ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

ANTERIOR CRUCIATE LIGAMENT, DESCRIPTION, RUPTURE AND TREATMENT

Diana Carolina Martínez Pesántez[1], Bryam Esteban Coello García[2], Daniela Elizabeth Galarza Ulloa[3], Juan Francisco Vidal Moreno[4], Fabiana Domenica Palacios Rivera[5], Karina Noemí Contreras García[6], Gabriela Vanessa Vanegas Cadena[7]

[1]Postgraduate Doctor in Orthopedics and Traumatology at Faculdade de Ciências Médicas Minas Gerais. Belo Horizonte - Brasil. ORCID https://orcid.org/0000-0002-8622-7016
[2]Postgraduate Doctor in Orthopedics and Traumatology at Faculdade de Ciências Médicas Minas Gerais. Belo Horizonte - Brasil. ORCID https://orcid.org/0000-0003-2497-0274
[3]General Practitioner in Independent Practice, Faculty of Medical Sciences, Universidad Católica de Cuenca. Azuay- Ecuador ORCID https://orcid.org/0000-0001-9901-8857
[4]General Practitioner in "Centro de Salud Nabón, tipo C". Azuay- Ecuador. ORCID https://orcid.org/0000-0002-5700-8084
[5]Medical Intern in "Fundación Pablo Jaramillo''. Cuenca. Azuay- Ecuador. ORCID https://orcid.org/0000-0001-9922-2030
[6]General Practitioner in "Hospital Básico de Gualaquiza - Misereor". Gualaquiza - Morona Santiago. Ecuador. ORCID: https://orcid.org/0000-0001-5899-1618
[7]General Practitioner in Independent practice, Faculty of Medical Sciences, Universidad Católica de Cuenca. Azuay- Ecuador ORCID https://orcid.org/0000-0003-4363-7426

Corresponding Author : *Bryam Esteban Coello García,* ***Address:*** *Rua Tiradentes 266.Campo Belo. Minas Gerais. Brasil,****Postal Code:*** *37270-000*

Article DOI: https://doi.org/10.36713/epra12217
DOI No: 10.36713/epra12217

SUMMARY

Introduction: *the anterior cruciate ligament (ACL) along with the posterior cruciate ligament are the central stabilizers of the knee. Rupture of the ACL usually occurs in active and young people. For a correct diagnosis it is necessary a good clinical history, examination and a complementary study. The literature recommends surgical treatment in athletes and young people.*

Objective: *to detail current information related to anterior cruciate ligament injury, embryology, anatomy, biomechanics, incidence, risk factors, diagnosis, management, approach and treatment of the disease.*

Methodology: *a total of 72 articles were analyzed in this review, including review and original articles, as well as clinical cases, of which 46 bibliographies were used because the other articles were not relevant to this study. The sources of information were PubMed, Google Scholar, SciELO and Cochrane; the terms used to search for information in Spanish, Portuguese, German and English were: ACL, anterior cruciate ligament, anterior cruciate ligament, Vordere Kreuzband.*

Results: *ACL deficiency not only causes instability episodes but also changes in joint mechanics that may lead to degenerative changes. Meniscal lesions are linked to 50% of these injuries. The Lachman test is the most accurate clinical diagnostic test, with a reported combined sensitivity of 85% and specificity of 94%. The anterior drawer test has high sensitivity and specificity for chronic ACL tears (92% sensitivity and 91% specificity), but lower accuracy for acute cases. In MRI, the following statistics were found in patients with acute ACL injuries in several studies: specificity 98-100% and sensitivity 94%.*

Conclusions: *The ACL is a specialized band of connective tissue located in the knee joint that joins the tibia and femur. It consists primarily of collagen fibers, making up 70% of its dry weight.Variation in the anatomy of the intercondylar groove of the distal femur is a factor that appears to be related to an increased risk of ACL injury. ACL injuries are rarely diagnosed with an MRI, but in some circumstances, such as a meniscal tear or bone contusion, this test may be useful. The decision on the course of treatment for a patient with an ACL injury depends on a number of variables. Surgical reconstruction in anterior cruciate ligament (ACL) tears has proven to be a very effective technique that usually provides satisfactory results. Patients with ACL insufficiency may receive conservative treatment, which may involve activity modification, rehabilitation, and sometimes bracing. Proprioception and strength deficits should be taken into account when designing rehabilitation programs for knees with ACL insufficiency.*

KEY WORDS: *ligament, anterior cruciate, ACL, rupture.*

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

INTRODUCTION

The anterior cruciate ligament (ACL) together with the posterior cruciate ligament (PCL) are the central stabilizers of the knee. It maintains the stability of the tibia against increased internal rotation and anterior translation(1).

ACL rupture generally occurs in active and young people; it can have negative psychological and physical impacts. For a correct diagnosis it is necessary a good clinical history, examination and a complementary study; in this case the ideal would be an MRI, to be able to verify the rupture of the ligament. The ideal approach is to restore knee function, in addition to preventing further injury, osteoarthritis and to address psychological barriers to perform better the activities and ensure a quality of life for the patient(2,3).

Among the main treatment choices we have: rehabilitation followed by ACL reconstruction (ACLR) in patients who develop functional instability, ACLR followed by postoperative rehabilitation and preoperative rehabilitation followed by ACLR plus postoperative rehabilitation(2,3).

The literature recommends surgical treatment in athletes and in young people, as it may eventually reduce the risk of other relevant meniscal and cartilage injuries. ACL injury shows a significant psychological effect and a negative psychological state thus influencing the reduction or cessation of sports participation after ACL reconstruction surgery. In some countries the standard of surgical treatment is ACL reconstruction with an autologous tendon graft. Although in some cases the preservation of the ACL through arthroscopic refixation presents favorable results(4).

