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Short Communication

Pulsed Ultrasound Does Not Affect Recovery From Delayed Onset Muscle Soreness

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Abstract:

Aim: To investigate the effects of pulsed Ultrasound (US) in recovery from Delayed Onset Muscle Soreness (DOMS).

Methods: Twelve healthy male athletes (mean age 23.83±1.697 year) performed an eccentric exercise protocol of non-dominant elbow flexors to induce muscle soreness on 2 occasions separated by 3 weeks. Subjects in experimental group received pulsed US (1 MHz, intensity 0.8 W/cm^2, mark space ratio 1:10), whereas control group received sham US after 24 h, 48 h and 72 h. Perception of muscle soreness, active ROM and muscle strength were the parameters measured at 0 h, 24 h, 48 h and 72 h with the help of VAS, manual goniometer and JONEX muscles master instrument respectively.

Results: Post hoc t test analysis revealed significant differences ($p < 0.05$) between 0 h and 72 h in the parameter of ROM ($t = 6.18$) and muscle power ($t = 2.54$) as well as between 24 h and 48 h in the parameter of muscle soreness ($t = 3.13$) in control group. Similar differences were also observed in the experimental group. No significant inter-group differences at α level of 0.05 was observed in any parameter at any level.

Conclusion: The pattern of recovery from DOMS was not influenced by the application of pulsed Ultrasound at the parameters discussed here.
Key Words: Ultrasound, Delayed Onset Muscle Soreness

Introduction:

Delayed Onset Muscle Soreness (DOMS) is defined as the sensation of pain or discomfort in the skeletal muscles following unaccustomed physical activity, usually eccentric muscular contraction.[1]

Several hypotheses have been offered with regard to the cause of DOMS like torn tissue theory, connective tissue theory, muscle spasm theory etc.

DOMS is an annoying condition that may interrupt performance of athletes. Thus, an effective treatment has been sought for many years by athletes and sports medicine professionals constantly to accelerate recovery. To date, a sound and consistent treatment for DOMS has not been established. Although multiple practices exist for the treatment of DOMS such as stretching, massage, ultrasound, and many more. Pulsed ultrasound (US) could be used in the treatment of DOMS. The aim of present study is to investigate the effects of pulsed US in recovery from DOMS.

Materials and Methods:

This study, a same-subject repeated measure clinical trial, was confined to 12 male athletes from Guru Nanak Dev University, Amritsar. Only male subjects were selected in order to eliminate any potential gender related differences in the perception of muscle soreness. Subjects included in this study were in between 21 to 26 years (Mean age = 23.83±1.697 year) and not engaged in any weight training program of the upper extremity 4 weeks prior to and at the time of data collection. Subjects with recent musculoskeletal injuries to tested upper extremity and taken medications 24 hours prior to DOMS induction until the last day of data collection were excluded from the study.

Prior to participation in this experiment, all subjects were informed of the procedures of the study and completed a pre-test health screening questionnaire and all subjects signed a written informed consent.

Subjects were randomly assigned to either a treatment or control group; in the cross-over design with 12 subject in each group undertaken treatments after exercise at day 1, day 2 and day 3. Subjects in treatment group received pulsed US (1 MHz, intensity 0.8 W/cm2, Mark space ratio 1:10) for 8 minute , while control group received sham US with the power output set to 0 for 8 minute.

Induction of DOMS:
Subjects performed an exercise protocol designed to induce DOMS on 2 separate occasions, separated by 3 weeks on non-dominant elbow flexors. The subject was required to lift a fixed weight of 20 pound in his hand from a fully extended to a fully flexed position in standing position. The weight was reduced to 15 pound in those subjects who could not lift 20 pound. Amount of weight was determined by subject's perception. Repetitions were performed with a concentric contraction followed by an eccentric contraction lasting 7 seconds. For this purpose a stop watch was used. During the eccentric contraction subjects were verbally encouraged to maintain the force level. Assistance was provided if subjects were unable to complete the concentric phase of the repetition; while during the eccentric phase no assistance was provided. Each subject was required to perform at least 4 sets of 10 repetitions with a 3 minute rest between each of the sets. Repetitions were determined by subject's feeling of exhaustion. Sets of repetitions were increased for those subjects who could lift it till exhaustion.

