Return-to-play process after injuries in the hamstring region in soccer players: A systematic review

Proceso de vuelta a la competición en lesiones de la región isquiosural en el futbolista: Una revisión sistemática

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Abstract

Injuries to the ischiosural musculature account for 12% of all injuries to soccer players. The aim of this systematic review is to present the current methodology used during the rehabilitation process in soccer players with respect to injuries to the ischiosural region. For this purpose, a search was carried out using Google Scholar, Pubmed and Sportdiscus platforms including a time frame from 2011 to May 2021. Inclusion criteria included soccer players, in addition to including only studies with intervention. An analysis of 7 studies was carried out, in which it has been possible to observe how a multifactorial approach, acting on coadjuvant components and with the aim of improving the return to play process, offers greater efficacy in the return to competition. During the rehabilitation process it is necessary to identify synergies in sport-specific movement patterns in order to offer the player an optimal recovery.

Keywords: Return to play, multifactorial, coadjuvant, synergies.

Resumen

Las lesiones de la musculatura isquiosural engloban el 12% de las lesiones totales del futbolista, El objetivo de la presente revisión sistemática es exponer la metodología actual durante el proceso de rehabilitación en futbolistas respecto a la lesión de la región isquiosural. Para ello, se ha realizado una búsqueda mediante las plataformas Google Scholar, Pubmed y Sportdiscus incluyendo una franja temporal desde el 2011 hasta mayo de 2021. Los criterios de inclusión incluían jugadores de fútbol, además de incluir solo estudios con intervención. Se realizó un análisis de 7 estudios, en los que se ha podido observar cómo un enfoque multifactorial, actuando sobre componentes coadyuvantes y con el fin de mejorar el proceso de return to play ofrece mayor eficacia en la vuelta a la competición. Durante el proceso de rehabilitación es necesario identificar las sinergias en los patrones de movimiento específicos del deporte, con el fin de ofrecer al jugador una óptima recuperación.

Palabras clave: vuelta a la competición, multifactorial, coadyuvante, sinergias.

Introduction

In high-performance men's soccer, approximately 9 injuries occur in every 1000 hours of exposure, taking training and competition into account (Cos et al., 2010). Of these injuries, 90% affect the hamstring area, adductors, quadriceps, and gastrocnemius (Ekstrand et al., 2012); although within this subtype we must bear in mind that injury to the hamstring area, comprising the biceps femoris, semi-membranosus, and semitendinosus (Mason et al., 2012), is the most common, accounting for 12% of all injuries (Ekstrand et al., 2016a). The rate of injuries in male professional soccer players, in turn, has increased substantially since 2001, averaging an annual increase of 2.3% and a total of 4.1% over the following 13 years (Ekstrand et al., 2016b).

The mechanism of injury is defined mainly by two specific actions. The first arises during high-speed running and may include the long head of the biceps femoris, and the second can occur in movements involving an extensive lengthening of the region (kicking a ball), a situation that could involve the proximal tendon of the semimembranosus (Brukner, 2015). As risk factors, the literature reports that elements such as instability of the joint, lack of muscle strength, asymmetry of force or amplitude of movement between the two legs, an excess of tension in the reported area, psychological issues such as anxiety, unsuitable mechanical postures, the athlete's level of training, field conditions, level of competition, position on the field, and finally having had a previous injury in the same area, as well as inadequate rehabilitation of the affected area may be potential predisposing factors for suffering an injury (Dvorak & Junge, 2000).

In 44% of cases relapse of muscle injuries involves the same mechanism of injury and location as the previous injury, showing that a third of moderate or severe injuries occur less than two months after a lesser injury (Dvorak & Junge, 2000). With regard to the hamstring area, relapse rates are between 12% and 41% and as the above-mentioned authors show, the relapse is usually more severe than the initial injury (Visser et al., 2012), normally involving biceps femoris injuries (Brukner, 2015). These data could indicate that traditional rehabilitation treatments, based on unidirectional methodologies and analytical contents of rehabilitation, are not sufficiently effective, in contrast to current multifactorial and complex proposals (Mendiguchía et al., 2012).

