

## IN BRIEF

# Repeat Revision Anterior Cruciate Ligament Reconstruction Remains a Challenge for Orthopedic Surgeons

E. Carlos Rodriguez-Merchan, MD, PhD

Research performed at Department of Orthopedic Surgery, La Paz University Hospital, Madrid, Spain

Received: 11 December 2023

Accepted: 9 December 2024

## Abstract

The re-revision of anterior cruciate ligament reconstruction (ACLR) can be contemplated a secure and efficacious surgical technique with good results, whether it is performed in one-stage or two-stages or is performed with autograft or allograft. With regard to the surgical technique, there is no evidence that performing ACLR in one stage is superior to performing it in two stages. With respect to graft choice, allograft is the most chosen, and the allograft most frequently utilized is the Achilles tendon. However, the best graft to use for re-revision is not yet known. For revision ACLR orthopedic surgeons have to contemplate the amendment of an outrageous posterior tibial slope, especially after having failed two or more consecutive interventions. The potential benefit of combining ACLR with an anterolateral ligament reconstruction is to achieve greater rotational stability. It will diminish both the elevated failure percentages observed specifically in young individuals and increasing osteoarthritic changes encountered following sole ACLR.

**Level of evidence:** III

**Keywords:** Anterior cruciate ligament repeat revision, Complications, Rerupture, Results, Return to preinjury activity level

## Introduction

**D**isruption of the anterior cruciate ligament (ACL) is increasingly usual worldwide, and its surgical solution by means of an ACL reconstruction (ACLR) is the gold standard in current orthopedic literature. However, it is common for the first reconstruction to also rupture, necessitating a second or even third reconstruction.<sup>1-16</sup>

## Main body

Regarding the prevalence of the first graft rupture, Annear et al (2019) investigated 10-year graft failure rates in individuals experiencing ACLR with remnant preservation (RP, N=24), versus remnant debridement (RD, N=25). Two graft ruptures (10%) were found in the RP cohort and three (13.6%) in the RD cohort.<sup>1</sup>

Regarding ACLR in children, in 2023 Rangasamy et al reported that after a minimum follow-up of 2 years, the rate of graft rupture using quadriceps tendon (QT) autograft (3.5%) was substantially lower than the rupture rate using

hamstring tendon (HT) autograft (12.4%).<sup>2</sup> In the series of Honeywill et al (N=332) published in 2024, at 7-year follow-up ACL graft rupture occurred in eleven (4%) women who experienced ACLR with HT autografts.<sup>3</sup>

The study of Pettinari et al (2024) compared isolated ACLR versus ACLR + LEAP (lateral extra-articular procedures). Two cohorts of 551 individuals each were analyzed, and the follow-up was 8 years on average. The age was 37 years on average. The LEAP cohort included 503 (91.3%) individuals who underwent anterolateral ligament (ALL) reconstruction and 48 (8.7%) individuals who underwent a Lemaire technique. Graft failure was detected in nineteen (1.7%) individuals: fifteen (2.7%) in the no-LEAP cohort and four (0.7%) in the LEAP cohort.<sup>4</sup>

Concerning the need of a second or third ACLR, it is not true for all individuals. In the study of Geffroy et al (2018), which analyzed children and adolescents under 18 years of age, re-tears occurred in 9% of individuals, after 1 year.<sup>5</sup> The study of Ebert et al (2022) analyzed 155 individuals experiencing

**Corresponding Author:** E. Carlos Rodriguez-Merchan, Department of Orthopedic Surgery, La Paz University Hospital-IdiPaz, Madrid, Spain

**Email:** ecrmerchan@hotmail.com



THE ONLINE VERSION OF THIS ARTICLE  
ABJS.MUMS.AC.IR



selective posterolateral bundle (PLB) reconstruction (N=28) or anteromedial bundle (AMB) reconstruction (N=17). At 2-year follow-up, two out of 55 (3.6%) re-tears were found, one in the AMB cohort and one in the PLB cohort.<sup>6</sup> in elite athletes Homan et al recommended bone-tendon-bone (BTB) autograft.<sup>7</sup>

