

Clinical Viewpoint

Ligament Healing After Anterior Cruciate Ligament Rupture: An Important New Patient Pathway?

Florian Forelli^{1,2,3a}, Jérôme Riera^{4,5}, Jean Mazeas^{1,2}, Claire Coulondre^{3,6}, Sven Putnis⁷, Thomas Neri^{8,9}, Alexandre Rambaud^{3,8,10}

¹ Orthosport Rehab Center, ² Orthopedic Surgery Department, Ramsay Healthcare, Clinic of Domont, Education, Functional Exploration and Clinical Research unity, ³ SFMKS-Lab, Société Française des Masseurs-kinésithérapeutes du Sport, ⁴ University Savoie Mont-Blanc, Inter-university Laboratory of Human Movement Biology, University Jean Monnet Saint-Etienne, ⁵ College of Health Sciences, University of Bordeaux, ⁶ Sports Orthopedics and Traumatology Center, ⁷ Avon Orthopaedic Centre, University of Bristol & Weston NHS Foundation Trust, ⁸ University Jean Monnet Saint-Etienne, Lyon 1, University Savoie Mont-Blanc, Inter-university Laboratory of Human Movement Biology, ⁹ Department of Orthopaedic Surgery, University Hospital of Saint Étienne, ¹⁰ Department of Clinical Physiology and Exercise Sports Medicine Unit

Keywords: anterior cruciate ligament, spontaneous healing, management, risk, return to sport

<https://doi.org/10.26603/001c.88250>

International Journal of Sports Physical Therapy

Vol. 18, Issue 5, 2023

Recent studies have shown satisfactory functional results after spontaneous healing of a ruptured anterior cruciate ligament (ACL). However, current literature on this topic may exclude important parting selection, outcome measures, and long-term results. Rehabilitation protocols applied in those studies, as well as objective assessments appear far from the usual gold standard after ACL reconstruction. Ideally, outcomes measures should be based on the same testing procedures that are recommended to clear an athlete to return to sport following ACL reconstruction. There is still a lot to understand in how an injured ACL may heal, and therefore ACL injury management should be individualized to each patient and carefully discussed.

INTRODUCTION

In the last few years, non-operative management after anterior cruciate ligament (ACL) injury has gained a lot of popularity and surgery may not always be recommended. Specific criteria such as age, desired sport and work activities, intensity of sporting activities and associated lesions might be able to inform patients and practitioners on the possibility of non-operative management. A battery of functional tests and Patient Reported Outcomes Measures (PROM) have been shown to identify patients who might respond well to conservative treatment (copers) versus those who might not (non-copers).

In parallel to studies focusing on outcomes without ACL reconstruction, there is emerging evidence that the ACL may spontaneously heal offering similar perceived quality of life and sport participation than patients with reconstructed ACL in the long term.¹ Within this context, a review of this new literature is necessary to best inform patients of the options available to them.

WHAT DETERMINES WHETHER AN ACL CAN HEAL?

It is well documented that the ACL attempts to heal, and a decrease and reduction in tibial translation may be observed in some patients.² However, the process of healing is not considered optimal; the ACL may not heal onto the anatomical femoral attachment, and different patterns of scar formation may influence ligament length and subsequent knee stability. In a retrospective study, Costa Paz et al. demonstrated the possibility of ACL healing using magnetic resonance imaging (MRI).³ It should be noted that two patients over fourteen had a re-injury (and needed a reconstruction) and 30% had knee-related deficiencies on clinical examination (Lachman and pivot shift tests).⁵ These results are similar to Fujimoto *et al.* who showed that 26% of patients with a hypothetical ACL healing (MRI and KT-2000 arthrometer were performed) had to subsequently undergo reconstruction.^{3,4} Recently, a secondary analysis of the KANON trial showed that within the non-reconstructed group, those who were considered to have healed ACL's based on MRI findings, had better functional scores than the rest of the non-reconstructed group as well as the ACL reconstructed group at 2 years follow-up.¹ These results

a Corresponding Author:
florian.forelli.mk@gmail.com

may challenge current clinical practices and management of ACL injury. However, the term “healed” should not only refer to ACL’s fibers continuity observed on MRI but also to functional recovery. The “healed” ligament may have different mechanical properties than the original. This could explain why within the healed ACL group 25% had an abnormal pivot shift test, 56% had an abnormal Lachman’s test and an increased tibial translation was observed in laximetry testing.

