**Physiologic Effects of Cryotherapy**

Cryotherapy is a pain treatment that uses a method of localized freezing temperatures to deaden an irritated nerve. Cryotherapy is the local or general use of low temperatures in medical therapy. Cryotherapy is used to treat a variety of benign and malignant tissue damage, medically called lesions.

The therapeutic use of cold, has clinical applications in rehabilitation and in other areas of medicine. Cryotherapy is used primarily outside of rehabilitation for the destruction of malignant and non—malignant tissues growths; very low temperature are used, and cooling is generally applied directly to the tissue being treated. In rehabilitation, mild cooling is used to control inflammation, pain and edema; to reduce spasticity; to control symptoms of multiple sclerosis; and to facilitate movement. This type of cryotherapy is applied to the skin but can decrease tissue temperature deep to the area of application, including the intra—articular area.

**Physiologic Effects of Cryotherapy**

Cryotherapy is broad term that covers a number of specific techniques, including ice packs, cold gel packs, ice massage, ice immersion, cold whirlpool, and vapocoolant spray.

Initially, after application of ice pack, patient feels cold, which progresses to burning, warming sensation. Aching, tingling, and finally numbness follow. First response is constriction of arterioles and venules (within 15 minutes or less). Blood flow to area decreases, and body attempts to conserve heat. Vasodilation can be cold-induced after initial period of vasoconstriction when cold is maintained for longer than approximately 15 minutes or when temperature is reduced below 10°C. Period of alternating vasodilation and vasoconstriction also may occur, known as “hunting response.” This response is most predominant in apical areas where arteriovenous anastomoses are located in skin and has been shown to be absent in deeper tissues. After cold is removed, temperature rises in adjacent body parts.

**HEMODYNAMIC EFFECTS—**

**Initial decrease in blood flow**

Generally, cold applied to the skin caused immediate constriction of the cutaneous vessels and reduction in blood flow. This vasoconstriction persists as long as the duration of cold application is limited to less than 15 to 20 minutes. Studies show that repeating ice application after an initial 20 minutes application for two repetitions of 10 minutes off and 10 minutes on lowers blood flow significantly more than a single 20 min ice application.

The vasoconstriction and reduction in blood flow produced by cryotherapy are most pronounced in the area where the cold is applied because this is where the tissue temperature decrease is greatest.

**Cryotherapy decrease blood flow**

Cold cause cutaneous vasoconstriction both directly and indirectly. Activation of cutaneous cold receptors by cold directly stimulates the smooth muscles of blood vessel wall to contract. Cooling of tissue decreases the production and release of vasodilator mediators such as histamine and prostaglandins, resulting in reduced vasodilation. Decreasing the tissue temperature also causes a reflex activation of sympathetic adrenergic neurons, resulting in cutaneous vasoconstriction in the area that is cooled and, to a lesser extent, in the area distant from the site of cold application. It is thought that the body reduces blood flow in response to decreased tissue temperature to protect other areas from excessive decrease in temperature and to stabilize the core body temperature.

**Later increase in blood flow**

The immediate vasoconstriction response to cold is a consistent and well documented phenomenon however when cold is applied for longer periods of time or when the tissue temperature reaches less than 10 degreeC(50 °F), vasodilation may occur this phenomenon is known as cold induced vasodilation (civid).

**NEUROMUSCULAR EFFECTS**

**Decrease nerve conduction velocity**

When nerve temperature is decreased nerve conduction velocity decreases in proportion to the degree and duration of the temperature changes. Reversible total nerve conduction block can occur with the application of ice over superficially located major nerve branches such as the peroneal nerve at the lateral aspect of knee.

**Increase pain threshold**

Applying cryotherapy can increase the pain threshold and decrease the sensation of pain proposed mechanisms for these effects include counterirritation via the gate control mechanisms and reduction of muscle spasm, sensory nerve conduction velocity or post injury edema.

**Altered muscle strength**

Proposed mechanisms for this response to brief cooling include facilitation of motor nerve excitability and increased psychological motivation to perform in contrast after cooling for 30 minutes or longer isometric muscle strength has been found to decrease initially and the to increase an hour later to reach greater than precooling strength for the following 3 hours or longer because muscle strength can be temporarily influenced by cryotherapy strength testing should be performed before rather than after cryotherapy application.

**Decreased spasticity**

After more prolonged cooling lasting 10 to 30 minutes a temporary decrease in or elimination of spasticity and clonus, depression of the Achilles tendon reflex and a reduction in resistance to passive motion have been observed in some patients with spasticity.

**USES OF CRYOTHERAPY**

**Inflammation control**

Cryotherapy can be used to control acute inflammation there by accelerating recovery from injury or trauma. A recent critical review of studies on various treatment modalities for soft tissue injuries of the ankle concluded that cryotherapy reduced pain and edema and shortened recovery time if it was applied within the first 2 days after an injury.

