

Spontaneous Healing in Complete ACL Ruptures

A Clinical and MRI Study

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Published online: 4 June 2011
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Abstract

Background Most authors believe the ACL does not spontaneously heal after a complete rupture. Although several studies have reported spontaneous healing of torn ACLs, it is difficult to determine its healing potential and whether patients will be able to return to sports activities.

Questions/purposes We therefore asked whether (1) a complete ACL rupture in patients can spontaneously heal without the use of a specific rehabilitation program or bracing and (2) patients are able to return to their athletic activity after spontaneous ACL healing.

Patients and Methods We retrospectively reviewed 14 patients with acute ACL injury established by physical examination and MRI (proximal third in eight patients and the midligament in six). Average age at injury was 31 years (range, 23–41 years). All patients were athletically active before injury. Surgery was indicated in all patients but for various reasons postponed. We obtained International Knee Documentation Committee scores, Lysholm-Gillquist scores, and MRI. The minimum followup was 25 months (mean, 30 months; range, 25–36 months).

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Each author certifies that his or her institution approved the human protocol for this investigation that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Results At last followup, the mean Lysholm-Gillquist score was 97. According to the International Knee Documentation Committee evaluation, 10 knees were normal and four nearly normal. All knees regained end point with a negative pivot shift test; MRI at followup showed an end-to-end continuous ACL with homogeneous signal. All patients returned to their former activity level. However, after the study period, two patients had a rerupture of the ACL (2.5 years after the first lesion).

Conclusions Our observations indicate an acutely injured ACL may eventually spontaneously heal without using an extension brace, allowing return to athletic activity.

Level of Evidence Level IV, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

ACL rupture is frequent in young athletes. When associated with symptomatic anterior knee instability, the injury may limit or preclude sports activity [12]. Multiple studies have shown the poor potential for primary healing in cases of complete rupture of the ACL [1, 5, 13, 16, 19, 20]. These observations have led most surgeons to reconstruct the ACL in symptomatic patients. Thus, this reconstructive surgery has become one of the most common procedures performed by orthopaedic surgeons.

However, several studies have reported a spontaneous healing of the ACL after acute rupture [4, 6, 8], and in most cases, the authors of these studies have indicated a nonoperative treatment with bracing and a specific rehabilitation program [4, 6, 8]. Thus, while most observers suggest a complete ACL rupture will not heal, there are apparently some situations in which it will heal.

We therefore asked whether (1) a complete ACL rupture in patients can spontaneously heal without the use of a specific rehabilitation program or bracing and (2) patients are able to return to their athletic activity after spontaneous healing of the ACL.

Patients and Methods

We retrospectively reviewed 20 patients with acute complete ACL rupture that evolved with spontaneous healing. The lesion was established by physical examination, presenting positive Lachman and pivot shift tests, and MRI studies from 2005 to 2007. We do not have data on the number of patients with acute ruptures of the ACL who underwent nonoperative treatment during the 3 years of the study, but during that period, we performed 462 ACL reconstructions. Of the 20 patients, we excluded six with less than 24 months' followup, leaving 14 patients (14 knees). We excluded 11 patients with partial ACL tears, previous knee ligament reconstruction, and known contralateral ligament injuries. The average age at the time of injury was 31 years (range, 23–41 years) (Table 1). Twelve patients were male and two female. Twelve involved right knees and two left. All patients were athletically active before the injury and suffered the lesion during a sport activity. Twelve of them were recreational soccer players, one was a gymnast, and one practiced karate. Minimum followup was 25 months (mean, 30 months; range, 25–36 months) after trauma. No patients were lost to followup. No patients were recalled specifically for this study; all data were obtained from medical records and MRIs.

Table 1. Demographic data

Patient	Age (years)	Sex	Sport	Followup (months)
1	32	Male	Soccer	28
2*	27	Male	Soccer	28
3	29	Male	Soccer	30
4	26	Male	Soccer	29
5	41	Female	Gymnastics	28
6	37	Male	Soccer	36
7*	34	Male	Soccer	29
8	34	Male	Soccer	28
9	34	Female	Karate	36
10	32	Male	Soccer	25
11	23	Male	Soccer	31
12	25	Male	Soccer	35
13	28	Male	Soccer	30
14	22	Male	Soccer	31

* Patients who suffered a rerupture of the ACL after the study period.

