

To Compare the Immediate Effect of Hold-Relax Technique Versus Myofascial Release on Delayed Onset Muscle Soreness of Quadriceps Muscle in Runners

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ABSTRACT

Background and purpose: The objectives of the study were to assess and compare the effectiveness of Hold and Relax technique (H&R) with Thera gun and Myofascial release (MFR) with Thera gun on Delayed Onset of Muscle Soreness (DOMS) of quadriceps in runners. Myofascial release and Hold and relax technique both are used for a recovery from exercise induced fatigue which involves pain, soreness and decreased range of motion (ROM) which is crucial for subsequent performance. Along with both these techniques vibrational therapy also helps in alleviating DOMS.

Method: This study was an experimental study design. The samples were selected on the basis of Simple Random Sampling method. 40 subjects selected, in the age ranging from 20 to 40 years were assigned in two groups; Group A received hold and relax technique along with Thera gun (20 subjects) and group B received myofascial release technique with Thera gun (20 subjects). Pain, muscle soreness and range of motion was measured using Visual analogue scale (VAS), 7- point Likert scale and Universal goniometer. Both, Pre intervention and post intervention was done. Immediate effect after the technique applied was recorded in the study.

Results: Means were analyzed using Paired 't' test as a parametric and Wilcoxon signed rank test as a non-parametric test have been used to analyze the variables from preintervention to post-intervention with calculation of percentage

of change, there was a significant improvement in means of VAS, 7-point Likert scale and universal goniometer in terms of pain, muscle soreness and range of motion.

Conclusion: Myofascial release technique was marginally more effective in reduction of pain and muscle soreness and increase range of motion.

Keywords: delayed onset of muscle soreness, hold and relax, myofascial release, vibrational therapy, Thera gun, visual analogue scale, 7- point Likert scale, universal goniometer, pain, range of motion

INTRODUCTION

The quadriceps femoris muscle is inserted into the patella with three layered marshalling through a common tendon of vastus medialis, vastus lateralis, vastus intermedius and rectus femoris muscle. [1] The quadriceps femoris insertion into the patella is said to be through a common tendon with a three-layered arrangement: rectus femoris (RF) most superficially, vastus medialis (VM) and lateralis (VL) in the intermediate layer, and vastus intermedius (VI) most deeply. [2]

Delayed-onset muscle soreness (DOMS) is a kind of pain that you feel in your muscle after a heavy workout. Your muscle experiences sore, aching feeling after an intense workout which your body is not familiar or accustomed with. Exercise

induced muscle damage DOMS is considered as a type 1 muscle strain injury that has a pain free period of 12-24 hours and muscle soreness peaks between 24-72 hours. DOMS are experienced more after eccentric exercises rather than concentric exercises as it causes more damage to muscle fibres and connective tissues.^[3]

Unaccustomed exercise can also produce a build-up of metabolites within the working muscle. This in turn will give rise to osmotic changes in the cellular environment of the muscle, causing fluid retention and subsequent pressure on sensory nerves.^[4] Type II motor units are affected more than type I motor units because the maximal force is maximum in large cells, in which the loads inflicted are approximately 60% greater than the maximal force that the cells can develop. The sequential morphologic changes in runners suggest that the increase in skeletal muscle CK-MB is a marker of cellular regeneration. Hence the recovery of delayed muscle soreness is slow and depends on the regeneration of the injured sarcomeres.^{[5][6]}

Running and muscle soreness almost goes hand in hand. Musculoskeletal problems like pain and muscle soreness are very common in runners. Every long-distance runner must have experienced delayed onset of muscle soreness. Experiencing DOMS is common among runners as running stresses the muscles, causing tiny tears and inflammation. As the muscles get accustomed to working, the soreness decreases. In delayed onset of muscle soreness, the muscles are felt tight and fatigued in 12 to 24 hours of your last run.^[7]