Regarding the posterior tibial slope (PTS), in a systematic review published in 2022 by Liu et al it was concluded that after ACLR, an elevated PTS was related to a higher risk of ACL graft failure.<sup>8</sup> ACLR repeat revision remains a challenge for the orthopedic surgeon in many respects. Such as what type of graft should be used, whether or not an extra-articular procedure should be associated, what technique should be used, and logically what are the results and expectations that the patient should have when facing this type of surgery.<sup>9-17</sup>

The purpose of this paper is to review the current role of repeat revision ACLR. For this purpose, on December 8, 2024, a literature search was carried out in PubMed using "repeat revision ACL reconstruction." as keywords. Forty-four articles were found, of which only 17 were finally analyzed because they were strictly related to the title of this article.

In 2022 Fradin et al found that both second revision ACLR and nonsurgical treatment of failed first revision ACLR were related to elevated percentages of return to sport. However, second revision ACLR yielded better functional results than nonsurgical management. That is, it seemed clear that repeat surgery is a better option than nonsurgical treatment of the

problem.<sup>14</sup> In fact, other authors have opted for surgical treatment of this problem.<sup>9-13, 17</sup> I have considered it interesting to evaluate these results based on three fundamental parameters: percentages of return to preinjury activity level, ruptures and complications.

**Return to preinjury activity level**

The systematic review published in 2022 by D'Ambrosi et al showed that 10.5% of individuals return to their level of activity prior to ACLR.<sup>17</sup> Regarding published case series, in Wegrzyn et al this figure was 20%,<sup>9</sup> 27% in Griffith et al,<sup>10</sup> and 44% in Gorodischer.<sup>13</sup>

**Re-ruptures**

The systematic review published in 2022 by D'Ambrosi et al showed a 6.4% rate of re-ruptures after ACLR repeat revision.<sup>17</sup> Regarding published case series, in Griffith et al this figure was 13%,<sup>10</sup> and 21% in Engler et al.<sup>12</sup>

**Complications**

The systematic review published in 2022 by D'Ambrosi et al showed 1.4% complications after ACLR repeat revision, all of them minor: two (0.7%) superficial infections, one (0.3%) cyclops lesion and one (0.3%) flexion loss.<sup>17</sup>

[Table 1] shows the most important data from the case series published on repeat revision ACLR.<sup>9-14</sup> [Table 2] and [Figure 1] show the most relevant information from the recently published systematic review on repeat revision ACLR.<sup>17</sup>

