

Return to Play and Player Performance After Meniscal Tear Among Elite-Level European Soccer Players

A Matched Cohort Analysis of Injuries From 2006 to 2016

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Background: Meniscal injuries are extremely common in soccer athletes, and little is known about postrecovery performance.

Purpose: To (1) identify characteristics associated with return to play (RTP) to the same league level and (2) evaluate long-term effects that injury and management approach may have on player performance.

Study Design: Cohort study; Level of evidence, 3.

Methods: Using publicly available records, we identified athletes who sustained meniscal tears across the 5 major European soccer leagues (English Premier League, Bundesliga, La Liga, Ligue 1, and Serie A) between 2006 and 2016. Injured athletes were matched to controls 1:2 by demographics and performance. Investigations included rate of RTP to the same league level, reinjury, player characteristics associated with RTP within 2 seasons, long-term availability, field time, and performance metrics standardized to 90 minutes of play during the next 4 seasons.

Results: A total of 250 players sustaining meniscal tears were included, of which 106 (42%) received surgical management. Median absence was 57.5 days (interquartile range [IQR], 35-92) or 7 games (IQR, 4-12). Rate of RTP was 70%, and the reinjury rate 5% if a player could RTP. Age greater than 30 years was a negative predictor for RTP (odds ratio [OR], 0.62; $P = .002$), whereas higher preinjury goals per game (OR, 2.80; $P = .04$) and surgical management (OR, 1.38; $P = .002$) were positive predictors for RTP. Surgical management was associated with higher long-term availability ($P < .01$). As compared with the control, there were no significant differences in field time or performance metrics after RTP, either overall or by player position. As compared with nonoperative management, defenders undergoing surgery demonstrated decreased field time. Attackers and midfielders demonstrated similar field time and performance regardless of management.

Conclusion: RTP of elite soccer athletes sustaining meniscal tear is contingent on age, preinjury performance, and management approach. Those who RTP to the same league level can be expected to demonstrate equivalent field time, performance, and long-term availability as noninjured athletes.

Keywords: case-control; football (soccer); general sports trauma; meniscal tear; performance outcomes

Soccer is the most popular sport in the world, with nearly 129,000 athletes competing professionally and over 220 million playing recreationally worldwide.^{9,10} Injuries to the meniscus are particularly prevalent in soccer players, with an incidence of 0.448 injuries per 1000 hours of playing.³ The sport-specific demands for quick cutting, pivoting, and tackling render these athletes particularly susceptible to

meniscal tears. The athlete with a meniscal tear is often treated with meniscectomy or meniscal repair, depending on the size and location of the tear. Potential sequelae of meniscal injuries include the loss of in-season competition days and diminished career longevity.

With regard to the timing of return-to-play (RTP), previous investigations have demonstrated that athletes typically RTP 1 to 3 months after meniscectomy^{1,14,23} and 4 to 6 months after meniscal repair.^{2,22} However, only 2 of these aforementioned studies have specifically isolated elite soccer players in their analyses.^{2,23} It is critical to consider this

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high-risk patient population individually when delineating a timeline for return to sport after meniscal injury.

The ability to return to preinjury level of competition after meniscal repair is subject to debate in current literature. Several previous studies have shown that most athletes return to their preinjury level of competition at 1 year postoperatively,^{18,22} whereas others have found that many athletes never return to their preinjury levels of competition after surgery.^{2,16} The current literature has largely utilized the Tegner score as a means by which to compare pre- and postinjury competition levels.^{2,16,18,22}

No studies to date have used objective data, such as goals scored or number of minutes played, to compare onfield athletic performance pre- and postmeniscal injury. It is important to elucidate the impact of a meniscal injury on an athlete's onfield performance after RTP to provide appropriate preoperative counseling and guide expectations during rehabilitation. Thus, the aims of this case-control analysis were to (1) identify characteristics associated with RTP to the same league level and (2) evaluate long-term effects that the approach to injury and management may have on player performance.

METHODS

Player Identification

A retrospective review of male soccer players in any 1 of the 5 major European soccer leagues (English Premier League, Bundesliga, La Liga, Ligue 1 and Serie A) was conducted from 2006 to 2016 via a publicly available database as established in previous investigations.^{11,24,29} Institutional review board approval was not required for this study. Players with meniscal tears and those without reports of any lower extremity injury were identified in the database. All player injury reports were cross-referenced with official league reports, official team websites, injury reports, official team press releases, personal websites, and professional statistical websites.

