ABSTRACT

Background: Stretching to hamstring muscles to improve the flexibility is routine programme in football players. Hamstring tightness is one of the predisposing factors in producing soft tissue injuries to the lower limbs in these players. Among the different stretching techniques, passive static stretching is commonly used to treat this tightness. But nowadays eccentric stretching is performed to improve the flexibility of hamstring tightness. This study compares the effect of these two stretching techniques in improving flexibility in football players. Methods: Thirty (30) football players from first divisional club with unilateral hamstring tightness were divided into three groups of 10 subject each. Group–A passive static stretching, Group – B eccentric training and Group – C combination of passive static stretching and eccentric training. Each group received intervention for a total of 6 weeks. The outcome measures were assessed by Sit and Reach Test. Result: The analysis of data indicated that improvement in hamstring tightness was seen in all three groups as measured by sit and reach test. But on comparison of these three groups, group C showed better result than the other two groups (p< 0.01) Conclusion: Combination of static stretching along with eccentric stretching is effective than static stretching alone in improving the hamstring flexibility in football players.

Keywords: Hamstring flexibility, Passive static stretching, Eccentric training.

INTRODUCTION

Football is considered by many to be the most popular sport in the world and is played by at least 200 million licensed players. Physiologically, football game is characterized as a high-intensity, intermittent, non-contiguous exercise. About one-fourth of football injuries are musculoskeletal lesions mainly located in the thigh (17%) and the groin (8%). A large percentage of the game is performed at maximum speed, and the functional activities include accelerations, decelerations, jumping, cutting, pivoting, turning, and kicking of the ball. It has been found that as many as 68% to 88% of all football injuries occur in the lower extremities. Poor flexibility of hamstrings is one of the pre disposing factor for injury of this muscle group. Muscular flexibility is an important aspect of normal human function. Limited flexibility has been shown to predispose a person to several musculoskeletal overuse injuries and significantly affect a person’s level of function.

Hamstring plays an important role in managing the stride length during running, if the stride length is longer, then fewer contraction cycles are needed to cover the same distance. This equates to a conservation of energy, allowing for greater all longer performance prior to fatigue and a reduction in chance of injury. Muscle tightness is caused by a decrease in the ability of the muscle to deform, resulting in a
decrease in the range of motion at the joint on which it acts. Muscle tightness usually results from inadequate or improper rehabilitation following sustained muscle injury or low levels of physical activity in individuals. Tight hamstrings are proposed to be one of the main causes of hamstring strains. Hamstring tightness is defined as 30 degree loss of active knee extension with femur held at 90 degree of hip flexion.

Tight hamstring muscles increase the patellofemoral compressive force because of the increased passive resistance during the swing phase of ambulation and running. Decreased hamstring flexibility is a risk factor for development of patellar tendinopathy and patello-femoral pain. Hamstring tightness has been reported to be the cause of posterior pelvic tilting, reduced lumbar lordosis and exacerbation of existing pain in patients with low back pain.

Static stretching is one of the safest and most commonly performed stretching methods used to increase muscle length. This type of stretch is applied slowly and gradually at a relatively constant force to avoid eliciting a stretch reflex. The literature supports that a static stretch of 30 seconds at a frequency of 3 repeated stretches per single session is sufficient to increase muscle length. It is a commonly used method of stretching in which soft tissues are elongated just apart the point of tissue resistance and then held in the lengthened position with a sustained stretch force over a period of time. Eccentric training that allows the muscle to elongate naturally and in its relaxed state, this elongation is achieved by having the subjects eccentrically contract the antagonist muscle to move the joint through the full available range in slow controlled manner to stretch the agonist muscle group. Eccentric resistance exercise may prevent injury to the muscle tendon unit by improving the muscle’s ability to absorb more energy before failing. It is a better training strategy to improve the flexibility and also able to increase in strength and protect against muscle damage.

To prescribe suitable rehabilitative measures, it is necessary to know the effects of stretching on range of motion, but also to learn about the effects of stretching and eccentric training on muscle flexibility. Therefore, the purpose of the study was to combine the effect of passive static stretching along with eccentric training to improve flexibility of hamstrings.

**MATERIAL AND METHODS**

Thirty young male football players randomly selected from various professional clubs in Thiruvananthapuram district of Kerala state in India were selected for the study. The need and significance of the study was explained to the players and consent form for participation was obtained prior to data collection. The primary inclusion criteria was the presence of unilateral Knee Extension Angle (KEA) >20°. Subjects who had an acute or chronic low back pain, hamstring tightness with pain, soft tissue injury, fracture, arthritis and inflammatory joint conditions were excluded. The ethical clearance was obtained from the Calicut University and study was conducted from January 2010 to September 2010.

