

Impact of Anterior Cruciate Ligament Injury on European Professional Soccer Players

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Background: The impact of anterior cruciate ligament reconstruction (ACLR) on the performance and career of professional soccer players has not been extensively investigated.

Purpose: To evaluate in professional European soccer players (1) the ACL injury incidence, (2) the return-to-play (RTP) rate and time after ACLR, (3) career survival and athlete performance in the first 3 postoperative seasons after RTP, (4) factors likely related to different outcomes after ACLR, and (5) any related differences between the top 8 European soccer leagues.

Study Design: Descriptive epidemiology study.

Methods: Included were professional soccer players in the top 8 European Soccer leagues (Serie A [Italy], Premier League [England], Ligue 1 [France], LaLiga [Spain], Bundesliga [Germany], Jupiler Pro League [Belgium], Liga NOS [Portugal], and Premier Liga [Russia]) who sustained an ACL injury during seasons 2014 to 2015, 2015 to 2016, and 2016 to 2017. Data were retrieved from publicly available online sources. Outcomes were evaluated based on player age (<25 years, 25–30 years, and >30 years), position (goalkeeper, defender, midfielder, and forward), affected side (dominant vs nondominant), and league.

Results: Overall, 195 players sustained an ACL injury, for a mean annual ACL injury incidence of 1.42%. The RTP rate was 95%, with a mean RTP time of 248 ± 136 days. Within the third postoperative season, 66 players (36%) competed in a lower level national league, and 25 (13.6%) ended their careers; a significant reduction in the mean minutes played per season was found in all 3 postoperative seasons. Player age correlated significantly with reduction in performance or recovery from an ACL injury. No significant correlation was found between postoperative player performance and affected side, position, league, or time to RTP.

Conclusion: A substantial ACL injury incidence was found in top European elite soccer players; however, a high RTP rate in a reasonable time was seen after ACLR. Nevertheless, professional soccer players experienced a short-term decline in their performance.

Keywords: ACLR; career; football; professional athletes; return to play; soccer

Despite extensive research on anterior cruciate ligament (ACL) injuries, the rates of such injuries among professional athletes have not decreased over the past few decades, neither in contact nor noncontact sports.^{2,6,8,15,21} Among Major League Soccer (MLS) players in the United States, an increase in annual ACL injuries was registered between 1996 and 2012.¹⁰ ACL rupture may represent a troublesome event for elite soccer players' careers because of the long rehabilitation process, the risk of further ipsilateral and contralateral injuries, and the development of early osteoarthritis.¹⁷ Several works investigating the return to play (RTP) after ACL reconstruction (ACLR) are present in the literature,^{5,7,10,17,18,23,25} and differences in ACLR results between various sports have been found.¹⁴

A higher RTP rate has been reported in elite soccer players than in other sports, ranging from 77% to 95%.^{23–25} The mean time to RTP ranged from 6 to 13 months.¹² Recently, it was reported that 86% of elite male soccer players still played soccer 3 years after ACLR, but only 65% competed at their preinjury level.²⁴

In this regard, the impact of ACLR in professional soccer players' career, in terms of recovery time, postoperative performance, level of play, career ending, or further injuries, has not been investigated extensively. Furthermore, in the current literature, there are no studies that extensively investigate elite European soccer players, assessing the existing differences between the top European Soccer leagues. Such information could not only enlighten expectations of physicians, clubs and athletes but also guide the rehabilitation process until RTP following ACLR. For these reasons, the purposes of this study were to evaluate (1) ACL injury incidence in professional European soccer players,

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(2) the RTP rate and time after ACLR, (3) the outcomes after RTP in term of career survival and athletes' performance in the 3 postoperative seasons, (4) the factors likely related to different outcomes after ACLR, and (5) the differences existing between the top 8 European leagues.

METHODS

In this retrospective study, we identified the top 8 European Soccer leagues according to the United European Football Association (UEFA) country ranking during seasons 2014 to 2015, 2015 to 2016, and 2016 to 2017. Leagues that were included were Serie A (Italy), Premier League (England), Ligue 1 (France), LaLiga (Spain), Bundesliga (Germany), Jupiler Pro League (Belgium), Liga NOS (Portugal), and Premier Liga (Russia). Players affected by an ACL injury who belonged to the first-team rosters of these leagues were considered eligible for study inclusion.

