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ORIGINAL ARTICLE

COMPARATIVE STUDY BETWEEN MUSCLE ENERGY TECHNIQUE AND ECCENTRIC TRAINING IN IMPROVING HAMSTRING MUSCLE FLEXIBILITY AND PERFORMANCE IN MALE COLLEGE ATHLETES

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ABSTRACT

Background: Hamstrings muscles are large, long muscle located on back of the thigh which acts upon two joints, the hip and knee. The functions of the hamstring muscles are knee flexion and hip extension. Lack of hamstring flexibility and strength is the most important characteristic of hamstring injuries in athlete's. Purpose of this study was to investigate compare the effectiveness of Muscle Energy techniques and eccentric training to improve Hamstring muscle performance and flexibility tightness in college male athletes. **Methods:** sixty subjects with age group 18-25 were recruited in this study. The subjects were divided into two groups Group A (Experimental1) and Group B (Experimental2). Group A underwent muscle energy technique and Conventional treatment, Group B underwent eccentric training and Conventional treatment. Interventions were conducted over a period of 5 days. All subjects were assessed for pain flexibility using hand active knee extension test and performance using single leg hop test before and after intervention period. **Results:** The data was analyzed through paired test for comparing pre and posttest values of the active knee extension and single leg hop within both group and Independent t test for comparison of data between the two groups. Results of this study show that Muscle Energy techniques and eccentric training improves Hamstring muscle flexibility and performance in college male athlete's. **Conclusion:** Muscle energy technique is more effective than eccentric training in improving hamstring muscle tightness and performance in college male athletes.

Keywords: Muscle Energy Techniques, Eccentric training, Active knee extension test, Single hope length test

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INTRODUCTION

Dynamicity of human body is essential for healthy living, which is important to reduce health care costs, and is a major concern for physical therapists. The ability of an individual to move smoothly and perform correctly depends on his flexibility or the range of motion of that particular joint. Flexibility is the indisputable component of fitness, which can be defined as the ability to move a joint through a normal range of motion without producing stress to the musculo-tendinous unit. It enhances both safety and optimal physical activity¹⁰.

Enhanced flexibility is desirable in synovial joint for a number of reasons. These include increased reach distance, increased stride length etc, and thus a repeated activity over a fixed distance/displacement results smaller number of contraction cycles¹¹.

Activation and deactivation of muscle consumes energy over and above force production and therefore in fewer times, muscle is turned on and off, the less energy is consumed. When muscles are allowed sufficient time to accelerate and decelerate limb segments, connective tissue are spared and are therefore less prone to rupture. Thus enhanced flexibility is associated with improved movement economy and reduced risk of injury¹¹.

Hamstring muscle is one of the commonest muscles that often get tight. Hamstring tightness increases apparently from childhood up to age 40-49 years and its incidence is higher in males than females². The major aetiological factors in musculoskeletal injuries are considered to be due to muscle stiffness of the lower extremity and the consequential

decrease in joint flexibility. The ability of the muscle to lengthen allowing one joint (or more than one joint) to move through the range of motion is due to the flexibility of the muscle. If a muscle has good flexibility it will allow muscle tissue to accommodate to imposed stress more easily and allows efficient and effective movement. If there is enhanced muscle flexibility it will assist in preventing or minimizing injuries and enhance performance of the muscle. The muscle which is found to be most prevalent for the tightness in the body is the hamstrings⁷. Worrel, et al. stated that a "lack of hamstring flexibility was the single most important characteristics of hamstring injuries in athletes⁸.

Hamstrings contribute to posture stabilization and the control of the pelvis region. Hamstring muscles have the ability to generate high forces rapidly through their eccentric and concentric contractions due to their high composition of type 2 muscle fibers¹⁶. Mainly hamstring flexibility may prevent acute and chronic musculoskeletal injuries, low back ache problems, postural deviation, gait limitation and risk of fall³. Good muscle flexibility will allow muscle tissue to accommodate to imposed stress more easily and allow efficient and effective movements.