In this context, the objective of this systematic review is to define the current methodology for the rehabilitation process in soccer players with regard to injury in the hamstring region.

Methodology and procedure

Sources of information

We carried out a bibliographical search in the period from 2011 to 2021, ending in May 2021. The databases used in the review were PubMed, Google Scholar, and SPORTDiscus.

Search strategy

We searched title, abstract, and keyword fields in each of the databases used, with the following search terms: in PubMed, we used Rehabilitation AND Hamstring injury AND male soccer. In the Google Scholar search, we used Rehabilitation AND male football player reconditioning NOT prevention, as well as using "Hamstring injuries" as words implicit in the title. Finally, regarding the search in SPORTDiscus, we used Rehabilitation OR treatment AND hamstring injury AND soccer.

Eligibility criteria

The eligibility criteria for the review were to use studies that included an intervention, with subjects in an age range between adolescence and adulthood, related only to male soccer. Finally, the languages included in the criteria were Spanish, Catalan and English. We excluded interventions based on prevention of injuries, uncontrolled trials, studies that used auxiliary elements, letters to the editor, conference summaries, books, and reviews. The methodological quality was rated according to the SIGN criteria (Müller-Riemenschneider et al., 2008).

No study was excluded on grounds of methodological quality.

Data extraction and study selection process

The records were exported to an electronic database with bibliographic reference management software (Mendeley Desktop, 1.19.4, Mendeley Ltd., 2008–2019) in which duplicate references were eliminated. A total of 3 researchers carried out the review process, which was done in 3 stages. In a first stage, the authors examined the titles, abstracts, and keywords of the relevant studies. In the second step, full-text articles were examined, the exclusion criteria were applied to exclude studies not related to the research, and then a full review of texts was conducted to definitively exclude studies that did not conform to the selected criteria or were not related to the objective of the study. In the third phase, we looked for additional articles in the reference lists of the articles included and of review articles on the rehabilitation process in soccer players with respect to injury in the hamstring region. Two articles were included. Any disagreement was discussed until a consensus was reached.

A protocol was developed for extracting data from the articles. Information related to (1) authors, (2) sample, (3) intervention, and (4) results was extracted.

Synthesis of the results

The texts were reviewed in search of the main study variables, such as: type of protocol used during rehabilitation, type of training used during the protocol, days of periodization, and recovery time.