METHODOLOGY

A total of 72 articles were analyzed in this review, including review and original articles, as well as cases and clinical trials, of which 46 bibliographies were used because the information collected was not important enough to be included in this study. The sources of information were Cochrane, PubMed and Google Scholar, SciElo; the terms used to search for information in Spanish, Portuguese, German and English were: ACL, anterior cruciate ligament, anterior cruciate ligament, Vorderes Kreuzband.

The choice of the bibliography exposes elements related to the anterior cruciate ligament, its approach, anatomy, biomechanics, incidence, risk factors; in addition to these elements, the diagnosis, management and treatment of the disease are investigated.

DEVELOPMENT

The authors consider it important, before discussing anterior cruciate ligament (ACL) rupture, to first address its embryology, anatomy, biomechanics and risk factors, to continue with the natural history, diagnosis and treatments of ACL rupture.

EMBRYOLOGY OF THE ACL

From a mesenchymal concentration, the knee begins to form at four weeks of gestation. At 6 weeks of gestation, a knee joint can be discerned. Between 6 and 7 weeks, the fetal blastoma shows the formation of the anterior cruciate ligament (ACL). At nine weeks of gestation, both the ACL and the posterior cruciate ligament (PCL) are visible, well-oriented structures. Initially, the ACL is a ventral ligament, but as the intercondylar space grows, it migrates posteriorly at the knee joint. The PCL remains in its initial position(5-7).

ACL ANATOMY

The ACL is a band of specialized connective tissue located in the knee joint that joins the tibia and femur. It consists primarily of collagen fibers, making up 70% of its dry weight. Type I collagen represents 90% and type III collagen (10%) (5,6).
The anterior cruciate ligament usually presents an approximate size of 4-7 mm in thickness, 7-12 mm in width and 25-38 mm in length. In the proximal portion near the femoral origin the ligament is narrower, subsequently it widens when it reaches the tibial insertion. The tibial insertion of the ACL is in an anterior fossa and lateral to the medial spine; this insertion is 11 mm wide and 17 mm in the anteroposterior direction. The insertion in the tibia sends front fibers that cross under the transverse meniscal ligament(6,8,9).

The ACL is intracapsular as it is covered by the synovial membrane. Due to its spiral arrangement the fibers that come from the most posterior and proximal portion of the lateral femoral condyle and insert into the most anterior and medial portion of the tibia, form the so-called anteromedial band (AM). The fibers that begin at the most anterior and superior part of the femoral origin and are routed to the most posterolateral part of the tibial insertion, give rise to the posterolateral band (PL). Because of this configuration, the PL band and the AM band of the ACL experience tension throughout the range of motion. The PL band experiences tension in hyperextension, where it becomes even tighter(8,10).

The ACL is supplied by the medial genicular (terminal ligamentous branches) and inferior and lateral genicular (terminal branches) arteries; also from the synovial plexus attached to the infrapatellar fat(8).

BIOMECHANICS

The first restriction of anterior tibial displacement is the ACL. The ACL, along with the PCL, controls how the tibia and femur slide and roll with each other to form the kinematics of the normal knee. Therefore, ACL deficiency not only causes episodes of instability but also changes in joint mechanics that can lead to degenerative changes(8).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

INCIDENCE OF RUPTURES

Among athletes, 78% of ACL injuries are caused by soccer, baseball, basketball, and skiing. ACL injuries occur 60% to 70% of the time, according to Noyes' research using arthroscopic evaluation of patients with acute traumatic hemarthrosis of the knee. In addition, meniscal injuries are linked to 50% of these injuries. In soccer and basketball, ACL tears occur three times more frequently in women than in men, according to a recent meta-analysis; the injury rate for expert alpine skiers is the lowest(8,11).

Multiligamentary knee injuries are rare and occur in only 0.02% to 0.2% of orthopedic injuries, but in 50% of high-energy trauma(12,13).

RISK FACTORS

Variation in the anatomy of the intercondylar groove of the distal femur is a factor that appears to be related to an increased risk of ACL injury, particularly in noncontact circumstances. In patients with acute ACL tears, the intercondylar groove is smaller and the difference is statistically significant. The risk of ACL injury is determined by comparing the width of the groove to the width of the entire distal femur; if the ratio is less than 0.2, the groove is considered narrow(8).

They can be divided into intrinsic and extrinsic categories; examples include subtalar joint pronation, limb misalignment and anteroposterior knee laxity. The second factor consists of how the shoe interacts with the ground, the playing field and modified neuromuscular control techniques(8).

Table 1. Risk factors for ACL rupture.

RISK FACTORS	
ENVIRONMENTAL	• Type of playing surface • Protective equipment • Weather conditions • Footwear
ANATOMICAL	• Alignment of the lower extremity • Joint laxity • Muscle strength • Intercondylar groove • ACL size
HORMONALS	• Effect of estrogens on the mechanical properties of the ACL • Increased risk of injury during the preovulatory phase of the menstrual cycle.
BIOMECHANICAL	• Altered neuromuscular control influencing movement patterns • Increased joint loads

Source: the authors.

NATURAL HISTORY

A patient's activity level and quality of life can be significantly affected by an ACL tear, which is a devastating injury. When complete, it can lead to osteoarthritis, meniscal and cartilage surface damage, instability and other long-term knee problems. Two-thirds of patients who undergo conservative treatment for a complete ACL tear develop chronic knee instability and, as a result, meniscal or articular cartilage damage. Only 31% of patients with an ACL tear had moderate to severe limitations in their ability to walk, compared to 44% who had limitations in other daily activities and 77% who had limitations in sports(8).

