Acute Effect of 2 Topical Counterirritant Creams on Pain Induced by Delayed-Onset Muscle Soreness

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Context: The effectiveness of topical counterirritants in relieving pain remains unproven. Objective: To examine the effectiveness of 2 topical counterirritant creams in reducing DOMS. Design: Subjects performed eccentric contractions of the non-dominant elbow-flexor muscles. 48 hours later they were randomly assigned to the following groups (n = 18 per group): placebo cream, capsaicin cream, or menthol/methyl salicylate cream. Measures: Pain was assessed using a visual analog scale (VAS) before the exercise, 48 hours afterward, and 15 minutes after the cream was removed. Results: All groups demonstrated a significant ($P < .05$) elevation in their VAS scores 48 hours after the eccentric exercise, $0.12 \pm 0.04$ vs $2.79 \pm 0.22$. Only the subjects in the menthol/methyl salicylate group indicated a significant ($P < .05$) reduction in the perception of pain after treatment; their VAS declined to $1.22 \pm 0.25$. Conclusions: A single application of the menthol/methyl salicylate cream is effective in relieving DOMS. Key Words: capsaicin cream, visual analog scale


Delayed-onset muscle soreness (DOMS) is a type of musculoskeletal pain elicited by unfamiliar exercise, especially eccentric contractions.¹⁻³ The soreness begins 8–24 hours after exercise, with peak intensity between 24 and 72 hours postexercise.¹⁻³ One mechanism proposed to explain the delayed sensation of pain is the inflammatory response to tissue injury induced by exercise.¹⁻³ Histamines and prostaglandins are released during inflammation, thereby stimulating nociceptors, which activate nociceptive pathways and lead to the perception of discomfort or pain.¹⁻³

Various treatment regimens are employed to reduce the severity of DOMS. One such regimen is the application of a counterirritant cream (also known as sports cream) to the skin overlying the painful muscle. Counterirritant creams penetrate the epithelial layer of the skin and stimulate cutaneous sensory receptors, which in turn can evoke a range of
Topical Menthol/Methyl Salicylate’s Attenuation of DOMS

sensations. The counterirritant-induced sensations suppress or relieve the perception of deeper pain. The effectiveness of the cutaneous application of counterirritant creams in alleviating the pain induced by DOMS has not been examined extensively. In our study we proposed to examine the acute effectiveness of 2 popular counterirritant sports creams in alleviating DOMS.

Methods

Subjects

Fifty-four men (n = 19) and women (n = 35) age 19–30 years participated in the study. Subjects did not regularly perform upper body weight-training exercise. All subjects completed a health-history questionnaire that screened for cardiac, pulmonary, and bone diseases; Raynaud’s phenomenon; and any peripheral vascular disease. Written consent was obtained from all subjects. The experimental protocol for this study was preapproved by the Chapman University Institutional Review Board.

Protocol

A commonly used visual analog scale (VAS) was employed (Figure 1) to determine pain perception associated with full extension of the elbow of the nondominant arm before the eccentric-exercise regimen, 48 hours afterward, and 20 minutes after the application of a counterirritant cream. All subjects attended 2 appointments spaced 44–52 hours apart.

Appointment 1. Before the eccentric-exercise regimen, baseline (BL) pain perception associated with full extension of the nondominant arm was assessed using the VAS. Each subject performed eccentric exercise with the nondominant arm to induce DOMS. We used an eccentric-exercise protocol because it has been reported to effectively induce DOMS.

Figure 1  Visual analog scale (VAS) with 2 opposing extremes identified as no pain and pain as bad as it could be. The scale measures 10 cm in length. Measurements were taken from no pain to the mark indicated by each subject and expressed in centimeters.
The seat height was adjusted to achieve 70° of shoulder flexion with the subject’s feet flat on the floor and back supported. The subject performed eccentric elbow flexion at a rate of 30°/s through a range of 110° to 10°. The subject completed 2 sets of 35 eccentric repetitions with 1 repetition every 15 seconds and a 5-minute rest interval between sets.

