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## Comparison of Injuries to the Anterior Cruciate Ligament in Male Soccer and Football Athletes and the Effect of Varying Rehabilitation on Recovery Time

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Director, Honors Program Date



Comparison of Injuries to the Anterior Cruciate Ligament in Male Soccer and Football Athletes  
and the Effect of Varying Rehabilitation on Recovery Time.

A Thesis  
Presented to the Department of Health Sciences  
and  
The Honors Program  
of  
Butler University

In Partial Fulfillment  
Of the Requirements for Graduation Honors

Matthew Moraw

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### **Abstract:**

Injuries are commonplace when a sport involves high levels of physical contact and quick movements. Athletes often strain or tear muscles and sprain ligaments when they are putting above normal levels of stress on the connection points through their explosive motions and high force collisions. Two sports where this is particularly common are soccer and football. Due to the high levels of running and cutting in both sports, lower body injuries, particularly to the knee are some of the most common injuries that occur. The purpose of this study was to take a retrospective look at ACL tears in college football and male soccer athletes, and to analyze their recovery period to determine if the sport that the athlete participated in affected their return to play duration. In this study, the recovery of six football players and two soccer players was analyzed based on the exercises they completed during their therapy. The results found were that the soccer players had more rehab sessions in which they did more range of motion exercises and recovered significantly faster.

## **Introduction:**

According to the NCAA, “more than 2,000 NCAA student-athletes will experience an ACL injury in a given year” within the 15 sports listed as high risk for producing ACL injuries (NCAA, 2012). For all athletes, recovery can be both difficult and lengthy. Recovery time for ACL injuries can be the difference in their remaining collegiate experience, not to mention their daily lives. Does the sport in which it occurred make a difference in recovery time? How can an athlete maximize their recovery to be able to be fully cleared as quickly as possible? The purpose of this study was to use a retrospective lens to examine ACL tears in college football and male soccer athletes from a small Midwest university, and to analyze their recovery period to determine if the sport that the athlete participated in affected the speed of their recovery and if recovery from ACL repair surgery is affected by factors such as the sport an athlete plays, or type of recovery exercises.

## **Anatomy of the Knee**

The knee is commonly referred to as one of, if not the most complicated joint in the body. It is a hinge joint whose main function is to connect the femur bone of the upper leg to the tibia, as part of the lower leg. As a hinge joint, the knee also does not have as much stability due to its lack of a ball and socket as in the hip or shoulder. Stability, therefore, in the knee is accomplished by using ligaments and surrounding muscle strength. The primary muscles that provide stability to the knee can be grouped into two categories, the quadriceps muscles and the hamstring muscles. The ligaments within and around the knee are also a large factor in keeping the joint stable. The knee is stabilized medially and laterally by the medial collateral ligament (MCL) and the lateral collateral ligament (LCL) which stretch along the sides of the joints. Internally, support is provided through the posterior cruciate ligament (PCL) which works to prevent the anterior displacement of the femur on the tibia (Loudon, 1998, p. 363). Finally, the most well-known ligament of the knee, and the one that is the focus of this paper, is the anterior cruciate ligament or the ACL. The ACL stretches through the interior of the knee from the anterior intercondylar fossa of the tibia to the posterior medial side of the lateral condyle of the femur, crossing over the PCL (Loudon, 1998, p. 363). The ACL provides stability to the knee by preventing the anterior displacement of the tibia in regard to the femur. In other words, it works

to prevent the shin from sliding forward away from the thigh, as well as preventing knee hyperextension.

### ***Range of Motion***

One of the most important facets of ACL rehabilitation is returning to a normal range of motion within the knee joint due to the necessity of an unrestricted range motion for athletes to maximize their performance (Arnheim, 1999, p. 50). After surgery, movement to the knee is restricted due to swelling and tight muscles, and the result is an extremely stiff knee joint with little range of motion. The return to a full degree of motion should be achieved as quickly as possible due to the importance of range of motion for the success of the remaining rehabilitation (Cavanaugh, 2017, p. 291). In terms of knee extension, a full degree of extension (0 degrees) is an important prerequisite for most doctors to transition their patients off crutches. Knee flexion is equally important, though takes much longer to achieve. According to John Cavanaugh, there should be a goal of 120 degrees of flexion within four weeks of surgery, and full, symmetrical range of motion within 12 weeks of surgery (Cavanaugh, 2017, p. 291). Achieving these range of motion goals can be extraordinarily helpful in terms of a successful recovery.

