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Return to High School– and College-Level Football After Anterior Cruciate Ligament Reconstruction

A Multicenter Orthopaedic Outcomes Network (MOON) Cohort Study

Kirk A. McCullough,* MD, Kevin D. Phelps,* MD, Kurt P. Spindler,*[†] MD, Matthew J. Matava,[‡] MD, Warren R. Dunn,* MD, MPH, Richard D. Parker,[§] MD, MOON Group,^{||} and Emily K. Reinke,* PhD

Investigation performed at Vanderbilt University Medical Center, Nashville, Tennessee

Background: There is a relative paucity of data regarding the effect of anterior cruciate ligament (ACL) reconstruction on the ability of American high school and collegiate football players to return to play at the same level of competition as before their injury or to progress to play at the next level of competition.

Purpose: (1) To identify the percentage of high school and collegiate American football players who successfully returned to play at their previous level of competition, (2) to investigate self-reported performance for those players able to return to play or reason(s) for not returning to play, and (3) to elucidate risk factors responsible for players not being able to return to play or not returning to the same level of performance.

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

Methods: This study was a retrospective analysis of prospective patients taken from the Multicenter Orthopaedic Outcomes Network (MOON) cohort who identified football as their primary or secondary sport. Identified patients were then questioned in a structured interview regarding their ACL injury, participation in football before their injury, and factors associated with returning to play. Data were analyzed for player position, concurrent meniscal/ligamentous/chondral injury, surgical technique and graft used for ACL reconstruction, and issues pertaining to timing and ability to return to play.

Results: One hundred forty-seven players (including 68 high school and 26 collegiate) met our criteria and were contacted from the 2002 and 2003 MOON cohorts. Return to play rates for all high school and collegiate athletes were similar (63% and 69%, respectively). Based on player perception, 43% of the players were able to return to play at the same self-described performance level. Approximately 27% felt they did not perform at a level attained before their ACL tear, and 30% were unable to return to play at all. Although two thirds of players reported some “other interest” contributing to their decision not to return, at both levels of competition, fear of reinjury or further damage was cited by approximately 50% of the players who did not return to play. Analysis of patient-reported outcome scores at a minimum of 2 years after surgery between patients who returned to play and those who did not demonstrated clinically and statistically significant differences in the International Knee Documentation Committee form, Marx Activity Scale, and Knee injury and Osteoarthritis Outcome Score knee-related quality of life subscale in the collegiate players. Similar clinical differences were not statistically significant in the high school students. Player position did not have a statistically significant effect on the ability to return to play for high school players, and 41% of “skilled” position players and 50% of “nonskilled” position players were able to return to play at the same performance level.

Conclusion: Return to play percentages for amateur American football players after ACL reconstruction are not as high as would be expected. While technical aspects of ACL reconstruction and the ensuing rehabilitation have been studied extensively, the psychological factors (primarily a fear of reinjury) influencing the ability to return to play after ACL surgery may be underestimated as a critical factor responsible for athletes not returning to play at any level of competition.

Keywords: ACL outcomes; ACL deficient; return to sport; knee arthroscopy; injuries

extensive rehabilitation program.¹⁰ In the United States alone, it is estimated that approximately 175,000 ACL reconstructions (ACLRs) were performed in the year 2000 at a total cost of over \$2 billion.³³

Anterior cruciate ligament injury is an all too common occurrence in American football players at all levels of play. The High School Sports-Related Injury Surveillance Study found that 15% of high school football players from the 2010-2011 academic year sustained knee injuries, with ACL injury incidence being third only to medial collateral ligament (MCL) sprains and patella/patellar tendon injuries.¹² Nearly 8% of participants at the National Football League's (NFL) Invitational Camp (also known as the NFL Scouting Combine) have a history of ACL injury.^{7,8} Consequently, ACLR is the third most commonly performed surgical procedure among the Combine participants.^{7,8} While published studies on return to play for professional American football players exist in the literature, there is a relative paucity of data regarding the effect of ACLR on return to play in the high school and collegiate player population.^{9,30}

Return to play after ACLR is of significant concern among athletes after their initial injury.²¹ American football is unique because there are a wide variety of athletes who play the game, in terms of size, speed, and positional requirements.¹³ Likelihood of ACL injury has been shown to be variable across positions.^{14,31} Some positions, such as a running back or wide receiver, require high-speed cutting and pivoting motions. Others, such as linemen, are more frequently subjected to direct blows to the knee.⁶ Given this, it is likely that there are different predictors of return to play after ACLR as a function of position played. It is important that these differences be acknowledged and adequately conveyed so that the patient can better understand his chances of returning to the previous level of competition.

