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REHABILITATION OF SURGICAL PATIENTS FOR CORRECTION OF COMPLETE RUPTURE OF THE ANTERIOR CRUCIATE LIGAMENT: A MULTIDISCIPLINARY ANALYSIS

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Abstract: The Anterior Cruciate Ligament (ACL) corresponds to a structure whose main function is to prevent the cranial displacement of the tibia in relation to the femur, offering greater stability to the lower limb. ACL rupture represents a public health problem because, in addition to affecting an exorbitant number of individuals annually, it is costly to health services, requiring surgical interventions and multidisciplinary rehabilitation, with physiotherapeutic support, bodybuilding and other therapies. support. In view of this, the relevance of this project is justified, with the objective focused on the multidisciplinary analysis of the rehabilitation process of patients undergoing corrective surgery for total ACL rupture. To develop the study, original articles published in the last 32 years, in English, Portuguese and Spanish, were analyzed in the main bibliographic databases, such as SciELO, PubMed and Google Scholar, in order to ensure greater reliability of the information presented. It was realized, with the analysis of the studies, that the rupture of the Anterior Cruciate Ligament presents itself as a prevalent health problem, responsible for causing temporary immobility for the patient, in addition to causing costly public health expenses. Injury to this segment, in most cases, requires surgical intervention associated with postoperative rehabilitation with physiotherapy and other adjuvant techniques. Among the techniques used are cryotherapy, kinesiotherapy and electrotherapy, which help to reduce edema and the risk of hemarthrosis, in addition to improving recovery. Associated with physiotherapeutic interventions, weight training and hydrotherapy are methods that help to recover joint mobility and strengthen regional muscles. Therefore, these techniques, when added together, become indispensable for greater efficiency in the patient's recovery and better joint restoration during the postoperative period of ACL ligamentoplasty,

favoring the rehabilitation process in a shorter time, in addition to causing fewer residual effects of the operative process for patients affected by the injury.

Keywords: Physiotherapy; Anterior Cruciate Ligament; Ligamentoplasty; Rehabilitation; ACL rupture.

INTRODUCTION

The Anterior Cruciate Ligament (ACL) is an anatomical structure present in the knee whose function is to prevent the anterior displacement of the tibia in relation to the femur, in addition to preventing joint hyperextension and exorbitant internal tibial rotation (FERREIRA, 2009). Furthermore, this segment provides greater stability to the anterior portion of the lower limbs (ROCHA et al., 2006; ARLIANI, 2012). Direct injuries involving this ligament occur, predominantly, in young and active individuals, being more recurrent in women during the practice of physical activities (ALANÍS-BLANCAS, 2012). On the other hand, indirect injuries have a more complex mechanism, combining environmental, physical, endocrine-metabolic, neuromuscular factors and even associated family conditions (PINHEIRO, 2015).

ACL rupture occurs when it is forced beyond its elastic capacity, and can be classified according to severity, into grades I, II and III, and the quality of the injury, being partial or total (PINHEIRO, 2015). This injury presents, in absolute numbers, around 200,000 cases reported annually in the United States, with high costs related to rehabilitation, which requires, in most situations, surgical intervention associated with physiotherapeutic supports and other repair methods (ARLIANI, 2012; DO NASCIMENTO OLIVEIRA; LOPES, 2020).

Faced with this injury, one of the main surgical methods applied is ligamentoplasty, performed with the aid of an arthroscope, which aims to reconstruct the affected ligament, by replacing the injured segment with an appropriate graft, which can be of three types: bone -tendon-bone, with collection in the patellar tendon; bone-tendon, collected in the quadriceps tendon; and hamstring tendons (BONANÇA, 2014; SALGADO, 2014). Although this surgery is preferred in cases of ACL rupture, more recent studies point to experimental models in animals, which use extra-articular syndesmoplasty with autogenous fascia lata, without ACL arthrotomy, with the aim of guaranteeing joint stability, causing minimal tissue damage and provide an effective postoperative recovery for the patient (FERREIRA, 2009).

Combined with surgery, there are essential techniques that help in the recovery of patients after ACL rupture, with physiotherapy being the main indication for the return of mobility, on a continuous basis, as well as the reduction of edema and pain present (FIGUEIRA, 2022). As it is an injury with a complex postoperative period, and the patient may have restrictions in carrying out activities for a period of up to 6 months, adequate rehabilitation and reinsertion into practices that enable not only the restoration of the function of the knee, but also strengthening the region, in order to improve the local reaction to impact situations and minimize the risks of re-injury (ALVES et al., 2021; TOMIELO, 2021). Therefore, among the main auxiliary activities that can act in the rehabilitation of these patients, there are physiotherapy, bodybuilding and hydrotherapy (RODRIGUES, 2014; SALGADO, 2014).