Researchers observed a significant increase in the joint range of motion after using the MFR technique and no decrease in muscle force or changes in performance after treatment with MFR.^[8] Myofascial release is a hands-on soft tissue technique that facilitates a stretch into the restricted fascia. A sustained pressure is applied into the restricted tissue barrier; after 90-120 seconds the tissue will undergo histological

length changes allowing the first release to be felt. The therapist follows the release into a new tissue barrier and holds. After a few releases the tissue will become softer and more pliable. The restoration of length and health to the myofascial tissue will take the pressure off the pain sensitive structures such as nerves and blood vessels, as well as restoring alignment and mobility to the joint.^{[9][10]} Therefore, MFR is a form of manual medicine which is widely used by physiotherapists in the management of different musculoskeletal pathologies. MFR therapy produced a significant improvement in both pain and disability.^[11] Despite the heterogenicity of the studies, myofascial release appears to have a positive effect on range of motion, soreness, fatigue following high intensity eccentric exercises to aid performance and recovery.^[12] Also myofascial release is beneficial in improving flexibility and strength of the muscle.^[13]

Hold relax-agonist contraction is another technique which showed a significant increase in muscle activity and a significant decrease in muscle fatigue.^[14] In Hold and Relax technique patient should be in relaxed position and the muscle should be stretched passively to the end range. Further muscle activation is done by trying to perform the movement and match the resistance which is applied by the therapist externally. Generally, the contraction should be of 5 secs and then the muscle should be relaxed for 10 secs. This helps in increasing the flexibility of the muscle which eventually leads to increase in range of motion.^[15]

On the other hand, Vibrational therapy is also considered to be beneficial as it stimulates the muscle spindles and alpha-motor neurons muscle causes muscle contraction, and it increases electromyographic activity. Vibration is periodic alteration of force, acceleration and displacement over time in form of mechanical oscillation. Vibration exercise is a forced oscillation, in a physical sense, in which energy will transfer from an actuator

(i.e., the vibration device) to a resonator (i.e., the human body, or parts of it). Three aspects may attribute to acute vibratory stimulation effects; they are motor pool activation, frequency of vibratory stimulation and initial length of stimulatory muscle.^[16] Effective exercise intervention for amplifying neuromuscular performance in athletes. It enhances muscular power, strength development, decrease in muscle soreness, kinaesthetic awareness, increased range of motion and blood flow under the skin. Post workout vibrational therapy demonstrates muscle soreness with less reduction maximal isometric and isokinetic voluntary strength and low creatine kinase levels in blood.^[17]

Not many studies were found on the effects myofascial release and hold and relax along with vibrational therapy on muscle soreness. Hence, a need arises to find out and compare the immediate effect of Hold and relax with Thera gun versus the immediate effect of Myofascial release with Thera gun on muscle soreness in runners.

Materials used:

- Treatment couch.
- Thera gun.
- Universal Goniometer.
- Scales- Visual Analogue scale and Likert scale of muscle soreness.
- Pen and paper.

METHOD

All the subjects who fulfil the inclusion criteria were assigned to two groups based on simple random sampling. The subjects were randomly allocated into two groups of 20 each. 40 pieces of paper were used; twenty papers written with the letter 'A' to identify the subjects to take into Thera gun with Hold- relax technique group and the other twenty letters with the letter 'B' to identify the subjects to take into Thera gun with myofascial release technique group. All the 40 pieces of paper were tightly folded and placed in a box. 20 subjects with the letter 'A' were enlisted under Thera gun combined with Hold- relax

technique group and the other 20 subjects with the letter 'B' were enlisted under Thera gun with myofascial release technique group. Complete explanations were given to both the groups separately and the subjects were unaware to which group they belong. Subjects were blinded in either type of intervention, or to which group they belong. Throughout the treatment sessions, subjects from both the groups were not allowed to have any interaction to each other and the subjects were not aware of what kind of treatment will they receive and how will it affect.

Once the subject agreed to participate in the study, an informed written consent was taken from the subjects. As the study includes human subjects' ethical clearance is obtained from ethical committee of K.T.G. College of physiotherapy and KTG Hospital, Bangalore as per the ethical guidelines for Bio-Medical research on human subjects, 2000 ICMR, New Delhi. The subjects were treated in the out-patient physiotherapy department. Informed written consent was taken from each subject. Runners suffering from DOMS in quadriceps muscle group with age between 20 to 40 years were included in the study. Both males and females were included in the study. Those who participated in vigorous exercises for 6 months or having a history or having history of deep vein thrombosis, sports haematuria, any kind of surgery, stress fracture, Achilles tendinopathy, Limb length discrepancy, Hypertrophic cardio myopathy, unresolved balance disorder, intraarticular joint injection within 4 weeks, upper or lower motor neuron lesion, spine surgery, subjects under steroids or any kind of medication, meniscal tears or patellofemoral pain syndrome were excluded from the study.