**Data Collection Procedure**

Prior to study a consent letter was obtained from team management in order to conduct the study. Consent was obtained from 30 participants agreeing to participate in the study and they were screened for inclusion and exclusion criteria. The subjects were divided into three groups, Group A (Passive Static Stretching), Group B (Eccentric training) and Group C (Combined Protocol of passive static stretching and eccentric training). They were grouped by randomized design. Pretest measurements were taken using goniometry for Knee Extension Angle (KEA) and sit and reach test for hamstrings flexibility prior to the stretching. Each group undergone prescribed stretching method according to the protocol specified for 6 weeks. The post test measurements were obtained after 6 weeks.
**Passive static stretching protocol.**
1. Subject is positioned supine on a treatment plinth and instructed to relax as the examiner performed the stretch.
2. To stretch the right and left hamstrings, the hip was passively flexed to 90 and the knee passively extended until the subject report a strong but tolerable stretch.
3. The contra lateral extremity remained flat on the plinth.
4. The Static stretch has to be maintained for 30 seconds at a frequency of 3 repeated stretches per single session with 10 seconds rest interval between each stretch.
5. Perform 3 sessions in a week and continue for 6 week.

**Eccentric training protocol**
1. The subject lay supine with the contra lateral leg fully extended.
2. A piece of (3 feet) (0.91-m) black Theraband was wrapped around the heel and the subject held the ends of theraband in each hand.
3. Subject was instructed to keep the treatment knee locked in full extension and the hip in neutral internal and external rotation throughout the entire activity.
4. The subject was then instructed to bring the treatment leg into full flexion by pulling on the theraband attached to the foot with both the arms making sure the knee remained locked in full extension at all times.
5. As the subject pulled the hip in to full flexion with the arms, he was instructed to simultaneously resist the hip flexion by eccentrically contracting the hamstrings muscle during the entire range of motion of hip flexion.
6. The subject was instructed to provide sufficient resistance with the arms to overcome the eccentric activity of hamstring muscle.
7. The entire hip flexion took approximately five seconds to complete.
8. Then the extremity was gently lowered to ground by the subjects arm.
9. This procedure was repeated 6 times with no rest between repetitions, thereby providing a total of 30 seconds of stretching at the end range.
10. Perform three sessions in a week for 6 week.

**Combined protocol for passive static stretching and eccentric training.**
Subject is positioned supine on a treatment plinth and instructed to relax as the examiner performed the stretch.
1. To stretch the right and left hamstrings, the hip was passively flexed to 90 and the knee passively extended until the subject reports a strong but tolerable stretch.
2. The contra lateral extremity remained flat on the plinth.
3. The Static stretch has to be maintained for 30 seconds at a frequency of 3 repeated stretches per single session with 10 seconds rest interval between each stretch.
4. The subject lay supine with the contra lateral leg fully extended.
5. A piece of (3 feet) (0.91-m) black theraband was wrapped around the heel and the subject held the ends of theraband in each hand.
6. Subject was instructed to keep the treatment knee locked in full extension and the hip in neutral internal and external rotation throughout the entire activity.
7. The subject was then instructed to bring the treatment leg into full flexion by pulling on the theraband attached to the foot with both arms, making sure the knee remained locked in full extension at all times.
8. As the subject pulled the hip in to full flexion with the arms, he was instructed to simultaneously resist the hip flexion by eccentrically contracting the hamstrings muscle during the entire range of motion of hip flexion.
9. The Subject was instructed to provide sufficient resistance with the arms to overcome the eccentric activity of hamstring muscle.
10. The entire hip flexion took approximately five seconds to complete.
11. Then the extremity was gently lowered to ground by the subjects arm.
12. This procedure was repeated 6 times with no rest between repetitions, thereby providing a total of 30 seconds of stretching at the end range.
13. Perform three sessions in a week for 6 week

Outcome Measure:
Sit and reach test
The test involves sitting on the floor with back and head against the wall, legs stretched out straight ahead. Shoes are removed and the sole of feet are placed flat against the box. Both knees should be locked and pressed flat on the floor with the palms facing downwards and the hands on top of each other side by side. Subject reaches forward along the measuring line as far as possible. Ensure that the hands remain level at the same one reaching for the forward than the other. After some practice reaches, the subject reaches out and holds the position as for at one- two seconds while the distance is recorded. Make sure there are no jerky movements

Data Analysis
Data was analyzed using SPSS version 17.0 for windows with t-test, ANOVA and post hoc LSD test. The significance level was kept at p<0.05.

RESULTS
Independent t-test values indicated significant increase in hamstrings flexibility as measured by sit and reach test in subjects after the treatment in all the three groups; group A-passive static stretching (p≤ .001), group B-eccentric training (p ≤0.001) and for group C - combination of passive static stretching along with eccentric training (p ≤ 0.001).

