







# Return to Sports after ACL Reconstruction with Resection or Remnant-Preserving Technique\*

## *Retorno ao esporte após reconstrução do LCA com ressecção ou preservação do remanescente*

Ruben Marcelo Maldonado Diaz<sup>1</sup> Fernando Cury Rezende<sup>1,2</sup> Antonio Carlos Moscon<sup>1</sup>  
 Carlos Eduardo da Silveira Franciozi<sup>2</sup> Ana Luiza Cabrera Martimbiano<sup>1,3</sup> Aires Duarte Junior<sup>1,4</sup>

<sup>1</sup>Knee Group from Ortoctcity, SP, Brazil

<sup>2</sup>Orthopedics and Traumatology Department, Universidade Federal de São Paulo, São Paulo, SP, Brazil

<sup>3</sup>Health and Environment Postgraduate Program, Universidade Metropolitana de Santos, Santos, SP, Brazil

<sup>4</sup>Orthopedics and Traumatology Department, Santa Casa de Misericórdia de São Paulo, São Paulo, SP, Brazil

Address for correspondence Dra. Ana Luiza Cabrera Martimbiano, Rua Brigadeiro Gavião Peixoto, 526, Lapa, São Paulo, SP, 05078-000, Brazil (e-mail: analuizacabrera@hotmail.com).

Rev Bras Ortop 2020;55(4):432–437.

### Abstract

**Objectives** To analyze the results of anterior cruciate ligament (ACL) reconstruction with remnant-preserving versus remnant-resecting technique, concerning the return to pre-lesion activity level.

**Methods** The present retrospective cohort study has assessed adults > 18 years old who underwent ACL anatomical reconstruction between 2010 and 2014. The main outcomes assessed were: level of physical activity (4-point scale), sports participation rate, ACL rerupture defined as documented lesion requiring revision surgery and the numeric pain scale rate (NPSR).

**Results** A total of 83 individuals were included in the study, with a mean age of 31.8 years old and follow-up mean time of 4.2 years after the surgery. A total of 34 patients underwent ACL reconstruction with remnant-preserving technique, and 49 without remnant preservation. No statistically significant difference was found between groups in all outcomes assessed: level of physical activity before the lesion and after the surgery, ACL rerupture rates and postoperative pain level. Subgroup analysis has shown a statistically significant decrease in the activity level in both groups. The most practiced sport was football; 72% of patients in the remnant group have resumed football activity versus 52.6% of the control group.

**Conclusion** Based in these findings, the comparison between ACL reconstruction with remnant preserving technique and remnant resecting technique has shown no differences concerning the return to prelesion activity level.

### Keywords

- ▶ anterior cruciate ligament
- ▶ rupture
- ▶ anterior cruciate ligament reconstruction
- ▶ return to sport

\* Work developed by the Knee Group from Ortoctcity, São Paulo, SP, Brazil, and the Knee Group, Orthopedics and Traumatology Department, Universidade Federal de São Paulo, São Paulo (UNIFESP/EPM), SP, Brazil.

## Resumo

**Objetivo** Analisar os resultados da reconstrução do ligamento cruzado anterior (LCA) com preservação do remanescente, comparada à técnica convencional, no retorno do paciente ao nível de atividade física pré-lesão.

**Métodos** Estudo transversal retrospectivo, que avaliou indivíduos adultos submetidos à reconstrução anatômica do LCA no período de 2010 a 2014. Os desfechos analisados foram: nível de atividade física, taxa retorno ao esporte, relesão do LCA definida como lesão documentada que necessite de nova reconstrução ligamentar, e dor pela escala numérica de dor (EVN).

**Resultados** Foram incluídos 83 indivíduos com média de 31,8 anos de idade e seguimento médio de 4,2 anos após a cirurgia, 34 submetidos à reconstrução do LCA com preservação do remanescente, e 49 à convencional. Não houve diferença estatisticamente significativa entre os grupos na frequência de atividade física pré-lesão e pós-operatória, na taxa de relesão do LCA reconstruído e na intensidade da dor no pós-operatório. Na análise intragrupos, houve uma queda estatisticamente significativa na frequência da prática de atividade física pós-operatória para ambos os grupos em comparação ao nível pré-lesão. O tipo de esporte mais praticado foi o futebol, onde 72% pacientes do grupo remanescente retornaram ao esporte comparado a 52,6% do grupo controle; porém, essa diferença não foi estatisticamente significativa.

