ABSTRACT

Objective: A review was conducted to present current views and effectiveness of prevention and rehabilitation methods of hamstring injuries.

Methods: a review searching on the electronic data bases, including Proquest, Medline, Sport Discus, Cinahl plus, Health source Nursing / Academic edition, Academic search complete, Pub med and Scholar Google. Only randomized control studies (RCT’S were included) which contained the intervention and control groups concerning either the prevention or rehabilitation of hamstrings.

Results: Fourteen randomized control studies were included. Twelve concerned the prevention and two the rehabilitation of hamstring injuries. From the analysis of the articles concerning prevention we concluded that stretching, especially static and warm up program named “The 11” did not show any benefits in preventing hamstring injuries whilst strength training exercises

Key Words: Hamstrings strain, Hamstring and rehabilitation, Nordic exercises, Prevention hamstrings.
with eccentric contraction (Nordic exercises) and warm-up program “The 11+” containing eccentric exercises of hamstring showed significant differences regarding the prevention. It is postulated that the effectiveness of this may be due to the fact that the researchers had targeted the progressive increase in the intensity and frequency of eccentric exercises.

**Conclusions:** Eccentric exercises seem (based on the findings included in this study) to have an important role in the prevention and strengthening immediately after hamstring injury and also significantly role on reducing the risk of reinjury. A rehabilitation program that includes mainly stretching exercises with eccentric loading of hamstrings muscles and secondly an exercise program which includes core stability and progressive agility exercises were found to be the most effective for recovery after hamstrings injury.

**INTRODUCTION**

Muscle injuries are very common in sports. They constitute 31% of all injuries in high performance athletes in football and 92% involving injuries affecting four major muscle groups of the lower limbs, hamstrings 37%, adductor 23%, quadriceps 19%, and gastrocnemius 13% (7).

Thigh injuries are presented as a usual diagnosis in athletes and in sports on the lawn (field) surface 16% (12, 13) and have also been reported in sports such as basketball for adolescents 17.1% (9). The fact that a male high-level football team with a total of 25 athletes expects about 15 injuries each season with an average absence of 223 days, 148 absences from training and 37 lost games indicates the high importance for athletes and also for the sports club. It has been observed that muscle injuries occur more frequent towards the end of either half. Age also seems to be a factor, with athletes over 30 years old experiencing a significantly higher incidence of hamstrings injuries than younger athletes under 22 years old (7).

One of the most widely used muscle injury grading systems was devised by O’Donoghue, 1963. This system utilizes a classification that is based on injury severity related to the amount of tissue damage and associated functional loss. Acute muscle injuries are commonly classified into three grades, ranging from grade 1 with no appreciable tissue tear, grade 2 with tissue damage and reduced strength of the musculotendinous unit and grade 3 with complete tear of musculotendinous unit and complete loss of function (17).

A new proposal of muscle injury system (6) that takes into account imaging (based on MRI and US) features of acute muscle strain injuries which is more precisely defines muscular injuries by anatomical site of lesion. This new classification separates the muscle injuries in 3 grades (6).
The structure of a new comprehensive classification system for athletic muscle injuries (17) with a clear definition of each type of muscle injury, a differentiation according to symptoms, medical history, clinical signs, inspection, location and imaging. The classification was empirically based and includes some new aspects of athletic muscle injuries, specifically the highly relevant functional muscle injuries (17). He describes 4 types of muscle injuries with a subcategory of each one classification adding also the contusion of the muscle.

An attempt for a new classification of muscle injuries especially for hamstrings was made helping the clinicians to classify the injury with an easy way (14). According to this system an objective range of movement of accessing deficit measured in the knee extension is compared to the healthy side so as to accurately predict recovery time and hence the severity of the problem. That difference is called the “active range of motion deficit” and according to the difference observed he ranked muscle hamstring injuries in four categories (14).

