Rates and Determinants of Return to Play After Anterior Cruciate Ligament Reconstruction in NCAA Division 1 College Football Athletes

A Study of the ACC, SEC, and PAC-12 Conferences

Jimmy H. Daruwalla,* MD, Patrick E. Greis,† MD, Robert Hancock,‡ MD, ASP Collaborative Group,§ and John W. Xerogeanes,*|| MD

Investigation performed at Emory University School of Medicine, Atlanta, Georgia, USA

Background: For competitive athletes, return to play (RTP) and return to preinjury levels of performance after anterior cruciate ligament (ACL) reconstruction are the main goals of surgery. Although outcomes of ACL surgery are well studied, details on factors influencing RTP in elite college football players have not been evaluated thoroughly.

Purpose: To determine the rate of RTP following ACL surgery among National Collegiate Athletic Association (NCAA) Division 1 collegiate football athletes and to examine variables that may affect these rates. The hypothesis was that the RTP rate in this cohort will be influenced by factors reflecting skill and accomplishment; that is, athletes higher on the depth chart, those on scholarship, and those later in their careers will have higher RTP rates. It was also predicted that graft type and concomitant procedures may have an effect on RTP rates.

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

Methods: Using athlete- and surgery-specific data from participating institutions in 3 major Division 1 college football conferences, information on athletes who had ACL reconstruction from 2004 through 2010 was collected. Statistical analyses were performed to determine the RTP rate as a function of the variables, such as depth chart position, in the data collected.

Results: Of the 184-player cohort, 82% of the athletes, including 94% of starters, were able to RTP. Rates were greater among athletes higher on the depth chart ($P = .004$) and on scholarship ($P = .008$). Year of eligibility also affected RTP rates ($P = .047$), which increased from the redshirt and freshman year to the sophomore and junior years, but then decreased slightly into the senior and fifth-year senior seasons. The use of an autograft versus allograft was associated with increased RTP ($P = .045$). There was no significant difference ($P = .18$) between players who underwent an isolated ACL reconstruction versus those who underwent additional procedures.

Conclusion: More than 80% of football players at the Division 1 level were able to RTP following ACL reconstruction. Factors representative of a player's skill were associated with higher rates of RTP. Surgery-specific variables, in general, had no effect on RTP, except for the use of autograft, which was associated with a greater RTP rate.

Keywords: return to play; ACL; reconstruction; college athletes; football

|| Address correspondence to John W. Xerogeanes, MD, Emory University School of Medicine, 59 Executive Park South, Atlanta, GA 30329, USA (e-mail: jxeroge@emory.edu).

*Emory University School of Medicine, Atlanta, Georgia, USA.

† University of Utah School of Medicine, Salt Lake City, Utah, USA.

‡ University of Georgia, Athens, Georgia, USA.

§ All members are listed in the Contributing Authors section at the end of this article.

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The anterior cruciate ligament (ACL) plays an important role in preventing anterior translation and rotation of the tibia with respect to the femur and is frequently injured during sports involving jumping, pivoting, and cutting maneuvers. With approximately 100,000 performed per year in the United States,[1] ACL reconstruction is a common orthopaedic procedure, particularly in athletes and patients involved in recreational sports. It is widely recommended that athletes desiring to return to sports activities should undergo reconstructive surgery. While return to play (RTP) is a common goal for all athletes after ACL reconstruction, returning to preinjury levels of performance is also of great

relevance and importance. This is especially true for high-level athletes, in whom a decrease in postoperative performance and production is especially detrimental. Thus, information regarding RTP after ACL surgery is vital for physicians to be able to adequately council patients on realistic expectations after surgery.

Although RTP outcomes have been studied in a variety of patient populations, detailed data pertaining to certain specific athlete groups is still limited. Moreover, data on rates of RTP and return to preinjury levels of competition have varied widely with regard to type of sport, level of play, and duration of follow-up.[19] A modest number of studies have examined various demographic and surgery-related factors influencing RTP rates, though comprehensive data are still lacking. Furthermore, most of these studies have either been large meta-analyses or small studies of specific athlete populations, such as National Football League (NFL) players.[1,2,5,11,16] McCullough et al[12] studied RTP in college football players, but they included athletes from National Collegiate Athletic Association (NCAA) Divisions 1, 2, and 3. Furthermore, only 26 total college athletes were included, and the study was underpowered to analyze certain factors that may determine RTP rates. As such, there is currently a lack of information on the rates of successful return to competition after ACL reconstruction, specifically in NCAA Division 1 college football athletes. Furthermore, certain factors unique to this cohort that may potentially impact RTP rates, such as athletic scholarship status, graduating from college or not, and year of college eligibility, have never been evaluated in the literature.

