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## Return to Play and Future ACL Injury Risk Following ACL Reconstruction In Soccer Athletes From the MOON Group

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### Abstract

**Background**—There is limited information on outcomes and return to play (RTP) after ACL reconstruction (ACLR) in soccer athletes.

**Hypothesis**—The purpose of this study was to (i) test the hypotheses that player sex, side of injury and graft choice do not influence RTP, and (ii) define the risk for future ACL injury in soccer players after ACLR.

**Study design**—Retrospective cohort study, Level II.

**Methods**—Soccer players in a prospective cohort were contacted to determine RTP following ACLR. Information regarding if and when they returned to play, their current playing status, the primary reason they stopped playing soccer (if relevant) and incidence of subsequent ACL surgery was recorded.

**Results**—Initially, 72% of 100 soccer athletes (55 male, 45 female) with a mean age of 24.2 years at the time of ACL reconstruction returned to soccer. At average follow up of 7.0 years, 36% were still playing, a significant decrease compared to initial RTP ( $p < 0.0001$ ). Based on multivariate analysis, older athletes ( $p = 0.006$ ) and females ( $p = 0.037$ ) were less likely to return to play. Twelve soccer athletes had undergone further ACL surgery, including 9 on the contralateral knee and 3 on the ipsilateral knee. In a univariate analysis, females were more likely to have future ACL surgery (20% v. 5.5%,  $p = 0.03$ ). Soccer athletes who underwent ACLR on their non-dominant limb had a higher future rate of contra-lateral ACLR (16%) than soccer athletes who underwent ACLR on their dominant limb (3.5%) ( $p = 0.03$ ).

**Conclusion**—Younger and male soccer players are more likely to return to play after ACL reconstruction. Return to soccer following ACLR declines over time.

### Keywords

Gender; graft choice; leg dominance; anterior cruciate ligament; football

### Introduction

Soccer is the most popular sport worldwide with an estimated 240 million active players.<sup>34</sup> It is one of the fastest growing sports in the United States with approximately 20 million registered players<sup>17</sup> and an annual increase in participation of over 20%.<sup>1</sup> The incidence of soccer related injuries is estimated to be 10 to 35 per 1000 playing hours in adult male players,<sup>34</sup> and is often higher in younger and less skilled players.<sup>26</sup> Approximately 60–80%

of severe injuries occur in the lower extremities,<sup>8,11,19</sup> most commonly at the knee (29%) or ankle (19%).<sup>8</sup> The most serious and frequent injuries occur to the ACL, PCL and MCL.<sup>11,19</sup> A review of collegiate women's soccer injuries from the 1988–89 season through the 2002–3 season reported a rate of 1.0 ACL injuries per 1000 athlete game exposures and compared to 0.10 per 1000 athlete practice exposures.<sup>9</sup> An identical study of collegiate men's soccer for the same period reported less than 0.19 ACL injuries per 1000 athlete game exposures and less than 0.04 ACL injuries per 1000 athlete practice exposures.<sup>2</sup> A study of elite European soccer reported that a high level professional men's team can expect 0.4 ACL injuries per season and a similar level women's team can expect 0.7 ACL injuries per season.<sup>33</sup> These injuries have been shown to be associated with a delayed return to play<sup>12,27</sup> and may be career ending.<sup>30</sup>

Despite ACL rupture being a common and potentially serious soccer injury, there are relatively few studies on outcomes and specifically return to play after ACL reconstruction in these athletes.<sup>4,28,30,32,33</sup> Although females have a higher risk for this injury,<sup>3,33</sup> large general cohort studies have not reported any effect of gender on outcome after ACL reconstruction.<sup>29,31</sup> However, no studies have compared ACL outcomes in male soccer players to those in female soccer players. Furthermore, no studies have looked at whether involvement of the dominant limb or graft choice affects return to play in these athletes. Finally, there is little known about the reasons that soccer athletes do not get back to sport, i.e. due to the injury itself or due to other circumstances. The purpose of the present study was to test the hypothesis that gender, side of injury and graft choice do not relate to return to play and determine the incidence of subsequent ACL surgery after ACL reconstruction in soccer players.

