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Review Article

Rehabilitation of hamstring muscle injuries: a literature review☆

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ABSTRACT

Hamstring injuries are among the most frequent in sports. The high relapse rate is a challenge for sports medicine and has a great impact on athletes and sport teams. The treatment goal is to provide the athlete the same functional level as before the injury. Thus, functional rehabilitation is very important to the success of the treatment. Currently, several physical therapy modalities are used, according to the stage of the lesion, such as cryotherapy, laser therapy, therapeutic ultrasound, therapeutic exercise, and manual therapy. However, the evidence of the effectiveness of these modalities in muscle injuries is not fully established due to the little scientific research on the topic. This article presents an overview of the physiotherapy approach in the rehabilitation of hamstring muscle injuries.

Reabilitação nas lesões musculares dos isquiotibiais: revisão da literatura

Palavras-chave:
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Traumatismos em atletas
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RESUMO

As lesões dos isquiotibiais estão entre as mais frequentes do esporte. A alta taxa de recidivas representa um desafio para a medicina esportiva e apresenta grande impacto para atletas e clubes esportivos. O objetivo do tratamento é proporcionar ao atleta o mesmo nível funcional anterior à lesão. Dessa forma, a reabilitação funcional é muito importante para o sucesso do tratamento. Atualmente, usam-se várias modalidades fisioterápicas de acordo com o estágio da lesão: crioterapia, laserterapia, ultrassom terapêutico, terapia manual e cinesioterapia. Entretanto, as evidências da eficácia dessas modalidades nas lesões musculares ainda não estão completamente estabelecidas, devido à baixa investigação científica sobre o tema. O

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presente artigo apresenta uma revisão sobre a abordagem fisioterápica na reabilitação das lesões musculares de isquiotibiais.

Introduction

Hamstring injuries are some of the most frequent in the field of sports medicine.[1,2] A prospective study by Elkstrand et al.[3] demonstrated that they account for 37% of muscle injuries in professional soccer players and for 25% of athletes' absence in games. Other studies indicate that one-third of hamstring injuries relapse and that many of these relapses take place within the first two weeks after returning to sport.[4,5] This high recurrence rate may be related to a combination of factors, such as ineffective rehabilitation and inadequate criteria for return to sport practice.

The goals of hamstring injury rehabilitation are to achieve the same functional level observed prior to injury and to allow for the return to sports practice with minimal risk of recurrence.[6] Many interventions are widely used to achieve full rehabilitation. These include PRICE (protection, rest, ice, compression, and elevation), to control the inflammatory process[7]; therapeutic exercises to strengthen and restore the functionality of the musculature[8]; photothermal therapy for inflammation modulation[9]; massage and mobilization to realign and relieve tension of soft tissues[10]; joint and nerve manual therapy[11,12]; and functional rehabilitation. However, evidence of the effectiveness of these treatment modalities is not yet fully established, due to the sparse scientific research on the subject.

Therefore, the present study aimed to investigate the current evidence on physical therapy approaches used in the rehabilitation of hamstring injuries.

Methods

A literature review in the databases PubMed, LILACS, SciELO, and the Cochrane Database of Systematic Reviews (Cochrane Library) was made. The following keywords were used: muscle injury, hamstrings injury, muscle strain, functional rehabilitation, and physical therapy.

The inclusion criteria for this study were studies with high quality evidence, such as systematic reviews, meta-analyses, randomized controlled trials, and classical studies relevant to the proposed goals. The exclusion criteria were articles that did not match the proposed theme.

Classification

Muscle injury is characterized by changes in the morphological and histochemical aspects that create a functionality deficit in the affected segment.[13]

There are two major forms of muscular injury in sports: muscle strain and contusion.[14] Strain is the most common muscle injury in sports, and is classified as follows: grade I, in which there is minimal structural disruption and rapid return to normal function; grade II, in which there is a partial rupture, with pain and some loss of function; and grade III, in which a complete tissue rupture is observed, with muscular retraction and functional disability.[15] Ekstrand et al.[3] demonstrated that hamstrings are the muscles most affected by this type of injury.

The other form is muscle contusion, which is a direct result of external trauma forces, common in contact sports. It is characterized by the presence of pain, swelling, stiffness, and range of motion restriction.[15] It can affect any muscle, but the quadriceps and the gastrocnemius are the most commonly affected.[14]

A new comprehensive classification system, known as the Munich consensus, was developed by specialists[16] and distinguishes four types of injury. The first group is the functional muscle disorders, comprising type 1 (disorders related to overexertion) and type 2 (disorders of neuromuscular origin). These disorders are characterized by not presenting evidence of macroscopic lesions in the muscle fiber. The classification also includes structural muscle disorders, comprising type 3 (partial muscle injuries) and type 4 (total or subtotal lesions that may present tendon avulsion). In these cases, there is macroscopic evidence of injury, *i.e.*, structural damage. Subclassifications are given for each type.

