IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

EFFECT OF MUSCLE ENERGY TECHNIQUE OVER STATIC STRETCHING ON THE FLEXIBILITY OF CALF MUSCLES

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ABSTRACT

Background: Muscle energy techniques are widely used by osteopaths and other manual therapists, there is limited research supporting and validating its use, there is a demand on research to find out efficacy of MET over static stretching technique in improving flexibility. Thus, there was an effort taken to prove the effectiveness of MET in improving calf muscle flexibility.

Study Design: Experimental Study

Method: Forty normal individuals were selected and assigned randomly into two groups; Group-I and Group-II (of twenty subjects each) who received a Muscle energy technique and Static stretching for calf muscles respectively.

Result: This study implies that MET and static stretching both can be equally preferred for relieving the tightness developed in the muscles, but the MET is more effective, and it can be considered as a training programme in the field of sports physiotherapy.

Keywords: MUSCLE ENERGY TECHNIQUE (MET), Static Stretching.

INTRODUCTION

There are many studies done to find the importance and effectiveness of improved flexibility in the performance of players in many games. And, it has been proved that flexibility plays an important role in improving functional activities of hypomobile joint structures.

Flexibility is the ability to move a single joint or series of joints smoothly and easily through an unrestricted pain free range of motion. Having good flexibility allows a person to increase his physical performance, allowing the joint the ability to move further with less energy. It is joint specific; it means that a person may have excellent range of motion in one joint and be limited in another. Flexibility increases blood supply and nutrients to joint structures, which in turn increases circulation, leading to greater elasticity of surrounding tissues, which reduces muscle tension, decreases risk of injury. According to **SynerStretch**[5] flexibility in a joint is also specific to the action performed at the joint (the ability to do front splits doesn't imply the ability to do side splits even though both actions occur at the hip).

Many people are unaware of the fact that there are different types of flexibility. These different types of flexibility are grouped according to the various types of activities involved in athletic training. The ones which involve motion are called dynamic and the ones which do not are called static. The different types of flexibility (according to Kurz) are: Dynamic flexibility, Static-active flexibility and Static-passive flexibility. Dynamic flexibility (also called kinetic flexibility) is the ability to perform dynamic (or kinetic) movements of the muscles to bring a limb through its full range of motion in the joints.

Static-active flexibility (also called active flexibility) is the ability to assume and maintain extended positions using only the tension of the agonists and synergists while the antagonists are being stretched. For example, lifting the leg and keeping it high without any external support (other than from your own leg muscles).

Static-passive flexibility (also called passive flexibility) is the ability to assume extended positions and then maintain them using only the body weight, the support of the limbs, or some other apparatus (such as a chair or a barre). Being able to perform the splits is an example of static-passive flexibility.

Research has shown that active flexibility is more closely related to the level of sports achievement than is passive flexibility. Active flexibility is harder to develop than passive flexibility (which is what most people think of as flexibility); not only does active flexibility require passive flexibility in order to assume an initial extended position, but it also requires muscle strength to be able to hold and maintain that position.

Flexibility exercises are used to increase the length of musculotendinous unit. The term flexibility exercise is often used synonymously with stretching exercises. Flexibility training has been shown to improve joint range of motion and prevent exercise induced muscle injury. Musculoskeletal injuries such as strains and tears are extremely common in daily activities. The overall result of muscle injury is not only an influence on individual’s activities of daily living (ADL) but is also the source of pain. As muscle tightness is one of the predisposing factors for injuries, preventive measures such as stretching exercise have been widely practiced.

Tight muscles and adaptive changes in connective tissue can alter an athlete’s style performance, reducing biomechanical efficiency and predisposing the athlete to injury. Tightness may vary the length tension of the muscle and alter the limbs shock absorbing properties.

Erik Witvrouw et al (2003) did study on 146 male professional soccer players during the 1999–2000 Belgian soccer competition. The flexibility of the hamstring, quadriceps, adductor, and calf muscles of these players was measured goniometrically before the start of the season. All of the examined players were monitored throughout the season to register subsequent injuries and they concluded that soccer players with an increased tightness of the hamstring or quadriceps muscles have a statistically higher risk for a subsequent musculoskeletal lesion.

The Gastrocnemius is the calf muscle that is visible from the outside of the body. It attaches to the heel with the Achilles tendon and originates behind the knee on the femur, crossing two joints. The Gastrocnemius has two heads; the medial and the lateral. When fully developed, these two heads appear to form a diamond shape. The Soleus is not visible when looking at the body from the outside as it lies underneath the gastrocnemius on the rear of the lower leg. Soleus attaches below the knee joint and then also to the heel via the Achilles tendon. Both muscles act to plantarflex the ankle (point the foot away from the body). As gastrocnemius attaches above the knee it also helps with bending the knee. In this position, with the knee bent, soleus becomes the main plantar flexor.