The natural course and treatment of anterior cruciate ligament (ACL) tears of the knee are debatable because in some people the joint becomes inefficiently functional after an ACL tear, while in others it is relatively asymptomatic and the patient can resume strenuous athletic activity at least temporarily. It has been a challenge to determine the true natural history of the evolution of the ACL-injured knee, which has been based on follow-up of cases in which conservative nonsurgical treatment has been used. The level of activity and quality of life that a patient may experience after sustaining an ACL tear can be significantly affected. Complete ACL tears can lead to osteoarthritis, meniscal and cartilage surface injuries, instability and other chronic knee problems. The menisci and/or articular cartilage are subsequently damaged in two-thirds of patients with complete ACL tears, who also have chronic knee instability(14,15) .

As a result of ACL and meniscal injuries, damage to the articular structures of the knee has also been shown to result in osteoarthritis, which can significantly restrict the patient's independence and negatively impact daily activities(8).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

DIAGNOSIS

A good anamnesis is crucial in evaluating serious knee injuries and may be the most reliable sign of an ACL tear. An athlete who lands on his or her foot and feels a snap and sharp pain in the knee probably has a torn ACL, can no longer exercise, and over the course of the next 12 to 24 hours develops joint edema. Numerous patients describe how their knee felt "out of place"(8).

The physician will combine the patient's medical history, physical examination and, if necessary, imaging results to make an accurate diagnosis of an ACL tear. The meniscus, cartilage or other knee ligaments may also be injured at the same time as an ACL tear. To correctly diagnose significant concomitant injuries, special care must be taken. ACL tear should always be considered if the patient reports a mechanism of injury involving deceleration/acceleration combined with valgus loading of the knee, hearing or feeling a "pop" at the time of injury, or hemarthrosis within the knee two hours after the accident(2).

A rotational knee injury, followed by a snap, functional disability and edema, is a common ED history. Although ACL tears can occur during direct contact in sports, non-contact rotation and unexpected deceleration or hyperextension are the most frequent causes(8).

PHYSICAL EXAMINATION

To help the patient relax, you should begin by examining the uninjured and apparently healthy knee. Beginning with observation of the patient's active range of motion without involving the examiner, the injured knee should be examined. If a painful effusion is discovered and the knee is strained, it can be punctured to aspirate the hemarthrosis following strict aseptic procedures and administering lidocaine into the joint to relieve pain. The blood that is drawn is then examined for fat droplets that may be a sign of an osteochondral fracture(8).

If the injured knee is found to be hyperextended, an ACL tear and possible injury to the posterolateral ligamentous complex may be suspected; if a full extension lock is discovered, a meniscal injury may also be present. Check the patella and medial retinaculum for tenderness, as this may indicate patellar dislocation. To determine if they are damaged, palpate the medial and lateral collateral ligaments. The presence of pain on both sides of the knee is a sign that the ACL may have been injured, although the pain may also be meniscal or capsular in origin. The likelihood of an ACL injury increases when the knee is injured on both sides. Two clinical tests for ACL damage assess anterior tibial translation: the anterior drawer with the knee in 90° flexion and the Lachman test. The Lachman test is the most accurate clinical diagnostic test, with a reported combined sensitivity of 85% and specificity of 94%. The anterior drawer test has high sensitivity and specificity for chronic ACL tears (92% sensitivity and 91% specificity), but lower accuracy for acute cases(2,8,16-18).

Tests showing anterolateral rotation laxity, such as the Pivot Shift, Losse's test, flexion/rotation box test and Slocum's test, are a crucial component of the clinical examination in cases of chronic ACL injury. According to recent meta-analyses, the Pivot Shift has the best positive predictive value. When positive, it is a very clear indication of an ACL rupture (98% specificity). However, a negative test is not sufficient to rule out injury (24% sensitivity), whereas the Lachman test has the best negative predictive value in cases of suspected ACL injury(2,8,16,17).

IMAGING STUDIES

Plain Radiography

Plain radiographic examinations should be performed in every knee suspected of having an ACL injury. Anteroposterior (AP), lateral, and weight-bearing views of the patellofemoral joint of the knee, as described by Merchant at 45 degrees of flexion, should be part of routine radiologic examinations. The groove or tunnel is the fourth projection, which is very useful in chronic conditions. It is pathognomonic of an ACL injury to see Segond's fracture or lateral capsular sign on the AP projection of the lateral border of the tibia(8).

Magnetic resonance imaging (MRI).

ACL injuries are rarely diagnosed with an MRI, but in some circumstances, such as a meniscal tear or bone contusion, this test may be useful. The following statistics were found in patients with acute ACL injuries in several studies: specificity 98-100% and sensitivity 94%. It was found that scarring of the ACL stump that attaches to the posterior cruciate ligament may make it difficult to distinguish between chronic tears and the intact ligament. In chronic tears, sensitivity drops to 80% but specificity remains at 93%. Only in 70 to 90% of cases, arthroscopy proves the suspicion of an ACL tear indicated by MRI(8).