Injury mechanism

Two specific mechanisms are described for hamstring injuries, which appear to influence the location and severity of the injury. Heiderscheit et al.[6] demonstrated that, during terminal swing phase of running, the hamstrings absorb elastic energy to contract eccentrically and promote deceleration of the limb's advance in preparation for the initial contact of the calcaneus. In this phase, muscles become more susceptible to damage; the biceps femoris muscle is the most affected, as it is more active than the semitendinosus and semimembranosus muscles.[17,18]

Another mechanism that commonly damages the proximal portion of the semitendinosus muscle is a movement of combined high power and extreme range of hip flexion with knee extension, which biomechanically matches the movements of kicking, running hurdles, and artistic dancing.[19,20]

Risk factors

The proposed risk factors for hamstrings injuries are classified as modifiable and non-modifiable.[21]

Modifiable factors comprise muscle imbalances, including the strength ratio of the quadriceps and hamstrings of the same limb, and the bilateral relationship of the hamstrings.[22,23] Another factor is muscle fatigue, since studies have shown that the incidence of hamstring injuries is higher in the last stages of matches and competitive training, when the musculature is at a high level of fatigue.[24,25] A hamstring flexibility deficit is also considered by some authors to be a risk factor,[26,27] but it is not consensual, as other studies have shown that flexibility deficit was not associated with injury.[28] During the rehabilitation process, the physical therapist should identify these factors so that the return of the athlete to sport practice can be more effective.[21]

Regarding the non-modifiable risk factors, history of previous hamstring injury is noteworthy, as many authors consider it to be the main risk factor for hamstring injury.[29–31]

Pathophysiology

Jarvinen et al.[32] described the stages of muscle injury healing:

Step 1 destruction (three to seven days) – characterized by disruption and subsequent necrosis of myofibrils by hematoma formation in the space formed between the torn muscle and by proliferation of inflammatory cells.

Step 2 repair (four to 21 days) – consists of phagocytosis of necrotic tissue, regeneration of myofibrils, and concomitant production of scar tissue, as well as vascular neoformation and nerve growth.

Step 3 remodeling (14 days to 14 weeks) – period of maturation of the regenerated myofibrils, and reorganization of the muscle functional capacity.

The physiotherapist needs to understand the healing process in order to use the adequate therapeutic approaches in the appropriate period, so that rehabilitation can be conducted properly.

Rehabilitation

Cryotherapy

The traditional treatment in acute muscle injury is described by the PRICE protocol.[33,34] The most easily recognizable effect of cryotherapy is the reduction of tissue temperature. In fact, virtually all the effects observed in cryotherapy are direct results of the change in tissue temperature.[35] These effects include reduced perfusion, reduced inflammatory signs (heat, redness, swelling, and pain), and reduced metabolic rate.[7]

It is believed that the most important goal of cryotherapy is the reduction of metabolic rate of the cold tissue. This reduction is beneficial, as it increases the ability of a tissue to survive the events of secondary injury following the primary trauma. Thus, the total amount of injured tissue is limited, reducing the time required to repair the damage and return to activity.[7,36]

The authors recommend cryotherapy for 20 minutes every two hours during the acute stage of muscular injuries.[37]

Therapeutic ultrasound (TUS)

TUS is a commonly used resource in musculoskeletal injuries.[38] According to Backer et al.,[39] the acoustic vibration produced by TUS induces cellular changes that changes the concentration gradient of molecules, as well as calcium and potassium ions, which excites cellular activity. This event may result in several changes, such as increase in protein synthesis, secretion of mast cells, fibroblast proliferation, and angiogenesis stimulation, among others.

Nonetheless, the effectiveness of TUS in muscle injury repairing process is still controversial. While some authors have observed positive results with use of TUS,[40,41] others have not.[36,42] Some factors, such as intensity and frequency of treatment with ultrasound, and, moreover, lack of calibration of the device and of a protocol for determining the specific dose for each individual contribute to the divergence of results.[38]

Low level laser therapy (LLLT)

LLLT is a light source that differs from others because it is monochromatic, coherent in time and space, and collimated, which allows for a good tissue penetration.[43]

The high incidence of muscle injury has caused an increase in studies related to physical therapy resources that are involved in the injury healing process.[44] Among the most widely used, LLLT is noteworthy, as it triggers the production of adenosine triphosphate (ATP),[45] enhances the migration of satellite cells and fibroblasts, and promotes angiogenesis.[46] These effects are essential to achieve more effective muscle regeneration and prevent tissue fibrosis.[9] The conclusion of the most recent systematic review on the subject confirms these findings and highlights the positive effects of LLLT on muscle repair.[47]

