# **Return to Soccer After Acute Anterior Cruciate Ligament Primary Repair**

# A 2-Year Minimum Follow-up Study of 50 Amateur Players

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**Background:** Return to sport (RTS) after treatment of an anterior cruciate ligament (ACL) tear is a critical parameter to assess the outcome of a surgical procedure. However, few studies have investigated RTS after ACL repair.

Purpose: To evaluate RTS of a group of amateur soccer players at a minimum follow-up of 2 years after ACL repair.

Study Design: Case series; Level of evidence, 4.

**Methods:** A retrospective review of all patients treated with acute ACL repair was conducted. A total of 50 amateur soccer players were included in the study. Patients were examined clinically or contacted to complete postoperative patient-reported outcome measures, namely the Knee injury and Osteoarthritis Outcome Score, the International Knee Documentation Committee questionnaire, the ACL-Return to Sport After Injury scale, and the Forgotten Joint Score–12.

**Results:** The patients' mean age was  $25.8 \pm 7.7$  years (range, 14-47 years), and the mean follow-up was  $34.3 \pm 10.7$  months (range, 24-51.3 months). The median Tegner Activity Scale score was 9. The ACL repair failure rate was 16% (8/50). The mean time from repair to failure was  $23.1 \pm 12.7$  months (range, 6-44 months), and the mean age of patients who sustained ACL repair failure was  $19.9 \pm 3.3$  years (range, 14-24 years), significantly lower compared with patients who did not experience ACL repair failure ( $26.9 \pm 7.9$  years; range, 16-47 years; P = .017). Multivariate analysis showed that age  $\leq 21$  years was the only significant risk factor for ACL repair failure (odds ratio, 5.45; confidence interval, 1.24-27.91; P = .041). Excluding the 8 patients who experienced repair failure, 31 of 42 patients (73.8%) returned to soccer after ACL repair, with 29 of the 31 (93.5%) returning at their pre-injury level of play. Moreover, patients who played competitive soccer and returned to their preinjury level of play were significantly younger than those who did not return to their preinjury level of play (mean,  $21.1 \pm 3.4$  vs  $29.2 \pm 9.5$  years, respectively; P = .002) and had significantly better ACL-Return to Sport After Injury scores (mean,  $96.6 \pm 4$  vs  $87.8 \pm 11$ , respectively; P = .044).

**Conclusion:** In this study, 73.8% (n = 31) of patients returned to playing soccer, of whom 93.5% (n = 29) returned to their preinjury level after ACL repair. The failure rate was 16% (n = 8) and mainly involved patients  $\leq$ 21 years old.

Keywords: knee; soccer; ACL; repair

Return to sport (RTS) after anterior cruciate ligament (ACL) rupture is one of the most important parameters to assess the outcome of surgery and rehabilitation and the level of patient satisfaction.<sup>13,18</sup> RTS after ACL surgery is generally allowed between 6 and 12 months, with the rate of patients who return to the same preinjury levels ranging from 55% to 65%.<sup>2,26</sup> RTS after ACL reconstruction (ACLR) is affected by several factors. Studies have shown that male patients aged  $\leq$ 25 years returned to level 1 sports (jumping and pivoting) <1 year after surgery, whereas patients aged 26 to 35 years demonstrated a lower

rate of RTS.<sup>8,31</sup> In addition, psychological readiness, often assessed by the ACL–Return to Sport After Injury (ACL-RSI) score, influences RTS.<sup>8,32</sup>

Interest has arisen recently in primary acute repair of the ACL, especially in proximal tears, because its proximal vascularization provides the repaired ligament with a chance of healing.<sup>11,15</sup> In addition, ACL repair preserves the proprioceptive function of the native ligament and the range of motion (ROM) of the knee and prevents donor site morbidity.<sup>16,22,28</sup>

Although limited research on RTS after ACL primary repair is available, a recent study including 60 patients with a minimum 2-year follow-up demonstrated a 60% rate of return to preinjury activity levels.<sup>26</sup> However, to the best of our knowledge, specific research focusing on return to soccer after ACL repair is lacking.<sup>22,26</sup>

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The purpose of this study was to evaluate RTS in a cohort of amateur soccer players who had undergone primary ACL repair. The hypothesis was that most of these soccer players would be able to resume sports at levels comparable to their preinjury state.