Inclusion Criteria

Inclusion criteria consisted of the following: A player was on the team roster during a season the team was ranked within 1 of the 5 major leagues, the player participated in at least 1 game before injury, and the player had a minimum 1-year follow-up after injury. Data collected for each player

include demographic data (age, height, position, and playing experience), recovery time (days and games missed), and performance metrics (games played, minutes played per game/season, goals scored, assists, clean sheets, and conceded goals). RTP was defined as return to any 1 of the 5 major European leagues. Players who were transferred to a team qualifying for 1 of the 5 major leagues were included in the RTP cohort, whereas players transferred to lower tiered teams were not included in the RTP cohort.

Case-Control Matching

A matched cohort analysis was completed to compare performance metrics of players with meniscal injury with those without any lower extremity injury. Using techniques derived from *k* nearest-neighbor clustering, players with meniscal injury were matched to the control cohort in a 2:1 ratio using an optimized matching frontier methodology as described in peer-reviewed studies with similar methodologies.¹⁹ Players were matched by both demographic (age, height, playing experience, position) and performance metrics (total field time, goals per 90 minutes of play, assists per 90 minutes of play) recorded 1 season before the index time point.¹⁵ The acceptable ranges of variability in matching for playing experience, goals, and assists were chosen based on the variability of these features before any data manipulation. Goalkeepers were included in the descriptive analysis but subsequently excluded due to the very low number of injured players.²⁵

Statistical Analysis

Logistic multivariable regression was utilized to investigate player characteristics associated with RTP within 2 seasons of injury, and the log-rank test was utilized to compare player retention in the league between control and injured cohorts during the follow-up period. Based on the work of Peduzzi et al,²⁷ our sample size of 250 patients with a meniscal injury provided more than 80% power to detect a difference in the rate of in RTP within 2 seasons, controlling for the 6 prespecified predictors (age, player position, surgical versus nonsurgical management, games played, goals per game, and assists per game) with an alpha of .05. Seasonal field time and performance metrics were collected from 3 seasons before the index time point (year of injury for the meniscal injury cohort) through 4 seasons

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Ethical approval was not sought for the present study.

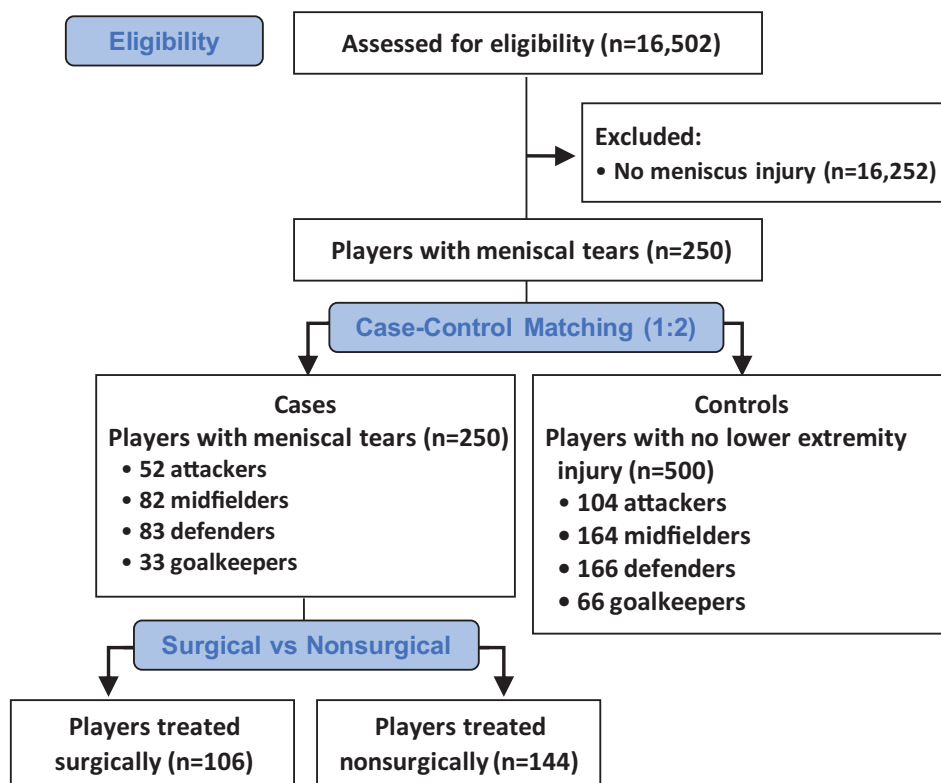


Figure 1. STROBE (Strengthening The Reporting of Observational Studies in Epidemiology) diagram for study enrollment.

after the index time point. Overall differences between control and injured cohorts were assessed for each metric and time point combination with subsequent subgroup analysis by player position. Independent 2-group *t* tests and independent Wilcoxon rank-sum tests were utilized where appropriate, while chi-square tests were utilized to compare categorical data. Statistical significance was set at *P* < .05, and a Bonferroni analysis was used for comparisons of more than 2 groups. All analyses were performed using R Studio software Version 3.6.2 (R Foundation for Statistical Computing).