Return to preinjury level of play is commonly considered an indicator of the success of an ACLR.^{15,17,25,32,34} However, other factors including postoperative strength and knee function, psychological hindrances, talent/skill level, and social reasons often affect the ability to return.^{3,5,25} With this in mind, the primary goal of our study was to identify the percentage of high school and collegiate football players who return to play after ACLR. Secondly, we sought to investigate the relationship between validated 2-year outcome scores and both patient return to play and perception of return to performance. Additionally, we hoped to elucidate reasons why some players were unable to return after ACLR. Lastly, we wanted to identify risk factors affecting player performance and inability to return to play.

MATERIALS AND METHODS

Study Design

A retrospective review of a prospective cohort was used to examine the return to sport outcome in patients who had previously undergone ACLR. This study was approved by the coordinating center's Institutional Review Board for database access and patient contact before performing data collection.

Participants and Data Collection

All patients within the Multicenter Orthopaedic Outcomes Network (MOON) cohort who underwent ACLR in 2002 and 2003 were reviewed. At the time of surgery, and a minimum of 2 years later, each patient completed an extensive MOON cohort questionnaire pertaining to the current level of activity, overall health, and nature of the ACL injury. Data for inclusion and validated outcome measures (International Knee Documentation Committee [IKDC] subjective form,¹ Marx Activity Scale,²⁶ and Knee injury and Osteoarthritis Outcome Score [KOOS]²⁹) were obtained from these questionnaires. Patients eligible for inclusion in our study indicated that football was either 1 of the 2 sports they participated in most over the past 2 years or the sport in which they believed they tore their ACL. All eligible patients were then contacted and asked a series of structured questions from a nonvalidated study-specific questionnaire regarding their participation in football around the time of injury as well as the highest activity level attained after ACLR (see Appendix 1, available in the online version of this article at <http://ajs.sagepub.com/supplemental/>). Athletes found to be inappropriately identified as football players during the time period of their ACL injury were not interviewed further. Collected data from the interview, including return to play status, advancement to next level of competition, position played, performance following ACLR, and reasons for not returning to play (if applicable), were then combined with the initial surgical and enrollment/follow-up cohort data for analysis. Specific surgical data points included the presence of a concomitant articular, meniscal, or nonoperative ligamentous injury. Athletes who had multiligamentous injuries requiring surgery were excluded from the analysis. Given the inherent variability of recreational sport participation and the low number of middle school and semiprofessional/professional participants in this study,

[†]Address correspondence to Kurt P. Spindler, MD, Vanderbilt Sports Medicine, 4200 Medical Center East, South Tower, 1215 21st Avenue South, Nashville, TN 37232-8774 (e-mail: kurt.spindler@vanderbilt.edu).

^{*}Vanderbilt University Medical Center, Nashville, Tennessee.

[‡]Washington University at St Louis, St Louis, Missouri.

[§]Cleveland Clinic Foundation, Cleveland, Ohio.

^{||}All members are listed in the Contributing Authors section at the end of this article.

