The Technical Benefits of Icing

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KEY POINTS

- Cryotherapy, or cold therapy, when used in the proper clinical situation can diminish pain, metabolism, and muscle spasm, thus minimizing the inflammatory response and improving recovery after soft tissue trauma.
- Benefits of compression used in conjunction with cryotherapy include improved contact between the skin and the cold source, greater reduction of blood flow to the region, and an increased insulation effect, which may further reduce tissue temperatures.
- Caution should be used when applying to areas where a superficial nerve is located. It is recommended that the best practice is to always check with the individual's physician to see if any medical condition may prevent the use of cryotherapy.
- Joints and muscles may benefit from the routine use of cryotherapy even when an injury has not taken place.

INTRODUCTION

The purpose of this article is to review the normal response to a musculoskeletal injury, either traumatic or exercised induced, and the therapeutic effects of cold therapy. In addition, we will review the physiological effects of icing and how icing relates to injury prevention and facilitates and speeds recovery from injury and return to sport.

The use of ice, or cryotherapy, for musculoskeletal injuries has been a primary treatment approach used by healthcare providers for many years. Although ice use dates back to ancient Greece, it has been a regular part of injury management only since the early 1950's (1,2). Today, cryotherapy use continues to be a proven and beneficial adjunct to managing soft tissue injury. It is proposed that applying cooling to a musculoskeletal injury decreases the tissue temperature, resulting in diminished pain, cellular metabolism, and muscle spasm, thus minimizing the inflammatory response and improving recovery after soft tissue trauma (3,4,5). Ice, although predominantly used in injury management, in theory can also reduce the pain associated with the micro-trauma of regular exercise. Use of ice on the shoulders and knees of players is a well-known practice in sports such as professional baseball or basketball, even when no acute injury has occurred.

THE INFLAMMATORY RESPONSE

In order to understand the rationale for using cryotherapy in the treatment of a musculoskeletal injury, it is important to recognize what is occurring at the cellular level as a result of the injury. An inflammatory response occurs at the site of the injury and is the local, tissue-level response to the injury and the mechanism by which a tissue heals (2). Signs of tissue inflammation may include pain, redness, warmth, swelling/edema, and decreased function. Inflammation can develop from both acute injuries, such as ligament sprains or tears, and chronic injuries, such as arthritis or tendinitis.

At the microscopic or cellular level, trauma causes disruption of the cell wall, which damages the cell and the surrounding cells. The cell damage results in an interruption in the normal metabolic processing of the cell. A damaged cell resorts to

using anaerobic metabolism (glycolysis) as its energy source secondary to cellular hypoxia. This mechanism of energy production cannot be sustained for prolonged periods of time, therefore the cell's energy needs cannot be met and the cell's ability to regulate concentration gradients is impaired. Due to the lack of gradient regulation, water is allowed to pass into the cell, which leads to cellular swelling and ultimately to rupture of the damaged cell (2). In an attempt to control the injury, the body releases chemical mediators including cyclooxygenase, prostaglandins, leukotrienes, histamine, serotonin, bradykinin, and leukocytes that enter into the affected area. These cells and mediators are a normal response to the injury and are meant to control the inflammatory response and help remove cellular debris so tissue repair can occur (6). Vascular changes contribute to the inflammatory response. The vessels in the affected region of the damaged tissue begin to vasodilate. Vasodilatation facilitates greater flow of blood to the region allowing the transportation of important fluids and proteins into the area that further assist the body's defense mechanisms. This process accounts for the redness and heat associated with inflammation. Further intra-capillary pressure is increased, which may cause compression of the surrounding nerve endings resulting in pain (7). Swelling of the injured region is not uncommon and contributes to loss of movement and ultimately a decrease in function.

THERAPEUTIC EFFECTS OF ICE

Cryotherapy, or cold therapy, is a common modality used in the treatment of soft tissue injuries. (8) Cold therapy has an impact on a tissue's metabolism, pain response, and hemodynamics, thus aiding in the management of the inflammatory response (2.9). Cryotherapy reduces tissue temperature, which slows the rate of chemical reactions, thereby decreasing the demand for energy (2,10). This is an important concept because an injured cell uses glycolysis for its energy production. This metabolism puts a high demand on the cell and leads to hypoxia and, eventually, to cell death. By lowering the metabolic/energy demand with cryotherapy, this allows more cells to survive the period of anaerobic energy production (11). In addition, when a tissue is injured, specific nerve fibers become activated and begin sending input to the spinal cord. The faster the conduction of this input, the higher the perception of pain and the greater the possibility for muscle spasm. When cryotherapy is applied, the velocity of the fibers is decreased, an analgesic effect is produced and muscle spasm is reduced (12,13). When tissue temperature is decreased 1C there is a decrease of 1.2 m per second in motor nerve conduction velocity and subsequently a 2 m-per-second drop in sensory nerve conduction velocity (14,15). It has also been demonstrated that the application of cryotherapy decreases blood flow to the injured region, thus reducing edema formation (1). The combined effects of decreased energy requirements, reduced blood flow, analgesic response, and swelling reduction all diminish the tissue's inflammatory response, ultimately resulting in a shortened healing process and hastened return to activity.

