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Research Article

Effect of Vibration on Delayed Onset Muscle Soreness before and after the Eccentric Exercise in Biceps Brachii Muscle of Females

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A B S T R A C T

Objectives: To compare the effects of vibration on biceps brachii applied before and after eccentric exercise for preventing of Delayed Onset Muscle Soreness (DOMS).

Methods: Pretest-posttest experimental control group design was used. 30 subjects were randomly assigned into three groups. Subjects performed 30 eccentric contractions of the dominant biceps brachii muscle using a dumbbell 80% of the pre exercise maximum isometric force. One experimental group receives 1 minute of vibration before exercise and other experimental group receives 1 minute of vibration after exercise and control group did not receive any vibration. Muscle soreness, Arm circumference, maximum isometric force, range of motion were assessed before and immediately after exercise and then 24 hrs, 48 hrs after exercise in all groups.

Result: vibration therapy significantly prevents muscle soreness, and prevents increased arm circumference and decreased muscular strength, range of motion in both experimental groups ($p<0.001$).

Conclusion: These results showed that the application of vibration helps to reduce intensity and allow early recovery of DOMS resulting from eccentric exercise of biceps. Application of vibration after eccentric exercise have marginally better improvement from DOMS as compared to it applied before exercise.

Keywords: Biceps Brachii, Delayed Onset Muscle Soreness, Muscle Strength, Range of Motion, Vibration

Introduction

In day-to-day life, sports, and training we may come across conditions which may lead us to do an unaccustomed or unfamiliar activity. This unaccustomed activity may cause muscular pain and soreness, decreased limb activity or swelling which is the result of clinical entity namely Delayed Onset Muscle Soreness (DOMS). Exercise induces muscle soreness which can be of two types- acute or delayed onset. Acute muscle soreness starts during exercise and may last up to 4-6 hours before subsiding. Delayed onset muscle soreness develops after 8-10 hours with soreness peaking 24-48 hours post exercise.[1,2] Theodore Hough was the first one to give a detailed description of Delayed Onset Muscle Soreness (DOMS) in 1902.[3]

The etiology of DOMS has been the topic of numerous studies, from which several theories have evolved. Despite differences in theories, the following factors have been documented: Strenuous activity-especially eccentric exercise causes injury or trauma to the muscle, its musculotendinous junction, or both. Injury and/ or trauma initiate an inflammatory response, resulting in muscles feeling painful and swollen. Pain occurrence is delayed approximately 8 hours post activity and gradually increases, peaking 24 to 48 hours post exercise before gradually subsiding to pre-exercise levels. Pain is associated with decreased Range of Motion (ROM) and strength. Trauma or resulting pain may directly or indirectly result in muscle spasms and a pain-spasm feedback cycle.[4]

DOMS is usually associated with unaccustomed high-force muscular work and occurs chiefly by eccentric exercise such as downhill running plyometric and resistance training.[2,5] DOMS often develops after resistance training especially with an increase of the intensity and volume of training, the order of exercise is changed or a new training regime is performed.[2,6]

Numerous theories of DOMS have been proposed in the literature. There are six hypothesis theories which are predominantly used to explain the mechanism of DOMS. These are Lactic Acid Theory, Muscle spasm Theory, Connective Tissue Damage theory, Muscle Damage Theory, Inflammation theory and Enzyme efflux Theory. Features of DOMS include strength loss, pain, swelling, tenderness or stiffness to palpation, loss of range of motion, flexibility, decreased force production and mobility.[7] DOMS is evident as disruption of the normal banding patterns (alignment) of skeletal muscle and broadening or complete disruption of sarcomere Z lines. The disruption leads to release of CK, which in turn contributes to strength deficits. In eccentrically exercised muscle edema, resulting from production of prostaglandin E2, has been observed at 24, 48, and 72 hours. Prostaglandin E2 also sensitizes the group IV afferent fibers of muscle connective tissue, which are responsible for dull, aching pain.[2]