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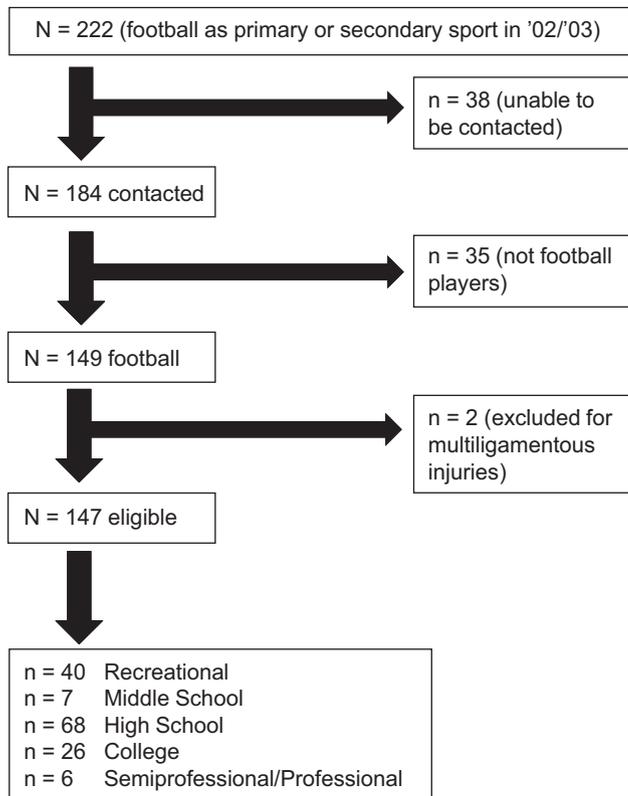


Figure 1. Patient recruitment from the Multicenter Orthopaedic Outcomes Network (MOON) cohort based upon football participation before anterior cruciate ligament reconstruction.

analysis regarding return to play was limited to high school and collegiate athletes. We did not attempt to further stratify these athletes as a function of school level (ie, high school: 4A, 5A, etc; college: National Collegiate Athletic Association Division I, Division II, etc). Seniors not eligible to return to play for the next season at the same level because of graduation (15 high school, 2 college) were excluded from analyses of factors influencing return to play. Six study participants (5 high school, 1 college) were removed before analysis by Fisher and Kruskal-Wallis/Wilcoxon tests because of discordance in timing of their return to play, level, and surgical data.

Statistical Analysis

All analyses were performed using R software.²⁷ Descriptive statistics of all college and high school players’ return to sport as well as progression to the next level were calculated as percentages. For those college and high school players who were eligible to return to play at the same level (ie, freshmen, sophomores, juniors, and eligible college seniors), percentages were calculated for return to performance level, effect of position on return to play, and distribution of reasons for not returning to play.

For the purposes of evaluating the effect of position on return to play, a consensus was reached defining “skilled” versus “nonskilled” positions. “Skilled” positions were defined as requiring an increased need for speed, quick changes of

TABLE 1
Return to Play Percentages for All High School and College Athletes

Return to Play Response for Football, n (%)	High School (n = 68)	College (n = 26)
No	25 (37)	8 (31)
Yes	43 (63)	18 (69)

direction, noncontact pivoting, or a well-defined specific skill set (ie, kicking or punting). The “skilled” positions therefore included quarterbacks, running backs, wide receivers, defensive backs (cornerbacks and safeties), and “special teams” players. All others were considered “nonskilled.” Because of the limited numbers of collegiate study participants, player position analysis was only performed on high school athletes.

To better evaluate reasons for not returning to play, similar factors were merged into larger categories, reducing the original 14 categories to 5. This resulted in the following combinations: loss of speed and strength, physical symptoms of knee pain, swelling and instability, advice from any source, and fear of reinjury or further damage. The remaining categories were included under “other interests.”

Fisher exact tests were performed on college and high school players eligible to return to play to test the hypothesis that return to play outcomes would differ in subsets of patients who experienced (1) the presence of a meniscal excision or repair versus none, (2) a grade 2 or 3 chondral defect versus a grade 1 or none, or (3) allograft versus autograft reconstruction.