As highlighted in a recent systematic review, studies on this topic are of low quality and their results could not lead to a reliable and generalizable conclusion.⁵ This review also pointed out that healing capacity of the ACL may be dependent on the rupture’s location and the conservation of the sheath of the ACL. Proximal ruptures having more chance to heal than distal ruptures. Another important factor observed by authors was that in many included studies rehabilitation protocols were not detailed. Rehabilitation protocols are different and have the potential to alter the outcomes between groups in studies.⁵ For example, Razi et al. recommended from the first week of injury to perform active range of motion out of brace, isometric quadriceps exercise, close kinetic chain exercise based on each individual’s pain tolerance, and stationary biking from the third week. In patient with valgus knees, they delay weight bearing until 6 weeks.⁶ During the acute phase Fujimoto et al. allowed early range of motion and quadriceps muscle strengthening exercises with a brace that had a 20° initial range of motion restriction. Weight-bearing was also allowed, as tolerated, with crutches initially. Full weight-bearing without the use of crutches was generally achieved within 4 weeks after the trauma.⁴ According to Jacobi et al., full weight bearing was allowed from the start of the treatment. Range of movement to the extent possible in the brace was allowed, giving patients a range of flexion of about 0° to 100°. Removal of the brace was allowed in 90° of knee flexion (sitting position) without quadriceps contraction. With the knee in flexion it was also the recommended position to take a shower. After four months, the brace was removed and exercises and physiotherapy were started to aid the recovery of muscle strength and full mobility. Sporting activity, including cutting and pivoting, was allowed after six months.⁷

According to Blanke et al. ACL healing happened in low-demand patients with femoral single bundle lesions without increased posterior tibial slope.⁸ In general, evidence is lacking regarding which criteria may indicate whether ACL healing is possible after an injury.⁵ The healing process of the ACL is still poorly understood, and it is difficult to know which patients are likely to have a healed ACL. It is also questionable whether some ACLs healing are not confused with ACLs scarring to the posterior cruciate ligament. This may happen in studies using MRI outcomes instead of an arthroscopic assessment which is the gold standard for ACL rupture.

FUNCTIONAL KNEE BRACE MANAGEMENT

To support ACL healing, some current protocols propose functional bracing management for periods of up to 12 weeks.^{4,7,9,10} Few studies have assessed the effect of functional bracing management on ACL healing.⁴ Fujimoto *et al.* showed that functional bracing management can help ACL healing but in a population with low intensity of physical activity.⁴ Functional bracing management seems to reduce ACL strain, which may improve the healing process. More recently, a case series in which they immobilized patients at 90° of knee flexion for four weeks after ACL injury was published.¹⁰ The purpose was to diminish the distance between the origin and the insertion of the ACL to favor the healing process. They obtained interesting result with 90% of patients showing signs of ACL healing at 3 months post injury (MRI and Lachmann test). However, 50% were classified as grade 2-3 on the ACL Osteoarthritis Score which may be indicative of a non-functional ACL explaining significantly lower scores of this group on the ACL-Quality Of Life score.