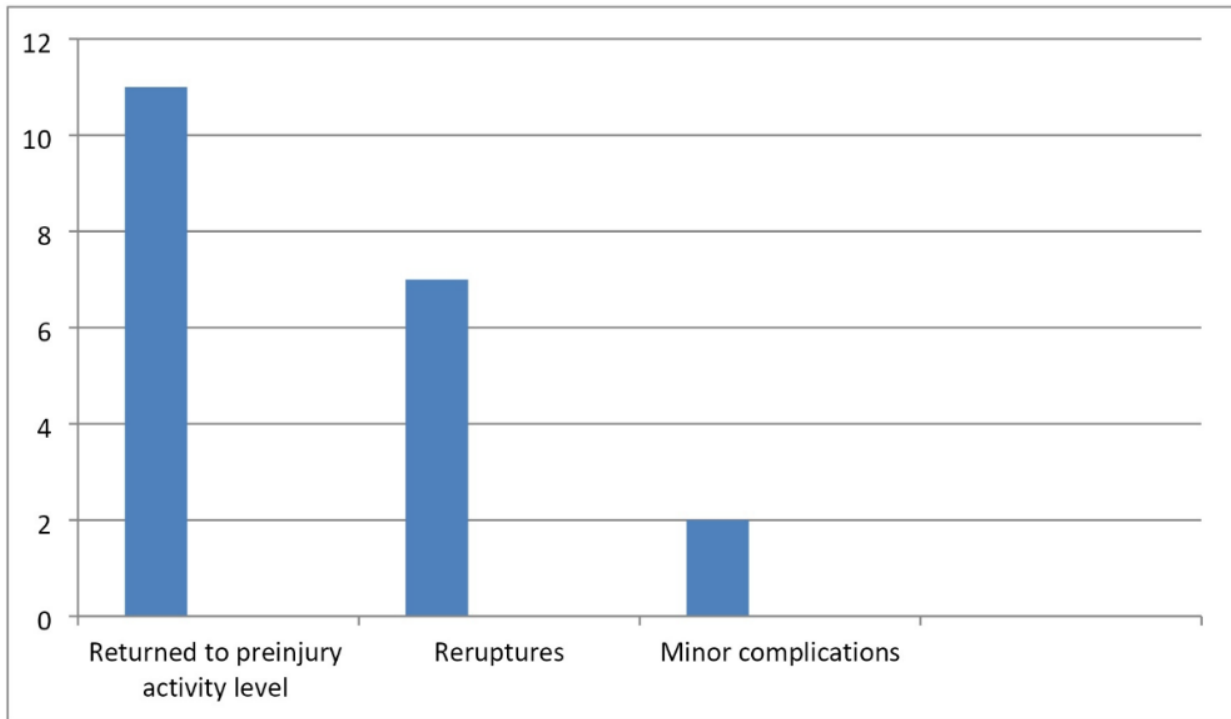


Figure 1. Percentage of patients who returned to preinjury activity level (about 11%), who suffered re-rupture (around 7%) and had minor complications (about 2%) according to the systematic review published by D'Ambrosi et al.<sup>17</sup>

**Table 1. Case series on repeat revision anterior cruciate ligament reconstruction (ACLR)**

AUTHORS [REFERENCE]	YEAR	N / MEAN AGE	MEAN FOLLOW-UP	SOURCE OF GRAFT AND RESULTS	CONCLUSION
Wegrzyn et al <sup>9</sup>	2009	10 / 30 years	3.2 years	Source of graft not mentioned.  Postoperatively, only 2 individuals recovered to the same sports activity level they had before their first ACLR. Four had a lower level, and 4 discontinued sports activity.	Result of repeat ACLR was excellent or good in 70% of the cases, although diminished after the second revision, in relation to the occurrence of meniscal tears and articular cartilage lesions. Meniscal and articular cartilage lesions were more common and more severe with recurrent laxity. The cause of failures was mainly recurrent trauma, followed by surgical technical errors.
Griffith et al <sup>10</sup>	2013	15 / 27 years	5 years	Source of graft not mentioned.  Mean Lysholm score was 60 preoperatively and increased to 82 postoperatively. Mean preoperative IKDC score was 59, which increased to 80 postoperatively. Mean preoperative Tegner score was 6. Mean postoperative Tegner score was 4.5, with only 4 of 15 (27%) individuals having returned to their prior activity level. Two individuals (13%) sustained a traumatic rerupture. Presence of grade 3 or 4 chondral lesions and body mass index greater than 28 at the time of repeat revision were associated with a "fair" or "poor" result by Lysholm score and IDKC subjective scoring.	Repeat revision ACLR may improve the functional results of individuals who have failed revision ACLR. Most individuals did not return to prior activity level following repeat revision. Presence of grade 3 or 4 chondral lesions and body mass index greater than 28 were associated with worse results.
Sonnery-Cottet et al <sup>11</sup>	2014	5 / NA	2.6 years	Source of graft not mentioned.  The mean differential anterior laxity was 10.4 mm, and this significantly diminished to 2.8 mm at the last follow-up. Using the Kellgren-Lawrence classification to assess the presence of osteoarthritis, 1 individual was grade 1, 3 individuals were grade 2, and 1 individual was grade 3.	Combined ACL re-revision with proximal tibial anterior closing wedge osteotomy restored knee stability and function with satisfactory clinical results in individuals who experienced recurrent ACL ruptures with an associated increased PTS.
