

# Effects of muscle energy techniques and its comparison to self stretch of bilateral ankle plantarflexors on performance of balance scores in healthy elderly subjects

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## ABSTRACT

**Purpose of the study:** is to investigate whether the application of muscle energy technique on bilateral ankle plantarflexors influence the balance scores of the elderly subjects. Secondary aim is to determine the effect of practice of muscle energy technique on bilateral ankle plantarflexors compared to self stretching for performance on balance tests in elderly subjects. **Materials and Method :** A sample of convenience of 60 healthy elderly subjects were taken. All the subjects (N=60) who were fulfilling the inclusion and exclusion criteria were recruited for the study and randomly assigned into two groups. **Results** From the result t-test and its significance in the pre and post intervention collected from the subjects the following has been inferred In group-1 (MET group): The TUG was significantly decreased by 7.4%. FRT scores were significantly increased by 9.5% along with 31% increase in ankle passive range of dorsiflexion after the intervention. In group-2 (self stretching): The TUG was significantly decreased by 5.4%, FRT scores were significantly increased by 7.9% along with 15% increase in ankle passive range of dorsiflexion after the intervention The average mean increase in the group-1 was greater than group-2 but the difference was not statistically significant. **Conclusion** This appears to be a positive effect of MET which in the first place is considered to be and is applied as a method for improving flexibility and range of motion as well as precarious balance or stability of the elderly, but a less significant change was also found by self stretching but further comparative investigation was done to determine the performance by MET and self stretching maneuver was found not to be significant.

**Keywords:** Muscle energy technique; Plantar flexors.

## INTRODUCTION

Falls present a substantial health problem among the elderly population. Research shows that altered balance is the greatest collaborator towards falls in the elderly, with a high correlation between balance deficit and incidence of falls [1]. The musculoskeletal system plays a great role in the maintenance of balance [2]. As postural control mechanism

deteriorate with age and disease, balance becomes increasingly tenuous resulting in susceptibility to falls often resulting in fractures and other injuries [3]. Health surveys have indicated that there is a loss of flexibility and range of motion (ROM) in elderly people[4]. There is definite decrease in ankle ROM and is considered as a risk factor associated with decrease in balance thus limiting functional activities such as ambulation [5]. A decrease length of the calf muscle tendon unit (MTU) defined as the decrease in dorsiflexion range of motion with the knee extended is also associated with normal aging in both men and women [6]. Therefore we have studied the ankle joint complex because of its significant role in gait, standing posture, maintenance of balance, shock absorption and adaptation to non level surfaces. A

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Stretching increases muscle flexibility, maintains and augments the range of joint motion and increases the elasticity and length of the musculotendinous unit. These results can be expected to improve balance[7]. Muscle Energy Techniques (MET) is a manual technique developed by osteopaths that is claimed to be effective for variety of purposes including lengthening a shortened or contractured muscle, strengthening

muscles, as a lymphatic or venous pump to aid the drainage of fluid or blood and increasing the range of motion of a restricted joint[8]. It not only restores joint mobility, but also normal function and physiology of muscles[9]. Sandra Yale extols METs potential in even fragile and severely ill patients, older patients with restricted motion from arthritis or brittle osteoporotic bones[10].

Many studies show that increase in ankle ROM increases balance but there is limited amount of information comparing these different stretching techniques, the purpose of this study was a comparison of effect of MET and self stretch on the performance of balance scores of healthy elderly subjects having restricted ankle joint dorsiflexion. Ballantyne F, Fryer G et al conducted a study on the effect of muscle energy technique on hamstrings extensibility and concluded that just a single application of MET produced significant increase in range of motion at the knee joint. Denise K Burns et al conducted a study that showed, the muscle energy technique produced a significant increase in overall regional cervical range of motion. Similar results were given by KL Lenehan, G Fryer, P McLaughlin who conducted a study over the effect of muscle energy technique on gross trunk range of motion. Geiringer et al indicates that muscle demonstrate decreased length can cause joint malalignment and alter the normal available range[11]. Knott and Voss have hypothesised that muscle which surround an abnormal joint undergo length-tension changes according to altered position and restricted range of motion. MET may be valuable for correcting faulty joint positions and hypomobile joints by restoring the original length-tension relationship.