In this context, considering the high occurrence of cases of ACL rupture, its long restoration time, as well as the successful public health expenses resulting from its rehabilitation process, the relevance of the present study is justified, with the objective

focused on the multidisciplinary analysis of the rehabilitation process of patients undergoing surgery to correct a total rupture of the Anterior Cruciate Ligament. In view of this, it is possible to understand the importance of adequate rehabilitation in the postoperative process, to maintain the quality of life of the affected patient, as well as the recovery of joint strength and mobility, which were severely compromised by the injury.

METHODOLOGY

In order to construct the present study, a bibliographical research was carried out to compose the descriptive review. For this, original articles were used, published in the last 32 years, in English, Portuguese and Spanish, published in the main bibliographic databases, such as SciELO, PubMed and Google Scholar, in order to guarantee greater reliability of the data presented and veracity to the search. As search criteria, the terms "Physiotherapy", "Anterior Cruciate Ligament", "Ligamentoplasty", "Rehabilitation" and "ACL rupture" were used.

LITERATURE REVIEW

ANTERIOR CRUCIATE LIGAMENT

The Anterior Cruciate Ligament (ACL) is a complex structure present in the knee, made up of dense connective tissue that comprises the connection between the femur and the tibia. It has a multiple composition of fibers, predominantly formed by type I collagen fibers, in addition to a glycoprotein matrix, elastic compounds and glycosaminoglycans. During the extension process, the ACL reaches approximately 32mm in length and up to 12mm in diameter. Furthermore, it is composed of two distinct bundles, the anteromedial bundle (AMB/AI) and the posterolateral bundle (PLB/PE), which exhibit distinct behaviors during the knee flexion process, causing shortening of the knee. PLB and consequent lengthening of the AMB. This complex anatomical structure is what allows the support of great tensions and tractions arising from multiple axes (DUTHON, 2006; RIOS, 2011).

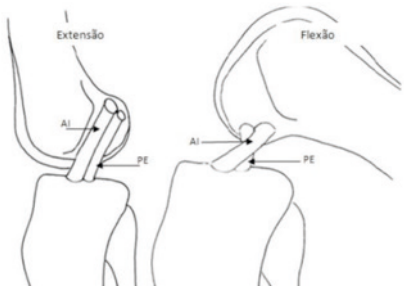

Figure 01. Representation of the anteromedial (AI) and posterolateral (PE) bundles during knee extension and flexion.

Source: adapted by: RIOS, 2011.

The ACL is innervated by the posterior articular branches of the Tibial Nerve. Furthermore, the vascularization of this ligament is carried out, preferably, by the Middle Genicular Artery. The distal portion of the segment receives predominant vascularization from the Medial and Lateral Inferior Genicular Artery (RIOS, 2011). Furthermore, from anatomical-vascular studies, it was noticed that the ACL is covered by a richly vascularized synovial membrane, receiving nutrition from soft tissues, such as synovial fat and Hoffa's bursa (MARQUES, 2016). Thus, in experimental studies on animals, a better response to surgical treatment was noted, in addition to effective ligament healing, when surgery was performed to correct partial rupture without opening the synovial membrane and preserve nutritional structures (ABDALLA; COHEN; GORIOS, 1995).

Figure 02. Vascularization of the ACL.
Source: adapted by: RIOS, 2011.

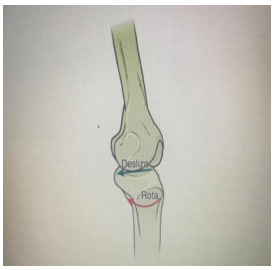

Figure 03. Injury mechanism of ACL rupture.
Source: adapted by: HOUGLUM; BERTOTI, 2014

This segment is essential for maintaining mobility of the lower limb, ensuring local stability, as well as preventing joint hyperextension, excessive internal rotation of the knee and anterior sliding of the tibia in relation to the femur (ARLIANI, 2012). This entire complex mechanism makes it possible for serious events to not occur, however, disruption of the stability of this system, through rupture of the Ligament, whether partial or total, contributes to restriction of movement and immobility syndrome, which can be extend for up to 6 months, during the patient's effective recovery (TOMIELO, 2021; FIGUEIRA, 2022).