The high incidence of injuries on hamstring muscles force medical team of the international football federation to create a warm-up program called “The 11” in 2005 so as to reduce this frequency. Two articles that included in our review (24,27) indicated that there were no significant differences in injury rates of hamstrings while the revised warm-up program “The 11+” by the same group of men, women and adolescents as part of training and competition indicated that there is a statistically high degree of injury reduction (25,7).

Alternative prevention method used was stretching as part of the warm-up program (20), which sought to reduce the rate of injury, without any results. Lack of muscle flexibility can be considered as a high risk factor for muscle injuries. Searching as an outcome measure the rate of injury two other authors (4, 15) try to use passive stretching to increase flexibility to minimize the injury rates, again with no significant results.

Eccentric exercises (Nordic exercises) showed great effectiveness on prevention indicating that the occurrence of hamstring strain injuries was clearly lower, improving also the strength by 11% measuring eccentric torque and 7% on isometric strength. Eccentric exercises also helps to improve the speed in training groups referring to progressive strengthening (16,1,19,2,12)

Regarding rehabilitation, progressive agility exercises and core stabilization exercises (22) or strengthening of hamstrings during maximum stretching primarily eccentric contraction exercises are the most effective methods of treatment reducing the time to return (1).

Regarding the use of electro-physical devices, such as the therapeutic ultrasound, TENS and laser therapy there is no indication of having an additional value in the treatment of hamstring strain (3,28,21,23).

The aim of this study is to evaluate existing evidence presenting the modern views and the effectiveness of prevention methods and rehabilitation of the
hamstring injuries. This information may be helpful and useful for the best quality treatment of athletes with this type of injury.

METHODOLOGY

Search strategy

Electronic databases searched for the purpose of this systematic review included: EBSCO Host, Proquest, Medline, SportDiscus, Cinahl plus, Health source Nursing/Academic edition, Academic search complete, Pubmed and Scholar. All searches were undertaken from 2002 to 2014. Articles selected were limited to those written in the English language and included journal articles. The following key terms were included in searches performed: “hamstrings”, “rehabilitation”, “prevention”, “eccentric”. Also a combination of key words included: “hamstrings strain”, “prevention hamstrings”, “hamstring and rehabilitation”, “eccentric and hamstrings”, “Nordic exercises”, “core stability and prevention”, “hamstring tear and prevention”, “hamstring prevention and stretching”. Articles and summaries which were not published were not included. All keywords as well as the search strategy were chosen only by the author of the review without the help of a librarian based only on his personal experience in the field of research for medical issues. All articles screened by one author.

Inclusion criteria

Study selection criteria included: randomized control studies (RCT’S) with or without a future follow-up that included adults and adolescents aged 13-17 years old. Citation must have diagnosis of hamstring strain (any grade), otherwise healthy individuals using the intervention mainly for prevention. The method of treatment we selected for preventive or therapeutic rehabilitation was evaluated through the following: (i) intervention with stretching or without (ii) intervention with eccentric’s vs traditional strengthening training (iii) intervention with special warm-up exercises vs classic warm up (iii) intervention with proprioception exercises and coordination or no intervention control. Outcome measures sought were: injury frequency before and after an intervention, extensibility of muscle and agility, isometric strength, return time after injury and evaluation of neuromuscular control.
RESULTS

Literature search strategy

Results of the overall search strategy are summarized in Figure 1. Using the criteria established for inclusion, 14 studies were included.

![Flowchart](image.png)

**Figure 1. Flow of information through the different phases of a systematic review.**

An initial 543 primary articles were identified for potential inclusion. Of these articles, 197 were excluded after duplicates and 146 after titles screening, leaving
200 citations. For the remaining 200 citations, abstracts were obtained and screened for eligibility. One hundred forty-seven abstracts were excluded in the second phase of screening, leaving 22 eligible full text articles. After review of the completed texts, eight studies were excluded; leaving fourteen eligible RCT’s to be included in the review. No additional eligible RCTs were found by screening the references. In total, fourteen full text articles were included after the systematic review of the literature.

