Comparison of effect of Eccentric Training Versus Static Stretching on Hamstring Flexibility

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ABSTRACT

Purpose: To Compare the effect of eccentric training versus static stretching on hamstring flexibility in healthy male subjects

Design: We used a pre-test, post- test experimental group design where subjects were randomly assigned into 3 groups-static stretching, eccentric training and control group.

Subjects: 45 subjects (males) ranging in age from 18 to 25 years with limited hamstring muscle flexibility (i.e. at least 20º of knee extension deficit with hip at 90º of hip flexion).

Methods and Measures: Hamstring flexibility was measured using knee extension ROM and Sit and Reach test before training and at the end of 3rd and 6th week. Both static stretching and eccentric training group performed training for 3 days in a week for 6 weeks, while control group did not performed any training. Data was analyzed using one way ANOVA with post hoc Bonferroni for ROM and Kruskal Wallis with post hoc Mann Whitney for SRT.

Results: The data analysis revealed that there was significant improvement in hamstring flexibility after both static stretching and eccentric training group, but not in the control group. Significant improvement was obtained in both static stretching (ROM 11.83º, SRT 4.22cm) eccentric training (ROM 11.13º, SRT 4.05cm) but not in control group (ROM 0.3º, SRT 0.3 cm). No significant difference was found between both experimental groups.

Conclusion: Eccentric training group and static stretching group both showed significantly greater gains in flexibility than control group. There was no significant difference between eccentric training and static stretching on hamstring flexibility in healthy young males.

Key: ROM-range of motion, SRT- Sit and Reach test

INTRODUCTION

Each year, sports activities lead to numerous injuries resulting in decrease in physical activity, work time lost in addition to substantial medical costs. Muscle strain injuries of lower extremity are common in high intensity sports involving sprinting such as football; hamstring strains being most common and problematic.[1]

Out of various risk factors identified, poor flexibility is one of the modifiable intrinsic risk factor in hamstring strains.[2]

Flexibility is an essential element of normal biomechanical functioning in sports, therefore therapists incorporate exercises designed specifically to improve flexibility of musculotendinous structure. To improve flexibility, for rehabilitation after injury and promotion of healing, [3] improved muscle or athletic performance[4] stretching has been recommended.

Various methods of stretching are Static, Ballistic and variations of Proprioceptive Neuromuscular Facilitation (PNF). Static stretching is applied slowly and gradually at a relatively constant force to avoid eliciting a stretch reflex, therefore it is safest and most commonly used method in improving flexibilty[5]

Another method used in preventive care or rehabilitation of musculotendinous strain is eccentric exercise,[6] as it is the last line of defense against muscle injury and ligament disruption.[7] Hamstring muscles are commonly injured when working eccentrically while decelerating or landing.[8] Muscles have an ability to adapt rapidly following damage from eccentric exercise [9], so this can be clinically applied for protecting a muscle against more major injuries with minimal increase in metabolic demand.[10]

As, eccentric contractions are lengthening contractions, the stretching component of eccentric training may have an influence on elastic properties of tendon,[11] it can also be used as a means to improve flexibility. [12]

Although earlier groups have examined various forms of stretching and dynamic range of motion training as a means to improve flexibility, an activity that has been addressed to a limited extent for achieving improvement in flexibility is eccentrically training the muscle through a full range of motion. Therefore the purpose of our study is to determine whether there is an improvement in hamstring flexibility after 6 weeks of eccentric training as compared to static stretching and no exercises.

MATERIALS AND METHODS

SUBJECTS

Subjects were recruited on the basis of following criteria (a) 18 to 25 age group (b) no current disease or disorder of hip, knee, thigh, lower back, upper extremity from last 6 months (c) tight hamstrings - defined as at least 20 degrees of knee extension deficit with hip at 90 degrees of flexion[13] (d) no involvement in any exercise program for trunk or lower extremity [5] (e) no neurological disorder. 45 subjects met the criterion and participated in the study. They were volunteers and signed an informed consent.

EQUIPMENTS

Hamstring flexibility was measured using Goniometer [5] and Sit and Reach box.[14] Universal Goniometer, which was double armed; full circle protractor made of transparent plastic was used. Standard Sit and Reach box made of wood, of 12 inches height was used.

PROTOCOL

45 Subjects were randomly assigned into three groups-static stretching (n-15), eccentric training (n-15) both as experimental group and third as control group (n-15). Dominant leg was chosen for the study.