DISCUSSION
The reviews of existing literature in the role regarding the different techniques in improving hamstring flexibility reveals a confusing picture so as to which technique out of eccentric training and passive static stretching is best for the purpose. So the current study was undertaken to investigate the effectiveness of a combined protocol of eccentric training along with passive static stretching on hamstring flexibility in football players.
A comparison of the pre-post test values of sit and reach test for the groups shows that there is significant improvement in all the three groups. Thus it may be said that these techniques are effective individually in improving hamstrings flexibility in football players. But comparing the effectiveness among the three groups, the individuals who got combination of passive static stretch and eccentric stretch experienced a better flexibility in their hamstring muscles than the players who received the these techniques individually. Thus it is evident from this study that the combination of stretching techniques of static and eccentric type is ideal in improving the hamstring flexibility in football players.
The increase in range of motion and flexibility often reported after the combination of stretching techniques involves the biomechanical, neurological and molecular mechanisms. The biological and molecular
consequences of the application of stretch to muscle appear to be known. Force transmission is likely to occur through a chain of protein-protein interactions and may lead to a chain of biological signals and ultimately to myofibrillogenesis. The potential mechanisms may be the phosphorylation of integral membrane proteins and associated cytoskeletal molecules, the secretion of selective growth factors, regulated by an autocrine or paracrine mechanism, and changes in the intracellular ion flux through stretch-activated ion channels.

The scientific basis of the combination of stretching techniques may actually be found in the cellular and molecular adaptive mechanisms of a muscle fiber. When a substance is exposed to a passive force (stretch), it will deform according to its material properties, and when a relatively low force is sustained for a long period of time, most materials will deform in a time-dependent manner. This creep property is a result of the visco-elastic properties of the material. Nearly all tissues exhibit this property including muscles. The mechanism behind the increased flexibility with eccentric hamstring activity through the full range of motion is unclear. Skeletal muscle has a large adaptation potential induced by eccentric contraction and morphological changes are related to addition of sarcomeres in series and this could be an reason in improvement of hamstring flexibility after eccentric stretching.

Thus whatever may be biomechanical explanations for the improvements in the hamstring flexibility following static and eccentric stretch, hamstring muscle flexibility less than 20˚ in football players is serious matter of concern as it can lead to significantly higher risk for sports injuries. To overcome this, these players should be encouraged to stretch the hamstring muscles both statically and eccentrically as routine event along with the warm up sections of practices.

Even though the study was done as methodologically sound as possible, certain limitations couldn’t avoided. The study was done on young male football players and the sample size was small. Also only one outcome measurement was taken. Hence authors suggest that further studies can be done on female population and also on other sports rather than football with larger sample size and additional outcome measurements.

CONCLUSION
A combined protocol of passive static stretching and eccentric training can be advocated for improving the hamstrings flexibility in football players thereby preventing the tightness related muscle injuries for the players.

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REFERENCES
5. Chomiak J, Junge A and Peterson L.
Table I: Represents the mean of pre-post test measurements for each group for the variable Sit and reach test.

<table>
<thead>
<tr>
<th></th>
<th>Pre Test Score</th>
<th>Post Test Score</th>
<th>Mean Difference</th>
<th>df</th>
<th>t Value</th>
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<tbody>
<tr>
<td>Group A</td>
<td>18.1</td>
<td>25.7</td>
<td>7.6</td>
<td>9</td>
<td>20.48**</td>
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<tr>
<td>Group B</td>
<td>18.1</td>
<td>21.8</td>
<td>3.1</td>
<td>9</td>
<td>9.86**</td>
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<tr>
<td>Group C</td>
<td>18.4</td>
<td>30.1</td>
<td>11.7</td>
<td>9</td>
<td>27.66**</td>
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Table II: Summary of the ANOVA for the scores of sit and reach test in group A, B and C

<table>
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<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F Ratio</th>
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<tr>
<td>Between Groups</td>
<td>88.47</td>
<td>2</td>
<td>44.23</td>
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<tr>
<td>Within Group</td>
<td>139.4</td>
<td>27</td>
<td>5.16</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>227.87</td>
<td>29</td>
<td></td>
<td>8.57**</td>
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</table>

Significant at 0.001 level

Table III: Summary of the LSD for the scores of sit and reach test in group A, B and C

<table>
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<th>Pair</th>
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<td>Group B C</td>
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<td>Group B C</td>
<td>4.2</td>
<td>1.02</td>
<td>0</td>
</tr>
</tbody>
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Figure I: graphical representation of mean differences of pre and post test measurements of sit and reach test.