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EFFECT OF ECCENTRIC TRAINING USING THERA-BAND, MUSCLE ENERGY TECHNIQUE AND STATIC STRETCHING IN HAMSTRING MUSCLE FLEXIBILITY OF PATIENTS WITH MECHANICAL LOW BACK PAIN- A Pilot Study

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ABSTRACT

Objectives: To determine if the flexibility of patients with mechanical low back pain will improve after 6-weeks of eccentric exercise program and MET technique. In addition the changes in the hamstring flexibility that will occur after these interventions will be compared with 6-weeks of program of static stretching. We also determine the pain and disability of the patients.

Study design: We used pre-test post-test control group design. Subjects were assigned randomly to 1 of 3 groups: eccentric training, MET technique, and static stretching.

Method and measurement: A total sample of 12 participants with mean age of 31.91 with tight hamstring and mechanical low back pain participated in the study. Subjects were assigned randomly to 1 of 3 groups: (A) eccentric training, (B) MET technique and (C) static stretching. Each group includes 4 Participants. They were treated for 30 seconds of intervention, 5 days in a week for six weeks.

Results: All groups, eccentric training (9.25), MET technique(6.75) and static stretching(5.00) was compared for between group and within group analysis to check statically significant improvement and shown statically significant improvement in hamstring muscle flexibility, whereas follow up analysis indicated significant differences between each group.

Conclusion: this study shows that eccentric training, MET technique and static stretching, all are effective in increasing hamstring flexibility, but the eccentric training is more effective and statistically significant in improving hamstring muscle flexibility of patients with mechanical low back pain.

Introduction

Stretching is used as part of physical fitness and rehabilitation program because it is thought to positively influence performance and injury prevention. Numerous studies[1,3,5,] have been conducted to investigate the effectiveness of stretching. Shortness and contracture of hamstring muscle may cause limitation in range of motion (ROM) that restricts the normal range of muscle. This potentially harmful condition may be managed with a stretching program, which may be positively influence an individual's functional capacity of daily living and decrease of injuries. . Knee extension range of motion from tight hamstring muscle have been linked to injuries such as hamstring tendonitis and hamstring strains. These patient often receive specific hamstring-stretching exercises as part of an overall rehabilitation programme Several studies have reported an immediate increase in knee extension ROM following the application of hamstring stretching exercises.[2,4,5]

Flexibility has been defined as the ability of a muscle to lengthen and allow one joint (or more than one joint in a series.) to move through a range of motion[2]. Increased flexibility is one of the basic concerns addressed in the day to day practice of physical therapy. It is a goal for any patient recovery from a period of immobilization or injury involving the connective tissue. Optimal flexibility is also desirable for participants in most athletic activity and normal day to day function. A shortened muscle may create imbalance at joints and faulty postural alignment that may lead to injury and joint dysfunction.

Extensibility is defined as the ability to stretch a muscle tendon unit to its fullest length[1]. Muscle contracture result in decreased extensibility joint motion. Physical therapists have used many different methods to maintain and increased joint motion and prevent deformity and dysfunction resulting from the muscle contracture. Research with clinical trials has long advocated the use of thermotherapy to increase flexibility in conjunction with a stretching program design to lengthen tissue. Lengthening the musculotendinous unit and supporting connective tissue increase the range of motion(ROM) through which a joint can move as well a the muscle ability to respond to stress placed upon it . [8.14,15,16]

Increased hamstring stiffness could be a possible contributing factor to low back injuries. Clinical observations have suggested that hamstring tightness influences lumbar pelvic rhythm. Movement restrictions or postural asymmetry likely lead to compensatory movement patterns of the lumbar spine, and subsequently to increased stress on the spinal soft tissues and an increased risk of low back pain (LBP).

The literature reflects some interesting differences of opinion regarding flexibility training and consideration of static stretching as the gold standard. Some authors have questioned the importance of using static stretching to help reduce injuries and improve performance.

