The Use Of Cold And Hot Compressive Therapy On Musculoskeletal Tissue For Injury Treatment And Prevention

A Current Concepts Review

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Introduction

The application of heat and cryotherapeutic agents has become very popular in the clinical and rehabilitation settings, as growing scientific evidence supports the benefits of cold and hot treatments for musculoskeletal injury. When applied in the appropriate setting, local changes in tissue temperature can have a broad range of effects through positive alterations in metabolism, blood flow, nerve conduction, and the viscoelastic properties of soft-tissue.1,2 Recent studies investigating the application of soft-tissue compression in conjunction with local temperature alterations have demonstrated significant enhancement in the healing potential of soft-tissue injuries.3,4 These observations have resulted in technological advances directed towards combining these modalities in an effort to effectively manage and prevent musculoskeletal injury. In this review, the scientific basis for thermal based therapeutic modalities, both alone and in conjunction with soft-tissue massage and compression, will be discussed. Additionally, the advantages of the ThermA-Roller as an effective device for the treatment and prevention of musculoskeletal injury will be considered.

The Benefits of Cryotherapy (Cold Therapy)

Musculoskeletal injuries are among the most common injuries that occur during athletic activities, with a reported incidence as high as 26% for all observed injuries.5 In the setting of acute soft-tissue trauma, a highly coordinated inflammatory response involving various cell types is initiated. Macrophages are recruited to the site of injury to eliminate necrotic cellular debris and start the repair process; however, a vigorous inflammatory reaction can also generate reactive metabolic byproducts that produce oxidative cellular damage and impair normal cellular function.6,7 Numerous studies have demonstrated that immediate application of cryotherapy is beneficial in the acute phase of inflammation as local elevations in tissue pressure with subsequent hypoxic injury and edema formation.1,8,9 Additionally, the decrease in edema leads to improved analgesia, as local elevations in tissue pressure with subsequent activation of painful nociceptors is reduced.10 Overall, similar observations and improvements in clinical outcomes have been observed following numerous orthopaedic procedures including total knee arthroplasty (TKA), total shoulder arthroplasty (TSA), rotator cuff repair, and anterior shoulder stabilization.11,12,13

Clearly, the benefits of cryotherapy are not limited to the postoperative setting, as studies suggest clinical improvements following the addition of intermittent cold treatment to the rehabilitation of routine musculoskeletal injuries. As an example, a study by Bleakley et al demonstrated intermittent cryotherapy resulted in significantly better subjective pain control during the early stages of rehabilitation following ankle sprains.14

Bibliography

**Cryotherapy with Compression & Massage**

Intermittent soft-tissue compression is a mechanical treatment directed towards increasing passive blood flow by the application of external pressure. The observed biomechanical effects of this treatment include reduced venous stasis and venous pressure, as well as increased arterial blood flow. While reductions in venous pressure can result in less edema formation, increased arterial blood flow may play an important role in tissue healing.

An animal study by Dahl et al demonstrated that intermittent compression treatment can improve neurovascular ingrowth and fibroblast proliferation in healing tendon and may even accelerate the repair process. Recently, these observations have been described in vivo. Knochel et al evaluated the microcirculation of the midportion of the Achilles tendon in healthy volunteers following treatment with either cryotherapy alone or combined cryotherapy/intermittent compression.

The authors found that the addition of compression to cold therapy leads to significantly increased tendon oxygenation and reduced postcapillary venous filling pressures. While the precise therapeutic effects of these observations have not been determined, the authors speculate they may play a positive role in the treatment of Achilles tendinopathy.

The combination of cryotherapy and tissue massage may play an important role in delayed onset muscle soreness (DOMS). DOMS is a form of muscle injury that is characterized by significant localized muscle tenderness and loss of joint range of motion. A number of theories have been proposed to explain the pain stimulus associated with DOMS; however, the process remains vaguely understood.

One theory is based upon direct muscle damage, which is caused by disruption of the contractile component of muscle tissue during high-intensity eccentric exercise. Specific enzymes have been measured in the post-exercise period to support this theory, as creatine kinase (CK) has been identified as a reliable indicator of muscle damage secondary to increased cell membrane permeability.

A study by Howatson et al investigated the efficacy of ice massage therapy on the effects of DOMS by measuring the blood levels of CK following eccentric exercise. The authors found that the addition of compression to cold therapy leads to significantly increased tendon oxygenation and reduced postcapillary venous filling pressures. While the precise therapeutic effects of these observations have not been determined, the authors speculate they may play a positive role in the treatment of Achilles tendinopathy.

The benefits of heat therapy

The viscoelastic properties and biologic response of soft tissue to local increases in temperature have been well documented in several in vivo animal studies. A study by Noonan et al demonstrated controlled increases in thermal temperature have a significant effect on the viscoelastic properties of skeletal muscle. While the precise therapeutic effects of these observations have not been determined, the authors speculate they may play a positive role in the treatment of Achilles tendinopathy.

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**Advantages of the Therma4™ Roller**

As with any medical treatment, patient education is important to achieve a safe and effective outcome following musculoskeletal injury. Modalities for administering local cold and hot treatments should be relatively easy and safe to use by both the individual and health care practitioner (e.g., trainer, nurse, physician). The Therma4™ Roller facilitates the easy application of hot or cold therapy combined with compression and massage by a practitioner or the injured party. Static thermal therapy devices (ice packs, motorized cryo-therapy units, hydropulser pads) can cause a thermal injury if applied incorrectly; there have been reports of continuous-flow cold therapy machines causing severe hypothermic injury. The dynamic nature of the Therma4™ Roller treatment modality make the likelihood of thermal injury very low. In addition, the effective nature of the device encourages treatment of the affected area and therefore a speedy recovery.

In summary, scientific evidence supports the use of dual modality thermal massage treatment. The Therma4™ roller is a unique and versatile device that can be used to self-administer hot or cold treatments in a controlled manner with individually appropriate compression. The manual nature of the compression applied by the patient or health care practitioner aids in ensuring even distribution of external force over the anatomic area of interest. The roller is not in constant contact with the skin, thereby minimizing the potential for thermal related injury, but ensuring adequate compression to aid in recovery. Current literature supports the use of combined modalities to optimize lymphatic drainage, increase blood flow, and stimulate tissue healing, as the addition of external compression increases the depth of temperature alteration to optimize soft-tissue healing.

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**Table 1. Factors that affect local soft-tissue cooling**

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<thead>
<tr>
<th>Factor</th>
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<tbody>
<tr>
<td>Temperature differential between the body and cryotherapy device</td>
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<tr>
<td>The regeneration of body heat and cryotherapy device cooling</td>
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<tr>
<td>The size (surface area) of the cold modality</td>
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<tr>
<td>Amount of soft tissue contacted by the cryotherapeutic device</td>
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<tr>
<td>Depth of soft tissue penetration/thickness of adipose tissue</td>
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<td>Length of application</td>
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**Table 2. Observed biologic activity with temperature increase over baseline body temperature (36°-37°)**

<table>
<thead>
<tr>
<th>Temperature Increase</th>
<th>Biologic Activity</th>
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<tbody>
<tr>
<td>1° C (mild heating)</td>
<td>Increase in tissue metabolis</td>
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<tr>
<td>2° - 3° C (moderate heating)</td>
<td>Reduction in muscle spasm, pain</td>
</tr>
<tr>
<td>4° C (vigorous heating)</td>
<td>Increase in peripheral blood flow</td>
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<tr>
<td></td>
<td>Alteration in viscoelastic properties of collagen</td>
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<tr>
<td></td>
<td>Inhibition of sympathetic activity</td>
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