A number of studies have investigated the prophylactic, therapeutic, and analgesic effects of intervention on the symptoms of eccentric exercise induced muscle damage, such as cryotherapy, stretching, anti-inflammatory drugs, supplementation, ultrasound, electrical stimulation, homeopathy, massage, compression, and hyperbaric oxygen therapy. Controversy exists concerning the efficacy of the intervention on DOMS and other symptoms of muscle damage, and only limited success of these intervention has been reported.[6,8]

Various intervention has been investigated with respect to DOMS. Rob D Herbert et al. concluded that stretching before or after exercising has no effect on DOMS.[9] Law and Herbert et al concluded that warm-up produced a small reduction on muscle soreness that was most apparent 48 hours after exercise. Cool-down did not reduce muscle soreness.[10] According to Jeffrey C. Stay, pulsed ultrasound as did not significantly diminish the effect of DOMS on soreness perception, swelling, relaxed-elbow extension angle, or strength.[11]

Various other interventions aimed at alleviating DOMS has been proposed like Transcutaneous Electrical Nerve Stimulation (TENS), ultrasound, and the administration of aspirin, other anti-inflammatory drugs, steroids, vitamin C and other antioxidants. Despite the volume of work there is little consensus among practitioners regarding the most effective way to prevent the symptom of DOMS or muscle damage.[2,12]

Therefore, further studies are necessary to investigate the effect of the new intervention and prevention of DOMS. One of the interventions that has not been investigated extensively on symptoms of eccentric exercise induced muscle damage is vibration therapy. Only few studies have investigated the prophylactic or therapeutic effect of vibration on DOMS. More studies are needed to establish the effectiveness of vibration. Therefore, the purpose of this study to see the effect of vibration on various parameters like pain, Arm circumference, Isometric strength, Range of motion on dominant biceps brachii muscle before and after eccentric exercise in reducing the duration and intensity of DOMS and thereby preventing it and enabling the individual to perform his or her activity of daily life normally and it might be a useful method for athletes to prevent any DOMS in their sports activities.

Methods

This study was approved by Research And Ethical Committee of Rehabilitation Sciences, Jamia Hamdard University and the data was collected from November 2012-February 2013 of the age 18-27 years old young adult females in rehabilitation centre of Jamia Hamdard, Delhi. The informed consent was taken from all subjects who participated in this study. This study used Pretest-Posttest Experimental Control Group Design. 30 subjects were randomly assigned into three groups with 10 subjects in each group. Subjects performed 30 eccentric contractions of the dominant biceps brachii muscle using a dumbbell 80% of the pre exercise maximum isometric force. One experimental group received 1 minute of vibration before exercise and the other experimental group received 1 minute of vibration after exercise, and the control group did not receive any vibration. Muscle soreness, arm circumference, maximum isometric force, range of motion were assessed before and immediately after exercise and then 24 h, 48 h after exercise in all groups.

MS, AC, MIF, ROM were assessed before and immediately after exercise, and then 24 h, 48 h after exercise in all groups. All parameters were assessed two times at each point of time and data thus obtained were average.

Protocol for induction of DOMS (Eccentric Exercise)

Exercise Protocol

Subject standing with her back supported against the wall. Subject performed eccentric exercise of the elbow flexors with the dominant arm using a dumbbell weighing 80% of pre exercise maximum isometric force. Subject was instructed to lower the dumbbell from elbow flexed position towards extended position in 4-5 sec, keeping the velocity as constant as possible following the examiner counting zero for the beginning and[1,2,3,4,5] during movement. After the end of each eccentric action, the examiner removes the load and then arm was returned to the starting flexed position. The movement was repeated after every 45 sec for 30 repetitions. 45 seconds rest between the repetitions was given to minimize the effect of fatigues.

Vibration Therapy

Vibration therapy was given using a squirrel massager vibrator (CE ISO 9001 certified). The machine consists of a handle, body speed controller and gem articulation stick (7 cm diameter). The equipment had five speed options including 0-3000 RPM for gentle massage, 3000-4000 RPM for normal vibration and 5000 RPM for giving muscular vibration. As per guideline of the manufacturing company. We used 5000 RPM for giving vibration to biceps brachii. For application of vibration to muscle the patient lies supine with arm relaxed and "gem articulation stick" was placed against the target muscle, the speed option was selected for 5000 RPM and machine switched on while maintaining it stable against target muscle belly.