Age, body mass index (BMI), position, injury history, affected side, RTP rate and time, and percentage of played minutes-per-season (MPS) before and after ACLR were retrieved from the publicly available media-based platform Transfermarkt (<https://www.transfermarkt.com/>). This is an online archive of data about soccer players, which has been used in previous similar papers. Missing data were retrieved through other publicly available online sources.

Primary ACL injury was defined as a first-time rupture of the ligament. ACL injury incidence was calculated as the rate of injury per year, with total incidence calculated as an average of all included years. RTP rate was defined as the percentage of players, among all the injured players, having played at least 1 game at a professional level after ACLR. RTP time was assessed as the number of days from an ACL injury to the first match appearance. MPS was defined as the percentage of minutes played divided by the total playable minutes during each season. The mean MPS was calculated both for the 3 preinjury and the 3 postoperative seasons; players were excluded from the MPS evaluation if they did not play 3 seasons before or after the injury or if data were not available. The rate of minutes played during the first postoperative season was measured by the total playable minutes since the RTP date.

Players who were transferred to other clubs, changed to an inferior league, or stopped their career for any reason before the end of the third season were recorded. The downgrade leagues were defined as being transferred to an inferior competitive level according to the United European Football Association (UEFA) country ranking during the same seasons. Complications were defined as reruptures (ipsilateral or contralateral), patellar fractures, reoperation,

or any adverse event occurring within the rehabilitation period resulting in a delayed or missed RTP.

The RTP rate was compared by league, player age (>25 years, 25-30 years, and >30 years), position (goalkeeper, defender, midfielder, and forward), and season (2014-2015, 2015-2016, and 2016-2017).

The statistical analysis generated standard descriptive statistics means, standard deviations, and proportions. The Mann-Whitney *U* test was applied to verify statistical differences. Correlation between RTP time played MPS, level of competition, age, affected side, position, and league was evaluated by calculating the Pearson correlation coefficient and linear regression. The entire study is adequately powered with a 95% CI. Statistical significance was set at $P < .05$. SPSS (IBM) software was used for all calculations.

RESULTS

During the study period, 195 elite male soccer players sustained an ACL injury, for a mean annual ACL injury incidence of 1.42% (ie, 195 injured from 13,736 players in the 3 investigated seasons). Overall, 183 players satisfied inclusion criteria, while 12 were excluded due to insufficient available data. Demographic data of the participants are reported in Table 1. The mean age at the time of injury was 25.4 ± 3.9 years (range, 18-37 years). The injury occurred during matches in 77.6% of cases. No predominant position was observed. There were 9 players who did not return to sport after ACLR. The small number of players who did not RTP precluded further analysis.

The RTP rate was 95%, and the mean RTP time was 248 ± 136 days (range, 101-1294 days). The shortest RTP time was found in the Ligue 1 (France) (193 days) and the longest in the Premier League (England) (321 days). The studied leagues from France, Italy, and Germany presented a significantly shorter RTP time than the English league ($P < .001$). The French league also showed a considerably faster RTP than its Spanish, Russian, and Portuguese counterparts ($P < .001$) (Figure 1). The mean RTP times according to age group, position, and season of injury are reported in Figure 2. Players older than 30 years presented a statistically significantly shorter RTP time than players aged 25 to 30 years ($P < .001$). No significant differences were found in RTP time when considering player position or season of injury.

The mean preoperative MPS was $46\% \pm 22\%$ (range, 1%-96%), and it decreased to $33\% \pm 26$ ($P < .001$) in the first postoperative season to $40\% \pm 28$ ($P = .020$) in the second, and to $38\% \pm 29$ ($P = .005$) in the third (Table 2). Players younger than 25 years significantly reduced MPS only in the

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first postoperative season ($P = .002$). According to the different leagues in Italy, England, and Belgium, a statistically significant difference between the mean preinjury and the mean postoperative MPS was present. In the Italian league, a statistically significant reduction in MPS was found in all 3 postoperative seasons. The greatest MPS reduction between the preinjury and the first postoperative season was found in the English league. Even though an overall reduction in MPS

was found in the leagues from Germany and Portugal, this did not reach statistical significance (Table 3).