Three subsets of high school players eligible to return to play at the same level were analyzed: (1) those who did not return to play, (2) those who returned to play but at a lower performance level, and (3) those who returned to play at their previous level of performance. Kruskal-Wallis rank-sum tests were performed to test the hypothesis that these 3 subsets of players would be different in regard to the following validated outcome measures at 2 years after ACLR: (1) IKDC, (2) Marx activity score, (3) KOOS sports and recreation subscore, and (4) KOOS knee-related quality of life subscore (KRQOL). In the college athletes, 3 of the 7 participants who reported that they returned to play football at a lower level of performance did not return their 2-year questionnaires, and as a result, this subset was excluded from analysis. Instead, Wilcoxon rank-sum tests with continuity correction were performed between the subsets of those who returned to play at the same performance level and those who did not return to play.

RESULTS

A total of 222 patients were identified from the 2002 and 2003 MOON cohorts as having listed football as either their primary or secondary sport. Of this total, 184 (83%) were successfully contacted for follow-up, and 147 eligible football players met our study criteria (including 28 collegiate and 68 high school), as outlined in Figure 1. Return to play percentages were then calculated for both high

TABLE 2
Return to Play and Level With Validated Outcome Measures (IKDC, Marx Activity Scale, KOOS Sports and Recreation, and KOOS Knee-Related Quality of Life)^a

2-Year Post-ACL Outcome Scores by Return to Play and Level Status	IKDC			Marx Activity Scale			KOOS (Sports and Recreation)			KOOS (Knee-Related Quality of Life)		
	25%	50%	75%	25%	50%	75%	25%	50%	75%	25%	50%	75%
High school (grades 9-11)												
No return to play (n = 11/13)	76	84	95	6.0	12.0	14.0	68	75	100	72	75	88
Returned to play, not level (n = 12/12)	78	86	95	9.8	15.5	16.0	74	88	96	67	84	95
Returned to play and level (n = 19/23)	89	95	97	12.0	16.0	16.0	78	90	98	81	94	97
Kruskal-Wallis rank-sum test	<i>P</i> = .14			<i>P</i> = .36			<i>P</i> = .25			<i>P</i> = .24		
College (freshman-junior)												
No return to play (n = 6/7)	73	81	89	9.2	10.0	11.5	58	68	85	55	72	75
Returned to play, not level (n = 4/7)	89	92	98	16.0	16.0	16.0	85	85	95	81	94	94
Returned to play and level (n = 9/9)												
Wilcoxon rank-sum test	<i>P</i> = .04			<i>P</i> < .01			<i>P</i> = .10			<i>P</i> < .01		

^aTwo-year post-ACL outcome scores by return-to-play and level status. Freshman- through junior-level athletes from high school (upper row) and college (lower row). For each outcome measure, 25th, 50th, and 75th quartiles are shown. *P* values for statistical comparisons are at the bottom of each column; median values are bolded. IKDC, International Knee Documentation Committee; KOOS, Knee injury and Osteoarthritis Outcome Score; ACL, anterior cruciate ligament.

school and college players (Table 1). Regarding advancement to the next level of competition, 15% of both high school and collegiate athletes in this study were able to play at the next level of competition after ACLR. Because seniors are not eligible to return to play at the same level at which they incurred the injury, and advancement to the next level of play (eg, high school to college) is complicated by skill level and competing interests, 15 high school and 2 college seniors were excluded from further return to play analysis. Regarding high school seniors, 27% (4/15) were able to return to play and compete at the collegiate level, and 50% (1/2) of the collegiate seniors competed at the professional level.

Players' perception of skill/performance level upon return to play is shown for high school and college athletes in Figure 2. We compared participants' return to play and performance level responses with IKDC, Marx activity, KOOS sports and recreation, and KOOS KRQOL subscores collected at least 2 years after their ACLR (range, 2.1-2.9 years) (Table 2). For high school students, the 3 groups showed the largest differences on the IKDC (*P* = .14) and the KOOS subscores (sports and recreation: *P* = .25; KRQOL: *P* = .24). A smaller difference was seen for the Marx activity level (*P* = .36). However, despite these differences being clinically relevant, they were not significant, as indicated. Significant differences for college students who did not return to play and those who returned to play at the same performance level were seen on the IKDC (*P* = .04), Marx Activity Scale (*P* < .01), and KOOS KRQOL subscore (*P* < .01). Only the KOOS sports and recreation subscore (*P* = .10) was not significant.