# METHODS

# Patient Selection and Clinical Outcomes

After our institutional review board granted approval, a retrospective review of all patients who had undergone acute (within 14 days from injury) primary ACL repair between January 2018 and July 2021 was conducted. Inclusion criteria included amateur soccer players who, at the time of injury, had a preoperative Tegner score of  $\geq$ 7, indicating intense knee sports activity.<sup>5</sup> For the purposes of this study, an amateur soccer player was defined as one who participated in the fourth to ninth Italian divisions. These leagues, which fall under the aegis of the Italian Football Federation, include both national and regional matches and comprise the largest player base in Italy. They are, by definition of the Italian Football Federation, amateur leagues.

Patients were excluded if they met  $\geq 1$  of the following criteria: inability to undergo surgery within 14 days of injury, chronic inflammatory diseases, multiligament injuries, Kellgren-Lawrence grade 3 or 4, playing sports at the professional level, or refusal to participate in the study.

Patients were examined on an outpatient basis or contacted to complete postoperative patient-reported outcome measures (PROMs), namely the Knee injury and Osteoarthritis Outcome Score (KOOS) and the International Knee Documentation Committee (IKDC) questionnaire, and to report time back to sports. They were also asked to complete the ACL-RSI scale and the Forgotten Joint Score–12 (FJS-12).<sup>27,32</sup>

# Surgical Technique

The surgical technique has been described in detail.<sup>11</sup> All surgeries were performed within 14 days of the index injury, and only patients with proximal reducible type 1 and 2 ACL lesions with good or fair tissue quality, according to the Sherman classification modified by van der List and DiFelice,<sup>23</sup> were included in the study. Reducibility of the tear was assessed with the Figure-of-4 Cruciate Remnant Objective Assessment test. This test is performed at 90° of knee flexion and in the figure-of-4 position by gently pulling the remnant to the femoral footprint with a grasper.<sup>19</sup> If no detachment was observed between the remnant and the footprint, and the quality of the remnant allowed the sutures to be held, the lesion was repaired. The



**Figure 1.** Arthroscopic images of the right knee, viewed via a transpatellar tendon portal, showing (A) a proximal anterior cruciate ligament (ACL) tear with good tissue quality prepared with high-strength sutures and (B) the final appearance of the repaired ACL.

tibial remnant of the ACL was prepared by passing the suture through the 2 bundles of the ligament with a Scorpion Suture Passer (Arthrex), using high-strength sutures (Arthrex) looped through the ligament with a lasso-loop knot-tying configuration. Subsequently, a femoral guide with an outside-in technique was placed at the level of the femoral stump to produce the femoral tunnel and allow the suture stitches to pass through and be fixed with a button using a pull-out technique (Figure 1).

# Postoperative Rehabilitation Protocol

The postoperative rehabilitation protocol was standardized. A short-ROM knee brace was applied for the first 4 postoperative weeks. The brace was locked in extension for the first 7 days and unlocked between  $0^{\circ}$  and  $90^{\circ}$  of flexion for the remaining 3 weeks, after which time the brace was removed. Full weightbearing as tolerated was allowed from the first postoperative day unless a concomitant meniscal repair was performed, in which case full weightbearing was delayed for 2 weeks. After the first week, patients began rehabilitation focusing on full ROM recovery, especially extension. The protocol allowed for a gradual return to athletic activity at 6 months. Return to pivoting contact sports was allowed at 8 to 9 months after surgery. In addition to the standard rehabilitation protocol, patients were given the opportunity to participate in a customized RTS program, with validated criteria. However, not all patients chose to participate in this additional program.