Group A was treated with Hold and relax technique along with Thera gun. While applying Thera gun position of the patient was supine and position of the therapist was walk standing. The vibrational therapy with the help of Thera gun was applied to the whole course of quadriceps

muscle of the subject. This therapy was given to the subject for 5 minutes. After the therapy with Thera gun, Hold- relax technique was be applied on the subject immediately.

For Hold and relax technique patient is in prone line and therapist is in walk standing position. The Hold-relax technique was started with 10 seconds of passive stretch by flexing the knee of the subject and extending their hip passively. After that the resistance applied at the lower leg in the

same position for 6 seconds. The subject was asked to hold the position by applying same amount of pressure applied by the therapist. The patient was asked to try to do the knee extension and match the resistance but not actually do the knee extension. The technique was ended by applying the same passive stretch which was applied in the start of the technique for 10 seconds. This whole technique was carried out 5 times per session

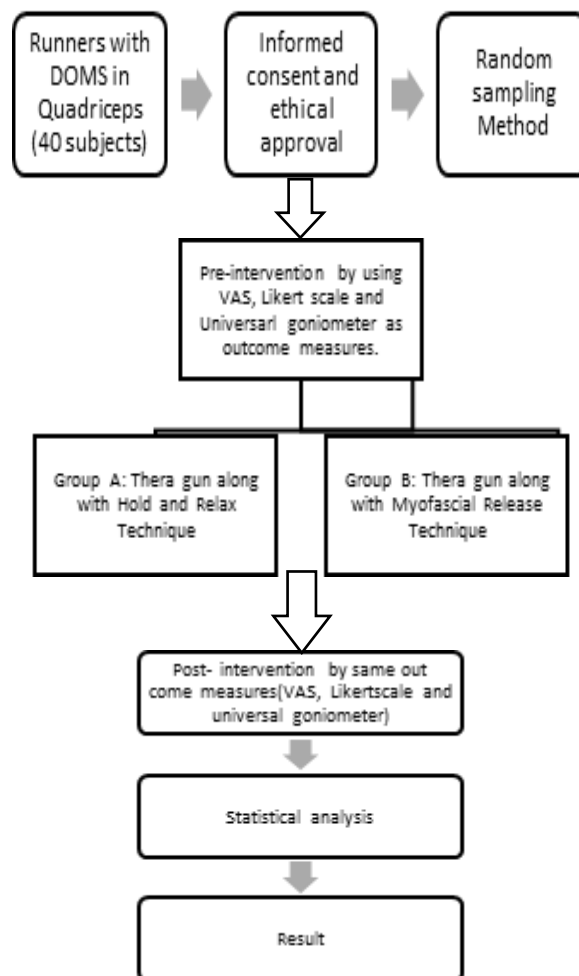


Fig 1: Applying Thera gun on subject of Group



Fig 2: Applying Passive Stretch to Quadriceps



Fig 4: Applying Thera gun on subject of group B



Fig 3: Applying Hold and Relax Technique



Fig 5: Applying Myofascial Release Technique

Procedure of intervention group B

- The position of the subject and the method of vibrational therapy with Thera gun was similar as mentioned above in the procedure of intervention group A. The patient was lying in supine position and was told to be relaxed. Again, a pillow was placed under both knees of the subject for the muscle to be in a relaxed position. Therapist is standing on the foot end of subject. The position of the therapist is walk standing. Both the hands of the therapist were used in this technique. They were placed on the subject's Quadriceps group of muscles. One hand of the therapist was used to lock the muscles on the upper side of the thigh and the other hand was sliding through the entire thigh with sustained pressure, lengthening the muscle. The strokes of myofascial release were continued for 3 minutes per session to release the tension built in the muscles.

OUTCOME MEASURES:

All the patients were assessed for the following:

- **Severity of Pain was described by VAS (Visual Analogue Scale):**

A 10 cm visual analogue scale (VAS) was used for rating the intensity of perceived pain. The scale had 0 (no pain at all) and 10 (maximum pain felt at this moment) at either ends. The scale was explained properly to the subjects and then they were asked to specify the severity of pain from this scale.

