

Beyond Failure Rates: A Systematic Review of Post-Revision ACL Reconstruction Outcomes in Pediatric and Adolescent Populations

Kristen N Reikersdorfer<sup>1</sup>, Christopher Jayne, Colleen McGauley, Serafina Faith Zotter, Mark Cote<sup>2</sup>, Nikolaos K Paschos<sup>1</sup>Harvard Medical School, <sup>2</sup>UConn Hlth Ctr

INTRODUCTION: Primary anterior cruciate ligament (ACL) injuries are extremely common injuries in the pediatric and adolescent populations. Surgical management is the treatment of choice for ACL injuries in children, with an increasing incidence of primary ACL reconstruction (ACLR). Unfortunately, the high activity level in these age groups often leads to subsequent reinjury and ACL graft failure. Therefore, there is an increasing number of young patients that undergo revision ACL reconstruction. While the number of revision ACLRs in the pediatric population is increasing, there remains limited data on the clinical outcomes of revision ACLR, with most studies reporting on relatively small samples of patients. The purpose of this systematic review is to evaluate the outcomes following revision ACL reconstruction in pediatric and adolescent patients, to identify graft failure rates and to describe functional outcomes post-operatively.

METHODS: This systematic review identified original studies reporting clinical outcomes for patients undergoing revision ACL reconstruction at age ≤19 years. Exclusion criteria included studies with patients ≥19 years at time of revision, non-English works, and manuscripts that failed to include both failure rates plus either functional data, patient-reported outcome measures, or return to sports rates. Characteristics such as patient demographics, injury mechanism, surgical technique, graft choice, and concomitant injuries present on diagnostic arthroscopy were collected from all included studies. The primary outcomes included graft failure rates, patient-reported outcome measures (PROM), rates of return to sport, and occurrence of contralateral ACL injury. This study was registered with the National Institute for Health Research’s PROSPERO database, and risk of bias was evaluated with the MINORS tool. Statistical heterogeneity was quantified with the I2 statistic and Gwet’s AC1 was calculated to assess inter-rater reliability for the MINORS scores.

RESULTS: Five studies with a total of 239 knees in 234 patients were included in this review. Revision ACLR failure rate ranged from 9% to 21%. Return to previous level of activity ranged from 27% to 68%. PROMs exhibited good Lysholm score (range 84.5 to 93.7), good Tegner activity score (range 5.5 to 9), and moderate IKDC scores (range 79.9 to 80.0). Allograft was used in 48% of revisions, followed by bone patellar tendon bone (BPTB) autograft in 34%, and hamstrings (HS) autograft in 14%. Meniscus injury and cartilage injury was present in 53.1% to 92.5% and 5.5% to 59.4% of knees, respectively. The average MINOR score was 6 and inter-study heterogeneity was low (I2=9%).

DISCUSSION AND CONCLUSION: Revision ACLR yields variable graft failure rates amongst pediatric and adolescent patients, ranging from 9 to 20%. While these rates of rupture are lower than those reported following primary ACLR in this population, revision patients experience decreased PROMs and lower rates of return to pre-injury level of sport compared to primary ACLR. Further, revision ACLR was associated with high rates of intraarticular damage and relatively low rates of meniscal repair at the time of second surgery. Thus, while revision ACLR should be considered as a surgical option with favorable outcomes and lasting graft fidelity, patients should be counseled appropriately regarding nuanced post-operative expectations for activity level, and return to sports.

Table 1: Study Characteristics									
Author	Publication Year	Level of Evidence	N	Patient Age at time of Primary ACLR Mean (SD)	Female Participants	Mechanism of Injury	Statistical Maturity	Follow-Up Mean (SD), months	Time from Reconstruction to Re-Injury Mean (SD), months
Rugg	2020	4	32	18	17 (53.1%)	Sports Related: 18 (56.3%)	32 (100%) at Revision	29.5 (22.2)	18.6
Christine	2020	4	68	16.6 (1.7)	44 (65.0%)	Sports Related: 58 (85.3%)	71.2% at Revision	18.8	15.4 (13.2)
Quillette	2019	4	57	17.0 (2.0)	27 (47.4%)	Non-Contact: 40 (70.2%) Contact: 10 (17.5%) Non-Contact: 16 (28.2%)	72.0% at Index 85.0% at Revision	53.0 (25.0)	13.9 (11.0)
Saper	2018	4	21	16.5 (1.6)	9 (42.9%)	Non-Contact: 20 (95.2%) Contact: 1 (4.8%)	-	46.4 (19.8)	13.1 (9.0)
Reinhardt	2012	4	36	16.9 (1.1)	22 (61.1%)	Non-Contact: 23 (63.9%) Contact: 7 (20.2%)	36 (100%) at Revision	36.0	17.3 (11.6)

Table 2: Outcome Measures													
Author	Year	Revision Failure Rate	Time to Graft Failure Mean (SD)	Revision ACLR Graft Type	Graft size Mean (SD), mm	Contralateral Injury	Meniscus Injury at Revision	Cartilage Damage at Revision	Lysholm Score Mean (SD)	IKDC Score Mean (SD)	Tegner Score Mean (SD)	RIS Rate	Same or Higher RIS
Rugg	2020	3/32 (9.4%)	22.4 months	Allograft 4 (12.5%) BPTB Autograft 18 (56.3%) HS Autograft 10 (31.2%) Composite: 12 (37.5%)	8.1	5/32 (15.6%)	1/32 (3.1%)	16/32 (50.0%)	-	-	-	-	-
Christine	2020	18/68 (26.5%)	21 (18.1) months	Allograft 15 (83.3%) BPTB Autograft 19 (27.1%) HS Autograft 1 (1.5%) HS Autograft 1 (1.5%)	8.5	18/68 (26.5%)	62/67 (92.7%)	15/62 (24.2%)	84.5 (SD 15.9-89.7)	79.9 (SD 63.0-89.7)	5.8 (SD 7.0-10.0)	29/42 (69.0%)	16/29 (55.2%)
Quillette	2019	10/48 (20.8%)	14.9 (13.0) months	BPTB Autograft 17 (35.4%) HS Autograft 1 (2.1%) Allograft 30 (62.5%)	9.4 (1.0)	1/48 (2.1%)	30/37 (81.1%)	-	86.1 (15.4)	-	5.5 (1.2)	-	13/41 (31.7%)
Saper	2018	3/21 (14.3%)	26.0 (14.0) months	BPTB Autograft 11 (52.4%) Composite BPTB 4 (19.0%) HS Autograft 5 (23.8%) Allograft 1 (4.8%)	9.9 (1.1)	0/21 (0.0%)	13/21 (61.9%)	11/21 (52.4%)	93.7 (8.4)	87.5 (12.7)	7.2 (2.0)	19/21 (90.5%)	13/21 (61.9%)
Reinhardt	2012	3/36 (8.3%)	-	BPTB Autograft 19 (44.4%) HS Autograft 1 (2.2%)	-	-	21/26 (80.8%)	2/26 (7.7%)	-	89.0 (5.0)	-	-	11/22 (50.0%)

1 Failure defined as complete or partial tear of revision graft