Worldwide many techniques are in practice to improve muscle or soft tissue flexibility and many studies have been carried out to find the most effective technique which can be used for soft tissue manipulations. The common techniques are static stretching, cyclic stretching, ballistic stretching, mechanical stretching, facilitated stretching, proprioceptive neuromuscular facilitation techniques, and many more.

Static stretching is the most common term used to describe a method by which soft tissues are lengthened just past the point of tissue resistance and then held in the lengthened position for an extended period of time with a sustained stretch is either predetermined prior to stretching or is based on the person's response during the stretching procedure.[1] In the research literature 'Static Stretching' has been linked to durations ranging from as few as 15 seconds to several minutes.

The action of static stretching pulls the actin-myosin filaments beyond overlapping. It results in increased sarcomere length, and overall increase in the muscle length. By making use of the viscoelasticity of the muscle tendon unit, 'creep- response' occurs under low load and long duration static stretch. As a result, a temporary increase in muscle length can be achieved. It is also reported that stretching results in increased muscle compliance (reduce muscle stiffness) and decrease energy absorption to failure.

Lucas RC Koslow R (1984) did a comparative study of static, dynamic and proprioceptive neuromuscular facilitation stretching techniques on flexibility in 63 college subjects. The findings indicated all 3 methods of flexibility training produced significant improvements when pretest and posttest mean scores were compared.

Montgomery K et al (2003) did a comparative study on effectiveness of active isolated stretching and passive static stretching in increasing hamstring flexibility in individuals with tight hamstrings. The results of this study indicated that passive static stretching was more effective than active isolated stretching.

Muscle Energy Technique (MET) is a manual technique developed by osteopaths that is now used in many different manual therapy professions. Elements of MET have been described and documented for many years (under different names and with different descriptive terminology) **Fred Mitchell, Sr.** is generally given credit for developing the MET system into its modern-day form.

There are many preceding examples of techniques that used elements of eventually what was to be called Muscle Energy Technique (MET). Examples of Swart's strap techniques in the 1919 & 1921 books - where Dr. Swart used leather straps to provide the resistance against the effort that the patient was instructed to give so that self-correction took place, are an early example of MET. Other practitioners in Europe, Dr's Kabat, Knott, and Voss at the Kabat-Kaiser Institute during the late 1940's, developed a similar technique approach which they called Proprioceptive Neuromuscular Facilitation (PNF) made use of post-isometric relaxation and other related neurophysiologic mechanisms. Dr. T.J. Ruddy developed a technique called "Resistive duction" that utilized physician resisted multiple rapid patients generated efforts to improve blood flow and strengthen weakened muscles. However, with all these items considered, Fred Mitchell, Sr. is generally credited by knowledgeable individuals as being the major developer of what now is known as MET. He developed it in the 1940's-50's and published his work in the 1958 Yearbook of the American Academy of Osteopathy.

MET is defined as a 'manual therapy procedure which involves the voluntary contraction of patients' muscle in a precisely controlled direction, at varying levels of intensity, against a distinctly executed counterforce applied by the therapist. Typically, the muscle is directed to contract isometrically to move a joint or affect movement at that articulation. Any articulation in the body that can be moved by voluntary muscular contraction can be affected by a muscle energy technique procedure. An isometric muscular contraction is the more commonly used form of MET with the duration and force of the muscular contraction varying and dependent upon the desired outcome. Outcomes include lengthening of a spastic or contracted muscle.

However, METs are typically used to mobilize a dysfunction or restricted joint. Muscle Energy Technique can be used to treat most joints in the body, including the intervertebral joints, in a gentle, soft, safe, and effective manner.

In terms of treatment, Muscle Energy Technique is a system of manual therapy for the treatment of movement impairments that combines the precision of passive mobilization with the effectiveness, safety, and specificity of reeducation therapies and therapeutic exercise. The therapist localizes and controls the procedures, while the patient provides the corrective forces and energies for the treatment as instructed by the therapist, MET focuses on joint range-of-motion limitation, and uses light to moderate force muscular contractions precisely controlled to affect a specific joint, to restore normal joint motion.[2,4] Since it was originally developed over 45 years ago, MET is now part of the curricula at all of the Osteopathic colleges and physical therapy programs, and is practiced by many Osteopaths, physical therapists, chiropractors, and other manual therapists world-wide.