Post Hoc Analysis of Surgical Versus Nonsurgical Management

After identification of injured players who underwent knee arthroscopy for treatment of meniscal tear, the cohort of injured players was classified into surgical and nonsurgical cohorts (Figure 1). Identification of surgical management was pursued in the same manner as above by cross-referencing player injury reports with official league reports, official team websites, injury reports, official team press releases, personal websites, and professional statistical websites. Players without clear demonstration of surgical management in the above data sources were categorized into the nonsurgical cohort. Comparative analysis of overall field time and performance metrics between cohorts was conducted in the same manner as for the a priori matched cohort analysis, followed by subgroup analysis by player position.

TABLE 1
Player Characteristics Between Injured and Control Players

	Control (n = 500)	Meniscal Tear (n = 250)	<i>P</i>
Case-control match			
Player position, n			.84
Attacker	104	52	
Midfielder	164	82	
Defender	166	83	
Goalkeeper	66	33	
Season of play	2011 ± 5.7	2011 ± 3.3	.09
Total years played in league	4.9 ± 3.6	6.29 ± 4.3	>.99
Height, m	1.8 ± 0.1	1.83 ± 0.1	>.99
Age during season	24.7 ± 4.4	25.2 ± 4.5	.13
Baseline metrics ^a			
Games played	12.5 ± 13.2	14.4 ± 12.9	.06
Total time played	926.1 ± 1067.7	1077.8 ± 1074.5	.07
Goals scored	0.2 ± 0.2	0.2 ± 0.1	.80
Assists recorded	0.2 ± 0.1	0.2 ± 0.1	.35

^aMetrics 1 season before the index time point.

RESULTS

Demographics

A total of 500 controls and 250 players who sustained a meniscal tear between 2006 and 2016 were included (Table 1). The

TABLE 2
Injury Characteristics in the Meniscal Tear Group
(n = 250)^a

Characteristic	Value
Primary injury	
Surgical management	106 (42)
Days missed	57.5 [35-92]
Games missed	7 [4-12]
RTP	
At any time point	176 (70)
By 1 season postinjury	154 (62)
By 2 seasons postinjury	164 (66)
By 3 seasons postinjury	172 (69)
By 4 seasons postinjury	176 (70)
Secondary injury	
Meniscal retear, n (%)	12 (5)
Time to meniscal retear (years)	2 [1-3]
Days missed*	45.5 [40-56]
Games missed**	6 [5-7]

^aData are reported as n (%) or median [IQR]. IQR, interquartile range; RTP, return to play.

*P value compared with primary injury = .33.

**P value compared with primary injury = .45.

case-control match was satisfactory, with no significant differences in player demographics (position, height, age, season of play, and total years played) or baseline performance (games and total time played as well as goals and assists 1 season before the index time point) between cohorts (Table 1). Within the meniscal tear cohort, 106 players (42%) underwent subsequent knee arthroscopy (Table 2).

Return-to-Play

A total of 176 (70%) players sustaining meniscal tear returned to play at the same league level. Of these, 154 (62%) players returned the season after injury and 164 (66%) returned 2 seasons after injury (Table 2). Players were absent for a median 57.5 days (IQR, 35-92) and 7 games (IQR, 4-12) (Table 2). Players older than 30 years of age were less likely to RTP (odds ratio [OR], 0.62; $P = .002$) while players scoring more goals per game before injury (OR, 2.80; $P = .04$) and undergoing surgical intervention (OR, 1.38; $P = .002$) were more likely to RTP. No other player characteristics were associated with RTP on multivariable regression (Table 3). Of those returning to play, 12 (5%) experienced meniscal retear at a median of 2 years (range, 1 to 8 years) after initial injury (Table 2). There were no significant differences in player absence between initial and repeat meniscal tears (Table 2).

Player Availability After RTP

Players sustaining meniscal tears had a slightly higher long-term retention than the control cohort ($P < .001$) (Figure 2).