At the time of the initial office presentation, all 14 patients presented complete ACL ruptures with positive Lachman and pivot shift tests. MRI studies, based on ACL morphology, showed tears were located in eight patients at the proximal third with a low signal intensity and a band-like fragmented shape (Fig. 1) and in six patients at the midligament with increased signal intensity and edematous mass-like shape (Fig. 2). We found three small tears of the medial meniscus, one tear of the lateral meniscus, and five Grade I medial collateral ligament (MCL) sprains. Also, we found 10 patients with bone bruising, five with PCL buckling, two with lateral meniscus subluxation, and two with buckling of the patella tendon [2, 14]. From a clinical point of view, we believed surgery was indicated in all patients, but it was postponed for different reasons, including related labor problems, need to travel, illnesses, planned holidays, and the patient's personal decision not to undergo surgery. Most of the patients let the injury run its course with no bracing and unspecific rehabilitation protocol.

The followup schedule in this series was not standardized; eight patients came back spontaneously at different times after diagnosis and the other six were given appointments for their re-evaluation. However, the patients

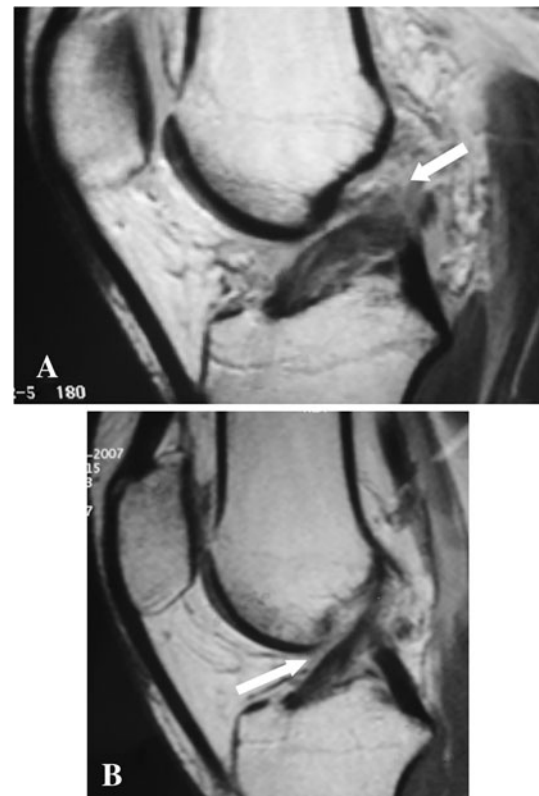


Fig. 1A–B (A) A MR image sagittal view of the knee shows a complete proximal ACL rupture (arrow). (B) A MR image of the same patient after 2 years shows a continuous ACL (arrow).

