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Effect of Microcurrent Stimulation on Delayed-Onset Muscle Soreness: A Double-Blind Comparison

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Objective: To examine the efficacy of microcurrent electrical neuromuscular stimulation (MENS) treatment on pain and loss of range of motion (ROM) associated with delayed-onset muscle soreness (DOMS).

Design and Setting: We assigned subjects to 1 of 2 groups. Group 1 received treatment with microcurrent stimulation (200 μA, 30 Hz, for 10 minutes, then 100 μA, 0.3 Hz, for 10 minutes) 24, 48, and 72 hours after DOMS induction. Group 2 served as a sham group and was treated using a machine altered by the manufacturer so that no current could flow through the electrodes.

Subjects: DOMS was induced in the biceps brachii of the nondominant arm of 18 subjects (3 males, 15 females: age = 20.33 ± 2.3 years, ht = 170.81 ± 7.3 cm, wt = 69.61 ± 13.1 kg). Dominance was defined as the arm used by the subject to throw a ball.

Measurements: Subjective pain and active elbow extension ROM were evaluated before and after treatment each day. Two methods were used to assess pain: constant pressure using a weighted Orthoplast sphere and full elbow extension to the limit of pain tolerance. Subjective pain was measured with a graphic rating scale and active elbow extension ROM using a standard, plastic, double-armed goniometer. Three repeated-measures ANOVAs (between-subjects variable was group, within-subjects variables were day and test) were used to assess ROM and pain scores for the 2 groups.

Results: We found no significant difference in the measurement of subjective pain scores or elbow extension ROM when the MENS group was compared with the sham group.

Conclusions: Our results indicate that the MENS treatment, within the parameters used for this experiment, was not effective in reducing the pain or loss of ROM associated with delayed-onset muscle soreness.

Key Words: electrical stimulation, MENS, DOMS, graphic rating scale

Electrical stimulation is a modality frequently used by athletic trainers in the treatment of symptoms (such as pain, swelling, loss of range of motion [ROM], and spasm) that are commonly associated with musculoskeletal trauma.[1] Recently, microcurrent stimulation has received attention as another type of electrotherapeutic modality capable of providing the beneficial effects commonly associated with the more classical forms of electrical stimulation.[2] Microcurrent electrical neuromuscular stimulation (MENS) is a subsensory modality that employs current intensities between 1 and 999 μA. It has been successfully used to enhance soft tissue healing[3–5] and to treat fracture nonunions.[6] The efficacy of microcurrent stimulation in the treatment of these conditions has led some clinicians to suggest that it might also be valuable in the treatment of musculoskeletal injury. Although MENS is used in the sports medicine setting, controlled, scientific studies documenting its efficacy are lacking. The purpose of our study was to examine the effect of microcurrent stimulation on pain and decreased ROM associated with delayed-onset muscle soreness (DOMS) using a double-blind research design.

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METHODS

Subjects

Eighteen subjects (3 males, 15 females: age = 20.33 ± 2.3 years, ht = 170.81 ± 7.3 cm, wt = 69.61 ± 13.1 kg) volunteered to participate in this study. None of the subjects were involved in any type of weight-lifting regimen. Subjects were asked to avoid any treatment other than the prescribed microcurrent treatment during their participation in the study. The procedures for this study were approved by a university institutional review board, and each subject provided informed consent.

Procedures

We assigned subjects to 1 of 2 groups. Group 1 served as the treatment group and received microcurrent stimulation (MENS

2000, Monad Corp, Pomona, CA). Group 2 served as the sham group and received treatment from a microcurrent unit that had been disabled by the manufacturer to provide no electrical stimulation. During the initial testing session, we assessed subjects for pain and elbow extension ROM. After this initial assessment, DOMS was induced. Subjects returned at 24-hour intervals for 3 days (days 2 through 4).

To ensure the blind nature of the study, neither experimenters nor subjects knew which microcurrent unit was the sham unit until the study was completed. Also, we asked subjects to refrain from commenting on any sensations experienced during treatment unless they felt pain or discomfort.

Range of Motion

We measured active elbow extension ROM using a standard, plastic, double-armed goniometer (Jamar, Clifton, NJ) with the subjects supine on a table and a towel roll just proximal to the elbow of the affected arm. The goniometer was aligned proximally with the head of the humerus and distally with the radial styloid. Elbow ROM was measured as subjects extended their elbows into a relaxed position.

Delayed-Onset Muscle Soreness

After initial evaluation for pain and ROM, DOMS was induced in the nondominant biceps brachii of each subject. The protocol for inducing DOMS has been previously described and proved effective.[7–12] Male subjects began with a 13.5-kg (30-lb) dumbbell, whereas female subjects began with an 11.25-kg (25-lb) dumbbell. Beginning in full elbow flexion, subjects were instructed to lower the dumbbell to full extension over 3 seconds. Upon reaching full extension, the primary investigator assisted the subjects in returning the weight to the starting position. Subjects performed continuous repetitions until they could no longer control the weight during the 3-second period. At this point, the weight was reduced by 2.25 kg (5 lb), and the protocol was repeated. As subjects continued to fatigue, the weight was sequentially lowered in 2.25-kg (5-lb) increments until a total weight of 2.25 kg (5 lb) was reached. At this weight, subjects were asked to perform repetitions either to fatigue or until 10 repetitions were completed.