During the study period, 30 cases of complications were reported in 26 players (14.2%): 7 (3.8%) sustained an ipsilateral rerupture, 14 (7.7%) a contralateral ACL injury, 3 (1.6%) an ipsilateral patella fracture, and 6 players (3.3%) reported an unspecified complication on the operated side during the rehabilitation, resulting in an RTP delay.

Within the third postoperative season, 66 players (36%) competed in a lower-level national league, and 25 players (13.6%) ended their careers. Players older than 30 years presented a statistically significant higher rate of ending their career/changing to a lower league ($P < .001$). Among 21 injured players older than 30 years of age, 10 were transferred to a lower league and 6 stopped their career. Age younger than 25 years was significantly associated with better recovery of the postoperative MPS than older age ($P < .01$). No other statistically significant correlation ($P > .05$) was found between player performance after ACLR (ie, played MPS, level of competition or career-ending) and age, affected side, position, league, or RTP time.

TABLE 1

Demographic Data of the Participants (N = 183)^a

Age, y	25.4 ± 3.9 (18-37)
Height, m	1.82 ± 0.0 (1.68-1.90)
Weight, kg	75.8 ± 6.6 (63-89)
BMI, kg/m ²	22.7 ± 2.3 (20.9-24.5)
Injured side	Right, 101 (55.2); left, 82 (44.8)
Dominant side	Right, 109 (59.6); left, 74 (40.4)
Position	
Goalkeeper	15 (8.2)
Defender	67 (36.6)
Midfielder	58 (31.7)
Forward	43 (23.5)
Injury	
Match	142 (77.6)
Training	38 (20.7)
Other/unknown	3 (1.6)
Return to play	174 (95)
Complications	30 (16.4)
Rerupture	7 (3.8)
Contralateral ACL injury	14 (7.7)
Ipsilateral patellar fracture	3 (1.6)
Other/unknown	6 (3.3)
League downgrade	66 (36)
Ended career	25 (13.6)

^aData are presented as mean ± SD (range) or n (%). ACL, anterior cruciate ligament; BMI, body mass index.

DISCUSSION

The main findings of the current study were that a sizable ACL injury incidence was found between top European elite soccer players. ACLR appears to be a reliable surgical procedure, resulting in a high RTP rate in a reasonable time, with 95% of players returning to play after ACLR, and 81% of players still competing 3 years after their injuries. However, by more careful analysis, some data could lead to a less optimistic view. ACL injury may affect athletes' performance, even after successful RTP. During the 3 postoperative seasons, a statistically significant reduction in the MPS was present, and 49.6% of players were active at a lower national level or retired. Furthermore, the player's

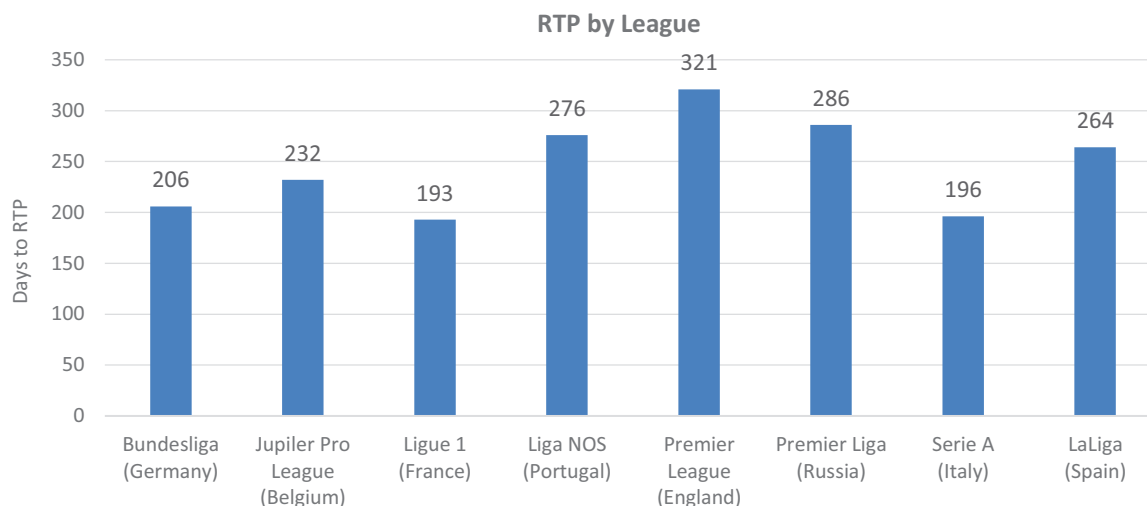


Figure 1. RTP time in the top 8 European leagues by country. RTP times in the French, Italian, and German leagues were significantly shorter compared with the English league ($P < .001$). The French league also showed a significantly faster RTP than its Spanish, Russian, and Portuguese counterparts ($P < .001$). RTP, return to play.