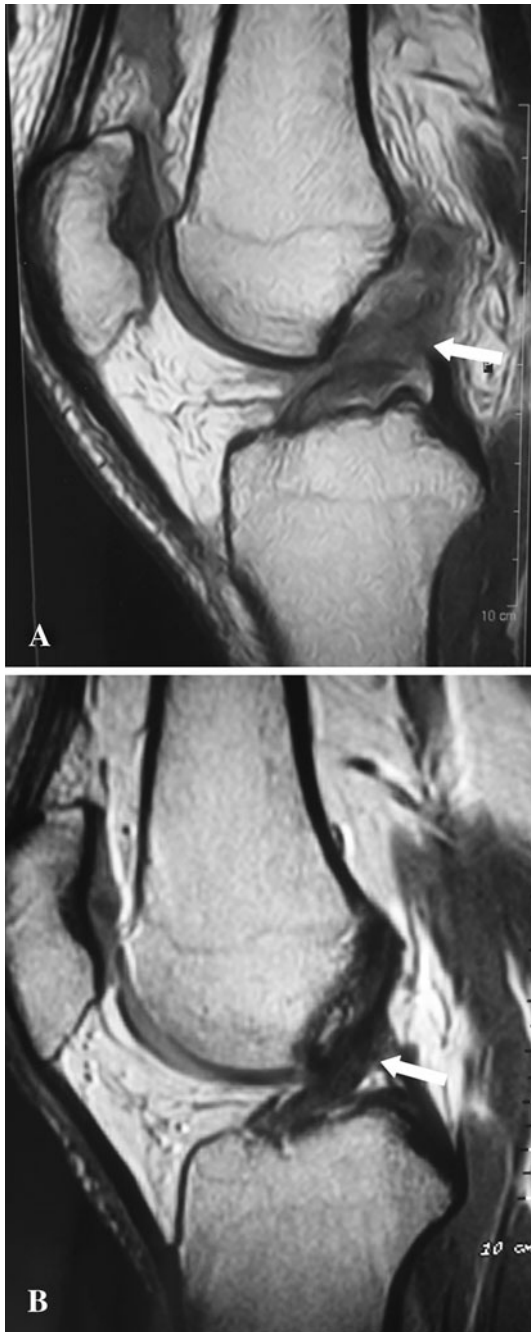


Fig. 2A–B (A) A MR image shows a midligament rupture with increased signal intensity and edematous mass-like shape (arrow). (B) A MR image sagittal view performed 2 years after the injury shows a continuous ACL (arrow).

were clinically evaluated at least once a year. All patients were evaluated according to the International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form [7], considering the following criteria: subjective evaluation of the patient, presence of symptoms, passive motion deficit, ligament examination, compartment findings, radiographic findings, and the functional test. The final result was classified as a normal, near to normal,

abnormal, or severely abnormal knee. The Lysholm-Gillquist knee scale [9] was also used, taking into account eight parameters: pain, subjective instability, use of a walking device, claudication when walking, articular blocking, effusion, possibility of climbing stairs, and difficulty in kneeling. The patients were also evaluated using the activity scale of Tegner and Lysholm [17]. The instrumented Lachman test was performed with the KT-1000TM arthrometer (MEDmetric Corp, San Diego, CA) according to the manufacturer's protocol, with the knee at 25° of flexion. The side-to-side maximal manual difference in anterior displacement was recorded in millimeters [15].

MRI was performed in a 1.5-T superconductive magnet. All patients underwent both T1-weighted and T2-weighted imaging performed in the sagittal and coronal planes in sections that were 3 to 4 mm thick. Two of the authors (MCP, MAA) evaluated every knee with a symptomatic ACL lesion, and two (IT, JA) assessed all MR images for primary and secondary signs of ACL rupture on the initial and last followup MRI, obtaining clinical scores. Interobserver variability of the MRI grading scheme was assessed using the kappa statistic rating: the kappa statistic was 98.

The primary signs included (1) ACL morphology and signs of edema, (2) thickening of the ACL, and (3) location of the lesion observed on sagittal T1-weighted images [14], while the secondary signs included (1) bone bruising, (2) PCL buckling, (3) lateral meniscus subluxation, and (4) buckling of the patella tendon. The ACL was considered to be completely torn if there was a disruption of all fibers or if it was not discernible at all on MR images [14].

Results

At last followup, all patients had a stable knee. All knees regained end point and the pivot shift was negative. The average KT-1000TM arthrometer manual maximum value was 1.9 mm (range, 1–3.5 mm) (Table 2). In all patients, MRI at the time of followup showed an end-to-end continuous ACL with homogeneous signal and disappearance of the secondary signs [2] (Fig. 3). The ACL spontaneous healing was arthroscopically confirmed in only one patient with a lateral meniscus tear (Fig. 4). Therefore, we performed a partial meniscectomy.

All patients returned to the same or almost the same physical activity as before the lesion. The average Lysholm-Gillquist score was 97 (range, 90–100), and according to the IKDC evaluation, 10 patients' knees were normal and four nearly normal.

After the study period, two patients had a rerupture of the ACL (2.5 years after the lesion). Subsequently, these two patients underwent a surgical ACL reconstruction (Fig. 5).

Table 2. Results of clinical evaluation of patients at a minimum of 2 years after ACL rupture