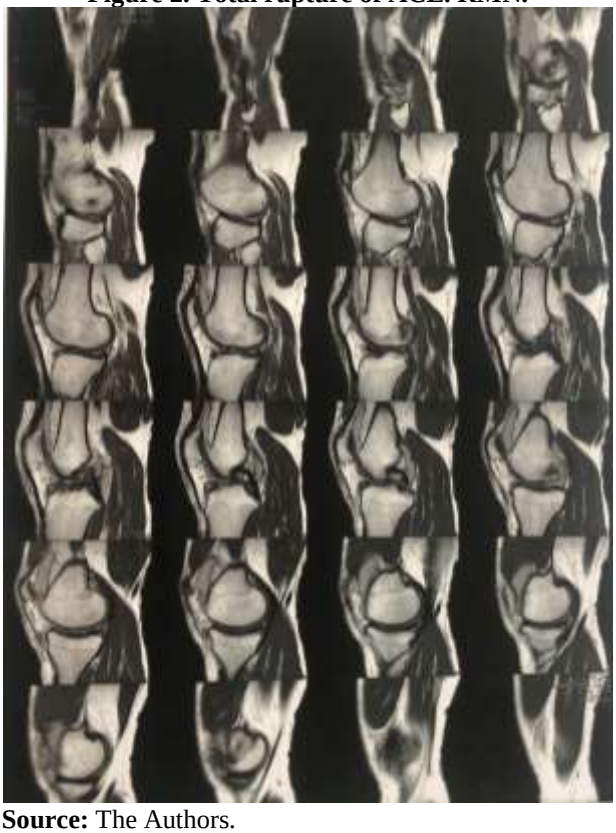
The patient's history and clinical examination combined with the evaluation by an experienced evaluator are usually sufficient to determine whether the patient has an ACL tear. Although it may be difficult to find the injury during a clinical examination due to pain and effusion in an acute setting. In an orthopedic emergency unit, half of the patients with an acute ACL tear were misdiagnosed as having a simple knee sprain, a common occurrence. Repeat clinical examination or subacute MRI may be necessary to rule out the injury. MRI has diagnostic accuracy comparable to Lachman's test and is useful for patients with suspected ACL tears when the clinical diagnosis is unclear and when evaluating concurrent knee injuries that may be more difficult to diagnose clinically(2,16-18).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Figure 1. Total rupture of ACL (RMN).

Source: The Authors.

Figure 2. Total rupture of ACL. RMN.



Source: The Authors.

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Differential Diagnosis

The Ottawa knee rule should be used to eliminate a fracture after significant acute trauma to the knee. The rule is intended to accurately rule out knee fractures (sensitivity 98.5), but is insufficient to specifically rule out a fracture (specificity 48.6). Patients who provide at least one affirmative answer to any of the five questions should be considered for x-ray imaging. Acute effusion in adolescents who have sustained a rotational knee injury should also be carefully evaluated to rule out dislocation(2,19-22).

Table 2. Validation Ottawa Knee Rules.

A knee radiographic examination is only required for patients with acute knee injuries with one or more of these findings related to age, tenderness, or function
➔ Age 55 years or older. ➔ Tenderness at head of fibula ➔ Isolated tenderness of patella ➔ Inability to flex to 90° ➔ Inability to bear weight both immediately and in the emergency department (ED) (four steps)

Source: Emparanza JI, Aginaga JR. Validation of the Ottawa Knee Rules(23)**.**

ASSOCIATED INJURIES

Concurrent injuries should be considered when treating a patient with ACL disease.

Meniscal Injuries

ACL injuries, both acute and chronic, can coexist with meniscal injuries. Depending on whether or not they had an ACL tear, Noyes studied patients with acute hemarthrosis and found partial or complete meniscal damage in 62% of the former and only 25% of the latter. Meniscal injury occurs in 65% of persons with ACL injury, according to similar findings by other investigators. The following frequencies of meniscal injury have been identified in patients with ACL tears: 77%, 45%, and 64%(8,24-26).

Meniscal injuries are more common and are linked to chronic ACL instability. Patients with this instability had a 91% incidence of these injuries, according to Indelicato and Bittar. In a group of patients with symptomatic chronic ACL instability, meniscal tears were reported 73% of the time, on average 5.8 years after ACL injury(8,25).

Ligamentous Injuries

ACL tears isolated from other ligamentous tears are more frequent in acute injuries. 48% of isolated ACL tears, 29% of medial collateral ligament (MCL) tears, 13% to 18% of combined ACL and MCL injuries, 1% of combined ACL and lateral frame injuries, and only 4% of isolated PCL injuries(8).

Associated Articular Cartilage Injuries

Articular cartilage injuries following acute trauma caused by ACL injury have been described in 6-22% of cases, with this frequency being even higher in chronic cases. MRI has shown subchondral bone contusions in 48% to 90% of patients with ACL injuries(8,24).

Osteochondral Fractures

Very rarely related to an ACL injury and could be the cause of loose fragments in the joint(27).

Patellar Dislocation

Despite its rarity (less than 1% of patients experience it), it is essential to detect it in order to avoid chondral and osteochondral fractures(8,28).

TREATMENT

The decision on the course of treatment for a patient with an ACL injury depends on a number of variables, including the patient's age, occupation, severity of injury, activity level, presence of coexisting injuries, participation in sports, frequency and severity of instability episodes, and the patient's commitment to postoperative rehabilitation(8).

Depending on the degree of pathological laxity and the percentage of involvement, the treatment strategy for patients with partial ACL tears is determined. Conservative treatment is recommended if a partial tear on arthroscopic examination appears to involve less than half of the ligament and the Pivot-Shift test is negative; however, if the Pivot-Shift test is strongly positive or if the tear involves more than 50% of the ligament, the patient should be treated as if he/she has a complete tear(8,29).

Participation in high-risk activities and recurrent instability are the main risk factors for patients with complete ACL tears. When these risk factors are present, conservative treatment is generally not recommended. Patients who experience instability during daily activities, patients who wish to continue playing sports that require the ACL, such as soccer, basketball or volleyball, patients who have associated meniscal lesions that can be repaired even when they are less active, and patients with an associated ligamentous tear, such as injury to posterolateral structures, are all candidates for surgical treatment with ligament reconstruction(8).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Surgical reconstruction in anterior cruciate ligament (ACL) tears has proven to be a very effective technique that usually provides satisfactory results. However, despite the fact that most patients recover their function after this procedure, ACL reconstruction (ACLR) is still imperfect(30,31).