- **Knee range of motion was measured by goniometer:**

Each subject was told to sit in high sitting position to measure knee extension from 90-degree knee flexion. The patient was told to sit straight without leaning there back backwards. The measurement was done using a universal goniometer.



Fig 6: Measuring Range of motion for Knee extension.

- **The severity of DOMS was measured by 7- point Likert scale of muscle soreness:**

Similar to the visual analogue scale, Likert scale was explained in detail to the subjects and then they were asked to tick the sentence in the scale to describe their level of muscle soreness in past 12 hours after the physical activity.

RESULTS

Table-1: Distribution of runners with DOMS of quadriceps according to gender in both groups.

Sr.no.	Gender	Group	
		Group-A: Thera gun with Hold relax technique	Group-B: Thera gun with MFR
1	Male	13(65.0%)	13(65.0%)
2	Female	7(35.0%)	7(35.0%)

Chi-Square value=0,
df=1, p>0.05, NS

NS-Not significant. i.e., p>0.05.

The above table shows the proportion of Runners with DOMS of quadriceps according to gender. In group-A, the subjects with DOMS of quadriceps in Runners 13(65.0%) of them were males and 7(35.0%) of them were females. In group-B, the same gender proportion of 13(65.0%)

and 7(35.0%) of girls was found. It evidenced the baseline characteristic of gender is homogeneous in both the groups. The following pie diagrams depicted the proportion of Runners with DOMS of quadriceps according to gender.

Table-2: Range, mean and SD of age of the Runners with DOMS of quadriceps in both the groups.

Sno	Variable	Group-A		Group-B		Unpaired t-test
		Range	Mean ± SD	Range	Mean ± SD	
1	Age in years	20-38	30.02±6.13	22-39	29.15±5.13	t=0.475, p>0.05, NS

NS-Not significant. i.e., p>0.05.

Statistical Methods

Descriptive statistical analysis has been carried out in the present study. Outcome measurements are measured for pain, soreness and range of motion using VAS, 7-point Likert scale and universal goniometer respectively. Significance is assessed at 5% level of significance with p value 0.05 less than this is considered as statistically significant difference.

Statistical Tests

- **Pearson Chi-Square test** and has been used to analyse the significant of basic characteristic of gender, age and side distribution of the subjects studied.
- **Paired 't' test** as a parametric and **Wilcoxon signed rank test** as a non-parametric test have been used to analysis the variables pre-intervention to post-intervention with calculation of percentage of change.
- **Independent 't' test** as a parametric and **Mann Whitney U test** as a nonparametric test have been used to compare the means of variables between groups with calculation of percentage of difference between the means.

The table 3 presents the outcomes of age in years of the runners with DOMS of quadriceps in both the groups. In group-A, the subjects were ranging within the age of 20-38 with mean and SD of 30.02±6.13. In group-B, the subjects were ranging within

the age of 22-39 with mean and SD of 29.15±5.13. The unpaired t-test was carried to compare the means, which was found to be not significant at 5% level (i.e., p>0.05). It revealed that the baseline characteristic of age was similar in both the groups.

Table-3: Distribution of runners with DOMS of quadriceps according to type of running in both groups.

Sr.no.	Type of running	Group	
		Group-A	Group-B
1	Treadmill	8(40.0%)	9(45.0%)
2	Marathon	12(60.0%)	11(55.0%)
		Chi-Square value=0.102 df=1, p>0.05, NS	

NS-Not significant. i.e., p>0.05.

The above table shows the proportion of Runners with DOMS of quadriceps according to type of running. In group-A, the subjects with Runners with DOMS of quadriceps 8(40.0%) of them did treadmill running and 12(60.0%) of them did marathon running. In group-B, more or less the same proportion of runners of

9(45.0%) did treadmill running and 11(55.0%) did marathon It evidenced the baseline characteristic of type of running is homogeneous in both the groups. The following pie diagrams depicted the proportion of Runners with DOMS of quadriceps according to type of running.

Table-4: Range, mean and SD of outcome measures of runners with DOMS of quadriceps in group-A

Sr. no.	Outcome measures	Group-A				Wilcoxon test/ paired t-test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	VAS	5-8	6.28±0.91	4-7	5.45 ± 0.99	z=3.017*	p<0.001
2	Muscle soreness	4-5	4.45±0.51	3-5	3.90±0.64	z=3.054*	p<0.001
3	ROM	30-50	41.00±7.88	50-70	62.00±6.15	t=13.077*	p<0.001

Note; * denotes –Significant (p<0.05), z- Wilcoxon test, t-paired t-test.