### ***Weight Bearing Capacity***

Another important aspect of ACL rehabilitation is the weight bearing considerations of recovery. Weight bearing is a topic that is not always agreed upon among recovery specialists due to the significance it can carry. When an athlete is recovering from a knee injury, doctors and therapists may desire to limit the weight bearing capacity of the athlete to protect the knee. While this is important to an extent, studies by Cavanaugh and Tyler show that immediate weight bearing can be extremely beneficial when the progression is done correctly. Progressions that involve crutches, water-based therapy, and tolerable weight bearing can lead to lower pain levels and higher mobility later in recovery (Cavanaugh, 2017, p. 292), while the isometric activity that is facilitated through immediate weight bearing can lead to better muscle growth and recovery (Tyler, 1998, p. 142).

### ***Kinetic Chain***

The idea of a kinetic chain is often used to rehab an ACL properly. The term “kinetic chain” refers to how an exercise is performed, and how the stress is placed on the body part. For

example, when looking at the lower body, an open kinetic chain exercise would be one where the end of the limb (the foot) is free to move, such as a knee extension on a machine. Conversely, a closed kinetic chain exercise would be one where the foot is locked into place and cannot move, such as with a squat (Jewiss, 2017, p. 1). In terms of recovery from significant injury, there is no significant data suggesting whether open or closed kinetic chain exercises should be used over one another in terms of ACL recovery (Jewiss, 2017, p. 7), however, it is accepted by most that open kinetic chain exercises put an increased amount of strain on the ACL (Jewiss, 2017, p. 2). This increased level of stress could be helpful because it stimulates more growth, but it also could be harmful by putting too much strain on the recovering ligament.

### **Repair, Rehabilitation, and Functional Progression**

Another vital part of knee rehabilitation is the process of functional progressions. A functional progression is a sequence of activities done in a specific order that allows for the acquisition of skills required for safe and effective athletic endeavors (Kegerreis, 1983, p. 14). In essence, this means that the patient will work through a list of more simple actions allowing themselves to work up to those that are more difficult. Cavanaugh defines it as having patients “master a simple activity before advancing to a more demanding activity” (Cavanaugh, 2017, p. 289). One way that this is implemented in an ACL recovery is through using a criterion-based protocol as opposed to a time-based protocol. In a criterion-based protocol, athletes progress through their therapy after showing that their knee can do various activities as opposed to using a set timeframe. Previously, many therapists would stick to the standard of allowing athletes to return to sport after six months regardless, however that does not take individual struggles, progressions, or advancements into account. Each athlete goes through rehabilitation at their own individual rate (Wang, 2020, 6:55).

### ***Knee Repair***

In terms of recovery, one of the most significant decisions an athlete with a torn ACL will have to make revolves around how they want their ACL to be repaired. There are many types of commonly used techniques to properly repair an ACL. Some of the more popular choices are a cadaver graft, a patellar tendon graft (also known as bone-tendon-bone), and a hamstring graft, though there are others that can also be utilized. These various surgeries involve

reconstructing the anterior cruciate ligament by using parts of either the ligament of a cadaver or grafts of the hamstring or patellar tendon. Studies by Samuelsen have shown that the hamstring grafts are less stable than the bone-tendon-bone grafts, though both had incredibly low re-tear rates (Sameuelsen, 2017, p. 2460). Similarly, Yunes and his colleagues found that patellar tendon grafts allowed for a greater chance of return to previous level of sport when compared to hamstring grafts (Yunes, 2001, p. 254). It was worth noting that the type of graft may play a role in their recovery. This was accounted for by having all athletes included in the study have the same physician who is known for doing either hamstring or cadaver ACL repairs.

### **Study Demographics**

An important aspect of this study was determining who would be considered for the study. A number of things were analyzed in order to modify the inclusion criteria for athletes with torn ACLs. In the end, it was decided to study male athletes from the football and soccer teams of a small Division 1 Midwestern institution. The study chose only male athletes as this would make the effects of gender negligible, as well as the fact that the school does not have a women's football team. Next, it was determined that athletes would have had to be injured in the past six years (since 2015). The reasoning for this was to take a look at the significance of current treatments for ACL rehabilitation and going much further back than six years could lead to researching trends that were no longer valid. After installing this inclusion criteria, only eight athletes remained, six football players and two soccer players.

While the study was done anonymously, some measure of demographic data was still collected. The study included the athlete's height, weight, and year in school at the time of the injury to determine if there was an association between body type or age and the time necessary for recovery.