**Stretching and prevention**

The twelve included studies were grouped into 3 subgroups. The first subgroup was stretching with 3 studies (20, 15, 4). The primary outcome measures (15) were hamstring extensibility, passive shortening and strength for 4 weeks after passive stretching while Ben and Harvey, (2010) assessed the passive stretching of the hip and sensitivity of the pain using visual analogue scale 11-point after 6 weeks stretching sessions. A third author examined the frequency of injury as an outcome measure after 12 weeks of the stretching treatment (20).

**Effectiveness of eccentric exercise**

The effectiveness of eccentric exercises on muscle strength training with eccentric’s exercises performed on hamstrings with the use of a YoYo machine (2) in the intervention group for 10 weeks, 1-2 times a week, and no exercise for the control group. They recorded as outcome measurements the maximum strength of concentric and eccentric in isokinetic dynamometer at an angle of 60°/sec, the maximum speed timing within 30m and injury frequency before and after a period of 10 months. In addition, eccentric exercises (19) were used in the intervention group VS no exercises before the season starts (control group) for 10 weeks with a weekly program during the football season by recording the frequency of injuries during the 12-month season.

In two other studies (16, 11), tested the effectiveness of eccentric and concentric training. The first author (16) examined Nordic Exercises as an intervention group and leg curl exercises for the control group. They try to compare the eccentric strengthening Vs concentric strengthening on isokinetic dynamometer at 60°/sec and isometric angle contractions at 90°, 60° and 30°. Plyometric exercises Vs stretching was conducted in two groups (11), intervention and control, recording the frequency of hamstring injuries on both interventions.
**Efficiency of warm-up**

Preparation for athletic activity often includes warm up. A special warm-up program specialized for football designed from the medical research team of FIFA “The 11” was tested in adolescent female (24) and men footballer’s players (27). Their attempt was to record the frequency of injuries after the therapeutic intervention on injuries of lower limb and also assessed whether this pre-warming program improves the performance of athletes accessing the power in an isokinetic dynamometer and the agility of the athletes with functional tests (24).

Later on the warm-up program “The 11” having received the appropriate treatment and changes was presented as “The 11+” (25, 7) tested in adolescent’s men and female footballers aged 13-17 years and male basketball players (12), the frequency of injuries during the sports season.

**Recovery and rehabilitation**

Regarding the recovery of hamstrings only two studies were found. The latest intervention (1) which recorded the number of days that athlete needed to return back to the pitch, after loading the hamstrings during extensive lengthening during eccentric exercise (L-protocol) in injured athletes compared with stretching and strengthening with traditional resistance elastic bands (C-protocol).

The second and final intervention in the recovery (22) assessed and recorded the time of return of injured athletes, presenting a new effective rehabilitation program. This study compared static stretching with progressive resistance strengthening of hamstrings and progressive agility exercises with core stability (22).
Table 1
Summary of included studies