**Conclusão** Não foi possível observar diferenças entre os pacientes submetidos às técnicas cirúrgicas de reconstrução LCA com e sem a preservação do remanescente em relação ao retorno ao esporte, frequência de atividade física e intensidade da dor. Estudos futuros prospectivos são necessários.

## Palavras-chave

- ▶ lesões do ligamento cruzado anterior
- ▶ ruptura
- ▶ reconstrução do ligamento cruzado anterior
- ▶ retorno ao esporte

## Introduction

Anterior cruciate ligament (ACL) reconstruction aims to restore knee joint stability, to recover functional and sportive capacity to prelesion levels and to prevent meniscal injuries and secondary osteoarthritis.<sup>1</sup> However, knee function restoration depends not only on the surgical technique, but also on anatomical and biomechanical factors and the interaction of the nervous and musculoskeletal systems.<sup>1,2</sup>

In addition to its mechanical functions, the ACL acts as a proprioceptive sensitive organ due to the presence of mechanoreceptors around its fibers, which maintain knee joint stability by stimulating coordinated muscle contractions.<sup>2,3</sup> Histological studies revealed the existence of residual mechanoreceptors in the remnant tissue of the injured ligament, in addition to the high healing potential due to the vascular support provided by the intact synovial sheath. As such, it is believed that the preservation of ACL remnant fibers may help the biological process of graft healing and accelerate the synovial covering of the reconstructed ligament.<sup>1,3-8</sup>

Tie et al.<sup>1</sup> published a systematic review in 2016 comparing the remnant-preserving with the conventional technique. There was no difference between groups regarding joint stability, but the authors demonstrated a lower percentage of tibial tunnel increase when the remnant was spared. Despite satisfactory clinical outcomes in recent studies,<sup>1,6,9,10</sup> the literature is not clear on if the preservation or resection of

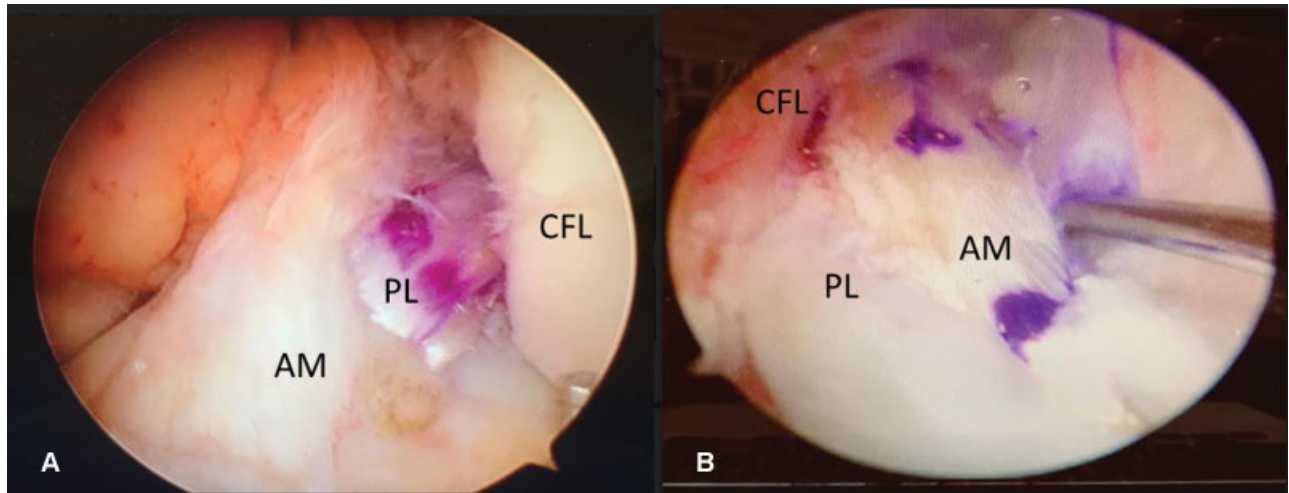
this tissue may influence the risk of knee functional complications and the return to sportive activities. Therefore, the present study aimed to compare the results from ACL reconstruction with the remnant-preserving technique with the conventional technique regarding return to physical activities, lesion recurrence and pain.