Movements and stabilizing forces about the ankle joint contribute to normal gait patterns and postural control. During the swing phase of the

gait approximately 10 degrees of dorsiflexion are necessary for toe clearance, strong ankle plantarflexion during the stance phase is needed for a rapid propulsion of the body forward. An adequate range of motion at the ankle joint complex is an important prerequisite to the precise, efficient gait execution required for just enough elevation to ensure toe clearance during the swing phase. Adequate ankle movements are also necessary for muscular response used to maintain perturbations to balance (McIlroy & Maki, 1996) since locomotion is an integral component of many daily activities, mobility at the ankle joint complex is a constant demand of these tasks.

It is generally thought that the muscles of the lower limbs play a key role in standing, with the calf muscles specially shortening and lengthening to control sway. So this notion leads to an association of calf muscle strength to postural stability. Hence, we hypothesised that aging deteriorates these muscle-tendon characteristics, which in turn are associated with and may partly explain the variance in postural balance performance, especially in more demanding postural tasks[12].

Impairment of this mobility poses a threat to physical safety and can lead to fear for one's safety with imposed restrictions on activity[13]. Hence the high prevalence of falls and dysmobility in older individuals require that geriatric assessment included a reliable, easily administered measure of balance. Functional reach is a new clinical measurement intended to assess dynamic balance of healthy elderly. Diminished reach distance has been associated with an increased risk of fall and frailty in older adults[14]. Hence Functional reach possesses both concurrent and predictive validity and continues to be a strong predictor of falls risk when

we control the age[15]. The Timed up and go test (TUG): is another test of basic functional mobility.

## MATERIAL AND METHODS

A sample of convenience of 60 healthy adults fulfilling inclusion criterion were taken for the study. Subjects were selected from the elderly camp organised by a private physiotherapy clinic and were randomly assigned in two groups.

### Inclusion Criteria

Asymptomatic healthy and independent elderly, age 60-80 yrs[16].

- Ankle dorsiflexion passive range of motion of less than 10 degrees
- Independent in activities of daily living
- Good cognitive function ( Mini-Mental State Examination score of > 23)[17].

### Exclusion Criteria[5,8,14]

- A FRT score of less than 7 and a TUG score of more than 30 seconds
- Any recent injury, surgery, pain or deformity around the ankle.
- Presence of any disorder that can account for problem in balance or unexplained fall.
- Shoulder flexion less than 90 degrees.
- Elbow flexion contracture
- Muscle tightness as hamstrings, quadriceps.
- Absent proprioception and / or abnormal tone.
- Had any previous neuromuscular or vestibular disorder.
- Malignancies of lower extremities
- Diabetes with neuropathy in lower extremities.
- Any systemic pathologies: Rheumatoid arthritis, Ankylosing Spondylitis, etc.

- Persons undergoing mobilization exercises for lower limb , especially ankle and / or balance training.

### **Procedure**

The study was a Pre-test Post-test Control Experimental Design to measure balance scores before and after a stretching intervention. The independent variable was the application of MET and self stretching. The dependent variable was the performance in the balance score of the elderly.

The variables like height, weight, ankle dorsiflexion in lying (active and passive), plantar flexion in lying (active and passive) were measured.

The correlation of functional reach values and timed up and go test scores with ranges of motion were analyzed after applying different stretching techniques.

*Total number of subjects was divided into two groups:*

\*Experimental group 1 (group 1): 30 subjects

\*Control group (group 2): 30 subjects

Group 1- Application of superficial heat for 10 minutes, followed by muscle energy technique for 10 seconds for 3 times once a day for each leg (plantarflexors) alternately.<sup>10</sup>

Group 2- Application of superficial heat for 10 minutes, followed by 10 repetitions in each in a single daily session. Each stretch was held for 30seconds with upto a 30-second rest period between repetitions. Subjects who were unable to hold a stretch for 30 seconds were instructed to hold each stretch as long as possible with the goal being 30 seconds [guidelines of American College of Sports Medicine (ACSM) [18].

The balance scores were measured before and after stretching intervention soon after the completion of intervention on the same day.

### **Protocol**

The purpose of the study was explained to the subject. Verbal description of all the procedure was given. Testing was performed only after informed consent was taken from the subject. Each subject who agreed to participate in the study was asked to complete a MMSI questionnaire which is a neurological examination test done in elderly[17].