Conservative Treatment

Patients with ACL insufficiency may receive conservative treatment, which may involve activity modification, rehabilitation and sometimes bracing. The level of activity performed by the patient is probably the most crucial element in the success of conservative treatment(8).

Rehabilitation

According to some recent meta-analyses and reviews, there is insufficient data to support the use of any particular exercise program for the rehabilitation of patients with ACL injuries(32).

Proprioception and strength deficits should be taken into account when designing rehabilitation programs for ACL-injured knees. The neuromuscular response to anterior tibial translation and periarticular musculature are affected by the loss of proprioception caused by an ACL tear. Patients with chronic ACL insufficiency have been shown to have significant quadriceps atrophy, particularly in the vastus medialis obliquus, and less knee flexor atrophy. Treatment of acute ACL injuries should focus on reducing swelling and pain, restoring range of motion, regaining muscular endurance, and protecting the knee from further damage. Early restoration of range of motion should be undertaken while attempting to prevent escalation of pain and edema. If the latter persists and range of motion does not improve, there may be a displaced meniscal tear that needs to be surgically repaired. Early isometric exercises for the gastrocnemius, knee flexors and quadriceps should be performed to prevent muscle atrophy and loss of strength; full active extension and normal gait should be attempted within the first seven to ten days. Over the course of one to three weeks, the inflammatory phase slowly subsides. Once the problem is resolved and full range of motion is achieved, a more rigorous rehabilitation program is initiated to increase muscle endurance. To avoid excessive load on the secondary restrictors and to prevent patellofemoral symptoms, exercises that cause anterior tibial translation, such as open chain quadriceps, should be avoided. Begin closed-chain quadriceps and knee flexor exercises, which reduce anterior tibial translation and patellofemoral loading. These exercises include squatting, using stairs or steps, trying to sit down by pressing a ball between the thighs, and cycling. There is no restriction because the knee flexors are a dynamic stabilizing group that prevents anterior tibial displacement, but they need to be strengthened. In addition, it is advisable to promote resistance exercises such as swimming and treadmill jogging, as well as hip and leg strengthening exercises (gastrosoleus)(8,28,33).

To improve dynamic stability during the strengthening and endurance phases of the rehabilitation process, neuromuscular control must begin to be developed. To stabilize the knee, patients must learn to recruit the correct muscles, especially the knee flexors, with the correct amount of force, at the correct time and in the correct order. Proprioceptive neuromuscular facilitation techniques are used once strength and endurance have reached at least 70% of the healthy side, starting with controlled, low-velocity, low-force movements and progressing to sudden, uncontrolled, high-force, high-velocity movements. Then, patients progress with stop-and-start movements, cutting movements, jumping, dodging or dribbling, and turning. The usefulness of functional knee orthoses is a matter of debate. They offer only modest mechanical stability to the joint, according to scientific studies, but many patients still request them because they seem to increase confidence and give more "feel" to the knee, which helps prevent re-injury(8,34,35).

SURGICAL TREATMENT OF LCA INJURY

Knee instability related to ACL insufficiency can be stabilized by a wide range of surgical techniques. Extra-articular, intra-articular, or both procedures are employed. According to a review of the literature, intra-articular reconstructions produce more favorable, reliable and repeatable results. Consideration needs to be given to edema, range of motion and capsular induration. When the tissue is soft and smooth, range of motion is normal, and neuromuscular coordination has returned along the entire length of the extremity, surgery is performed. Surgery on a stiff knee ensures that it will remain stiff after surgery because a stiff knee has a worse natural history than a knee with an insufficient ACL. The arthroscopic technique is currently used for most ACL reconstructions and its benefits include improved aesthetics, less disruption of the quadriceps mechanism, faster recovery, and preservation of articular cartilage hydration(8,36,37).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Figure 3. Patellar approach

Source: The Authors.

GRAFT SELECTION

The initial stiffness and strength of the natural ACL should be taken into account when choosing the type of graft to use, as well as the ease of stable fixation to allow for adequate graft remodeling and a rehabilitation program. In addition to allografts, which are primarily from the patellar and Achilles tendons, autologous goosefoot, quadriceps, and ipsilateral and contralateral patellar tendons grafts are also used. Each type of graft has advantages and disadvantages(8).

With respect to knee laxity in particular, allograft and autograft were compared in ACL reconstruction without revealing appreciable differences in results. Disadvantages of allograft include a slower incorporation rate, the potential for transmission of viral disease, and observations by some authors that there may be more residual laxity and less strength than with autologous reconstructions. Some investigators have concluded that autologous patellar tendon grafts should be the first choice, and that allografts should be suggested for revision surgery (new ACL tear already repaired) or when multiple grafts are needed due to complex instabilities; they are most effective when used in patients who perform low-intensity physical activity(8,38-40).

Figure 4. ACL preparation. Gracilis tendon.

Source: The Authors.

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Figure 5. ACL preparation. Gracilis and Semitendinosus tendon

Source: The Authors.

Figure 6. Patellar tendon preparation.

Source: The Authors.

RECONSTRUCTION RESULTS

Fox et al. in a review of the literature on the results of patellar tendon graft reconstruction found that the frequency of patellar pain ranged from 3 to 17 percent; today, this frequency is lower than it was 20 years ago, most likely due to a more rapid rehabilitation process that emphasizes early limb support. Most surgeons still employ patellar tendon grafting as their method of access, particularly for young, competitive athletes. There have not been many research-based studies comparing the results of ACL reconstruction with patellar tendon graft or hamstring tendons; the results were comparable in terms of patient satisfaction, objective assessment of stability, ultimate recovery of muscle strength, and time to return to sporting activity; the only difference was the finding of a higher level of activity in the patellar tendon group(8,41).