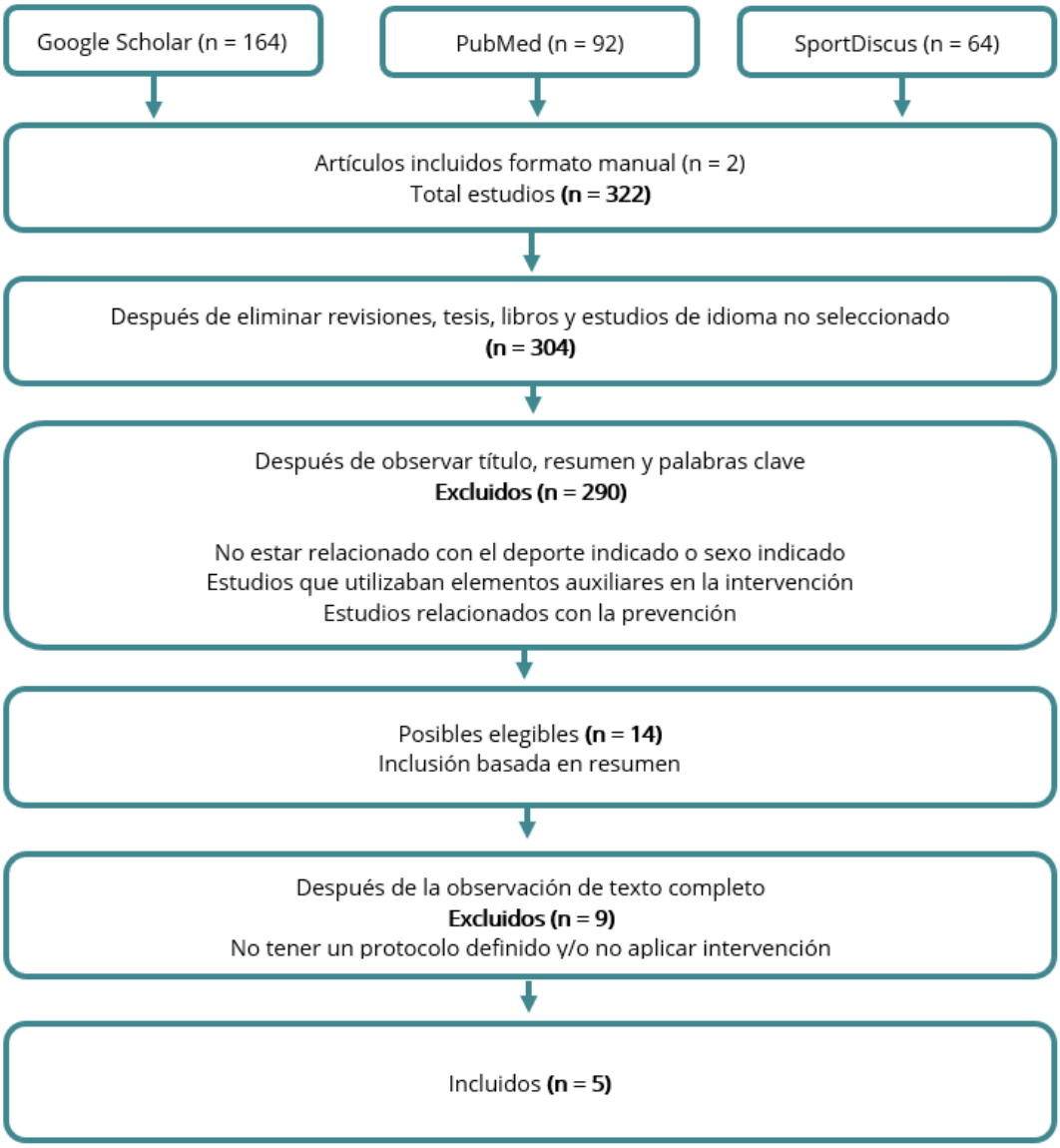
The measures and parameters derived from the variables presented were considered their main result.

Results

Study selection

The search we carried out reported a total of 322 results, and 2 articles identified in the bibliography were included manually; after elimination of duplicates, previous reviews, theses and books, the search was reduced to 304 results. Subsequently, review of the titles, abstracts and keywords used eliminated a total of 290 studies, and we obtained a total of 14 studies as possibly eligible. During screening of the full texts, 9 articles were excluded, leaving a total of 5 studies in the final selection (Figure 1).

Figure 1. Flow diagram in relation to the search



Participants

The search was conducted in studies related to the male sex, although in one of the studies the female sex was included (Askling et al., 2013). As regards sports, five selected studies used soccer players in their intervention. The athletes in the studies analyzed were aged between 13 years and adulthood.

Characteristics of the studies

The types of interventions performed were randomized in four cases; one study was not randomized. According to SIGN criteria, most of the studies were of low quality (N = 3); only 2 were of moderate quality. The low-quality rating was due in most cases to small sample size, inadequate duration of the study or possible selection and information bias.

Reported results

In relation to the type of training, the results of three of the studies used working methodologies based on a multifactorial approach, including different manifestations of movement (Jiménez-Rubio et al., 2020b; Tol et al., 2014; Mendiguchía et al., 2017), although in other studies an analytic approach was found, directly solely at the area of the injury (Askling et al., 2013; Silder et al., 2013). However, regardless of the type of approach, all show positive results in relation to return to play (RTP) and the reduction of asymmetries (Table 1).