Dependent variables of this study are the following:
1. Measurement of Muscle Soreness (DOMS)
Visual Analogue Scale (VAS) ranging from 0 to 10 cm was used to measure soreness. The subject had to mark the line at the point corresponding to the intensity of pain perceived. It was used after treatment on day 1 to day 3.
2. Measurement of Active Joint Range of Motion of Elbow
Subjects had to lie in supine comfortably. Goniometer was placed with it's axis on lateral epicondyle, stable arm was kept parallel with the humerus while movable arm was kept parallel with the long axis of forearm. Subjects had instructed to bend the elbow actively from full extension position to fully flexed position. The score was taken on goniometer ranging from 0-180° before and after treatment on day 0 to day 3.
3. Measurement of Jonex Muscle Master Score (JMMS)
Subjects by sitting in half squatting position had to pull the wire of Jonex Muscle Master by keeping the elbow at right angle. Scale after pulling indicated the strength of the elbow flexors. It was used before and after treatment on day 0 to day 3.

Statistical Analysis: Data were statistically analysed using ANOVA with repeated measures. Post hoc t tests were performed to investigate the source of statistical significance for all main effects. Significance was accepted at $p < 0.05$.

Results:
Fig. 1 presents the graphical representation of Range of Motion (in degree) of experimental and control group at different stages of treatment.

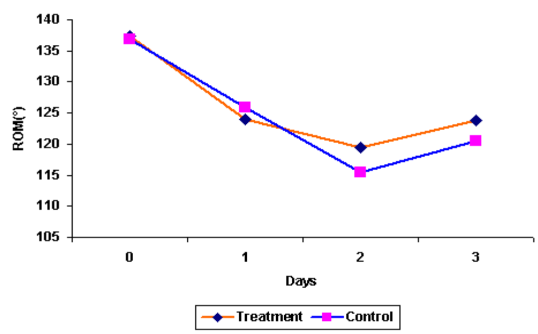

Fig. 1: Comparison of mean Range of Motion between experimental and control group at different stages of treatment.

ROM is decreasing rapidly immediately post exercise in both group upto 2nd day (i.e. 48 hr). This value decreased to lowest of 119.42±9.307 in treatment group and 115.5±7.562 in control group at day 2 (48 h). ROM starts increasing in both groups from day 2 to day 3 post exercise, though remained lower than pre-treatment level.

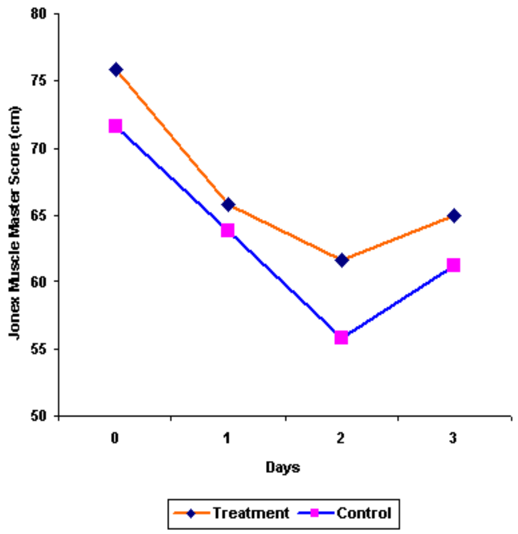

Fig. 2: Comparison of mean Jonex Muscle Master Score (JMMS) between experimental and control group at different stages of treatment.

Fig. 2 shows graphical representation of Jonex Muscle Master Score (JMSS) between experimental and control group at different stages of treatment. JMMS decreased in both groups from day 0 to day 2 post exercise reaching the lowest value of 61.67±18.505 in treatment group and 55.83±9.252 in control group, on day 2 post exercise. JMMS started increasing after day 2 but it did not reach the baseline value on day 3.

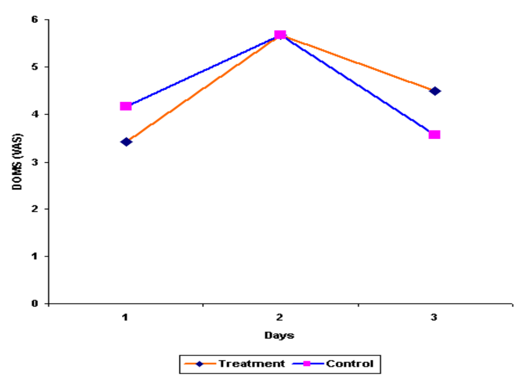

Fig. 3: Comparison of mean Visual Analogue Score (VAS) between experimental and control group at different stages of treatment.

Fig. 3 presents the graphical representation of Visual Analogue Score (VAS) of experimental and control group at different stages of treatment. VAS starts increasing from day 1 and reached its maximal value on day 2 in both group. On day 3 the VAS is less than day 2 but more than day 1.

Discussion:

Many modalities have been advocated for enhancing the recovery of pain and range of motion in the treatment of Delayed Onset Muscle Soreness (DOMS), however there is lack of concrete information regarding the efficacy of those modalities. Evidence with regard to the efficacy of ultrasound (US) on DOMS are conflicting. Some study[2] showed that US helps relieve DOMS while the other have observed contradictory findings of no effects[3,4] and also adverse effects.[5] The present study was designed to evaluate the possible contribution of pulsed ultrasound for recovery of the active Range of Motion (ROM), pain and muscle power following DOMS.