Murphy made a compelling argument against the use of static stretching. Although static stretching is often used as part of pre-activity preparation, Murphy argued that the nature of static stretching is passive and does nothing to warm muscle. Murphy suggested a better opinion for maintaining or increasing flexibility of a muscle is through active contraction using dynamic range of motion, there by adding fourth type of stretching.

Previous author[1] suggested that most of injuries occurs in the eccentric phase of activity. Although early groups have examined dynamic range of motion, none have investigated the use of an eccentric agonist contraction to improve flexibility; eccentric training a muscle through a full range of motion theoretically could reduce injury rates and improve the performance of subject and flexibility.

Russel et al[2] proved that in males ages 15-17 years old, hip flexion range of motion gains with eccentrically training were equal to those made by static stretching of hamstring muscle.

Felipe Jose Jandre Reis et al, evaluated Influence of Hamstring Tightness in Pelvic, Lumbar and Trunk Range of Motion in Low Back Pain, and they found that : Participants with LBP showed restriction in the pelvis and TF(trunk flexion) range of motion, but had higher amplitudes in the lumbar spine during forward bending

METHODOLOGY

It is a comparative study. The study has pre-test, post-test experimental group design. Measurement was taken prior to and after respective treatment session at the end of 3rd, 6th and after 2 weeks of follow up on 8th week. It was a Double blinded study, the subjects and researcher being unaware of the groups they belong to.

There were 3 independent variables: eccentric training, static stretching and Muscle Energy technique. The dependent variable was active knee extension range of motion by 90-90 test, hamstring flexibility, pain and disability.

Subjects

A sample of 12 subjects having mechanical low back pain with hamstring tightness with the mean age of 31.91 years participated in the study. All the subjects were recruited from physiotherapy clinic and health centers in Ahmedabad.To participate, the subjects needed to have tight hamstring muscles (inability to achieve 20^{o} of active knee extension in 90-90 trest) & mechanical low back pain. Exclusion criteria included hypermobility, Subject under medication (muscle relaxants), Skin disease, wounds, neurological problem, any circulatory problem or metal implants in the leg.

All the subjects were informed the purpose and procedure of the study and an informed consent was taken from them prior to participation. Subjects were randomly assigned into Group A (eccentric training), Group B (static stretching) and Group C (Muscle energy technique) each group includes 4 subjects.

Instruments

A black colored thera-band, a standard transparent full circle goniometer and a standard stop watch was used.

PROCEDURE

The study was done over 8 week's period with each subject receiving 1 treatment a day for 3 days a week for 6 weeks. Measurement was taken at pre-treatment on 1st day and post-treatment at the end of 3rd and 6th week. The hamstring range of motion of all the subjects were measured after 2 weeks of the last treatment session as a follow up measurement.

The eccentric group performed full range of motion eccentric training for the hamstring muscles. The subject lie supine with left leg fully extended. A 3-feet (0.91m) piece of black theraband was wrapped around the heel of the foot and the subject held the ends of the thera band in each hand.The subject was instructed to keep the right knee locked in full extension and the 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 defined as the position of hip flexion at which a gentle stretch was felt by the subject. As the subject pulls the hip into full flexion with the arms, he was instructed to simultaneously resist the hip flexion by eccentrically contracting the hamstring muscles during the entire range of hip flexion. The subject was instructed to provide sufficient resistance with the arms to overcome the eccentric activity of the hamstring muscles, so that the entire range of hip flexion took approximately 5 seconds to complete.(Figure.1)

Once achieved, this position was held for 5 seconds, and then extremity was made to gently relaxed. This procedure was repeated 6 times, with no rest in between, here by providing a total of 30 seconds of stretching at the end range.[2]

Figure 1. Eccentric training with Thera-band.

Figure 2. Subject doing self-stretching of Hamstring Muscle

The static group was asked statically stretched for 30 seconds 3 days per week for 6 weeks using methods described by Bandy et al[3] and Russel et al[2] Subjects performed the hamstring stretch by standing erect with the left foot planted on the floor and the toes pointing forward. The heel of the foot to be stretched placed on a plinth/chair with the toes directed toward the ceiling. The subject then flexed forward at the hip, maintaining the spine in a neutral position while reaching the arms forward. The knee remained fully extended. The subject continued to flex at the hip until a gentle stretch was felt in the posterior thigh. Once this position was achieved, the subject maintained this position for 30 seconds.(Figure.2)

Figure 3. Performing Muscle Energy Technique.