In the present study, we aimed to determine the rates of RTP after ACL reconstruction among college football players by analyzing data from teams in 3 Division 1 Football Bowl Subdivision (FBS) conferences. Furthermore, we hoped to identify specific factors related to a player's skill, such as depth chart position, scholarship status, and years of play, which may affect an athlete's successful RTP. Surgery-specific data, such as the type of ACL graft used and the presence of concomitant procedures performed during surgery, were also analyzed to determine their effect on RTP.

We hypothesized that rates of RTP among Division 1 college football players would be higher than data previously reported in the literature for the general population. We expected that players on scholarship, at higher depth chart positions, and with more years of experience would be more likely to RTP and return to preinjury levels of play than players who were not on scholarship, were lower on the depth chart, and had fewer years of experience. Furthermore, we postulated that graft choice and presence of concomitant injury might have an effect on RTP rates.

METHODS

Our study was a multi-institution, retrospective case series involving 3 Division 1 FBS conferences: the Southeastern Conference (SEC), Atlantic Coast Conference (ACC), and Pacific 12 (PAC-12). After institutional review board (IRB) approval was granted by our university, the orthopaedic staff or head team athletic trainer at institutions in all 3 conferences were contacted individually to ask for their participation.

All institutions agreeing to participate obtained IRB approval and were sent a data collection spreadsheet. Athlete-specific data included age, year in school, position, scholarship status, and depth chart position. We also requested specific information about each subject's surgery, including surgical method of ACL reconstruction (transtibial, 2 incision, or medial portal technique), type of graft utilized, graft fixation method, and concomitant procedures performed. Finally, data related to our outcome measures were collected: if the athlete returned to play, time to RTP, depth chart position on return, and whether the player eventually graduated and/or continued to play after college. No identifiable patient information was asked for or reported to the research team. Participating institutions were requested to report data on all eligible athletes over a 7-year period from the 2004 to the 2010 seasons. The cutoff was made at the 2010 season to allow athletes undergoing surgery during that season at least 1 full year to achieve RTP status, as data were collected after the 2011 season.

For this study, inclusion criteria were any Division 1 college football athlete at participating schools in the SEC, ACC, or PAC-12 who suffered an ACL injury and subsequently underwent ACL reconstruction, primary or revision, during the study period. Exclusion criteria included any patient who left his institution before determination of RTP could be made and any patient who was never cleared to RTP for medical reasons unrelated to their knee injury. Athletes who underwent ACL reconstruction late enough in their careers (senior year without adequate remaining eligibility) such that they never had an opportunity to RTP at the college level were excluded as well. This was determined by a subjective assessment that we asked the head team orthopaedist from each participating school to make. RTP was defined as achieving full, unrestricted participation in a full-contact practice, scrimmage, or regular season game at any time after the date of surgery. RTP could occur at any point during the player's collegiate career after the injury. All players who went on to play at the professional level were considered to have returned to play, even if they had not participated in additional college games after surgery. Depth chart position both before and after surgery was divided into 3 groups: starter, utilized player, or rarely/never played. Once all data were collected from each institution, it was combined into a master spreadsheet for analysis.

Statistical analysis was performed using SAS 9.3 software (SAS Inc). Descriptive statistics were run on all variables including preoperative, operative, postoperative, and RTP data. Chi-square analysis and Fisher exact tests were performed to identify any relationship between RTP and our outcome measures, including scholarship status, depth chart position, and years of playing experience.

RESULTS

A total of 13 institutions chose to participate in this study: 5 from the ACC, 5 from the PAC-12, and 3 from the SEC. From these conferences, data from 49 players from the

ACC, 78 from the PAC-12, and 57 from the SEC were obtained, comprising a total of 184 athletes in this study. We observed an overall RTP rate of 82% (151/184) in our cohort of college football athletes from 3 Division 1 FBS conferences. Average time to RTP was 251 days.

Player-Specific Data

When grouping athletes by depth chart position, we observed a significant ($P = .004$) association between higher depth chart position and increasing rates of RTP. Starting players returned at a 94.2% rate (65/69), utilized players returned at an 87.7% rate (50/57), and players who rarely played before surgery RTP 72.9% of the time (35/48). There were no data available on depth chart position for 10 players.