"Hamstrings" refers to four muscles located in the posterior compartment of the thigh: semitendinosus (ST) and semimembranosus (SM) medially, and biceps femoris, long head and short head laterally. Proximally, Biceps femoris and Semitendinosus arise from a common overall origin on the ischial tuberosity, but independent origins can be identified for these two muscles on the lateral one-quarter of the medial portion of the ischial tuberosity⁶. The proximal tendon of semimembranosus

passes lateral and deep in relation to those of biceps femoris and semitendinosus, to insert on the lateral part of the upper half of the ischialtuberosity⁶. Furthermore, the four hamstring muscles differ from each other with respect to muscle architecture, e.g. fascicular length, physiological cross-sectional area, length of the proximal and distal free tendons and extent of the intramuscular tendons^{5, 6}.

A hamstring muscle's length can change by up to one third as a result of eccentric or concentric contraction and is subject to high forces in closed and open kinetic chain activities. Hamstring injuries mainly occur while running or sprinting in the biceps femoris with the muscle-tendon junction being the most common injury site; therefore, it is important to look at running and sprint mechanics. Of the three hamstring muscles, the bicep femoris has the greatest muscle-tendon length and is stretched the most during sprinting, hence being the most frequently injured muscle.

Athletes also requires quick change of direction and speed and this may also be a factor to the higher rate of bicep femoris injuries as they act as lateral rotators when the knee is semi-flexed and the hip is extended. In the first half of the stance phase, the hamstrings remain active through a concentric contraction, resisting knee extension distally while extending hip. The hamstrings act to decelerate knee extension distally while proximally assisting hip extension in the later stage of swing phase while running. During the eccentric contraction of the hamstrings at the end of the swing phase, the muscle reaches maximal length, and it is suggested this is when strain injury is most likely to occur just before heel strike¹⁶.

Some studies have shown the decreased hamstring flexibility is risk factor for the development of patella tendinopathy, patellofemoral pain, hamstring strain injury and symptom of muscle damage following eccentric training. Tight hamstrings can have profound effect on seated postural alignment of body and number of studies showed positive correlation between decreased hamstrings flexibility and low back pain of lumbar inter vertebral disc pathology^{3,4}.

Most of the epidemiological studies pointed out that the number of injuries during competition is about 4–6 times more than that in training.¹² Prevalence of hamstring tightness is present at significantly higher rates among athletes who engaged in contact sports rather than athletes who engaged in athletics, martial arts and other sports, There is no significant association between hamstring tightness and body height, femoral length, duration of warm up period and duration of cool down periods of the athletes who were engaged in each category of sports Hamstring injuries are the most common type of injury among athletes. Hamstring injuries are the most common type of injury among athletes. These injuries are slow to recover, make high health expenditure and decrease the performance level of the athletes²¹.

Most medical professional, coaches and athletes consider aerobic conditioning, strength training and flexibility is integral component in any conditioning program. Flexibility is considered as essential element of normal biomechanical functioning in sports. Flexibility has been defined as the ability of muscle to lengthen and allow one joint (or more than one joint in a series) to move through a range of motion. Loss of flexibility is

defined as a decrease in the ability of a muscle to deform. Some of the proposed benefits of enhanced flexibility is reduced risk of injury, pain relief, improved coordination, prevention or reduction of post exercise soreness and improved athletic performance⁸.

Techniques commonly used by athletes to increase flexibility include static and ballistic stretch as well as PNF. Although eccentric training of hamstring muscles achieves the same flexibility gain as static stretching, the eccentric training offer a more functional option for flexibility training. Various stretching technique and warm up procedure are often suggested prior to sport or physical exercises that are believed to have beneficial effects over flexibility and increase in joint motion.

A variety of stretching activities has been presented in the literature in order to regain or maintain the muscle flexibility and avoid a decrease in range motion that can impair functional activities in an individual¹⁵. A study found that regular hamstring stretching help to significantly decrease the number of overuse injury that occur with physical training.