TABLE 3
Multivariable Regression of RTP Within 2 Seasons of Injury^a

	OR (95% CI)	P
Age, years		
<21	Reference	
26-30	1.00 (0.81-1.24)	.98
>30	0.62 (0.46-0.83)	.002
Player position		
Attacker	Reference	
Midfielder	1.12 (0.83-1.49)	.46
Defender	1.33 (0.93-1.88)	.12
Type of management		
Nonsurgical	Reference	
Surgical	1.38 (1.14-1.68)	.002
Games played ^b		
<10	Reference	
10-19	0.87 (0.40-1.87)	.72
20-29	1.10 (0.51-2.37)	.81
≥30	1.05 (0.50-2.24)	.89
Goals per game ^b	2.80 (1.07-7.34)	.04
Assists per game ^b	0.53 (0.20-1.43)	.22

^aRTP at same league level. OR, odds ratio; RTP, return-to-play.-
bOverall metrics for 1 season before the index time point.

bOverall metrics for 1 season before the index time point.

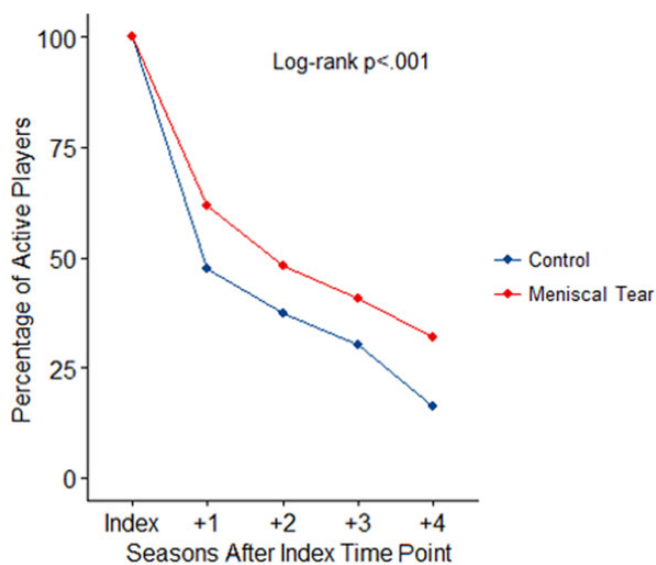


Figure 2. Player retention in the leagues by injury status during the study follow-up period.

Overall Player Performance

Players sustaining a meniscal tear played 2.6 fewer games ($P < .01$) and 0.09 more points per game ($P < .05$) during the season of injury; however, both the injury and control cohorts demonstrated equivalent field time all seasons after the index time point ($P > .05$) (Figure 3). Despite equivalent games played per season, the injury cohort maintained slightly higher points per game from the year