Arthroscopic ACL reconstruction is known to have the following benefits: faster recovery, less postoperative pain, and a better ability to see where the bone tunnels are located. A full arthroscopy (one incision), a two-incision arthroscopy, and a mini-incision technique (without dislocating the patella) have produced similar results. However, no discernible differences in outcomes have been found. After reconstruction, anterior cruciate ligament rehabilitation is similar to that described for conservative treatment: continued passive mobility, early support, sporadic bracing, home rehabilitation, open and closed kinetic chain exercises, neuromuscular electrical stimulation and, in some patients, accelerated rehabilitation(8,42).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Figure 7. Patient with previous ACL reconstruction.

Source: The Authors.

Figure 8. Patient with previous ACL reconstruction.

Source: The Authors.

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Figure 9. Reinsertion of the new ACL.

Source: The Authors.

EMERGING TRENDS

Several factors, including the likelihood of osteoarthritis (OA), graft healing, and mechanical restoration of the ACL, should be considered in patients with ACL injuries undergoing surgical reconstruction. Recent work has compared the results of reconstruction with patellar tendon (PT) versus semitendinosogracilis tendon (ST-G) autografts. Keays in Australia found that six years postoperatively there was no difference between the two groups with respect to stability, but that the frequency of radiological changes of osteoarthritis was 62 percent in the PT group and only 33 percent in the ST-G group. Comparing the two grafts in a study with a five-year follow-up, Sajovic in Slovenia found that while stability was the same in both groups, the frequency of OA was 50 percent higher in the PT group and 17 percent in ST-G. Roe et al. , seven years after the intervention, found that the PT group had an incidence of OA of 45 percent compared to 14 percent in the ST-G group. Age greater than 25 years, time between injury and surgery, and any associated chondral or meniscal injury have been identified as risk factors for developing OA after ACL reconstruction. Ligation of the graft, which has less mechanical and functional properties, malpositioning of the bone tunnels in the femur or tibia, and inadequate initial graft tension are some factors that may affect the development of OA. It is understood that the graft used for ACL reconstruction heals through a process known as avascular necrosis, which is followed by revascularization and subsequent remodeling. The following graft stages have been observed(8,43,44):

Table 3. Ligation stages.

PHASES	
SYNOVIALIZATION	1 TO 4 WEEKS
AVASCULAR NECROSIS	1 TO 6 WEEKS
REVASCULARIZATION	6 TO 12 WEEKS
CELL PROLIFERATION	20 WEEKS
REMODELING (MATURATION)	24 TO 48 WEEKS

Source: The Authors.

Biological augmentation (BA) techniques of various types have been used, mainly in animal models, to improve these results. These include growth factors (such as bone morphogenetic protein, epidermal growth factor, granulocyte colony-stimulating factor, basic fibroblast growth factor, transforming growth factor, hepatocyte growth factor, vascular endothelial growth factor and fibrin clot), autologous tissue, mesenchymal stem cells, various pharmaceuticals (such as matrix metalloproteinase inhibitors alpha.-2- macroglobulin bisphosphonates), biophysical/environmental approaches (hyperbaric oxygen, low-intensity pulsed ultrasound, extracorporeal shock wave therapy), biomaterials (fixation techniques, biological coatings, biosynthetic bone substitutes, osteoconductive materials) and gene therapy. Clinical studies on BA published to date are very heterogeneous and have a low level of evidence, although all of them have shown good results in experimental studies. Platelet-rich plasma has so far been the most widely used method (30,31,35,45,46).

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

CONCLUSIONS

The ACL is a band of specialized connective tissue located in the knee joint that joins the tibia and femur. It consists primarily of collagen fibers, making up 70% of its dry weight. Formed by the anteromedial and posterolateral bands. Deficiency of the ACL not only causes episodes of instability but also changes in joint mechanics that can lead to degenerative changes. Meniscal lesions are linked to 50% of these injuries. Variation in the anatomy of the intercondylar groove of the distal femur is a factor that appears to be related to an increased risk of ACL injury. The Lachman test is the most accurate clinical diagnostic test, with a reported combined sensitivity of 85% and specificity of 94%. The anterior drawer test has high sensitivity and specificity for chronic ACL tears (92% sensitivity and 91% specificity), but lower accuracy for acute cases. ACL injuries are rarely diagnosed with an MRI, but in some circumstances, such as a meniscal tear or bone contusion, this test may be useful. The following statistics were found in patients with acute ACL injuries in several studies: specificity 98-100% and sensitivity 94%. The decision on the course of treatment for a patient with an ACL injury depends on a number of variables. Surgical reconstruction in anterior cruciate ligament (ACL) tears has proven to be a very effective technique that usually provides satisfactory results. Patients with ACL insufficiency may receive conservative treatment, which may involve activity modification, rehabilitation, and sometimes bracing. Proprioception and strength deficits should be taken into account when designing rehabilitation programs for ACL insufficiency knees.