Muscle energy technique (MET) is a procedure that involves voluntary contraction of a patient's muscle in a precisely controlled direction, at varying levels of intensity. It is unique in its application as the client provides the initial effort while the practitioner facilitates the process. The benefits of MET include: Restoring normal tone in hypertonic muscles, strengthening weak muscles, preparing the muscle for subsequent stretching, improved joint mobility²⁴. It includes two techniques post isometric relaxation technique and reciprocal inhibition. Hamstring

tightness is a common problem faced by the general population as well as sports players¹⁷.

The MET is a widely accepted method for treating hamstring tightness and active knee extension is a procedure used to measure hamstring flexibility¹⁸. The active knee extension t is the most common flexibility test used in health related fitness test batteries. It is also suggested to use this test to evaluate hamstring flexibility because the test have acceptable reproducibility, have moderate validity, simple procedure that is easy to administer, require minimal skills training and particularly useful in large scale flexibility evaluation²⁶.

Eccentric training is focuses on slow down the elongation of muscle process in order to challenge the muscle which can lead to stronger muscle, faster muscle repair, increase metabolic rate and also increase the hamstring flexibility.

Aim of the study: The aim of this study was to find out the most effective technique between muscle energy technique and eccentric training to improving hamstring muscle flexibility and performance in male college athletes.

Objectives:

- To compare the effectiveness of Muscle Energy techniques and eccentric training to improve Hamstring muscle performance and tightness in college male athletes.
- To asses which mode of treatment is more beneficial and therefore provides increased hamstring muscle performance and flexibility in college athletes.

Hypothesis:

Alternative hypothesis: There will be significant difference between Eccentric training and Muscle energy technique in improving hamstring muscle flexibility and performance among male college athletes.

Null hypothesis: There will be no significant difference between Eccentric training and Muscle energy technique in improving hamstring muscle flexibility and performance among male college athletes.

Study design: Pre Vs Post test experimental design

Study setting: athletes with tight hamstring diagnosed and referred by consultant orthopaedician from Outpatient department, Bethany Navajeevan College of Physiotherapy.

Sample size: 60 who fulfilled the inclusion criteria were included in the study.

Inclusion criteria: Aged between 18-25 years. Gender- male., Hamstring tightness referred by physician. Tight hamstring (deficit of 20 degree from full knee extension with hip at 90° of flexion).

Exclusion criteria: Acute or chronic low back pain., Acute or chronic hamstring injury., Inability to actively extend the knee fully in sitting position., Visible acute swelling in the region of hamstring muscle., Congenital abnormality., Trauma in and around hip and knee, Recent surgical procedure. Red flags, Type 1 diabetic., Arthritis.

Sampling design: Purposive sampling method used to select the samples in the study.

Study duration: The study was conducted over a period of 9 months.

Outcome Measures:

1. Flexibility - Active knee extension test
2. Performance - Single leg hop distance test.

Statistical tools:

- Independent t test
- Paired t –test

Procedure: Subjects between the age group of 18-25 years were screened. 60 subjects who fulfilled the inclusion criteria were included in the study. A standardized assessment conducted prior to their inclusion in the study. The subject were divided into two groups, i.e., Group A (experimental group1) and Group B (experimental group 2), with 30 subject each. This study was comprised of 3 steps,

1. Pre-testing
2. Treatment Intervention
3. Post –testing

Once the subjects were classified into these groups, an informed consent collected from them. Prior to pre testing, preparation session involving the demonstrations and practice of the testing was held twice for all participants to achieve familiarization with the testing procedures.

Pre-test was conducted on Group A and Group B by goniometer for active knee extension test for hamstring flexibility, and single leg hop distance test for performance, measured using tape.

After a brief demonstration about muscle energy technique, eccentric training and

conventional exercise, Group A subjects were subjected to muscle energy technique and conventional exercise for a period of total 5 days, 1 session per day with each session with duration of 10 minutes.