Aply cryotherapy immediately after injury and during the acute...
inflammatory phase of healing to help control bleeding edema and pain and to accelerate recovery cryotherapy is often recommended for the treatment of acute inflammation and may be helpful in patient with chronic inflammatory condition such as osteoarthritis and rheumatoid arthritis. 

**Edema control**

Cryotherapy can be used to control the formation of edema particularly when edema is associated with acute inflammation to minimize the edema formation cryotherapy should be applied soon as the possible after an acute trauma the formation of edema associated with inflammation will be controlled most effectively by cryotherapy is applied in conjunction with compression and elevation of the affected area. cryotherapy along with compression and elevation reduces post injury edema.

**Cryotherapy with compression and elevation Pain control**

The decrease in tissue temperature produced by cryotherapy may directly or indirectly reduce the sensation of pain by gating pain transmission through the activity of cutaneous thermal receptor this immediate analgesic effect of cold is exploited when vapocoolant sprays or ice massage is used to cool the skin before stretching the purpose of this sequence of treatment is to reduce muscle spasm thus allowing patient to exercise applying a cooling agent to the point of numbness shortly after any intervention is vasoconstriction.

Applying cryotherapy for 10 to 15 min or longer can control pain for 1 hour or longer this prolonged effect is thought to be the result of blocking conduction by deep pain transmission by cutaneous thermal receptors.

**Cryokinetics and cryostretch**

Cryokinetics is a technique that combines the use of cold and exercise in the treatment of pathology or disease this technique involves applying a cooling agent to the point of numbness shortly after any injury to reduce the sensation of pain thus allowing patient to exercise and work toward regaining range of motion as early as possible in recovery process.

**Cryostretch**

is the application of a cooling agent before stretching the purpose of this sequence of treatment is to reduce muscle spasm thus allowing greater ROM increase with stretching it has been found that application of a cold pack after a hot pack is more effective than a hot pack alone in improving passive ROM (PROM) in people with restricted knee ROM.

**Indications of Cryotherapy**

a. Michlovitz notes rationale for application of cold 24-48 hours after acute injury.
   i. Decreases fluid filtration into interstitium by vasoconstriction.
   ii. Decreases inflammation.
   iii. Decreases pain and muscle spasm.
   iv. Decreases metabolic rate.
   b. In acute injury cold is used most often in conjunction with compression and elevation.
   c. Cryotherapy is also indicated for treating acute burn. Bloch’s extensive review led to conclusion that cooling burns can decrease magnitude of injury by reduction in edema, pain, local fluid loss, tissue injury, and blood volume during the first 48 hours after injury.
   d. Patients with acute spinal cord injury (SCI) also improve with local hypothermia treatments. Bricolo et al. reviewed SCI cases from the literature and noted that complete destruction of spinal cord often may not occur at initial moment of impact but relates to self-destructive process in cord and hypoxic neurologic changes secondary to vascular alterations.
   e. Decreasing spasticity.
   f. Reduction of fever.
   g. Facilitation of muscle contractions by increasing motor neuron excitability.
   h. Especially effective for bursitis and tendinitis.


**Contraindications**

a. Impaired sensation. Patients cannot report when they become anesthetized from cold. Tissue damage occurs slightly below temperatures that produce numbness.
   b. Impaired circulation: tissue damage may result from vasoconstriction.
   c. Open wounds after 48 hours.
   d. Hypersensitivity to cold, such as Raynaud’s phenomenon, cold urticaria, cryoglobulinemia, and paroxysmal cold hemoglobinuria.
   e. Angina pectoris or other severe cardiac disease.
   f. Regenerating peripheral nerves.


**Precautions**

a. **Hypertension**
   i. Careful monitoring is needed because of transient increases that can occur in systolic and diastolic blood pressure.
   ii. Treatment should be discontinued if increase in blood pressure is seen.
   b. **Elderly patients**
   i. Decreased efficiency with vasoconstriction.
   ii. Therefore, they have decreased ability to conserve heat.
   c. **Length of treatment**
   i. Do not use cold gel packs longer than 15-20 minutes directly on skin, and do not apply any cryotherapy directly to skin for > 1 hour continuously.
   ii. Extended treatment may lead to neurapraxia or axonotmesis of superficial peripheral nerves.


**Adverse effects**

A variety of adverse effects have been reported when cold is applied incorrectly when contraindicated the most severe adverse effect resulting from improper application of cryotherapy is tissue death caused by prolonged vasoconstriction ischemia and thromboses in the smaller vessels tissue death may also result from freezing of the tissue damage can occur when the tissue temperature reaches 15 degree c (59 degree F).

