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ICE AND HIGH VOLTAGE PULSED STIMULATION IN TREATMENT OF ACUTE LATERAL ANKLE SPRAINS*

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The purpose of this investigation was to compare ice versus ice and high voltage pulsed stimulation (HVPS) for the treatment of ankle sprains. Thirty young adult subjects with grade I or II lateral ankle sprains were included in this study. Subjects received treatment within 30 hours following injury and were treated once daily for three days. Group I (N = 10) received ice for 30 minutes; group II (N = 10) received combination ice and HVPS (28 pps, negative polarity, current to comfort without contraction) for 30 minutes, and group III (N = 10) received ice and HVPS (80 pps, negative polarity, 30 minutes). All groups showed a tendency toward a decrease in pain, decrease in edema, and increase in ankle dorsiflexion following treatment. ANOVA for edema and dorsiflexion changes revealed that there were no significant differences in treatment effects among groups. HVPS, as utilized, did not further affect pain, edema, or range of dorsiflexion in the treatment of acute lateral ankle sprains.

High voltage pulsed stimulation (HVPS) is widely used in the conservative treatment of acute trauma, particularly for edema control.[1,3,5,8-10] Limited quantitative data are available demonstrating the effects of this electrotherapeutic agent on acute edema. A recent review of the literature has suggested that HVPS protocols are not well developed or consistent.[10] The purpose of this study was to evaluate the effects of HVPS using negative polarity continuous modulation at 28 pulses per second (pps) or at 80 pps in addition to a standardized regimen of ice, elevation and compression on ankle edema, range of motion (ROM), and pain during the acute phase following grades I and II lateral ankle sprains. It was hypothesized that HVPS would contribute to a reduction in edema, increased ROM, and a reduction in pain over and above the effects of ice, compression, and elevation.

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MATERIALS AND METHODS

Subjects were 30 healthy military recruits ranging in age from 18 to 38, who sustained a grade I or II lateral ankle sprain between 1 and 28 hours prior to initial physical therapy assessment and treatment.

The patients were randomly assigned to one of three treatment groups. There were 10 in each group. Group I received an ice pack circumferentially wrapped about the ankle for 30 minutes. Group II received combination ice pack and HVPS at 28 pps continuous modulation for 30 minutes. Group III received the same treatment as group II except that the frequency was set at 80 pps. Both 28 and 80 pps have been frequencies suggested at seminars, in company printed protocols, and by practicing clinicians. An EGS model 100 (Electro-Med Industries, Miami, FL) was used for the electrical stimulation. Treatments were given once a day for 3 days.

The assessment consisted of volumetric measurements of the foot and ankle, ROM in dorsiflexion and perceived pain. Volume and ROM were measured pre-treatment and post-treatment on days 1 and 3. Pain was assessed prior to and following the treatment on day 1.

Volumetric measurements were determined by the water displacement technique using a Lucite tank (Volumeters Unlimited, Idyllwild, CA) and a graduated cylinder. The patient was seated, then placed the involved foot at the bottom of the tank with the heel against the back wall. After the foot was situated in the tank the obturator cube was put in place to improve accuracy of measurement by displacing more water. The displaced water was collected in a large receptacle, then poured into a large narrow graduated cylinder for more precise measurement. Reliability of measurement of this volumeter was determined to be ±25 ml on an average of 10 trials on one uninjured subject.

Active dorsiflexion was measured with a goniometer with the patient prone-lying and the knee flexed to 90°.

The patients were asked to rate the intensity of pain using a horizontal numerical 10 point scale. They were asked to choose one number to indicate the level of pain. A rating of 10 indicated the most severe pain.

TREATMENT PROTOCOL

All patients were positioned in supine with the affected lower extremity elevated to 45°. A 3 inch by 3 inch carbon silicone impregnated rubber electrode was applied to each side of the ankle and held in place with an elastic wrap. Wet gauze was placed between the electrode and the skin. Electrodes on the ankle were negative in polarity and served as the active electrode. The dispersive electrode (8 inches by 10 inches) was placed on the low back and held in place by body weight. An ice pack was then applied around the ankle and held in place with an elastic wrap. For the patients in group I the current was not turned on. For both group II and group III patients receiving HVPS with negative polarity, intensity was turned up to the point of muscle contraction and then turned down to just below palpable contraction for the duration of the 30 minute treatment. These treatment protocols were administered once a day for 3 days.