After a brief demonstration about eccentric training, Group B subjects were subjected to eccentric training for 5 seconds per one repetition 6 repetition per session, one session per day, with no rest between repetitions, thereby providing a total of 30second of stretching at the end range. It was given for 5 days.

Post test was conducted on Group A and Group B by goniometer for active knee extension test for hamstring flexibility and single leg hop distance test for performance by using tape after the treatment.

Outcome Measures

1. Flexibility by Active knee extension test:
Group A and B subjects were subjected to hamstring flexibility measurement using active knee extension test.

Procedure: Each subject was positioned in right side, lying on examination table for bony land mark identification. The lateral femoral condyle, head of fibula and lateral malleolus of the right leg were marked to ensure that the same reference points were used for repeated measurement. Once the landmarks were identified, subjects were instructed to lie in supine position. The subject flexed both hip to 90 degree and grasp the behind the knee to stabilize hip at the 90 degree. A stationary arm along lateral femur and movable arm aligned with lateral femoral condyle as axis .patient actively extends the right knee as much as possible without moving the thigh from vertical

position. Active knee ROM was measured by goniometer.

2. Performance by Single leg hop distance test:

Group A and B subjects were subjected to hamstring performance measurement using single leg hop distance test.

Procedure:Tape measure was secured to the floor subject began by standing on the right leg, with their toe at the zero mark of the tape measure .subject were instructed to hop as far as possible forward and land on the same leg. The investigator measured the distance hopped from the zero mark of the tape measure to the point where the subject heel hit. Subject performed two practice repetition followed by two test repetition for testing extremity.

Treatment Invention

Muscle Energy Technique: Subject is supine lying with contra lateral hip and knee extended position. Therapist standing on the right side of the subject, facing the head end of the plinth. The right leg is passive flexed at hip and knee level and extended until the restriction barrier was identified. The calf of the right leg was placed on the right shoulder of the therapist. The subject is instructed to give gently bend the knee against the resistance here the counterforce was given by the therapist's shoulder starting slowly and using only sub maximal strength. Inhale, and slowly built up an isometric contraction; hold the breath during the 7-10 sec of contraction. Release the breath as slowly cease the contraction. Inhale and exhale fully once more following cessation of all efforts. During the second exhalation leg was straightened at the knee towards its new barrier. Procedure was repeated after the contraction of the hamstrings and during the

relaxation phase, the therapist passively took the leg into further flexion with 30 s hold. Then the subject's leg is lowered on the treatment table for a short resting period with duration of approximately 10s. The procedure is repeated again with the frequency of 2 reps.



Figure 1: Subject Receiving Muscle Energy Technique

Eccentric Training

Procedure: The subject is lying in supine with the left leg fully extended position. A 3 foot (0.91 m) piece black theraband was wrapped around the heel and the subject held the ends of the theraband in each hand. The subject instructed to keep locked right knee locked in full extension and hip in neutral internal and external rotation throughout the entire activity. The subject was then instructed to bring the right 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 is defined as the position the hip flexion at which gentle stretch felt by the subject. As the subject pulls the leg into hip flexion with the arms, he was instructed to simultaneously resist the hip

flexion by eccentrically contracting the hamstring muscle during the entire range of hip flexion. The subject was instructed to provide sufficient resistance with the arm to overcome the eccentrically contracting activity of the hamstring muscles so that the entire range of hip flexion took approximately 5 second to complete, once achieved, this flexed hip position was held for 5 seconds and then the extremity will be gently lowered to the ground (hip extension) by the subject arm. This procedure was repeated 6 times, with no rest between repetitions, thereby providing a total of 30 seconds of stretching at the end range.