Table 1. Variables analyzed in the selected studies

Authors	Sample	Intervention	Results	QUALITY
Silder et al. (2013)	24 subjects 24 ± 9	1. Progressive agility and trunk stabilization work 2. Progressive running work and exercises with eccentric emphasis 5 sessions/week in 3 phases	No significant differences between the two protocols used ($P > .05$)	LOW
Askling et al. (2013)	75 subjects L: 25 ± 5 C: 25 ± 6	**Protocol L:** Emphasis on eccentric actions **Protocol C:** Traditional exercises without emphasis on the eccentric component **PROTOCOL** 1. Increase in flexibility 2. Strength + trunk stabilization 3. Specific strength exercise 5 sessions/week and 1 phase	Positive correlations were found in relation to days of recovery and protocol L ($P > .001$)	LOW
Tol et al. (2014)	52 subjects 24.9 (range: 18-38)	Program consisting of exercises for range of motion amplitude, central stabilization, progressive strengthening and agility + Specific program made up of specific actions simulating muscle fatigue 6 phases	Reduction of asymmetry in relation to peak force in an isokinetic machine in different manifestations of force until reaching <10%	MODERATE
Mendiguchía et al. (2017)	48 subjects RP: 22.9 ± 6.0 RA: 24 ± 4.4	**RP:** Protocol of emphasis on eccentric actions + general rehabilitation program + progressive running program **RA:** Modified Mendiguchía and Bruguelli (2011) protocol including manual therapy, flexibility, hamstring strength, gluteal strength, plyometrics, ankle stabilization, lumbopelvic control and running technique. **RP:** 4 sessions/week **RA:** minimum of 3 sessions/week 3 phases	Significant differences in maximum power, maximum speed, V0 and time at 10 m (s) (90% *CI*)	MODERATE
Jiménez-Rubio et al. (2020b)	19 subjects 24.3 ± 5.36	**I:** Controlled knee and hip mobilizations →Controlled movements in the frontal and sagittal planes increasing speed→Unipedal strength work and motor actions involving posterior chain activation **O (from AE to ANAE):** Re-education of ACC+DECC patterns→Motor control of lower limbs and CORE → Repeated sprint work → Tactical rehabilitation Average range (16 to 26 days) 2 phases	Significant differences ($P > .001$) with moderate improvements were identified in variables such as maximum sprint speed and distance; on the other hand, small improvements were found in variables such as mean speed, distance at very high intensity and distance at high intensity.	LOW

RP: Rehabilitation protocol, RA: Rehabilitation algorithm, I: Indoor, O: Outdoor, AE: Aerobic, ANAE: Anaerobic

Discussion

The most important finding of this systematic review is that methodologies of a multifactorial nature, acting on contributory components with the aim of improving the return-to-play process, offer greater effectiveness for this purpose that those of an analytic nature. Current methodologies for rehabilitation of injuries in the hamstring area show two types of approach (unidirectional and multidirectional), and they are defined in turn according to their proposal for treatment when confronted with this injury. While the unidirectional approach is based on rehabilitation of the muscles in question, the multidirectional approach is based on rehabilitation of the movement as a whole, taking into account the synergy of those muscles with the adjacent muscles and their relationship during movement in sport.

We can see how both an analytic approach (Askling et al., 2013; Silder et al., 2013), and a multifactorial approach (Jiménez-Rubio et al., 2020b; Tol et al., 2014; Mendiguchía et al., 2017) produce improvements in recovery treatment, although when the two types of treatment are compared, significant improvements are observed in relation to possible relapses, as well improving performance in sprinting and mechanical properties (Mendiguchía et al., 2017). These benefits provided by the multidirectional model, involving a synergistic interaction of all parts, can be exemplified by situations such as those that occur when reduced activation of the gluteus produces more tension in the hamstring area, or the way in which lumbopelvic control affects the ability to extend/flex the knee and hip, or even discovering the relationship between excessive neural tension and how this can affect horizontal force production (Mendiguchia et al., 2012). This multidisciplinary approach could help physiotherapists and fitness coaches during the

processes and times of injury prevention and rehabilitation of those muscles (Lahti et al., 2020).