ANTERIOR CRUCIATE LIGAMENT RUPTURE

When there is excess tension or force on the lower limbs, affecting the knee portion, or even a greater rotation than that supported by the joint, the consequence may be total or partial rupture of the ACL (MARQUES, 2016). This injury normally occurs during physical activities, without direct contact with other individuals, when the femur dislocates posteriorly, while the knee is at 90 degrees of flexion, with the tibia fixed (SILVA; SANTOS, 2020). In addition to the qualitative classification of the rupture, it can also be characterized according to the degree of involvement, into grades I, II and III (PINHEIRO, 2015).

Grade I injuries correspond to those in which microlesions similar to a stretch occur, with respective pain and edema, but with maintenance of joint stability. In grade II injuries, in turn, the patient suffers a moderate sprain, commonly of direct or indirect traumatic origin, presenting pain, partial limitation of mobility and joint instability, due to partial rupture of the ligament fibers and consequent ligament laxity. Finally, in grade III injuries there is total ligament rupture, with instability in the joint, intense pain and immobility. (SILVA; SANTOS, 2020). In partial grades I and II, it is still possible to perform a conservative intervention, evaluating the possibility of surgical application, however, in total injuries, surgery is essential for the patient's recovery (PINHEIRO, 2015).

LIGAMENTOPLASTY

Corrective surgery is the main strategy used to reconstruct the Anterior Cruciate Ligament affected by a total rupture, with ligamentoplasty being performed using an arthroscope to access the cavity in a minimally invasive way. This surgery consists of the anatomical reproduction of the ACL, by replacing the injured ligament with a graft appropriate to each clinical case, which can be of three main types: bone-tendon-bone, collected in the patellar tendon; bone-tendon, in the quadriceps tendon; and hamstring tendons (BONANÇA, 2014; SALGADO, 2014).

The surgical technique consists of making two incisions in the knee, through which the arthroscope, consisting of magnifying lenses, lighting system and camera for internal visualization, and the instruments used during the procedure will be inserted. The graft that will be placed to replace the injured ligament is inserted inside the knee, passing through bone tunnels, being fixed to the femur with the aid of an Endobutton, and to the tibia with an absorbable screw (CAMANHO; CAMANHO; VIEGAS, 2003; MARQUES, 2016). The success of corrective surgery is closely associated with the rehabilitation process, carried out post-operatively, ensuring the return of mobility and the restoration of joint function (BONANÇA; ALMEIDA; CRUZ, 2013).

Figure 04. Anteroposterior radiography of the knee, after ACL reconstruction with fixation of the graft by Endobutton in the femur and absorbable screw in the tibia.

Source: adapted by: CAMANHO; CAMANHO; VIEGAS, 2003.

Different graft techniques can be used to reconstruct the ACL, which have been studied over the years, such as the conventional technique and the All Inside technique. In the conventional technique, two tendons are used, the semitendinosus and the internal rectus. In the All Inside technique, only the semitendinosus is used, preserving the internal rectus (ALMEIDA-HERDOÍZA et al., 2016; COSTA, 2022). Although there are no concrete data regarding the superiority of one technique over the other, it is suggested that both present significant results in the rehabilitation and recovery of joint function, however, the removal of both tendons tends to increase morbidity in the region, in addition to consequently, having a greater deficit in strength, range of motion and rotational capacity, when compared to the removal of a single tendon (MARQUES, 2016; COSTA, 2022; POLAT et al., 2023).

Although these techniques present high therapeutic efficacy, more recent clinical trials evaluate new intervention possibilities, previously restricted to animal models, but with possible expansion, later, to the human population. One of the techniques under study is extra-articular syndesmoplasty with autogenous fascia lata, which provides for the correction of ACL rupture without requiring arthrotomy of this same ligament, through an extra-capsular intervention. Thus, this technique, which proved to be low cost and quick to perform, in addition to minimizing surgical trauma, as it is not an intra-articular intervention, led to effective joint stabilization, minimal local damage and, consequently, recovery satisfactory and in less time, compared to conventional techniques (FERREIRA, 2009; LOPES, 2019).