Dependent Variables

They are muscle soreness, Arm circumference, Maximal isometric force, and Range of motion.

Muscle Soreness

It was evaluated by a horizontal, 10 cm Visual Analogue Scale. The subject was asked to indicate perceived level of muscle soreness in the dominant biceps brachii along a 10 cm. 0 indicates no muscle soreness at all to 10 most severe muscle soreness that severely restricted her activities.

Arm Circumference

It was measured at 8 cm above the elbow joint with a measuring tape while allowing the arm to relax hang down by the side of the body. The measurement point was marked on the subject's arm to ensure consistent placement of the tape measure. Two measurements were taken for each subject and mean was taken as her score.

Elbow ROM

To determine the elbow joint angles, subject is in the standing position; the goniometer was placed on the subject arm with the centre located at the elbow joint movable arm along with radius and stationary arm is line with deltoid tuberosity. The elbow joint angles were measured in two positions.

1. **Relaxed Elbow Angles (RANG)**

This was measured when the subject arm is relaxed and hanging down by the side. Decreases in this angle provide a measure of spontaneous muscle shortening as a protective muscle soreness. Two measurements were taken for each subject and mean was taken as her score.

2. **Flexed Elbow Angle (FANG)**

After measuring the relaxed elbow angle, the client asked to flex elbow so as an attempting to touch palm to shoulder with arm kept supinated. Maximum flexion was attempted in pain free range. Two measurements were taken for each subject and mean was taken as her score.

Maximum Isometric Force

Subject was tested with supine lying on a padded mat on the floor. The designated dominant upper extreme was positioned with the shoulder abducted about 30 degree, the elbow flexed 90 degree and forearm supinated with their feet against their wall. The strength was measured with the help of a strain gauge (Mounted on a wall). The adjustment gauge would be changed according to the length of the subject forearm. The instractions to the subject were to take 1 to 2 sec to come to maximum flexion while pulling the chain attached to the strain gauge and then continue bending your elbow as hard as possible until one says stop.

Consistent verbal encouragement was provided throughout each effort. The examiner instructed to maintain the pull for approx. 5 sec. and the strength measurement was taken for each subject and the second effort was done after 2 min rest. Their mean was taken as a final maximum isometric force.

Statistical Analysis

Statistical analysis was performed using SPSS 16.0 version software. Oneway analysis of variance (ANOVA) with Bonferroni test was used to compare difference for all four variables i.e.; muscle soreness, arm circumference, maximum isometric force, range of motion between group A, group B and group C.

Further one-way analysis with post hoc Bonferroni test was used to compare difference for all four variables i.e.;

muscle soreness, arm circumference, maximum isometric force, range of motion between all groups. Intergroup and intragroup comparison was done.

Repeated measure ANOVA (multivariate) was done to find difference within group A, group B and group C for all four variables i.e.; muscle soreness, arm circumference, maximum isometric force, range of motion. Post hoc Bonferroni analysis was done to find pair wise differences. Independent (two tailed) t-test was done to compare difference for all four variables i.e.; muscle soreness, arm circumference, maximum isometric force, range of motion between group A, group B and group C.

A statistically significant difference was defined as 'p' value less than 0.05.

Results

Muscle Soreness

The results show that muscle soreness increased immediately after exercise in all 3 groups and this increase in soreness was statistically significant in all 3 groups, group A ($p<0.001$), group B ($p=0.01$) and group C ($p=0.04$). However, increase in muscle soreness was highest in group C (1.2±0.99), and group A (1.1±0.63). This increase in muscle soreness was least in group B (0.70±0.48).

At 24 hrs after exercises the value of muscle soreness remained significantly high in all groups while compared to their respective pre-exercise score; therefore, muscle soreness increased 24 hrs after exercises.

At 48 hrs after exercise, the value of muscle soreness remained high as compared to "immediate after exercise" score but remained low while compared to "after 24 hrs scores" therefore it shows that by 48 hrs muscle soreness had started recovering.

Furthermore, it was found that soreness in group B was now not significantly different from pre-exercise score i.e.; soreness in group B had now significantly recovered towards pre-exercise level. On the contrary, the soreness remained still significantly high in group A and C (Tables 1, 2 and Figure 1).