Phases of recovery and criteria of progress

With regard to phases of recovery, there is a relationship between the number of phases and the type of approach to the rehabilitation of that injury, since in unidirectional approaches the number of phases is lower (1 phase) (Askling et al., 2013), whereas in multifactorial approaches a higher number of phases is established (Mendiguchía et al., 2017; Tol et al., 2014). The 3-phase method (acute, regeneration and functional phases) of Mendiguchía et al. (2017) shows features in common with the proposal presented by Caparrós et al. (2017), which follows progressive patterns in relation to the type of kinetic chain (from closed to open), type of contraction (isometric-concentric-eccentric), extent of work (internal-medial, external-total, and total) and orientation of content (general, directed, and specific).

In connection with this, while the unidirectional protocols showed their emphasis on the target muscles (Askling et al., 2013; Silder et al., 2013) through flexibility and strength exercises, the multifactorial protocols focused not only on these target muscles, but on the use of manual therapy, improving the flexibility of hip extensors and flexors, strength of the hamstring group, exercises for the gluteal area, plyometric work, lumbopelvic control, ankle stabilization, and running technique in the frontal and sagittal planes (Mendiguchía et al., 2017), as well as adding actions specific to the sport itself (Tol et. al., 2014) and the reeducation of biomechanical postural patterns (Jiménez-Rubio et. al., 2018).

The objectives for each phase will be different (Mendiguchia & Brughelli, 2011), showing how in phase 1 they will be aimed at preventing excessive inflammation, increasing tissue elasticity, reducing interstitial fluid accumulation, and identifying and treating lumbopelvic dysfunctions. With respect to phase 2, the approach will be directed more at reducing pain during muscle actions by improving muscle strength and symmetry, as well as improving the flexibility of the chain flexors and extensors, providing better neuromuscular control. In phase 3, we should supplement the previous objectives with improvement of horizontal force production while running and improving torsional capacities. Finally, in a higher phase (Tol et al., 2014), the objectives would be to guide players toward their return to play through technical and tactical actions conditionally similar to the sport in question, evolving from an aerobic toward an anaerobic context (Jiménez-Rubio et al., 2020b). There are discrepancies between authors on the criteria of progress to be followed.

Mendiguchía et al. (2017) focus on reducing leg asymmetries through strength and/or flexibility exercises (between 20% and 5%), while Tol et al. (2014) aim their proposal at improving the range of motion of the affected leg and managing the sensations of pain when performing the proposed exercises. This last point has been analyzed by Hickey et al. (2015), who adopts a controversial stance on doing exercises without pain, indicating that tolerating up to 4 or less out of 10, on a numerical pain rating scale (NPRS), does not provide a reduction in RTP time, but does show greater recovery of isometric strength and better maintenance of the length of the fascicles in the area.

Type of muscle stimuli to be applied during treatment

The main objective of the initial phase of treatment is to prevent excessive inflammation, and early mobilization of the area by the physiotherapy staff is important (Mendiguchía et al., 2017), with the objective of promoting proper alignment and regeneration of the myofibrils (Mendiguchía & Brughelli, 2011) as well as sacroiliac mobilization and the use of auxiliary elements that may help to prevent excessive inflammation, such as cryotherapy and/or non-steroidal anti-inflammatory drugs (NSAIDs), although the use of the latter is controversial in the literature because of their possible harmful effects on muscle repair (Mendiguchía & Brughelli, 2011), inhibition of angiogenesis and revascularization, delaying of neutrophil and macrophage infiltration, and increase in immature myofibrils, issues that could lead to impairment of tissue repair and excessive synthesis of collagen (Dubois & Esculier, 2020).