Player position did not have a statistically significant effect on the ability to return to play for high school players (*P* = .76). However, the results showed that 41% of "skilled" position players were able to return to play at the same performance level compared with 50% of those in "non-skilled" positions.

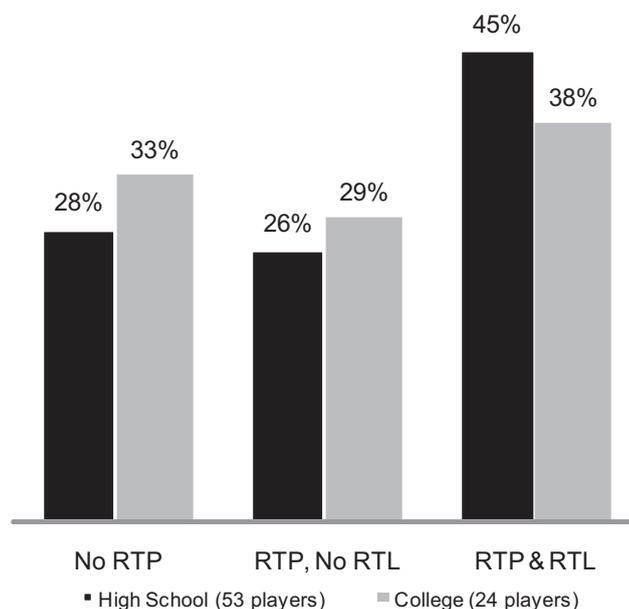


Figure 2. Retrospective perception of the ability to return to preinjury level of performance after anterior cruciate ligament reconstruction. Percentages of patients reporting no return to play (No RTP), return to play but not return to the same level of performance (RTP, no RTL), or return to play and return to the same level of performance (RTP & RTL). High school freshmen through juniors are represented.

Reasons cited for not returning to play are listed in Table 3. Two-thirds of both high school and collegiate players listed "other interests" as reasons for not returning to play (ie, lost interest in sport, other sports interest, other life interest, etc). Of the specific performance-related reasons, 53% of high school players and 50% of collegiate players identified fear as a major or contributing factor to not returning to play.

TABLE 3
Reasons for Not Returning to Play Reported
by High School and College Freshmen Through Juniors^a

Specific Factors Negatively Affecting Return to Play, %	High School	College
Other interests ^b	67	75
Fear	53	50
Physical symptoms	20	12
Advice	13	25
Loss of speed or strength	13	12

^aFactors will total >100% because participants were asked to report any factor contributing to not returning to play.

^bCumulative answer, including specific answers such as the following: lost interest, other sports interest, other life interests (ie, job, school, family, etc), and other.

The prevalence of concomitant nonoperative MCL, articular cartilage, and meniscal injuries requiring treatment is shown in Figure 3. Neither concurrent meniscal surgery (excision or repair) or articular injuries in either age group nor concurrent nonoperative MCL injuries in the high school athletes were found to statistically significantly affect return to play ($P > .1$ for all).

Regarding graft selection, the most common choice was a bone–patellar tendon–bone (BTB) autograft. Only 12 (25%) of the 48 high school athletes had hamstring reconstructions, and 5 (10%) had soft tissue allografts. In the collegiate athletes, 6 of the 23 (26%) had hamstring reconstructions, 2 (9%) had soft tissue allografts, and 1 (4%) had a BTB allograft. Because of low numbers, effect of the graft on return to play was not statistically tested.

DISCUSSION

The findings of this study are consistent with those of other recent similar studies evaluating overall (mixed sports) return to play after ACLR. In a review of 15 studies, Kvist²² reported that 56% of patients in all sports had returned to their preinjury activity level after ACLR. Ardern et al,³ in a systematic review of 48 studies, identified a 44% rate of return to competitive sport and further demonstrated a 46% return to competitive sport in a case series study on 196 competitive-sport athletes.² Lee et al²⁵ reported a 62% rate of return to play over 5 years after ACLR utilizing hamstring autografts. Carey et al⁹ reported an approximately 80% return to play rate for NFL running backs and wide receivers after ACLR; however, performance was reduced by one third of their preinjury level based on performance-based criteria (ie, yards gained, touchdowns scored, etc).