A goniometer was used to measure joint range of motion of ankle joint. Three measurements were made for each movement and the average value was taken.<sup>19</sup>

### **Measurement of Balance Scores**

#### *Functional Reach Test 8*

The initial position was standing by the side of the wall mounted with the yardstick. The yardstick was positioned horizontally on the wall at the level of the acromion of the dominant glenohumeral joint. A pointer (pencil) was attached at the head of third metacarpal of the subject. the subject was asked to Raise arm from the shoulder from the horizontal plane in front. Make a fist and hold it. Care was taken not to allow trunk rotation / shoulder protraction by emphasizing the subject to keep both the shoulders in the same horizontal plane, to maintain wrist in neutral, elbows extended and arm in horizontal position to the trunk while taking the initial measurement. The measurement at the yardstick that corresponds to the third metacarpal level was marked. This was taken as the initial reach. Then the subject was asked to reach forward along the yardstick as far as possible without losing balance or taking a step. The subject is asked not to touch the wall or the ruler. The position of the third metacarpal is noted and taken as the final reach. The difference between these two values has given the functional reach value. Two practice trials were

allowed followed by three measurement trials.

The researcher guarded all the subjects during the test.

#### *Timed Up and Go Test*<sup>20</sup>

The timed up and go test measures the time it takes a subject to stand up from an arm chair, walk a distance of 3 meters, turn, walk back to the chair and sit down. A chair of 46 cm of height was used for the study. A 3 meter distance was marked on the floor in front of the chair. The test began with each subject sitting, back against the chair, arms resting on the lap and feet supported on the ground. The subject was instructed that on the word "GO", one should stand up, walk comfortably and safely to the mark on the floor, turn around, come back and sit on the chair. The subject was informed that the trial would be timed. Timing began at the word "GO" and ended when the subject's back rested against the chair upon returning. A practice trial was performed for all subjects before the recorded trial. This was to make the subject familiar with the procedure.

#### *Data Acquisition*

For all the dependent variables (functional reach value and timed up and go test scores), objective evaluation was done during the procedure. Three readings were taken.

#### *Placement of Strain gauge*<sup>[21]</sup>

Measurement of maximum voluntary contraction (MVC) of ankle plantarflexors.

The patient is positioned supine with hip and knee at full extension with heel raised by placing cushion below the calf. The strap is placed around the metatarsals with the therapist stabilizing around the ankle and knee. The strain gauge is mounted to a wall. The foot is moved into plantar flexion for measuring MVC and the reading is recorded.

#### *Assessment of Tight Plantarflexors*<sup>[10]</sup>

The patient is supine with feet extending over the edge of the table. For right leg examination the therapist left grasps the Achilles tendon just above the heel, avoiding the pressure on the tendons. The heel lies in the palm of the hand, fingers curving around it. The practitioner's right hand is placed so that the fingers are placed on the dorsum of the foot (these are not active and do not apply any pulling stretch), with the thumb on the sole, lying along the medial margin.

Stretch is introduced by the means of a pull on the heel with left hand, taking out the slack of the muscle, while at the same time the right hand maintains the cephalad pressure via the thumb (along its entire length).

A range of movement should be achieved which takes the sole of the foot to a 90degrees angle to the leg without any force being applied. If this is not possible(i.e. force is required to achieve the 90degrees angle between the sole of the foot and the leg), there is shortness in the plantar flexors.

It is possible to use the (left) hand which has removed slack from the muscles via traction to palpate for a sense of bind, as the foot is dorsiflexed. The leg must remain resting on the table all the while and the right hand holding/palpating the muscle insertion and the heel should be placed so that it is an extension of the leg, not allowing an upward (towards the ceiling) pull when stretch is introduced.

#### *MET Treatment of Shortened Plantar flexors*<sup>10</sup>

The exact same position is adopted for treatment as for testing. Starting from the appropriate position, at the restriction barrier or just short of it, based on the degree of acuteness or chronicity, the patient is asked to exert a small effort (no more than 20% of available strength) towards plantarflexion, against unyielding resistance, with appropriate breathing.



This effort isometrically contracts gastrocnemius and soleus. This contraction is held for 10seconds together with held breadth.

On slow release, on an exhalation, the foot/ankle is dorsiflexed to its new restriction barrier if acute, or slightly and painlessly beyond the new barrier if chronic, with the patient’s assistance.

If chronic, the tissues should be held in slight stretch for atleast 10 seconds to allow a slow lengthening of tissues.