<table>
<thead>
<tr>
<th>Authors</th>
<th>Participants -groups</th>
<th>Treatment method</th>
<th>Outcome measures</th>
<th>Intervention</th>
<th>Effectiveness</th>
</tr>
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<tbody>
<tr>
<td>Daneshjoo et al, (2013)</td>
<td>3 groups:</td>
<td>11+ Vs Harmoknee Vs control group</td>
<td>Isokinetic testing on 30°, 60°, 90° angles of isometric power holding 5” MVC of quadriceps – hamstrings . 1 week before the intervention and 8 weeks after.</td>
<td>Programme 11+ 1. Running with active stretching. 2. six different sets of exercises to develop strength, balance, muscle control and core stability 3. running exercises combined with soccer-specific exercises. 20-25 minutes, 3 per week, 24 sessions Harmoknee warm-up exercises at low speeds, followed by muscle activation, balance, strength, and ends with core stability components. 20-25 minutes, 3 per week, 24 sessions Control group carry on with their regular warm-up and training throughout the study period</td>
<td>Yes</td>
</tr>
<tr>
<td>Study</td>
<td>Sample</td>
<td>Intervention</td>
<td>Outcomes</td>
<td>Exercise Details</td>
<td>Program Duration</td>
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<tr>
<td>Sherry et al, 2004</td>
<td>11 (9 Men) + 2 (Women)</td>
<td>Static stretching, isolated progressive hamstring resistance exercise, and icing (STST group) Vs progressive agility and trunk stabilization exercises and icing (PATS group)</td>
<td>Number of days for full return to sports, injury recurrence within the first 2 weeks, injury recurrence within the first year of returning to sports, and lower-extremity functional evaluations were collected.</td>
<td>(STST group) Phase 1: static stretching and isometric strengthening of the hamstrings. Phase 2: dynamic stretching was incorporated with concentric and eccentric hamstring strengthening. (PATS group) progressive agility and trunk stabilization exercises and icing. Daily program</td>
<td>Yes</td>
</tr>
<tr>
<td>Askling et al, 2003</td>
<td>2 groups (15 men)</td>
<td>Specific hamstring training Vs control group</td>
<td>1. Isokinetic hamstring strength on 60°/sec 2. Maximal running test 30m. 3. Injury frequency for 10 months Extra training for 10 weeks 1-2 times per week</td>
<td>Bilateral knee flexion in prone on flywheel with concentric and eccentric with action muscle lasted about 2.2s and 1.5s. 16 sessions of specific hamstring strength training every fifth day for the first 4 weeks and every forth day the last 6 weeks. 4 x 8 reps. 8 weeks preseason plus 10 months competition season. Control group same program only on the 10 months competition season</td>
<td>Yes</td>
</tr>
<tr>
<td>Gabbe et al 2006</td>
<td>intervention groups ( (n = 114) ) control groups ( (n = 106) ) Australian football players</td>
<td>intervention (eccentric exercise) or control group (stretching) groups</td>
<td>i. sudden onset posterior thigh pain; ii. tenderness on palpation; iii. with or without pain on stretch of the hamstring muscles; and iv. with or without pain on contraction of the hamstring muscles.</td>
<td>Intervention: five-session program over a 12-week period. First three sessions were undertaken during the final 6 weeks of the pre-season period. These three sessions were 2 weeks apart. The fourth and final sessions were completed over the first 6 weeks of the season and were 3 weeks apart. Program involves one exercise performed as 12 sets of six repetitions with 10 s rest between repetitions and rest periods of 2-3 min between sets (nordics exercises). Control group: program involved a group of stretching and range of movement exercise on i. gastrocnemius, ii. hip flexor iii. hamstring iv. Active Knee Extension or “90/90” stretch iv. hamstring stretch performed in sitting. v. Lumbar spine rotation performed in supine.</td>
<td>No</td>
</tr>
<tr>
<td>Study</td>
<td>Participants</td>
<td>Interventionarme</td>
<td>Outcomes</td>
<td>Intervention Group Results</td>
<td>Yes/No</td>
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<tr>
<td>Petersen et al. 2011</td>
<td>Intervention group (461 players) or a control group (481 players) Danish male professional and amateur soccer teams</td>
<td>Intervention group: 10-week progressive eccentric training program. Control group followed their usual training program.</td>
<td>Numbers of overall, new, and recurrent acute hamstring injuries during 1 full soccer season.</td>
<td>Intervention group performed 27 sessions of the Nordic hamstring exercise in a 10-week period during the midterm of the season.</td>
<td>Yes</td>
</tr>
<tr>
<td>Marshall et al. 2011</td>
<td>22 healthy students 14 (M) 8 (W)</td>
<td>Intervention group: 4 w. stretching program- 4 hamstrings and hip stretch for 5 times per week. Control group: no stretching</td>
<td>Hamstring injuries during 1 full soccer season (12 months)</td>
<td>Intervention group: 4 passive stretching exercises 5 times a week for a period of 4 weeks with 1 session per week, lying hamstring stretch, good morning stretch, lying and seated gluteus stretch. Control group: no stretching</td>
<td>Yes</td>
</tr>
<tr>
<td>Ben et al. 2009</td>
<td>30 intervention group 30 control group</td>
<td>Intervention group: passive stretching Control group: no stretching</td>
<td>Passive hip flexion pain sensitivity at the end of ROM. 6 weeks after the intervention.</td>
<td>Intervention group: Passive hip flexion with extended knee for 30 min five times a week for 6 weeks. Control group: received no stretch intervention to either leg</td>
<td>No</td>
</tr>
<tr>
<td>Mjolsnes et al 2004</td>
<td>11 (M) well trained players</td>
<td>Intervention group Eccentric group (Nordic exercises)</td>
<td>Two hold-relax hamstring contractions before the knee was extended passively with an 8-kg load, as measured with a fish scale. Warmed up by pedaling for another 5 min before doing three series of 20 heel-to-butt kicks and 10 high running steps strength testing protocol consisted of tests for concentric quadriceps strength, eccentric hamstring strength and isometric hamstring strength.</td>
<td>Eccentric group 1w. 1 session 10 RM test 2w 2 sessions 2 x 6 60% 3w. 3 sessions 3 x6x8 60–80% 4w. 3 sessions 3 x8x12 Progressive loading. Increase load by 2.5 kg when subject is capable of doing 3 x12 reps Traditional strengthening 1w. 1 session 2 x 5 2 2w. 2 sessions 2 x 6 3w. 3 sessions 3 x6x8 4w 3 sessions 3 x 8x10 5–10w. 3 sessions 3 sets, 12x10x8 reps Load is increased as subject can withstand the forward fall longer. When managing to withstand the whole ROM for 12 reps, increase load by adding speed to the starting phase of the motion. The partner can also increase loading further by pushing at the back of shoulders</td>
<td>Yes (Nordics exercises more effective)</td>
</tr>
</tbody>
</table>