On day 1, before commencement of training protocol, ROM and SRT readings were recorded and considered as baseline measurement. Following this, both experimental groups performed their respective training protocol consisting of 3 days in a week for 6 weeks, while control group did not perform any training program. If a subject missed a schedule session, he made up the session on another day during the same week. Any subject who missed more than 4 days of training was eliminated from the study. Next measurements were obtained at the end of 3rd weekand 6th week. Each reading was taken 3 times and their average was recorded as final score.

PROCEDURE

TESTING

For measuring ROM, Goniometer was centered over lateral epicondyle of femur; arms were aligned with greater trochanter of femur as proximal landmark and lateral malleolus of tibia as distal landmark. Subjects wore shorts and were positioned supine with the hip and knee of dominant leg flexed to 90 degrees. The leg was moved passively toward terminal knee extension and measurement recorded. Terminal knee extension was the point at which a firm resistance was felt. [5]

Sit and Reach test score was measured using Modified Sit and Reach test.[15]A sliding ruler with markings was centered on top of box so that 0 cm mark represented the point at which subjects' fingertips were in line with their toes. Subject sat on the floor with back and head against the wall, knees fully extended, ankles in neutral dorsiflexion. They placed one hand on top of the other and stretch towards the box. The ruler was slided on the box and zero end was moved towards subject's fingertips. The point at which ruler touched the fingertips was considered as zero point i.e. initial position. Subjects then leaned forward as far as possible moving along surface of box, keeping the knees extended. This point was considered as the final point and reading was recorded. The difference between final and initial position of reach was measured. [14]

INTERVENTION

After testing, subjects in static stretching group (n-15) performed the hamstring stretch for30 secs by standing erect with the non dominant foot on the floor and the toes pointing forward. The heel of the foot to be stretched was placed on a chair with the toes directed toward the ceiling. Subject then flexed forward at the hip, maintaining the spine in a neutral position and knees extended and continue to flex at the hip until a gentle stretch was felt in the posterior thigh. This position was maintained for 30 seconds.[5] 6 repetitions per session, with 10 seconds of rest between each repetition and one session in a day was performed.

In Eccentric training group (n-15), subject lay supine with the non dominant leg fully extended. Dominant

leg was locked in full knee extension, hip in neutral internal and external rotation. 3-ft piece of black theraband was wrapped around the heel with ends of the theraband held in each hand. Subject then brought the dominant hip into full hip 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. Full hip flexion was defined as the position of hip flexion at which a gentle stretch was felt by the subject. As the subject pulled the hip into full flexion with the arms, he was instructed to simultaneously resist the hip flexion by eccentrically contracting the hamstring muscles during the entire range of hip flexion. The subject was instructed to provide sufficient resistance with the arms to overcome the eccentric activity of the hamstring muscle, so that entire range of hip flexion took approximately 5 seconds to complete.

This flexed hip position was held for 5 seconds, and then the extremity was gently lowered to the ground (hip extension) by the subject's arms.[12] 6 repetitions per session, with 10 seconds of rest between each repetition and one session in a day was performed.

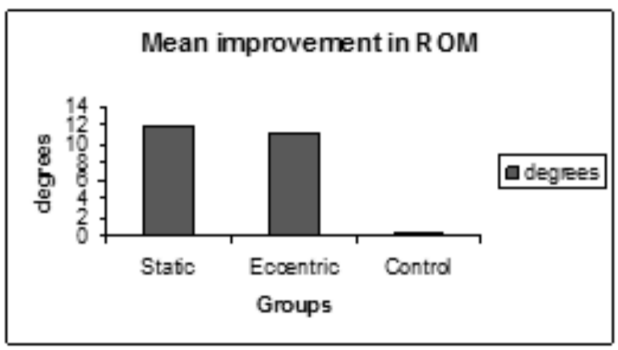
Control Group (n-15), did not perform any training.

DATA ANALYSIS

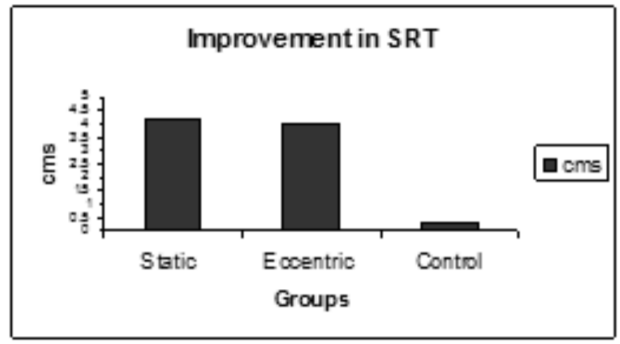
Mean and standard deviation of age, height, weight, BMI, were calculated for all the subjects. We used one way ANOVA with Post Hoc Bonferroni for ROM, Kruskal Wallis test with Mann –Whitney for post hoc analysis for SRT. The tests were applied at 95 % confidence interval and p value at 0.05. The data analysis was performed using STATA 9.0 software package.