Figure 2: Subject receiving Eccentric Training

Conventional Exercise

Self Stretching Technique: To stretch the hamstrings, subjects were in the standing position and they placed the heel of the extremity that was to be stretched on a desk or table that allowed the hip to be flexed with the knee fully extended¹⁵. Subjects were asked to rotate their pelvis anteriorly and extend their cervical, thoracic, and lumbar spines with their scapulae retracted while maintaining the knee of the extremity being stretched in full extension and the foot in relaxed ankle plantar

flexion .They were asked to bend forward at the hip while maintaining their pelvis in an anteriorly tilted position until they perceived tightness in the hamstring region. Subjects were instructed to stretch the assigned lower

extremity once per day for 5 times per day for five consecutive days. Stretches were held for 30 seconds and repeated 5 times on the assigned lower extremity per session 10-second period separated each repetition.

RESULTS

Group A (Experimental 1)

OUTCOME MEASURE	MEAN		STANDARD DEVIATION		T VALUE	P VALUE
	PRETEST	POST TEST	PRE TEST	POST TEST		
ACTIVE KNEE EXTENSION	38.67	61.133	10.1971	10.7885	-25.744	.00
SINGLE LEG HOP	80.47	102.80	13.933	17.199	-14.698	.00

Table 1: Pre and post test for active knee extension test and single leg hop distance test of Group A

Group B (Experimental 2)

OUTCOME MEASURE	MEAN		STANDARD DEVIATION		T VALUE	P VALUE
	PRETEST	POST TEST	PRE TEST	POST TEST		
ACTIVE KNEE EXTENSION	37.467	47.300	9.9611	9.9694	-14.954	.00
SINGLE LEG HOP	77.50	86.93	10.589	10.471	-18.214	.00

Table 2: Pre and post test for active knee extension test and single leg hop distance test of Group B

COMPARISON BETWEEN BOTH GROUPS

OUTCOME MEASURE	GROUP	N	MEAN	STANDARD DEVIATION	T VALUE	P VALUE
ACTIVE KNEE EXTENSION	A	30	61.133	10.7885	5.159	.00
	B	30	47.3	9.9699		
SINGLE LEG HOP	A	30	102.80	17.199	4.316	.00
	B	30	86.93	10.471		

Table 3: Comparison of post test values of active knee extension test and single leg hop distance test between Group A and Group B

The above pre and posttest mean value tables 1 and 2 shows that both the groups show improvement in active knee extension test and single leg hop test. Table 3 shows that Group-A with muscle energy technique and conventional treatment shows better improvement than group-B subjects with eccentric training and conventional treatment

DISCUSSION

The aim of the study was to compare the effectiveness of muscle energy technique and eccentric training in improving hamstring muscle flexibility and performance in male college athletes having tightness of hamstring muscles in the age group of 18-25 years.

Active knee extension test for measuring flexibility and single leg hop test for performance was used in this study. The right leg of the subjects was used for evaluation purpose. All the outcome measures were collected before and after the intervention protocol in both groups. The software program SPSS 16 was used for statistical analysis. In

Group A and Group B, paired t test was used to compare pre and posttest scores. The post test scores of Group A and Group B was analyzed using independent t test. The results showed that after five days of treatment, Group A and Group B subjects showed improvement in hamstring flexibility and performance, but Group A subjects (MET technique) shows greater improvement than Group B (eccentric training) subjects in hamstring flexibility and performance.

Hamstring strains and tears are one of the common musculotendinous injuries in sports due to its reduced flexibility. Tight hamstring muscles not only increase the risk of injury but also can affect the sports performance among young athletes. Flexibility of hamstring muscle is dependent upon the fascicular length, physiological cross-sectional area, length of the proximal and distal free tendons and extent of the intramuscular tendons. Theoretically, patients with lower extremity overuse injuries would benefit by muscle stretching because greater force will be absorbed, and it will lessen the overload on weakened and inflamed

tissues. In addition, muscle performance will be increased for activities of daily living or sports by increasing the potential energy available for concentric contractions.