Patient	First evaluation		Second evaluation			Test			
	MRI ACL tear	Lachman test	Pivot test	Lachman test	Pivot test	KT-1000™ (mm)	Tegner-Lysholm activity level (initial/final)	Lysholm-Gillquist score (points)	IKDC
1	Proximal	Severe	Jump	Negative	Negative	1.5	6/7	91	A
2*	Proximal	Severe	Jump	Negative	Negative	3	6/7	100	A
3	Middle	Severe	Jump	Negative	Negative	3	7/7	100	A
4	Middle	Moderate	Glide	Negative	Negative	3.5	6/7	95	B
5	Proximal	Severe	Jump	Negative	Negative	2.6	6/7	95	B
6	Proximal	Moderate	Glide	Negative	Negative	1	7/7	100	A
7*	Middle	Severe	Jump	Negative	Negative	2.2	6/7	96	A
8	Middle	Severe	Jump	Negative	Negative	2	7/7	100	A
9	Proximal	Severe	Jump	Negative	Negative	2	7/7	95	A
10	Proximal	Severe	Jump	Negative	Negative	2	7/7	100	A
11	Middle	Moderate	Glide	Mild	Negative	1	6/7	90	B
12	Proximal	Severe	Jump	Negative	Negative	1	7/7	100	A
13	Proximal	severe	Glide	Negative	Negative	2	6/7	95	B
14	Middle	Moderate	Jump	Negative	Negative	1	6/7	100	A

* Patients who suffered a rerupture of the ACL after the study period; IKDC = International Knee Documentation Committee Subjective Knee Evaluation Form; A = normal; B = nearly normal.

Discussion

ACL spontaneous healing after a complete rupture is still controversial. Conventional knowledge states a completely ruptured ACL does not heal [5, 10, 19]. However, several studies have reported a spontaneous healing of the ACL after acute rupture with specific rehabilitation programs [4, 6, 8]. To confirm these studies, we therefore asked whether (1) a complete ACL rupture in patients can spontaneously heal without the use of a specific rehabilitation program or bracing and (2) patients are able to return to their athletic activity after spontaneous healing of the ACL.

Several limitations should be noted when interpreting our findings. First, the small number of patients precludes any analysis of predictive factors that would help us determine which patients might heal. Second, as it is a retrospective study of the acute injury, the MR images we used were not acquired as a sequential series. We do not know how many patients had nonoperative treatment who did not heal and thus cannot define the incidence of spontaneous healing. It was not our intent to estimate an incidence of spontaneous healing. Third, we did not perform the arthrometer test on the patients when we diagnosed the initial ACL rupture. Instead, this is a study describing an infrequent process with accurate clinical data and MRI followup after a minimum of 2 years. The evaluators were also the treating physicians.

The primary healing potential of the ACL is reportedly poor in both experimental and clinical studies. Yoshida and Fujii [20] investigated the responses of human MCL and

ACL cells to various growth factors. Composite data have confirmed human ACL cells have lower responses to growth factors than human MCL cells, suggesting a decreased reparative capacity of ACL tissue [20]. In a recent study, Tang et al. [16] concluded, although the regular wound-healing mechanism also occurs after ACL injury, accumulation of matrix metalloproteinase activity in the synovial fluids due to all the intra-articular tissues may be at least one of the important reasons why an injured ACL cannot be repaired. Studies have also described the poor healing potential in complete ACL ruptures in rabbits and dogs [5, 13].

Noyes et al. [12] concluded nonoperative treatment in acute ruptures of the ACL does not allow athletes to continue with activities involving changes in direction and twisting of their knees. On the other hand, McDaniel and Dameron [11] showed in a mean 14-year followup 76% of untreated patients with ACL ruptures returned to strenuous sports. Potential influencing factors leading to the poor healing of primary ACL repair include biomechanical forces, the unique anatomy of the ligament, poor blood supply to the core of the ligament, the biologic environment of the joint, synovial fluids, and intrinsic cellular reparative properties [3, 18]. The precise contributions from these various sources are not well established at present.

Only a few cases of documented spontaneous ACL healing have been reported [4, 6, 8, 10]. Ihara et al. [6] analyzed 50 athletes with acute ACL intrasubstance rupture treated nonoperatively using a specially designed brace.