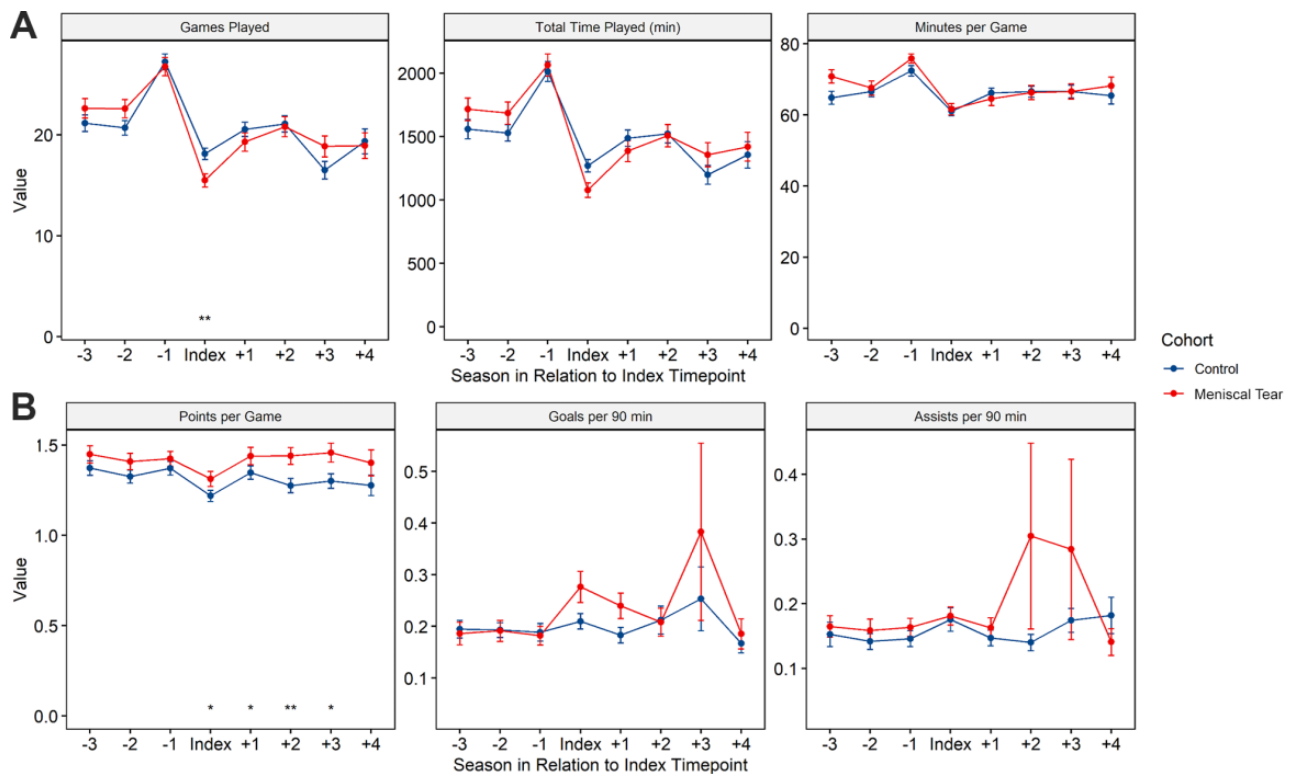


Figure 3. Overall athlete (A) field time and (B) performance metrics. Significance values: * $P < .05$, ** $P < .01$, *** $P < .001$.

of injury up to 3 years after injury ($P < .05$) (Figure 3B). On the other hand, both cohorts demonstrated equivalent goals and assists per 90 minutes of play for all seasons during the study follow-up (Figure 3B).

Field Time by Position

Subgroup analysis of field time by player position revealed that midfielders sustaining a meniscal tear played 4 fewer games ($P < .01$) but similar minutes per season and game ($P < .05$) as compared with control during the season of injury (Figure 4). Overall, position-dependent field time metrics between injured and control cohorts were similar, with only minor statistically significant differences 4 seasons after RTP. Injured attackers demonstrated no significant differences in field time across the follow-up period, whereas midfielders played 494 fewer minutes ($P < .05$) per season as compared with controls 4 seasons after RTP ($P < .05$) (Figure 4). On the other hand, injured defenders played 566 more minutes per season ($P < .05$) and 6 more games per season ($P < .05$) as compared with controls 4 seasons after RTP (Figure 4). For all other time points after RTP, there were no position-dependent differences in field time between injured and control cohorts (Figure 4).

Player Performance by Position

Overall, there were no clinically significant differences in position-dependent performance metrics after RTP. All player positions demonstrated equivalent trends in points

per game, goals per 90 minutes, and assists per 90 minutes during the study period (Figure 5). Of note, attackers who sustained meniscal tears scored 0.14 more goals per 90 minutes of play (approximately 1 goal per 7 games played; $P < .05$) than controls during the season of injury (Figure 5). Injured defenders scored slightly more points per game as compared with controls from the year of injury up to 4 seasons after RTP ($P < .05$); however, this difference was minimal, ranging from 0.18 to 0.35 more points per game (approximately 1 point per 3-6 games) (Figure 5). Goalkeepers demonstrated equivalent field time (games and total time played) as well as performance (conceded goals and clean sheets) throughout the study period.

Post Hoc Analysis: Field Time and Performance by Injury Management

Overall, there was a position-dependent association between type of management and performance after RTP. Defenders who received surgical intervention played 6.5 fewer games ($P < .05$) and 632 fewer total minutes ($P < .01$) as compared with those treated nonoperatively 2 seasons after injury. On the other hand, attackers recorded 0.3 more points per game ($P < .05$) as compared with those treated nonoperatively 2 seasons after injury. Midfielders demonstrated equivalent field time and performance regardless of injury management. There were no other significant differences in field time or performance on subgroup analysis. Finally, athletes receiving operative