The last group received MET(Muscle Energy Techinique), in that we follow PIR(post isometric relaxation) technique, which will be repeated 4 times (5 second contraction, 3second

relaxation) for 3 days a week for 6 weeks. (Figure.3)

Terminal extension is determined as the point at which the researcher felt a firm resistance to the movement. Once terminal extension reached, the researcher holding the goniometer ensure proper alignment and the blinded goniometer is revealed to the assisting examiner for the measurement to be read and recorded. Zero degrees of knee extension were considered full hamstring muscle flexibility. No warm-up was allowed before data collection.

Assessment: pre-test measurement of hamstring flexibility were performed with 90-90 test. Subjects, who found suitable for the study, was requested to sign consent forms. A detailed subjective examination was done.

Subjects were also evaluated with pain and disability by using NPRS and Oswestry Disability Index(ODI). This is also taken pre intervention on first day, and at the end of 3rd, 6th and 8th week.

Figure 4.Measuring hamstring flexibility with Goniometry(90-90 test)

Data Analysis

Means and SDs for all groups and all measurements were calculated. We used ANOVA with repeated measure to analyze the data. Appropriate post hoc tests were performed to interpret the findings. An alpha level of $P<0.05$ was the level of significance.

RESULTS

A total of 12 subjects, 9 males and 3 females participated in the study. Each group included 04 subjects. Mean age of the subjects were 31.91±5.28. In our study the participants divided in to 3 groups, and we have taken 90-90 test, nprs and ODI at pre-test and post week at the end of 3rd, 6th and 8th week. Mean and S.D for pre-test and post-test measurements were calculated for each group. A multivariate test was also applied to compare the dependent variable in all three groups. Post hoc analysis for ANOVA was performed using Tukey Kramer multiple comparison in order to interpret the significant effect on dependent variable. The data was analyzed for both within group and between groups. Significance for all the statistical tests was accepted at the 0.05 level of probability.

Knee extension range of motion between three group were compared at Pre-test (ROM 1), at the end of 3rd week(ROM 2), 6th week (ROM 3) and 8th week (ROM 4).(Table.1)

All pretest mean values for knee extension ROM for group A, B, C were 144.25±2.99, 140.50±7.33 and 132.75±2.22 respectively (P= 0.001). At end of 3rd week mean

values for knee extension ROM for group A, B, C were 151.25±2.99, 146.00±7.07 and 139.00±2.16 respectively. At the end of 6th week mean values for knee extension ROM for group A, B, C were 158.00±2.71, 150.50±5.92 and 144.50±2.52 respectively. At the end of 8th week mean values for knee extension ROM for group A, B, C were 153.50.±1.91, 145.50±6.86 and 139.50±2.08 respectively .

	Group A		Group B		Group C	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Age	33.00	4.40	27.75	6.70	35.00	0.82
ROM 1	144.25	2.99	140.50	7.33	132.75	2.22
NPRS 1	3.50	0.58	3.75	0.96	4.75	0.50
ODI1	28.00	3.65	31.00	12.27	33.50	7.55
ROM 2	151.25	2.99	146.00	7.07	139.00	2.16
NPRS 2	2.50	0.58	2.50	0.58	4.00	0.00
ODI 2	22.50	3.00	27.50	13.10	29.50	7.55
ROM 3	158.00	2.71	150.50	5.92	144.50	2.52
NPRS 3	1.75	0.50	1.75	0.50	2.75	0.50
ODI 3	20.50	3.00	25.50	13.10	28.00	8.16
ROM 4	153.50	1.91	145.50	6.86	139.50	2.08
NPRS 4	1.75	0.50	1.50	0.58	2.75	0.50
ODI 4	20.50	3.00	25.50	13.10	27.50	7.55

Table 1. Within group comparison for all the groups.