FINDINGS

Forty five subjects with a mean age 22.2 ± 2.32, weight 62.75 ± 5.00, height 171.44 ± 5.28, and BMI 21.22 ± 1.70 completed all requirements for the study. The gains in knee extension ROM were static stretching group (11.83), eccentric group (11.13 degrees), control group (0.3) as shown in Graph1. SRT score in static stretching group (4.22cm), eccentric group (4.05cm), control group (.27cms) as shown in Graph2.



Graph: 1 Improvement in Range of Motion after 6 weeks



Graph: 2 Improvement in Sit and Reach Test scores after 6 weeks.

DISCUSSION

The results suggested that eccentric training group and static stretching group both showed significantly greater gains in flexibility than control group. There was no significant difference in knee extension ROM and SRT score between both exercise groups, thus suggesting that eccentric training and static stretching appears to be equally effective in increasing hamstring flexibility. To our knowledge, till date only few studies have investigated the effect of eccentric training on changes in muscle flexibility. Nelson et al, supported our results that there was improvement in hamstring flexibility after 6 week protocol[12]. Similarly Mahieu et al, also observed an increase in dorsiflexion range of motion after eccentric training of plantarflexors for 6 weeks.[16]

Improvement in flexibility in Static Stretching group

The gains in knee extension ROM in this group is quite similar to previous longitudinal studies conducted for 6 weeks and with 30 seconds as stretch duration. Bandy et al in his studies examined the effect of static stretching where the gains of 12.50°, [5] 11.50° [17] and 11.42° [18] of range were consistent with our findings.

There was also significant improvement in Sit and Reach measurement. But the values obtained in our study in static stretching group of 4.22 cm were in partial agreement with those obtained by Draper et al, i.e.6.06 cm. This could possibly be due to use of diathermy as heating modality in later study.[19] As heated collagen causes increased extensibility and allows for more plastic deformation of tissues when stretched, possibly leading to more improvement in hamstring flexibility and hence increased Sit and Reach score.

Improvement in flexibility in eccentric training group

ROM in this group also showed a significant improvement which is in agreement with previous study by Nelson et al, where almost similar gains of

12.79° was observed.[13] Improvement in dorsiflexion range of motion after Eccentric training of plantar flexors for 6 weeks was also observed by Mahieu et al. [16]

Our results did not match with the study conducted by Silbernagel et al, where there was no improvement in dorsiflexion range of motion after 12 weeks of eccentric training of plantarflexors.[20] This can be attributed to inclusion of healthy subjects in our study as opposed to Achilles tendinopathy patient in later study.

Sit and Reach score measurement also showed significant improvement of 4.05 cm .But we could not compare our results with any other study, because of paucity of evidence.

Mechanisms for improvement in flexibility through eccentric training remain unclear but it can be possibly explained on the physiological basis of muscle adaptation. As Eccentric exercises involve active lengthening of the muscle tendon unit, or myofibrils which occurs nearly by popping of sarcomeres one at a time, followed by near uniform lengthening of sarcomeres. Accompanied by lengthening there is also increase in number of sarcomeres[21] which occur in series and makes muscle more compliant[22] and hence theoretically can improve flexibility.

Comparison of static stretching group and eccentric training group in improving flexibility

Static stretching and eccentric training group both produces almost similar gains in flexibility but eccentric training offers a more functional option for flexibility training. Low volume eccentric training is associated with little muscle damage, faster recovery, more adaptation and protection against injury,[23] hence the protocol used in our study can be incorporated as a part of flexibility program. However, the preventive effect of a conservative eccentric training as in our study needs further research validation.

LIMITATION AND FUTURE RESEARCH

Our study was performed on limited number of subjects and included only healthy young males so the results cannot be generalized to persons outside the sample population.

Future research needs to be carried out on a large sample and also needed to verify long term effect of these protocols, particularly with respect to injury prevention and improvement in athletic performance.

CONCLUSION

The result of this study shows that eccentric training group and static stretching group both showed significantly greater gains in flexibility than control group. There was no significant difference between eccentric training and static stretching on hamstring flexibility in healthy young males.

ACKNOWLEDGEMENTS

I would like to thank my guides and my colleagues and a special thanks to all my subjects.

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