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The Short-Term Effects of 2 Different Cryotherapy Methods on Acute and Subacute, Noncomplicated, Bilateral Neck Pain

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Background: Cryotherapy has since long been used by physical therapists and chiropractors in the management of acute pain; more recently, its use has been shown to be effective in managing chronic pain. Multiple studies have shown that both ice and menthol reduce blood flow to the affected area and help control pain; however, there is limited research to determine the form of cryotherapy that works better on individual patients.

Purpose: The purpose of this study was to compare the effect of a cold pack and menthol topical gel on reports of pain among individuals with neck pain.

Methods: In this randomized study, 51 individuals in the age range of 19–65 years (37 ± 11.2 years) with bilateral, nonradicular, acute neck pain (myalgia) were included. Cold packs and Biofreeze[®], a topical analgesic, were applied on either side of the neck (ie, ice on one side and Biofreeze on the other). The patients were asked to rate their pain on a 0–10 visual analog scale for either side of the neck both before and immediately following the 10-minute treatment. In addition, the patients were asked to answer 2 questions about which modality they would prefer to use in the future for pain management and their level of comfort with each modality during its application and to rate their answers on a 5-point scale (1 = very unlikely or very uncomfortable and 5 = very likely or very comfortable). On the next day of treatment with cold packs and Biofreeze, patients were asked to choose their preferred mode of treatment among the two and the modality that had a longer-lasting effect.

Results: Overall, when asked to rate the comfort and preference, patients preferred Biofreeze 8:1 ($P = .000$). The average score on the 5-point Likert scale was 4.20 and 2.57 for Biofreeze and cold pack, respectively. In addition, 9 out of 10 patients reported that the effect of Biofreeze lasted longer than that of ice ($P = .000$). Further, the average score for Biofreeze and ice was 4.47 to 2.63, respectively. For actual levels of pain relief, the

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average pretreatment visual analog scale score decreased from 6.24 to 3.65 for Biofreeze and from 6.31 to 5.00 for ice. A paired *t* test showed that both cold packs and Biofreeze significantly reduced pain ($P = .000$). However, the pain reduction was 2-fold with the Biofreeze treatment.

Conclusions: Both cold packs and Biofreeze significantly reduced pain; however, there was a 2-fold reduction in pain with Biofreeze. Biofreeze was rated as substantially more comfortable; patients preferred it, and its effect lasted longer in 9 out of 10 trials. This study was the first to evaluate the immediate effects of 2 different cryotherapy methods. It is not unexpected that the results of this study would differ slightly from other published studies evaluating menthol products. Conservative care specialists are often looking for methods to improve patient satisfaction and compliance. The present study indicates that Biofreeze is the preferred method of cryotherapy application by many neck pain patients on their first visit to the clinic.

Keywords: Biofreeze; neck pain; cryotherapy; ice

Key Point: A topical analgesic (Biofreeze) provided more acute pain relief than ice application among patients with neck pain.

Cryotherapy is the application of an agent, such as ice, menthol agents, and gel-based cold packs, that causes the cold receptors to stimulate the temperature pathway in the spinothalamic tract. It has for long been used by physical therapists and chiropractors in the management of acute pain.¹⁻³ More recently, the use of cryotherapy has been shown to be effective in managing chronic pain.⁴ There is limited research to determine which form of cryotherapy works better on patients presenting with a variety of conditions.

The cervical spine has the potential for a significant amount of motion while supporting the weight of the head. The neck is less protected than the rest of the spine and is subsequently vulnerable to injuries and disorders that result in pain.⁵ Neck pain is a very common disorder that affects ~70% of individuals at some time in their lives⁶, and ~54% of people will have it at some point over a 6-month period.⁷ Neck pain can be caused by injury, muscle strain, or tension, as well as numerous other mechanisms.⁷ Management of neck pain is complicated because of the common lack of etiology and the potential involvement of shoulder, jaw, head, or upper arm.⁸

