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Comparative study between Light Concentric exercise and Foam rolling on Delayed Onset Muscle Soreness in young adult females

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ABSTRACT

Background
Delayed onset muscle soreness frequently occurs after exhaustive or unaccustomed exercise, particularly if the exercise involves eccentric muscle contraction. Eccentric contraction often induces muscle fibre injury which is associated with the muscle's decreased ability to generate force and a set of indirect muscle damage markers, such as muscle soreness, increased muscle stiffness with reduced range of motion.

Aim
To compare the effect of light concentric exercise and foam rolling on delayed onset muscle soreness in young adult females.

Methods
In this comparative study, 32 young adult females who fulfilled the inclusion criteria were recruited from MVP'S College of Physiotherapy. Subjects were then were divided into two groups- Group A –Light concentric exercise and Group B – Foam rolling. First of all, DOMS was induced in each subject using exercise protocol. Then the treatment was given for next 3 days. Outcome measures of NPRS, ROM of knee flexion and 30 sec Chair-Stand test were evaluated before and after each treatment session.

Results
'p' values are found significant for paired t tests and not significant for unpaired t tests.

Conclusion
Light concentric exercise and Foam rolling are found equally effective on DOMS. Both Light concentric exercise and Foam rolling are found to significantly reduce NPRS and improve knee flexion ROM.

Keywords: DOMS, Light concentric exercise, Foam rolling

INTRODUCTION

Delayed onset muscle soreness frequently occurs after exhaustive or unaccustomed exercise, particularly if the exercise involves eccentric muscle contraction.[1]Eccentric contraction often induces muscle fiber injury which is associated with the muscle's decreased ability to generate force and a set of indirect muscle damage markers, such as muscle soreness, increased muscle stiffness with reduced range of motion.[1] Eccentric type of exercise causes a disruption of normal skeletal muscle banding pattern (alignment) and the broadening or complete disruption of Z lines. This

leads to alteration in protein expression and inflammation, which play an important role in muscle recovery and adaptation.[1]Up to six hypothesized theories have been proposed for mechanism of DOMS, namely: lactic acid, muscle spasm, connective tissue damage, muscle damage, inflammation and enzyme efflux theories. An integration of one or more theories is likely to explain muscle soreness. DOMS can affect performance by causing a reduction in joint range of motion, shock attenuation and peak torque. Alteration in muscle sequencing and recruitment patterns may also occur, causing unaccustomed stress to be placed on muscle ligament and tendons. The compensatory mechanism may increase the risk of further injury if a premature return to sport is attempted.[3]

Researchers have shown decrease in pain associated with DOMS after post exercise massage. Foam rolling is another form of massage that therapist use to aid recovery (i.e. to alleviate DOMS) or prevent the tissue restrictions. During foam rolling, the individual uses their own body weight on a foam roller to exert pressure on the soft tissue. This motion places both direct and sweeping pressure on the soft tissue, stretching it and generating friction between it and foam roller. Foam rolling can be considered a form of self-induced massage because it resembles the pressure exerted on the muscle through manual manipulation. [4]Foam rolling is a type of self-myofascial release(SMR) and is alternative modality proposing an increase in acute range of motion, athletic performance and delayed onset muscle soreness. Through foam rolling, SMR adds pressure to the underlying soft tissue. Many of the perceived benefits of foam rolling are derived from massage. [5]In non-DOMS study, it was also found that an acute bout of foam rolling increases ROM without subsequently decreasing neuromuscular (isometric) function. Similar to massage, foam rolling may benefit recovery of dynamic (multijoint, sport-specific movements) measures for duration of DOMS. Hence, it is plausible that foam rolling will aid in recovery from DOMS and help in maintain physical performance. [4]

Light concentric exercise is a type of muscle contraction in which the muscle generates enough forces to overcome the resistance to joint movement so it shortens as it contracts. [6]It has been documented that exercise increases pain threshold and pain tolerance a phenomenon often referred to as exercise induced analgesia. [6]Exercise is one among the foremost effective way for assuaging DOMS, but the pain relief is additional temporary and speedily resumes once more following exercise cessation. It's been projected that temporary alleviation of pain throughout exercise is also because of breaking of adhesions within the sore muscle, a rise in removal of waste material via increase blood flow or a rise in neurochemical activity. Increased afferent input is noted from large, low threshold sensory unit within the muscle and subjects direct attention to the activity and faraway from the pain can also be the reason for improvement with exercise. Light exercise have been shown to bring about an improvement in the patients with DOMS.[2]

METHODOLOGY

- Type of study: comparative study
- Sampling method: convenient sampling
- Sample size: 32
- Study setting: MVP'S College of Physiotherapy.
- Study duration:6 months

32 female subjects were selected for the purpose of study between the age group of 18-35 years. Only those subjects were included who had BMI within normal range i.e. between 18.5-24.9. The females who underwent surgeries involving a lower extremity within the previous six months and those who have had underwent any musculoskeletal injuries over last 6 months were excluded from the study. Also those females who were involved in weight training program and those who performed lower body exercise 48 hours prior to testing session were excluded.