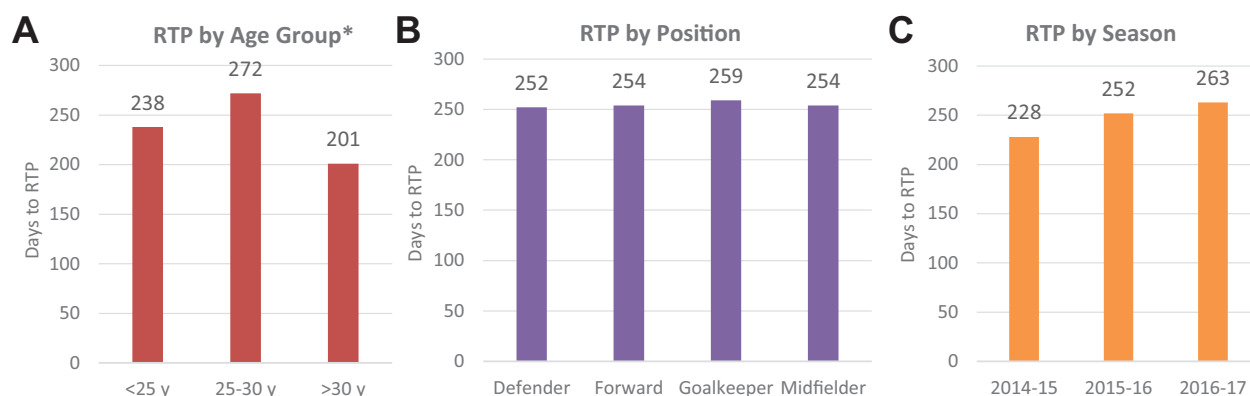


Figure 2. RTP time according to (A) player age, (B) player position, and (C) season of injury. *Players in the >30-year group had a statistically significantly shorter RTP time than players in the 25- to 30-year group ($P < .001$). No significant differences were found between position or seasons.

TABLE 2
MPS According to Age^a

	Total	Under 25	25-30	Over 30
Preinjury, %	46	40	50	55
Post-ACLR season 1, %	33 ^b	29 ^b	35 ^b	39 ^b
Post-ACLR season 2, %	40 ^b	43	40 ^b	31 ^b
Post-ACLR season 3, %	38 ^b	41	39 ^b	28 ^b
Post-ACLR mean, %	35 ^b	36 ^b	36 ^b	32 ^b

^aACLR, anterior cruciate ligament reconstruction; MPS, minute-per-season.

^bStatistically significant reduction compared with the preinjury MPS ($P < .05$).

league and age seemed to affect RTP time and recovery after ACLR.

Soccer has been the sport most commonly associated with an ACL tear in the Norwegian National Knee Ligament Registry.¹³ The United Kingdom National Ligament Registry 2017 estimated that 46.7% of all ACL injuries occurred playing soccer. Moreover, according to the UEFA Champions League Injury study,⁹ every top team should expect an ACL tear every 2 seasons. To the best of our knowledge, the current study presents the most extensive series of elite European soccer players suffering from an ACL injury. A total of 195 ACL injury cases among the first team rosters of the top-8 European Soccer Leagues during seasons 2014 to 2015, 2015 to 2016, and 2016 to 2017 were found. The mean ACL injury incidence was 1.42%, confirming previous findings that European soccer is a sport with a substantial risk for ACL tears.

