

Progression of the Psychological ACL-RSI Score and Return to Sport After Anterior Cruciate Ligament Reconstruction

A Prospective 2-Year Follow-up Study From the French Prospective Anterior Cruciate Ligament Reconstruction Cohort Study (FAST)

Mansour Sadeqi,* MD, Shahnaz Klouche,*[†] MD, Yoann Bohu,*^{‡§} MD, Serge Herman,*[§] MD, Nicolas Lefevre,*[§] MD, and Antoine Gerometta,*[§] MD

Investigation performed at Clinique du Sport, Paris, France

Background: Successful return to sport after anterior cruciate ligament (ACL) reconstruction requires optimal physical and psychological recovery. The main validated tool to quantify a patient's psychological readiness to return to sport after this surgery is the Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI) scale.

Purpose: The primary aim was to analyze the progression of the ACL-RSI score from preoperatively to 2-year follow-up. A secondary goal was to identify the factors associated with returning to the same preinjury sport.

Study Design: Cohort study; Level of evidence, 2.

Methods: This prospective study included athletes older than 16 years in all sports and levels of play who underwent primary and revision isolated ACL reconstruction from 2012 to 2015 and responded to all study questionnaires at 2-year follow-up. The primary outcome was the ACL-RSI score obtained preoperatively and at 4-month, 6-month, 1-year, and 2-year follow-up. The secondary outcomes were return to sport (running and the same preinjury sport) and various functional scores. The optimal threshold value of the ACL-RSI score for returning to the same preinjury sport was determined with the receiver operating characteristic curve. Multivariate analysis was performed to identify other factors associated with returning to the same sport at 2-year follow-up.

Results: A total of 681 patients were analyzed (467 men, 214 women; mean age, 30.2 ± 9.5 years); 298 (43.8%) patients were professional or competitive athletes. The ACL-RSI score improved significantly over time: 41.3 ± 25.4 preoperatively, 55.1 ± 21.3 at 4 months, 58.3 ± 22.3 at 6 months, 64.7 ± 24.2 at 1 year, and 65.2 ± 25.3 at 2 years ($P < .00001$). At 2-year follow-up, 74.9% of patients had returned to running and 58.4% to their same preinjury sport. The ACL-RSI score was significantly higher in patients who had returned to sport and in those who returned to the same level of play or higher ($P < .00001$). The optimal ACL-RSI score threshold to return to the same sport at 2-year follow-up was ≥ 65 . Multivariate analysis showed that the predictive factors of returning to the same preinjury sport at 2-year follow-up were primary reconstruction, professional or competitive level of play, an ACL-RSI score ≥ 60 at 6-month follow-up, and the absence of postoperative complications.

Conclusion: The psychological ACL-RSI score improved regularly after ACL reconstruction and was strongly and significantly associated with return to sport.

Registration: NCT02511158 (ClinicalTrials.gov identifier)

Keywords: anterior cruciate ligament reconstruction; ACL-RSI scale; psychological score; return to sport

Anterior cruciate ligament (ACL) injuries are one of the most common injuries involving contact and noncontact sports that require jumping, pivoting, and cutting

maneuvers. According to a 2016 study,⁹ 91% of patients scheduled for primary or revision ACL reconstruction expect to return to sport at the same preinjury level, with minimal or no restrictions (67% and 24%, respectively), at least 1 year after surgery. Studies in the literature have shown that ACL reconstruction successfully provides stable and sufficient postoperative knee function,¹ although less

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than half of patients have returned to a competitive sport at a mean 41.5 months after surgery.⁴ According to Ardern et al³ and Langford et al,¹⁵ despite satisfactory physical recovery, most patients had not returned to their preinjury level of play 12 months after reconstruction because of a lack of psychological readiness. Positive psychological responses in relation to motivation, confidence, and limited fear are associated with a greater likelihood of returning to the preinjury level of play and a more rapid return to sport.² Patients who do not return to their preinjury level have a greater fear of reinjuries.¹⁴ Because of patients' high preoperative expectations, it is important to analyze the psychological factors associated with return to sport and to quantify the influence of these factors on recovery so as to provide appropriate therapeutic management. The Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI) scale was developed to quantify these psychological factors.²² This scale includes 12 items and was developed based on 3 components correlated to return to sport in the literature: emotions, confidence in performance, and risk appraisal.