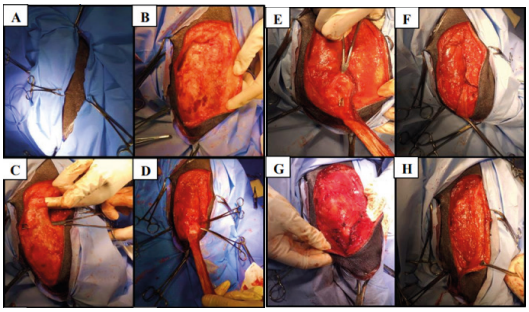

Figure 05. Extra-articular syndesmoplasty with autogenous fascia lata in a dog. In (A) placement of surgical drapes; (B) skin and subcutaneous tissue incision; (C) beginning of fascia lata divulsion; (D) fascia lata released; (E) transposition of the neotendon; (F) total crossing; (G) suture in the patellar ligament; (H) plan synthesis.

Source: adapted by: LOPES, 2019.

REHABILITATION

After reconstruction of the anterior cruciate ligament, physiotherapeutic intervention to rehabilitate the injury becomes inevitable, which aims to reduce edema and hemarthrosis, gain range of motion (ROM), and strengthen muscles in the lower limbs (LL).) and the patient's return to their daily activities before the injury (MONTEIRO, 2008). To achieve these goals, there are several approaches that the physiotherapist can use, ranging from more conservative actions, which protect the movement joint in the initial phases of rehabilitation, to more aggressive conduct, which advocates inserting the individual into the gait phases and exercise exercises. kinetic chain closed immediately after the surgical process (FONSECA, 1992).

There are several techniques that can be used in ACL rehabilitation, which assume the patient's biological individuality. Individuals who lead a more active lifestyle end up being subjected to more aggressive methods, while people with a more sedentary lifestyle are exposed to more conservative approaches, being, in both cases, subject to planning changes as the injury progresses (BORGES; VENEZIANO, 2022). Didactically, the phases of wound healing are: necrosis, revascularization, repopulation, synovialization and slow remodeling; while rehabilitation is divided into: analgesia, strength and ROM, resistance and flexibility, power and, finally, the return to the old routine. Each of these steps occurs in parallel, respectively (LEONARDI, 2008).

The first phase of treatment is characterized by the period of necrosis, in which the objective is analgesia, reduction of edema and hemarthrosis, gain in ROM and avoid muscular atrophy of the lower limbs. Cryotherapy is used during this period as an analgesic, as tissue cooling helps control edema by stimulating vasoconstriction, reducing local metabolic activity and the speed of nerve conduction. The use of ice ends up influencing the sensation of pain, allowing movements to be performed without discomfort, in addition to increasing the viscosity of the synovial fluid, facilitating the control of the patient's amplitude (MONTEIRO, 2008; QUEIROZ et al, 1998).

During this first stage, the use of isometric exercises combined with electrotherapy to stimulate quadriceps muscle activation are essential to avoid muscle atrophy, since in the first days after surgery patients find it difficult to recruit the quadriceps due to a nociceptive blockade (DE MATTOS, 2009). During this same period, the patient begins gait training, with single-leg and two-leg support, using crutches as an aid so that the work of inserting the old routine begins from the first days of rehabilitation (BONNETI, 2017). Hydrotherapy can act in all phases of rehabilitation, but, in these first moments, it is of significant importance, given that performing exercises in the pool increases the gain in ROM due to the relaxation of the muscles, which consequently reduces the pain and edema, in addition to providing an increase in muscle strength, resulting from constant water resistance, without the risk of joint impact (BORGES; VENEZIANO, 2022).

The second phase is ligamentization, called graft revascularization, in which the objectives are to gain ROM, muscle strength and proprioceptive training. At this point, the patient begins to perform closed kinetic chain (CCF) and open kinetic chain (CCA) exercises, depending on the individuality of each person, however, without overload so as not to stress the joint. It is worth noting that CCF end up having priority due to less joint friction, greater proprioceptive stimulation and involving more muscles in the work, being considered functional exercises as they are closer to daily needs (BARBALHO; ZOGHBI;

FATARELLI, 2014).

Figure 06. Closed kinetic chain exercise. The distal units (feet) remain immobile while the proximal units (thighs) move.

Source: adapted by: BONNETI, 2017.

