# **Overview of Anterior Cruciate Ligament treatment**

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Abstract. This paper presents the findings of every basis to know about an ACL (Anterior cruciate ligament) rupture. The purpose of this paper is to help understand aspects of an ACL rupture basis from its anatomy and physiology to recovery factors highlighting key aspects about the injury. Understanding anatomy of and around the knee can prevent further injuries to other ligaments or cartilage. Research indicates that ACL tears can be taken care of through various techniques surgical or non-surgical. Rates of ACL tears vary reliant on factors such as age, training type, gender and other factors. Diagnostics of ACL ruptures are very crucial to understand the type of treatment you need from manual tests such as the Lachman test or to decide for a CT, MRI, X-ray or an ultrasound. Rehabilitation programs are the most important part of the injury where the athlete should follow the guide of a physical therapist by a 3-5 month program.

Keywords: Anatomy, epidemiology, Rehabilitation.

#### 1. Introduction

Sports are very common among hobbies and activities people participate in modern days. Along with playing the sport, unfortunate injuries usually occur after altercations or incorrect inputs. Anterior cruciate ligament (ACL) injuries are among the most common injuries, affecting both professional athletes and recreational players worldwide. The function and purpose of the ACL is to create stability within the knee and to prevent excessive tibia translation relative to the femur commonly used in sports with movements such as change of directions, stopping and starting, and explosive movements. The ACL is commonly injured in sports such as basketball, lacrosse and football dealing with aggressive movement changes. The ACL is a critical component of the knee, providing essential stability and enabling the complex movements required in various physical activities. Its injury can severely impact knee functionality, highlighting the importance of its role in maintaining knee health and the necessity for proper treatment and rehabilitation following injury. This paper aims to provide better comprehension of the ligament during an ACL rupture from the exploration of anatomy and structure, the epidemiological background, diagnosing for ACL tears and different types of treatments for an ACL tear.

The anatomy of the knee is very complex as it allows us to do extensive movements whether it is sport related or daily tasks. The knee contains various components making up the overall structure that works collaboratively allowing these complex motions. The main bones around the knee are the patella (knee cap), tibia (shin bone), fibula (calf bone) and femur (thigh bone). behind the patella contains 4 ligaments acting as connective tissue attached from the femur to the fibula or tibia. The four ligaments in the knee are the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), lateral collateral ligament (LCL) and the medial collateral ligament (MCL). The ACL and the PCL form an X crossing over each other located between the femur and the tibia. The MCL is closer to the midline of the body and connects from the tibia to the femur, whereas the LCL is distal from the MCL and connects from the femur to the fibula. These four ligaments play a role in stabilizing the knee allowing flexion, extension and a small degree of medial and lateral motion to not hyperextend leading to injuries. It is approximately 38 mm in length and 11 mm in width, though these dimensions can vary among individuals [1]. The ACL is composed of two functional bundles: the anteromedial (AM) and posterolateral (PL) bundles. These bundles are named based on their insertion points on the tibia and their behavior during knee movement. The AM bundle is tightest when the knee is flexed, playing a crucial role in preventing anterior tibial translation, while the PL bundle is more active when the knee is extended, contributing significantly to rotational stability. The ACL's positioning and structure allow it to bear significant loads during various activities, particularly those involving rapid changes in direction, jumping, and deceleration [2]. However, this also makes the ACL prone to injury, particularly in sports. ACL injuries often occur due to non-contact mechanisms, such as sudden stops, pivots, or awkward landings, leading to a partial or complete tear of the ligament. Such injuries are common in sports like soccer, basketball, and skiing. When the ACL is injured, it can lead to significant knee instability, particularly during activities that involve cutting or pivoting motions. This instability arises because the knee is no longer adequately constrained by the ligament, leading to abnormal movement between the femur and tibia [3]. An ACL injury occurs when there is a rupture in the ligament pulling or tearing the ACL usually caused by excessive anterior tibia translation or increased internal tibial rotation.