## Methods

Patients for this study were selected from the prospective Multicenter Orthopaedic Outcomes Network (MOON) ACL cohort. Patients completed a questionnaire documenting demographics, injury mechanism, patient-based outcome measures, history of previous knee surgery and activity level prior to their surgery. The attending surgeon completed a form documenting examination under anesthesia (EUA), status and treatment of meniscal<sup>10</sup> and articular cartilage<sup>23</sup> injuries, and details of ACL reconstruction and rehabilitation milestones as detailed in previous publications.<sup>31,35</sup>

After approval of the study by the Institutional Review Board from amongst three of the largest enrolling participating institutions (Washington University in St. Louis, Cleveland Clinic, and Vanderbilt University), those institution's enrolled patients in the 2002 and 2003 cohort were reviewed. As part of enrollment at the time of surgery, each patient completed a questionnaire pertaining to their sports participation, level of activity, overall health, and the nature of their ACL injury. Patients who answered "soccer" in response to either their primary or secondary sport participated in most over the last two years were considered eligible for participation in the current study. All eligible patients were then contacted and asked a structured series of questions about their participation in soccer at the time of injury and since their injury (Figure 1).

Collected data, including preferred kicking leg (defined in this study as the dominant leg), level of play at the time of ACL injury and reconstruction, return to play (including timing and level of play), current level of play, and reasons for not returning to play (if applicable), and need for subsequent ACL surgery on either leg was then combined with the general cohort database for analysis.

Specific variables extracted from the general database included graft choice, injury mechanism, and incidence and dates of subsequent surgery. Descriptive statistics were generated for all data. Return to play, both initially and at latest follow-up, and the need for subsequent surgery were the primary outcome variables analyzed for the overall cohort. Gender based comparisons of age and time of return to play were conducted using a t-test. Return to play, both initially and at final follow-up was analyzed with free open source R statistical software ([www.r-project.org](http://www.r-project.org)) using a multivariable logistic regression model with return to play as the dependent variable, and with age, gender, and graft type as the independent variables. Interquartile range (IQR) odds ratios (OR) are given for continuous variables, IQROR demonstrate the effect of increasing a baseline variable from its first quartile to its third quartile. All other comparisons were conducted as a univariate analysis using a  $\chi^2$  test.

## Results

### Demographics

A total of 117 patients from the 2002 and 2003 database were identified as soccer athletes. We were able to contact 103 of these patients for 88% follow up in our cohort (Figure 2). Three of the contacted patients were not soccer players and were excluded from any analysis. Mean age of the 100 soccer athletes (55 male, 45 female) in this cohort was 24.2 years with a range of 11.1–53 years. Males (mean 27.7, range 14.7–49.8) were older than females (mean 19.8, range 11.1–53.0) ( $p < 0.0001$ ). Most of the athletes were treated with bone patellar tendon bone autograft (69%) and hamstring autograft (28%). Four athletes (4%) were treated with bone patellar tendon bone allograft.

### Return to play

Overall 72% of soccer athletes (male 76%, female 67%) returned to soccer at an average of  $12.2 \pm 14.3$  months after surgery, with 85% of those returning to soccer getting back to the same or higher level of play as prior to their injury. There was no significant difference between males and females in the mean time to return to play (males  $10.2 \pm 7.3$  months v. females  $15.0 \pm 20.3$  months,  $p = 0.23$ ). At long term follow-up of  $7.2 \pm 0.9$  years, only 35% of soccer players who underwent ACL reconstruction (male 38%, female 31%) were still playing the sport, a significant decrease compared to initial return to play ( $p < 0.0001$ ). Of those still playing, only 46% were still playing at the same or higher level of play as prior to their injury, a significant decrease compared to initial return to play ( $p < 0.0001$ ).

In the multivariate analysis of initial return to play analyzing age, gender and graft type as potential risk factors, only age and gender were predictors of initial return to play (Figure 3). Specifically, females were less likely than males to return to play OR = 0.31 (95% CI: 0.10, 0.93)  $p = 0.037$ , and older subjects were less likely to return to play IQROR = 0.38 (95% CI: 0.19, 0.76)  $p = 0.006$ . However, at latest follow-up, age, gender and graft choice did not predict long term return to play.