After the exercise bout, subjects received a set of postexercise instructions. They were asked to abstain from applying any type of therapeutic treatment to the nondominant arm. Specifically, they were instructed to refrain from the following: applying hot or cold treatments to the non-dominant arm, taking oral drugs to relieve discomfort, applying any topical ointment to the nondominant arm, compressing the nondominant arm with a wrap, applying any type of massage to the nondominant arm, and performing exercises with the nondominant arm.

**Appointment 2.** To determine whether the eccentric exercise performed 48 hours earlier had induced DOMS, pain associated with full extension of the nondominant arm was assessed using a second VAS (Ex). Each subject was queried about compliance with the postexercise instructions. All subjects complied with the instructions; therefore, none were excused from the study. Subjects were randomly divided into 3 groups (n = 18 per group): placebo (Lubriderm®, Warner-Lambert Corp), capsaicin (Zostrix®, Gen-Derm Corp), and menthol/methyl salicylate (Greaseless Bengay®, Pfizer Inc). Subjects were not told what the 3 treatment groups were or to which group they were assigned.

Each subject identified the most painful area of the flexor surface of the nondominant arm. A 4-cm² circular stencil was centered over the area identified by the subject, and a syringe containing 2 ml of the cream was applied with a tongue depressor to minimize any inadvertent effects of massage. The cream remained on the arm for 5 minutes and was immediately removed after the 5 minutes had elapsed. Adopting the protocol used by Haynes and Perrin, we waited 15 minutes after removal of the cream to assess the effectiveness of treatment on pain sensation using a final VAS (Tr).

A repeated-measures ANOVA was used to compare changes within a group. When a significant $F$ ratio was identified, differences were assessed using a Bonferroni post hoc test. A Friedman nonparametric analysis was used to assess differences in VAS (BL, Ex, Tr) between groups. A $P$ value <.05 was used as the criterion for statistical significance. Finally, all the results are expressed as mean ± SE.

**Results**

All subjects (n = 54) who qualified and committed to the study completed the study. The age of the subjects, 25.9 ± 0.4 years, was not significantly different between groups (Table 1). In addition, there was no significant difference between groups (Figure 2) in perceived pain before DOMS (BL)
Table 1  Subject Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Placebo</th>
<th>Capsaicin</th>
<th>Salicylate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age*</td>
<td>25.8 ± 0.6</td>
<td>25.9 ± 0.8</td>
<td>26.0 ± 0.7</td>
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<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Women, n</td>
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<td>10</td>
<td>12</td>
</tr>
</tbody>
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*No significant difference in age between groups.

Figure 2  Visual analog scale (VAS) score in centimeters from each group. Placebo indicates group treated with a placebo cream (n = 18); capsaicin, group treated with a capsaicin cream (n = 18); and salicylate, group treated with a menthol/methyl salicylate cream (n = 18).

*Significant difference between baseline VAS score (BL) and postexercise VAS score (Ex). †Significant difference between postexercise VAS score (Ex) and VAS score after treatment (Tr).

and 48 hours after the induction of DOMS (Ex).

The group receiving the menthol/methyl salicylate cream reported a significant reduction in DOMS (P < .05) 15 minutes after the cream was removed from the skin (Figure 2). In contrast, neither the group receiving the placebo cream nor the group receiving the capsaicin cream demonstrated a significant reduction in pain 15 minutes after cream removal (Figure 2).
Comments

We examined the effectiveness of the topical application of 2 different counterirritant creams in alleviating the pain associated with DOMS. Eccentric exercise of the nondominant arm induced DOMS, the severity of which was assessed using a VAS. We found that 15 minutes after the removal of topically applied menthol/methyl salicylate, the pain of DOMS was significantly attenuated, whereas 15 minutes after the removal of topically applied placebo or capsaicin, the pain of DOMS was not reduced. Our findings suggest that menthol/methyl salicylate applied to the skin over the area of muscle pain attenuates the perception of DOMS.