ACL injuries are the most common knee injury especially being caused from sports. There are certain attributes to an individual that can increase the chances of an individual tearing an ACL such the NCAA study showing that females typically injure their ACL more often than males, this phenomenon is hypothesized to be caused by the difference in anatomical structure, neuromuscular connection, general muscle strength and hormonal issues. Studies of the case of gender contributing to ACL tear rates and gender correlation showed inconsistent results with some studies showing a 2-8 times higher chance of injury for women than men however in the NCAA study there was a differentiated ratio of injury rates from men to women. Poor conditioning increases risk for an individual's health for ACL tears caused if an individual's body isn't prepared or trained for certain loads being pressured on the ACL causing an unnatural movement to lead to a stretch or a tear. Age also plays a role, with the highest incidence observed in individuals between 15 and 25 years old, corresponding with peak levels of sports participation. While non-contact mechanisms, such as sudden changes in direction or improper landings, account for the majority of ACL injuries, contact injuries are also common, particularly in collision sports. ACL injuries often occur in combination with other knee injuries, such as meniscal tears, cartilage damage, and other ligamentous injuries, which complicate recovery and may lead to long-term issues such as osteoarthritis. train cases [4]. The high rates of ACL reconstruction surgery, especially in the United States, reflect the significant impact of these injuries on function and quality of life, as well as the desire to return to pre-injury levels of activity. Rehabilitation following ACL injury is crucial and involves a structured program that focuses on restoring strength, flexibility, and proprioception, but even with successful surgery and rehabilitation, there is a high risk of re-injury, particularly in younger athletes. Additionally, a substantial proportion of individuals who suffer ACL injuries do not return to their pre-injury level of sports participation, often due to fear of re-injury, ongoing knee symptoms, or altered knee function. The long-term consequences of ACL injuries, including an increased risk of developing knee osteoarthritis, underline the importance of preventive strategies. These strategies have become a major focus in recent years, with programs designed to enhance neuromuscular control, improve landing techniques, and strengthen the muscles around the knee showing promise in reducing the risk of ACL injuries. Public health initiatives aimed at educating coaches, athletes, and healthcare providers about these preventive measures are essential to reduce the incidence of ACL injuries and their associated burden. Ongoing epidemiological research is vital to further understanding the risk

factors, mechanisms, and outcomes associated with ACL injuries, with the ultimate goal of improving prevention, treatment, and long-term outcomes for individuals affected by this significant health issue [5].

# 2. Diagnosis

ACL injuries such as tears are usually extremely painful and often realized quickly, however to understand more about the injury usually your physician will do tests such as a physical examination looking for signs of swelling, tenderness and compare injured knee to uninjured knee for a difference. The physician typically would also move the leg around to test the range of motion of the patient understanding about the severity of the injury [6]. There are manual tests that could be performed by anyone to determine whether someone has an ACL tear with a 70% to 80% accuracy rate being the Lachman test. The Lachman test is a drawer test in which the knee to be tested is held at a 20-30° bend [7]. The heel is in contact with the couch. The examiner grasps the lower leg with both hands so that the index fingers are in the back of the knee. The lower leg is pulled ventrally. The ability of the lower leg to move relative to the femur indicates whether or not there is an injury to the cruciate ligament. A positive testing result would be if the tibia showed excessive anterior translation relative to translation in the femur, whereas a negative test result would be indicated by no excessive anterior translation in the tibia relative to the femur. The Lachman test should not be performed when the injury happened right away shown by the shock the person will experience but the Lachman test is to be performed at a time where the athlete is not in pain but not too late [8]. After a physical examination, more complex testing such as a magnetic resonance imaging (MRI), computed tomography (CT), X-ray or an ultrasound. will be performed. An X-ray uses radiation to create a 2D image primarily detecting bones and finding cancers and pneumonia. A CT scan is generally more powerful than an X-ray creating a 3D image focusing on diagnosing conditions in organs and soft tissues, a CT scan is common for a rapid diagnosis for ACL injuries. A more modern technique was by using ultrasound for diagnosing ACL cases showing a 93% to 96% accuracy rate done in only necessary conditions. The most common and reliable diagnostic for ACL injuries is through an MRI using powerful magnetic and radio waves creating a 3D cross section imaging being able to examine every detail. An MRI is shown best for diagnosing ACL injuries because of the necessity of every detail assessing the severity of the ACL tear whether it is a grade 1 or a grade 3 ACL tear [9].

## 3. Treatment

After confirming a diagnosis with your physician, they would usually give advice for recovery but for further recovery the patient should see a physical therapist. The standard procedure following an ACL rupture that is possible to do at home is the RICE method. RICE is an acronym for rest, ice, compression and elevate. The original method was invented in 1978 by Gabe Mirkin to show a simple method that can be done by anyone at home. Resting is to prevent further damaging any tissue and to prevent the common philosophy of "No pain, no gain". Doctors suggest that for 48-72 hours no pressure should be applied to the injured area causing risk of further injuries or delaying recovery. Icing the injured area is to minimize pain and swelling but ice should not be applied for too long as it risks damaging tissues (Sachdev et al, 2024). With most cases of ACL ruptures, they are accounted for as high-risk injuries where necessary treatments such as surgery is highly recommended [9]. Non-surgical procedures are possible such as knee braces, physical therapy or rehabilitation programs, NSAIDs (Non-steroidal antiinflammatory drug) and Ice Therapy, or time. Knee braces are a possibility before any surgical procedure relying on the nature of the injury (University of Penn, 2024). If the ACL is stretched or partially torn but not fully separated, knee braces can be seen as a suitable recovery recommendation for individuals with lower demands in physical activity. The point of knee brace is to prevent excessive knee mobility allowing the ACL to repair itself instead of damaging the ACL any further. There are also functional knee braces that support the knee whilst allowing physical movement which can be used as support while still playing a sport, commonly used near the end of rehabilitation programs [3]. NSAIDs aren't used primarily for ACL recovery. NSAIDs such as ibuprofen and naproxen are used commonly,