Pain is a complex phenomenon consisting of a physiological and emotional response to a noxious stimulus.⁹ In the treatment of pain, cryotherapy is extensively used to aid in the healing process of muscle damage and delay the onset of an inflammatory response.^{1,2,10,11} Cold packs are one of the most common types of cryotherapy used because of its cost factor and clinical effectiveness. Cryotherapy has been extensively studied in relation to pain, blood flow, and muscle damage.⁴ Topical menthol is another form of cryotherapy, and there is limited evidence to support the efficacy of this treatment compared with that of the application of ice as a standard form of cryotherapy.¹²⁻¹⁵

Upon application of any cryotherapy treatment, the blood vessels in the direct-contact area constrict, reducing the blood flow to the affected area.¹¹ In a cold environment, adrenergic sympathetic vasoconstrictors cause the skin blood vessels to reduce circulation, guarding against heat loss from the body. Cryotherapy has been shown to reduce tissue temperature, reduce inflammation and consequent edema, reduce pain sensation, and decrease time to recovery.^{1,2} A single cold pack application



produces an immediate but short-term beneficial effect on muscle soreness following eccentric exercise.¹⁶

Menthol application with respect to muscle damage or fatigue is not a widely studied area in human models. Theories have emerged on the mechanism of topical menthol and muscle contraction using animal models.^{17,18} Menthol blocks voltage-dependent sodium channels, leading to a higher action potential threshold.¹⁸ The majority of the studies with menthol focus on providing temporary pain relief; therefore, further studies are needed on the assessment of menthol as a cryotherapy treatment and on its effect on muscle damage and fatigue.

Cryotherapy is commonly used in both clinical and athletic settings to manage injuries and reduce pain and inflammation following an injury; however, cold packs (ice or gel) are not portable and thus require the patient to be sedentary for at least 10 minutes.^{1,2} However, in 21st century healthcare, treatment portability has become necessary because of busy lifestyles. Topical menthol is an inexpensive, portable form of cryotherapy, but its effectiveness has not been sufficiently proven in direct comparison with cold packs.

Given the high frequency and incidence of neck pain, it is our aim to determine if topical menthol gel can provide pain relief in the short term for symptomatic patients. The purpose of this study is to compare the effect of gel-based cold packs and a menthol topical gel (Biofreeze[®], Performance Health, Akron, OH) on pain among individuals with acute or subacute, uncomplicated, bilateral neck pain. A secondary purpose is to compare patients' acute neck pain cryotherapy treatment preference between gel-based cold packs and topical menthol. These purposes were addressed through the following hypotheses:

H1. Patients with acute or subacute, uncomplicated neck pain who are treated with either gel-based cold packs or menthol gel will experience a significant reduction in neck pain within 10 minutes of application.

H2. Patients with acute neck pain will experience a significant difference in the degree of pain following 10 minutes of treatment with either cold packs or menthol gel.

H3. Patients with acute neck pain will experience a significant difference in the preference for treatment based on comfort following 10 minutes of treatment with cold packs or menthol gel.

METHODS

Design

Patients presenting to an outpatient chiropractic clinic with complaints of acute or subacute, bilateral, uncomplicated neck pain were examined for determining the appropriateness for care. Following the examination, they received cryotherapy treatment consisting of the topical menthol gel and cold packs.

Sample

In total, 29 males and 22 females in the age range of 19–65 years (36.76 ± 11.2 years) (Table 1) with either acute or subacute bilateral, uncomplicated neck pain participated in the study. The Neck Disability Index, used to measure disability due to pain, with a mean disability score of 36.8 indicated moderate disability.¹⁹ These patients were recruited by a convenience sample of those presenting to an outpatient clinic with complaints of bilateral neck pain and with onset ≤ 30 days without radiation or referral distal to the shoulders. Patients were excluded if they had a history of previous neck surgery, had received cortisone injection within the past year, or had symptoms that extended past the glenohumeral joint on either side. Patients who were < 18 years or > 65 years of age were also excluded.