The main goal of this study was to analyze the postoperative progression of the ACL-RSI score over time. The secondary goals were to assess the relationship between this score and return to sport and to identify factors related to returning to the same preinjury sport. The main hypothesis was that the psychological ACL-RSI score would gradually improve during follow-up and be associated with the rate of recovery at each postoperative interval.

METHODS

Study Design and Participants

This prospective single-center cohort study included all patients over the age of 16 years with an ACL tear who participated in all types of sports at all levels of play and who underwent primary or revision ACL reconstruction between 2012 and 2015 by 1 of 4 senior surgeons. The study was approved by an ethics committee, and all patients provided informed consent. This cohort study was registered with ClinicalTrials.gov. A retrospective analysis was performed of prospective data. Exclusion criteria were associated lesions of the posterior cruciate ligament, isolated lateral ligament tears, and patient refusal.

Study Protocols

The protocols (surgical, anesthetic, and analgesic) were standardized. Spinal or general anesthesia was

administered according to the patient's choice. Arthroscopic surgery was performed using the semitendinosus-gracilis graft, the semitendinosus alone (quadruple stranded), or the patellar or fascia lata tendon technique. Extra-articular reinforcement of the fascia lata was associated with ACL reconstruction if the surgeon felt that it was needed for knee stability.¹⁶ The aim of this technique was to perform anatomic reconstruction of the anterolateral ligament using the iliotibial band to improve the control of anterior laxity and medial rotation of the tibia.

The postoperative analgesic protocol was standardized. Oral analgesia included paracetamol and/or an opioid-like and/or a nonsteroidal anti-inflammatory drug with omeprazole. Morphine was titrated in hospitalized patients if the pain score was above 5 on a 10-point numeric rating scale.

Data Collection

A web survey was administered to the participants using the validated version of the ACL-RSI scale⁵ before surgery and at 4 months, 6 months, 1 year, and 2 years after surgery. The ACL-RSI scale includes 12 questions on the patient's emotional well-being and confidence in his or her performance and risk appraisal. The scale, with scores ranging from 1 to 10, includes 5 questions on emotional well-being, 5 questions on confidence in physical performance, and 2 questions on the appraisal of risk. Higher scores indicated a more positive psychological response. The total score was determined by adding the values of the 12 responses and then calculating their relationship to 100 to obtain a percentage. Four months after surgery, patients received an electronic link by email to the web survey to access and respond to an electronic version of the ACL-RSI scale. If patients failed to answer, they received a reminder by email and then a telephone call. This process was repeated at 6 months, 1 year, and 2 years after surgery.

The questionnaires included different functional scores: the subjective International Knee Documentation Committee (IKDC) score,¹² the Knee injury and Osteoarthritis Outcome Score (KOOS),¹⁹ and the Lysholm score.¹⁷ Patients completed these scores preoperatively and at 6 months, 1 year, and 2 years after surgery. Patients were invited to respond to the following questions concerning return to sport at 6 months and 1 year after surgery: "Did you return to running?" "Did you return to your same preinjury sport?" The following were asked at 2-year follow-up: "Did you return to and do you still participate at your same preinjury sport?" "If yes, at an identical, better, or lower level than the preinjury level?"

†Address correspondence to Shahnaz Klouche, MD, Clinique du Sport, 36 boulevard Saint Marcel, 75005 Paris, France (email: klouche_shahnaz@yahoo.fr).

*Clinique du Sport, Paris, France.

‡Racing 92, Le Plessis-Robinson, France.

§Institut de l'Appareil Locomoteur Nolle, Paris, France.

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Ethical approval for this study was received from the Comité de Protection des Personnes Ile-de-France VI, Hôpital Pitié-Salpêtrière.

Outcome Criteria

The primary outcome criterion was the ACL-RSI score evaluated preoperatively and at 4 months, 6 months, 1 year, and 2 years after surgery. The secondary outcome criteria were return to sport (running and the same preinjury sport) at 6 months, 1 year, and 2 years after surgery; the level of play of the preinjury sport at 2-year follow-up (identical/better/lower than the preinjury level); the correlation between the ACL-RSI score and the different functional scores (subjective IKDC, KOOS, and Lysholm scores); and overall satisfaction at 2-year follow-up (very satisfied/satisfied/fairly satisfied/not satisfied).