Men were more likely (56%) than women (26%) to attribute their ACL injury as the primary reason they were no longer playing soccer ( $p = 0.02$ ).

### Side of Injury

Overall, the dominant leg was injured in 57% of the soccer athletes. There was no difference between men (56%) and women (58%). Women were more likely to be right foot dominant (96% v 78%,  $p = 0.02$ ). There was no difference based on involvement of the dominant or non-dominant leg in terms of rate of return to (dom 70% v. non dom 74%) or time to return

to play (dom  $11.7 \pm 12.2$  months v. non dom  $12.8 \pm 16.8$  months). There was no difference in the long term return to play between the dominant (33%) and non dominant leg (37%).

### Future ACL Surgery

Twelve soccer athletes (12%) had undergone further ACL surgery, including 9 on the contralateral knee (9%) and 3 (3%) on the ipsilateral knee. Overall, 25% of the athletes who underwent further ACL surgery were still playing at final follow-up, including 4 of the 9 athletes who underwent ACL reconstruction on the contralateral knee (44%) and none of the 3 athletes who underwent revision ACL reconstruction. There was more subsequent ACL surgery in females (20%) compared to males (5.5%) ( $p=0.03$ ). Soccer athletes who underwent ACL reconstruction on their non-dominant limb had a higher future rate of contra-lateral ACL reconstruction (16%) than soccer athletes who underwent ACL reconstruction on their dominant limb (3.5%) ( $p=0.03$ ).

## DISCUSSION

Soccer players have a good initial rate of return to play following ACL reconstruction which declines over time, although many athletes are still playing years after surgery. Younger and male soccer athletes are more likely to return to soccer after ACL reconstruction while graft does not appear to have any impact on return to play. Males may be affected more directly than females by the injury itself as opposed to other factors or life events in terms of their potential return to play. There is a high risk of recurrent ACL injury in these athletes, particularly in female soccer players and those who injure their non-dominant leg.

Previous studies have shown results similar to ours. A recent study of ACL injury in high level soccer athletes from Europe reported 94% return to play within 10 months,<sup>33</sup> with no long term follow-up. A study of 118 soccer players who underwent ACL reconstruction with iliotibial band autograft reported that 68% of athletes were still playing soccer at a median follow-up of 4 years.<sup>4</sup> Return to play occurred at a median of 7 months (range 5–24 months) in this cohort. A survey of over 300 soccer players from Sweden reported that only 28% of male and female soccer players were playing soccer three years out from ACL injury.<sup>28</sup> Four years later, only 25% of men and 7% of women were playing soccer in this cohort. However, only half of these athletes underwent ACL reconstruction. Among those who received surgical treatment, 26% of males and 12% of women were still playing at 7 year follow-up.

A few studies have looked at the effect of gender on outcome after ACL reconstruction in the general population. A prospective study comparing ACL outcomes by gender among athletes in various sports found greater laxity and some strength deficits in females compared to males after reconstruction using hamstring but no differences when using bone patellar tendon bone.<sup>18</sup> Two additional studies found no significant gender based difference in outcomes after ACL reconstruction with bone patellar tendon bone in all comers.<sup>15,25</sup> Large general cohort studies have not reported any effect of gender on outcome after ACL reconstruction.<sup>29,31</sup> In our cohort, female soccer athletes are less likely to get back to soccer than their male counterparts. The reasons for this are probably complex as women were less likely than men to attribute their ACL injury as the primary reason they were no longer playing soccer. Nevertheless, female soccer players should be made aware of this information prior to surgery, particularly if return to play is a primary motivation for the surgery.

The general consensus in the literature is that outcomes from BPTB and hamstring autograft are very similar.<sup>7,22,24</sup> A recent case control study comparing BPTB with hamstring autograft in the young athlete found no difference in return to play between the two grafts.<sup>24</sup>

The recent study of ACL reconstruction in elite European soccer players reported no difference in time of return to play between the two grafts although the percentage of athletes getting back to soccer was not reported by graft.<sup>33</sup> In our study, there was no significant effect of (auto)graft choice on return to play in soccer athletes.