Most muscle energy procedures use POST-ISOMETRIC RELAXATION. This is postulated to work because after an isometric contraction there is a refractory period during which passive stretching of the dysfunctional muscle may be done without strong opposition.

A less common way to use muscle energy is RECIPROCAL INHIBITION. This takes advantage of the fact that when a muscle's antagonist is contracted, the original muscle is inhibited and relaxes. One example of this is contraction of the biceps muscle to inhibit and relax the triceps muscle.

The mechanical component of muscle flexibility during static stretch is better understood than the mechanisms of therapeutic action of MET. Resting tension in skeletal muscles is taken up mainly by the myofibrils, and as the muscle stretches the limit to the range of motion is attributed to the Visco-elastic elements of the connective tissues. Visco-elasticity refers to the response of a tissue to load, a property of elastic and viscous components. The elastic component is the ability of the tissue to return to its previous form after deformation. The viscous component relates to the fluid part of the muscle, which deviates in response to mechanical forces. When Visco-elastic structures are held at constant stretch, the stress or force of the material gradually declines.

Taylor et al have demonstrated Visco-elastic change in rabbit foreleg muscles. In human experiments, Visco-elasticity seems harder to demonstrate. While a small number of studies have found that Visco-elastic stress relaxation is evident in human skeletal muscle. Both **Magnusson et al** and **Halbertsma et al** demonstrated that increased muscle extensibility was attributed to use of increased torque. A Visco-elastic change would have been evident if increased muscle length was achieved using a constant torque (force of stretch). The change in extensibility after stretching can only be attributed to an increase in stretch tolerance (the subject can tolerate more force applied to the muscle) because increased muscle flexibility resulted only when the torque increased.

Apart from the flexibility of the myofascial tissue itself, other structures are involved in the resistance of a muscle to stretch. When measuring the range of motion of a joint, the structures surrounding the joint itself like joint capsules, ligaments and physical structures of the bone articulation provide resistance to the overall range of motion of a particular joint. In addition to this, the skin and subcutaneous connective tissue may also play a large part in the restriction of a joint's motion. **Johns and Wright** have shown that the passive torque that is required to move a joint is contributed by the joint capsule (47%), tendon (10%), muscle (41%), and skin (2%).

Some authors have speculated on the neurological mechanisms that may produce increased range of motion of a joint after MET; however, there is little research to substantiate these theories. **Kuchera** attributed the effectiveness of MET to the inhibitory Golgi tendon reflex. This reflex is believed to be activated during isometric contraction of muscles, which is claimed to produce a stretch on the Golgi tendon organs and a reflex relaxation of the muscle. This theory, however, is poorly supported by research. **Taylor et al** showed in rabbit muscles that no difference in response to stretch was found between innervated and denervated muscles, suggesting that the neural component to muscle flexibility is negligible.

Various studies have shown that passive stretch does not influence the electrical activity of the hamstring muscle (using EMG) demonstrating that low level muscle contraction does not limit muscle flexibility, disputing the proposal of a neurological mechanism.

Several researchers have examined the effect of contract-relax techniques (similar to MET) on hamstring flexibility and found that these techniques produced increased muscle flexibility. **Handel et al** identified significant increases in hamstring flexibility along with an increase in passive torque (increase in force used to stretch the hamstring) after a contract-relax exercise program. **Wallin et al** claimed that contract-relax techniques were more effective than ballistic stretching for improving muscle flexibility over a 30-day period, whereas other researchers, however, have reported no differences between the two techniques**. Lenehan KL et al (2003)** conducted a study to examine whether a single application of thoracic MET could significantly increase the range of motion in asymptomatic volunteers with restricted active trunk rotation.

The study result supported the use of MET to increase restricted spinal rotation range of motion.

Despite extensive use by manual therapists, there is a lack of experimental evidence supporting the efficacy of MET, particularly in calf muscle flexibility. There are very few researchers that have done studies to find the clinical importance of MET over flexibility and joint functioning. These studies support the idea that application of MET increases flexibility as well as the strength of the muscle and joint mobility. This study aimed to determine the effect of Muscle Energy Technique and Static Stretching in calf muscle flexibility and which technique produced more significant improvement of calf muscle flexibility.

NEED OF THE STUDY

Muscle Energy Technique (MET) is a manual medicine procedure that has been described as a gentle form of manipulative therapy effective for treating movement restrictions of both the spine and extremities. Muscle Energy Technique is a direct, noninvasive manual therapy used to normalize joint dysfunction and increase range of motion. Whereas Static stretching is a very common technique used to lengthen a shortened muscle or group of muscles.