This pattern is repeated for further gains for 3more times (backing off to mid-range for the next contraction, if chronic, and commencing the next contraction from the new resistance barrier if acute)

*Self stretching protoco*[122]

Patient is in long sitting position with a towel wrapped around foot and held in the both hands to provide resistance during isometric phase each stretch will be held for 30 seconds with up to a 30 seconds rest period between each repetition, stretching were done for 10 repetition in a single session (guidelines of the American College of Sports Medicine [ACSM])

**Data Analysis**

All data was collected and analysed using SPSS for windows version15. The data collected consisted of subjects score on the Timed up and go test, Functional reach test, Range of motion at ankle joint. The scores on timed up and go test was determined by taking mean of two readings awarded by each member of the group and mean for a subject over 3 trials was taken as the score of the elderly on functional reach test. The test -retest reliability of the performance of the patient on the balance score was determined using mean, standard deviation, the paired t-test at 95% confidence intervals, the

pearson’s coefficient were used to determine whether a true linear relationship existed between muscle energy technique and balance score of elderly. Also for comparison between the experimental group and control groups, the magnitude of difference in the values between pre treatment and post treatment were tested. Pre and post intervention were analysed for both the control and experimental groups using independent t test and significance was set at 95% confidence

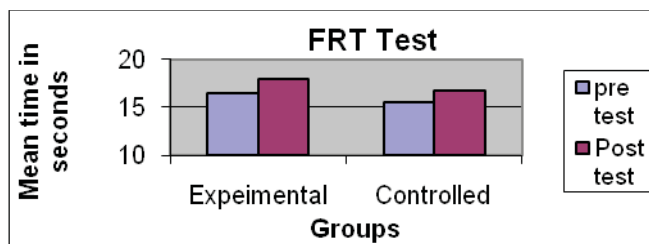
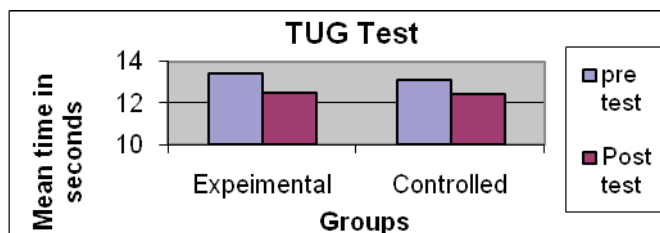
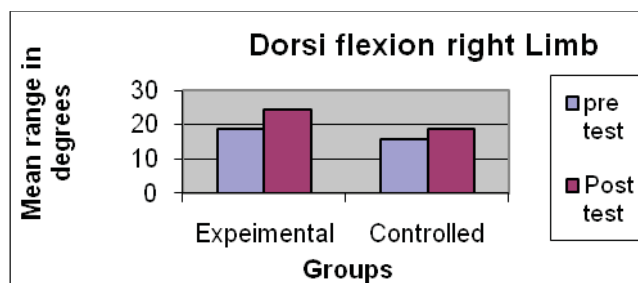


Fig 1.1. Comparison for Timed up and go scores

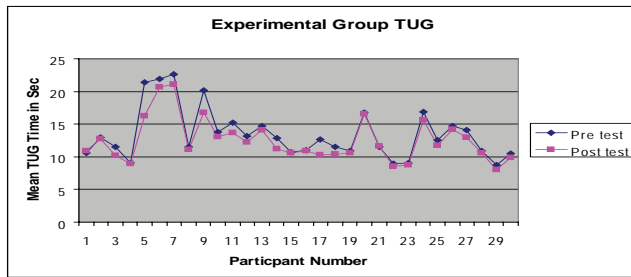


for experimental and control group

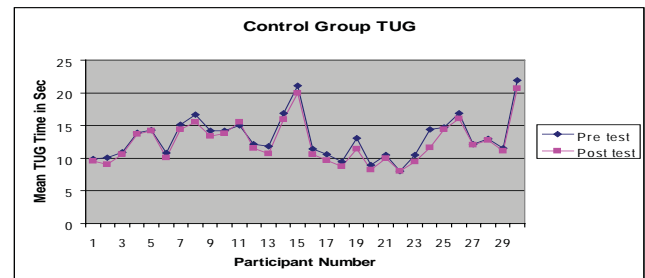
**RESULTS**

Sixty subjects of both sexes with mean age of 65.08 ± 5.29 were agreed to participate in the study.