#### Statistical Analysis

Descriptive data were analyzed for the entire cohort of patients. All analyses were performed with SPSS Statistics

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**Figure 2.** Study flowchart in line with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement (http://www.strobe-statement.org). ACL, anterior cruciate ligament; ACLR, ACL reconstruction.

software (Version 27.0.1.0; IBM). Statistical significance was set at P < .05. Descriptive data analyses were performed according to the type of criteria considered. For quantitative data, this included the number of observations (and missing values, if any), mean, standard deviation, median, first and third quartiles, and minimum and maximum values. For qualitative data, this included the number of observed and missing values and the number and percentage of patients per class. Comparisons between variables were assessed using the chi-square or Fisher exact test for categorical variables and the Student t test or Wilcoxon test for quantitative variables. Normality of variables was assessed by Kolmogorov-Smirnov test. Failure was defined as ipsilateral second ACL injury. To assess Patient Acceptable Symptom State for the included PROMs, ACL repair-specific thresholds were defined according to Ferreira et al<sup>9</sup>: subjective IKDC, 73.6; Lysholm, 89.0; KOOS Pain, 91.7; KOOS Symptoms, 85.7; KOOS Activities of Daily Living, 99.0; KOOS Sport and Recreation Function, 75.0; KOOS Quality of Life; 62.5; ACL-RSI, 54.2; and FJS-12, 68.8. An analysis of factors influencing RTS and soccer was then conducted. These included demographic variables, characteristics of surgery, objective clinical outcomes, and PROMs. Multivariate logistic regression was used to identify risk factors associated with graft failure. Factors included were those selected as statistically significant at the 25% threshold and those of clinical interest. The threshold of 82.2 for ACL-RSI was evaluated as a risk factor.<sup>34</sup>

TABLE 1 Patient Characteristics  $(N = 50)^a$ 

Patient Characteristic	Value
Age, y	$25.8 \pm 7.7 \ (14-47)$
Body mass index	$23.7 \pm 2.7 (17.6-29.4)$
Sex	
Male	43 (86)
Female	7(14)
Injured lower limb	
Dominant	33 (66)
Nondominant	17 (34)
Time from injury to surgery, d	$7.7 \pm 3.3 (2-14)$
Follow-up, mo	$34.3 \pm 10.7 \ (24-51.3)$
Tegner activity scale, median (range)	9 (7-9)
Tegner activity scale	
Recreational soccer (7)	17 (34)
Competitive soccer—lower divisions (9)	33 (66)

 $^aData$  are presented as mean  $\pm$  SD (range) or n (%) unless otherwise noted.

## RESULTS

## Patient Characteristics

During the study period, 201 patients were referred to our institution with acute ACL tears. After application of inclusion and exclusion criteria, the final study population comprised 50 patients (Figure 2).

The mean age was  $25.8 \pm 7.7$  years, and the majority of patients (86%) were male. In terms of activity level, as assessed by the Tegner Activity Scale, the median score was 9. Patient characteristics of the study population are summarized in Table 1 and the characteristics of surgery in Table 2.

# ACL Repair Failures

At a mean final follow-up of  $34.3 \pm 10.7$  months (range, 24-51.3 months), the ACL repair failure rate in the overall population was 16% (8/50). All 8 patients who experienced failure underwent ACLR with ipsilateral hamstrings autograft, and no specific difficulties were encountered in performing the reconstruction arising from the previous surgery. The mean time from repair to failure was  $23.1 \pm 12.7$  months (range, 6-44 months). The Kaplan-Meier cumulative survivorship of ACL repair is reported in Figure 3.