While muscle energy techniques are widely used by osteopaths and other manual therapists, there is limited research supporting and validating its use, there is a demand on research to find out efficacy of MET over static stretching technique in improving flexibility. Thus, there was an effort taken to prove the effectiveness of MET in improving calf muscle flexibility.

MATERIAL AND METHODS

Study Design:

This study is an experimental design involving the comparative analysis of Muscle energy technique over Static stretching in improving calf muscle flexibility. In this study the subjects were analyzed with the parameter of calf muscle flexibility assessed using static ankle flexibility test.

Sampling method:

Forty normal individuals, based on selection criteria, were selected using the Convenience sampling (non-probability). All these subjects were participated in the study after signing a consent form. The demographic data were collected from each subject and the purpose of the study was explained to all the subjects.

Selection criteria:

The selection criteria were as follows:

Inclusion Criteria

- Male only.
- Age group: 20-25 years
- Body Mass Index: 23-25

Exclusion Criteria

- History of recent injury in and around ankle joint.
- History of acute/chronic pain in lower limb.
- Skin diseases.
- History of cardiovascular and respiratory problems.
- Joint instability.
- Hyper or hypomobile joints.
- Female gender.
- Age below 20 years and above 25 years.
- The Body Mass Index is below 23 and above 25.

Materials Used:

- Inch tape
- Weighing Machine
- Treatment table
- Pillows
- Towels

Measurement Tools:

Calf muscle flexibility was considered as a parameter for the study & it was assessed using static ankle flexibility test.

Static Ankle Flexibility Test

Starting position: Subject is in standing position, facing towards a wall with his feet flat on the ground and toes touching the wall. He leans onto the wall with the hands, chin, and chest touching the wall.

Movement: Subject is asked to slide slowly his feet away from the wall as far as possible keeping the feet flat on the ground, also the body and knees are fully extended and the chest in contact with the wall. At the maximum possible position of the above description, the distance between the toe line and the wall (nearest 1/4th inch) is measured. The test is repeated 3 times and the best distance is recorded.

Analysis: Analysis of the result is by comparing the pretest and posttest measurements.

Procedure:

Forty normal individuals were selected for this study based on inclusion and exclusion criteria and were equally divided into two groups; namely, Group-I and Group-II consisting of 20 subjects each. The baseline measurements of ankle flexibility were assessed using Static Ankle Flexibility Test before the intervention. Proper warm-up was given to the subjects in both the groups for 5 minutes, which included light jogging or skipping, and they also were advised not to participate in any other training program till the end of the study.

Group-I

Twenty subjects in this group were given Muscle Energy Technique (post isometric relaxation) to the gastrocnemius and soleus muscles bilaterally.

Position: The subject was in supine with feet extending over the edge of the table, with the knee flexed over a rolled towel for soleus and the knee straight for gastrocnemius. Starting from the restriction barrier or just short of it, the subject was asked to exert a small effort towards plantar flexion, against unyielding resistance, with appropriate breathing. This contraction was held for 7-10 seconds together with a held breath. On slow release, on an exhalation, the ankle was dorsiflexed slightly and painlessly beyond the new barrier, with the subject's assistance, (and the tissues were held in slight stretch for at least 10 seconds to allow a slow lengthening of tissues).[2] This cycle was repeated for 5 times in each session per day for five days in a week for the total period of 5 weeks. The single session lasted for 30 minutes including 5 minutes each of warm up and cool down exercises and rest period of 1 minute in between every cycle of muscle energy technique.

Group-II

Twenty subjects in this group were given Static Stretching to the gastrocnemius and soleus muscles bilaterally.

Position: The subject was in supine with feet extending over the edge of the table, with the knee flexed over a rolled towel for soleus and the knee straight for gastrocnemius.

In this, ankle was dorsiflexed, and soft tissues were lengthened just past the point of tissue resistance and then held in the lengthened position for 30 seconds, and then slowly released.[1] This cycle was repeated for 5 times in each session per day for five days in a week for the total period of 5 weeks. The single session lasted for 30 minutes including 5 minutes each of warm up and cool down exercises and a rest period of 1 minute in between every cycle of static stretching.

The posttest measurements of calf muscle flexibility were measured at the end of 5 weeks training for both the groups and compared with the pretest measurements by using statistical analysis method.

RESULTS & INTERPRETATION

Forty male healthy individuals with a mean age of 21.9 years, & SD = $\pm$1.29 were selected for the study. The mean, variance and standard deviation values of the age and BMI of the study groups are shown in Table-1 & 2.

This study implies that MET and static stretching both can be equally preferred for relieving the tightness developed in the muscles, but the MET is more effective, and it can be considered as a training programme in the field of sports physiotherapy.

