



The Mechanism of Rupture and Surgical Methods of Anterior Cruciate Ligament Reconstruction

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ABSTRACT

Anterior cruciate ligament (ACL) injuries are among the most common in sport. They occur as a result of trauma caused by twisting the knee, and the most common mechanism is when the patient's foot is fixed to the ground and the trunk is rotated. The aim of this study was to survey and analyze the mechanisms of injury and surgical procedures for anterior cruciate ligaments. Material and Methods: To carry out a study on the systematic approach and objective description of the evidence summarized on injury processes and surgical reconstruction of the anterior cruciate ligament. Final considerations: From the articles analyzed in this study, the majority of ACL reconstructions are performed using knee arthroscopy. It is essential for doctors to get to know their patients, their life aspirations and their daily activities in order to guarantee the best possible treatment.

Keywords: Key: anterior cruciate ligament injuries, mechanism of injury, rehabilitation and ACL reconstruction procedures.

INTRODUCTION

Anterior cruciate ligament (ACL) injuries are among the most common sports injuries. However, the success of this reconstruction, in the medium and long term, is directly linked to the alignment and positioning of the bone tunnels, as well as the tension of the ligament graft (BEZERRA et.al, 2022).

Ligament injuries can be classified according to the degree of injury (QUINTAS et.al, 2015).

Due to the complexity of this joint, a medical assessment of the anatomy of the knee is essential and should cover various aspects, including the patient's anamnesis, signs, symptoms and physical examination. In addition, a high level of knowledge of the femorotibial, patellofemoral and superior tibiofibular joints is required (PERERA & BUNOLA, 2015).

The positioning of the bone tunnels is fundamental to the kinetics and biomechanics of the knee and influences the final results of the surgery (SERRA, 2008).

The knee joint plays one of the most important roles in locomotion in the human body. It is made up of three bone structures: the femur, tibia and patella. It can also be divided into two more joints, the patellofemoral joint and the femorotibial joint (BIGONI et.al, 2017).

The knee joint capsule is made up of ligaments closely adhered to it, one of which is the ACL, responsible for stabilization. Knee ligaments are the most investigated in orthopedics today, with new studies on the concept of anatomical reconstruction, with great advances in surgical processes (SALMON et.al, 2008).

The knee is made up of 4 main ligaments (FIGURE 1): - anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL) and lateral collateral ligament (LCL). These ligaments attach the thigh bone (femur) to the two leg bones (tibia and fibula), providing strong support and stability for the knee joint (SALMON et.al, 2008).

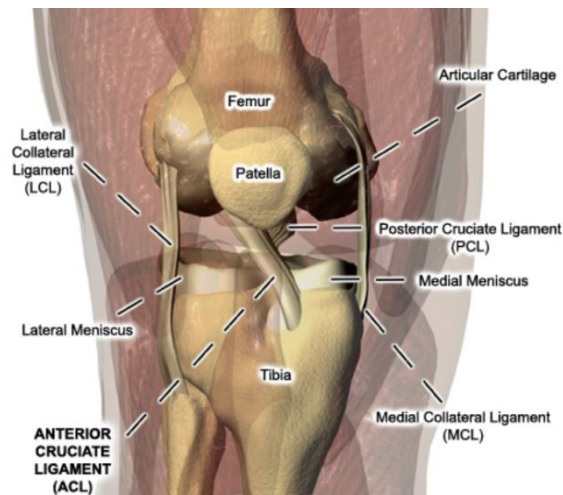


Figure 1 - Ligaments that make up the structure of the knee. Source: Ortho Virginia, 2023.

An ACL sprain is classified on a scale of 1 to 3, depending on the severity of the injury: Grade 1 - the ACL is stretched or slightly damaged, but is still intact and can therefore provide a small amount of stability to the joint; Grade 2 - the ACL is stretched or partially torn, decreasing the stability of the joint; Grade 3 - the ACL is completely torn and requires surgical repair (FIGURE 2) (RODRIGUES, 2008).



Figure 2 - Ruptured anterior cruciate ligaments. Source: Ortho Virginia, 2023.

Common symptoms following an ACL injury can include pain, swelling, difficulty walking and reduced range of movement (SALMON et.al, 2008; BONFIM & PACCOLA, 2000).