Engler et al <sup>12</sup>	2020	14 / NA	3.5 years	In each individual, the residual failed graft was debrided. Removal of femoral and tibial hardware from the primary ACLR was carried out if it impeded proper tunnel placement. If the previous graft tunnel coincided with the planned graft tunnel, single-staged grafting was utilized on the tibial and/or femoral tunnels to fill the bony defect with either a Milagro biocomposite screw or allograft bone graft. The planned tunnels were then drilled through these grafts. Two-stage reconstruction was not undertaken for any individuals by the surgeon over this time period. The optimal graft for the patient was chosen after shared decision making with the patient, taking into consideration prior grafts utilized, available autografts, and patient age and activity level. Fixation of the revision ACL graft was secured with Guardsmen interference screws or Milagro screws.  Twelve individuals experienced secondary revision procedures, and 2 experienced tertiary revisions. Three individuals (21%) had subsequent failure of the revision graft with mean time to failure of 2.3 years. PTS was significantly higher in the failures than in the nonfailures. Eleven individuals completed outcomes measures at a mean of 3.5 years postoperatively. The mean Tegner activity score was 6.3 at follow-up, compared with 8.3 prior to the original ACL injury. The mean IKDC-SKF score was 70 at follow-up.	Multiple revision ACL reconstruction surgery seemed to have reasonable functional results but was associated with a relatively high failure rate. Activity level following repeat revision surgery was diminished compared to the preinjury state, but most individuals were able to return to recreational sports.
Gorodischer et al <sup>13</sup>	2022	9 / 32 years	NA (minimum 2 years)	Source of graft not mentioned.  One individual was considered a failure at 16 months postoperative. Only 44% (four out of nine) individuals were able to return to their sports. None of these individuals had a cartilage injury, while three out of five individuals who did not return to their sports had International Cartilage Regeneration & Joint Preservation Society grade III or IV cartilage injury.	Individual should be counseled on the challenging results of repeat revision ACLR.