The above table-4 shows the pre and posttest outcomes of outcome measures among the subjects with runners with DOMS of quadriceps in group-A. In pretest, the pain (VAS) was ranging within 5-8 with mean and SD of 6.28±0.91. But in posttest, it was found to be decreased to the range 4-7 with mean and SD of 5.45 ± 0.99. The Non parametric test for significance of dependent outcomes and ordinal the Wilcoxon test was carried out and it was found to be significant (p<0.001).

Regarding functional activity level in pretest, the scores were ranging within 4-5 with mean and SD of 4.45±0.51. But in posttest, the scores were found to be decreased to the range of 3-5 with mean and

SD of 3.90±0.64. The parametric test for significance of dependent outcomes and measurable the paired t-test was carried out and it was found to be significant (p<0.001)

According to ROM, in pretest, the scores were ranging within 30-50 with mean and SD of 41.00±7.88. But in posttest, the scores were found to be increased to the range of 50-70 with mean and SD of 62.00±6.15. The parametric test for significance of dependent outcomes and measurable the paired t-test was carried out and it was found to be significant (p<0.001).

It evidences that there is a significant reduction in pain and muscle soreness and improvement in ROM of runners with DOMS of quadriceps in group-A.

Table-5: Range, mean and SD of outcome measures of runners with DOMS of quadriceps in group-B

Sr. no.	Outcome measures	Group-B				Wilcoxon test/ paired t-test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	VAS	5-8	6.45±0.88	3-7	4.40 ± 0.91	z=4.072*	p<0.001
2	Muscle soreness	3-5	4.35±0.0.52	2-5	3.43±0.68	z=3.358*	p<0.001
3	ROM	30-50	41.50±6.86	60-90	72.00±8.84	t=15.699*	p<0.001

Note; * denotes –Significant (p<0.05), z- Wilcoxon test, t-paired t-test.

The above table-5 shows the pre and posttest outcome measures among the subjects with runners with DOMS of quadriceps in group-A. In pretest, the pain (VAS) was ranging within 5-8 with mean and SD of 6.45±0.88. But in posttest, it was found to be decreased to the range 3-7 with mean and SD of 4.40 ± 0.91. The Non parametric test for significance of dependent outcomes and ordinal the Wilcoxon test was carried out and it was found to be significant (p<0.001).

Regarding functional activity level in pretest, the scores were ranging within 3-5 with mean and SD of 4.35±0.0. 52.. But in posttest, the scores were found to be decreased to the range of 2-5 with mean and

SD of 3.43±0.68. The parametric test for significance of dependent outcomes and measurable the paired t-test was carried out and it was found to be significant (p<0.001).

According to ROM, in pretest, the scores were ranging within 30-50 with mean and SD of 41.50±6. 86.. But in posttest, the scores were found to be increased to the range of 60-90 with mean and SD of 72.00±8.84. The parametric test for significance of dependent outcomes and measurable the paired t-test was carried out and it was found to be significant (p<0.001).

It evidences that there is a significant reduction in pain and muscle soreness and improvement in ROM of runners with DOMS of quadriceps in group-B

Table-6: Comparison of pre and posttest outcome measures of runners with DOMS of quadriceps in between the groups.

Sr. no.	Outcome measures	Pre test		Post test	
		Group-A	Group-B	Group-A	Group-B
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	VAS	6.28±0.91	6.45±0.88	5.45 ± 0.99	4.40 ± 0.91
2	Muscle soreness	4.45±0.51	4.35±0.0.52	3.90±0.64	3.43±0.68
3	ROM	41.00±7.88	41.50±6.86	62.00±6.15	72.00±8.84
Between group comparisons: Mann- Whitney U test / Unpaired t-test		<ul style="list-style-type: none"> VAS:z=0.213, p>0.05, NS Soreness, z=0.653 p>0.05, NS ROM, t=1.024, p>0.05, NS 		<ul style="list-style-type: none"> VAS: z=0.786, p>0.05, NS Soreness, z=1.986 p<0.05, S ROM, t=4.119, p<0.05, S 	

S-denotes significant (p<0.05); NS – not significant (p>0.05).