Treatment

Subjects returned to the testing site 24, 48, and 72 hours after the initial treatment session. A 5.08 × 10.16-cm (2 × 4-in) pad was attached to the positive electrode and placed over the belly of the biceps brachii. A 5.08 × 5.08-cm (2 × 2-in) pad was placed posteriorly over the belly of the triceps brachii. Subjects received a 20-minute treatment. For those subjects receiving the MENS treatment, the intensity for the first 10 minutes was set at 200 μA and the frequency at 30 Hz. After 10 minutes, the intensity and frequency were lowered to 100 μA and 0.3 Hz, respectively.

Pain Assessment

Pain was assessed using a graphic rating scale (GRS).[13] The scale consisted of a horizontal axis with verbal descriptors of pain intensity placed at equal distances along the length (Figure 1). Subjects were asked to place a vertical line at the point on the scale that best described their pain. The distance from the left side of the scale to this mark was measured in centimeters.

Pain was elicited in 2 ways. For the first pain measurement, pain was recorded as constant pressure was exerted on the belly of the muscle. A 5.08-cm (2-in) diameter sphere constructed from Orthoplast (Johnson & Johnson, Pittsburgh, PA) was glued to a 10 × 10-cm (4 × 4-in) square of the same material (Figure 2). A 2.25-kg (5-lb) ankle weight was attached to the Orthoplast sphere. After pilot testing, a 2.25-kg (5-lb) ankle weight was found to have adequate mass to elicit discomfort. Each subject was seated with the arm resting on a table at 90° of horizontal shoulder abduction and 90° of elbow flexion. The Orthoplast sphere was looped over the belly of the biceps brachii, and the subject was asked to rate pain while the weight rested on the arm. For the second pain measurement, each subject was asked to rate pain while actively extending the elbow as far as possible. To limit the potential influence of pain, this measurement was taken after elbow extension ROM. Pain measurements were taken before and after DOMS induction and before and after treatment during subsequent sessions.

RESULTS

Three repeated-measures analyses of variance (the between-subjects variable was group and the within-subjects variables were day and test) were used to assess ROM and pain scores for the 2 groups. Increased ROM and decreased pain score indicate improvement after the treatment. Means and standard deviations for all conditions are presented in Tables 1–3. A

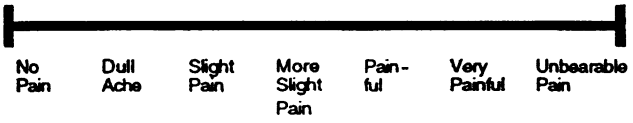

Figure 1. Graphic rating scale used for pain measurement.

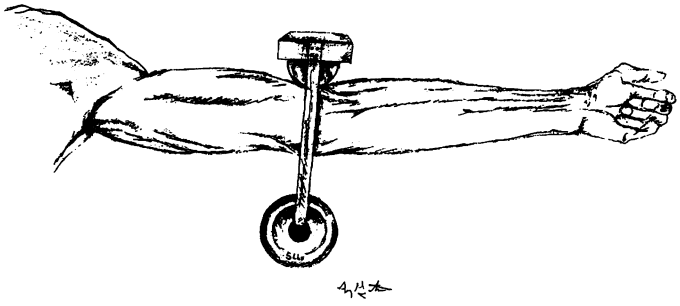

Figure 2. Orthoplast sphere and 2.25-kg (5-lb) weight used for compression during pain measurement.

Table 1. Means and Standard Deviations (degrees) for the ROM Condition for the MENS and Sham Groups Before (Pre) and After (Post) Treatment

	Day 1		Day 2		Day 3		Day 4	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
MENS								
Mean	3.89	−14.00	−20.89	−18.44	−28.00	−23.33	−23.78	−17.78
SD	7.21	13.52	14.93	15.19	14.35	24.62	13.47	17.50
Sham								
Mean	−0.44	−23.44	−25.22	−24.22	−36.44	−33.00	−30.00	−28.00
SD	12.30	16.05	21.86	24.12	22.62	23.13	23.83	19.10

Table 2. Means and Standard Deviations (cm) for the Extension Condition for the MENS and Sham Groups Before (Pre) and After (Post) Treatment

	Day 1		Day 2		Day 3		Day 4	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
MENS								
Mean	0.39	1.27	3.54	3.74	4.65	3.93	2.63	2.21
SD	0.31	1.20	1.78	2.09	2.99	2.91	1.62	1.73
Sham								
Mean	0.41	1.56	3.47	3.00	4.59	4.31	3.20	3.16
SD	0.25	1.95	1.71	1.54	1.56	1.40	1.99	2.11