Table 1.The VAS scores of muscle soreness

	Group A (mean±SD)	Group B (mean±SD)	Group C (mean±SD)
Pre-exercise	0.00	0.00	0.00
At immediate post exercise	1.10±0.63	0.70+0.48	1.2+0.99
At 24 hrs post exercise	3.40+1.07	2.30+1.41	5.6+1.07
At 48 hrs post exercise	1.90+1.10	0.70+0.94	5.2+1.13

Table 2.The level of significance (p) for VAS score of muscle soreness

	Group A	Group B	Group C
Pre vs immediate	0.00	0.01	0.04
Pre vs 24 hrs	0.00	0.00	0.00
Pre vs 48 hrs	0.00	0.27	0.00

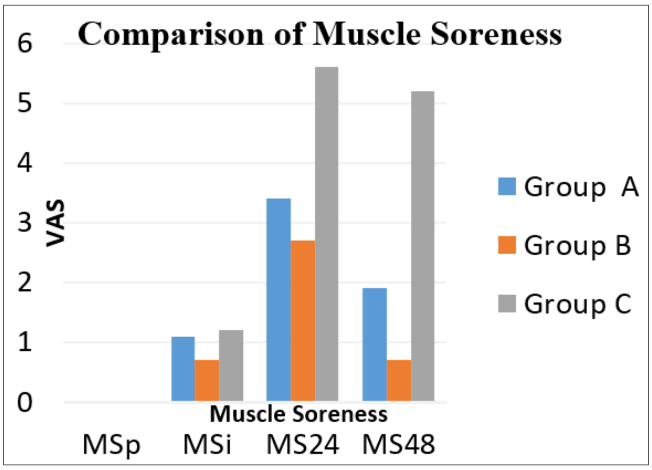

Figure 1.Comparison of Muscle Soreness (MS)

Arm Circumference (AC)

The results show that immediately after exercises Arm Circumference and related swelling was not significantly changed from pre-exercise score group A ($p=1.00$), group B ($p=0.67$), group C ($p=0.51$) (Tables 3 & 4).

However, after 24 hrs the Arm Circumference and exercise related arm swelling was significantly high in all 3 groups while compared to their pre- exercise score. The increase in Arm Circumference was highest in group C ($p<0.001$).

At 48 hrs after exercise to Arm Circumference was not significantly different from pre-exercise score in group A ($p=0.51$) and group B ($p=1.00$) but Arm Circumference remained significantly higher in group C while compared with pre--exercise score ($p<0.001$) (Figure 2).

Table 3.The score of Arm Circumference (AC)

	Group A (mean ± SD in cm)	Group B (mean ± SD in cm)	Group C (mean ± SD in cm)
Pre-exercise	25.31±1.73	23.11±2.49	24.46±1.33
At immediate post exercise	25.32±1.75	23.17±2.43	24.56±1.36
At 24 hrs post exercise	25.67±1.81	23.38±2.43	25.48±1.37
At 48 hrs post exercise	25.41±1.74	23.13±2.48	25.30±1.38

Therefore, it shows that applied vibration before as well as after exercise session did not present increase in Arm Circumference and related swelling, yet the application of vibration caused quick improvement in recovery of Arm Circumference by 48 hrs. The control soreness was not given any vibration; therefore, it did not recover from increased Arm Circumference even after 48 hrs.

Table 4.The level of significance (p) score for Arm Circumference (AC)

	Group A	Group B	Group C
Pre vs immediate	1.00	0.67	0.51
Pre vs 24 hrs	0.03	0.03	0.00
Pre vs 48 hrs	0.51	1.00	0.00

Score for Arm Circumference (AC)