After the patients gave informed consent, cold packs and the topical analgesic menthol gel were applied one on each side of the neck and upper back simultaneously. The cryotherapy treatments, that is, menthol gel and cold packs, were randomly applied to either the right or left side of the cervical spine. A

**Table 1.** Patient descriptors ($n = 51$)

<i>Continuous Variables</i>			
Variables	Mean \pm SD	Minimum	Maximum
Age	36.8 \pm 11.2	19	65
Days since onset of pain	8.2 \pm 6.7	1	30
Neck Disability Index	36.8 \pm 17.7	4	72
<i>Discrete Variables</i>			
Variables	Frequency	%	
Gender			
Males	29	57%	
Females	22	43%	
Primary diagnosis			
739.1 (Nonallopathic lesions, cervical region)	50	98%	
726.1 (Rotator cuff syndrome of shoulder)	1	2%	

nickel-sized sample of the menthol gel was rubbed lightly into the skin in the region of the upper trapezius and levator scapulae by the researcher. Before receiving the therapy, the patients were asked to rate their pain on a 0–10 visual analog scale (VAS) for each side of the neck. Following the treatment, the patient again rated the pain on the right and left side of their neck on the VAS. The VAS has been shown to correlate well²⁰ with physician assessments of pain ($r = 0.70$) and to have high test–retest reliability ($r = 0.97$).²¹ Our previous work with this method revealed significant test–retest reliability over a 1-week duration ($r = 0.61$ – 0.74) and that these measures are sensitive to exercise interventions in older adults.^{22,23}

In addition, the patients were asked to answer 2 questions about which modality they would prefer to use in the future for pain management and their level of comfort with each modality during its application and to rate their answers on a 5-point scale (1 = very unlikely or very uncomfortable and 5 = very likely or very comfortable). On the next day

of treatment with the cold packs and menthol gel, patients were asked to choose their preferred mode of treatment among the 2 and the modality that had a longer-lasting effect.

Analysis

To address *H1*, 2 paired *t* tests were performed to compare the pain reported by the patients on the VAS before and after application of cold packs and menthol gel. Following this analysis, change scores between pretreatment and posttreatment VAS pain scores were calculated for both therapies. These change scores were then compared using a paired *t* test to address *H2*. Finally, questions concerning the patient’s preferences between the 2 treatment modalities were assessed by asking each patient to “choose which cryotherapy modality they would prefer to use in the future for pain management.” Patients rated both the cold pack and the menthol gel intervention on a 5-point Likert scale anchored by “very likely” and “very unlikely”. All analyses used $P < .01$ to determine statistical significance and to allow for artificial



inflation of type-I error due to repeated *t* test calculations.

RESULTS

The patients had an average onset of pain of 8.2 ± 6.7 days (acute to subacute pain) and an average Neck Disability Index of 36.8 ± 17.7 , indicating that they had a moderate level of disability. The results of the *t* test to address *H1* are presented in Table 2. This analysis indicates that both menthol gel and cold packs resulted in statistically significant reduction in pain. When comparing the changes in pain resulting from the therapies (*H2*), the change resulting from the menthol gel (-2.59 ± 1.28) was statistically significantly greater than the reduction in pain resulting from the cold packs (-1.31 ± 1.01) ($P < .00$) (Table 3). The patients were asked 2 questions immediately after the treatment (Table 4). A comparison of the preferences for the treatments (*H3*) indicated that the patients were significantly more likely to use the menthol gel than cold packs in the future ($P < .00$) and that they rated the comfort and ease of use of the menthol gel higher than those of the cold packs ($P < .00$). Finally, 88% (45 of 51) of the patients preferred the menthol gel over the cold packs, and 90% (46 of 51) of the patients reported that the effect of the menthol gel lasted longer than that of the cold packs. One patient preferred the menthol gel,

but reported that the effect of the cold packs lasted longer. The analysis of crossover effect of pain relief, that is, the menthol gel causing symptom reduction on the opposite side of the neck, in addition to the side where it was originally placed, showed a nonsignificant, low effect ($r = -0.08$, $P = .56$). Thus, there was a low correlation of pain reduction on the menthol side compared with that on the cold pack side; therefore, no effect of the cold packs and the menthol gel was noticed on the opposite side of their application.