Muscle energy technique (MET) is a manual procedure that uses controlled, voluntary isometric contractions of a target muscle group and is widely advocated by authors in the field of osteopathy that is now used in many different manual therapy professions¹. These techniques are now widely recognised as an effective approach to the treatment of musculoskeletal dysfunction. RoshanAdkitte et.al in his study shows that MET increases the flexibility of hamstring in athletes and hence it can prevent the injuries²⁰. Sonal.et.al found that the post isometric relaxation technique is more beneficial in improving hamstring flexibility in young healthy adults. MET gently re-educates the hypertonic muscle to its original range and function. METprepare the muscle for athletic activity and may delay or prevent the injuries. It is effective for lengthening of shortened muscle, strengthening the muscle as a lymphatic or venous pump to help drainage of fluids and for increasing range of motion (ROM).

Skeletal muscle is capable of as much as 50% more force production during maximum eccentric contractions compared to concentric contractions. Sale et al found that resistance-trained subjects are thought to have already developed greater muscular activation, and the increase in the performance after further resistance training is considered to be due to muscular adaptations. HaraldVikne et al found that gains in strength and velocity performance occurred after eccentric training in trained men. O'Sullivan et al (2012) has suggested that reduced flexibility increases injury risk

secondary to inability of the muscle to produce adequate force in a lengthened position and exposes the muscle to damaging lengthening forces. Interestingly, stretching does not seem to positively influence length-tension relationships in the same fashion as eccentric training, which improves the ability of a muscle to produce force in a lengthened position. Accordingly, this lead O'Sullivan et al. (2012) to his study that if eccentric training, which has proven benefits in injury risk reduction and power development, could be utilized to improve flexibility¹⁴. Therefore, this study aims to determine the best intervention that can improve hamstrings flexibility and performance in athletic population. So this study compared the effectiveness of muscle energy technique and eccentric training along with conventional treatment in college athletes.

Russell T.Nelson et al in his comparative study on the immediate effects of eccentric training vs static stretching on high school aged males shows that eccentric training is more effective than a control intervention for high school male athletes in improving flexibility. Jesper Petersen et.al found that in male professional and amateur soccer players, addition of eccentric hamstring exercise decreased the rate of overall, new, and recurrent acute hamstring injuries^{8,9}.

60 subjects fulfilling the inclusion criteria were included in the study and they were dividing into two groups i.e., Group A and Group B with 30 subjects in each group. Each subject was well explained the procedure of the intervention and the possible risk involved. A written informed consent from each subject was obtained. Group A received Muscle energy technique and conventional treatment and Group B received eccentric training¹³ and

conventional treatment. All subjects well tolerated the intervention given and no one was dropped out of the study.

The result of the present study supports the above studies. Active knee extension test was reliable tool for assessment of hamstring flexibility. Active knee extension range of motion for right knee was collected before and after the intervention in both groups. Comparison of the data obtained before and after the protocol for both groups was statistically analyzed using Independent t test. Post test results of both groups were statistically analyzed using Paired t –test. Group A have a mean base line pre test value of 38.867 and Group B have a mean base line pre test value of 37.467 for active knee extension. Group A showed post test mean value with standard deviation of 61.133 ± 10.7885 , Group B showed post test mean value with standard deviation 47.300 ± 9.9694 . The result of study revealed that there was improvement in active knee joint extension range motion in both groups after intervention. The range of motion gain in Group B was significantly higher than the Group A. subjects received MET shows more improvement in active knee extension compared with subjects received eccentric training.

Richard Gajdosik et.al in his intra tester reliability study of active knee extension test which is designed to measure tightness in the hamstring muscle on 15 men found that reliability coefficients for test and retest measurements were .99 for the left extremity and .99 for the right extremity. High reliability resulted from strict body stabilization methods, a well-defined end point of motion, and accurate instrument placement. If conducted properly, the active knee extension test should

be an objective and reliable tool for measuring hamstring muscle tightness^{22,23}.