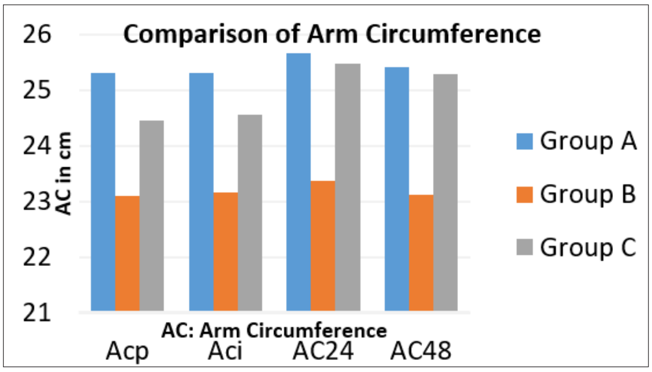

Figure 2.Comparison of Arm Circumference (AC)

Maximum Isometric Force (MIF)

The results show that MIF at immediate after exercise, as well as 24 hrs was significantly less as compared to the pre-exercise score in all 3 groups. Therefore, in all 3 groups participants were able to apply less isometric force whole compared to their pre-exercise scores (Tables 5, 6 and Figure 3).

Further it was found that at 48 hrs the reduction in force (MIF) remained maximum in group C (11.42 to 9.42); therefore, it was group C which showed minimum recovery in MIF strength even after 48 hrs.

Table 5.The score of Maximum Isometric Force (MIF)

	Group A (mean±SD in kgs)	Group B (mean±SD in kgs)	Group C (mean± SD in kgs)
Pre-exercise	10.79±1.18	9.94±2.86	11.42±2.47
At immediate post exercise	8.85±1.83	7.96±2.61	9.08±2.42
At 24 hrs post exercise	8.02±2.41	7.08±2.54	7.56±2.41
At 48 hrs post exercise	10.01±1.53	9.06±2.67	9.42±3.03

There was no significant difference of MIF score from their respective pre-exercise score in group A (0.07) as well as group B (0.07) at 48 hrs; therefore, both group A and group B had significantly recovered MIF scores. Therefore, vibration therapy whether applied before or after the eccentric exercise, will help to recover MIF by 48 hrs significantly.

Table 6.The level of significance (p) score for Maximum Isometric Force (MIF)

	Group A	Group B	Group C
Pre vs immediate	0.00	0.00	0.01
Pre vs 24 hrs	0.01	0.00	0.00
Pre vs 48 hrs	0.07	0.07	0.00

Score for Maximum Isometric Force (MIF)

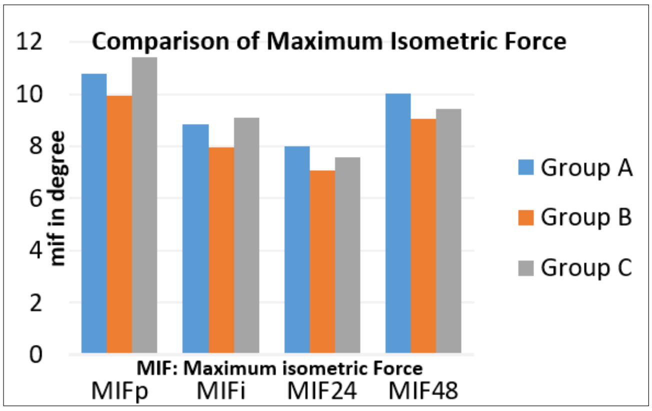

Figure 3.Comparison of Maximum Isometric Force (MIF)

Range of Motion (ROM)

The result of study shows that immediately after exercise there was no significant change in ROM of elbow flexion in group A (p=0.06) as well as group B (p<0.001). However, in group C there was a significant reduction (p<0.001) in ROM of elbow flexion (Tables 7, 8 and Figure 4).

Table 7.The score of Range of Motion (ROM)

	Group A (mean ± SD in degree)	Group B (mean ± SD in degree)	Group C (mean ± SD in degree)
Pre-exercise	131.3±5.26	133.25±7.51	129.44±6.17
At imme-diate post exercise	122.05±11.05	128.45±9.38	120.11±9.83
At 24 hrs post exercise	123.15±9.99	127.79±6.48	112.61±8.88
At 48 hrs post exercise	130.54±5.7	132.00±7.04	117.98±6.17

At 24 hrs even group A as well as group B developed significantly reduced ROM elbow flexion which might correspond with increased Muscle Soreness, increased Arm Circumference and decreased MIF. This might be due to the effect of DOMS.