Subsequently, in a phase oriented toward regeneration, as well as initiating stimulation of flexibility for chain extensors and flexors, work is also done on the antagonist muscles (Tol et al., 2014) with the aim of not losing functionality. Furthermore, in this phase we can begin the task of isometric stimulation of the target muscles (Mendiguchía & Brughelli, 2011), evolving toward concentric stimulation and then toward eccentric contractions, although it is of interest to prioritize the eccentric emphasis over the concentric during the recovery process (Arnason et al., 2013), given that the former reported a lower percentage of recurrence than the concentric group. This phase must be supplemented by nerve release exercises, since traction or compression forces may compress the nerve tissue, thereby making this one of the risk factors in hamstring injury (Mendiguchía & Brughelli, 2011). It could be interesting to introduce stimulation of horizontal force production in this phase, by activating the gluteus, with the aim of reducing demand on the hamstrings during hip extension in the sprint mechanism (Mendiguchía & Brughelli, 2011). At the same time, exercises oriented toward biomechanical re-education of sports actions can be added, by introducing running technique exercises (Mendiguchía et al., 2017), in which hip extension will be the predominant movement (Jiménez-Rubio et al., 2020b), as well as initiating actions in a sagittal plane in a controlled manner (Jiménez-Rubio et al., 2018), with the object of offering players a return to their sports discipline through the safest and most effective possible rehabilitation process (Mendiguchía et al., 2017).

When we enter the functional phase (Mendiguchía et al., 2017), we need to distinguish dominant hip or knee exercises with the object of stimulating different muscle bellies, depending on the location of the injury and the mechanism of injury (Mendiguchía et al., 2017). Coupled with this factor, introducing rotational exercises seems indicated, given that good stabilization levels will be required in specific actions such as changes of direction, kicking or high-speed running (Mendiguchía & Brughelli, 2011), to help perform these actions correctly; Jiménez-Rubio et al. (2018) propose using asymmetric exercises. During this phase, deficits in horizontal force production could involve a risk of relapse during the running support phase. A type of training to be included in this phase would be plyometrics (Mendiguchía et al., 2017), with the object of resolving neuromuscular deficiencies and being able to prepare the musculoskeletal system for the demands imposed during sports practice (Chmielewski et al., 2006). A means of doing so would be to gradually increase speed in lateral movements as well as using exercises involving pushing sledges (Jiménez-Rubio et al., 2018).

Finally, having completed the three stages mentioned above, a specific phase of readjustment to soccer needs to be introduced (Tol et al., 2014) through a progressive program in terms of volume and intensity, in which a retraining of the specific qualities of the sport in question is introduced, also increasing complexity during the process. This can be structured in 13 items (Jiménez-Rubio et

al., 2018), progressively introducing frontal and lateral movement, as well as actions such as receiving and specific motor skills, progressing toward the re-education of specific agility and coordination patterns. Finally, an evolution from an aerobic to an anaerobic context, involving RSA (repeated sprint ability) training, would be aimed at completing the RTP process by performing simulations of specific situations, with an emphasis on decision-making (Jiménez-Rubio et al., 2020a). As a cross-cutting element, aerobic conditioning by running is valuable, as long as the player does not report discomfort or pain during the movement (Mendiguchía et al., 2017), although in previous stages this element could be emphasized through activities that do not produce discomfort or pain (Tol et al., 2014).

Limitations of the study

The main limitation of the study was the small number of studies that applied an intervention process and used a control group, since in the documents we found, the predominant type of study was descriptive, without intervention, a factor that impeded analysis of the benefit of these protocols for the injury studied. In addition, the selection of these sources of information possibly restricted access to important unidentified information.

Conclusions

The multifactorial approach in relation to the treatment of hamstring injuries and the return-to-play process shows more benefits than a protocol with a unidirectional component. During this process, it is important to recognize synergies in the specific patterns of movement of the sport in question, seeking to offer the player a safe and effective recovery, with the object of combating the possible future risk factors and preventing relapses. Elements such as including lumbopelvic control training, running technique, training of the gluteal area or plyometrics show benefits in the RTP process in hamstring injuries. Furthermore, knowledge of the affected area and its mechanism of injury is essential when it comes to applying correct treatment, given the differences in muscle activation that are present depending on their dominance.

Practical applications

To carry out this process, coordination of all the staff who will take part in it is indispensable, in order to provide and reinforce the multidisciplinary approach during this process and seek the overall recovery of the player. To achieve this, protocolization in the record and more longitudinal studies would enable us to confirm effectiveness with regard to the type of approach in the multidisciplinary rehabilitation process (Mendiguchía et al., 2017).

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