In order to detect a total injury to this ligament, a clinical examination must be carried out, together with an imaging test such as magnetic resonance imaging. With a sum of clinical findings it is possible to give a definitive diagnosis of the injury (BIGONI et.al, 2017).

GENERAL OBJECTIVE

To review the literature on injury mechanisms, surgery and the anterior cruciate ligament.

METHODOLOGY

The study was carried out by means of an indirect literature review, using scientific journals and articles available on virtual databases.

The bibliographic survey corresponded to a review characterized by the design of studies conducted with an up-to-date systematic approach and an objective description of the evidence summarized on the processes of injury and rehabilitation of the anterior cruciate ligament.

We used the following indexing terms: "Anterior cruciate ligament injury mechanisms"; "Anterior cruciate ligament rehabilitation"; "Anterior cruciate ligament surgical processes", with the titles and abstracts to select articles that responded to our research objective. Thus, only the articles that indicated the selected themes in their title or abstract were analyzed.

The selected articles were read in their full version and their reference lists were manually searched for additional relevant publications. Foram encontrados artigos no PubMed, no Medline, no Cochrane Database e no Google Scholar.

We then excluded articles that were simultaneously indexed in more than one database. Textual analysis and thematic and interpretative analysis were carried out.

LITERATURE REVIEW

There is a lot of interest in surgical reconstruction of the anterior cruciate ligament, since the long-term results of conservative treatment are not satisfactory, with a low percentage of return to the same pre-injury level, without restrictions, as well as frequent complaints of instability, leading to the need for secondary reconstruction. There is also a likelihood of future osteoarthritis in between 60 and 100% of cases after 20 years (RODRIGUES, 2008).

According to Senter & Hame (2006), the most commonly used surgical technique for its treatment is arthroscopic reconstruction, with a single band, the femoral tunnel being made through the tibial tunnel, favoring the former being made in a higher location on the intercondyle, different from the anatomical description of the femoral insertion site.

Knee injuries can be caused by various factors, ranging from a sedentary lifestyle to intense physical activity. Trauma from blows or rotations to the knee (resulting from accidents or falls, for example) can hit bones and menisci, tear ligaments or dislocate the patella (SENER & HAME, 2006; LAPRADE & WIJICKS, 2012).

Several ligaments help keep the knee in place: Collateral ligaments: these ligaments, located on each side of the knee, prevent the knee from moving too much from side to side. The medial collateral ligament is located on the inside of the leg, and the lateral collateral ligament is located on the outside of the leg (INGRAM et.al, 2008; LAPRADE & WIJICKS, 2012).

The menisci in turn act as "cartilage shock absorbers" and fill the space between the thigh bone (femur) and the shin bone (tibia). They help stabilize and cushion the knee joint (LUTTER et. Al, 2020).

According to Lutter et.al (2020), the anterior cruciate ligament can be injured in a number of ways, such as a quick change of direction, or stopping at once and slowing down during a run. Another mechanism of injury occurs when supporting the feet incorrectly after a jump, direct contact or collision or even as a tackle in soccer.

The most commonly injured structures in the knee are the medial collateral ligament and the anterior cruciate ligament (LUTTER et al, 2020).

The direction of the force against the knee determines which structures will rupture. The medial collateral and anterior cruciate ligaments: one or both of these ligaments can rupture if the side of the knee is hit when people are resting their weight on a foot firmly on the ground, such as when preventing a lunge. Damage is more likely if the knee is also twisted. The lateral collateral and anterior cruciate ligaments can be damaged when the force against the knee is directed outwards. This type of injury can occur when the leg is pushed from the inside. The anterior and posterior cruciate ligaments can be damaged when the knee is extended with force. Finally, the Meniscus can be damaged when people put their weight on one foot and their knee twists when it is injured (HEWETT et.al, 2006; LUTTER et. Al, 2020; INGRAM et.al, 2008; SENTER & HAME, 2006; LAPRADE & WIJICKS, 2012).

ACL ruptures can be divided into two groups: asymptomatic patients who have adapted to the injury and patients who still feel impaired and have difficulty performing daily activities, who have symptoms such as pain, swelling and misalignments during knee movements (BIGONI et.al, 2017).