At 48 hrs there was no significantly significant difference in MIF value of group A (p=0.48) and group B (p=0.31) compared to their repeated pre-exercise score but group C the ROM score remained significantly lower (p<0.001) from their respective pre-exercise score.

Therefore, vibration therapy whether given before or after exercise will help to recover pain free ROM of elbow flexion while compared to a group receiving no vibration therapy.

Table 8.The level of significance (p) score for Range of Motion (ROM)

	Group A	Group B	Group C
Pre vs immediate	0.06	0.15	0.00
Pre vs 24 hrs	0.04	0.01	0.00
Pre vs 48 hrs	0.48	0.31	0.00

Score for Range of Motion (ROM)

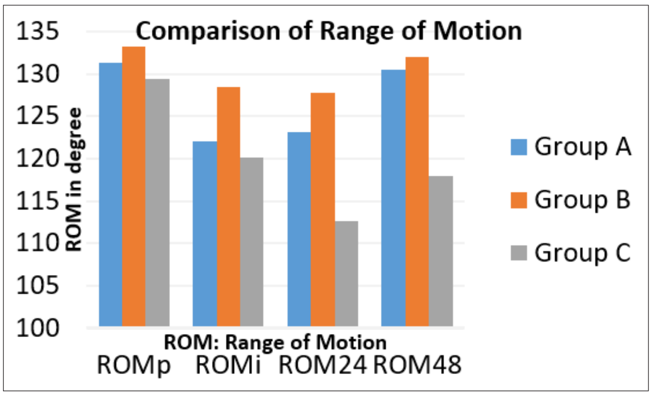

Figure 4.Comparison of Range of Motion (ROM)

Discussion

This study was designed to compare the effect of vibration on DOMS applied before and after eccentric exercise in dominant biceps brachii in healthy females. The effect of two experimental groups i. e; vibration applied before verses vibration applied after eccentric exercise was examined. Third group was control group that included only eccentric exercise without any vibration applied. The dependent variables were Muscle Soreness (MS), Arm Circumference (AC), Maximum Isometric Force (MIF), pain free Range of Motion (ROM) of elbow flexion. These were assessed before, immediately after exercise, and at 24 h, and at 48 h after eccentric exercise in all groups.

The results suggest that both the experimental groups, i.e.; vibration applied before eccentric exercise (group A) and vibration applied after exercise (group B) were significantly better than control group (group C). There was no significant difference between both experimental groups, thus suggesting that vibration applied before exercise and vibration applied after exercise appeared to be equally effective in all variables i.e.; MS, AC, MIF, ROM.

To our knowledge, till date only few studies have investigated the effect of vibration on DOMS resulting from eccentric exercise. However, specific therapeutic parameters are not available. Limitations are therefore imposed due to lack of enough literature in this area, leading to a limited scope for using vibration for managing DOMS.

Muscle Soreness (MS)

In the study, muscle soreness was assessed using VAS (Visual Analogue Scale) score taken from 10 cm horizontal line. VAS score increases immediately, at 24 h and decrease at 48 h in all groups. Pattern was same in all 3 groups but increase in soreness was maximum in group C, following group A and least increase in group B. It implies that eccentric exercise leads to muscle soreness that may start immediately after exercise, reaches peak at 24 h and slightly starts reducing after 48 hrs. The further implication is that intensity of soreness may be decreased and speed of recovery may be facilitated by application of vibration therapy. Further, at 48 h post-exercise, it was found that application of vibration after eccentric exercises bring more favourable reducing muscle soreness and facilitating recovery as compared to the application of vibration before eccentric exercises.