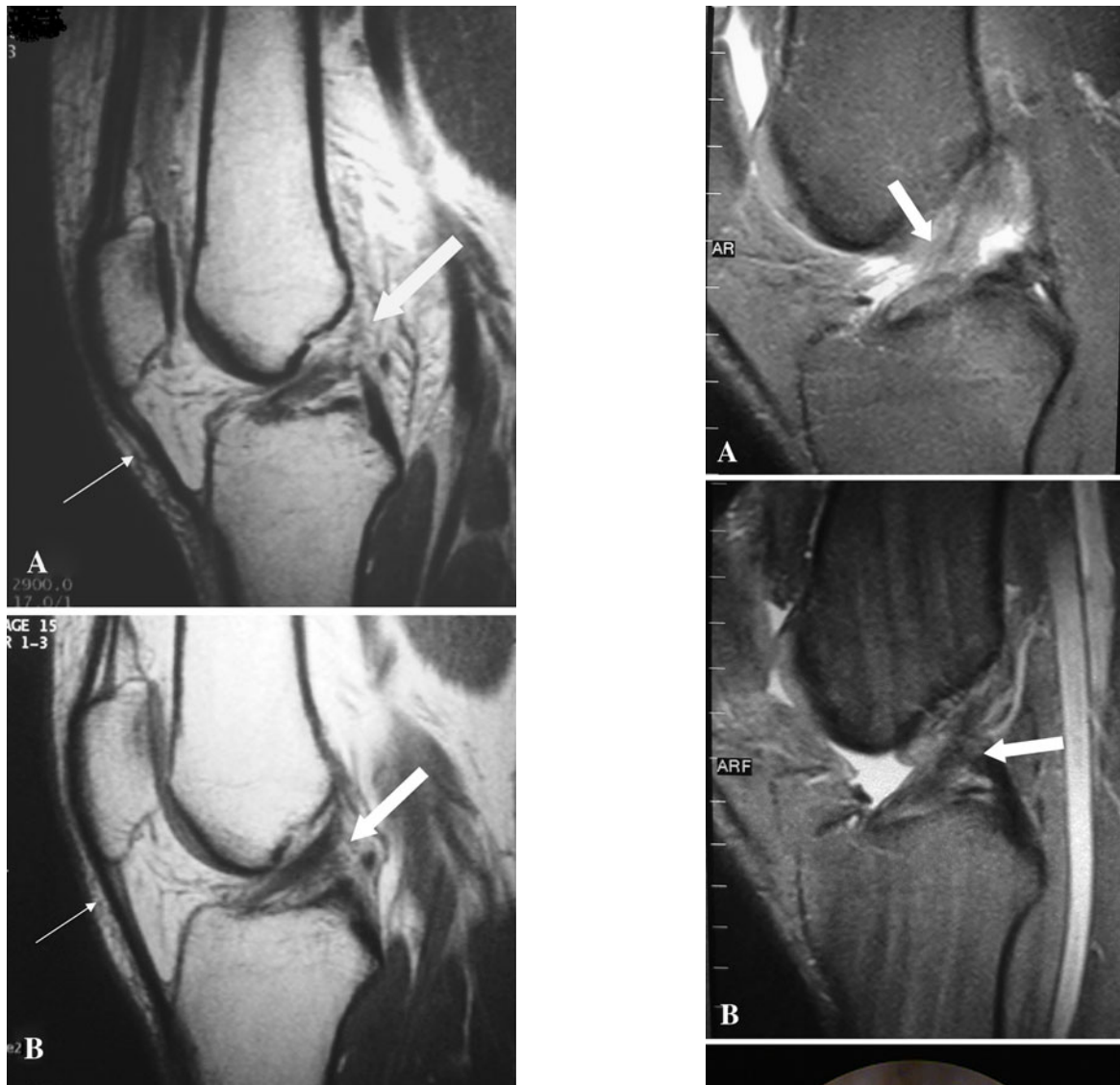


Fig. 3A–B (A) A MR image sagittal view of the knee demonstrates the complete proximal ACL rupture (thick arrow) and patella tendon buckling as a secondary sign of ACL rupture (thin arrow). (B) A MR image sagittal view of the same patient 3 years after the rupture shows ACL healing (thick arrow) and disappearance of the patella tendon buckling (thin arrow).

Eleven months later, the authors evaluated 29 of these patients, who showed a continuous ACL on MRI. However, the patients' activity and followup time were not reported. They concluded MRI may demonstrate ACL healing treated with bracing. Moreover, Fujimoto et al. [4] evaluated the spontaneous healing capability of acute ACL injuries in a selected group of 31 patients who had low athletic demands. Each patient demonstrated a continuous ACL on MRI and an area of high intensity was detected in the substance of the ACL. The injured knees were treated using an extension block soft brace for 2 to 3 months. The average followup was 16 months. Eight knees required

Fig. 4A–C (A) A MR image sagittal view of the knee shows the ACL rupture (arrow) at the midligament with increased signal intensity and edematous mass-like shape. (B) A MR image sagittal view of the same patient 1 year after the rupture shows an end-to-end continuous ACL with homogeneous signal (arrow). (C) An arthroscopic view of the same patient 1 year after the ACL tear shows a continuous ligament (arrow).

