A Novel Method of Compressing and Cooling Ankle Injuries

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Introduction

Every year, over 30 million children ages 8 to 17 participate in sports in the United States [1]. Regarding these athletes, an average of 3.5 million sports-related injuries are reported each year, where 22.6% of cases concern the ankle [2].

The most common therapy for such injuries is the RICE method– Rest, Ice, Compression, and Elevation– which aims to reduce swelling and increase blood flow throughout the affected areas. High school athletes primarily resort to applicators such as ice packs or bags of frozen peas to treat injuries at home. While these remedies can be effective, they have a limited range of applications, especially in regards to areas such as the ankle, as they do not provide compression and demand that the user remain stationary. More elaborate products do exist, but these are often too expensive to be practical for the average youth athlete. Therefore, there is a need for an inexpensive method of compressive cooling that is available to young athletes.

The Ice Applicator combines the support of a compressive brace with an endothermic reaction for effective cooling, allowing athletes to treat ankle injuries at home for an affordable price.

Competitor Analysis

<table>
<thead>
<tr>
<th>Game Ready® Ankle Wrap</th>
<th>Ice/Instant Cold Pack</th>
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<tbody>
<tr>
<td><strong>Cons:</strong></td>
<td><strong>Cons:</strong></td>
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<tr>
<td>Expensive ($370)</td>
<td>Non-Reusable</td>
</tr>
<tr>
<td>Requires users to be stationary</td>
<td>Low mobility</td>
</tr>
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<td></td>
<td>No barrier provided which can cause frostbite</td>
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<td></td>
<td>Chemical spills</td>
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Brainstorming Ideas

<table>
<thead>
<tr>
<th>Prototypes</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Cooling: Peltier Cooler</td>
<td>One side must get hot for other side to get cold</td>
</tr>
<tr>
<td>Cooling: Endothermic Reaction</td>
<td>Needs new reactants for each reaction</td>
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<tr>
<td>Compression: Ankle Brace</td>
<td>Adjustment isn’t very precise</td>
</tr>
<tr>
<td>Compression: Air Pump</td>
<td>Less portable-need to carry hand pump with device</td>
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Need Statement

1. A cost effective way to decrease pain while providing recovery to muscle/fatament injuries in the ankle
2. Compress affected tissues in ankle to promote recovery

Need Specifications

Must Have:
- Cool for ~20 minutes.
- Skin doesn’t get below 0 degrees C
- Compression pressure 20-40 mmHg
- <$50

Nice to Have:
- Cool for 30 minutes
- Cooling begins within 1 minute
- Cold pack <250 grams (not including brace)
- <$15

Concept Selection and Analysis

Endothermic reaction with urea:

Energy + CO(NH₂)₂(s) + H₂O(l) → 2NH₃(l) + CO₂(g)

- Absorbs heat as reaction proceeds (feels cool)
- Replaceable reaction packets

Figure-eight brace:
- Stabilizes the injury
- Allows the user to be mobile
- Adjustable velcro strap

Conclusions

We created an affordable device that provides compression to help heal ankle injuries. We used an endothermic reaction created by mixing urea and water to provide cooling and found that it reached its coldest temperature in under 1 minute and lasted for about 15 minutes.

The adjustable ankle brace provides compression which allows the user to be mobile and provides a barrier to prevent frostbite. The reaction pouches placed inside the brace provide cooling and compression simultaneously.

References


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