Table 3. Means and Standard Deviations (cm) for the Orthoplast Sphere Condition Measured for the MENS and Sham Groups Before (Pre) and After (Post) Treatment

	Day 1		Day 2		Day 3		Day 4	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
MENS								
Mean	1.47	1.28	3.23	2.89	4.11	3.58	1.44	1.61
SD	1.87	1.06	2.65	2.08	3.41	3.12	0.57	1.32
Sham								
Mean	0.90	1.61	3.02	3.33	3.85	3.36	2.34	2.07
SD	0.70	1.85	2.01	2.21	1.61	1.54	2.07	1.62

significant main effect for day was found for all measurements: GRS-Orthoplast sphere ($F_{3,48}$ = 44.26, P = .001), GRS-extension ($F_{3,48}$ = 18.62, P = .001), and ROM ($F_{3,48}$ = 13.40, P = .001). A significant day-by-test interaction was found for GRS extension ($F_{3,48}$ = 5.04, P = .004) and ROM scores ($F_{3,48}$ = 19.77, P = .001). No significant differences were found for any of the group-by-test interactions: GRS-Orthoplast sphere ($F_{1,16}$ = 0.74, P = .402), GRS-extension ($F_{1,16}$ = 0.14, P = .717), and ROM ($F_{1,16}$ = 0.96, P = 3.42).

DISCUSSION

The lack of controlled scientific study on the effectiveness of MENS for musculoskeletal trauma provided the rationale for this study. Our findings suggest that microcurrent treatment, at the selected parameters, was not effective in reducing pain and loss of ROM associated with DOMS. The lack of significant differences for pain and ROM scores between the treatment and sham groups also suggests the lack of placebo effect associated with microcurrent stimulation.

We chose DOMS as a model for musculoskeletal injury for this experiment. We have used a DOMS model in our laboratory for numerous studies[7–12] based on the similarity of DOMS to musculoskeletal trauma. DOMS is a condition characterized by pain, swelling, and loss of strength and ROM after unaccustomed eccentric exercise.[14,15] Symptoms associated with DOMS usually increase in intensity during the first 24 hours after exercise and reach peak intensity 24 to 72 hours postexercise.[15] The significant change in pain and ROM measurements between days indicates that the protocol used in this experiment effectively induced DOMS.

In previous DOMS studies, pain measurements have generally been collected as subjects actively extended the involved extremity as far as possible. The distinct loss of ROM associated with DOMS makes this task quite uncomfortable and provides 2 reasons for avoiding such a procedure. First, active elbow extension stretches the muscle, thereby affecting subsequent ROM measurements, and second, the discomfort created by active elbow extension could inhibit subsequent ROM. ROM measurements taken before pain measurements could also affect pain ratings. To avoid these effects, we chose to measure pain using the Orthoplast sphere before ROM measurements and then obtained a second pain measurement using active elbow extension immediately after ROM measurement.

Much of the support for the use of microcurrent stimulation on musculoskeletal trauma is purely testimonial. Recently, researchers have begun experimenting with this modality to investigate its efficacy in musculoskeletal trauma. Their findings provide conflicting data. Denegar et al[8] found that microcurrent treatment (100 μA at 0.3 Hz for 20 minutes) provided transient analgesia but did not significantly reduce the loss of strength associated with DOMS. Maurer et al[16] reported less reduction in ROM after treatment with microcurrent stimulation at individual subsensory levels but concluded that MENS was not effective overall in the treatment of DOMS. Weber et al[14] reported no significant difference among MENS, massage, upper body ergometry, and control treatments on DOMS. Finally, Rapaski et al[17] found that MENS treatment at an intensity of 100 μA and individual subsensory levels was effective in reducing postexercise creatine kinase levels after the induction of DOMS.

Previous authors have reported enhanced soft tissue healing[3–5] and treatment of fracture nonunions[6] after subsensory electrostimulation. Direct current stimulation was used in all 3 studies[3–5] and alternating current in only one.[3] Bach et al[3] examined the biochemical and biomechanical effects of direct and alternating current subsensory stimulation on the healing of skin incisions. They reported an increase in collagen concentration in and around the wound (biochemical effect) and no difference in the tensile strength or wound thickness (biomechanical effects) when compared with control groups. MENS was delivered via an alternating current in our study. Therefore, the biochemical increases in collagen formation after MENS are advantageous but may not be reflected when clinical measures such as ROM and subjective pain measures are used. The conflicting results of the aforementioned studies demonstrate the need for further investigation of the efficacy of microcurrent stimulation before we can use it confidently as a treatment for musculoskeletal trauma. Further research should address the efficacy of specific treatment parameters, including current, intensity, frequency, and treatment times, so that clinical applications can be identified.

CONCLUSIONS

At the parameters selected for this experiment, microcurrent stimulation was not effective in reducing pain and loss of ROM associated with DOMS. Additional research is needed before we can use microcurrent stimulation confidently in the sports medicine setting to reduce pain after musculoskeletal injury.

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