DISCUSSION.

In present study, and experimental study design of 40 subjects with Delayed onset of muscle soreness in quadriceps muscle were randomized in two groups: Group A (n=20) Group B (n=20). The study showed that both Hold and relax technique and myofascial release technique are effective in reducing pain, muscle soreness in quadricep muscle of runners. It was also found that there was increase in range of motion after both the techniques were applied on the subjects.

When compared between the groups there is marginal significant difference

between hold and relax technique and myofascial release technique in reducing pain which was assessed using visual analogue scale (VAS), reducing muscle soreness assessed using 7- point Likert scale for muscle soreness and there is statistically significant difference in improving range of motion assessed using Universal Goniometer.

The difference between pre and post outcome measures imply a significant relief in pain and soreness and increase in range of motion. Immediate effect of the techniques was recorded by the therapist with the help of VAS, & 7-point Likert scale and

universal Goniometer. According to Tojima M (2015) running and muscle soreness in quadriceps go hand in hand. Long distance running leads to muscle tightness and change in serum creatine kinase levels and muscle soreness due to microdamage caused in muscle fibers. [18] The pain is normally triggered by muscle contraction, stretch, pressure, or mechanical stimuli that do not usually induce pain in an unexercised muscle.

A study showed that all examined force output profiles (maximal voluntary contraction, rate of force development, and force steadiness of the knee extensors) were disturbed immediately following eccentric exercise of the knee extensors. Hence muscle soreness is common in quadriceps group of muscle in runners. [19] Muscle from veteran runners showed intercellular collagen deposition suggestive of a fibrotic response to repetitive injury. Control tissue from nonrunners showed none of these findings. [20] Up to six hypothesised theories have been proposed for the mechanism of DOMS, namely: lactic acid, muscle spasm, connective tissue damage, muscle damage, inflammation and the enzyme efflux theories. [55] The above statement suggests that DOMS can affect the athletic performance by causing reduction in joint range of motion, shock attenuation and peak torque. [21] A study done by C villa Cha showed that eccentric exercise and subsequent DOMS of the quadriceps reduce the maximal force, rate of force development and force steadiness of the knee extensors, and is accompanied by different adjustments of agonist and antagonist muscle activities. [19]

The method used for group A was Hold and relax technique along with Thera gun and the method used for group B was myofascial release along with Thera gun. Group A which was treated by hold and relax technique with Thera gun showed decrease in pain and muscle soreness and improved range of motion for knee extension. A study done by Kim, Ji-seon, woo, Young-keun and ki, kyong also stated

that the hold and relax application showed greater changes in tenderness thresholds, in range of motion and in pain intensities. [22] An interventional study on effectiveness of hold and relax technique showed marked difference in muscle pain and tightness. [23]

Group B which was treated by myofascial release with Thera gun also showed significant changes pre and post technique. A study done by Chris Beardsley and Jacob Skarabot implied that MFR appears to have a potentially valuable effects on athletes and general population by increasing flexibility and reducing soreness which eventually enhances the recovery. [24] Myofascial release is a technique which can be used for a recovery from exercise induced fatigue which involves pain, soreness and decreased ROM which is crucial for subsequent performance. [25] The literatures regarding the effectiveness of myofascial release were mixed in both quality and results. MFR is emerging as a strategy with solid evidence base and tremendous potential. [26]

In both the groups Thera gun was used as a vibrational Therapy on the quadriceps group of the subjects. Vibrational Therapy is being increasingly used to treat or prevent DOMS. Meta analysis was done to evaluate the effectiveness of vibration therapy on muscle soreness. This study indicated that vibration is a beneficial and useful form of physiotherapy used for alleviating DOMS. [27] Mechanical oscillatory motion was provided to the quadriceps muscle by the Thera gun. These vibrations eventually helped in increasing potential hormonal responses which helps in reducing pain and soreness and increases the proprioceptive neuromuscular functions. [17] Vibrations provide stimulation to muscle spindles and increases the afferent activities. Hence it can be very beneficial if used as prevention of DOMS. [28]

Subjects in both groups experienced Delayed onset of muscle soreness after running on treadmill for a longer time than usual or after running a marathon.