Table 1. Continued

Fradin et al <sup>14</sup>	2022	41 / NA	8.7 years	Source of graft not mentioned.  Both second revision ACLR and nonsurgical management of failed first revision ACLR were associated with high rates of return to sport. However, second revision ACLR was associated with significantly better functional outcome scores with respect to Tegner, Lysholm, KOOS Quality of Life, and KOOS Sport and Recreation scores compared to nonsurgical management.	This study showed that a second revision ACLR (N=31) gave better functional results than nonsurgical treatment (N=10). Nonsurgical treatment was the only significant predictor of failure to achieve a good/excellent Lysholm score at the final follow-up, and this was likely a function of inferior knee stability in that group.
----------------------------	------	---------	-----------	---	---

N, number of patients; NA, not available; ACL, anterior cruciate ligament; PTS, posterior tibial slope; IKDC, International Knee Documentation Committee; IKDC-SKF, International Knee Documentation Committee Subjective Knee Evaluation Form; KOOS, Knee injury and Osteoarthritis Outcome Score

Table 2. Systematic review on repeat revision anterior cruciate ligament reconstruction (ACLR)

AUTHORS [REFERENCE]	YEAR	N / MEAN AGE	MEAN FOLLOW-UP	SOURCE OF GRAFT AND RESULTS	CONCLUSION
D'Ambrosi et al <sup>17</sup>	2022	295 / 30 years	5.6 years	Allograft in 139 (47.1%) cases [72 (24.4%) not specified, 18 (6.1%) Achilles tendon, 15 (5.1%) tibialis posterior, 9 (3.1%) tibialis anterior, 1 (0.3%) QT and 24 (8.1%) PT]; in 111 (37.6%) cases, it was an autologous homolateral graft [92 (31.2%) not specified, 16 (5.4%) PT, 2 (0.7%) HT and 1 (0.3%) QT]; in 38 (12.9%) cases, an autologous contralateral graft [31 (10.5%) HT and 7 (2.4%) PT], while in 7 (2.4%) cases, it was a mixed graft.  In 47 (15.9%) patients an extra-articular plasty was performed for the anterolateral ligament (ALL). In all studies that reported pre- and post-operative IKDC (subjective and objective) and Lysholm score, there was a significant improvement compared to the preoperative value. At the final follow-up, laxity measured with KT-1000 was found to be 2.2 mm. Thirty-one (10.5%) out of 295 individuals returned to their preinjury activity level. A total of 19 (6.4%) re-ruptures were found, while only 4 (1.4%) adverse events (all minors) were reported, out of which 2 (0.7%) were superficial infections, 1 (0.3%) cyclops lesion and 1 (0.3%) flexion loss.	Multiple revisions of ACLR allowed acceptable clinical outcomes and a good grade of knee stability with a low rate of subsequent new reruptures but the possibility of regaining preinjury sports activity was poor; whenever feasible, it is preferred to revise the ligament in one stage. This surgery remains a challenge for orthopedic surgeons and many doubts persist regarding the ideal grafts, additional extraarticular procedures and techniques to utilize.

N, number of patients; PT = patellar tendon; QT = quadriceps tendon; HT = hamstring tendon; IKDC, International Knee Documentation Committee

## Conclusion

Following a re-revision ACLR knee function improves. However, the procedure is associated with low percentage of return to preinjury sports level activity. Although the re-revision ACLR gives satisfactory results, the likelihood of returning to sports activity is lower than after revision ACLR. With regard to the surgical technique, there is no evidence that performing ACLR in one stage is superior to performing it in two stages. With respect to graft choice, allograft is the most chosen, and the allograft most frequently utilized is the Achilles tendon.

However, the best graft to use for re-revision is not yet known. For revision ACLR orthopedic surgeons have to contemplate the amendment of an outrageous PTS, especially after having failed two or more consecutive interventions. The potential benefit of combining ACLR with an ALL reconstruction is to achieve greater rotational stability. It will diminish both the elevated failure percentages observed specifically in young individuals and increasing osteoarthritic changes encountered following

sole ACLR.

## Acknowledgement

N/A

**Authors Contribution:** All steps were done by the only author.

**Declaration of Conflict of Interest:** The author does NOT have any potential conflicts of interest for this manuscript.

**Declaration of Funding:** The author received NO financial support for the preparation, research, authorship, and publication of this manuscript.

**Declaration of Ethical Approval for Study:** N/A

**Declaration of Informed Consent:** N/A

E. Carlos Rodriguez-Merchan, MD, PhD<sup>1</sup>

<sup>1</sup> Department of Orthopedic Surgery, La Paz University Hospital-IdiPaz, Madrid, Spain