## Materials and Methods

This is a retrospective transversal study, approved by the Ethics and Research Committee under the number CEP/UNIFESP n: 1107/2016.

The study included 83 adult patients > 18 years old in a consecutive series from 2010 to 2014. The mean follow-up time was 4.2 years (ranging from 2 to 7 years). A total of 34 patients were submitted to ACL reconstruction with remnant preservation, and 49 patients were submitted to the conventional reconstruction. Subjects with a history of previous knee or other joint surgery, total thickness chondral lesion grades 3 or 4 according to the International Cartilage Repair Society (ICRS), meniscectomy over two-thirds of the meniscus, concurrent lesion in other knee ligaments (except for medial collateral ligament [MCL], grade 1) and/or contralateral leg surgery or injury were excluded.

The ACL reconstruction with remnant-preserving technique was performed for partial ACL lesions through selective reconstruction with a single band (single bundle augmentation [SBA]), which consists in preserving the distal



**Fig. 1** (A) Selective anterior cruciate ligament posterolateral (PL) band reconstruction. (B) Selective anterior cruciate ligament anteromedial (AM) band reconstruction. CFL: lateral femoral condyle.

and proximal attachments of the remnant stump, and positioning the graft at the anatomical site (footprint) of the ruptured band (►Figure 1A and 1B).<sup>7,8</sup> The ACL reconstruction technique with no remnant preservation was performed through meticulous cleaning of the intercondylar area, removing all ACL remnant tissue.

The data of the patients were collected from medical records and surgical description; additional and follow-up data were obtained from personal or phone contact by two authors of the study, using an interview script and a standardized filling form. Analyzed outcomes included: physical activity level (4-point scale: [1] professional athlete, [2] amateur athlete [ $> 3$ /week], [3] recreational athlete [1–2/week], [4] sedentary), sports return rate, ACL rerupture defined as documented lesion requiring revision surgery and numeric pain scale rate (NPSR; ranging from 0 to 10 points).

All statistical analyses were performed using the commercially available STATA software<sup>11</sup> (STATA, version 13; StataCorp LP, College Station, TX, USA). Alpha level (type I error) was defined as 0.05. Normality was assumed based on histograms inspection and the Shapiro-Wilk test. Mean and standard deviation (SD) were calculated for continuous variables (95% confidence interval [CI]); dichotomic and categorical data were

shown in frequency (percentage) (95%CI). The chi-squared test was used to compare sample variables and the nonpaired t-test compared continuous variables of normal distribution between groups. The nonparametric Mann-Whitney test compared continuous variables of non-normal distribution. All tests considered a 95% CI.

## Results

In total, 71 patients (85.5%) were male, with a mean age of 31.8 ( $\pm 8.3$ ) years old. The right side was the most affected (65%). There were no statistically significant differences in the demographics of the patients. Regarding time to return to sports, difference at physical activity level at the prelesion and postoperative period, reconstructed ACL relesion rate and postoperative NPSR, there were no statistically significant differences between groups (►Table 1).

There were no statistically significant differences between groups when the prelesion and postoperative physical activity levels were compared (►Table 2). However, there was a statistically significant difference at the intergroup analysis of prelesion and postoperative physical activity levels for both groups, demonstrating a reduced level of physical activity at the postoperative period (►Table 3).

**Table 1** Sample distribution according to the characteristics of the patients

	Conventional Group (n = 49)	Remnant Group (n = 34)	p-value
Age (years old) (mean $\pm$ standard deviation)	32.3 ( $\pm 9.0$ )	31.2 ( $\pm 7.52$ )	0.88
Side	34 right/15 left	20 right/14 left	0.18
Time to return to physical activities (months; mean $\pm$ standard deviation)	8.3 ( $\pm 3.6$ )	10 ( $\pm 5.0$ )	0.19
Difference in physical activity level (Prelesion and postoperative; mean $\pm$ standard deviation)	-0.44 ( $\pm 0.9$ )	-0.46 ( $\pm 0.9$ )	0.74
Rerupture of neo ACL	1	3	0.15
Postoperative numeric pain scale rate (mean $\pm$ standard deviation)	1.6 ( $\pm 2.1$ )	1.2 ( $\pm 2.5$ )	0.78

Abbreviation: ACL, anterior cruciate ligament.