However freezing (frostbite) does not occur until the skin temperature drops to between 4 degree c and 10 degree c (39 degree F to 50 degree F) or lower excessive exposure to cold may cause temporary or permanent nerve damage resulting in pain numbness tingling hyperhidrosis or nerve damage the duration of cold application should be limited to less than 45 min and the tissue temperature should be maintained above 15 degree c (59 degree F).

Because prolonged application of cryotherapy to the distal extremities may cause reflex vasodilatation and increase blood flow cryotherapy should be applied for only 10 to 20 min when the goal of the intervention is vasoconstriction.

**Application Techniques**

It may be applied using a variety of materials including cold or ice packs ice cups controlled cold compression units vapocoolant sprays frozen towels ice water cold whirlpools and contrast baths cool cold packs for at least 2 hours before initial use and for 30 minutes between uses the typical sequence of sensation in response to cryotherapy is as follows:
Intensive cold, burning, aching, analgesia, and numbness these sensations are thought to correspond to increasing stimulation of thermal receptors and pain receptors followed by blocking of sensory nerve conduction as tissue temperature decreases.

**Cold packs or ice packs**

Cold pack are usually filled with gel composed of silica or mixture of saline and gelatin and are usually covered with vinyl. The gel is formulated to be semisolid at between 0 degree C and 5 degree C (between 32 degree F and 41 degree F) so the pack conforms to body contours when it is within this temperature range. The temperature of the cold pack is maintained by storing it in specialized cooling units or in a freezer at -5 degree C (23 degree F) cold packs should be cooled for at least 30 minutes between use and for 2 hours or longer before initial use.

**ICE MASSAGE**

Ice massage acts as an analgesic or pain-reliever by numbing tissues, reducing muscle spasms and slowing tissue metabolism. Because ice massage helps reduce swelling, inflammation and pain, it's the preferred modality for acute musculoskeletal injuries, such as ligament sprains, muscle strains, joint subluxations and dislocations, bruises and fractures. Ice cups or or frozen water popsicles can be used to apply ice massage. Frozen cups are made by freezing small paper or Styrofoam cups of water. To use, these, the therapist holds on the bottom of the cup and gradually peels back the edge to expose the surface of ice and put it in direct contact with the patient's skin.

**Cold compression unit and its application**

Cold compression units alternately pump cold water and air into a sleeve that is wrapped around a patient's limb. The temperature of water can be set at between 10 C and 25 C (between 50 F and 77 F) to provide cooling. A small study found that cold compression decreased capillary blood flow, preserved deep tendon oxygen saturation, and facilitated venous capillary outflow in the Achilles tendon when applied to this region.

The goal of a cold compression wrap for a shoulder injury is to optimize and ultimately decrease recovery time. Dislocated shoulder recovery typically takes 3-4 months to complete. This process can be reduced 7-14 days by using a cold compression wrap and engaging in an intermittent pneumatic compression process.

Cold compression therapy goes a step beyond an ice pack. With a compression wrap, the shoulder is fully enclosed and every part of the shoulder joint is being affected. Active compression helps to diminish pain by dulling nerve endings and reaching areas that an ice pack doesn't reach. Cold compression therapy works to assist the body in its natural healing process.

**Lowers Metabolic Rate & Promotes Healing**

According to a 1999 study published in the journal "Medicine and Science in Sports and Exercise," cryotherapy, or ice massage, also reduces the metabolic rate of injured tissues, allowing injured cells to survive the acute phase of injury, as well as reducing the area of secondary injury. Secondary injury is caused by post-trauma hypoxia or tissue oxygen deficiency, and is due to the following factors: bleeding of injured blood vessels, hemostasis or the stoppage of bleeding and reduced blood flow due to increased blood viscosity or thickness.

**CONTROLLED COMPRESSION THERAPY**

Cold Compression Therapy accelerates the body's natural healing process by increasing blood flow while reducing both pain and swelling. The compression wrap is snugly positioned around the injured area, then the pump is activated. Intermittent pneumatic compression is initiated, and the process of swelling and pain reduction begins. It is recommended that a patient continue to use a cold compression wrap until a significant reduction in swelling is evident.
Discussion
An extensive review of cold study results was made and a summary of these results was provided. The consistent findings were reductions in musculoskeletal pain, spasm, connective tissue distensibility, intramuscular temperature, nerve conduction velocity, and spasticity (except upon initial cold contact). The inconsistent findings were effects on swelling, blood flow, heart rate, blood pressure, intraarticular temperature, rheumatoid arthritis, the monosynaptic reflex, and the muscle spindle. The physical therapist should be aware of what has been documented and whether or not he has a valid reason for using cold therapy in the manner in which he uses it.

REFERENCE