A secondary purpose of this study was to determine patients’ retrospective perception regarding their ability to return to a previous performance level as well as to relate that to validated patient-reported outcome scores gathered prospectively and closer in time to the actual return to play. One third of the high school and nearly half of the collegiate athletes who returned to play reported that they did not return to their preinjury level

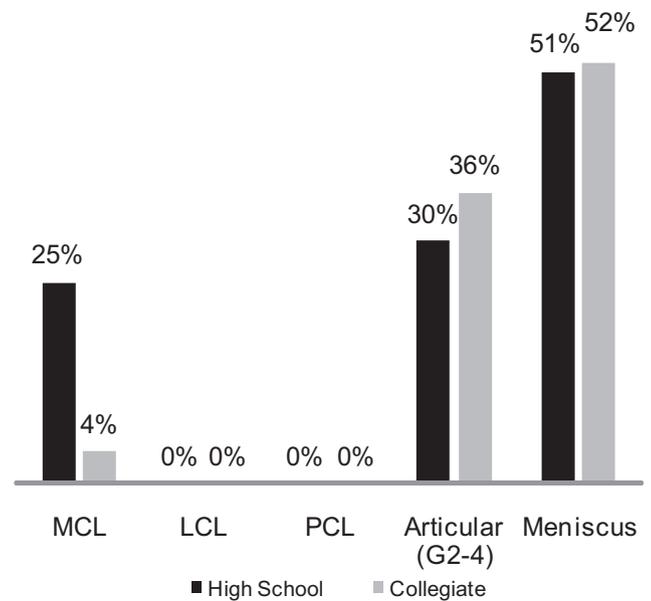


Figure 3. Concurrent meniscal/chondral/ligamentous injuries in addition to anterior cruciate ligament injury in our football player cohort. G2-4, Outerbridge classification of chondral injury.

of performance. This is in line with data presented by Laboute and colleagues²⁴ on a mixed-sport population. We are unable to comment as to whether any players felt they improved after their surgery compared with their preoperative level of play. In regard to Marx activity level 2 years after ACLR, collegiate athletes who returned to play and prior performance level showed a significant difference from those who did not return to play, whereas high school athletes did not. However, this may be because of some errors in patient reporting. Of the 3 high school students reporting Marx activity scores of zero, 2 likely incorrectly completed the form, as they were on teams during the year they completed the questionnaire. In a larger population, these athletes would have less effect on the overall statistical analysis. On IKDC and KOOS subscales, differences related to return to play and performance level in high school students were clinically relevant^{18,28} but not statistically significant. This suggests that our study was underpowered to show real differences between athletes who do and do not return to play given the variability in high school players, unlike the collegiate population in which we demonstrated statistical significance.

We also attempted to determine what effect physical and sports-related factors had on the patients’ return to both play and performance level. With the numbers available, we were not able to elucidate any surgically relevant differences that were related to return to play and/or performance level, including graft type, meniscal status, chondral damage, or MCL injury, or sport-specific differences, such as position. Despite the fact that our incidence of these various factors was quite low, they should be revisited in a larger population in future studies.

The ability to return to competition in the safest, most efficient manner after an ACL tear is paramount to most