Exercises to strengthen the quadriceps must be done with a flexion of 90º and 45º, given that this angle provides strengthening for the muscles without there being any previous shear, providing gain in ROM without other risks (SIQUEIRA et al, 2020). Even during the strengthening period, the patient can perform stretching exercises to maintain ROM and joint mobilization, divided into 5 types of protocols: static stretching, ballistic stretching, contract-relax, reciprocal relaxation and combined method (BENNETI, 2017). At this same moment, the patient begins to disengage from the crutches during walking, starting to use only one of them, until progressing to none during the final phases of this stage of rehabilitation (SA PIMENTA, 2012).

The third period of wound healing is repopulation. During this period of the protocol, the graft goes through the healing process and, at this point, the patient must be able to walk without the help of crutches. Thus, the focus becomes the gain of muscle mass, strength and resistance, as well as the gain of flexibility, in order to improve the quality of the movements performed and strengthen the joints, as these activities provide an increase in blood supply in the region and long-term strengthening, in addition to refining motor control through proprioceptive exercises (BONNETI, 2017; ALMEIDA; JABUR, 2007).

The use of stretches must be done cautiously, without the patient performing strength exercises in sequence, also stimulating proprioception, since it is necessary to be aware of the position of each limb to perform an effective stretch. Despite having a notable increase in strength, there is a short period of time in which the muscles become "softened" after being stretched, making it easier for the individual to get injured during the rehabilitation period, therefore, carrying out the Exercising cautiously is essential for recovery and minimizing risks inherent to the rehabilitation process (ZIPPERER; BRUN, 2013).

Strength and resistance training is done through CCA and CCF exercises, using maximum overload so that the muscle suffers the stress necessary to develop. Strength gain occurs through prioritizing more sets and fewer repetitions, giving preference to CCF, as they encompass more muscles during their execution, making it necessary to analyze the patient's needs, as strength production is directly related to the movement, and not to the muscle in isolation (MOURA, 2003). On the other hand, to gain resistance, the priority is to perform sets with more repetitions and, consequently, less load, in addition to a shorter rest period. Both approaches develop the muscles around the joint, strengthening the joint complex and preventing injuries (BARROSO; TRICOLI; UGRINOWITSCH, 2007).

Figure 07. Free squats, one of the exercises in CCF. It must start without load and progress according to the patient's reality.

Source: Adapted by GOIS, 2019.

In the graft synovialization stage, the objectives do not change, the patient will continue to aim to gain muscle strength in the lower limbs and ROM, undergoing plyometric training and running using orthoses (BONNETI, 2017). Plyometric training consists of exercises that target the stretching-shortening cycle (CAE) of the lower limbs, seeking to develop explosive strength, a method widely used in the physical preparation of athletes from different sports and in the rehabilitation of patients with injuries that impair gait (PIRES et al., 2011).

Plyometric exercises, in addition to strength gains, improve muscular reactivity, due to the stimulus suffered by the myotatic reflex. This consequently improves intra- and extra-articular coordination, corrects proprioceptive deficits, in addition to refining neuromuscular performance and neural activity, which ends up increasing the individual's body awareness. The use of jumps in this protocol improves hip muscle activation, which acts to stabilize the knee and support the body's load, influencing the prevention of future injuries and strengthening the joint complex (PIRES et al, 2011). During this period, the patient returns to their old routine, respecting their limitations and maintaining all training, to continue improving the injury.

In situations where the injured person is an athlete who intends to return to sport, the 5th phase of rehabilitation must proceed, consisting of more intense exercises and functional circuits based on the sport modality practiced. At this point, plyometric exercises are developed, with constant acceleration and deceleration, to, in addition to recreating the competitive scenario experienced by the athlete, effectively reinsert the individual into competitions, improving their conditioning and minimizing the risks of new ligament injury. anterior cruciate (BENNETI, 2017).

FINAL CONSIDERATIONS

From the present study, it was noticed that ACL rupture presents itself as a prevalent condition that, in addition to generating temporary immobility for the affected patient, causes successful public health expenses, requiring surgical intervention, in most cases, associated with physiotherapeutic rehabilitation and other supportive measures. The strategies currently used include cryotherapy, kinesiotherapy and electrotherapy, to recover from the injury, reduce edema and minimize the risk of hemarthrosis; weight training, which is essential for muscle strengthening; and hydrotherapy, responsible for assisting in the rehabilitation of strength and gradual recovery of joint mobility. These techniques, when combined and applied at the correct stage of healing, are essential for better joint restoration and more effective recovery during the postoperative period of ACL ligamentoplasty, favoring rehabilitation in less time and in a more satisfactory manner, as well as generating smaller long-term residual surgical effects on patients.

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