It is to remember that current guidelines do not recommend functional bracing management after ACL injuries or ACL reconstruction. Strict bracing, as used in the case series study, can lead to knee joint disuse, which may alter muscle activation, spinal excitability and intracortical inhibition.^{10,11} The role of functional bracing on postural control is not clear either. Birmingham *et al.* concluded that functional bracing may improve performance during simple tasks but not during more functional or daily living tasks.¹² From a broader perspective, a systematic review looked at the effect of functional bracing on patient-reported outcome measures and functional outcomes. No difference was observed between patients who wore a knee brace after ACLR and those who did not.¹³

Overall, there is very limited evidence that functional bracing influences ACL healing or is of any benefit for the patient and wearing a brace for a prolonged period may have undesirable effects.

RETURN TO SPORT AND SPONTANEOUS ACL HEALING

Filbay *et al.* presents the most advanced study in terms of objective results on spontaneous ACL healing with their secondary analysis of the KANON trial. Two-year outcomes were better in the healed ACL group (n=16) compared with the non-healed group (n=14) (mean difference (95% CI) KOOS-Sport/Rec: 25.1 (8.6-41.5); KOOS-QOL: 27.5 (13.2-41.8)).¹ It is to notice that the battery of tests used in this study (KOOS-Sport/Rec, KOOS-QOL, KOOS pain, KOOS symptoms, Tegner Activity Score, KT-1000, Lachman and pivot shift tests, radiography) does not correspond to validated return to sports evaluations found in the current international literature,¹ and KOOS subscales use as outcome measure in this study has been shown to be of poor responsiveness for patients with ACL injury.¹⁴ Objective data on muscle strength, functional tests and the psychological aspects of return to sport are lacking. Regarding the

level of activity, authors recorded a mean pre-injury Tegner score of 8, which corresponds to high-intensity activity level. Unfortunately, they didn't compare Tegner scores from the 2 and 5-year follow-up between healed and non-healed group. Similarly, the addition and comparison of a pre- and post-Marx activity scale would have provided information on the homogeneity of the groups in terms of their involvement in pivoting sports, which are responsible for most ACL injuries. It should also be noted that professional athletes were excluded from this study. It is therefore impossible to extrapolate the results to this specific population.

Patients' perceived function is very well represented in their study and it is a fundamental aspect of treatment's success. However, the authors may not have chosen the most appropriate questionnaire to assess this aspect. Future research also needs to include more objective data on strength, function, and psychological aspects. This is especially true for populations involved in pivoting activities with a high level of intensity. To date, there is a lack of evidence regarding return to sport, especially at the elite

level, after ACL 'healing' and too much uncertainty to recommend this type of protocol.

CONCLUSION

Different options to treat patient with an ACL rupture exist. Non-surgical options may not be suitable to every patient and should be taken with extreme caution and truthfully discuss with the patient and within the medical team. There is evidence that conservative treatment can be successful in the general population, with some people healing their ACL. This is not the case for elite athletes. The emerging evidence regarding the ability for the ACL to heal is intriguing and may change clinical practice in the future, but we urge clinicians to take these results with extreme caution as this may only be suitable for a very small percentage of the population. Much more research is needed before recommendations for this option can be generalized.