Statistical Analysis

The normal distribution was analyzed by the Shapiro-Wilk test. Differences were tested by the Student *t* test for continuous variables and the chi-square test for categorical variables. Analysis of variance was performed for multiple comparisons of means with the Bonferroni correction. Correlations between the functional scores and the ACL-RSI score were evaluated by the Pearson correlation coefficient. The strength of the correlation was classified as “strong” ($r > 0.5$), “moderate” ($0.5 < r < 0.3$), or “weak” ($0.3 < r < 0.1$).⁷ The optimal ACL-RSI score threshold for returning to and continuing to practice the same sport at 2-year follow-up (yes/no) was determined by constructing receiver operating characteristic (ROC) curves, with sensitivity as the ordinate and 1 – specificity as the abscissa. This threshold value was chosen to obtain the highest possible sensitivity and specificity with the best proportion of well-ranked participants, the highest positive likelihood ratio, and the lowest negative likelihood ratio. The diagnostic value of the ACL-RSI score was evaluated by the area under the ROC curve (AUC): nil (AUC = 0.5), uninformative ($0.5 < \text{AUC} < 0.7$), moderately informative ($0.7 \leq \text{AUC} < 0.9$), very informative ($0.9 \leq \text{AUC} < 1$), and perfect (AUC = 1).²⁰ Factors favoring returning to the same preinjury level of play 2 years after surgery were evaluated by univariate analysis, with the Student *t* test for continuous variables and the chi-square test for categorical variables, and then by multivariate analysis with logistic regression. Covariates were selected based on the results of univariate analysis (selecting only factors with a *P* value $< .2$) and any known potential causal relationships between factors to avoid overadjustment. A *P* value $< .05$ was considered to be statistically significant. Statistical analysis was performed with Stata 10 software (StataCorp).

RESULTS

Patient Characteristics

The study included a total of 681 patients, with 611 primary reconstructions and 70 revisions (Figure 1). It included 467 men and 214 women, with a mean age of 30.2 ± 9.5 years; patient and injury data are in Table 1. The initial injury was usually sport related (Figure 2).

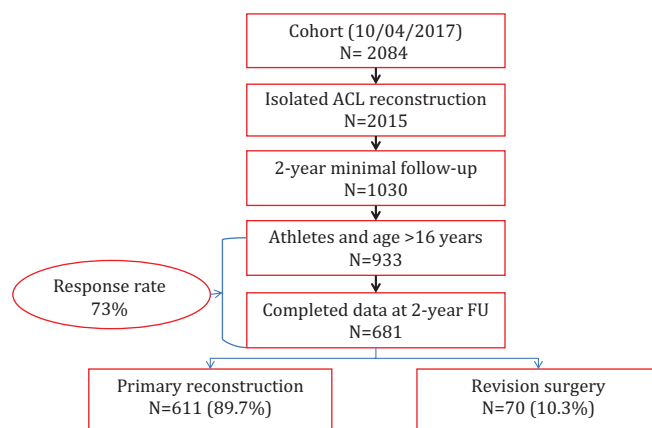


Figure 1. Patient selection. ACL, anterior cruciate ligament; FU, follow-up.

TABLE 1
Preoperative Data^a

| | |
|---|-------------|
| Level of sport, n (%) | |
| Professional | 26 (3.8) |
| Competitive | 272 (39.9) |
| Regular leisure | 294 (43.2) |
| Occasional leisure | 89 (13.1) |
| Type of preinjury sport, n (%) | |
| Pivot with contact | 434 (63.7) |
| Pivot without contact | 138 (20.3) |
| Without pivot | 109 (16.0) |
| Cause of injury, n (%) | |
| Sport | 604 (88.7) |
| Work | 32 (4.7) |
| Domestic | 24 (3.5) |
| Road traffic accident | 21 (3.1) |
| Sprain recurrence before surgery, n (%) | 223 (32.7) |
| IKDC subjective | 59.7 ± 16.4 |
| IKDC objective, n (%) | |
| A:normal | 0 (0.0) |
| B:nearly normal | 58 (8.5) |
| C:abnormal | 419 (61.5) |
| D:severely abnormal | 204 (30.0) |
| KOOS symptoms/stiffness | 71.5 ± 17.8 |
| KOOS pain | 60.7 ± 25.7 |
| KOOS function in daily living | 84.1 ± 17.4 |
| KOOS sport | 45.4 ± 27.0 |
| KOOS quality of life | 30.9 ± 21.4 |
| Lysholm | 71.5 ± 18.0 |
| Telos laxity at 25 kg | 6.4 ± 3.8 |
| Genourob laxity at 200 N | 3.8 ± 3.1 |

^aData are presented as mean ± SD unless otherwise indicated. IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score.