however it is a short-term prescribed medicine used to reduce inflammation and pain released by the ACL [10]. If an individual goes with a surgical procedure usually recommended only for grade 3 ACL tears, it would require a full ACL reconstruction, a procedure called primary repair and ACL restoration with BEAR® implant (McBrayer, 2022). ACL reconstruction surgery works by replacing the injured ACL with a new ACL from a graph of connective tissue either from a portion of the patient's own iliotibial band, hamstring, quadriceps or patellar tendon, or an allograft which is a tissue from a human organ donor. The procedure works first by commonly extracting a section of graft from the patellar ligament as the ACL replacement [11]. An incision will be made diagonally through an arthroscope creating a channel through the tibia and the femur. The new graft is then placed in through the channel then the use of special screws is placed to keep the new graft in place [8]. Any reasoning for which path of treatment a patient wants depends on their lifestyle where if an individual is more active in sports, the surgical procedure is recommended for them as it would enable that athlete to still be able to perform at a high physical rate.

Some exercises a physical therapist is likely to give out are such movements to promote knee movement such as heel slides but these exercises should only be performed at a very light rate usually where the section of the leg above the injury is supported so the injured area doesn't have to take a lot of pressure. Another relative motion to start rehabilitation with is prone hip extension where an individual lies on their stomach and slowly bends the leg bringing up the calf. The principle of general rehabilitation for the ACL is so that the patient should promote movements such as bending the knee but at different difficulty levels and then should start using bodyweight as a counter [12]. The standardized general idea of what to do after a surgery is recommended with these steps. The first week should be for recovery and relaxation, avoiding ice and NSAIDs to lower any chance of damaging tissues. individuals should however elevate and compression to promote blood flow. The goal for the end of the first week would be to perform a full extension and a 70° flexion. Knee brace post operations have been advised less throughout more research, as multiple doctors and studies have shown not much of a difference for a patient wearing a functional knee brace rather than no brace. After week 1 ice and elevation is no longer useful, the goal should be to cause flexion at the knee as much as possible and to be able to walk with little to no support from crutches. Main muscles to train for rehabilitation are the calf muscles, hamstrings and the quadriceps. Around 3-4 weeks an individual should aim to walk comfortably as well as performing body weight closed kinetic chain exercises. Closed kinetic chain exercises are movements where the hand and foot are locked in one position and can not be changed such as squats, push-ups and deadlifts. After 5 weeks the patient should do light intensity exercises working at 50% as well as starting open kinetic chain exercises and coordination work. The patient should generally just increase intensity in closed and open kinetic chain exercises and increase difficulty in stability movements and strength movements [13]. Closed kinetic chain exercises are highly beneficial for rehabilitation and strength training because they involve movements where the distal part of the limb remains fixed or in contact with a stable surface, leading to several key advantages. These exercises, such as squats, lunges, and push-ups, promote joint stability by engaging multiple muscle groups and joints simultaneously, which improves overall coordination and balance. Additionally, closed kinetic chain exercises mimic functional, everyday movements, enhancing their effectiveness in real-world scenarios and improving the carryover of strength and stability gains to daily activities or sports. They also tend to place less shear stress on the joints compared to open kinetic chain exercises, making them particularly suitable for patients recovering from injuries like ACL tears, as they allow for safe, progressive loading of the muscles and ligaments surrounding the joint. Furthermore, closed kinetic chain exercises create less force onto the ACL which then the patient can perform these exercises at their own level [14].

#### 4. Conclusion

Upon finalized research, the understanding of the severity and epidemiology of ACL ruptures are serious and should be treated properly. The correction of the injury can allow the individual to return at a different state of readiness whether it is an athlete or a non-athlete. Understanding the correct recovery aids at home and choices for procedures that are non-surgical or surgical affects how an athlete is in the long term. The value of knowing recovery can speed up the process of recovery and potentially train the individual to limit the same injury again. Understanding every basis of the process can lead an individual to the most optimal path in recovery as well as prevention from future injuries.

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