REFERENCES

1. Filbay SR, Roemer FW, Lohmander LS, et al. Evidence of ACL healing on MRI following ACL rupture treated with rehabilitation alone may be associated with better patient-reported outcomes: a secondary analysis from the KANON trial. *Br J Sports Med.* 2023;57(2):91-98. doi:10.1136/bjsports-2022-105473
2. Crain EH, Fithian DC, Paxton EW, Luetzow WF. Variation in anterior cruciate ligament scar pattern: Does the scar pattern affect anterior laxity in anterior cruciate ligament-deficient knees? *Arthroscopy: The Journal of Arthroscopic & Related Surgery.* 2005;21(1):19-24. doi:10.1016/j.arthro.2004.09.015
3. Costa-Paz M, Ayerza MA, Tanoira I, Astoul J, Muscolo DL. Spontaneous Healing in Complete ACL Ruptures: A Clinical and MRI Study. *Clinical Orthopaedics & Related Research.* 2012;470(4):979-985. doi:10.1007/s11999-011-1933-8
4. Fujimoto E, Sumen Y, Ochi M, Ikuta Y. Spontaneous healing of acute anterior cruciate ligament (ACL) injuries - conservative treatment using an extension block soft brace without anterior stabilization. *Archives of Orthopaedic and Trauma Surgery.* 2002;122(4):212-216. doi:10.1007/s00402-001-0387-y
5. Pitsillides A, Stasinopoulos D, Giannakou K. Healing potential of the anterior cruciate ligament in terms of fiber continuity after a complete rupture: A systematic review. *Journal of Bodywork and Movement Therapies.* 2021;28:246-254. doi:10.1016/j.jbmt.2021.06.003
6. Razi M, Soufali AP, Ziabari EZ, Dadgostar H, Askari A, Arasteh P. Treatment of Concomitant ACL and MCL Injuries: Spontaneous Healing of Complete ACL and MCL Tears. *J Knee Surg.* 2021;34(12):1329-1336. doi:10.1055/s-0040-1708858
7. Jacobi M, Reischl N, Rönn K, Magnusson RA, Gautier E, Jakob RP. Healing of the Acutely Injured Anterior Cruciate Ligament: Functional Treatment with the ACL-Jack, a Dynamic Posterior Drawer Brace. *Advances in Orthopedics.* 2016;2016:1-7. doi:10.1155/2016/1609067
8. Blanke F, Trинnes K, Oehler N, et al. Spontaneous healing of acute ACL ruptures: rate, prognostic factors and short-term outcome. *Arch Orthop Trauma Surg.* Published online December 14, 2022. doi:10.1007/s00402-022-04701-0
9. Delin C, Silvera S, Djian P, Courroy JB, Rousseau D, Legmann P. Paper 77: Conservative Treatment of Ruptured ACL: A Prospective Study of Controlled ACL Healing with Fully Restored Anatomy and Function in Patients Pre-selected by Diffusion-weighted MRI: Initial Experience. *Arthroscopy: The Journal of Arthroscopic & Related Surgery.* 2012;28(9):e378-e379. doi:10.1016/j.arthro.2012.05.561
10. Filbay SR, Dowsett M, Chaker Jomaa M, et al. Healing of acute anterior cruciate ligament rupture on MRI and outcomes following non-surgical management with the Cross Bracing Protocol. *Br J Sports Med.* Published online June 14, 2023;bjsports-2023-106931. doi:10.1136/bjsports-2023-106931
11. Lepley AS, Lepley LK. Mechanisms of Arthrogenic Muscle Inhibition. *Journal of Sport Rehabilitation.* 2022;31(6):707-716. doi:10.1123/jsr.2020-0479
12. Birmingham TB, Kramer JF, Kirkley A, Inglis JT, Spaulding SJ, Vandervoort AA. Knee bracing after ACL reconstruction: effects on postural control and proprioception. *Medicine and Science in Sports and Exercise.* 2001;33(8):1253-1258. doi:10.1097/00005768-200108000-00002
13. Yang X gang, Feng J tao, He X, Wang F, Hu Y cheng. The effect of knee bracing on the knee function and stability following anterior cruciate ligament reconstruction: A systematic review and meta-analysis of randomized controlled trials. *Orthopaedics & Traumatology: Surgery & Research.* 2019;105(6):1107-1114. doi:10.1016/j.otsr.2019.04.015
14. van Meer BL, Meuffels DE, Vissers MM, et al. Knee Injury and Osteoarthritis Outcome Score or International Knee Documentation Committee Subjective Knee Form: Which Questionnaire Is Most Useful to Monitor Patients With an Anterior Cruciate Ligament Rupture in the Short Term? *Arthroscopy: The Journal of Arthroscopic & Related Surgery.* 2013;29(4):701-715. doi:10.1016/j.arthro.2012.12.015