After the injury, 9 players did not return to sport. The current study found a 95% RTP rate, with a mean RTP time of 248 ± 136 days (range, 101-1294 days). These findings align with the recent literature, which reports a higher RTP rate in professional than in recreational athletes.^{4,5,20} Walden et al²⁴ found a 97% RTP rate among European professional soccer players. The mean RTP time was 7.4 months, and 85.6% of players returned to compete

within the first postoperative year. According to Niederer et al,¹⁷ in European soccer, a 98.2% RTP rate is present with a mean RTP time of 209 ± 93 days. Conversely, a lower RTP (77%) rate and a longer RTP time (10 months) were reported in the United States among MLS soccer players.¹⁰

The previous largest cohort of professional soccer players was reported by Barth et al³, who showed a 93% RTP rate with a mean RTP time of 310.9 ± 14.9 days after ACLR. However, in their study, they included 176 subjects from the European and US leagues, and more than half belonged to English Premier League. Furthermore, their analysis was conducted between 1996 and 2005, a long period in which the changes in surgical techniques and rehabilitation programs could hinder a homogeneous interpretation of the results.

RTP rate alone does not provide a clear insight into how players perform once they returned to the competition. Very few studies analyze how ACLR affects professional soccer players' career and performance or the factors likely predicting greater impairment after ACLR.^{3,22} A statistically significant decrease in the MPS during all 3 postoperative seasons was found in the current study. Mean MPS decreased from $46\% \pm 22\%$ preoperatively to $33\% \pm 26\%$ in the first postoperative season, $40\% \pm 28\%$ in the second postoperative season, and $38\% \pm 29\%$ in the third postoperative season. Return to the preinjury level of performance was more common and faster in players younger than 25 years. These findings are similar to those reported both by Barth et al,³ who showed a reduction in performance parameters in the first and second seasons after ACLR, and Niederer et al,¹⁷ who showed a decrease in players performance until 2 years from surgery when compared with a matched group. Conversely, Erikson et al,¹⁰ in a smaller sample of MLS, found no significant difference in performance parameters with the preinjury levels. However, during the same observation period, they also found a performance reduction in a control group of healthy players, suggesting that a control group might be affected by intrinsic variability or external factors (eg, other injuries). According to the findings of the current study, during the first postoperative season, a relevant dip occurs in

TABLE 3
MPS According to League^a

	Bundesliga (Germany)	Jupiler Pro League (Belgium)	Ligue 1 (France)	Liga NOS (Portugal)	Premier League (England)	Premier Liga (Russia)	Serie A (Italy)	LaLiga (Spain)
Preinjury, %	44	51	48	37	47	35	56	50
Post-ACL season 1, %	39	35 ^b	33 ^b	37	26 ^b	17 ^b	38 ^b	36 ^b
Post-ACL season 2, %	42	51	45	31 ^b	35	23	42 ^b	45
Post-ACL season 3, %	39	23 ^b	46	54	38	33	36 ^b	39
Post-ACL mean, %	40	36 ^b	38	33	33 ^b	24	38 ^b	41

^aACL, anterior cruciate ligament reconstruction; MPS, minute-per-season.

^bStatistical significant reduction compared with preinjury MPS ($P < .05$).

players' performance, which requires almost 2 years to return to previous performance. Such recovery can be expected more easily at younger ages.

As with National Football League (NFL) in the United States or basketball players, premature career-ending is believed to occur after ACLR in soccer.^{1,5,17,19} The results of the current study found that, 3 years after ACLR, 25 players (13.6%) ended their careers and one-third of players (36%) were transferred to a lower national league and competed at a lower level than preinjury. Age greater than 30 years was found to correlate negatively with career survival and level of competition. Due to the lack of a control group of healthy players, it is impossible to state if this finding represents the physiological career decline occurring with advancing age or if it confirms that ACL injury could mark irreparably the career of older players. In a study by Walden et al,²⁴ elite soccer players were followed until 3 years after ACLR. Sufficient data were available only for 93 players. Of these, 87% were still active (64.5% at the same and 22.5% at a lower level), and 13% of players in their series ended their careers. However, no factors predicting worse outcomes were reported. At 5 years after ACLR, Niederer et al¹⁷ noted that only 69.9% of players were still active, and 40.9% at the same level as preinjury. They found no association between RTP time, age, career duration, or competition level within 5 years of ACLR. In contrast with our findings, they reported a correlation between RTP time and player position, with the more offensive positions having longer RTP time.

