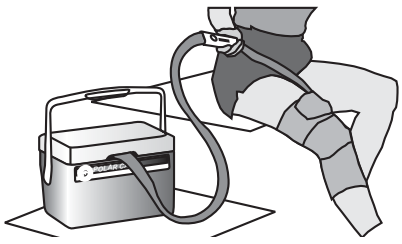
The Physiologic Effects of Immediate Cold Therapy

Mark E. Howard, ATC, OPA, OTC

Pain and swelling following orthopaedic trauma or surgery negatively affects the healing process, resulting in a prolonged rehabilitative period. Pain, and specifically, joint effusion (swelling within a joint), have been shown to have deleterious effects such as decreased range of motion, muscle spasm, muscle inhibition, and muscle atrophy. These effects lead to decreased function of the involved body part and an extended rehabilitative time frame. Minimizing the effects of pain and joint effusion can enhance the healing process and speed the patient's return to safe and pain-free activity.

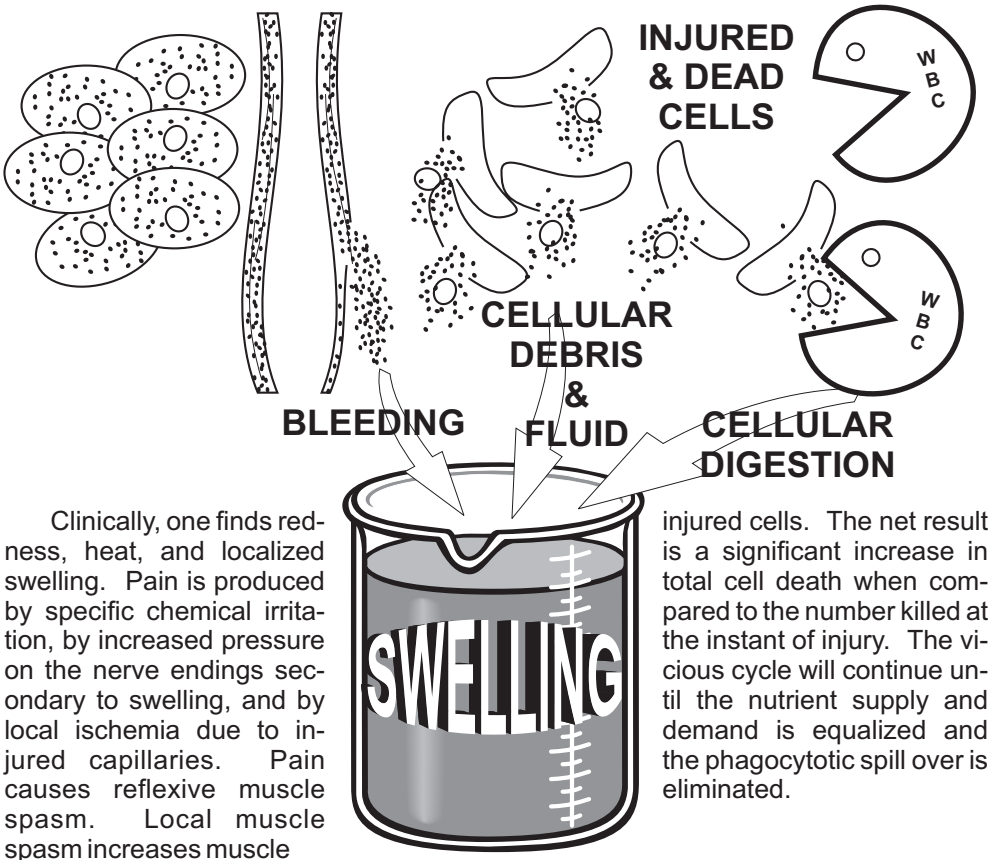
The use of cold following acute musculoskeletal trauma has been the standard of treatment for years. The immediate use of cold to reduce pain and swelling is universally accepted in the sports medicine world. However, the physiologic benefits of cold following trauma or orthopaedic surgery has not been harnessed due to either the inability of cold packs to penetrate bulky postoperative bandages or from lack of use due to fear of wound infection if the sterile dressings were removed and cold moist packs applied. The introduction of cold therapy systems that deliver cold through sterile circulation pads, such has Polar Care, has made it possible to apply continuous cold directly to the operative site, without the fear of infection. To adequately understand the physiologic response of an acute injury/surgery to immediate application of cold, one must understand the tissue's response to injury.



Tissue Response To Injury

Following an injury to the musculoskeletal system, whether due to trauma or surgery, cell damage and destruction of the involved ligaments, muscles, tendons, bone, blood vessels, nerves, or any other soft tissue, will be the direct pathological result. As the significance of the trauma increases, so does the magnitude of the physiologic response. This implies that the greater the injury, the more tissue destruction, pain, swelling, inflammation, and functional limitation exists clinically.

The initial reaction of the body to an acute injury is an inflammatory process that initiates the healing process, lasting 3-4 days. The inflammatory process is necessary for normal healing, but should be minimized for the timely repair of the injured tissues and the quick return of function. At the cellular level, direct damage to the capillary vessels *(small blood vessels)* results in local blood accumulation. Cell death, caused by tissue injury, results in intracellular fluid and exudate release into interstitial fluid spaces. After the initial transitory vasoconstriction, chemical mediators, such as histamine, are released into the area, which causes local vasodilatation to occur. This increases bleeding into the area. Vascular permeability and cell metabolism also increases, causing more fluid and exudate deposition. Leukocytes *(white blood cells)* begin to infiltrate the area and phagocytosis *(ingestion of damaged cells)* starts through enzymatic activity.