## References

1. Annear PT, Rohr EJ, Hille DM, Gohil S, Ebert JR. No clinical difference in 10-year outcomes between standard and minimal graft debridement techniques in patients undergoing anterior cruciate ligament reconstruction using autologous hamstrings: a randomized controlled trial. *Knee Surg Sports Traumatol Arthrosc.* 2019; 27(2):516-523. doi: 10.1007/s00167-018-5146-5.
2. Rangasamy K, Baburaj V, Gopinathan NR, Dhillon MS, Parikh SN. Quadriceps tendon autograft is promising with lower graft rupture rates and better functional Lysholm scores than hamstring tendon autograft in pediatric ACL reconstruction. A systematic review and meta-analysis. *J Orthop.* 2023; 49:156-166. doi: 10.1016/j.jor.2023.12.014.
3. Honeywill C, Salmon L, Pinczewski L, Sundaraj K, Roe J. Comparison of contralateral ACL rupture versus ACL graft rupture in Australian netballers after ACL reconstruction. *Orthop J Sports Med.* 2024; 12(5):23259671241247488. doi: 10.1177/23259671241247488.
4. Pettinari F, Carrozzo A, Saithna A, et al. Effect of lateral extra-articular procedures combined with ACL reconstruction on the rate of graft rupture in patients aged older than 30 years: a matched-pair analysis of 1102 patients from the SANTI study group. *Am J Sports Med.* 2024; 52(7):1765-1772. doi: 10.1177/03635465241247760.
5. Geffroy L, Lefevre N, Thevenin-Lemoine C, et al. French Arthroscopy Society. Return to sport and re-tears after anterior cruciate ligament reconstruction in children and adolescents. *Orthop Traumatol Surg Res.* 2018; 104(8S):S183-S188. doi: 10.1016/j.otsr.2018.09.006.
6. Ebert JR, Edwards P, Annear PT. Selective bundle reconstruction for symptomatic partial anterior cruciate ligament tears demonstrates good functional scores, high return to sport rates and a low re-tear rate. *Knee.* 2022; 36:53-64. doi: 10.1016/j.knee.2022.04.007.
7. Homan MD, Braaten JA, Banovetz MT, Monson JK, Kennedy NI, LaPrade RF. Principles for optimizing anterior cruciate ligament reconstruction outcomes in elite athletes: a review of current techniques. *Ann Jt.* 2024; 9:19. doi: 10.21037/aoj-22-40.
8. Liu Z, Jiang J, Yi Q, et al. An increased posterior tibial slope is associated with a higher risk of graft failure following ACL reconstruction: a systematic review. *Knee Surg Sports Traumatol Arthrosc.* 2022; 30(7):2377-2387. doi: 10.1007/s00167-022-06888-6.
9. Wegrzyn J, Chouteau J, Philippot R, Fessy MH, Moyon B. Repeat revision of anterior cruciate ligament reconstruction: a retrospective review of management and outcome of 10 patients with an average 3-year follow-up. *Am J Sports Med.* 2009; 37(4):776-85. doi: 10.1177/0363546508330141.
10. Griffith TB, Allen BJ, Levy BA, Stuart MJ, Dahm DL. Outcomes of repeat revision anterior cruciate ligament reconstruction. *Am J Sports Med.* 2013; 41(6):1296-301. doi: 10.1177/0363546513482568.
11. Sonnery-Cottet B, Mogos S, Thauan M, et al. Proximal tibial anterior closing wedge osteotomy in repeat revision of anterior cruciate ligament reconstruction. *Am J Sports Med.* 2014; 42(8):1873-1880. doi: 10.1177/0363546514534938.
12. Engler ID, Salzler MJ, Wall AJ, et al. Patient-reported outcomes after multiple-revision ACL reconstruction: good but not great. *Arthrosc Sports Med Rehabil.* 2020; 2(5):e539-e546. doi: 10.1016/j.asmr.2020.06.013.
13. Gorodischer TD, Zicaro JP, Yacuzzi C, Costa Paz M. Good short-term clinical outcomes and low rates of return to sports after repeat revision ACL reconstruction. *J Knee Surg.* 2022; 35(12):1312-1319. doi: 10.1055/s-0041-1723765.
14. Fradin T, Saithna A, Haidar IM, et al. Management of the failed first revision ACL reconstruction: clinical outcomes of nonsurgical management versus second revision ACL reconstruction from the SANTI group. *Am J Sports Med.* 2022; 50(12):3236-3243. doi: 10.1177/03635465221119202.
15. Roethke LC, Braaten JA, Rodriguez AN, LaPrade RF. Revision anterior cruciate ligament reconstruction (ACLR): causes and how to minimize primary ACLR failure. *Arch Bone Jt Surg.* 2023; 11(2):80-93. doi: 10.22038/ABJS.2022.60187.2970.
16. Bitar AC, Abreu G, Scalize ARH, Garofo G, D'Elia C, Castropil W. Double and single bundle in athletes: a comparison in medium and long-term rates to return to sport and re-injury. *Arch Bone Jt Surg.* 2024; 12(1):19-25. doi: 10.22038/ABJS.2023.66143.3168.
17. D'Ambrosi R, Meena A, Raj A, et al. multiple revision anterior cruciate ligament reconstruction: not the best but still good. *Knee Surg Sports Traumatol Arthrosc.* 2023; 31(2):559-571. doi: 10.1007/s00167-022-07197-8.