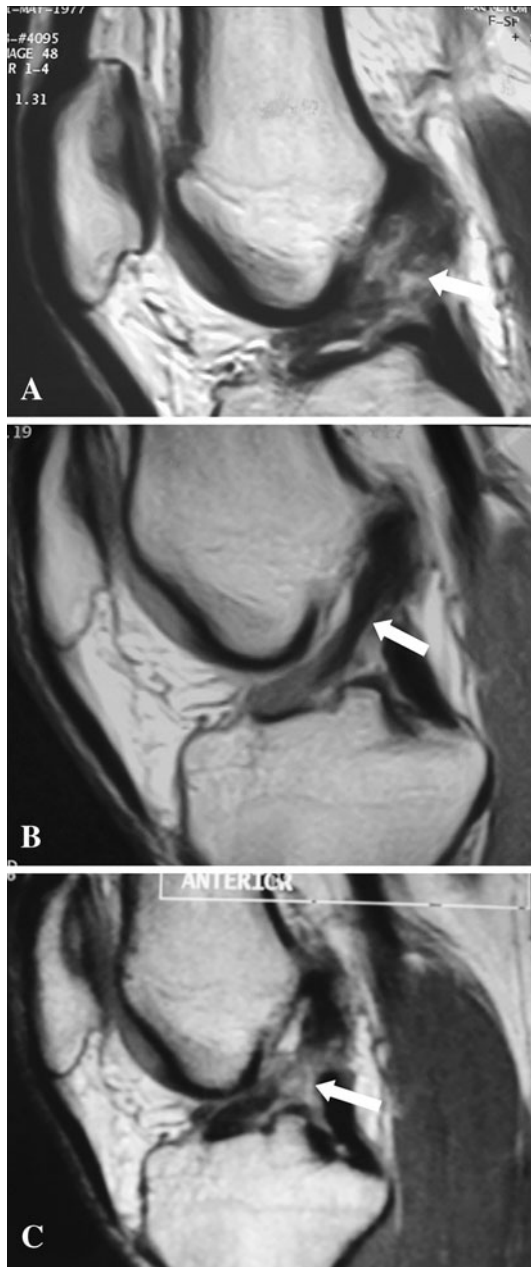


Fig. 5A–C (A) A MR image sagittal view shows a complete ACL rupture at the midligament (arrow). (B) A MR image sagittal view 2 years after the rupture shows an end-to-end continuous ACL (arrow). (C) A MR image 2.5 years after ACL rupture shows a rerupture of the ACL in the same area as the first lesion (arrow).

ACL reconstructions due to instability. Their study suggests an acutely injured ACL has healing capability. Also, Kurosaka et al. [8] reported two clinical cases of spontaneous healing of an ACL tear and concluded proximal injuries close to the bone should enhance the healing capability. All our patients had complete ACL ruptures according to the clinical evaluation and imaging. We did not use bracing and the patients did not perform a specific

rehabilitation program. We found different types of complete ACL ruptures in different locations according to the MRI. After an average of 30 months, the clinical evaluations showed the disappearance of instability and MRI showed an end-to-end continuous ACL with homogeneous signal. The Tegner-Lysholm activity level remained the same in seven patients and declined in seven. At 2.5 years after the lesion, two patients suffered a rerupture of the ACL, requiring an arthroscopic reconstruction.

It is difficult to speculate which patients presenting ACL rupture may have some healing potential, but we speculate patient age (average, 31 years), few fibers in continuity not shown in the MRI studies, and overlying synovial lining holding the ends in proximity might have influenced the spontaneous healing. However, we are not able to define a specific pattern in this series. Future developments may determine which patients could have the potential to heal their ACL rupture without need of surgery. Our study is unique as it shows ACL healing does not depend on the use of bracing or a specific rehabilitation program. It presents a natural evolution and spontaneous healing of this lesion with clinical and imaging followup. The spontaneous healing of the complete ACL rupture persisted in 12 patients without using an extension brace, and they were able to continue with their athletic activity.

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