All pretest mean values NPRS for group A, B, C were 3.50±0.58, 3.75±0.96 and 4.75±0.50 respectively (P= 0.001). At end of 3rd week mean values for NPRS for group A, B, C were 2.50±0.58, 2.50±0.58 and 4.00±0.00 respectively. At the end of 6th week mean values for NPRS for group A, B, C were 1.75±0.50, 1.75±0.50 and 2.75±0.50 respectively. At the end of 8th week mean values for NPRS for group A, B, C were 1.75±0.50, 1.50±0.58 and 2.75±0.50 respectively.

All pretest mean values for ODI for group A, B, C were 28.00±3.65, 31.00±12.27 and 33.50±7.55 respectively (P= 0.001). At end of 3rd week mean values for ODI for group A, B, C were 22.50±3.00, 27.50±13.10 and 29.50±7.55 respectively. At the end of 6th week mean values for ODI for group A, B, C were 20.50±3.00, 25.50±13.10 and 28.00±2.08 respectively. At the end of 8th week mean values for ODI for group A, B, C were 20.50±3.00, 25.50±13.10 and 27.50±7.55 respectively.

Since most of the variables are normally distributed, so parametric test has been used for the analysis.

Further comparing the range for the pre test and post test at the end of 8th week we found that final gain in Group A is 9.25, subsequently the final Gain in Group B (static stretching) is 5.00 degrees. where as in Group C (MET) is 6.75 degrees. So here we have found that significant difference in all group comparing to pre and post data.

When going for the NPRS and ODI scale we found the improving result in all three group in pre and post data. Means there is significant different in within group analysis.

Finally, a Repeated measure ANOVA was calculated to assess the posttest scores of the 3 groups, For ROM revealing a significant difference (F= 14.283, P<0.002). post hoc analyses indicated that the mean score of the eccentric training group (9.25±1.50) was significantly different from the static stretching

group (5.00±1.15), but the eccentric and MET(6.75±0.50) groups did not differ from each other. And also between static and MET group there is no significant different.

For NPRS and ODI, there were no significant different, so post hoc analysis was not done.

Finally, in an attempt to summarize the data, scores revealing a significant difference between groups (P =0.05). Post hoc analysis indicated a significant difference between the gains in the static Eccentric group (9.25± 1.50) and the static group (5.00±1.15). but the eccentric and MET(6.75±0.50) groups did not differ from each other. And also between static and MET group there is no significant different. (Figure 4) (Table 1).