In this series, a hamstring graft was used in 88.1% of patients, and extra-articular tenodesis was performed in 28.6% of patients. Early postoperative complications occurred in 5.7% of patients (Table 2).

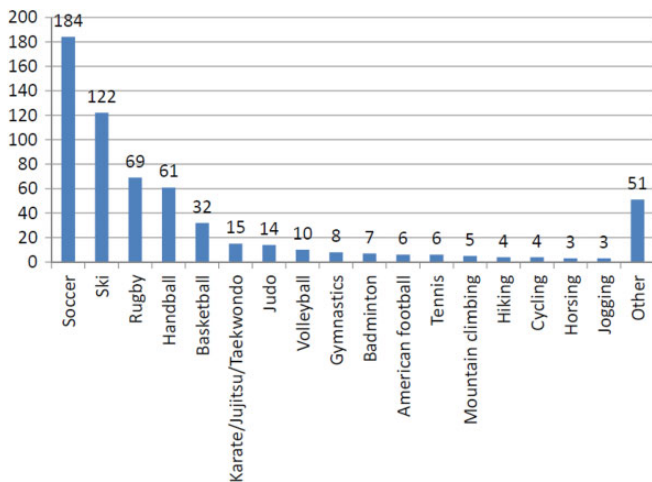


Figure 2. Sport practiced at the time of injury.

TABLE 2
Intraoperative Data and
Early Postoperative Complications^a

| | |
|--|------------|
| Hospital stay | |
| Outpatient | 200 (30.0) |
| Conventional | 481 (70.0) |
| Anesthesia | |
| Spinal block | 579 (85.0) |
| General | 102 (15.0) |
| Type of graft | |
| Hamstring tendon | 600 (88.1) |
| Bone-patellar tendon-bone | 67 (9.8) |
| Combined fasciae latae ^b | 14 (2.1) |
| Extra-articular tenodesis (tensor fasciae latae) | 195 (28.6) |
| Chondroplasty ^c | 159 (23.3) |
| Medial meniscal lesion ^d | 253 (37.2) |
| Lateral meniscal lesion ^e | 218 (32.0) |
| Postoperative complication (1 week) ^f | 39 (5.7) |

^aData are presented as n (%).

^bFor intra- and extra-articular anterior cruciate ligament reconstruction.

^c19 microfractures, 11 chondroplasties, 1 fragment removal, and 128 conservative treatments.

^d105 partial meniscectomies, 60 suturing, and 88 conservative treatments.

^e114 partial meniscectomies, 30 suturing, and 74 conservative treatments.

^f30 simple or diffuse hematomas in the popliteal fossa, 4 hemarthrosis, 2 phlebitis, 2 bleeding (drain > 300 mL), and 1 dressing bleeding.

Primary Outcome Criterion: Progression of the ACL-RSI Score During Follow-up

The mean ACL-RSI score increased significantly in all patients over time ($P < .00001$): 41.3 ± 25.4 (preoperative), 55.1 ± 21.3 (4 months), 58.3 ± 22.3 (6 months), 64.7 ± 24.2 (1 year), and 65.2 ± 25.3 (2 years). The greatest increase in the median score was between preoperatively and 4 months (+17.5 points) after surgery and between 6 months and 1 year (+9.2 points) after surgery (Figure 3).

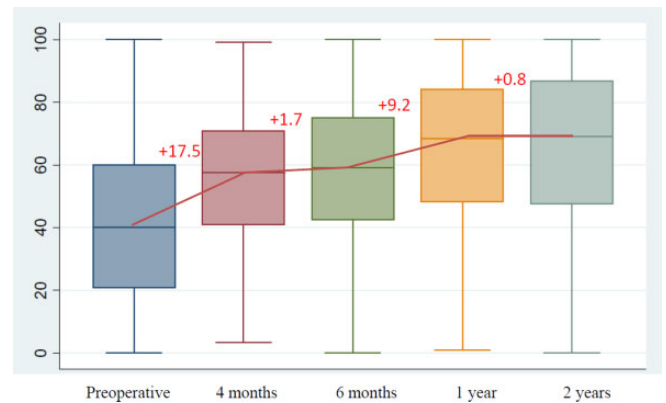


Figure 3. Progression of the Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI) score (median and range) regardless of return to sport.