<p>| Pope et al 1999 | 735 (M) intervention group 803 (M) control group soldiers | intervention group- stretch group control group - no stretch | Injury frequencies during the 12ws training | intervention group: stretching of gastrocnemius, soleus, hamstrings, quadriceps, hip adductors, hip flexor muscle group for 20sec. control group: no stretch | No |</p>
<table>
<thead>
<tr>
<th>Study</th>
<th>Number of Players</th>
<th>Intervention Group</th>
<th>Control Group</th>
<th>Intervention</th>
<th>Control Group</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Askling et al 2013</td>
<td>37 (M)</td>
<td>Intervention group</td>
<td>38 (M)</td>
<td>Intervention</td>
<td>Control group</td>
<td>Swedish elite football players</td>
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<td></td>
<td></td>
<td>lengthening exercises (L-protocol)</td>
<td>conventional exercises (C-protocol)</td>
<td>Number of days to return to full-team training and availability for match selection. Reinjuries were registered during a period of 12 months after return</td>
<td>L-protocol specifically aimed at loading the hamstrings during extensive lengthening, mainly during eccentric muscle actions. L-1 ‘The Extender’. L-2 ‘The Diver’. L-3 ‘The Glider’. C-protocol consisted of conventional exercises for the hamstrings with less emphasis on lengthening. C-1 Stretching—contract/relax. C-2 Cable-pendulum. C-3 Pelvic lift.</td>
<td>Yes</td>
</tr>
<tr>
<td>Soligard et al 2008</td>
<td>1055 (W)</td>
<td>intervention group</td>
<td>837 (W)</td>
<td>Intervention</td>
<td>Normal warm up</td>
<td>Norwegian players aged 13-17.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11+ warm up program</td>
<td></td>
<td></td>
<td></td>
<td>Injuries to the lower extremity (foot, ankle, lower leg, knee, thigh, groin, and hip)</td>
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<td></td>
<td></td>
<td>control group</td>
<td></td>
<td></td>
<td></td>
<td>intervention group improve awareness and neuromuscular control during standing, running, planting, cutting, jumping, and landing. We encouraged the players to concentrate on the quality of their movements and put emphasis on core stability, hip control, and proper knee alignment to avoid excessive knee valgus during both static and dynamic movements. Control group: warm up as usual during the season</td>
</tr>
<tr>
<td>Study</td>
<td>Intervention Group</td>
<td>Control Group</td>
<td>Intervention Outcomes</td>
<td>Control Outcomes</td>
<td>No. of Teams/Players</td>
<td></td>
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<tr>
<td>Van Beijsterveldt et al 2012</td>
<td>Intervention (n=11 teams, 223 players)</td>
<td>Control (n=12 teams, 233 players)</td>
<td>i. Injury incidence per 1000 h of soccer participation  ii. Exposure and all soccer injuries were recorded during the 2009-2010 competitive season</td>
<td></td>
<td></td>
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<tr>
<td>Steffen et al 2008</td>
<td>Intervention (n=18)</td>
<td>Control (n=16)</td>
<td>Tests included isokinetic and isometric strength protocols for the quadriceps and hamstrings, isometric hip adduction and abduction strength, vertical jump tests, sprint running and soccer</td>
<td>Tests included</td>
<td>Adolescent female football players Norway 16-18 years (17.1 ± 0.8)</td>
<td>No</td>
</tr>
</tbody>
</table>
Longo et al 2012