# Analysis of Potential Risk Factors for ACL Repair Failure

Univariate analysis indicated a higher risk of ACL repair failure in younger players, particularly those who were aiming to return to competitive soccer, corresponding to a Tegner Activity Scale score of 9. All 8 patients who experienced ACL repair failure achieved a postoperative Tegner score of 9, whereas no failures were observed in patients with a postoperative Tegner score of  $\leq 8$  ( $\chi^2 =$ 9.5; P = .002). Patients who experienced ACL repair failure

TABLE 2 Surgical Characteristics  $(N = 50)^a$ 

Surgical Characteristic	Value
Pivot-shift grade	
Negative	1(2)
Glide	11 (22)
Clunk	20 (40)
Gross	18 (36)
Medial meniscal tear	
No	42 (84)
Yes	8 (16)
Lateral meniscal tear	
No	39 (78)
Yes	11 (22)
ACL lesion	
Type 1: good	15 (30)
Type 1: fair	13 (26)
Type 2: good	12 (24)
Type 2: fair	10 (20)

 $^aData$  are presented as n (%). Anterior cruciate ligament (ACL) lesions were graded according to the Sherman classification as modified by van der List et al. $^{23}$ 

had a mean age of 19.9 years (range, 14-24 years) and were significantly younger than those who did not experience repair failure (mean age, 26.9 years; range, 16-47 years; P = .017). None of the other variables assessed reached statistical significance.

In the multivariate analysis, factors such as age, sex, preoperative and postoperative Tegner scores, preoperative pivot-shift grade, and postoperative ACL-RSI score were considered as possible risk factors for rupture. The only significant risk factor for developing an ACL repair failure that emerged from multivariate analysis was patient age  $\leq 21$  years (odds ratio, 5.45; confidence interval, 1.24- 27.91; P = .041).

### Return to Sport

All 8 patients who experienced ACL repair failure were able to return to their previous level of competitive soccer after ACLR. Overall, excluding the 8 patients who experienced failure, 73.8% (n = 31) of patients returned to soccer after ACL repair, of whom 93.5% (n = 29) returned to the same preinjury level.

Figure 4 shows the distribution of patient scores on the Tegner Activity Scale pre- and postoperatively.

Patients who resumed sport activity had significantly better outcomes on the ACL-RSI than those who did not resume sport activity (mean, 94.5  $\pm$  6.4 vs 72.6  $\pm$  12.9, respectively; P < .001). This difference was also highlighted for the return to soccer (95.5  $\pm$  5 vs 79.6  $\pm$  13.3; P < .001) and the return to preinjury level (mean, 95.5  $\pm$  5.1 vs 82.4  $\pm$  13.8; P < .001).

Regarding patients who played competitive soccer, those who returned to the same level as before the index injury were significantly younger than those who did not return to their preinjury level of play (mean,  $21.1 \pm 3.4$ 



Figure 3. Kaplan-Meier survival plot for anterior cruciate ligament repair survivorship between groups. Vertical axis, cumulative survivorship; horizontal axis, months of follow-up.



**Figure 4.** Tegner Activity Scale (TAS) distribution before and after surgery.

vs 29.2  $\pm$  9.5 years, respectively; *P* = .002) and had significantly better ACL RSI scores (mean, 96.6  $\pm$  4 vs 87.8  $\pm$  11, respectively; *P* = .044).

Overall, patients returned to sports at a mean of  $9 \pm 3.3$  months (range, 5-18 months). No difference was found in the timing of RTS between patients who returned to the same level of activity and those who did not. The mean time to return to soccer was  $9.8 \pm 4.1$  months (range, 5-18 months). Again, no differences were found between patients who returned to the same level and those who did not.

# PROMs and Knee Stability Outcomes

Postoperative PROMs are displayed in Table 3. Most patients achieved Patient Acceptable Symptom State postoperatively for the PROMs studied, with percentages ranging from 90.5% to 97.6% for the KOOS subscales, 97.6% for subjective IKDC score, 95.2% for Lysholm score, and 100%

TABLE 3 PROM Results for Patients Who Did Not Experience Failure of the ACL Repair  $(n = 42)^a$ 