TABLE 3
ACL-RSI Scores and Return to Running
at Each Follow-up Time^a

| | Return to Running | No Return to Running | <i>P</i> |
|----------|-------------------|----------------------|----------|
| 6 months | 61.8 ± 21.2 | 51.5 ± 22.9 | <.00001 |
| 1 year | 68.1 ± 22.8 | 53.3 ± 25.4 | <.00001 |
| 2 years | 70.4 ± 22.8 | 49.8 ± 26.2 | <.00001 |

^aData are presented as mean ± SD. ACL-RSI, Anterior Cruciate Ligament–Return to Sport after Injury.

Relationship Between the ACL-RSI Score and Return to Sport at Different Follow-up Times

The rate of returning to running was 66.3% at 6 months, 76.2% at 1 year, and 74.9% at 2 years after surgery. The rate of returning to the same preinjury sport was 19.9% at 6 months, 41.0% at 1 year, and 58.4% at 2 years. The ACL-RSI score was significantly higher at each follow-up time in patients who returned to either running or their same sport ($P < .00001$) (Tables 3 and 4).

The ACL-RSI score was significantly higher at the 2-year of follow-up in patients who had returned to and were still practicing their preinjury sport at the same or higher level (Table 5). Patients who returned to and practiced their preinjury sport at 2 years had a significantly better ACL-RSI score at the different follow-up times than those who did not: preoperative (45.9 ± 26.6 vs 37.5 ± 22.5; $P = .0002$), 4 months (59.3 ± 20.6 vs 49.8 ± 20.8; $P < .00001$), 6 months (63.8 ± 20.1 vs 50.6 ± 23.0; $P < .00001$), and 1 year (72.0 ± 20.4 vs 53.1 ± 25.3; $P < .00001$).

Relationship Between the ACL-RSI Score, Functional Scores, and Satisfaction at 2-Year Follow-up

A significant correlation ($P < .00001$) was found between the ACL-RSI score and all functional scores: a strong correlation ($r = 0.52-0.76$) with the IKDC, KOOS pain, KOOS sport, KOOS quality of life, and Lysholm scores and a

TABLE 4
ACL-RSI Scores and Return to the Same Preinjury Sport at Each Follow-up Time^a

| | Return to Same Sport | No Return to Same Sport | P |
|----------|----------------------|-------------------------|---------|
| 6 months | 70.6 ± 19.4 | 55.3 ± 22.0 | <.00001 |
| 1 year | 74.1 ± 19.8 | 53.8 ± 24.3 | <.00001 |
| 2 years | 75.7 ± 19.3 | 50.6 ± 25.6 | <.00001 |

^aData are presented as mean ± SD. ACL-RSI, Anterior Cruciate Ligament–Return to Sport after Injury.

TABLE 5
ACL-RSI Scores at 2-Year Follow-up Depending on the Level of Play^a

| | Same or Higher Level (n = 241) | Lower Level or Changed/Stopped Sport (n = 440) | P |
|----------------|--------------------------------|--|---------|
| ACL-RSI (/100) | 81.6 ± 16.1 | 53.2 ± 24.1 | <.00001 |

^aData are presented as mean ± SD. ACL-RSI, Anterior Cruciate Ligament–Return to Sport after Injury.

moderate correlation with the KOOS function in daily living ($r = 0.47$) and KOOS symptoms ($r = 0.48$) scores (Table 6).

At 2-year follow-up, 90.2% of patients were satisfied (very satisfied and satisfied, 53.2% and 37.0%, respectively), 7.5% were fairly satisfied, and 2.3% were not satisfied. The satisfied and very satisfied patients had a significantly higher ACL-RSI score compared with the other patients (68.5 ± 23.3 vs 35.6 ± 23.6 , respectively; $P < .00001$) and returned to and continued to practice their preinjury sport significantly more often (70.7% [very satisfied], 48.8% [satisfied], 29.4% [fairly satisfied], and 25.0% [not satisfied]; $P < .0001$).

ACL-RSI Score Threshold at 2-Year Follow-up

The binary criterion was return to the same preinjury sport. The AUC was 0.77 (95% CI, 0.74-0.81). The ACL-RSI score was moderately informative about returning to the same preinjury sport. The optimal ACL-RSI score threshold at 2-year follow-up was ≥ 65 , with a sensitivity of 75.1%, a specificity of 68.5%, 72.4% of well-classified patients, and a positive and negative likelihood ratio of 2.4 and 0.3, respectively (Figure 4).