### **Successful Rehab**

One of the important parts of this study was to determine what would qualify as successful rehabilitation of an athlete. While many studies, such as one done by Mai, define return to sport as when an athlete is cleared and placed on the active roster for a sport (Mai, 2017, p. 2), this study took a slightly different approach. In this study, an athlete was considered to have successfully completed rehab when they were cleared to return to practice with no



limitations or alterations. By assuring the athlete was fully cleared for practice participation, the study assures that the athlete has completely recovered from the tear, while also not leading to excess time where the athlete is not on the active roster due to the sport not being in season. In terms of clearing an athlete, most specialists adhere to an assessment-based clearance system. Doctors or therapists base an athlete's stage of recovery on their performance on certain tasks as opposed to using a set timeline where the athlete is cleared in a certain number of months (Cavanaugh, 2017, p. 294).

### **Method**

After IRB approval from Butler University, all data was obtained from the University's athletic training office for football players and men's soccer players who had experienced an ACL tear within the past 5 years. All data was raw data put into a file by Athletic Training staff with no name associated so as to keep information anonymous to the researcher. Data included dates of injury and surgery, type of surgery, number and type of exercises that were performed by an athlete during recovery session and full recovery dates provided. In total, six football players and two soccer players were studied, as they were the only athletes from these teams to have experienced ACL surgery and recovery at the university. This data was then all compiled and condensed in an excel document and exercises were categorized as open kinetic chain (OKC), closed kinetic chain (CKC), range of motion/mobility (ROM), stretching, or as "other" if they did not fit into any of these categories. This condensed data was then run through the REDCap data analysis program to determine if there was any relationship between variables.

### **Results**

An important note for the following results is that all soccer players had one specific athletic trainer, and all football players had a different specific athletic trainer, while all athletes had the same surgeon. An additional consideration is that five of the six football players and one of the two soccer players were injured and had surgery during their fall season, while the other two were injured during their spring season.

Table 1 provides a comparison of variables between the two sports and the speed at which they make a full recovery. The variables that were compared included OKC, CKC and ROM specifically.

**Table 1****Analysis Set 1: Compare Football vs. Soccer Athletes ACL Rehab and Recovery**

	Football	Soccer	
Total Participants	6	2	8
	Mean (SD, range)		p-value (t-test)
Time between Injury and Surgery (Days)	31.2 (9.7; 19-46)	19.0 (8.5; 13-25)	0.23
Time between Injury and Release Date(Days)	329.8 (22.2; 292-355)	241.5 (9.2; 235-248)	0.0005
Time between Surgery Date and Release Date (Days)	298.7 (23.2; 265-330)	222.5 (0.7; 222-223)	0.0046
Time between Injury and First Rehab Date (Days)	58.3 (58.9; 2-125)	10.0 (11.3; 2-18)	0.12
Time between Surgery and First Rehab Date (Days)	27.2 (52.4; -21-92)	-9.0 (19.8; -23-5)	0.21
Time between First Rehab Date and Release Date (Days)	271.5 (54.6; 205-347)	231.5 (20.5; 217-246)	0.19
Total Number of Rehab Sessions	58.3 (6.8; 37-76)	126.5 (10.5; 116-137)	0.034

Height (inches)	71.5 (2.2; 69-75)	71.5 (0.7; 71-72)	1.00
Weight (lbs.)	196.7 (12.9; 180-215)	161.0 (15.6; 150-172)	0.14
<b>Reps by Type of Exercise</b>			
OKC	111.7 (54.6; 11-157)	571.5 (128.0; 481-662)	0.11
CKC	128.7 (15.4; 109-146)	381.0 (38.2; 354-408)	0.056
ROM/Mobility	131.5 (38.1; 31-279)	336.5 (31.8; 314-359)	<b>0.004</b>
Stretch Based Exercises	8.5 (21.3; 0-50)	9.5 (6.3; 5-14)	0.92
Other	4.3 (9.2; 0-23)	38.5 (54.4; 0-77)	0.13
Total Number of Exercise Reps	404.0 (73.8; 328-529)	1383.0 (166.9; 1265-1501)	0.062

Based on the data analysis, it was found that soccer players had a statistically significantly shorter time between ACL injury and their rehab release date, as well as time between surgery date and rehab release date compared to football players. In conjunction, soccer players had a significantly greater number of total rehab sessions with their athletic trainer when compared to football players, and within those sessions, soccer players' rehab exercises consisted of a significantly greater number of ROM/Mobility exercise repetitions compared to football players.

In terms of significant data shown through Pearson's Correlation Coefficients, the number of days between injury and recovery is negatively correlated with number of OKC exercise reps (-0.98,  $p < 0.0011$ ), CKC exercise reps (-0.91,  $p = 0.0017$ ), injury year (-0.74,

p=0.04), and total number of rehab sessions (-0.79, p=0.02). This means that an increase in these factors is associated with a decrease in recovery days (from injury to release).