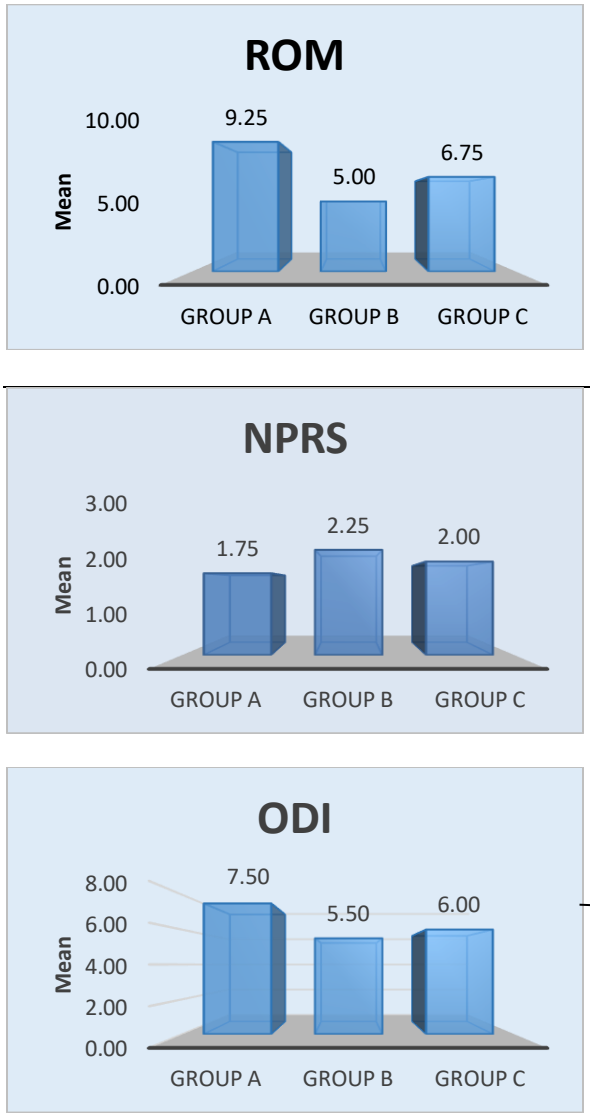

Figure 5. Mean change (difference between pre and post) in ROM, NPRS and ODI

	Group					
	Eccentric training		Static stretching		MET	
	Mean	SD	Mean	SD	Mean	SD

Pre test	144.25	2.99	140.50	7.33	132.75	2.22
Post test (8th week)	153.50	1.91	145.50	6.86	139.50	2.08
Gain	9.25	1.50	5.00	1.15	6.75	0.50

Gain = difference between pre and post

Table 2. Pre-test,Post test and gain ROM

	Group					
	Eccentric training		Static stretching		MET	
	Mean	SD	Mean	SD	Mean	SD
Pre test	3.50	0.58	3.75	0.96	4.75	0.50
Post test (8th week)	1.75	0.50	1.50	0.58	2.75	0.50
Gain	1.75	0.50	2.25	0.50	2.00	0.00

Gain = difference between pre and post

Table 3. Pre-test,Post test and gain NPRS

	Group					
	Eccentric training		Static stretching		MET	
	Mean	SD	Mean	SD	Mean	SD
Pre test	28.00	3.65	31.00	12.27	33.50	7.55
Post test (8th week)	20.50	3.00	25.50	13.10	27.50	7.55
Gain	7.50	1.91	5.50	1.91	6.00	0.00

Gain = difference between pre and post

Table 4. Pre-test,Post test and gain ODI

Discussion

We reject the null hypothesis that, there would be no difference seen in Hamstring muscle flexibility after 8 weeks of eccentric training compared with the static stretching and MET. In within group analysis, the entire groups that performed static stretching and eccentric training and MET in hamstring muscle, shows significantly greater gains in flexibility comparing the pre and post data of ROM and NPRS and also the ODI. Given the significant difference in hamstring muscle flexibility between the experimental groups, eccentric training appears to be more effective in

increasing hamstring muscle flexibility in comparison with static stretching group.

The result supports the theory that eccentric training through a full range of motion increases muscle flexibility. The gains obtained in static stretching group are quite similar to the 3 previous longitudinal studies on the effect of duration of static stretching.[3, 15,17]

Bandy et al[20] examine the effects of statically stretching the hamstring for a variety of duration, including 30 seconds. The gains in knee-extension range of motion after 6 weeks of statically stretching hamstring muscle for 30 seconds were very similar to the gains by the static stretching group in our study.

In a study done by Knight et al, comparison of the effects of 3 treatments on ankle dorsiflexion range of motion was seen. Our study has similar effects of static stretching as that of stretching group in his study.[4] In another study done by Youndas et al[5], the effects of a 6-week program of stretching of the calf muscle tendon unit MTU) on active ankle dorsiflexion range of motion (ADFROM) was examined, where he found that there was no effect of treatment, but in our study contrary to that significant difference in stretching group as compared to control group was seen.

Noberga et al[21, 2] says that resistance training alone did not increase flexibility, but resistance training did not interface with increase in joint range of motion during flexibility training. These results support the concept that specific training should be employed in order to increase either muscle strength or flexibility, whereas eccentric training increases strength of the muscle and in our study we had proved that it also increases flexibility.