Postoperative Complications at 2-Year Follow-up

In this series, 75 (11.0%) patients presented with at least 1 complication. The most common complication was cyclops syndrome (23 patients; 3.4%) that developed at a mean of 11.7 months. Retears were seen in 11 (1.6%) patients at a mean of 17.4 months; in all cases, it was a sport-related injury. Contralateral ACL tears occurred in 10 (1.5%) patients at a mean of 17.7 months; in all cases, it was a

TABLE 6
Correlation Between ACL-RSI Scores and Functional Scores at 2-Year Follow-up^a

| | Mean ± SD | Pearson Correlation Coefficient | P |
|-------------------------------|-------------|---------------------------------|---------|
| IKDC subjective | 91.5 ± 12.2 | 0.59 (strong) | <.00001 |
| KOOS symptoms/stiffness | 84.0 ± 14.5 | 0.48 (moderate) | <.00001 |
| KOOS pain | 92.4 ± 9.8 | 0.52 (strong) | <.00001 |
| KOOS function in daily living | 96.1 ± 7.3 | 0.47 (moderate) | <.00001 |
| KOOS sport | 81.2 ± 20.6 | 0.61 (strong) | <.00001 |
| KOOS quality of life | 73.1 ± 23.7 | 0.76 (strong) | <.00001 |
| Lysholm | 89.5 ± 11.9 | 0.58 (strong) | <.00001 |

^aACL-RSI, Anterior Cruciate Ligament–Return to Sport after Injury; IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score.

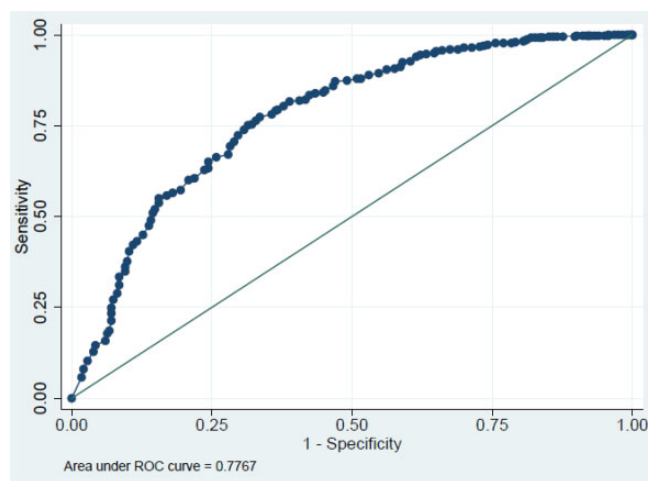


Figure 4. Optimal Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI) score threshold in patients who returned to the same preinjury sport at 2-year follow-up. ROC, receiver operating characteristic.

sport-related injury. Other complications and additional surgeries included medial meniscal lesions (1.3%), knee stiffness (0.9%), algodystrophy (0.9%), hemarthrosis (0.7%), lateral meniscal lesions (0.3%), septic arthritis (0.4%), chondroplasty (0.3%), and tibial cysts (0.1%).

Risk Factors for Not Returning to the Same Preinjury Sport at 2-Year Follow-up

Univariate analysis indicated no difference for age ($P = .50$), sex ($P = .40$), or extra-articular tenodesis ($P = .23$). The following variables were evaluated on multivariate analysis: body mass index >25 kg/m² (yes/no), revision surgery (yes/no), professional athlete or competitive sport (yes/no), complications during follow-up (yes/no), and preoperative functional scores with the following thresholds:

preoperative subjective IKDC score ≥ 50 , preoperative KOOS symptoms/stiffness score ≥ 55 , preoperative KOOS function in daily living score ≥ 75 , preoperative KOOS sport score ≥ 40 , preoperative KOOS quality of life score ≥ 20 , preoperative Lysholm score ≥ 65 , and ACL-RSI score at 6 months ≥ 60 . Although the ACL-RSI score at 4 months was also significantly higher in the patients who returned to the same preinjury sport at the 2-year follow-up (59.3 ± 20.6 vs 49.8 ± 20.8 , respectively; $P < .00001$), only the ACL-RSI score at 6 months was included in the final model because the 2 scores were strongly correlated ($r = 0.73$, $P < .00001$). According to the multivariate analysis, 4 variables were significantly related to returning to the same sport at 2-year follow-up: primary reconstruction (odds ratio [OR], 2.2 [95% CI, 1.2-3.9]; $P = .01$), professional or competitive level of play (OR, 2.7 [95% CI, 1.9-3.9]; $P = .0001$), no complications during follow-up (OR, 2.5 [95% CI, 1.4-4.5]; $P = .003$), and a 6-month ACL-RSI score ≥ 60 of 100 (OR, 3.1 [95% CI, 2.2-4.5]; $P = .0001$).