Seven teams were allocated to the intervention group (80 players; mean [SD] age 13.5 [2.3] years), and 4 teams were allocated to the control group (41 players; mean [SD] age 15.2 [4.6] years). Intervention group receive a program of warm-up exercises used to prevent injuries and enhance performance “The 11+” control group to warm up as usual during the season. Any injury to the athletes also collected the type of exposure (match or training), location in the body, and type of injury (acute or overuse). The secondary outcomes were any injury to the lower extremity (foot, ankle, lower leg, knee, thigh, groin, and hip). Intervention group i. running exercises at slow speed combined with active stretching and controlled contacts with a partner. The running course included 6 to 10 pairs of cones. ii. including strength, balance, jumping exercises, and Nordic hamstring exercises. The final part was speed running combined with basketball-specific movements with sudden changes in direction. Control group usual warm up. Yes

DISCUSSION

The aim of this systematic review was to evaluate current evidence on effectiveness of prevention methods and rehabilitation of the hamstring injuries.

The review of the available evidence clearly demonstrates that eccentric exercises (Nordic Exercises) are the most effective method of hamstring strengthening and thus preventing injuries. Studies also suggest that stretching alone is not a useful tool for prevention or for rehabilitation (20,15,4) while a good warm-up program with stretching (The 11+) can reduce the incidences of injuries (25,7,12).

It has been reported (16) that the exercise for 10 weeks with eccentric contraction exercises vs concentric contraction exercises showed 11% increase of hamstring power in isokinetic dynamometer in angular velocity 60°/sec concentric and 7% in isometric contraction of 5s. in an angular of 90°, 60° and 30°, in contrast to a study which examined the strength differentiation of the quadriceps muscle resulting from closed and open kinetic chain exercises. The open kinetic chain exercise is the most effective method strengthening the quadriceps than the closed kinetic chain (27).
The effectiveness using eccentric exercises as a mean of injuries reduction or recurrent injuries proved by few studies (19, 2).

Although there is evidence of the effectiveness of eccentric on prevention, no different was founded in a study using the eccentric contraction as strengthening method of injury prevention (11). This is because study failed to present results due to low compliance rate in the drill program and the inability of participants to complete the process due to abandonment cause of the delayed onset muscle syndrome (DOMS) on hamstrings.