PROM	Value
Overall KOOS	$94.1\pm9.3$
KOOS Symptoms	$92\pm9.3$
Patients achieving PASS	40 (95.2)
KOOS Pain	$93.3 \pm 11.8$
Patients achieving PASS	38 (90.5)
KOOS Activities of Daily Living	$98.1\pm6.5$
Patients achieving PASS	41 (97.6)
KOOS Sport and Recreation Function	$92.4~\pm~7.7$
Patients achieving PASS	41 (97.6)
KOOS Quality of Life	$94.2 \pm 12.8$
Patients achieving PASS	41 (97.6)
Subjective IKDC	$93.9\pm5.8$
Patients achieving PASS	41 (97.6)
Lysholm	$95.8 \pm 4.3$
Patients achieving PASS	40 (95.2)
FJS-12	$96 \pm 4.3$
Patients achieving PASS	42 (100)
ACL-RSI	$91.8 \pm 10.2$
Patients achieving PASS	42 (100)
Tegner activity scale, median	7

<sup>a</sup>Data are presented as mean  $\pm$  SD or n (%) unless otherwise noted. ACL, anterior cruciate ligament; ACL-RSI, ACL-Return to Sport after Injury; FJS-12, Forgotten Joint Score–12; IKDC, International Knee Documentation Committee score; KOOS, Knee injury and Osteoarthritis Outcome Score; PASS, Patient Acceptable Symptom State; PROM, patient-reported outcome measure.

for ACL-RSI and FJS-12. The median postoperative Tegner activity scale score was 7.

The mean postoperative side-to-side laxity was  $1.6 \pm 1$  mm. None of the patients in whom ACL repair was successful had a high-grade pivot shift (Table 4).

### Secondary Surgical Procedures

The rate of secondary surgery for indications other than ACL repair failure was 8% (4/50 patients). Two patients had contralateral ACL injuries; 1 of these patients underwent contralateral primary ACL repair and 1 patient underwent ACLR because the new injury did not meet the criteria of reparability. Two patients underwent secondary meniscectomy for medial meniscal lesion. No patients in our study experienced other complications requiring surgery.

### DISCUSSION

The main finding of the present study was that most of the amateur soccer players who had undergone primary ACL repair resumed sports activities, with a substantial proportion specifically returning to soccer. Moreover, most of those who had returned to soccer were able to play at their preinjury competitive level. These data are consistent with a recent study investigating RTS after ACL repair, which

TABLE 4Reported Knee Stability Outcomes for Patients Who DidNot Experience Failure of the ACL Repair  $(n = 42)^{\alpha}$ 

Knee Stability Outcome	Value
Side-to-side laxity, mm	$1.6 \pm 1 \; (0-4)$
0 or 1 +	42 (100)
2+ or 3+	0 (0)

 $^aData$  are prsented as mean  $\pm$  SD (range) or n (%). ACL, anterior cruciate ligament.

showed that 85% of the patients resumed any sport, of which 70% were pivoting sports.<sup>26</sup> However, our study is the first to specifically evaluate return to soccer, the most popular sport in Italy, after ACL repair.

One of the factors influencing RTS is psychological readiness, and fear of reinjury contributes to a decreased rate of RTS after an ACL injury.<sup>8,17</sup> Although several previous studies assessed ACL-RSI in patients who underwent primary ACLR and revision, few authors applied this score to ACL repair.<sup>7,26,30</sup> The current study showed that patients who returned to sports and soccer had better scores on the ACL-RSI. In addition, patients who returned to soccer at their preinjury level were younger and had higher scores on the ACL-RSI. This finding is consistent with ACLR studies showing that younger patients had a greater ability to return to their preinjury level. However, in other studies, older patients also returned to the same preinjury level.<sup>26,33</sup>

On average, the time to RTS was 9 months and the time to return to soccer was almost 10 months. These data are consistent with a recent study that showed a mean of 10 months for RTS after ACL repair, with no significant difference compared with ACLR.<sup>9</sup> However, another recent study showed a quicker RTS with a mean of 6 months after ACL repair plus anterolateral knee compartment repair compared with ACLR with lateral extra-articular tenodesis.<sup>10</sup> This quicker RTS may result from the lack of donor site morbidity, earlier recovery of ROM, and a better isokinetic muscle strength at 6 months after ACL repair.<sup>9,24,28</sup>

