (4.0, p = 0.02). BEAR patients had a significantly older median age than BTB or Quad patients (p = 0.005). In the BEAR group, higher MRI severity score was strongly correlated with persistent strength deficits (isokinetic extension ρ = −0.50, flexion ρ = −0.45 at 6 months; extension ρ = −0.59, flexion ρ = −0.63 at 9 months; all p ≤ 0.01). Severity score was also associated with poorer landing mechanics at 9 months in the BEAR group (LESS ρ = 0.73, p < 0.001). Preoperative severity score for BEAR patients also had a moderate negative association with 6-month IKDC scores (ρ = −0.33, p = 0.04) (Table 2). In contrast, BTB and Quad grafts showed only weak, non-significant correlations ($|\rho| \le 0.34$) (Table 2). Severity was not associated with KT-1000 laxity in any graft.

DISCUSSION AND CONCLUSION:

Greater baseline ACL-tear severity predicts clinically meaningful strength deficits and worse landing mechanics at 6–9 months after BEAR, but has minimal influence on early function after BTB or Quad autograft reconstruction. Pre-operative MRI severity may help identify patients who may be good candidates for BEAR ACL. Further study is needed to assess functional outcomes at later timepoints, as well as effect on return to play.

Table 1. Baseline Characteristics of the Cohort by Graft Type

Variable	Overall (N = 136)[1]	BEAR (N = 46)[1]	BTB (N = 45)[1]	Quad (N = 45)[1]	p-value[2]
Severity Score	3.00 [2.00, 5.00]	2.00 [2.00, 4.00]	4.00 [2.00, 5.00]	4.00 [2.00, 5.00]	0.023*
Age at Surgery (years)	25 [18, 34]	30 [20, 40]	20 [18, 25]	28 [18, 32]	0.005*
Sex					0.14
Female	49 (36%)	19 (41%)	11 (24%)	19 (42%)	
Male	87 (64%)	27 (59%)	34 (76%)	26 (58%)	

[1]Median [Q1, Q3]; n (%)
[2]Kruskal-Wallis rank sum test; Pearson's Chi-squared test
*denotes statistical significance

Table 2: Correlation between ACL Severity and Functional Outcomes
Spearman ρ (rho) and p-values shown side-by-side for each graft

	N BEAR	N BTB	N Quad	BEAR ρ MRI	BTB ρ MRI	Quad ρ MRI	p BEAR	p BTB	p Quad
6m									
ACLRSI	39	25	25	−0.16	−0.27	0.16	0.32	0.19	0.44
IKDC	39	25	26	−0.33	−0.09	0.04	0.04	0.68	0.85
IsoExt60	38	25	27	−0.50	−0.29	−0.13	0.00	0.17	0.53
IsoFlex60	38	25	27	−0.45	−0.16	−0.21	0.00	0.46	0.30
KT1000	38	24	26	0.13	0.03	0.31	0.42	0.88	0.12
9m									
ACLRSI	23	21	21	−0.18	0.11	−0.04	0.42	0.64	0.88
IKDC	23	21	20	−0.28	0.16	−0.13	0.20	0.49	0.59
IsoExt60	23	22	21	−0.59	−0.34	−0.36	0.00	0.12	0.10
IsoFlex60	23	22	20	−0.63	−0.19	−0.02	0.00	0.39	0.94
KT1000	23	18	19	−0.07	−0.02	0.20	0.76	0.94	0.40
LESS	17	19	17	0.73	0.21	0.14	0.00	0.40	0.60

Spearman ρ
1.0
0.5
0.0
−0.5
−1.0