Instruments and tools used

- Pen
- Paper
- Consent form
- Foam roller
- Goniometer
- Watch
- Chair

Procedure

The subjects were randomly allocated in two groups:

Group A : Light concentric exercise.

Group B : Foam rolling

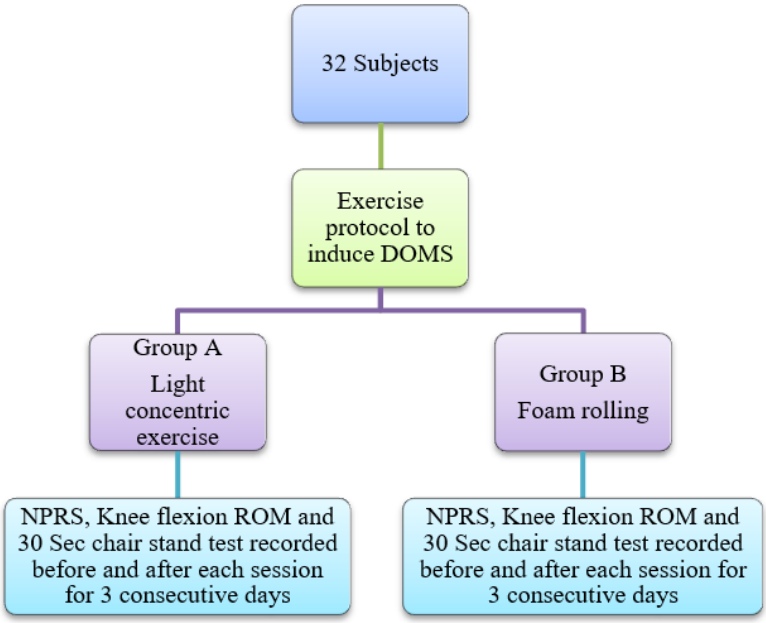

Figure 1

Exercise protocol to induce DOMS

The subjects were asked to perform 6 sets of 10 repetitions of squats exercise with 5 seconds rest between repetitions and 1 minute rest at end of each set.

Light concentric exercise

It consisted of 10 sets of 40 repetitions of full knee extension from 90 degree knee flexion , with 30 seconds rest between sets. The subjects were asked to perform exercise as comfortable as possible (i.e. with minimal effort). It took approximately 20 minutes to complete the exercise but actual muscle working time was approximately 15 minutes (2 seconds: flexion/extension×40 contractions/set × 10 sets = 800 seconds).

Foamrolling

Foam rolling was performed in plank position with the foam roller 3 inches below ASIS of both legs , with as much as body weight as possible on the foam roller. Then the subject were asked to roll the foam roller down their quadriceps using short kneading like motion until the foam roller was just above the patella and was rolled back to its initial position in one fluid motion. The subject then repeated this motion for 1 minute, then rested for 30 seconds and again repeated it again for 5 sets.

Data analysis

The collected data is analysed using GraphPad Instat. Comparison is done between the pre and post intervention values within the groups for each outcome measure(NPRS, 30 second chair stand test and knee flexion ROM) by using Paired t test for all the three days. Post intervention values are compared between the two groups for all the three outcome measures using Unpaired t test.

Statistical Analysis

Data analysis within the group

Group 1: Light concentric exercise

The statistical result of each outcome measure is found to be statistically significant within the group on comparing pre and post intervention scores.

Table 1: Comparison of pre and post intervention score of NPRS of lower limb

	DAY 1	DAY 2	DAY 3
Pre intervention score	3.88	5.31	2.56
Post intervention score	2.75	3.13	1.25
p Value	0.0001	0.0001	0.0001
t Value	7.2682	10.4895	5.5468
Result	Extremely Significant	Extremely Significant	Extremely Significant

Table 2: Pre and Post intervention score 30 Second chair stand test

	DAY 1	**DAY 2**	**DAY 3**
Pre intervention score	13.94	14.00	14.81
Post intervention score	15.06	14.94	15.31
p Value	0.0009	0.0019	0.0271
t Value	4.1367	3.7578	2.4495
Result	Extremely significant	Very significant	Significant

Table 3: Pre and Post intervention score of knee flexion ROM

	DAY 1	DAY 2	DAY 3
Pre intervention score	122.69	122.88	127.88
Post intervention score	126.00	125.75	129.50
p Value	0.0001	0.0001	0.0001
t Value	9.6825	9.5502	5.9753
Result	Extremely significant	Extremely significant	Extremely significant

Group 2: Foam rolling

The statistical result of each outcome measure is found to be statistically significant within the group on comparing pre and post intervention scores.