Injuries can originate directly, when the knee is at 90 degrees of flexion with the tibia fixed when the femur is pulled posteriorly, or indirectly, by a sudden change of direction, sudden stop or incorrect fall from a jump and can occur by various mechanisms, including: external rotation, abduction and anterior forces applied to the tibia, internal rotation of the femur on the tibia and hyperextension of the knee (BIGONI et.al, 2017; BONFIM & PACCOLA, 2000).

The most recurrent mechanism during physical activity is the anterior projection of the tibia in relation to the femur, but it also describes the aforementioned means. Some of the factors that lead to injury in athletes are: the type of footwear used, the surface of the court and the athlete's anatomy.

It's important to note that the forms of treatment for ACL injuries vary according to the extent of the ligament involved, and are divided into partial and complete injuries. Treatment is carried out according to each patient's needs, and it is very important to detect cases of low and high risk of injury progression (BONFIM & PACCOLA, 2000).

Low-risk patients have no associated injuries, so their treatment is conservative. High-risk patients, on the other hand, have clinical instability and a lifestyle that tends towards the occurrence of new injuries, thus requiring post-surgical physiotherapy treatment. Physiotherapy plays a fundamental role in both the pre- and post-surgical stages, as it leads the patient to a better life. The faster improvement by getting them back into their sporting activities and activities of daily living (HEWETT et.al, 2006; LUTTER et. Al, 2020; INGRAM et.al, 2008; SENTER & HAME, 2006; LAPRADE & WIJICKS, 2012).

According to Hewett et.al, 2006, non-invasive treatments include the use of orthoses to protect the knee from instability and physiotherapy plays an extremely important role in functional recovery, as specific exercises will restore function and help strengthen the muscles around the knee.

In the case of partial ACL injury, the patient's needs must be taken into account when deciding on the type of treatment to be carried out LAPRADE & WIJICKS, 2012).

A descriptive study of knee surgeons analyzed the preference of surgical methods and materials used in the reconstruction of total ACL injuries (FLEMING et.al, 2022).

Firstly, the time taken for the procedure to be carried out was analyzed, with a predominance of procedures being carried out between 1 and 4 weeks after injury.

In addition, the choice of the type of graft to be performed was evaluated, with the patella ipsilateral to the injury (DOMNICK et.al, 2021).

Although studies have shown differences between the types of grafts, the results have shown success in re-establishing the injury within 6 months and performed through reconstruction using the Chablat technique (KIAPOUR & MURRAY, 2014).

Alterations in the synergism between the quadriceps and hamstrings impair dynamic joint stability when the ligament is subjected to forces that excessively displace the tibia anteriorly and the receptors in the ACL (DOMNICK et.al, 2021).

A study by De Lima et.al (2021) compared the myoelectric activity of the vastus lateralis and biceps femoris muscles and the co-contraction between these two muscles in healthy individuals and those undergoing reconstruction, which found that myoelectric activity is disturbed after ligament reconstruction. This can reduce or completely abolish afferent information from ligament receptors. This is believed to be strongly related to an increased rate of re-injury and early joint degeneration.

Several factors are associated with a successful return to sport after a total ACL tear (CRISS et.al, 2021).

The aim of this surgery is to restore stability to the knee and allow a return to the pre-injury state, and thus to sports participation (DOMNICK et.al, 2021).

SURGICAL METHODS FOR ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION

ACL reconstruction is performed using a combination of open surgery and arthroscopy. The new ACL (graft) is then brought through these tunnels and fixed. With the healing process, these tunnels are filled with bone tissue, permanently fixing the graft. There are three grafting methods for replacing the ACL (NWACHUKWU et.al, 2021). The middle third of the tendon and a small portion of the bone on both sides is harvested and used as the new ACL. As shown in FIGURES 3 and 4, ACL reconstruction begins with a small incision in the leg, where small tunnels are drilled into the bone (KIAPOUR & MURRAY, 2014).



Figure 3 - Start of the ACL reconstruction surgical process. Source: Ortho Virginia, 2023.