Loria et.al in his study found that single hop test is a reliable tool for assessing lower limb extremity performance in athletes. Single hop test for right leg was performed before and after the intervention in both groups²⁵. Group A showed post test mean value with standard deviation of 102.80 ± 17.199 , Group B showed post test mean value with standard deviation 86.93 ± 10.471 . The result of this study revealed that there was gain in single leg hop in both Group A and Group B after the intervention. The gain in Group B was significantly higher than the Group A. ie, subjects received MET shows more improvement in single leg hop compared with subjects received eccentric training.

The use of eccentric training to reduce injury rates, is in accordance with SAID (Specific Adaptation to Imposed Demand) principle, that a muscle will adapt to the imposed demands. If the muscle adapts to the imposed demand of eccentrically training, theoretically, injury rates would be lower since most injuries occur during the eccentric phase of activity. Strength gains from eccentrically training a muscle would, also improve performance.

The major goal of clinicians and patients in rehabilitation setting is restoration of normal functional motion. Normal motion requires the patient to have the flexibility and the strength to perform the movement. Important clinical implications exist in performing eccentric training through full range of motion for restoration of normal functional motion. Strengthening through full range of motion increase the likelihood of not only maintains the range achieved, but also uses the range

functionally by the individual. Eccentrically training through a full range of motion, theoretically, will improve the functional ability of the extremity by improving the flexibility and strength in that range¹⁹.

Muscle energy technique was assumed to promote orientation of collagen fibers along the lines of stress and direction of movement. It also prevents muscle stiffness by limiting infiltration of cross bridges between collagen fibers, and excessive collagen formation. It involves stretching to an extent that fibrotic tissue and adhesions are broken called as controlled micro trauma. This injury is seen useful in relation to alter interface between fibrous and non-fibrous tissue. Studies found that single application of MET produced no biomechanical or viscoelastic change to the muscle, but created a change in tolerance to stretch due to reduction in pain (hypoalgesic effect). This change may prepare the muscle for athletic activity and may delay or prevent the injuries.

The mechanism behind the gained flexibility in muscle after MET maybe due to biomechanical or neuro-physiological changes or an increase in tolerance to stretch. However, 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 the addition of sarcomeres in series. Repeated (eccentric) contraction results in disruption and membrane damage, which in effect leads to uncontrolled Ca⁺⁺ movements and the development of localized contracture. This could be a cause of less improvement of

muscle flexibility in Eccentric Training than in Muscle Energy Technique.

The result of present study shows that increase in active knee range motion was temporary. This was perhaps due to contractile properties of a muscle. A temporary sarcomere lengthening might have occurred in the hamstrings after the intervention. The cause for decline in flexibility gain can be understood with the respect to viscoelastic properties of muscle, a permanent lengthening in muscle cannot be expected because of a temporary creep effect.

Limitations and Recommendations

- Female subjects were not taken in this study. Further study on female population can be done or a comparative study between genders would be of future interest.
- As this study was limited to effect of MET on the hamstring muscle, other studies are needed to evaluate the effect of MET on other muscle groups such as gastrocnemius, soleus and iliotibial band.
- Long term effects and follow-up must be reviewed.
- Further study can be done on the effect of intervention on other components of performance.

Based on the statistical analysis, the result of the present study shows that there is statistically significant difference in flexibility and performance between pre-test and post-test in both experimental group. Experimental group A shows greater improvement in flexibility while measuring using active knee extension test and performance while measuring single leg hop test than

experimental group B in subjects with tight hamstring muscle.

CONCLUSION

After analyzing this study, the following conclusions were drawn:

- Muscle Energy techniques and eccentric training improves Hamstring muscle flexibility in college male athletes.
- Muscle Energy techniques and eccentric training improves Hamstring muscle performance in college male athletes.

Muscle energy technique is more effective than eccentric training in improving hamstring muscle tightness and performance in college male athletes. Thus the study concludes that Muscle Energy technique is more very effective for improving flexibility and performance in tight hamstring muscle in college athletes.

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