We are not aware of any previous study reporting the effect of leg dominance on outcome from ACL reconstruction in soccer athletes. Our finding that 57% of ACL injuries occurred on the dominant limb is similar to the findings from other studies. In the recent study of elite male and female soccer players from Europe, half of the ACL injuries occurred in the dominant leg.<sup>33</sup> Another study of male soccer athletes reported that 50% of ACL injuries occurred in the dominant leg.<sup>14</sup> In a German study of injuries in their female national soccer league, 69% of the ACL injuries occurred in the dominant leg.<sup>13</sup> Although the dominant limb ACL may be at slightly higher risk of injury, our data suggests limb involvement does not have any impact on return to play in soccer athletes.

The reasons for not returning to play after ACL injury and reconstruction differed by gender in our cohort. The majority of men attributed their ACL injury as the primary reason they did not return to soccer compared to only one in four of the women. There are a number of possible explanations for this discrepancy. Men may find the injury and surgery more traumatic and/or painful and be more averse to repeating this experience. Conversely, women may be more likely to limit their participation due to other external factors such as graduating from a certain level of schooling or starting a career or family. Although a previous study reported that fear was the primary factor for not returning to play in 24% of athletes who underwent ACL reconstruction,<sup>21</sup> this area deserves more investigation both for soccer players in particular and athletes in general.

There was a high rate of subsequent ACL surgery in this cohort, especially in females and on the contra-lateral limb. These rates are similar to those reported for the general population.<sup>29,36</sup> In our study, the higher rate in females may be at least partly explained by the younger age of the female cohort. The limited events (i.e. further surgery) precluded a multivariable analysis; therefore, the univariate statistics reported are not controlled for age and activity level previously shown to predict ACLR graft failure.<sup>5</sup> Only a multivariate analysis can control for age and Marx activity level that have been previously shown to predict ACLR graft failure.<sup>5,20</sup> This would require more subsequent surgeries than reported in this study.

Soccer athletes who injure their non-dominant limb are at higher risk of injuring the ACL in their contra-lateral dominant limb in the future. The reasons for this relationship are not clear. Perhaps the injury and reconstruction create or increase neuromuscular differences between the limbs. Injury to the non-dominant limb may lead to even greater dependence on the dominant limb during play, potentially increasing the risk for future injury.

Fortunately, there is a growing body of evidence that ACL injury prevention programs may be effective in soccer athletes.<sup>6,16</sup> It may be particularly important to evaluate these programs in soccer athletes who have already undergone ACL reconstruction, especially females and athletes who injure their non-dominant leg, as they appear to be at heightened risk for recurrent or new injury.

The limitations of the current study include a dependence on subject recall at the time of follow-up which is more likely to be variable on level of performance, time interval until return to play or reason for not returning than whether they returned to play. The cohort includes a relatively limited number of athletes and may not be large enough to provide definitive results for all of the studied comparisons. Prospective data may yield slightly different results when asking on performance when they returned to play or all the reasons

why they did not. Furthermore, this cohort study was not adequately powered to perform a multivariable analysis of risk factors (predictors) on subsequent surgery. In addition, we do not know the expected rate of continued participation in soccer for athletes who do not injure their ACL. For example, what percentage of 27 year old soccer players with intact knees are still active in the sport 7 years later? Despite this limitation, the information is still relevant for soccer players who do injure their ACL and undergo reconstruction as it predicts the likelihood of their future participation in the sport.

This study represents a large, long term follow up of return to play in soccer athletes following ACL reconstruction. These athletes can get back to play despite the decline in participation over time. Younger and male soccer athletes are more likely to return to play after ACL reconstruction. There is a high risk for future ACL injury, especially in female soccer players, and ACL reconstruction in the non-dominant limb may increase the risk for future ACL injury in the dominant limb. Soccer players who undergo ACL reconstruction may benefit from and be the ideal population for targeted injury prevention programs. More research and a larger population of soccer players is needed to study more potential variables that impact return to play initially and over time in these athletes and subsequent ACL surgery.

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MOON Soccer Questionnaire

1.What was your preferred kicking leg at the time you injured your ACL?