DISCUSSION

This study shows that the mean psychological ACL-RSI score regularly and gradually increased after ACL reconstruction. The greatest increase occurred between preoperatively and 4 months postoperatively and then between 6 months and 1 year of follow-up. There was less improvement after the 1-year follow-up period. The ACL-RSI score was strongly associated with returning to running and to the same preinjury sport whatever the follow-up period. Patients practicing their same sport at the 2-year follow-up had a significantly higher mean ACL-RSI score than other patients preoperatively (45.9) as well as at the 4-month (59.3), 6-month (63.8), and 1-year (72.0) of follow-up periods. According to the ROC curve, the ACL-RSI score threshold for returning to the same preinjury sport at 2 years postoperatively was ≥ 65 . Patients who were not practicing any sport at 2-year follow-up had an ACL-RSI score of 53.2, and those who returned to sport at the same or a higher level of play as before their injury had a score of 81.6. Patient satisfaction at the 2-year follow-up was significantly and positively associated with the ACL-RSI score and returning to the same preinjury sport.

These findings are comparable with other published results and should help identify patients who may require psychological support and a reinforced program of remotivation. In a study of 87 patients, Langford et al¹⁵ found that athletes who returned to a competitive sport had a significantly higher ACL-RSI score and a more positive psychological response to participation in sport at both the 6- and 12-month follow-up compared with patients who did not return to a competitive sport. The ACL-RSI score improved over time to reach a mean of 58 at 6 months and 72 at 1 year postoperatively in patients who returned to a competitive sport. The authors suggested that patient confidence is reinforced by physical therapy. In a series of 187 patients, Ardern et al⁴ found a significant difference in the ACL-RSI score preoperatively (45) as well as at 4 months after surgery (57) in patients who returned to sport at the same level

at 1 year postoperatively. In another study by Ardern et al⁹ in 164 patients, the ACL-RSI score was the only variable associated with returning to sport at the same level of play, with patients who returned to play having a mean score of 65 at a mean of 34 months postoperatively, compared with a score of 45 at a mean of 36 months in the other patients. In a study including 40 patients, Müller et al¹⁸ showed that the neuromuscular single-hop test and the ACL-RSI score were the strongest predictive factors of return to sport at 6 months after surgery, with a cutoff score of 51.3 points (sensitivity, 0.97; specificity, 0.63).

These results support the biopsychological model described by Cornelius et al⁸ for the rehabilitation of sport injuries, suggesting that a certain number of psychological factors such as personality, cognition, feelings, and behaviors influence the results of rehabilitation after sport injuries. Thus, instead of concentrating on the physical aspects of the injury alone, clinicians and surgeons should take a holistic approach and treat all aspects of functional recovery.^{6,21} This would make it possible to create intervention strategies to facilitate return to competitive sport at the best moment. Standard rehabilitation protocols include objective evaluation criteria allowing step-by-step progress until return to sport.^{11,13} However, this protocol should also include a psychological evaluation at different follow-up periods to identify patients who may need psychological support. The ACL-RSI scale is a useful and well-adapted objective tool in this context. Recently, a battery of tests including functional tests were published to help determine return to sport after ACL surgery.¹⁰ Physical measurements such as isokinetic strength and hop test results were taken into account, but so also was the psychological ACL-RSI score and the subjective IKDC score.

In this study, the factors favoring returning to the same preinjury sport at the 2-year follow-up were a professional or competitive level of play, primary reconstruction, the absence of complications during postoperative follow-up, and an ACL-RSI score at the 6-month follow-up of ≥ 60 . All the other functional scores, which were significantly correlated with returning to the same preinjury sport in univariate analysis, were excluded from the final model.

The strengths of the current study are the large sample size, the high response rate, and the 2-year follow-up period. This study also had several limitations. The time between the initial injury and the first ACL reconstruction procedure was not obtained. Also, the severity of the injury was not assessed in this study, and this can significantly affect the chance of returning to sport in terms of healing and psychological consequences.

CONCLUSION

After ACL reconstruction, the psychological ACL-RSI score gradually increased during follow-up and was strongly and significantly correlated with return to sport. A high-performance athlete who underwent primary reconstruction with no postoperative complications and with a 6-month ACL-RSI score ≥ 60 , is significantly more likely

to return to the same preinjury sport at 2 years after surgery.