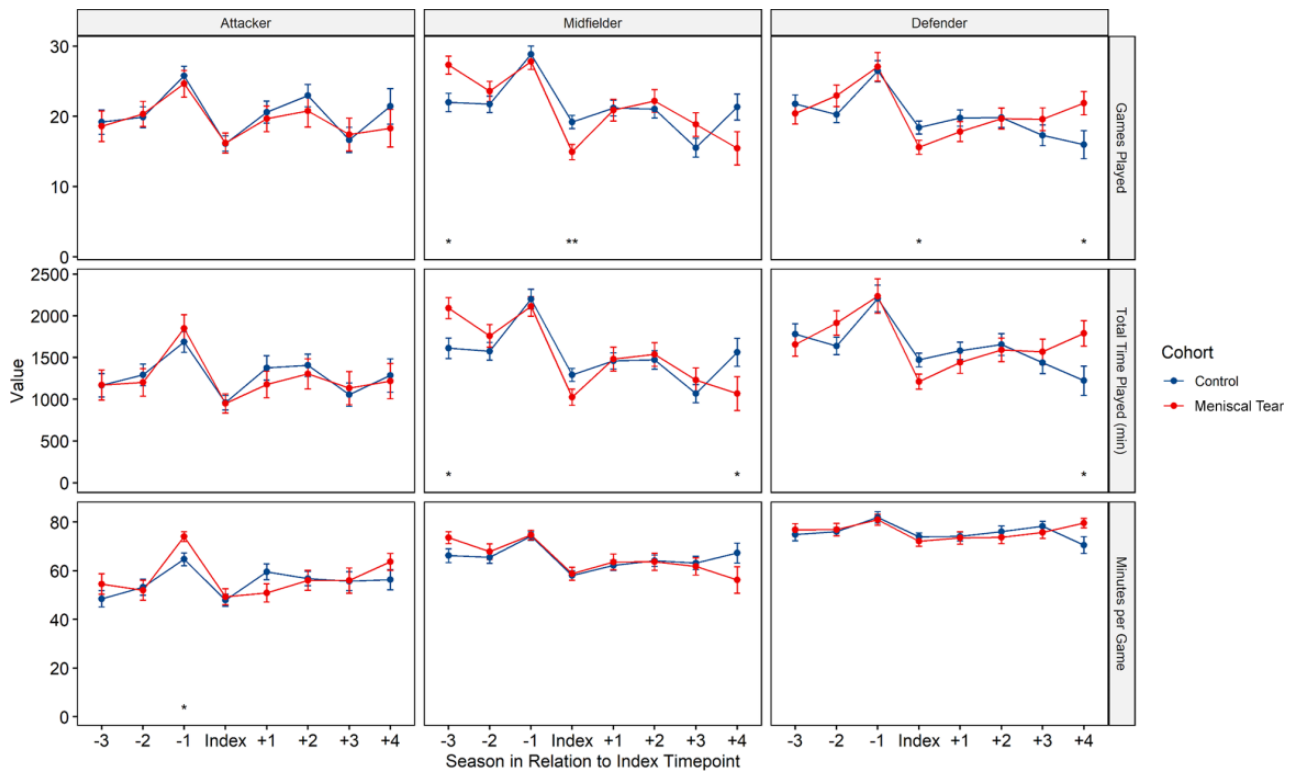


Figure 4. Field time by position. Significance values: * $P < .05$, ** $P < .01$, *** $P < .001$.