Table 4: Comparison of pre and post intervention score of NPRS of lower limb

	DAY 1	**DAY 2**	**DAY 3**
Pre intervention score	3.38	5.44	2.69
Post intervention score	1.88	2.75	1.25
p Value	0.0001	0.0001	0.0001
t Value	8.2158	13.5527	11.2229
Result	Extremely significant	Extremely significant	Extremely significant

Table 5: Pre and Post intervention score 30 Second chair stand test

	DAY 1	**DAY 2**	**DAY 3**
Pre intervention score	12.88	12.75	14.88
Post intervention score	13.75	14.31	15.44
p Value	0.0006	0.0001	0.028
t Value	4.3412	6.0634	3.5762
Result	Extremely significant	Extremely significant	Very significant

Table 6: Pre and Post intervention score of knee flexion ROM

	DAY 1	**DAY 2**	**DAY 3**
Pre intervention score	126.38	126.44	129.94
Post intervention score	128.63	129.44	131.19
p Value	0.0001	0.0001	0.0011
t Value	6.9714	9.4868	4.0379
Result	Extremely significant	Extremely significant	Very significant

Data analysis between the groups

Table7: Comparison of NPRS score pre and post intervention of day 1 between group A and B

	Pre	**Post**
Group 1	3.88	2.75
Group 2	3.38	1.88
T value	1.0215	1.8664
P value	0.3152	0.078

Result	Not statistically significant	Not statistically significant

Table8: Comparison of NPRS score pre and post intervention of day 2 between Group 1 and 2

	Pre	**Post**
Group 1	5.31	3.13
Group 2	5.44	2.75
T value	0.2940	0.9101
P value	0.7708	0.3700
Result	Not statistically significant	Not statistically significant

Table9: Comparison of NPRS score pre and post intervention of day 3 between Group 1 and 2

	Pre	**Post**
Group 1	2.56	1.27
Group 2	2.69	1.25
T value	0.3352	0.0792
P value	0.7398	0.9374
Result	Not statistically significant	Not statistically significant

Table 10: Comparison of ROM pre and post intervention of day 1 between Group 1 and 2

	Pre	**Post**
Group 1	122.69	125.19
Group 2	126.38	128.63
T value	1.8237	1.8350
P value	0.0782	0.0764
Result	Not quite statistically Significant	Not quite statistically Significant

Table 11: Comparison of ROM pre and post intervention of day 2 between Group 1 and 2

	Pre	**Post**
Group 1	122.88	125.75
Group 2	126.44	129.44
T value	1.8062	1.9096
P value	0.0809	0.0658
Result	Not quite statistically significant	Not quite statistically significant

Table 12: Comparison of ROM pre and post intervention of day 3 between Group 1 and 2

	Pre	**Post**
Group 1	127.88	129.38
Group 2	129.94	131.25
T value	1.3352	1.2355
P value	0.1919	0.2262
Result	Not statistically significant	Not statistically Significant

Table 13: Comparison of 30 seconds chair stand test pre and post intervention of day 1 between Group 1 and 2

	Pre	Post
Group 1	13.88	15.13
Group 2	12.88	13.75
T value	1.6021	1.9548
P value	0.1196	0.0600
Result	Not statistically significant	Not statistically Significant

Table 14: Comparison of 30 seconds chair stand test pre and post intervention of day 2 between Group 1 and 2

	Pre	**Post**
Group 1	14.00	14.94
Group 2	12.75	14.31
T value	2.0300	0.8825
P value	0.0513	0.3845
Result	Not statistically significant	Not statistically significant

Table 15: Comparison of 30 seconds chair stand test pre and post intervention of day 3 between Group 1 and 2

	Pre	Post
Group 1	14.81	15.31
Group 2	14.88	15.44
T value	0.1124	0.2048
P value	0.9112	0.8391
Result	Not statistically significant	Not statistically significant

DISCUSSION

The purpose of this study was to compare the effectiveness of light concentric exercise versus foam rolling for delayed onset muscle soreness in young adult females.In this study, 32 subjects were assigned, 16 subjects were in group 1 who received light concentric exercise after induction of DOMS for 3 days. Group B consisted of 16 subjects who received foam rolling after induction of DOMS for 3 days.The outcome measures were numerical pain rating scale, range of motion which was measured using a goniometer and 30 seconds chair stand test. Outcome measures were assessed on day 1, day 2, and day 3 pre and post treatment sessions in both the groups.

In group 1, the two tailed P value, for paired t test of NPRS was extremely statistically significant and for ROM too, was also extremely statistically significant and as for 30 seconds chair stand test, it was very statistically significant. Thus, the study showed that light concentric exercise was effective in decreasing pain and improving range of motion.