The mechanism for the increased flexibility with eccentric muscle activity through the full range of motion is unclear. One explanation may be found in examining the possible neurologic mechanism that occurs with stretching. Static stretching may be effective in increasing the length of the muscle due to the prolonged stretching, which may allow the muscle spindle to adapt over time and cease firing.[17]The result of this adaptation/relaxation of the muscle spindle increases length in the muscle. Given that eccentric exercise through the full range of motion is a continual movement lasting only 5 seconds, the muscle spindle does not appear to have time to adapt, and this explanation does not appear to be appropriate for explaining the change in flexibility due to the eccentric activity. Although eccentric training of the hamstring muscle achieves the same flexibility gains as MET, the eccentric training offers more functional option for flexibility training. Individuals training muscle eccentrically may reduce the chance of injury by training the muscle in a more functional type of activity.[2, 22]

In our study we found that after the 2 weeks of rest, lasting effect in all the groups' decreases, which support the previous studies. We also found that there was less decrease in eccentric group than that of stretching group. In a study by Zito et al, [24] who investigated that lasting effect of 15 seconds of passive stretch on ankle dorsiflexion range of motion, and found that after taking measurement over 24 hours no significant length gain was seen. This is similar to our study.

In another study Knight et al[4] found that after the six days of rest there is a increase in the ROM, which is contrary to our results. In our study there was a decrease in the ROM

T. G Potier et al[13] investigated whether eccentric strengthening changed the muscle architecture of human biceps femoris and consequently, knee range of motion and they found increase in FL (fascicle length) in the biceps femoris and this could lead to increase in ROM of knee.

Batista et al, [23] evaluated the effects of an active eccentric stretching program for the knee flexor muscles on range of motion and torque. They concluded that this program was effective for increasing the flexibility.

Russel et al [2] had studied on hamstring muscle flexibility by using both eccentric training and static stretching for six weeks program and after six weeks they concluded that the gains achieved in range of motion of knee extension

with eccentric training were equal to those made by statically stretching of hamstring muscle, and in our study on we concluded the gains achieved in range of motion of hamstring muscle with eccentric training for 8 weeks were significant as compared to those made by static stretching. Which also supports the study of Russel et al.[2]

Therefore, other research is now needed to determine if gains are made in strength, injury reduction, and performance improvement through an eccentric-training exercises program similar to the program used in the present study.

Move on to the muscle energy technique, Biswas et al, found that MET is more effective then static stretching , in our study as well we found that more improvement in hamstring muscle flexibility in MET group comparing to the static stretching group.

We also supports the ballentyne et al, who stated that MET is effective in increasing hamstring muscle extensibility.

Adel Rashed et al, proved that both MET and dynamic stretching improves hamstring flexibility, hence in our study also all the three intervention increases hamstring flexibility.

Jose Filpe et al, established that people with hamstring tightness are more prone to the LBP, hence in our study we have also proved that and found the participants with low back pain and almost all the participants have tightness of hamstring muscles.

Abdul Sattar et al, stated that Stretching exercises Program of Hamstring Muscles could improve Low Back Pain among Surgeon in Operation Theatre. Stretching Program of Hamstring Muscles is good methods that improve Low Back Pain among Surgeon. In our study we support this conclusion and can definitely put a mark that hamstring stretching not just increase the flexibility of hamstring muscles but also it improves the low back pain.

The first limitation of our study was we have included both male and female patients in all the groups. So here that might have possible that the ratio of male to female might have more in one group and less in other group. So future research can be organized in such a way that, we can categorize male and females in two different groups.

The second limitation was age group taken was applicable for both younger and elderly patients, but it was not taken for very old people. Further studies can be done with different age group, as here for the Oswestry disability index we found that it is limited according to our age group. Future studies can be done with more specific age groups or only elder or younger age groups.

The last limitation was measurement with goniometer needs more perfection, with inclinometer or more recent devices.

We suggest that, this project could also be adapted to test the extensibility of other joint muscle groups such as the Calf or quadriceps femoris muscle.

CONCLUSION

All the three groups in this study eccentric training, static stretching and MET showed increase in the flexibility of the tight hamstring muscles and show significant improvement comparing to the pre and post data.; however there is significant difference in eccentric training and static stretching group.

This result suggests that there is further scope for the use of eccentric training for flexibility training in individual muscle group in a more functional type of activity.

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