BIBLIOGRAPHY

1. *Kohn L, Rembeck E, Rauch A. Verletzung des vorderen Kreuzbandes beim Erwachsenen: Diagnostik und Therapie. Orthop. noviembre de 2020;49(11):1013-28.*
2. *Filbay SR, Grindem H. Evidence-based recommendations for the management of anterior cruciate ligament (ACL) rupture. Best Pract Res Clin Rheumatol. febrero de 2019;33(1):33-47.*
3. *Larwa J, Stoy C, Chafetz RS, Boniello M, Franklin C. Stiff Landings, Core Stability, and Dynamic Knee Valgus: A Systematic Review on Documented Anterior Cruciate Ligament Ruptures in Male and Female Athletes. Int J Environ Res Public Health. 6 de abril de 2021;18(7):3826.*
4. *Webster KE, Nagelli CV, Hewett TE, Feller JA. Factors Associated With Psychological Readiness to Return to Sport After Anterior Cruciate Ligament Reconstruction Surgery. Am J Sports Med. junio de 2018;46(7):1545-50.*
5. *Yoo H, Marappa-Ganeshan R. Anatomy, Bony Pelvis and Lower Limb, Knee Anterior Cruciate Ligament. En: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 [citado 6 de enero de 2023]. Disponible en: http://www.ncbi.nlm.nih.gov/books/NBK559233/*
6. *Duthon VB, Barea C, Abrassart S, Fasel JH, Fritschy D, Ménétrey J. Anatomy of the anterior cruciate ligament. Knee Surg Sports Traumatol Arthrosc. marzo de 2006;14(3):204-13.*
7. *Gardner E, O'Rahilly R. The early development of the knee joint in staged human embryos. J Anat. enero de 1968;102(Pt 2):289-99.*
8. *Márquez Arabia JJ, Márquez Arabia WH. Lesiones del ligamento cruzado anterior de la rodilla. Iatreia [Internet]. septiembre de 2009;vol.22(no.3). Disponible en: http://ref.scielo.org/83x9rg*
9. *Girgis FG, Marshall JL, Mona Jem ARSAl. The Cruciate Ligaments of the Knee Joint: Anatomical. Functional and Experimental Analysis. Clin Orthop. enero de 1975;106:216-31.*
10. *Smith BA, Livesay GA, Woo SL. Biology and biomechanics of the anterior cruciate ligament. Clin Sports Med. octubre de 1993;12(4):637-70.*
11. *Griffin LY. Anterior cruciate ligament injuries in female athletes: prevention strategies. Instr Course Lect. 2002;51:311-4.*
12. *Moatshe G, Chahla J, LaPrade RF, Engebretsen L. Diagnosis and treatment of multiligament knee injury: state of the art. J ISAKOS. mayo de 2017;2(3):152-61.*
13. *Guillén Morales JC, Garay Rojas FM, Torres Manrique AD. Reconstrucción del ligamento cruzado posterior en un paciente adulto mayor con lesión multiligamentaria de rodilla. An Fac Med [Internet]. 11 de enero de 2022 [citado 9 de enero de 2023];82(4). Disponible en: https://revistasinvestigacion.unmsm.edu.pe/index.php/anales/article/view/20824*
14. *Yu B, Kirkendall DT, Taft TN, Garrett WE. Lower extremity motor control-related and other risk factors for noncontact anterior cruciate ligament injuries. Instr Course Lect. 2002;51:315-24.*
15. *Márquez Arabia WH, Márquez Arabia JJ, Gómez JC. ¿Qué ocurre con las lesiones del ligamento cruzado anterior, su tratamiento, la recuperación de la función y el desarrollo de osteoartritis a largo plazo? ¿Hay espacio para el tratamiento conservador? Revisión de conceptos actuales. Rev Colomb Ortop Traumatol. junio de 2017;31(2):75-86.*
16. *Griffin LY, Albohm MJ, Arendt EA, Bahr R, Beynnon BD, DeMaio M, et al. Understanding and Preventing Noncontact Anterior Cruciate Ligament Injuries: A Review of the Hunt Valley II Meeting, January 2005. Am J Sports Med. septiembre de 2006;34(9):1512-32.*
17. *Logerstedt DS, Snyder-Mackler L, Ritter RC, Axe MJ, Godges JJ. Knee Stability and Movement Coordination Impairments: Knee Ligament Sprain: Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. J Orthop Sports Phys Ther. abril de 2010;40(4):A1-37.*
18. *Benjaminse A, Gokeler A, van der Schans CP. Clinical Diagnosis of an Anterior Cruciate Ligament Rupture: A Meta-analysis. J Orthop Sports Phys Ther. mayo de 2006;36(5):267-88.*
19. *Frobell RB, Lohmander LS, Roos HP. Acute rotational trauma to the knee: poor agreement between clinical assessment and magnetic resonance imaging findings. Scand J Med Sci Sports. 23 de mayo de 2006;0(0):061120070736044-???*
20. *Stiell IG, Greenberg GH, Wells GA, McKnight RD, Cwinn AA, Cacciotti T, et al. Derivation of a Decision Rule for the Use of Radiography in Acute Knee Injuries. Ann Emerg Med. octubre de 1995;26(4):405-13.*
21. *Van Dyck P, Vanhoenacker FM, Lambrecht V, Wouters K, Gielen JL, Dossche L, et al. Prospective Comparison of 1.5 and 3.0-T MRI for Evaluating the Knee Menisci and ACL: J*

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 9| Issue: 1| January 2023|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

Bone Jt Surg-Am Vol. mayo de 2013;95(10):916-24.