TABLE-1

MEAN, VARIANCE & STANDARD DEVIATION VALUES OF AGE IN GROUP-I & GROUP-II

SUBJECTS	N	MEAN	VARIANCE	SD
Group-I	20	21.95	1.83	1.35
Group-II	20	21.85	1.6	1.26
Total	40	21.9	1.68	1.29

TABLE-2

MEAN, VARIANCE & STANDARD DEVIATION VALUES OF BMI IN GROUP-I & GROUP-II

SUBJECTS	N	MEAN	VARIANCE	SD
Group-I	20	23.78	0.25	0.5
Group-II	20	23.68	0.29	0.54
Total	40	23.73	0.27	0.52

DISCUSSION

This study was done to analyze the effectiveness of MET over static stretching to improve calf muscle flexibility. Calf muscles (plantar flexors) are prone for tightness because of prolonged periods of sitting in this modern sedentary lifestyle. Tightness of muscles and adaptive changes in connective tissue can alter an athlete's performance during competition, reducing biomechanical efficiency and predisposing the athlete to injury. Tightness may vary the length tension of the muscle and alter the limbs shock absorbing properties.

In this study, totally forty normal individuals were selected and assigned randomly into two groups; Group-I and Group-II (of twenty subjects each) who received a Muscle energy technique and Static stretching for calf muscles respectively. The improvement in flexibility of calf muscles was assessed by using static ankle flexibility test. Pretest data were collected at the beginning of treatment and posttest data were collected at the end of treatment program that is after 5 weeks of duration. Data were analyzed using statistical methods and as seen in the graph showing the mean improvement of both the parameters (fig-11) there is a steady improvement in the mean of flexibility achieved; however comparing experimental Group-I and Group-II, it can be clearly seen that Group-I not only showed greater improvement but also recorded a high degree of consistency with 't' value for the measures of Ankle flexibility test.

The chief objective of the study was to compare the efficacy of MET and static stretching in improving the flexibility of calf muscles. The statistical analysis correlates the study by proposing that the group taken for the study; either Group-I treated by MET or Group-II treated by Static stretching showed significance in improving the flexibility of calf muscles and also showed that Group-I trained with MET had higher significance when compared to the Group-II trained by static stretching. Based on this data, the experimental hypothesis is accepted.

The results of this study were significant at $p<0.05$ and it strongly supports the earlier findings of **Madeleine S Gary F (2008)** [29] in which they proposed that MET increases the flexibility. Whereas **Ballantyne F et al (2003)** [39] conducted a study to investigate the effectiveness of muscle energy technique in increasing passive knee extension and to explore the mechanism behind any observed change. A significant increase in range of motion was observed at the knee following a single application of MET to the experimental group thus showing an increase in flexibility with MET.

The mechanisms by which MET may produce increased flexibility remain speculative. Many authors of MET claim that segmental muscle contraction restricts joint motion and attributes the efficacy of MET to relaxation of the affected muscles due to inhibition of motor activity through the Golgi tendon organs. Other authors have disputed this and claim that this model ignores the complex and dominant influence of the central nervous system, and the lack of evidence supporting muscle contraction as a factor in restricted ROM or spinal dysfunction.

Viscoelastic and plastic changes in myofascial connective tissue elements following isometric contraction is a likely explanation for increased muscle length according to some authors. A lengthening of connective tissue elements has been demonstrated to occur in conjunction with the contraction of muscle fibers, with the amount of connective tissue change correlated with the magnitude of muscle stretch. This suggests an increase in muscular extensibility that primarily occurs in the non- contractile connective tissue elements.

It has been suggested that a viscoelastic change in muscle is responsible for the increase in muscle flexibility after MET,[25] but this theory remains largely untested. Stretching of the connective tissue elements when the muscle isometrically contracts from a lengthened position has been offered as another explanation of the observed range of motion increase, and explains the greater flexibility achieved with contract- relax exercises when compared with static stretch. Increased tolerance to stretch, which has been demonstrated following passive static stretching of the hamstring muscles may also play a role in the apparent increased flexibility of muscles following MET. **Handel et al** suggested that an increased stretch tolerance is a possible mechanism behind the increased ROM seen in their study after the contract- relax exercise program.

The present study aimed to determine the effects of MET over Static Stretching in improving the flexibility of calf muscles, and the result of this study proves that though static stretching is beneficial, a more optimal benefit is achieved through MET in improving flexibility.

This study implies that MET and static stretching both can be equally preferred for relieving the tightness developed in the muscles, but the MET is more effective, and it can be considered as a training programme in the field of sports physiotherapy.

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