Warm-up program "The 11" did not provide significant results in prevention and the power outcome of hamstring muscle with eccentric's exercises (24, 27). The ineffectiveness of these studies may well be due to the large number of drop outs and poor compliance of the participants.

In contrast the "The 11+" showed significant results in injury prevention with eccentric exercise (7, 25, 12). The significant difference between the two warm up programs was the continuous progressive strengthening way of exercise during eccentric exercises reducing the risk of delayed onset muscle soreness (DOMS) symptoms. Avoiding symptoms eccentric exercises helps to increase muscle strength (7, 25, 12).

Searching for the effectiveness of stretching we have found that stretching as a prevention method before exercise (20) had no impact on the frequency of injuries. Also regular stretch does not change muscle extensibility in healthy subjects, however, stretch resulting in apparent increases in joint range of motion (4). Normal range of motion after stretching can often be the most effective therapeutic intervention. Physiological kinematic of a joint with normal range of motion and muscle length results to normal movement and function of muscle groups and articulation.

Our review also suggests that stretching doesn’t improve muscle power. In a study where participants were randomly allocated in one of two groups, intervention (stretching group) and control (no stretch), resulted no effectiveness on power testing 4 weeks after the intervention on isokinetic dynamometer machine on 30°/sec and 120°/sec (15).

It’s obvious that sports community all around the world refers to FIFA medical research team or big clubs medical teams spent more time searching the prevention methods of hamstrings instead of rehabilitation. This is reflected by the significantly small number of studies found which refer to the rehabilitation of hamstring injuries.

Two studies in this investigation were found regarding rehabilitation of hamstring injuries. One approach compared the effectiveness, in both groups with hamstring injuries, with the first group to receive treatment as static stretching with progressive resistance exercises and ice (STST GROUP) and the second group progressive agility and trunk stabilization exercises plus ice (PATS GROUP) as an
intervention, concluded that the agility exercises with stabilization exercises of the trunk and ice are more effective in time return of the athletes on the field and with less risk of another injury in an average return on 22,2 ± 8,3 days unlike 37,4 ± 27.6 days. One of the key of disadvantages of this trial was the first small sample of participants (11 and 13 individuals of each group respectively). Additionally and no attempt was made to measure the stability of the trunk so as to come to the conclusion that core stability use as preventive role in hamstring injuries.

In a different kind of intervention (1) the author separated two intervention groups with the first to receive as a treatment a protocol that focused on lengthening exercises (L-protocol) as «The extender», «The diver» and «The Glider» demonstrated that this program is more effective comparing the number of days for the return of the athletes on the field than the protocol which the second group received with conventional stretching exercises (C-protocol), hold and relax, isometric strength training with elastic resistance, and isometric contractions by lifting the pelvis on one leg (bridge single-leg). The average days for return of athletes who followed (L-protocol) was 28 days while in (C-protocol) was 51 days. Another important issue that this research indicated was that the type stretch muscle strain needed more time for recovery and return to the field in relation to the speed strains types in the two intervention groups (1).

A limitation of this research was the initial separation of the participants which was based on sex and strain type (stretching or speeding) and not based on the severity of the injury, degree of the strain (e.g. Grade 1 or 2).

CONCLUSION

Based on our findings eccentric exercise seems to have an important role in the prevention of hamstring muscles injury. Eccentric exercises also have an important role to the improvement right after hamstring injury using them as a rehabilitation program of hamstring muscles. Finally our study shows the effectiveness of reducing significantly the risk of another injury. A rehabilitation program including exercises mainly of stretching with eccentric loading of muscles and also a stabilizing program for the core including progressive agility exercises were found to be the most effective means of healing hamstring injuries. In conclusion, further research is needed to investigate new methods improving the prevention and rehabilitation of hamstring injuries.
REFERENCES


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