22. *Bachmann LM, Haberzeth S, Steurer J, ter Riet G. The Accuracy of the Ottawa Knee Rule To Rule Out Knee Fractures: A Systematic Review. Ann Intern Med. 20 de enero de 2004;140(2):121.*
23. *Emparanza JI, Aginaga JR. Validation of the Ottawa Knee Rules. Ann Emerg Med. octubre de 2001;38(4):364-8.*
24. *Roberts CC, Towers JD, Spangehl MJ, Carrino JA, Morrison WB. Advanced MR Imaging of the Cruciate Ligaments. Radiol Clin North Am. noviembre de 2007;45(6):1003-16.*
25. *Indelicato PA, Bittar ES. A perspective of lesions associated with ACL insufficiency of the knee. A review of 100 cases. Clin Orthop. septiembre de 1985;(198):77-80.*
26. *Wojtys EM, Anderson AF, editores. The ACL deficient knee. Rosemont, IL: American Academy of Orthopaedic Surgeons; 1994. 148 p. (American Academy of Orthopaedic Surgeons monograph series).*
27. *Bealle D, Johnson DL. TECHNICAL PITFALLS OF ANTERIOR CRUCIATE LIGAMENT SURGERY. Clin Sports Med. octubre de 1999;18(4):831-45.*
28. *Beynnon BD, Johnson RJ, Abate JA, Fleming BC, Nichols CE. Treatment of Anterior Cruciate Ligament Injuries, Part I. Am J Sports Med. octubre de 2005;33(10):1579-602.*
29. *Noyes F, Mooar L, Moorman C, McGinniss G. Partial tears of the anterior cruciate ligament. Progression to complete ligament deficiency. J Bone Joint Surg Br. noviembre de 1989;71-B(5):825-33.*
30. *Rodríguez-Merchán EC. Anterior Cruciate Ligament Reconstruction: Is Biological Augmentation Beneficial? Int J Mol Sci. 22 de noviembre de 2021;22(22):12566.*
31. *Kuršumović K, Charalambous CP. Graft salvage following infected anterior cruciate ligament reconstruction: a systematic review and meta-analysis. Bone Jt J. mayo de 2016;98-B(5):608-15.*
32. *Carter HM, Littlewood C, Webster KE, Smith BE. The effectiveness of preoperative rehabilitation programmes on postoperative outcomes following anterior cruciate ligament (ACL) reconstruction: a systematic review. BMC Musculoskelet Disord. diciembre de 2020;21(1):647.*
33. *Mohtadi N. Rehabilitation of Anterior Cruciate Ligament Injuries: A Review: Clin J Sport Med. julio de 2005;15(4):287-8.*
34. *Ingersoll CD, Grindstaff TL, Pietrosimone BG, Hart JM. Neuromuscular Consequences of Anterior Cruciate Ligament Injury. Clin Sports Med. julio de 2008;27(3):383-404.*
35. *Shah VM, Andrews JR, Fleisig GS, McMichael CS, Lemak LJ. Return to Play after Anterior Cruciate Ligament Reconstruction in National Football League Athletes. Am J Sports Med. noviembre de 2010;38(11):2233-9.*
36. *Buss DD, Warren RF, Wickiewicz TL, Galinat BJ, Panariello R. Arthroscopically assisted reconstruction of the anterior cruciate ligament with use of autogenous patellar-ligament grafts. Results after twenty-four to forty-two months.: J Bone Jt Surg. septiembre de 1993;75(9):1346-55.*
37. *Musahl V, Engler ID, Nazzal EM, Dalton JF, Lucidi GA, Hughes JD, et al. Current trends in the anterior cruciate ligament part II: evaluation, surgical technique, prevention, and rehabilitation. Knee Surg Sports Traumatol Arthrosc. enero de 2022;30(1):34-51.*
38. *Noyes FR, Butler DL, Grood ES, Zernicke RF, Hefzy MS. Biomechanical analysis of human ligament grafts used in knee-ligament repairs and reconstructions. J Bone Joint Surg Am. marzo de 1984;66(3):344-52.*
39. *Lobo Júnior P, Santos Neto ED, Borges JHDS, Dias LJRV, Machado RDS, Freitas A. CONTRALATERAL PATELLAR TENDON AUTOGRAFT IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION. Acta Ortopédica Bras. abril de 2018;26(2):140-4.*
40. *Krych AJ, Jackson JD, Hoskin TL, Dahm DL. A Meta-analysis of Patellar Tendon Autograft Versus Patellar Tendon Allograft in Anterior Cruciate Ligament Reconstruction. Arthrosc J Arthrosc Relat Surg. marzo de 2008;24(3):292-8.*
41. *Kimura Y, Hokugo A, Takamoto T, Tabata Y, Kurosawa H. Regeneration of Anterior Cruciate Ligament by Biodegradable Scaffold Combined with Local Controlled Release of Basic Fibroblast Growth Factor and Collagen Wrapping. Tissue Eng Part C Methods. marzo de 2008;14(1):47-57.*
42. *Wright R, Preston E, Fleming B, Amendola A, Andrish J, Bergfeld J, et al. A Systematic Review of Anterior Cruciate Ligament Reconstruction Rehabilitation – Part II: Open Versus Closed Kinetic Chain Exercises, Neuromuscular Electrical Stimulation, Accelerated Rehabilitation, and Miscellaneous Topics. J Knee Surg. 2008;21(03):225-34.*
43. *Seon JK, Song EK, Park SJ. Osteoarthritis after anterior cruciate ligament reconstruction using a patellar tendon autograft. Int Orthop. abril de 2006;30(2):94-8.*
44. *Andriacchi TP, Briant PL, Bevill SL, Koo S. Rotational Changes at the Knee after ACL Injury Cause Cartilage Thinning. Clin Orthop. enero de 2006;442:39-44.*
45. *Benjamin M, Toumi H, Ralphs JR, Bydder G, Best TM, Milz S. Where tendons and ligaments meet bone: attachment sites ('entheses') in relation to exercise and/or mechanical load. J Anat. abril de 2006;208(4):471-90.*
46. *Gulotta LV, Rodeo SA. Biology of Autograft and Allograft Healing in Anterior Cruciate Ligament Reconstruction. Clin Sports Med. octubre de 2007;26(4):509-24.*

Conflict of Interest Statement

The authors report no conflicts of interest.

Funding

The authors report no funding by any organization or company.