

# **Graft Choice in Primary ACL Reconstruction: Graft Failures, Patient-reported Measures and Functional Outcomes between Bone-Patellar-Tendon-Bone, Hamstring, and Quadriceps Tendon Autografts at Two-years Postoperative**

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## **INTRODUCTION:**

This study compares failure rates, quality of life, and functional outcomes at two-years postoperatively between patients undergoing anterior cruciate ligament reconstruction (ACLR) using a bone-patellar tendon-bone (BPTB), semi-tendinosis-gracilis (STG), or quadriceps tendon (QT) autograft.

**METHODS:** This was a prospective cohort study conducted at one centre with five fellowship trained knee surgeons. Eligible patients were consecutively enrolled and allocated to a graft group (BPTB, STG, QT) based on surgeon preference and expertise. All patients were >13 years old, skeletally mature and diagnosed with a complete unilateral ACL tear. Exclusion criteria included prior ACLR on either limb, partial tears not requiring reconstruction, concomitant ligament tear requiring surgical repair, severe chondromalacia, rheumatoid arthritis, Workers Compensation Board claim, or pregnancy at time of surgery. Primary outcomes were graft failure defined as  $\geq$  grade 2 pivot shift and/or >6mm side-to-side difference on KT 1000 testing. Revision surgeries were also documented. Secondary outcomes included patient-reported outcome measures (PROMs) including ACL QOL, SANE score, Marx Activity Rating Scale, Tegner Activity Score. Isokinetic strength testing was assessed using a dynamometer with concentric flexion and extension torques measured bilaterally. A Limb Symmetry Index (LSI) was calculated as a ratio (affected/unaffected) and expressed as a percentage. Descriptive statistics were used to summarize demographics. One-way ANOVA and chi-square tests were used to compare continuous and categorical variables respectively, with significance set at  $p < 0.05$

**RESULTS:** A total of 313 patients were enrolled (106 BPTB, 104 STG, 103 QT) with 271 (86%) completing 2-year follow-up (90 BPTB, 88 STG, 93 QT). Baseline demographics, PROMs and functional outcomes at baseline and two-years postoperative are summarized in Table 1. The QT group was statistically younger (mean age  $25.0 \pm 7.9$  years) than the BPTB ( $28.2 \pm 8.4$ ) and STG ( $29.3 \pm 9.0$ ) groups ( $p < 0.001$ ), and the proportion of males and females was approximately 50% for all groups ( $p = 0.922$ ). Graft failures in the BPTB, STG and QT groups were 12 (13.3%), 16 (18.2%), and 19 (20.4%), respectively ( $p = 0.434$ ). Five revisions were documented with details in Table 2. PROMs did not differ between groups at baseline or postoperatively. With respect to strength, the baseline LSIs for both knee flexion and extension were comparable across groups, however, at two-years postoperative, the QT group demonstrated superior flexion strength recovery (LSI: 101%), while BPTB and STG groups demonstrated better extension recovery (LSI: 86% and 87% vs. 77% for QT;  $p = 0.002$ ).

**DISCUSSION AND CONCLUSION:** At two-years postoperative, the QT group experienced a higher number of graft failures compared to the BPTB and STG groups. All revision surgeries, regardless of graft type, were performed in patients <24 years of age, further supporting the association between younger age and increased risk of graft failure. As the QT cohort was significantly younger, this may have contributed to the increased failure rate, independent of graft type. No significant differences were observed between groups in quality of life or activity level, however graft type was associated with different strength recovery profiles. QT grafts demonstrated superior flexion symmetry and BPTB/STG showed better extension symmetry at two-years postoperative. As a Level II prospective cohort study, potential confounding and surgeon bias may reduce internal validity compared to randomized trials; however the results demonstrate strong generalizability and accurately represent real-world clinical practice. Additional analyses are underway to further elucidate factors associated with graft outcomes, including a more detailed characterization of graft failure types such as re-rupture versus re-injury.

**Table 1. Demographics and outcomes for BPTB, STG and QT groups.**

	BPTB	STG	QT	p-value
Age (yrs)	28.2 (8.4)	29.3 (9.0)	25.0 (7.9)	<0.001*
Sex (M/F)	53/53	52/52	49/54	0.922
ACL QOL (%)				
• Baseline	35.6 (15.1)	34.1 (14.5)	37.0 (14.3)	0.358
• 2 years PO	79.7 (16.4)	75.7 (18.1)	78.4 (17.4)	0.435
SANE (%)				
• Baseline	48.5 (22.7)	47.7 (24.5)	51.7 (23.6)	0.454
• 2 years PO	87.6 (10.3)	83.8 (17.9)	85.9 (10.9)	0.210
Marx Activity (/16)				
• Baseline	5.1 (5.2)	6.0 (5.5)	4.4 (5.3)	0.103
• 2 years PO	7.3 (4.5)	7.3 (5.3)	7.4 (4.8)	0.976
Tegner Activity (/10)				
• Baseline	7.8 (1.6)	7.3 (1.9)	7.9 (1.5)	0.063
• 2 years PO	6.3 (1.8)	5.9 (1.9)	5.9 (1.9)	0.323
Flexion torque (% - affected/unaffected)				
• Baseline	82.6 (19.9)	81.7 (22.0)	82.0 (24.0)	0.963
• 2 years PO	94.0 (14.5)	89.0 (13.3)	101.4 (13.7)	<0.001*
Extension torque (% - affected/unaffected)				
• Baseline	70.6 (19.4)	71.4 (23.0)	71.2 (24.1)	0.097
• 2 years PO	86.3 (17.9)	87.4 (18.6)	77.6 (16.1)	0.002*

\* Significance level <0.05; Significant difference between groups based on 1-way ANOVA

**Table 2: Revision surgeries.**

Age	Sex	Beighton Score	BMI	Play Contact Sport?	Time to Failure	Mechanism of Re-Injury	Revision Surgery (timing and procedures)
18	M	0	22	No	18m	Soccer	@24m: two-stage revision - bone grafting, then BPTB and lateral meniscal repair
17	M	4	20.1	Yes	3m	Fall	@27m: revision BPTB + LET
17	M	0	22.6	Yes	20m	Basketball	@26m: revision with BPTB
14	M	3	18.3	No	7m	Fall	@40m: revision with BPTB + LET, lateral meniscal repair, and medial partial meniscectomy
23	F	0	21.1	No	10m	Grand mal seizure	@28m: revision with BPTB + LET

LET = lateral extraarticular tenodesis