Increase in muscle soreness (which is assessed by VAS) is associated with pain experienced by subjects. Pain is a cardinal symptom of DOMS. Eccentric exercise can lead to accumulation of the metabolic waste, which can sensitize the nociceptive fibres, mainly A-delta and C fibre, and hence increase the pain.[13,14] Eccentric exercise can lead to muscle ischemia which result in production of painful substance in the muscle. Pain and DOMS may result from the production of reflexive muscle spasm resulting from prolong ischemia.[13,15] There may be increase in intramuscular edema, which activate the mechanoreceptor, thus causing pain.[18]

Our results show that application of vibration reduces DOMS. This is similar to some previous studies where researches have shown that during application of vibration an increased blood flow and skin temperature is caused.[16,17] 'Broadbent' et al.[18] found that 40 Hz of vibration cause increased blood flow which is effective in reducing inflammation by reducing the number of lymphocyte and IL-6 (interleukin 6). Similarly, Hinds et al.[17] showed that 5 minutes of 50 Hz of vibration applied to the forearm muscle causes greatest increase in skin blood flow which may cause flush of metabolic wastes. Furthermore, the mechanical pressure of vibration therapy on the tissue may also enhance the blood flow and lymph flow, which in turn might reduce oedema, ischemia or accumulation of substance that directly or indirectly will help reduce pain and muscle soreness.

Arm Circumference (AC)

In the study, muscle shorting was assessed by the middle 1/3rd Arm Circumference (AC) measurement. AC increased immediately, at 24 h and decreased at 48 h in all groups, but remained increased in control group significantly at 48 h. On the contrary, AC increased more immediately, at 24 h, at 48 h in control group, suggesting that there was more increase in swelling in control group, and clinically less increase in group B as compared to group A.

Immediately after eccentric exercise, the AC was significantly higher ($p=0.05$) in group A (25.32±1.75) while compared to group B (23.17±2.42) and group C (24.56±1.36). This might indicate that application of vibration immediately after eccentric exercise (group B) was better, in comparison, when vibration is applied before (group A) exercise.

Increased arm Circumference can be attributed to swelling experienced by subjects. Increased AC is also a sign of DOMS. Swelling after eccentric exercise is caused by either intracellular and extracellular oedema, muscle or connective tissue damage or by the inflammatory response.[19] As documented by others, the intramuscular swelling and oedema brought about by the disruption of the sarcomeres and the formation of protein bound ions that exerted increased osmotic pressure.[20] AC was clinically less increased and quickly recovered in 48 hrs after applying the vibration because vibration treatment increases lymphatic flow and blood flow, which may enhance removal of pain substrates and reduce swelling.[21]

Maximum Isometric Force (MIF)

In the study Muscle strength was assessed by maximum isometric force (MIF). The MIF decreased immediately and then 24 hrs, 48 hrs in both all groups. In both experimental groups showed that the MIF decreased immediately, at 24 hrs as compared to baseline and then at 48 hrs that recovered about to normal. There was no significant difference between both experimental groups. While in the control group there was a decrease immediately, at 24 hrs and at 48 hrs after exercise.

Decrease in muscle strength in MIF might be due to pain experienced by subjects. Decreasing in MIF is also one the most important signs in DOMS. In DOMS, the ability of the affected area to generate force decreases. The exact cause of this loss of force is not well understood, but it is thought to be due to mechanical reflex inhibition of the muscle experiencing pain.[22] It has been assumed that strength decrement following eccentric exercise muscle action could be due to soreness which prevent subjects from fully activating their muscles due to the arthrogenic inhibition.[23] The strength reduction may be because of myofibrillar damage involving Z-band and sarcomere disruption by performing eccentric contraction.[24-26]

Many researchers found poor correlation of strength and muscle soreness. The greatest muscle strength reduction occurs immediately after the exercise which is before the onset of DOMS. Muscle soreness may recover within 3-4 days[27,28] but muscular strength will take about 1-2 weeks to come to the baseline.[29,30] The same pattern of recovery was found in all study where MIF decrease immediately after exercise and recovered in 48 hrs after application of vibration. In our study, MIF not recovered spontaneously in group which received no vibration.

Vibration therapy has previously been shown to have reflex tonic contraction called as Tonic Vibratory Reflex (TVR) when applied to muscle and tendon. This TVR has been shown to acutely enhance the strength of the vibrated muscle.[31-33] 'Bosco' et al. applied 5 min of vibration on elbow flexors and found that strength was increased. They concluded that initial increase in muscular strength is due to neural adaptation. Vibration applied to the muscle excites the alpha-motor neuron concerned with the tonic contraction. This can lead to sensitization of the motor fibres, which show immediate recovery of strength.[5,34]

In our study MIF not improved immediately after vibration therefore not due to neural adaptation. As we discussed earlier that soreness might limit the full activation of muscle. Soreness prevention by vibration application as described earlier might recover the capability of the muscle to generate force. However other cause of strength reduction cannot be ignored. Control group not recovered MIF therefore soreness not recovered.