Of those who were able to RTP, 87.5% (49/56) of starters were able to RTP as starters after surgery. Of those who did not return to a starting role, 6 became utilized players and only 1 fell to a "rarely playing" position after surgery. Of utilized players, 53.5% (23/43) returned as utilized players, while 27.9% (12/43) returned and became starters and 18.6% (8/43) rarely played after surgery. Overall, 81.4% (35/43) of utilized players were able to return at or above their preinjury level of play. Of the 29 players who rarely played before surgery and were able to RTP, 20 (68.9%) remained at the "rarely played" position, 6 (20.7) became utility players, and 3 (10.3%) rose to the starting position after RTP (Figure 1).

For players on an athletic football scholarship, we observed an 87.6% (127/145) RTP rate. Those not on scholarship returned only 68.8% of the time (22/32), representing a significant association ($P = .008$) between RTP and scholarship status. Scholarship status of 7 players was unknown. There was no statistically significant difference ($P = .20$) in RTP rates between athletes who graduated college (85.6%) and those who did not (70%). However, graduation data were obtained on only 100 total athletes, and just 10 of these players did not graduate. In our cohort, 21.1% (27/184) of players went on to play professionally in the NFL. By our definition, 100% of these athletes were able to RTP regardless of whether they participated in another college game or practice after ACL reconstruction.

A statistically significant ($P = .047$) effect was observed when trending players' years of football experience to RTP rates. As demonstrated in Figure 2, rates of RTP increased from the redshirt freshman year (33.3%) through the freshmen year (82.5%) and plateaued in the sophomore (93.9%) and junior (88.6%) years. Beyond that, more veteran players in their senior (72.8%) and fifth-year senior (75%) seasons had lower RTP rates. Players who were injured late in their last year of eligibility who did not have the potential to RTP due to lack of time were excluded from analysis.

Surgery-Specific Data

Of the 182 players for whom graft information was obtained, 155 (85%) received an autograft, and 27 (15%) received an allograft. Of the players who had autograft reconstruction, 140 were patella grafts and 15 were hamstring grafts. There were no reports of quad tendon graft

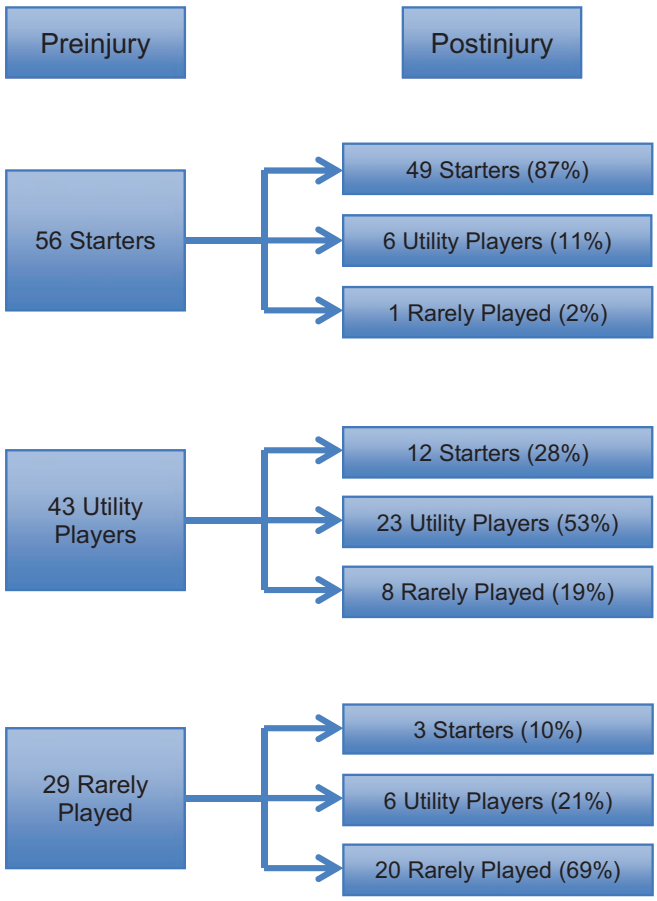

Figure 1. Flowchart demonstrating the relationship between pre- and postinjury depth chart position for players who were able to return to play.