**Table 2** Comparison of prelesion and postoperative physical activity frequency

Physical activity frequency	Conventional Group (n = 49)	Remnant Group (n = 34)	p-value
Pre-lesion (n):			0.24
(1) professional athlete	1	1	
(2) amateur athlete (> 3/week)	24	12	
(3) recreational athlete (1-2 /week)	19	20	
(4) sedentary	5	1	
Postoperative (n):			0.37
(1) professional athlete	0	1	
(2) amateur athlete (>3 /week)	14	6	
(3) recreational athlete (1- 2/week)	19	17	
(4) sedentary	16	10	

**Table 3** Intragroup analysis of prelesion and postoperative physical activity frequency

Physical activity frequency	Conventional Group (N = 49)	Remnant Group (N = 34)
Prelesion (mean ± standard deviation)	2.5 (±0.7)	2.6 (±0.6)
Postoperative (mean ± standard deviation)	3.0 (±0.7)	3.0 (±0.7)
p-value	< 0.01*	< 0.01*

Most athletes played football. From the 44 patients who played football before surgery, 25 (56.8%) belonged to the remnant-preserving group, and 19 (43.2%) were from the control group. After surgery, with a mean follow-up time of 4.2 years, 18 (72%) patients from the remnant group resumed playing football, compared with 10 (52.6%) from the control group. However, there was no statistically significant difference when both groups were compared ( $p = 0.97$ ).

## Discussion

Anterior cruciate ligament reconstruction with a remnant-preserving technique has been studied in recent years. However, studies remain controversial and little is known about the rate of return to physical activity when the remnant-preserving technique is compared to the conventional technique. The present study analyzed retrospectively ACL reconstruction techniques with and without remnant tissue preservation regarding the return of the patients to their physical activity level prior to the injury. No statistically significant difference was observed between the groups in any of the evaluated outcomes: prelesion and postoperative physical activity frequency, return to sports rate, reconstructed ACL reinjury rate and pain during a mean postoperative follow-up period of 4.2 years. However, in an intragroup analysis, both groups showed a statistically significant decrease in the physical activity frequency during the postoperative period when compared to the prelesion period.

Football was the most practiced athletic activity before the injury (53%), a fact that may be justified for being the most popular sport in our country and due to the great knee joint biomechanical requirement. In the subgroup analysis evaluating only soccer players, there was no difference in the rate of return to sports despite the theoretical basis of the previously reported synergistic association between an accelerated rehabilitation after ACL reconstruction and remnant tissue preservation.<sup>7,8,12,13</sup> The mechanical protection of the graft by the remnant stump in the early postoperative period seems to be responsible for the optimized rehabilitation in subjects submitted to the remnant-preserving technique, without relying solely on the initial graft incorporation phase.<sup>7,8,13</sup> In addition, proprioceptive innervation would also potentiate return to sports, since subjects with intact remnant fibers appear to have greater joint position sense, resulting in greater limb control at pivoting activities.<sup>7,8,13</sup> However, the present work could not confirm this theoretical superiority of the remnant-preserving group regarding return to sports; further clinical studies with better methodological refinement are required to ascertain these findings.