Although the pathophysiologic processes of DOMS remain occult, many forms of treatment have been investigated in an attempt to establish an effective and appropriate treatment. Pulsed US is an electrotherapeutic modality that has been used typically to decrease the symptoms of inflammation (pain and edema) and to increase the rate of healing in many conditions e.g. soft tissue injuries, musculoskeletal pain and chronic edema.[6]

The absorption of ultrasonic waves in tissues is suggested to cause an “oscillation” within those tissues. This vibration is believed to produce both thermal and non-thermal effects. It has been accepted that continuous US may cause a greater heating effect than pulsed US.[7] Moreover, continuous mode of US was studied by Ciccone *et al.*[5] who concluded that US enhanced the development of DOMS. They used continuous mode of US with 1 MHz, intensity 1.5 W/cm^2 for 5 minute.

According to Young[7] the criteria for the use of pulsed US versus continuous US remain in a grey area, with the practitioner having to decide whether thermal or non-thermal effects are required. Young[7] suggests that non-thermal effects may be preferable for tissue repair and stimulation of blood flow, therefore, pulsed US should be selected for conditions of this type. Given such putative effects, it is reasonable to postulate that pulsed US might be expected to accelerate the inflammation and healing processes while reducing the pain associated with DOMS. Pulsed US would therefore appear to be a useful modality for treating DOMS, where its reported anti-inflammatory effects would be beneficial.

In the current study analysis of the ROM, muscle power and muscle soreness data showed no significant difference between experimental and control group. ROM data indicated that the subjects who received sham US, showed as similar a pattern those who received pulsed US suggests that pulsed US has same effects on that sham US as far as ROM is concerned.

Delayed onset muscle soreness is typically associated with pain and stiffness that leads to a transient decrease in joint ROM in affected areas.[(8)] In the present study among control group, ROM decreased significantly ($p<0.001$) from day 0 and day 1 and from day 1 to day 2 ($p<0.01$).

Similarly, ROM in experimental group decreased significantly ($p<0.001$) between the intervals of day 0 Vs day 1 and non-significantly between the intervals of day 1 Vs day 2.

The possible explanation of the restriction of motion lies in the study of Howell *et al.*[8] which clearly indicate that neuromuscular activity is not the cause of restriction of motion in post-exercise muscle soreness.

The present study shows that muscle soreness peaked at 48 h after exercise. The similar observations had also been made by Mekjavic *et al.*[9] In the present study, muscle power decreased in both groups from day 0 to day 2 post exercise, reaching the lowest value of 61.67±18.505 in treatment group and 55.83±9.252 in control group, on day 2 post-exercise, and started increasing after day 2, though remained lower than pre-treatment levels, it is clear that muscle power did not recover in 3 days. This is in accordance with the findings of Cleak and Eston[10] which show maximum strength loss (46% of pre-exercise values) occurred 24 h later.

In this study significant loss of range of motion and increased pain level during first 24 h indicates that DOMS was successfully induced. This is in accordance with the study of Craig *et al*[3]

Conclusions:

In the present study efficacy of pulsed ultrasound has been investigated on the recovery pattern of pain perception, range of motion and muscle strength following delayed onset muscle soreness (DOMS). In the present study no significant benefits of pulsed ultrasound on DOMS in terms of pain relief, range of movement or muscle strength was observed. No intergroup differences were observed in any parameter at any level. These results, therefore, do not provide any evidence of the putative benefits of pulsed ultrasound in DOMS treatment.

Recommendations and Limitations:

The present study was delimited by the application of US dosage of 0.8 W/cm^2, mark space ratio of 1:10 to the DOMS of elbow flexor muscle for 3 days. Further studies are required to explore the efficacy of various doses of pulsed US on the other muscle group.

Current study was conducted with frequency of 1 MHz, further study may be done with 3 MHz. The US was applied once daily, it may be increased to 2-3 times a day. The duration of treatment was 8 minute which may be increased or decreased in further study. The follow-up treatment was given upto 3 days that may be increased upto 4-5 days. The site of application of US was only one on the anterior aspect of elbow flexors muscle which may be increased to multiple sites in future study. The sample of present study was 12, that may be increased in future study. The more effective and reliable measurement of variation of muscle power by the use of isokinetic machine would throw more light. Psychological status of the subjects should be monitored properly. Dietary control should be properly monitored in future study, which could affect the result. Dose measurement of the machine in present study could not be controlled, which should be clearly calibrated in future study by proper dosimetry. The parameters for DOMS induction should be clearly clarified.

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