It was observed that light concentric exercise has a short-lived palliative effect on DOMS. Saxton and Donnelly (1995) had subjects perform 50 concentric actions of elbow flexors for one to four days after maximal eccentric contractions. They reported that DOMS decreased by some 40% immediately after concentric exercise was performed but not on other recovery days. It has been documented both pain threshold and tolerance are raised following exercise, a phenomenon referred to as exercise-induced analgesia (Koltyn, 2000).[8]

Few studies have reported an analgesic effect following resistance exercise. The mechanisms responsible for exercise-induced analgesia are poorly understood, but are known to be associated with activation of endogenous opioid system acting at peripheral, spinal and central sites.[8]

Weerakkody et al found evidence that muscle spindles play a role in DOMS, and that input from large afferents inhibit nociceptive inputs. Increase in muscle blood and lymph flow and (or) temperature by light concentric exercise may have altered the threshold or response patterns of nociceptors.[8]

Zainuddin et al. demonstrated a clear analgesic effect of light concentric exercise on DOMS of 40

to 45% reduction in muscle soreness and tenderness immediately after light concentric exercise. This suggests the exercise induced analgesia however, the analgesic effect did not appear to last long. It was concluded that light concentric exercise has a temporarily analgesic effect on DOMS but no effect on recovery from eccentric exercise.[6]

This study hypothesized that the light concentric exercise performed 1-4 days after maximum eccentric contraction would alleviate DOMS and enhance recovery from muscle damage. Similar changes in work and torque have occurred. Moreover, the changes in muscle strength, range of motion, and limb circumference were comparable between conditions immediately and 1 day after maximum eccentric contraction. The results showed that light concentric exercise had a short lived palliative effect on DOMS but no sustained therapeutic effect.[6]

Elevated CK levels following a heavy eccentric exercise were found, adding light eccentric exercise after the heavy eccentric exercise bout resulted in a further reduction in the rise of CK levels. The present study examined the effects of additional concentric contractions, after a bout of heavy eccentric exercise involving the quadriceps muscle of a single leg. On CK activities, markers of inflammation and MRI images of the involved muscle group.[23]

Exercise induced muscle injury is coupled with a cascade of inflammatory and immunological processes. Additional concentric contractions during the recovery period after a bout of heavy eccentric exercise have no apparent effect on the degree of exercise induced muscle damage and breakdown of connective tissue.[23]

In group 2, the two tailed p value for paired t test of NPRS was extremely statistically significant and for ROM too it was extremely statistically significant and as for 30 seconds chair stand test, it was very statistically significant. Thus, the study showed that foam rolling was effective in decreasing pain and improving range of motion. Considering the effects of foam rolling on recovery, most investigations reveal that foam rolling has the greatest effect on flexibility which signifies an increase in range of motion after a session of self-myofascial release.[22]The second effect concerning foam rolling is linked with performance factor. Foam rolling did not have any impact on athletic performance during tasks such as vertical jumps, ground reaction force.[22]

The improvement in recovery is believed to be due to a decrease in soft tissue stiffness, especially in muscles and in fascia. Fascia contains water, this is expelled when compressed and can therefore affect stiffness. The decrease in pain sensation after massage is due to the activation of central pain modulatory mechanisms, through neural inhibition mechanisms.[22]

Another theory suggests that the pressure on the muscle during massage reduces mechanical hyperalgesia, which leads to the activation of descending inhibitory pathways. There may be improvements also due to enhanced removal of blood waste products and improved tissue repair and healing, increased blood flow enhances the removal of neutrophils and reduces prostaglandin production, thereby reducing any further damage associated with inflammatory process.[1]

The reductions in performance differed between the control and foam rolling groups. Similar to the effect of postexercise massage, foam rolling appears to aid in the recovery of muscle tenderness associated with DOMS. similar to other research we found that a 20 minutes foam rolling session caused participants to experience substantially less muscle tenderness. Foam rolling had a trivial effect on change of direction speed, however in contrast foam rolling positively affected both sprint speed and power performance. A sufficient number of substantial effects to indicate that foam rolling are likely to be effective DOMS recovery modality.[4]

Foam rolling enhances recovery from muscle tenderness due to decreased edema, blood lactate removal and enhanced tissue healing which are mainly due to increased muscular blood flow. Massage induced muscular blood flow also increases oxygen delivery.[4]

CONCLUSION

This study concluded that light concentric exercise and foam rolling both are equally effective for delayed onset muscle soreness. Both light concentric exercise and foam rolling decreased pain, improved range of motion and had an effect on 30 seconds chair stand test.

LIMITATIONS

The sample size is small.

In this study, squat exercise is used to induce DOMS which included both eccentric and concentric contraction of quadriceps muscle and not just eccentric contraction.

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