Days between surgery and recovery is negatively correlated with the number of OKC exercise reps (-0.86, p<0.0060), CKC exercise reps (-0.87, p=0.0054), and injury year (-0.77, p=0.0242). This means that an increase in these factors is associated with a decrease in recovery days (from surgery to release).

Injury year is positively correlated with OKC (0.72, p=0.042), CKC (0.78, p=0.023), and other (0.82, p=0.012) rehab exercise reps. This means that these reps were performed more during recent years compared to past years.

Total number of rehab sessions is positively correlated with OKC (0.87, p=0.0045), CKC (0.92, p=0.001), and ROM/Mobility exercise reps (0.89, p=0.0032). This means that a higher number of rehab sessions was associated with an increase in these types of exercises.

Weight is negatively associated with OKC (-0.8, p=0.01), CKC (-0.84, p=0.009), ROM/Mobility (-0.86, p=0.0067), and number of rehab sessions (-0.96, p=0.0001). This means that increased weight is associated with decreased OKC, CKC, ROM reps as well as number of rehab sessions.

## **Conclusions**

As shown by the collected data, the soccer players who had ACL surgery had a significantly shorter recovery time than the football players with the same injury. This decrease in recovery time was also tied to the increased number of rehabilitation sessions as well as the significantly larger number of range of motion or mobility exercises. In essence, the conclusion that was drawn was that those who had more opportunities for rehabilitation recovered quicker than those who had fewer sessions. More opportunities to work on an injured body part led to a strengthening of the muscles as well as increased blood flow to the area which in turn help improve the healing of the area and the strengthening of the muscles required for regaining full range of motion and movement.

## **Challenges**

As with any study, there were challenges that impacted the study in some way. As the study progressed, multiple things were noticed that could have impacted the resulting data. First

and foremost was the size of the data pool. This study only looked at eight college level athletes, and only one quarter of the total athletes were soccer players. In this study, this complication was unavoidable as the goal was seeking to minimize other possible confounding variables by using strict inclusion criteria. Another complication that arose within the study was the variability of data collection. There was not a specific method that data was transcribed between the two athletic trainers over the past six years. Occasionally, exercises would be recorded without the number of reps per set or without specifying what part of the body was stretched for example. While this challenge was mostly able to be mitigated through discussion with the trainers, there still is the possibility that a full set of data would have shown different results.

Another challenge arose through the dates and timing of rehabilitation. Throughout this study it was noticed that all the football players went home for extended periods of break throughout the year, both around the winter holidays and over the summer. While the soccer players also had a winter break, they remained on campus over the summer and continued to do rehab with the school's athletic training team. The results of this were that a soccer player was cleared to return to play mid-way through the summer while five out of the six football players were cleared to play the day they returned to campus in August, indicating that they likely could have been cleared earlier. The remaining football and soccer players were injured in months that led to their return earlier in the year, though they followed the same trend of work in the summer. If there was uniformity in how the athletes spent their summers in terms of rehab, that could have drastically changed the data in terms of length of time to recovery, especially for the football players.

Another challenge came from the variability of surgery type. Conveniently, all athletes had the same surgeon, Dr. Kollias, who is known for doing two different types of ACL repair, the hamstring repair, and the cadaver repair. For this study we were unable to acquire the data recording which of these repairs the athletes received, and thus, type of repair could be a confounding variable.

The final complication to this study was the lack of ability to do hands-on research. While this did not affect the results of the study, doing a retrospective study on body movement can be difficult as there is no way for the researcher to go back and watch how the athlete's bodies were moving while they recovered, which could have provided valuable insight into their recovery process.

However, this study was worthwhile because it indicates that there may be differences between sports, exercises, and the physical therapists and athletic trainers at the university that what they are doing with the soccer athletes does work and advances their recovery when comparing them against the football players. If the athletic trainers were to adopt a similar treatment plan for the football players, this could advance their recovery as well.

### **Future Studies**

The results of this study, while helpful and interesting, do lead to just as many new questions as they provide answers. Future studies could investigate a more equal division of sport, seeing if it was luck that led to these results. Another topic of future study would be determining if these results transfer to other school, particularly to a school that has both football and soccer as division one sports. In this study, the difference in summer treatment for the athletes was likely a factor, so that would be another variable to investigate, whether a school with more uniformity in their summer rehabilitation treatment would produce the same results. This data also leads to questions on athletes who play different sports than the two done here, female athletes, and athletes who experience a repeat ACL tear. Finally, more analysis could occur regarding the concept that certain exercises could impact recovery based on when they were performed during rehabilitation came up (Cavanaugh, 2017, p. 289, Kegerreis, 1983, p. 14). While it was noted during this study, this was not data that was thoroughly analyzed, so it is another area for future studies investigate the timing of certain rehabilitation exercises.

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