ROLE OF COMPRESSION

Compression is often used in conjunction with cryotherapy. Benefits of compression include improved contact between the skin and the cold source, greater reduction of blood flow to the region, and an increased insulation effect, which may further reduce tissue temperatures (16). Compression also assists with control of edema formation that may arise after injury or secondary to micro-trauma sustained during a hard workout (17,18). Compression appears to assist with cooling tissues more rapidly (19). This is particularly important in the case of an acute injury in which rapid cooling is desired to minimize the extent of inflammation and secondary ischemic injury to the tissue caused by the inflammatory process.

RECOMMENDED PARAMETERS

Clinical evidence-based cryotherapy protocols addressing the optimal temperature and duration of cryotherapy application to achieve therapeutic benefits have not been established. Recommendations for practice cryotherapy protocols have been proposed by expert consensus groups, however, these recommendations have been based on studies using animals or healthy humans, post-surgical subjects, and thus may not be applicable to all clinical situations where cryotherapy is recommended. For example, proposed icing protocols have ranged from the application of an icing product with or without compression from 10 to 20 minutes 2 to 4 times per day to icing up to 45 minutes every 2 hours (20). Evidence is highly based on clinical results rather than evidence-based study, thus there is a need for further studies.

One factor that has influenced proposed parameters is that secondary vasodilation can occur from prolonged exposure to cold. Although the initial effect of application of cryotherapy is vasoconstriction, prolonged application can actually lead to vasodilation. **This is often referred to as the hunting response or reflex and is described as a reflex vascular vasodilation in the affected area following the initial vasoconstriction caused by prolonged cold application (21).** It is proposed that when the tissue temperature reaches a certain level, this reflex occurs in an attempt to warm the tissue. Vasodilation is generally thought to occur after 15 to 20 minutes of continuous cold therapy, however there has not been conclusive research confirming this duration. Despite a lack of concrete evidence, many healthcare practitioners use 20 minutes as the maximum duration for application of cold in order to avoid this reflexive vasodilation. The theory is that the increased blood flow caused by vasodilation could actually prove counterproductive in that it may facilitate the inflammatory response rather than limit its effect, ultimately causing loss of the analgesic effect. When applying this theory to determine treatment duration one must also consider factors such as body mass, size and body region of the contact area, and

difference in starting temperature (11,22). Each of these factors has the potential to affect the time in which it takes the tissue to reach the temperature at which the hunting response occurs.

PHYSIOLOGICAL EFFECT OF EXERCISE ON SOFT TISSUE

Exercise participation can result in an acute muscle strain or injury causing sudden pain, often accompanied by an immediate loss of functional capacity (23). Exercise can also cause micro-trauma that may not necessarily be symptomatic. This micro-trauma is due to an accumulation of loading forces on the same musculotendinous unit during repetitive activity. This extra load could cause limited or no damage if it occurred for only a short period of time. However, if the activity is not slowly increased over time, or the activity is performed repetitively without rest, then micro-trauma will likely result (24). A paper by Johnston recommends that at the completion of exercise that cryotherapy be applied to reduce micro-trauma and the associated pain (7). It is important that the athlete increase his or her exercise activities slowly, allowing the body to adapt. The body's response to gradually increasing activity results in muscle proliferation, bone mass increase or maintenance of its density, and enhanced tensile strength of ligaments and tendons.

EFFECT OF CRYOTHERAPY ON RETURN TO PLAY

To date there are limited studies that have been published evaluating the application of cold and the speed of return to play. The application of cold therapy lowers tissue temperature to varying degrees. Immediate application of cryotherapy post injury has been shown to reduce tissue metabolism, resulting in the reduction of hypoxic injury, cell damage, and edema (25). Additional benefits of cryotherapy include analgesia and decreased muscle spasm. In theory, it seems reasonable to conclude that these physiological effects should have a positive outcome on a speedier return to activity. Hocutt, et. al performed a study to evaluate return to play time in 37 patients with ankle sprains. The patients were seen on day one or two of the ankle injury and treated with either cryotherapy or heat. Compression was applied to both groups. The initiation of cryotherapy on day one and continued for three days resulted in return to full activity significantly sooner than heat therapy or cryotherapy begun on day two (26). Merrick proposed that ice plus compression increases effectiveness of the ice in decreasing tissue temperatures thus providing a greater reduction in local metabolism and potentially greater reduction in secondary hypoxic injury, possibly allowing the athlete to recover sooner (16).

PRECAUTIONS AND CONTRADICTIONS TO CRYOTHERAPY USE

Cryotherapy, when used appropriately, is a safe modality (5). Ice should not be used in some conditions such as Raynaud's phenomenon, sickle cell anemia, cold allergic conditions, and in areas with impaired sensation. Caution should be used when applying to areas where a superficial nerve is located. It is recommended that the best practice is to always check with the individual's physician to see if any medical condition may prevent the use of cryotherapy. Ice can be used immediately following acute injury or workouts. If the pain and or the swelling do not resolve or there is an on-going functional deficit, the individual should consult with a physician.

In conclusion, cryotherapy, when used in the proper clinical situation, can reduce the inflammatory process and the associated pain and disability of injury and speed the individual's return to play. In addition, joints and muscles may benefit from the routine use of cryotherapy even when an injury has not taken place.

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