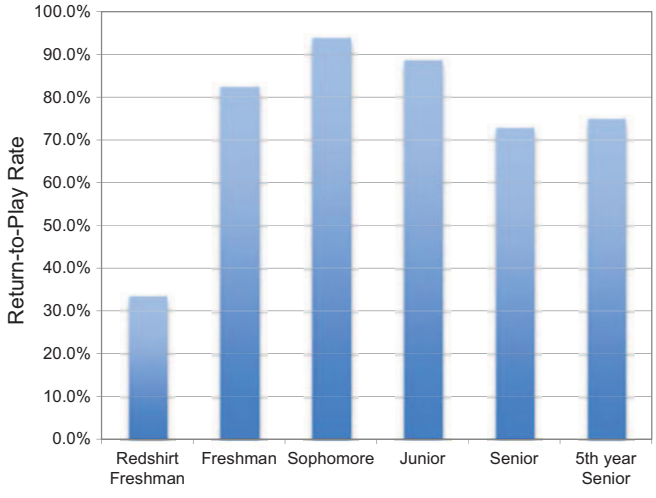

Figure 2. Rate of return to play (RTP) versus year of play. RTP rates increased over time to peak in the sophomore and junior years. Rates slightly decreased in the senior years. Interaction between RTP rates and year of play was statistically significant ($P = .047$).

use. When comparing RTP rates among players who received a patella tendon autograft (83.6%) versus those who received a hamstring autograft (93.3%), we found no statistically significant difference ($P = .3206$) in RTP rates. However, we did observe a significant difference ($P = .045$) in RTP rates when comparing players who received an autograft of any kind (84.5%) versus those who received an allograft (68.9%).

Variation in graft selection was observed when we analyzed graft type and reconstruction methods between the ACC, SEC, and PAC-12. While the patella tendon autograft was the most popular graft choice within each conference, the PAC-12 and SEC did show a propensity to utilize allograft tissue more than the ACC. A total of 20.5% (16/78) of PAC-12 athletes and 17.5% (10/57) of SEC athletes received an allograft, compared with only 2.1% (1/47) of athletes in the ACC. Of players who received an autograft, patella tendon utilization was most popular and appeared to be similar between conferences: 86.9% (40/46) in the ACC, 89.4% (42/47) in the SEC, and 93.5% (58/62) in the PAC-12.

Data on other procedures that were performed concomitantly with ACL reconstruction were collected for all the 184 athletes studied. Specifically, we collected data on whether each athlete underwent a medial and/or lateral meniscectomy, medial and/or lateral meniscal repair, medial collateral ligament repair, lateral collateral ligament repair, posterior cruciate ligament repair, microfracture, or chondroplasty. In our cohort, 69% of players (127/184) underwent at least one of the above concomitant procedures during ACL reconstruction. Cumulatively, no significant difference ($P = .18$) in RTP rates was observed between players who underwent an isolated ACL reconstruction versus those who underwent ACL reconstruction and a concomitant procedure. When analyzed individually, none of the concomitant procedures demonstrated a statistically significant effect on RTP. Similarly, we found no effect from the type of ACL reconstruction technique ($P = .68$) or type of tibial ($P = .66$) or femoral ($P = .73$) fixation method on our players' RTP rates.

DISCUSSION

Outcome measures used to evaluate success following ACL reconstruction have often utilized tools such as the International Knee Documentation Committee (IKDC), Lysholm, or Tegner score; the presence or absence of a positive Lachman or pivot-shift on examination; or the KT-1000 instrumented laxity value. These tools provide meaningful data about how well ACL reconstructive surgery restores knee function, mechanics, and laxity. However, in some ways, the truest test of ACL reconstruction is its ability to allow a high-level athlete to successfully return to their previous sport at the same level of performance. The present study is an attempt to evaluate ACL reconstruction in Division 1 football athletes in this manner. By doing so, one is able to discern, to some degree, the effect that ACL injury and reconstruction has on this specific athletic population.

Though we examined a number of surgery-specific variables that have been previously evaluated in the literature, such as reconstruction technique, graft choice, and fixation methods, our study also looked at several college athlete-specific variables and how they affected RTP following surgery. Issues such as scholarship status, depth chart position, and year of eligibility may reflect more on a players' innate ability or motivation, which may be equally, if not more, important in determining their success at returning to the game at their preinjury level of play.

Our reported RTP was 82% for the group of players as a whole. This compares favorably to the work of Shah et al,[16] who found that 63% of NFL players RTP following ACL reconstruction, and the work of Carey et al,[7] who found a 79% RTP rate in running backs and wide receivers in the NFL. A recent meta-analysis of 48 studies, which included athletes of all levels and ages, also reported a pooled RTP rate of 82%, but subgroup analysis only of athletes involved in competitive sports revealed a lower rate of RTP at 44%.[1] Given the above previously published data, one might infer that RTP rates would decrease linearly with increasing levels of competitive play. However, our results seem to contradict this theory and may instead suggest that our reported rate is more dependent on a unique set of factors and circumstances affecting RTP potential in this specific athlete population.