**Fig 1.2. Individual scores of subjects in timed up and go test in experimental group**



**Fig 1.3 Individual scores of subjects in Timed up and go test in Control Group**



Thirty subjects were randomly selected and placed in the treatment group and received muscle energy technique along with hot pack application and remaining thirty subjects were placed in the control group and underwent self stretching along with hot pack application. All values are expressed as mean  $\pm$  standard error. Independent t-test is used to find the significance between the experimental group and the control group. Dependent t-test or paired t-test was also used to find the significance within the group to see the effect of treatment.

go test and the result is found to very significant because  $p \leq .05$ .(Refer Fig 1.3)

**Functional reach test (FRT)**

Experimental Group: Independent t-test was applied to find the significance between both the groups but the result was found to be insignificant dependent t-test is also applied to find that is there any effect of muscle energy technique on functional reach test and the result is found to very significant (Refer Fig 1.4).

*Differences in pre and post data*

Paired t-test was performed to test the significance of the differences observed in the pre and post values of the various parameters in the data of the subjects in experimental and control group and independent t-test is applied to check which significance between two groups. Timed up and go test (TUG):

Experimental Group: the result was found to be insignificant because the  $p \geq .05$ .(Refer Fig 1.2)

Dependent t-test is also applied to find that is there any effect of muscle energy technique on timed up and go test and the result is found to very significant

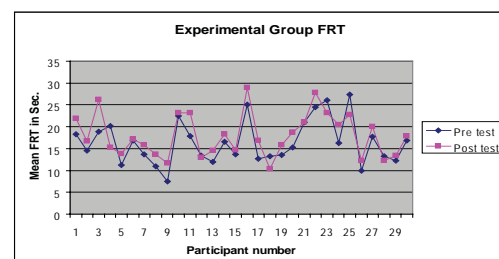
Control group: the result was found to be insignificant because the  $p \geq .05$ .

Dependent t-test is also applied to find that is there any effect of self stretching on timed up and

Control group: Independent t-test was applied to find the significance between both the groups but the result was found to be insignificant

Dependent t-test is also applied to find that is

**Fig 1.4. Individual scores of subjects in functional reach test in experimental group**



there any effect of Self stretching on functional reach test and the result is found to very significant

#### *Range of motion*

On right and left side: Dorsiflexion

Experimental Group: Independent t-test was applied to find the significance between both the groups the result was found to be highly significant Dependent t-test is also applied to find that is there any effect of muscle energy technique in increase the dorsiflexion at ankle joint and the result is found to very significant.

Control group: Independent t-test was applied to find the significance between both the groups the result was found to be highly significant. Dependent t-test is also applied to find that is there any effect of self stretching in increase the dorsiflexion at ankle joint and the result is found to very significant.

From the result t-test and its significance in the pre and post intervention collected from the subjects the

following has been inferred

Ingroup-1 (MET group): The TUG was significantly decreased by 7.4%. FRT scores were significantly increased by 9.5% along with 31% increase in ankle passive range of dorsiflexion after the intervention.

In group-2 (self stretching): The TUG was significantly decreased by 5.4%, FRT scores were significantly increased by 7.9% along with 15% increase in ankle passive range of dorsiflexion after the intervention.

The average mean increase in the group-1 was greater then group-2 but the difference was not statistically significant.

## DISCUSSION

An individual with limited ankle joint mobility may be a risk for tripping and fall, an event which sometimes leads to serious injury and dependence<sup>2</sup> On basis of various studies done, it established that a minimum of 10 degrees of dorsiflexion range of

**Table 1.1 Experimental Group Paired T-test/Dependent**

	Mean	Standard Deviation	T-Value	Deg of Freedom	P-Value
TUG1-TUG2	.9557	1.10	4.72	29	0.000
FRT1-FRT2	-1.57	2.76	-3.11	29	0.004
DFR1-DFR2	-5.77	3.04	-10.40	29	0.000
DFL1-DFL2	-5.20	2.62	-10.87	29	0.000

**Table 1.2 Control Group Paired T-test/Dependent T-**

	Mean	Standard Deviation	T-value	Degree of Freedom	P-value
TUG1-TUG2	.71	.58	6.60	29	0.000
FRT1-FRT2	-1.23	3.36	-2.01	29	0.054
DFR1-DFR2	-3.13	1.63	-10.50	29	0.000



motion is needed during stance (Murray et al; 1966, Stauffer et al; 1977) and swing phase (Patla, Frank and Winter, 1990) of normal gait. There is a correlation between ankle range of motion and balance in community dwelling elderly<sup>5</sup> and the literature reports that stretching significantly benefits flexibility imbalances may be associated with balance impairment and falls.<sup>7</sup>