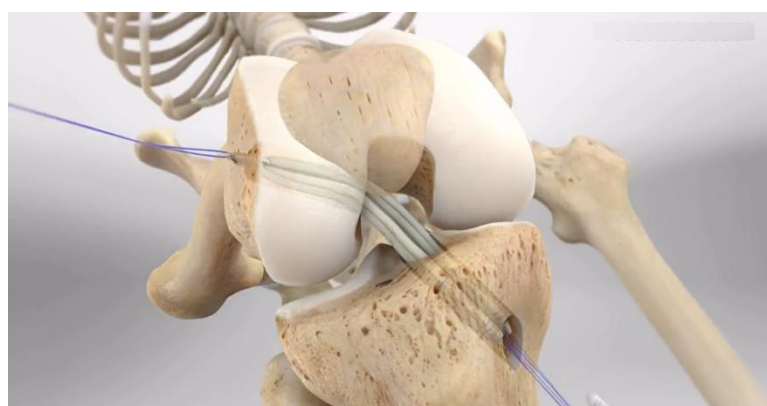


Figure 4 - Graft passage for ACL reconstruction. Source: Ortho Virginia, 2023.

According to FU et. al (2020), the patient needs to be admitted to hospital and have all the preoperative tests such as blood tests, X-rays and MRI of the knee. In addition, they must fast for 8 hours for food and liquids and 4 hours for water. To begin the surgery, the patient is anesthetized, usually by spinal anesthesia and sedation. Spinal anesthesia is performed by injecting an anesthetic drug through the lumbar spine (CRISS et.al, 2021).

Nowadays, more advanced anesthesia techniques also block the pain nerves in the knee. As a result, post-operative recovery is smoother, with less pain, and the patient can already start physiotherapy on the same day as surgery (WEBSTER et al, 2019; CRISS et.al, 2021; KIAPOUR & MURRAY, 2014).

Sedation helps the patient to relax and sleep during surgery, using drugs introduced through the vein or by inhalation. It is done even before the spinal anesthesia or nerve block. This way, the patient feels no pain, is calm and only wakes up when the surgery is over (FU et.al, 2020).

To make it easier to see the structures of the knee, after anesthesia, a tourniquet is placed on the patient's thigh, which compresses the vessels and prevents bleeding during surgery (WEBSTER et al, 2019).

The first stage of surgery consists of removing the graft. Once removed, the graft is prepared to acquire the shape of the anterior cruciate ligament. Once this stage is complete, arthroscopy is performed, a minimally invasive procedure in which a 4-6mm camera is inserted to see the structures inside the knee (ARNOLD et al, 2021).

During arthroscopy, other injuries such as menisci and cartilage are checked for. If any other injury is found, it is repaired. If not, only ACL reconstruction is performed. For the reconstruction procedure, a puncture is made in the femur and another in the tibia where the anterior cruciate ligament is located.

The graft is then passed through the holes (called tunnels) (FIGURE 5) and fixed with an implant, which can be a metal screw, suspensory button, biodegradable screw, etc (ARNOLD et al, 2021).



Figure 5 - ACL reconstruction technique using the patellar tendon. Source: Ortho Virginia, 2023.

At the end of the surgery, the patient is taken to the anesthetic recovery room, from where they go to their hospital room.

In the vast majority of cases, the patient is discharged from hospital on the same day as the surgery, but the date of discharge can change depending on other factors, such as the number and complexity of the procedures performed (WEBSTER & HEWETT, 2019).

RECOVERY TIME

The recovery time for this ACL surgery alternative is usually around half the time it normally takes for an ACL surgical graft to heal (WEBSTER & HEWETT, 2019).

This is consistent with the fact that most surgeons recommend that patients take a full year off before returning to sports. In fact, after experiencing an early return to sports at 6 months, a recent study found that only 19% of patients were able to return to their pre-injury level of sports that quickly (WEBSTER & HEWETT, 2019).

FINAL CONSIDERATIONS

From the articles analyzed in this study, the majority of ACL reconstructions are performed using knee arthroscopy. In this minimally invasive procedure, the surgeon makes several small incisions around the knee joint and inserts a narrow fiber optic device (called an arthroscope) to examine the condition of the knee.

ACL reconstruction surgery using an autograft (tissue from your own body) or an allograft (tissue from a cadaver) is usually most successful for patients who want to return to an athletic and demanding lifestyle.

As patients age and demands decrease, the success of the allograft procedure increases. Ultimately, it depends on the unique needs of each individual. Different techniques work better in different situations.

Getting to know your patient and their life aspirations and daily activities is essential for the doctor in order to guarantee them the best possible treatment.

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