REFERENCES

- Almekinders LC, Pandarinath R, Rahusen FT. Knee stability following anterior cruciate ligament rupture and surgery: the contribution of irreducible tibial subluxation. *J Bone Joint Surg Am*. 2004;86:983-987.
- Ardern CL, Taylor NF, Feller JA, Webster KE. A systemic review of the psychological factors associated with returning to sport following injury. *Br J Sports Med*. 2013;47:1120-1126.
- Ardern CL, Taylor NF, Feller JA, Whitehead TS, Webster KE. Psychological responses matter in returning to preinjury level of sport after anterior cruciate ligament reconstruction surgery. *Am J Sports Med*. 2013;41:1549-1558.
- Ardern CL, Webster KE, Taylor NF, Feller JA. Return to sports following anterior cruciate ligament reconstruction surgery: a systematic review and meta-analysis of the state of play. *Br J Sports Med*. 2011;45:596-606.
- Bohu Y, Klouche S, Lefevre N, Webster KE, Herman S. Translation, cross-cultural adaptation and validation of the French version of the Anterior Cruciate Ligament-Return to Sport after Injury (ACL-RSI) scale. *Knee Surg Sports Traumatol Arthrosc*. 2015;23:1192-1196.
- Clement D, Arvinen-Barrow M, Fetty T. Psychosocial responses during different phases of sport-injury rehabilitation: a qualitative study. *J Athl Train*. 2015;50:95-104.
- Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, New Jersey: Lawrence Erlbaum Associates; 1988.
- Cornelius AE, Brewer BW, Van Raalte JL. Applications of multilevel modeling in sport injury rehabilitation research. *Int J Sport Exerc Psychol*. 2007;5:387-405.
- Feucht MJ, Cotic M, Saier T, et al. Patient expectations of primary and revision anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2016;24:201-207.
- Gokeler A, Welling W, Zaffagnini S, Seil R, Padua D. Development of a test battery to enhance safe return to sports after anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2017; 25:192-199.
- Hildebrandt C, Müller L, Zisch B, Huber R, Fink C, Raschner C. Functional assessments for decision-making regarding return to sports following ACL reconstruction, part I: development of a new test battery. *Knee Surg Sports Traumatol Arthrosc*. 2015;23:1273-1281.
- Irrgang JJ, Anderson AF, Boland AL, et al. Development and validation of the International Knee Documentation Committee subjective knee form. *Am J Sports Med*. 2001;29:600-613.
- Kvist J. Rehabilitation following anterior cruciate ligament injury: current recommendations for sports participation. *Sports Med*. 2004;34: 269-280.
- Kvist J, Ek A, Spørstedt K, Good L. Fear of re-injury: a hindrance for returning to sports after anterior cruciate ligament reconstruction. *Knee Surg Sports Traumatol Arthrosc*. 2005;13:393-397.
- Langford JL, Webster KE, Feller JA. A prospective longitudinal study to assess psychological changes following anterior cruciate ligament reconstruction surgery. *Br J Sports Med*. 2009;43:377-388.
- Lefevre N, Klouche S, Mirouse G, Herman S, Gerometta A, Bohu Y. Return to sport after primary and revision anterior cruciate ligament reconstruction: a prospective comparative study of 552 patients from the FAST cohort. *Am J Sports Med*. 2017;45:34-41.
- Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med*. 1982; 10:150-154.
- Müller U, Krüger-Franke M, Schmidt M, Rosemeyer B. Predictive parameters for return to pre-injury level of sport 6 months following anterior cruciate ligament reconstruction surgery. *Knee Surg Sports Traumatol Arthrosc*. 2015;23:3623-3631.
- Roos EM, Lohmander LS. The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. *Health Qual Life Outcomes*. 2003;1:64.
- Swets JA. Measuring the accuracy of diagnosis system. *Science*. 1988;240:1285-1293.
- te Wierike SC, van der Sluis A, van den Akker-Scheek I, Elferink-Gemser MT, Visscher C. Psychosocial factors influencing the recovery of athletes with anterior cruciate ligament injury: a systematic review. *Scand J Med Sci Sports*. 2013;23:527-540.
- Webster KE, Feller JA, Lambros C. Development and preliminary validation of a scale to measure psychological impact of returning to sport following anterior cruciate ligament reconstruction surgery. *Phys Ther Sport*. 2008;9:9-15.