The data demonstrates that in group I where MET was applied to the bilateral ankle plantarflexor muscles there was significant increase in the balance scores of functional reach test ( $-1.57 \pm 2.76$ ;  $P= .004$ ), TUG ( $.95 \pm 1.10$ ;  $P= .000$ ) and passive range of ankle dorsiflexion for both right and left sides respectively (Right side  $=-5.77 \pm 3.04$ ;  $P= .000$ ), (Left Side  $=-5.20 \pm 2.62$ ;  $P= .000$ ). For the control group in which self stretching was applied at the ankle joint the increase in functional reach test ( $-1.23 \pm 3.36$ ;  $P= .054$ ), TUG ( $0.71 \pm 0.58$ ;  $P= .000$ ) and passive range of ankle dorsiflexion for both right and left sides respectively (Right side  $=-3.13 \pm 1.63$ ;  $P= .000$ ), (Left Side  $=-2.57 \pm 1.36$ ;  $P= .000$ ). However, the research provides us with the evidence that muscle energy technique is a valuable and good tool which can benefit the joints and muscles simultaneously.<sup>23</sup> The mechanism underline improved muscle flexibility may be a result of biomechanical or neurophysiological changes or an increase tolerance to stretching.<sup>3</sup> The joint is mobilized by the isometric muscle contraction and it is believed that golgi tendon reflex is activated which is claimed to produce a stretch on the golgi tendon organs and a reflex relaxation of the muscle.<sup>3</sup>

The another aim of study was to compare the two techniques for balance scores and the result shows undoubtedly the average mean increase in balance scores in group I where MET was applied was better than the group II where traditional self stretching technique was used. Subsequently, the two groups were not statistically significant.

The study reveals that MET is a physiologically adequate technique which utilizes the patient own muscle contraction to alter restriction of motion. MET provides safety for the patient as the intensity of contraction is lesser (20%-30% MVC) and the activating force is intrinsic and the patient can easily control the dosage with lesser effort which is easier for the elderly.<sup>24</sup> After the sustained but light contraction a momentary pause should occur before the therapist stretches the shortened and contracted muscle to a new resting length. Also it is an appropriate technique to correct postural balance and gait by treating group of muscles that influence joints to withstand gravitational strain.<sup>25</sup> Furthermore, it should be noted that the MET applied throughout this study aimed to increase gross range of motion at ankle joint which is a significant and independent predictor of balance, which it succeeded in doing.

In comparison, self stretching is a traditional and widely practiced intervention which leads to improvement but the effect is not maintained for long and even have some negative effects as revealed by the various studies done.

Kirsch et al also examined the effect of a maintained stretch on ankle ROM in healthy subjects and reported small and transient increases in ROM with 60 seconds of sustained stretching.<sup>26</sup>

As the study conducted by Scott G. Spornoga et al; 2001 reported that a single session of stretching does not deform tissues enough to produce a permanent change i.e a plastic deformation in musculotendinous unit. Therefore, the temporary improvement in hamstrings flexibility may be attributed to changes in elastic region caused by a single session of stretching.<sup>27</sup>

In addition, the results of the following study seem to produce improvement in the balance scores with regards to ankle ROM which is a important factor in

balance affection and hence provide therapist with a valuable tool to monitor and regulate falls status for the aged in the community.

The outcome of this study might contribute to the development of adequate exercise programs aiming at preventing or slowing down the age related decline of physical functioning and maintained optimal independence and quality of life without unduly restricting activities.

### CONCLUSION

In summary, the findings of the present study demonstrates that a moderate bout of MET (three repetitions for each individual) held to the point of discomfort/barrier can affect performance on test of balance as well as the passive range of motion (for dorsiflexion and plantarflexion). The technique used for stretching should be preferred as patient is actively participating in the treatment which is psychologically healthier for him and because likelihood of damage to the muscle and its supporting connective tissue is less.

This appears to be a positive effect of MET which in the first place is considered to be and is applied as a method for improving flexibility and range of motion as well as precarious balance or stability of the elderly, but a less significant change was also found by self stretching but further comparative investigation was done to determine the performance by MET and self stretching maneuver was found not to be significant.

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