The theoretical basis for ACL remnant stump preservation is the presence of mechanoreceptors, functional proprioceptive fibers, and subsynovial and intrafascicular vascularization, which are identifiable by conventional histopathology and immunohistology techniques.<sup>2,14,15</sup> Therefore, it would be logical to think that the conventional graft added to the remaining fibers containing mechanoreceptors and subsynovial vascularization would provide greater advantages over the conventional technique.<sup>7,8</sup> Despite this probable advantage, postoperative clinical evaluation studies have not shown statistically significant differences between these techniques.<sup>9,16,17</sup> Recently, a systematic review of randomized clinical trials<sup>18</sup> showed that remnant tissue preservation is not clinically superior to the conventional technique in terms of physical function (assessed by the International Knee Documentation Committee [IKDC] score), ligament stability tests (Lachman and Pivot-shift), knee range of motion, and adverse events, such as cyclops-type injury. Another systematic review published by Tie et al.<sup>1</sup> demonstrated a similarity between ACL reconstruction with

and without remnant tissue preservation regarding knee anterior stability and functional recovery. Remnant tissue preservation resulted in a lesser widening of the tibial tunnel.

Few studies have effectively evaluated the return of the patients to the preinjury physical activity level by comparing ACL remnant preservation or resection. Takazawa et al.<sup>19</sup> performed a case-control study and, when assessing physical activity levels using the Tegner score, did not observe any difference between groups with or without remnant tissue preservation after 1 year of postoperative follow-up; however, in the group with remnant tissue preservation, the reinjury rate was lower and anterior stability improved significantly. Our study found no differences between groups regarding return to sports or reinjury, but it showed a significant decrease in physical activity frequency in the postoperative period when compared to the preinjury period, regardless of the technique used. Return to sports after ACL reconstruction is a concern, especially when comparing preinjury activity levels. Most of the studies analyzing these data include elite athletes, obtaining better results compared with patients who practice sports at the recreational level. While studies involving the sportive elite report an 80% rate of return to sports and a 65% rate of return to the same preinjury level, researches involving mostly subjects involved in recreational activity, such as ours, represent the majority of patients undergoing ACL reconstruction; in addition, they are required to understand the evolution of these patients, which is usually less favorable.<sup>20,21</sup>

The main limitations of the present study were the small sample size, the retrospective design with data collection by telephone contact and the insufficient follow-up time to assess long-term outcomes. Despite these methodological constraints, the present study is one of the few to assess return to sports after ACL reconstruction with and without remnant tissue preservation. Therefore, prospective studies with greater methodological rigor are required to prove the benefits and disadvantages of this technique of ACL reconstruction with remnant tissue preservation, especially with emphasis on the return of the patients to previous physical activity levels.

## Conclusion

Our findings did not show any difference between patients undergoing ACL reconstruction with and without remnant tissue preservation regarding return to sports, frequency of physical activity and pain. There was no difference between the groups regarding injury recurrence rate. Future prospective studies are required to clarify the real influence of ACL remnant tissue preservation on return to preinjury physical activity levels.

### Conflict of Interests

The authors have no conflict of interests to declare.

### Acknowledgment

The authors are grateful to Dr. Guilherme Conforto Gracitelli for his help in designing this research project and reviewing the manuscript, and to Dr. Carolina Pelegrini

Barbosa Gracitelli for her assistance in the statistical analysis.