At the end of each treatment session, the foot and ankle were ace wrapped. The patients were instructed and trained in the use of axillary crutches. They participated in classroom activities, but sat on the sidelines during field activities.

DATA ANALYSIS

Volume and ROM were analyzed using a one way analysis of variance. Descriptive statistics are presented for the analysis of perceived pain. Significance was accepted at $p < 0.05$.

RESULTS

There were no significant differences in duration of injury among the three groups (Table 1).

There were no significant differences between the groups in volumetric or ROM measures. Following the first treatment, group I had a mean decrease in volume of −12 ± 11 (Table 2). Further, in groups II and III the volume changes were 22 ± 28 and 28 ± 12 ml, respectively. At the end of the third treatment, the average decrease in volume for all groups was between 32.5 ± 28 and 38 ± 56 from the initial pre-treatment measure on day 1. After the third treatment, no subjects in group I had an increase in volume from the pretreatment measure, whereas one subject in group

TABLE 1

Time since injury of all groups

Treatment*	Time since injury (in hours, mean and SD)
Ice (N = 10)	10 ± 11
Ice + HVPS 28 pps (N = 10)	8 ± 9
Ice + HVPS 80 pps (N = 10)	9 ± 9

Source	Sum of squares	df	Mean square	F†
Between	34.4199	2	17.21	.167746
Within	2564.89	25	102.596	
Total	2599.31			

* One-way analysis of variance of time since injury of all 3 groups.
† Critical F (p = 0.05); 3.39.

TABLE 2

Changes in foot and ankle volume displacement in millimeters

Treatment	Following first treatment* (millimeters, mean, and SD)	Following third treatment† (millimeters, mean, and SD)
Ice (N = 10)	−12 ± 11	−32 ± 28
Ice + HVPS 28 pps (N = 10)	−22 ± 28	−38 ± 56
Ice + HVPS 80 pps (N = 10)	−28 ± 12	−35 ± 39

Source	Sum of squares	df	Mean square	F‡
Between	920.071	2	460.036	1.36032
Within	9130.9	27	338.180	
Total	10051			
Between	161.223	2	80.6113	.0453107
Within	46256.1	26	1779.08	
Total	46417.3			

* One-way ANOVA of foot and ankle volume displacement after first treatment.
† One-way ANOVA of foot and ankle volume displacement after third treatment.
‡ Critical F (p = 0.05); 3.39.

II and two subjects in group III had increases in volume over the initial values.

Although all groups had an increase in ankle dorsiflexion over the course of the 3 days of treatment, the changes were minimal (Table 3). After the first treatment the mean increase and standard deviation in dorsiflexion were 1 ± 1° in group I and 3 ± 4 and 4 ± 3° in groups II and III, respectively. Following the third treatment, the mean increases were 7 ± 2, 10 ± 7, and 8 ± 3°, respectively. The changes among groups following both the first treatment and the third treatment were not significantly different.

Scores for perceived pain were determined only before and after the first treatment. The mean pre-treatment pain score was 5.7 for the ice only group and following the first treatment a mean of 3.2, resulting in a mean decrease in pain of 2.5 points (Table 4). Both groups treated with ice and HVPS had decreases in pain from pre- to post-treatment of 3.65 and 3.70. Eight of 10 patients in the ice treated group and 4 out of 10 in the HVPS at 28 and 80 pps improved from 1–3 points from pre- to post-treatment categorized by us as slight improvement (Table 5). Two out of 10 ice treated and 6 out of 10 treated with electrical stimulation improved from four to seven points, or moderately improved. Those treated with electrical stimulation tended to show a greater reduction in pain, but due to the subjective nature of the pain evaluation and the small number of subjects, statistical analysis was not performed.