The failure rate for ACL repair typically ranges from 7% to 11%.<sup>1,25</sup> However, in the current study, this rate was slightly higher, with 16% (n = 8) of the enrolled patients requiring subsequent ACLR. Several studies have investigated potential risk factors for failure of ACL repair.<sup>6,14</sup> Heusdens et al<sup>14</sup> found that a higher risk of failure was associated with third-degree healing of the ACL on magnetic resonance imaging 6 months after surgery and a preoperative Tegner score  $\geq$ 7. In contrast, a recent study found that risk factors for repair failure were age <17 or >35 years, elite competitive level, time from injury to surgery, and active smoking.<sup>6</sup> The failure rate of the current study is higher when compared with ACLR using the patellar tendon or hamstring tendon in soccer players.<sup>3,4</sup>

The only significant risk factor revealed by multivariate analysis associated with failure of an ACL repair was younger age. Indeed, the mean age of patients who underwent a subsequent ACLR was 19.9 years. This finding is consistent with the reported high failure rate of ACL repair in patients aged  $\leq 21$  years.<sup>12,28</sup> Vermeijden et al<sup>28</sup> found a 37% failure rate in patients  $\leq 21$  years of age, whereas Gagliardi et al<sup>12</sup> found a 41% failure rate of ACL repair in adolescents. Both studies suggested that primary ACL repair in these age groups should be cautiously considered. However, these are high-risk patient categories, because the rate of secondary ACL injuries after ACLR in patients <25 years old was 21%, with a rate of 20% for those returning to sports and 23% for those participating in high-risk sports.<sup>31</sup> In addition, a 14% rate of graft rupture after ACLR was observed in 18- to 19-year-old patients at a mean of approximately 2 years postoperatively.<sup>29</sup>

The underlying causes of ACL repair failure remain somewhat unclear. A recent study suggested that biological variations in the ruptured ACL stump may be a contributing factor. It has been observed that the stump tends to reabsorb more frequently and extensively in younger patients.9 This phenomenon may explain the increased incidence of ACL repair failure in this younger population. This hypothesis was based on findings from a previous study that found older patients had a higher volume of ACL remnant at the time of surgery.<sup>20</sup> These data are consistent with findings by Murray et al.<sup>21</sup> who showed that older patients had a significantly larger cross-sectional area of the healing ACL on magnetic resonance imaging 6 months after the bridge-enhanced ACL repair procedure. The cross-sectional area of the ligament is a marker of the tissue volume, and a larger cross-sectional area of the healing ACL is suggestive of higher maximum load and linear stiffness.<sup>21</sup>

Based on the current literature and the results of the present study, ACL repair appears more suitable for older patients. However, further studies with longer follow-up are needed to evaluate the outcomes of ACL repair in soccer players.

To our knowledge, this study is the first to evaluate return to soccer in amateur soccer players after ACL repair, and it had several limitations. One limitation is the retrospective design, which may have led to the introduction of potential bias. Also, we were not able to control individual changes in rehabilitation programs or compliance with them. Another limitation is that we could not clearly determine the reasons why patients did not return to their previous sports level for reasons independent of the knee, such as a lack of time or reduced interest in sports. ACL repair in this population showed good clinical outcomes. However, more mid- and long-term studies and comparisons with patients who underwent ACLR are needed to evaluate the outcomes of ACL repair in amateur soccer players and in patients involved in knee-strenuous activities.

# CONCLUSION

In this study, 73.8% (n = 31) of patients returned to playing soccer. Those who returned to playing soccer included 93.5% (n = 29) who returned to the same preinjury level.

Patients who returned to their preinjury level were younger and scored better on the ACL-RSI. The failure rate of ACL repair at 2-year follow-up was 16% (n = 8), with failures mainly occurring in patients aged  $\leq 21$  years. Nevertheless, and notwithstanding the limitations of the study design, the present results are to be taken into consideration when planning ACL repair using modern techniques in soccer players.

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