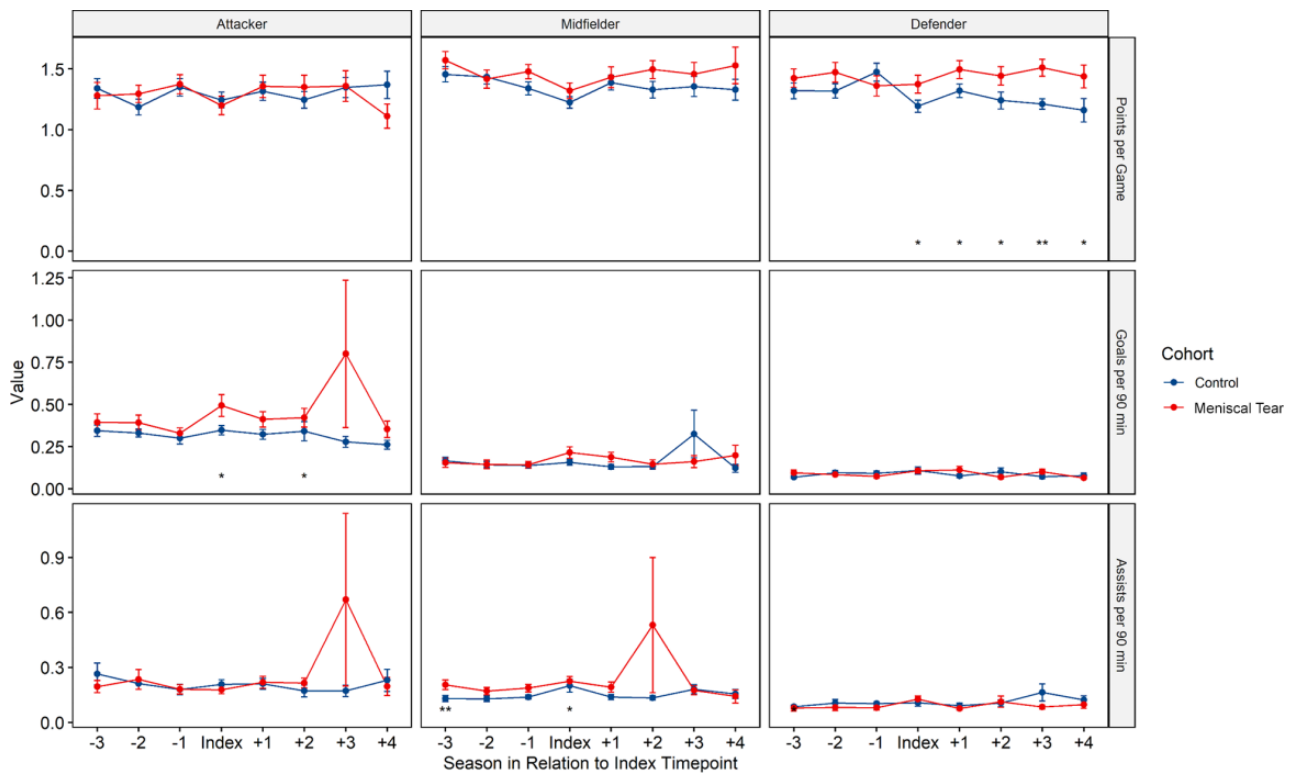


Figure 5. Performance metrics by position. Significance values: * $P < .05$, ** $P < .01$, *** $P < .001$.

management had higher long-term availability in the league ($P < .01$).

DISCUSSION

Although soccer athletes are at higher risk for knee injuries, the impact of meniscal tears on RTP and elite athlete performance remains unknown. In this retrospective study of modern elite soccer players sustaining meniscal tear, a moderate rate of RTP (70%) to the same league level was observed, with a moderate period of absence at a median 57.5 days and 7 games missed. A total of 106 (42%) received surgical intervention, and risk of reinjury in patients who did not retire medically was low (5%) within a broad period after RTP (range, 1-8 years). Age >30 years was a negative predictor of RTP whereas higher preinjury goals per game and surgical intervention were positive predictors of RTP. As compared with their noninjured counterparts, attackers scored more goals per 90 minutes of play during the season of injury but, overall, athletes were not affected after RTP in terms of field time, performance metrics, or long-term availability. Finally, post hoc analysis by injury management revealed a position-dependent association between field time and surgical intervention. In summary, younger athletes with higher preinjury performance managed operatively are most likely to RTP and can be expected to demonstrate equivalent field time, performance, and long-term availability as compared with noninjured athletes.

Of 250 elite soccer athletes sustaining meniscal tears, 176 (70%) players returned to the same level of play. Currently reported rates of RTP after meniscal injury focus largely on RTP after surgical intervention, with rates ranging from 59% to 92% for soccer athletes.¹⁷ In a cross-sectional review of professional soccer athletes, Steinbacher et al³⁰ report that 82% of players returned to any level of sport while only 59% returned to preinjury activity level, consistent with the observed rate in the present study. McCarty et al²¹ report that athletes with meniscal tear may choose to delay surgery until after the season ends if symptoms are not debilitating, whereas Brelin and Rue⁴ propose meniscectomy as an attractive option for inseason athletes due to the possibility of faster RTP. Our current cohort did not discriminate between players who had immediate versus delayed surgery but did demonstrate that players who had surgery overall were 40% more likely to return to playing at this elite level. A total of 106 (42%) players underwent subsequent knee arthroscopy, after which defenders appeared to have worsened performance and attackers appeared to have improved performance. These different positions harbor unique combinations of running, pivoting, cutting, and tackling movements. The frequency or aptitude at which these skills must be employed for RTP varies by position. Therefore, further studies should investigate the effects of the meniscectomized knee on the native biomechanics of the knee in the characteristic movements of attackers, midfielders, defenders, and goalkeepers.

Injured athletes were absent for a median of 57.5 days, amounting to approximately 7 games missed. While rates of surgical intervention in soccer athletes have been

reported to be at around 25%, there is a paucity of data on rehabilitation protocols for athletes pursuing conservative treatment.^{3,28} Reported time to RTP after arthroscopic meniscectomy in recent literature is incredibly broad, with studies reporting RTP at the same league level as soon as 1 month and up to 10.5 months postoperatively.¹⁷ Body mass index greater than 25, lateral meniscal tears, tear pattern, and concomitant knee instability have been associated with poorer postoperative outcomes in a general population.^{1,8,23,26,31} To the best of the authors' knowledge, there has been only 1 other report of factors associated with RTP specific to elite soccer athletes.²³ Despite the well-established prevalence of meniscal injuries in soccer players,²⁰ there remains a notable gap in the literature in regard to treatment of isolated meniscal tear without concomitant ligamentous injury.