Manual therapy

This approach assesses and treats articular, neural, and muscular systems. The hand contact stimulates mechanoreceptors, which produce afferent impulses and cause neuromodulations in the central nervous system to provide an analgesic response and an improvement in muscle and joint function.[48]

Cibulka et al.[11] hypothesized a relationship between hamstring injury and pelvic hypomobility. Their study observed a gain in torque in the flexor muscles as well as a faster return to sport in the experimental group, which received a traditional rehabilitation treatment of hamstring injuries, in addition to joint manipulations of the pelvis during treatment. Considering these facts, those authors recommend a detailed pelvic assessment in individuals with hamstring injury, as the patient may benefit from joint mobilizations.

Another approach is neural mobilization, which is a set of manual therapy techniques that allow for controlled mobilization and stretching of the connective tissue surrounding the nerves and of the nerve itself, which in turn improves nerve conduction and its intrinsic mobility.[49] Albeit an uncommon complication, some studies have reported that the formation of scar tissue after muscle injuries of the hamstrings can cause mobility deficit in the sciatic nerve.[12] In a recent case study, Aggen and Reuteman[50] reported this complication in an athlete who had suffered a grade III hamstring injury. In order to improve neural mobility and reduce its mechanical sensitivity, neural gliding techniques were initiated. Conservative treatment has shown to be effective. The authors suggest that neural gliding techniques should be used in cases of positive slump test after a hamstring injury.

Therapeutic exercises

One of the initial goals of muscle injury rehabilitation is to restore normal neuromuscular control and prevent the formation of tissue fibrosis.[6] Therapeutic exercises, such as isometric strengthening and controlled, pain-free, low-intensity active movements, are strategies recommended by experts to achieve these objectives at an early stage.[51]

In an intermediate phase, an increase in the intensity of exercises is allowed, with neuromuscular training at higher amplitudes and the initiation of eccentric resistance training.[51] Askling et al.[52] demonstrated the importance of eccentric strengthening in hamstring injuries, by comparing a protocol with conventional exercises and a protocol based on eccentric exercises with maximum dynamic stretching. Their study concluded that the eccentric exercise protocol was more effective, as it provided a faster return to sport and a lower relapse rate. Heiderscheit et al.[6] stressed the importance of restoring flexibility at this stage, in order to promote better orientation of fibers during healing. Nonetheless, it is important to respect patient's tolerance to stretching.

In the final phase of rehabilitation, it is recommended to increase the eccentric training and the high-speed specific neuromuscular training of the sport movement, in preparation for the return to sport.[32,51,53] Sherry et al.[4] compared two intervention programs: one consisted of specific stretching exercises and progressive strengthening of hamstrings and the other comprised progressive agility training and lumbopelvic stabilization. The authors found that time to return to sport and recurrence rate were lower in the group that underwent functional training, which demonstrated the importance of agility exercises and of lumbopelvic stabilization during rehabilitation. Another strategy indicated to improve the reactive ability of the neuromuscular system is plyometric training, an exercise that activates the eccentric-concentric cycle of the musculoskeletal system and provides a gain of mechanical, elastic, and muscular reflex ability.[54]

Return to sport criteria

The determination of objective criteria to define the appropriate time for an athlete to resume sport practice remains a challenge and an important area for future research. Based on the best evidence available,[6,55,56] athletes who have been authorized to return to sports activities without restrictions should be able to perform functional skills (running, jumping, dribbling) at full speed without pain or stiffness complaints. Flexibility needs to be similar to the contralateral limb, without complaints. Regarding strength, the athlete should be able to complete four consecutive repetitions of maximal effort without pain complaints in the manual test of knee flexion strength. If possible, isokinetic strength testing should also be performed, under both concentric and eccentric action conditions; the peak torque should have a deficit lower than 10% when compared with the contralateral side.

Final considerations

Hamstring injuries are common in the athletic population and have a high recurrence rate. Through a complete physical evaluation and understanding of the mechanism of injury and risk factors, a rehabilitation specialist can determine the most appropriate and individualized treatment. Proper rehabilitation must address muscular strength deficits, flexibility, neuromuscular control, lumbopelvic stability, and eccentric strengthening, since these have been shown to be important therapeutic targets for a successful return of the athlete to sports, with lower risk of recurrence. Furthermore, LLLT has arisen as an important resource in helping to heal the injury. Future research should include evaluation of the effectiveness of current rehabilitation programs, identification of appropriate return-to-sport criteria, and the development of effective prevention strategies to reduce the occurrence of injuries.

Conflicts of interest

The authors declare no conflicts of interest.

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