DISCUSSION

The results support each of the following 3 proposed hypotheses:

H1. Both cold packs and menthol gel resulted in a significant reduction in pain among patients with acute and subacute, uncomplicated neck pain.

H2. The reduction in pain was significantly greater on the menthol gel-treated side than that reported on cold pack-treated side. The reduction in pain with the menthol gel was 2-fold that with cold packs.

H3. Patients consistently reported their preferences for having their neck pain treated with menthol gel instead of cold packs.

The results of this study show that although cold packs and menthol gel are effective for

Table 2. Comparison of pain relief between cold packs and menthol gel

Treatment	Pretreatment Pain, Mean \pm SD	Posttreatment Pain, Mean \pm SD	<i>t</i> Score	<i>P</i> <
Menthol gel	6.24 \pm 2.20	3.65 \pm 1.65	14.40	.00
Cold packs	6.31 \pm 2.14	5.00 \pm 2.25	9.29	.00

Table 3. Comparison of change in pain scores between cold packs and menthol gel

Change in Pain Scores with Cold Packs, Mean \pm SD	Change in Pain Scores with Menthol Gel, Mean \pm SD	<i>t</i> Score	<i>P</i> <
1.31 \pm 1.01	2.59 \pm 1.28	14.40	.00

**Table 4.** Comparisons of patient preferences for treatment on a 5-point Likert scale

Questions with Responses on a 5-Point Likert Scale (14 = Very Unlikely, 5 = Very Likely)				
	Cold Packs Mean ± SD	Menthol Gel Mean ± SD	t Score	P <
How likely are you to use the following therapy in the future for pain management?	2.57 ± 1.12	4.20 ± 1.10	5.67	.00
Please rate the comfort and ease of use with each therapy modality	2.63 ± 1.15	4.47 ± .81	7.85	.00
Questions with Forced Responses				
Which modality did you prefer?	6 (12%)	45 (88%)		
Which modality had a longer-lasting effect?	5 (10%)	46 (90%)		

short-term (1 day) reduction in pain levels, treatment with menthol gel showed a significantly greater reduction in pain levels, was substantially preferred more by patients, and was reported to be more comfortable than treatment with cold packs. Therefore, in the management of acute and subacute neck pain, clinicians should consider topical menthol first. In addition, there is more research needed to determine the results of these treatments on chronic conditions or for application in other parts of the body.

Limitations

There was a concern that because the cold packs and menthol gel were applied concurrently on either side of the neck, there could be a crossover effect and the patient would experience a reduction in pain on each side because of the other modality. In other words, we needed to determine if the cold packs applied to the left side of the neck would have a pain reduction effect on the right side of the neck and if the menthol gel applied to the right side would have a pain reduction effect on the left side. However, the statistical analysis did not show that there was a crossover effect. The narrow range of diagnoses was also a limitation. It is unknown whether the results of this study can be applied to patients with pain in other regions, chronic neck pain, or even acute neck pain with radicular

symptoms. Further investigation is needed to determine these effects.

The majority of the studies with menthol, including this one, focus on providing temporary pain relief; therefore, further studies are needed to assess the effect of menthol on muscle damage and fatigue and its long-term outcomes. Thus, these findings should not be applied to functional outcomes in patients with acute or subacute neck pain.

CONCLUSION

The application of either topical menthol or cold packs in patients with acute and subacute neck pain provided a significant reduction in pain in the short term; however, menthol gel was associated with a 2-fold reduction in pain compared with cold packs, and it was reported to be more comfortable and the preferred treatment modality. Future research should be conducting in areas including evaluation of the long-term effects and clinical implications, the effects of different concentrations of menthol gel, and the effects of treatment plan compliance when receiving different applications of cryotherapy. Clinicians should consider using menthol gel as opposed to cold packs in patients with acute and subacute neck pain.

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