Overall, athletes sustaining meniscal tears demonstrated minimal differences in field time and performance metrics as compared with controls. Differences in field time between injury and control cohorts were observed in midfielders and defenders at only 4 years after injury. These differences may thus reflect expected athlete-specific variations in long-term decline rather than effects from injury. This is similar to results from Yeh et al,³¹ presenting no significant difference in basketball players' efficiency rating after RTP from isolated meniscal injury. After meniscectomy, basketball athletes have been shown to have similar agility, quickness, sprint, and jumping ability but with significantly shorter career lengths as compared with noninjured players,¹³ a finding not observed in the present cohort of elite soccer athletes. The single-surgeon series by Nawabi et al²³ of elite soccer players undergoing meniscectomy describes lateral meniscal injuries to have a 10-fold higher incidence of prolonged pain and swelling, as well as a likelihood of requiring a second arthroscopy. However, there remains a notable paucity of data on player performance after meniscal injury, lending a challenge for physicians counseling athletes sustaining meniscal tear. Interestingly, injured attackers recorded significantly more goals per 90 minutes of play during the season of injury. This observation, taken in consideration with the higher likelihood of lateral meniscal injury during player contact mechanisms of injury,³¹ suggests that there are perhaps patterns of movement during competitive play that incur a risk for more morbid meniscal injury.

Although the current study focused on RTP in elite-level athletes, these findings may be helpful in counseling recreational- and competitive-level athletes who present for a meniscal tear about their likelihood of RTP. As aforementioned, soccer is the most popular sport in the world, and many recreational soccer players follow the recovery course of injured elite athletes as inspirations for their own recoveries. Perceivably, most nonprofessionals have less access to expensive and time-consuming resources involved in meniscal injury and recovery, such as expert sports medicine specialists, physical therapists and physical therapy equipment, and personal trainers. By contrast, professional athletes must return to an intensity and frequency of play that is more demanding than that of nonprofessionals. These factors seem to balance based on the findings of a

recent systematic review of return to sport after meniscal injury by Lee et al,¹⁷ which reports similar rates of RTP at a preinjury level between professional and nonprofessional athletes (61%-98%, depending on the type of meniscal surgery and level of play). Therefore, the findings of the current analysis may be helpful for counseling the high school athlete or weekend warrior who wants to know if and when he or she may RTP and at what level compared with preinjury activity. Future investigations focused on both the prevention and natural course of meniscal tears in athletes will be crucial for improved specificity when guiding physician, athlete, and coach expectations.

Limitations

The limitations of this study are that of any database-driven investigation. Injury and control cohorts may be affected by selection bias, with a likely minimal effect in the present study, as rates of injuries identified are consistent with those published within the Union of European Football Associations (UEFA) Injury Study program.^{6,12} Moreover, it was not possible to obtain either specific treatment regimens or specific diagnoses without access to official medical record documentation. Therefore, there is a hypothetical risk of patients who underwent meniscal surgery being categorized improperly into the nonsurgical cohort; however, this chance is low since surgeries are reported routinely to league databases and surgical scars are difficult to obscure. However, the rate of 42% of players requiring surgical intervention is slightly higher than previously reported rates of 25% within a cohort of athletes with a broad range of skill level, aligning with current evidence indicating operative intervention may offer specific advantages for earlier RTP in elite cohorts.³ Of note, the UEFA Injury Study is funded and supervised directly by the UEFA.⁷ Publications have been limited to epidemiologic investigations of incidence, RTP, and reinjury rates rather than changes in performance after injury.^{5,7} Specifically, our estimates of reinjury rate can estimate the risk of recurrent tear only if a patient stayed in the database; that is, the injury did not prompt the athlete to retire from the UEFA. To our knowledge, there is no established infrastructure to process applications of study proposals utilizing these official data. Thus, we firmly believe that, despite the inability to include official medical record data, this study garners strength in the objective presentation of player performance and long-term availability after RTP following meniscal tear.

CONCLUSION

RTP of elite soccer athletes sustaining meniscal tear is contingent on age, preinjury performance, and management approach. Those who RTP to the same league level can be expected to demonstrate equivalent field time, performance, and long-term availability as noninjured athletes.

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