Given the investment of time and effort, and the innate talent that is often necessary for these athletes to reach these higher competitive levels, one may infer that talent and motivation play a big role in RTP success. Our data on the effect of depth chart position on RTP rates seem to support this theory: Although players without starting roles still had a high likelihood of RTP (80.9% combined rate for utilized and rarely played), they did not equal the results of starting players (94.2%). One may look at this in the context of starters being more talented to begin with so they return at a higher rate and/or that starters are more motivated to return, as they would have been more involved in play and would strive to attain that level again.

This theory is further supported by our data on postinjury depth chart position in those players who were able to RTP; 87.5% of starters were able to return to the same depth chart position after RTP. Of the 7 players who did not, 6 became utilized players. With regard to utilized players, 81% returned to the same depth chart position or higher, while only 19% dropped to the "rarely played" category. Interestingly, 28% of athletes in the "utilized player" category before injury were actually able to return as starters after surgery. Namdari et al[14] and Busfield et al[6] demonstrated that most professional athletes are able to return to preinjury levels of performance after surgery. Our findings agree with this work, but contrast with data from a meta-analysis by Ardern et al[1] and a study by Laboute et al[10] utilizing a mixed-sport cohort that found return to preinjury levels to be lower (63%-65%). We believe this discrepancy stems from our cohort's unique playing circumstances, likely more similar to those of professional athletes than casual and recreational athletes. Our findings on return to preinjury level of play suggest that, while certainly a considerable obstacle, undergoing ACL reconstruction does not necessarily portend a poor prognosis for continuing to improve and excel in one's collegiate career and beyond.

Scholarship athletes had a significantly higher ($P = .008$) RTP rate (87.6%) than those not on scholarship (68.8%). If one assumes that scholarship athletes were deemed initially to be more talented than those not offered football scholarships, one could again conclude that increased ability or talent is a factor in RTP success. These results are in agreement with previous studies on NFL athletes, which showed that earlier draft round and increasing years of experience correlated positively with RTP after sports-related surgery.[3,16]

Likewise, as playing through eligibility and graduating from college may be considered another marker of dedication to football after injury, we expected players who graduated to RTP at a higher rate than those who did not. While our data demonstrated a trend supporting this hypothesis, the difference did not reach statistical significance. This is likely because we only obtained data on 10 players who did not graduate, thereby limiting power for this analysis.

Year of eligibility had a statistically significant ($P = .047$) effect on RTP, as we had expected. Although when stratifying RTP by year of eligibility (see Figure 1), the trend was not the positive linear relationship that we had hypothesized. RTP rates for players early in their careers (redshirt freshman and freshman) were lower than or at average compared with our cohort as a whole, suggesting that early injury may be a barrier for career progression. A substantial portion of these players may not have progressed in their football careers regardless (ie, they may have been cut from the team or dropped out voluntarily for other reasons), though ACL injury and/or rehabilitation may still have been a salient factor in the termination of these players' careers. Once players were in their sophomore and junior years, RTP rates were highest (94% and 89%, respectively). We theorize that players at this stage of their careers had already proven their skill enough to remain on the team, and thus had more incentive to RTP. Furthermore, the injury still occurred early enough such that each player (especially the sophomores) could potentially make a full recovery and continue playing for a substantial period of time. RTP rates in the more veteran years returned at a lower than average rate (73% and 75% in the senior and fifth-year senior years, respectively). This may be because these players realized they were at the end of their careers and, if not continuing on to play professionally, may have been less willing to commit to the intensive rehabilitation required to return to football.

The presence of concomitant knee procedures during ACL reconstruction did not affect a player's ability to RTP. This was true when analyzing the performance of concomitant procedures in general and also when looking specifically at any of the 9 individual procedures that we had asked about in our data collection spreadsheet. Shah et al[16] also found no significant differences in RTP potential with respect to the number or type of concomitant procedures performed. Although these findings suggest that ACL tears and reconstructions are the limiting factor in an athlete's recovery after complex knee injury, these data should be interpreted with caution. A larger number of patients than ours is most likely required to truly tease out the effect that each specific procedure has on the overall RTP rate in athletes who undergo simultaneous surgical repair of multiple injuries in the same knee. Interestingly, a level 3 study by Brophy et al[4] demonstrated that a history of meniscectomy, but not ACL reconstruction, confers a deleterious effect on the longevity of an NFL player's career. While this study did not specifically assess RTP after surgery, it demonstrates that more work is needed to elucidate the effects of ACL tears with and without associated injuries on both short- and long-term outcomes in competitive football players.