athletes who sustain this type of injury.¹⁰ Considering this, return to play at either the same or higher level should arguably be considered one of the primary outcome measures in defining a successful outcome for the competitive athlete. Studies have demonstrated that poor knee function in patients (as determined by patient-reported outcome scales) is not always reflected as an inability to participate in sports.^{4,16} Furthermore, even those who are able to return to play frequently are unable to participate at the same level of performance as they had before their injury.¹⁹ While we continue to refine our understanding of the technical aspects of ACLR and optimal methods of postoperative rehabilitation, we often fail to appreciate the psychological component associated with the ability to return to play. Yet, the psychological component remains critical and might compromise an otherwise sound reconstruction and successful rehabilitation because of fear of reinjury. A study by Johnson²⁰ has shown that most athletes lack adequate psychological preparation for injury and have no strategy for how to deal with the extensive rehabilitation period. The psychological effect on play has been well documented by Kvist et al,²³ who found that 24% of 59 patients who underwent unilateral ACLR identified fear as the primary factor for not returning to play. This was further substantiated by Lee et al,²⁵ who found that the 2 main reasons for people in their study not returning to play were having an unstable knee or fear of reinjury. Interestingly, Chmielewski et al¹¹ found an inverse correlation between fear, as quantified by the Tampa Scale for Kinesiophobia (TSK-11), and IKDC, although we were unable to support this finding (data not shown) either because of the number of participants or by our more casual method of determining fear.

A potential weakness of this study was our inability to quantify or qualify the effect of 2 unique, yet important factors potentially responsible for return to play following ACLR: psychological factors and postoperative rehabilitation. Despite a technically sound ACLR and appropriate rehabilitation, emotional and psychological trauma associated with the ACL injury may prevent these athletes from achieving preinjury function. We are unaware of any prior studies evaluating this factor in competitive, amateur American football players. Considering the retrospective nature of our study at 6 years after injury, recall bias is a concern. In concordance with Ardern et al,² we believe that our primary outcome (return to sport) is a discrete event that our participants were keenly aware of when completed and therefore is subject to limited reporting bias. Retrospective perception of return to level of performance is likely not to be as robust. However, the expected effect of recall bias at this time point on the reliable evaluation of emotional factors affecting athletic performance, as elucidated by the TSK-11 previously utilized by Kvist et al,²³ might limit the validity of any conclusions that could be made. We did not assess the patients' psychological makeup preoperatively to determine whether this cohort of athletes was comparable to the general population of athletes in terms of coping mechanisms and other relevant psychological characteristics. Nevertheless, we have no reason to suspect that our patients differ from other athletic patients or the population at large. Secondly, the patients' level of

participation in and type of postoperative rehabilitation program were not assessed as to their effect on return to play. While physicians participating in MOON use the same rehabilitation guidelines, compliance in a study of this magnitude is difficult to measure or control.

An additional limitation of our study is our inability to utilize physical examinations, functional tests, and other structural measures to evaluate the post-ACL-reconstructed knee and athlete performance. This would include arthrometer, Lachman, magnetic resonance imaging, and/or pivot-shift testing to help evaluate a functionally stable graft. While a performance measure such as that proposed by Carey et al⁹ to evaluate preinjury and postinjury function would have been ideal, the lack of access to these data in our amateur athletes made this impossible. However, the measures utilized by Carey et al⁹ are limited to select positions and would not apply to a large portion of our athletes. Furthermore, given the previously mentioned discordance between structural measures and ability to return to play, the lack of these measures does not discount the importance of the observed psychological effect of fear on the athletic participation, nor does it discredit the potential correlation of patient-reported lower performance ability to athletic function.

Future studies should include increased numbers of observations, multivariate analyses, and data collected prospectively with additional psychological and performance measurements to complement patient-reported outcome scores.

CONCLUSION

The frequency of return to play in high school and collegiate American football after ACLR is similar to the return to preinjury activity level percentages reported in recent studies. While the surgical and rehabilitation components of ACLR have undergone extensive study and evaluation, the psychological component of return to play, in particular fear of reinjury, is frequently underestimated and likely plays a critical role in preventing athletes from returning to play.

CONTRIBUTING AUTHORS

Annunziato Amendola, MD (University of Iowa, Iowa City, Iowa); Jack T. Andrich, MD (Cleveland Clinic Foundation, Cleveland, Ohio); Christopher C. Kaeding, MD (The Ohio State University, Columbus, Ohio); Robert G. Marx, MD, MSc (Hospital for Special Surgery, New York, New York); Eric C. McCarty, MD (University of Colorado, Boulder, Colorado); and Rick W. Wright, MD (Washington University at St Louis, St Louis, Missouri).

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