Range of Motion (ROM)

In the study the muscle action was assessed by pain free elbow flexion and extension Range of Motion (ROM). In all three groups the ROM decreased immediately, at 24 h as compared to baseline but ROM recovered near to normal at 48 h in both experimental groups. While in control group there was no significant recovery at 48 hrs after exercise, clinically suggesting that there was increase the muscle stiffness and pain in control group.

Decreased ROM can be attributed to pain and muscle stiffness experienced by subjects. Decrease ROM is cardinal sign of DOMS.[35,36] Increase in muscle soreness level cause reduction in range of motion of a joint. Pain experienced when forcibly extending the elbow was related to mechanical stiffness which is due to the damage and shorting of non-contractile element in the muscle.[30] Shortening may be due to an abnormal increase of calcium ions in the muscle cell which has been attributed to a defect in the sarcoplasmic reticulum after damaging exercise.[29]

The ROM returned to its original value after 48 hrs in both experimental groups this can be attributed to application of the vibration. Vibration applied to the muscle or tendon is known to excite the primary or dynamic stretch sensitive receptor of muscle spindles result in repetitive trains of group Ia afferents impulses at a frequency that correspond with that of vibration. This leads to the depression of the excitability of homonymous alpha-motor neuron concerned with the monosynaptic reflex. The decrease in muscle tone by vibration application might be responsible for the relaxation of the muscle and restoration of ROM.[5,34]

As we discussed earlier that soreness might be the cause of decrease in ROM. Soreness reduction by vibration application as described earlier might fetch us to less decrease in the ROM in the experimental groups. Our results matched with other studies where there was also less decrease ROM by application of vibration before and after the exercise.[34,37]

Clinically group B appears to be partially better, i.e.; vibration applied after eccentric exercise appeared to produce less DOMS as compared to group A i.e.; vibration applied before eccentric exercise, but the reasons remain unclear but some speculation is possible.

This can possibly be explained on the basis that muscle vibration modulates sensory input from the muscle by activating afferent input from sensory units in the muscle (group Ia, Ib, and II fibers), which may modify the pain sensation associated with group III and IV afferent fibers. It is also possible that vibration reduces the excitability of dorsal horn neurons, which may increase pain threshold and alleviate pain. Gay et al. documented that the analgesic effect of vibration treatment might be explained by the ‘‘gate control’’ theory of pain in which non-nociceptive input from large-diameter fibres enhance spinal inhibition of nociceptive input. It has been shown that vibration treatment increases lymphatic flow and blood flow, which may enhance removal of pain substrates and reduce swelling.[23] It may be that the vibration applied after eccentric exercise had acute analgesic effect on muscle soreness associated with the reduction in DOMS.

Vibration applied after exercise session brought marginally and clinically better reduction in DOMS as compared to vibration applied before exercises. Though these differences are not statistically significant yet they are clinically useful.

Conclusion

Application of vibration helps to reduce the intensity of DOMS resulting from eccentric exercise of biceps brachii.

Application of vibration help to allow early recovery of DOMS resulting from eccentric exercise of biceps brachii.

Application of vibration after eccentric exercise have marginally better improvement from DOMS as compared to it applied before exercise.

Future Research

Further researches can be concluded to investigate whether changing the frequency, protocol and time of vibration will produce a different result.

Further research can be conducted by including biochemical markers, Ultrasonography, MRI images, EMG techniques to establish the effectiveness of vibration in the prevention of DOMS.

We do not know what the effect of vibration on muscle regeneration is, we recommend the researchers to work on this field to the best of our knowledge. This is the first research which shows the prevention of decrease of muscle strength by vibration application. Further researches are needed to establish the significance of vibration in the prevention of decrease MIF.

Future researches can be conducted by using the isokinetic for measuring maximum isometric force.

Further study may apply vibration before as well as after to see whether this device application will bring further reduction in DOMS.

Conflict of Interest: None

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