When analyzing surgery-specific factors pertaining to the ACL reconstruction, only the choice between autograft and allograft had an impact on our rates of RTP, with autograft superior. However, our study was likely underpowered to assess the impact of various specific types of autografts on RTP, given the low number of hamstring grafts used in our cohort. To our knowledge, our study is the first to compare the effect of allograft versus autograft on RTP rates. While allograft use has been at times thought of as an attractive alternative to autograft, there are certainly concerns raised by many authors relating to increased failure rate with allograft use in the younger populations.[17] Although most studies claiming the inferiority of allograft cite specifically the need for reoperation from graft failure[9] and not the lower rate of immediate RTP, it is nevertheless interesting to consider our findings in light of these previous reports. However, we must note that our study does not examine the reason behind a failure to RTP, and thus no direct causal relationship between graft choice and RTP can ultimately be concluded from our data.

While patellar tendon grafts were the most popularly utilized graft among all 3 conferences, we found no difference in RTP rates between patellar tendon grafts and hamstring tendon grafts in our cohort. This finding is consistent with the literature regarding the impact of graft choice, which has largely shown to have no effect on ACL reconstruction outcomes (though this topic remains controversial).[8,13,15,18] Similarly, reconstruction technique and type of tibia and femoral fixation did not affect RTP in our study. While the PAC-12 and SEC utilized allograft more frequently than the ACC, we did not explore the rationale behind graft choice.

While presenting novel and interesting findings that we believe will be clinically useful for physicians caring for the elite college football athlete, our study has several limitations that should be considered when interpreting our data. Foremost, this study is a retrospective case series and thus may have several types of biases inherent to that study design. As a multicenter study, there likely were variations in the data collection procedures used at each institution. In addition to variation in data collection, there may also be differences in rehabilitation protocols and training staff that may contribute to differences in RTP rates between schools and conferences. Again, we also did not examine the reasons why a player may not have returned to play. As previously demonstrated in college athletes, psychological factors such as fear of reinjury are significant factors in a player's decision to RTP.[12] As such, we cannot assume that a lack of RTP equates to surgical failure. It is also worth noting that graft selection is largely based on surgeon preference and, as such, data on graft preferences are inherently biased as only certain

institutions participated in our study. Thus, data on these preferences cannot be generalized to all institutions nor used to infer current preferences among Division 1 college institutions as a whole.

CONCLUSION

In our cohort of 184 athletes from 3 major NCAA Division 1 FBS conferences, 82% of all players and 94% of starters were able to RTP following ACL reconstruction. A large majority was able to return at or above their preinjury level of play. Having a starting position at the time of injury and being on scholarship had a positive effect on RTP. Year of play was also significantly associated with RTP, with sophomores and juniors having the highest rates. Autograft reconstruction increased RTP levels compared with allograft use, while operative technique, fixation method, and concurrent procedures did not seem to affect RTP. While our overall RTP rate was higher than that of most previously published data, the factors significantly associated with RTP in our study, such as markers of player skill, were consistent with preexisting data from similar athlete populations.

CONTRIBUTING AUTHORS

Eric C. McCarty, MD; Kirk Reynolds, MD; and Miguel Rueda, ATC (University of Colorado, Denver, Colorado). Claude T. Moorman, MD (Duke University, Durham, North Carolina). Darren Johnson, MD (University of Kentucky, Lexington, Kentucky). Jason Dragoo, MD, and Steve Bartlinski, ATC (Stanford University, Palo Alto, California). Jeffrey Spang, MD; R. Alex Creighton, MD; Tim Taft, MD; Scott Trulock, ATC; and Doug Halverson, ATC (University of North Carolina, Chapel Hill, North Carolina). George F. Rick Hatch III, MD; Jarrad Merriman, MPH; and Russ Romano, ATC (University of Southern California, Los Angeles, California). Kurt Spindler, MD, and Thomas Bossung, ATC (Vanderbilt University, Nashville, Tennessee). David Diduch, MD, and Kelli Pugh, ATC (University of Virginia, Charlottesville, Virginia). Edwin M. Tingstad, MD (Washington State University, Pullman, Washington). Lee Kaplan, MD, and Michael Gombosh, MD (University of Miami, Miami, Florida).

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