TABLE 3

Change in active ankle dorsiflexion ROM (in degrees)

Treatment	Following first treatment* (in degrees, mean, and SD)	Following third treatment† (in degrees, mean, and SD)
Ice (N = 10)	1 ± 1	7 ± 2
Ice + HVPS 28 pps (N = 10)	3 ± 4	10 ± 7
Ice + HVPS 80 pps (N = 10)	4 ± 3	8 ± 3

Source	Sum of squares	df	Mean square	F‡
Between	44.8665	2	22.4333	2.22601
Within	272.1	27	10.0778	
Total	316.967			
Between	53.3678	2	26.6839	1.3007
Within	533.389	26	20.515	
Total	586.757			

* One-way analysis of variance of active ankle dorsiflexion after first treatment.

† One-way analysis of variance of active ankle dorsiflexion after third treatment.

‡ Critical F (p = 0.05); 3.39.

TABLE 4

Perceived pain (0–10 point scale)

Treatment	Pretreatment	Following first treatment	Change in pain
Ice (N = 10)	5.7 ± 2.2	3.2 ± 1.9	−2.50 ± 1.43
Ice + HVPS 28 pps (N = 10)	6.1 ± 2.2	2.2 ± 1.5	−3.65 ± 2.10
Ice + HVPS 80 pps (N = 10)	6.2 ± 2.5	2.6 ± 1.3	−3.70 ± 2.36

DISCUSSION

The conventional management of ankle sprains is ice, compression, and elevation. Over the last decade, HVPS has often been included with this treatment paradigm. The proposed rationale for the inclusion of HVPS was to decrease edema and pain, thus reducing the inflammatory response. High voltage is used because of its negligible chemical effects[7] and low average current, thus offering the patient increased comfort level over traditional low voltage stimulation.

The mechanisms of action of electrical stimulation for edema reduction are unknown but may be through an electrophoretic effect or muscle pumping action.[4,10] With edema, interstitial proteins and fluids increase. Therapy should be geared toward restoring normal osmotic balances. We chose to look at the postulate that high voltage pulsed stimulation can cause movement of fluid, serum protein, and blood cells without muscular contraction. It is important to realize, though, that we did not directly measure fluid and cellular shifts but measured the clinical expression of such changes, i.e., distal limb volume. But, with the parameters reported in this study the HVPS did not add to the edema control resulting from the ice, compression, and elevation.

Electrical stimulation is a well accepted procedure for pain control.[2] There was some evidence from the descriptive data in this study that the addition of ES to treatment did provide an additional pain relief. The stimulus characteristics used were similar to those for conventional TENS.[6]

Other adaptions in the treatment protocol could be *1*) treat with postive polarity over the injured area, *2*) alter polarity through the treatment ses-

TABLE 5

Effect of treatment on perceived pain

Degree of improvement (change in pain score)	Ice	Ice + HVPS 28 pps	Ice + HVPS 80 pps
0–3 (slight)	N = 8	N = 4	N = 4
4–7 (moderate)	N = 2	N = 6	N = 6

sion, or 3) place both (all) electrodes over the injured area to concentrate current more in the area of injury. These aforementioned changes may perhaps enhance treatment effects. In addition, increasing treatment duration or the number of treatment sessions per day could perhaps have produced a different outcome.

Pain and ROM can be useful data to collect when looking at functional outcome but this study was limited to 72 hour data collection. The research question in this study was limited to the first 3 days and did not ask the broader question regarding final outcome.

The changes in volume measured with the volumeter were very small. With grade I and II ankle sprains the figure-of-eight girth measure may be more specific to the area of swelling than is volumetrics.

CONCLUSION

Ice and HVPS at 28 and 80 pps tend to produce a decrease in foot and ankle volume, an increase in range of motion in dorsiflexion, and a decrease in pain. However, there were no significant differences shown among the groups studied in any measured parameter. Therefore, within the limits of this subject sample, it was concluded that HVPS did not further enhance the effects of ice, compression, and elevation.

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