To the best of our knowledge, no study in the literature has investigated the differences between the various European leagues, which might explain the differences in terms of outcomes after ACLR present in multiple studies. Quite surprisingly, notable differences exist between different leagues. The mean RTP ranged from 193 (Ligue 1, France) to 321 days (Premier League, England). The French, Italian, and German leagues presented significantly shorter RTP times than the English league. Inadequate data to explain why some leagues presented such a rapid RTP time while others showed a more cautious recovery are present, and it must also be considered that this is the first study in

the literature assessing such differences between European professional leagues. It is also noteworthy that different RTP times were not correlated significantly with players' performance, complications, or adverse events during the 3 postoperative investigated seasons, raising doubts about the actual advantages of such an extended rehabilitation period.

Furthermore, in the Italian league, a statistically significant reduction in MPS was found in all 3 postoperative seasons. Notably, the English league saw the most significant MPS reduction between the preinjury and the first postoperative season. In Italian, English, and Belgian leagues, a statistically significant difference between the mean preinjury and mean postoperative MPS was present. Conversely, even though an overall reduction in MPS was found in the German and Portuguese leagues, this did not reach statistical significance. The MPS reduction in different Leagues was not found to correlate statistically with RTP time, complication rate, players' position, or age, except for players under 25 years who presented a significant shorter recovery of the preoperative MPS after an initial reduction in the first postoperative season. Thus, the differences noted in the current study between European leagues—similar to the differences reported between European and USA soccer players—likely witnessed a different approach of surgeons, clubs, or athletes themselves to an ACL injury. However, it is impossible to draw any definitive conclusion due to the public data source (no medical reports) and the lack of other comparable studies.

It has been estimated that elite players still have a 10% to 15% risk of sustaining a second ACL injury after RTP.^{3,22} The results of the current study are in line with existing literature, having found an overall 11.5% risk of ipsilateral or contralateral ACL rerupture. Reinjury risk was not associated significantly with player age, position, MPS, or RTP time. Younger age has been identified previously as a risk factor for second ACL injury.¹⁶ Such a finding was not confirmed by the current study, which limits the follow-up to 3 postoperative seasons. Younger patients may present a greater risk of reinjury because they inherently have more time during their career to sustain a second ACL injury and

not because the younger age inherently has a real greater risk of rerupture. Such bias could be eliminated by following players of different age for the same follow-up period.

The current study investigated the impact of ACL injury, in terms of RTP rate/time and player performance, among the most extensive series of elite European soccer players reported in literature and this represents the main strength of the study. Furthermore, to the best of our knowledge, this is the first study to assess the differences between the top-8 European Soccer leagues, also analyzing factors likely related to different outcomes after ACLR.

Because data are retrieved from public online sources, we acknowledge that this study also presents some limitations. The recent literature recognizes that such online sources could underreport the true incidence of athletes' injuries,¹¹ and it is certainly possible that the current study missed some injured players. Without available medical records or imaging, information about associated lesions (concomitant meniscus, collateral ligament, articular cartilage injuries), surgical techniques, graft choice, and rehabilitative rehabilitation programs were not available. Such factors may play a role in players' recovery and performance after an ACL injury, and the analysis of data categorizing those variables could be valuable. However, because an injury database like those used in NFL or the National Basketball Association (NBA) does not exist for European soccer, such sources represent the best available and independent option and have been previously employed successfully in other similar studies.

Furthermore, RTP was defined as returning to play at a professional level, which does not consider returning to train. Players may have not been selected for a match, despite being fully recovered and allowed to participate in training sessions. Lastly, the lack of a matched group does not allow comparison of players with ACLR and healthy players in terms of performance and career outcomes. However, ambiguous findings have been reported in similar studies with a control group because other injuries or unpredictable factors may likely alter players career, making the inclusion of healthy players for such a control group less reliable. Furthermore, the current manuscript is proposed as an epidemiologic study with the aim of enlightening aspects of ACL injuries and return to sport in European professional soccer players, and this could likely mitigate such limitation.

CONCLUSION

A substantial incidence of ACL injury was found in top European elite soccer players, confirming soccer as a sport at risk of ACL injury. ACLR could be considered a reliable and surgical procedure, leading to a high RTP rate in a reasonable time. Nevertheless, professional soccer players experience a short-term decline in their performance. Interesting differences were found between top 8 European Soccer leagues. Such information could not only help enlighten the expectations of physicians, clubs, and athletes themselves but also guide rehabilitation to RTP

following ACLR and should represent a prioritized research area in the near future.

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