## References

- 1 Tie K, Chen L, Hu D, Wang H. The difference in clinical outcome of single-bundle anterior cruciate ligament reconstructions with and without remnant preservation: A meta-analysis. *Knee* 2016;23(04):566-574
- 2 Dhillon MS, Bali K, Vasistha RK. Immunohistological evaluation of proprioceptive potential of the residual stump of injured anterior cruciate ligaments (ACL). *Int Orthop* 2010;34(05):737-741
- 3 Song GY, Zhang J, Li X, Chen XZ, Li Y, Feng H. Acute anterior cruciate ligament reconstruction with an augmented remnant repair: a comparative macroscopic and biomechanical study in an animal model. *Arthroscopy* 2014;30(03):344-351
- 4 Kazusa H, Nakamae A, Ochi M. Augmentation technique for anterior cruciate ligament injury. *Clin Sports Med* 2013;32(01):127-140
- 5 Muneta T, Koga H, Nakamura T, et al. A new behind-remnant approach for remnant-preserving double-bundle anterior cruciate ligament reconstruction compared with a standard approach. *Knee Surg Sports Traumatol Arthrosc* 2015;23(12):3743-3749
- 6 Gohil S, Annear PO, Bredahl W. Anterior cruciate ligament reconstruction using autologous double hamstrings: a comparison of standard versus minimal debridement techniques using MRI to assess revascularisation. A randomised prospective study with a one-year follow-up. *J Bone Joint Surg Br* 2007;89(09):1165-1171
- 7 da Silveira Franciozi CE, Ingham SJ, Gracitelli GC, Luzo MV, Fu FH, Abdalla RJ. Updates in biological therapies for knee injuries: anterior cruciate ligament. *Curr Rev Musculoskelet Med* 2014;7(03):228-238
- 8 Luzo MV, Franciozi CE, Rezende FC, Gracitelli GC, Debieux P, Cohen M. Anterior cruciate ligament - updating article. *Rev Bras Ortop* 2016;51(04):385-395
- 9 Hu J, Qu J, Xu D, Zhang T, Zhou J, Lu H. Clinical outcomes of remnant preserving augmentation in anterior cruciate ligament reconstruction: a systematic review. *Knee Surg Sports Traumatol Arthrosc* 2014;22(09):1976-1985
- 10 Song GY, Zhang H, Zhang J, et al. The anterior cruciate ligament remnant: to leave it or not? *Arthroscopy* 2013;29(07):1253-1262
- 11 Stata, Corporation. Stata statistical software: release 7.0. 2001
- 12 Borbon CA, Mouzopoulos G, Siebold R. Why perform an ACL augmentation? *Knee Surg Sports Traumatol Arthrosc* 2012;20(02):245-251
- 13 Dejour D, Ntagiopoulos PG, Saggin PR, Panisset JC. The diagnostic value of clinical tests, magnetic resonance imaging, and instrumented laxity in the differentiation of complete versus partial anterior cruciate ligament tears. *Arthroscopy* 2013;29(03):491-499
- 14 Bali K, Dhillon MS, Vasistha RK, Kakkar N, Chana R, Prabhakar S. Efficacy of immunohistological methods in detecting functionally viable mechanoreceptors in the remnant stumps of injured anterior cruciate ligaments and its clinical importance. *Knee Surg Sports Traumatol Arthrosc* 2012;20(01):75-80
- 15 Sha L, Xie G, Zhao S, Zhao J. A morphologic and quantitative comparison of mechanoreceptors in the tibial remnants of the ruptured human anterior cruciate ligament. *Medicine (Baltimore)* 2017;96(05):e6081
- 16 Demirağ B, Ermutlu C, Aydemir F, Durak K. A comparison of clinical outcome of augmentation and standard reconstruction techniques for partial anterior cruciate ligament tears. *Ekleml Hastalik Cerrahisi* 2012;23(03):140-144
- 17 Pujol N, Colombet P, Potel JF, et al; French Arthroscopy Society (SFA). Anterior cruciate ligament reconstruction in partial tear: selective anteromedial bundle reconstruction conserving the posterolateral remnant versus single-bundle anatomic ACL reconstruction:



- preliminary 1-year results of a prospective randomized study. *Orthop Traumatol Surg Res* 2012;98(8, Suppl):S171-S177
- 18 Ma T, Zeng C, Pan J, Zhao C, Fang H, Cai D. Remnant preservation in anterior cruciate ligament reconstruction versus standard techniques: a meta-analysis of randomized controlled trials. *J Sports Med Phys Fitness* 2017;57(7-8):1014-1022
- 19 Takazawa Y, Ikeda H, Kawasaki T, et al. ACL Reconstruction Preserving the ACL Remnant Achieves Good Clinical Outcomes and Can Reduce Subsequent Graft Rupture. *Orthop J Sports Med* 2013;1(04):2325967113505076
- 20 Ardern CL, Taylor NF, Feller JA, Webster KE. Fifty-five per cent return to competitive sport following anterior cruciate ligament reconstruction surgery: an updated systematic review and meta-analysis including aspects of physical functioning and contextual factors. *Br J Sports Med* 2014;48(21):1543-1552
- 21 Waldén M, Häggglund M, Magnusson H, Ekstrand J. ACL injuries in men's professional football: a 15-year prospective study on time trends and return-to-play rates reveals only 65% of players still play at the top level 3 years after ACL rupture. *Br J Sports Med* 2016;50(12):744-750