Many reports have implicated eccentric contractions as the cause of musculoskeletal injury with the subsequent release of biochemical markers of muscle damage.\(^2,3,7,8\) Creatine kinase (CK) is one of the biochemical indicators of tissue injury.\(^2,3,7,8\) In this regard, Clarkson et al.\(^6\) observed the induction of DOMS using a total of 60 maximal eccentric contractions of the elbow flexors. These investigators also observed elevations in blood CK activity that paralleled the subjective sensation of muscle soreness. This would suggest muscle injury, thereby substantiating the subsequent symptoms of DOMS. Using a modified eccentric-exercise protocol, we also observed the induction of DOMS. Although we did not measure serum CK activity in our subjects, the current study confirms the subjective elicitation of DOMS as assessed by a VAS.

We found that a single application of capsaicin cream did not lower the perception of pain from DOMS. We speculate that the capsaicin cream evoked a cutaneous sensation that was more painful than irritating. This speculation is based on capsaicin’s action. Capsaicin applied to the skin enhances the release of the neuropeptide substance P from nociceptors.\(^9\) It is the stimulation of nociceptors and the release of substance P that activate pain pathways and sets the stage for the perception of pain. Thus, the single application of the capsaicin cream might have evoked a cutaneous pain in addition to the pain of DOMS. This could explain the inability of the capsaicin cream to alleviate the pain and, although not statistically significant, might partially account for the elevation in pain. Furthermore, we speculate that the capsaicin cream might have eventually acted as an effective counterirritant if the cream had been applied repeatedly. Repeated application of capsaicin would begin to deplete nociceptors of substance P.\(^9\) This progressive depletion of substance P might eventually result in sensations that are more irritating than painful. The irritating sensation might then act as a counterirritant to DOMS.

One of the creams used in our study contained the active ingredient methyl salicylate. The topical application of salicylate esters\(^10,11\) and methyl salicylate\(^12\) has been shown to reduce pain. For example, the topical application of salicylate esters has been shown to reduce exercise-induced arthralgia\(^10\) and rheumatic pain.\(^11\) In addition, topical application of methyl
salicylate has been shown to evoke limited analgesia at the skin’s surface.\textsuperscript{12} In light of these findings, our observation that the topical application of menthol/methyl salicylate reduced the pain of DOMS was likely a result of the cream’s active ingredient, methyl salicylate. Furthermore, although both counterirritant\textsuperscript{13} and anti-inflammatory\textsuperscript{13} properties have been ascribed to methyl salicylate, in our study the effects of the topical application of menthol/methyl salicylate was likely explained by its counterirritant property. We showed that pain reduction occurred after a small dose of menthol/methyl salicylate was applied to the skin for a very brief time period, a finding consistent with the action of a counterirritant. If the cream’s anti-inflammatory action were to explain our result, the time period between cream application and pain reduction would need to be long enough to allow the absorption of methyl salicylate through the skin and fascia and into the muscle.

The VAS is a valid and reliable instrument used to discriminate pain intensity.\textsuperscript{14} Our use of the VAS is consistent with prior studies that have measured subjective pain.\textsuperscript{5,14} Although we observed a significant decrease in the VAS 15 minutes after the application of the menthol/methyl salicylate cream, the clinical interpretation of this reduction remains to be determined. Although a reduction in pain perception will ease patient discomfort, its effects on the recovery process and muscle function are unknown.

Our study suggests that menthol/methyl salicylate can temporarily attenuate the pain induced by DOMS. This might be the rationale for its popularity and use by exercise enthusiasts who experience musculoskeletal pain. Although empirical evidence suggests that the use of a counterirritant cream alleviates the pain of DOMS, this study provides documented evidence that a menthol/methyl salicylate cream is a beneficial adjunct in the treatment of DOMS. Furthermore, it suggests that pain reduction is not an obligatory effect of all counterirritant creams and that the degree of counterirritation or the contents of the cream might be the determining factor of its effectiveness.

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References