DOMS is most prevalent at the beginning of the sporting season when athletes are returning to training following a period of reduced activity. [29] Hence it was made sure that they were not indulged in high intensity of strenuous exercises for 6 months. Some of the subjects were a regular marathon runner who used to run a marathon once a month. While some of the subjects were not indulged into any kind of running. The age of the subjects varied from 20 to 40 years and both male and female runners were taken as subjects. The mean age of the runners who participated in the study for group A is 30.02 ± 6.13 and group B is 29.15 ± 5.13 . In this study 65% of the subjects were male and 35% of the subjects were female.

A study was done to determine if rating of perceived exertion correlated with perceived muscle soreness during delayed onset muscle soreness (DOMS) in female runners. Six female recreational runners (mean age = 24.5) performed level running at 65%, 75%, and 85% of their maximum oxygen uptake (VO₂) peak prior to downhill run (DHR) (baseline economy runs), as well as, immediately following and 4 successive days after the DHR. It was concluded in the study that running economy is adversely affected by the DOMS. [9]

In group A 60% of the subjects experienced soreness from treadmill running while the other 40% experienced soreness from running a marathon. Where as in group B 45 % of the subjects experienced muscle soreness in quadriceps from treadmill running and the other 55% experienced muscle soreness from marathon runners. The subjects were not aware of what technique is going to be applied on them.

In group A, hold and relax technique with Thera gun was applied to the subjects in which VAS and muscle soreness pre-test was 6.28 ± 0.91 and 4.45 ± 0.51 respectively which reduced to 5.45 ± 0.99 and 3.90 ± 0.64 after the technique was applied. Whereas the mean of range of motion pre-test was 41.00 ± 7.88 which increased to 62.00 ± 6.15 after the technique was applied.

In group B, myofascial release technique with Thera gun was applied to the subjects in which VAS and muscle soreness pre-test was 6.45 ± 0.88 and 4.35 ± 0.52 respectively which reduced to 4.40 ± 0.91 and 3.43 ± 0.68 after the technique was applied. Whereas the mean of range of motion pre-test was 41.50 ± 6.86 which increased to 72.00 ± 8.84 after the technique was applied.

As mentioned above, it is very clear that both the techniques were effectual in treating muscle soreness experienced after running. But, when compared between both the groups, the effectiveness of MFR technique with Thera gun was relatively higher than the hold and relax technique with Thera gun. A study done by Kage Vijay and D' Silva Pamela V stated that Administration of a 5-day intervention for myofascial release with foam roller has proved to be more effective than static stretching in releasing hip adductor tightness, increasing hip adduction range of motion and improving balance when subacute effects are intended. Hence myofascial release is much more beneficial in reducing pain, soreness and improving the range of motion. [30]

Therefore, considering the significant difference in pain, muscle soreness and range of motion after applying both the techniques the study accepts the alternate hypothesis.

CONCLUSION

The present study concludes that both Hold and relax technique applied with Thera gun and Myofascial release technique applied with Thera gun are individually effective in treating DOMS in quadriceps muscle group of runners. But while comparing both tests out come in between the group the intervention of Thera gun with Myofascial release was found to be better in reduction of pain and muscle soreness and improvement of range of motion of runners with DOMS in quadriceps.

It is recommended clinically to consider Thera gun with Myofascial release

technique as an effective technique for the treatment of DOMS in quadriceps muscle group of runners. Hence, the study helps to derive more effective technique for enhancing the performance of the runners and thus helpful in sports training

Limitations Of the Study

- Both male and Female subjects are taken together under the same condition
- Cardio Pulmonary capacity is also to be taken into consideration.
- Specific pathology of osteoarthritis of knee is not known and it's taken in general.
- Immediate effect of an intervention.
- Sample size is small with fixed population
- Findings were based on only three outcomes.
- Only DOMS in quadriceps muscle group was taken into consideration.
- Further randomized control trial is needed to find long term effects of both the techniques.

Recommendation For Future Research

- Further study can be carried to find the effect of hold and relax technique and myo fascial release technique.
- Further study to find the effect of vibrational therapy on DOMS.
- Further study to evaluate the reduction in pain and muscle soreness by incorporating various tests
- Further study can be done to investigate the improvement in range of motion of the joint
- Further study can be done on the larger sample population
- Further study can be done over different age groups of runners having DOMS
- Further study can be done on DOMS in different muscle groups.

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