\_\_\_\_\_
(please select the foot you would use to take a free kick, for example, even if you were skilled with both feet)

2.What level of soccer were you playing at the time of your ACL injury (select one):
professional/adult rec/adult club/college/high school/youth/other \_\_\_\_\_

3.Did you return to playing soccer after your ACL reconstruction? yes / no
If so, how many months after surgery? \_\_\_\_\_ At what level?
professional/adult rec/adult club/college/high school/youth/other \_\_\_\_\_

4.Are you currently playing soccer? yes / no If so, at what level?
professional/adult rec/adult club/college/high school/youth/other \_\_\_\_\_

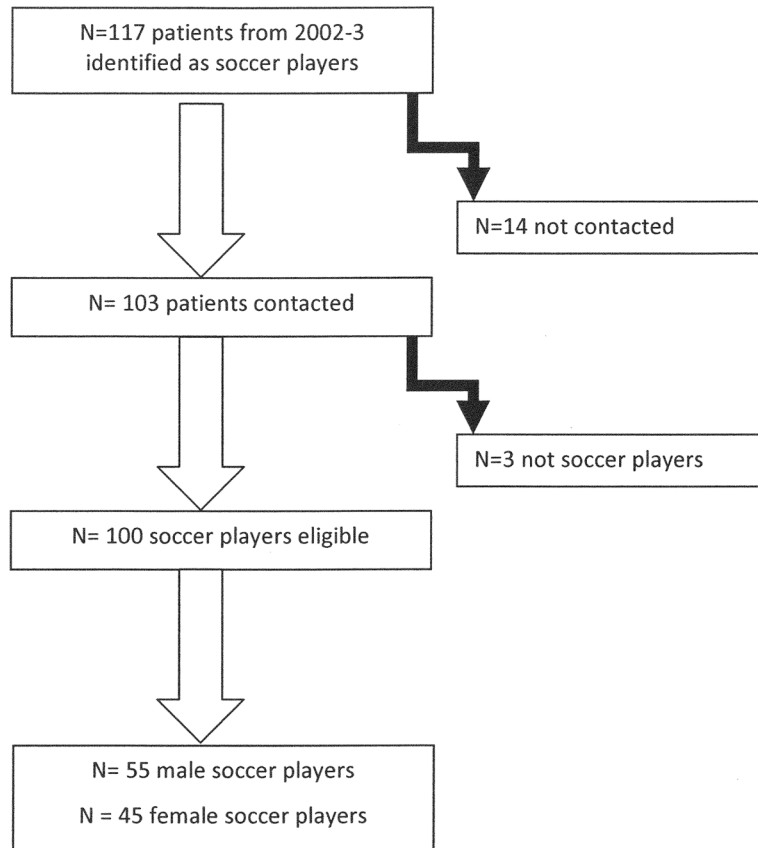
5.If you are currently not playing soccer, was the injury to your knee the primary reason
you have stopped playing soccer? yes / no If no, what was the primary reason?
\_\_\_\_\_

I understand that I have answered these questions as part of a follow up study related to
the MOON study of ACL reconstruction in which I am already enrolled. I agree to allow
my answers to be included in MOON related studies of outcome after ACL
reconstruction in soccer players.

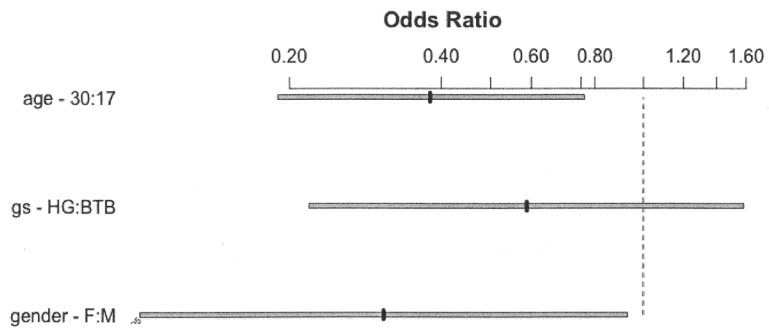
Signature: \_\_\_\_\_
Name (print): \_\_\_\_\_

(For minors)
Parent/guardiansignature: \_\_\_\_\_
Parent name (print): \_\_\_\_\_
Relationship to patient: \_\_\_\_\_

Figure 1. Soccer questionnaire



**Figure 2.** Follow up of soccer athletes from the MOON questionnaire



**Figure 3.** Summary plot of the predictors of initial return to play adjusted for all three variables the model.