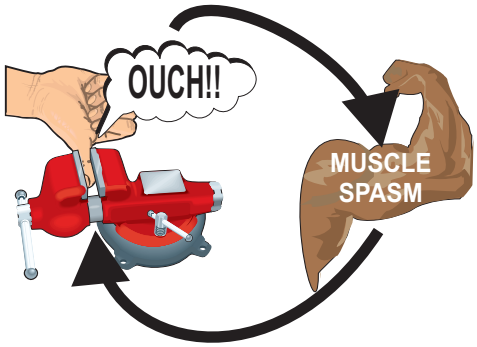
Clinically, one finds redness, heat, and localized swelling. Pain is produced by specific chemical irritation, by increased pressure on the nerve endings secondary to swelling, and by local ischemia due to injured capillaries. Pain causes reflexive muscle spasm. Local muscle spasm increases muscle ischemia and metabolic by products in the area. This in turn increases pain. A vicious pain-spasm cycle is thus created.

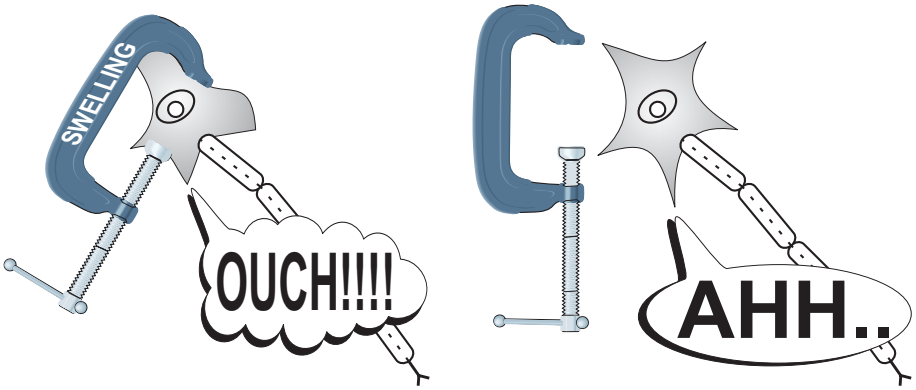
Further cell and tissue death to the initially non-traumatized tissues can occur due to lack of oxygen at the injury site and due to digestive enzymatic "spill over" from phagocytosis. The phenomenon, know as hypoxic secondary injury, is a result of injured cells competing with the normal adjacent uninjured cells for the available oxygen and nutrients. Lack of oxygen and nutrients, due to impaired primary vascular supply and/or ischemia from reflexive muscle spasms, coupled with an increased need for oxygen and nutrients due to an increased cell metabolism, creates a nutrient "tug of war". The uninjured adjacent cells are compromised in an attempt to aid the injured cells. The net result is a significant increase in total cell death when compared to the number killed at the instant of injury. The vicious cycle will continue until the nutrient supply and demand is equalized and the phagocytotic spill over is eliminated.

Trauma, Inflammation and Response to Cold

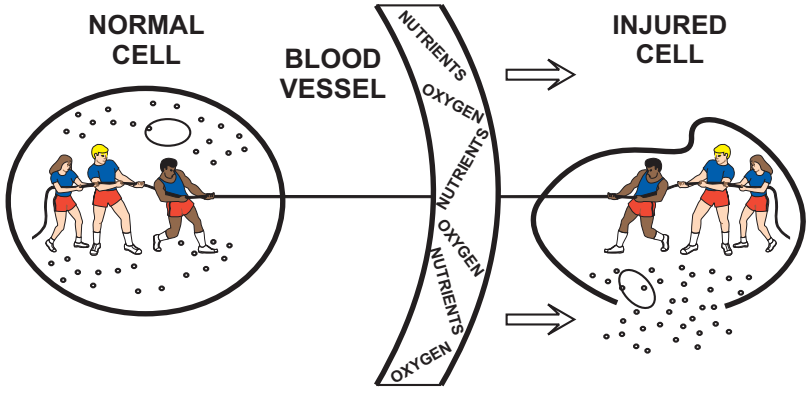
Immediate application of cold to the area of trauma has many potential benefits. Cold has a local anesthetic effect which significantly reduces pain following injury or surgery. The direct effect of temperature reduction of nerve fibers and receptors is to elevate the pain fibers threshold of stimulation, thus decreasing pain. Indirectly, pain can also be reduced by reducing painful swelling (secondary to hypoxic injury, edema, and capillary bleeding) and by inhibiting reflexive muscle spasms; both of which exasperate the pain-spasm cycle. In addition, the early use of cold will reduce primary bleeding and edema formation. Cooling of a traumatized area produces a direct vasoconstriction effect upon the blood vessels plus a reflexive vasoconstriction

via sympathetic nerve fiber stimulation. Reduction in the temperature also increases blood viscosity *(thickness)* thus enhances coagulation. Reducing tissue temperature will also significantly lower the metabolic rate of the involved and adjacent uninjured cells, thereby decreasing cellular demand for the available oxygen and nutrients. Thus, the oxygen/nutrient supply and demand is balanced, maintaining uninjured cell viability. Additionally, by lowering the cell metabolism and slowing the blood flow, the overall cell output of waste products and the digestive "spill over" of enzymatic destruction is decreased. In turn, the hypoxic secondary injury cycle is broken, minimizing any further cell destruction.

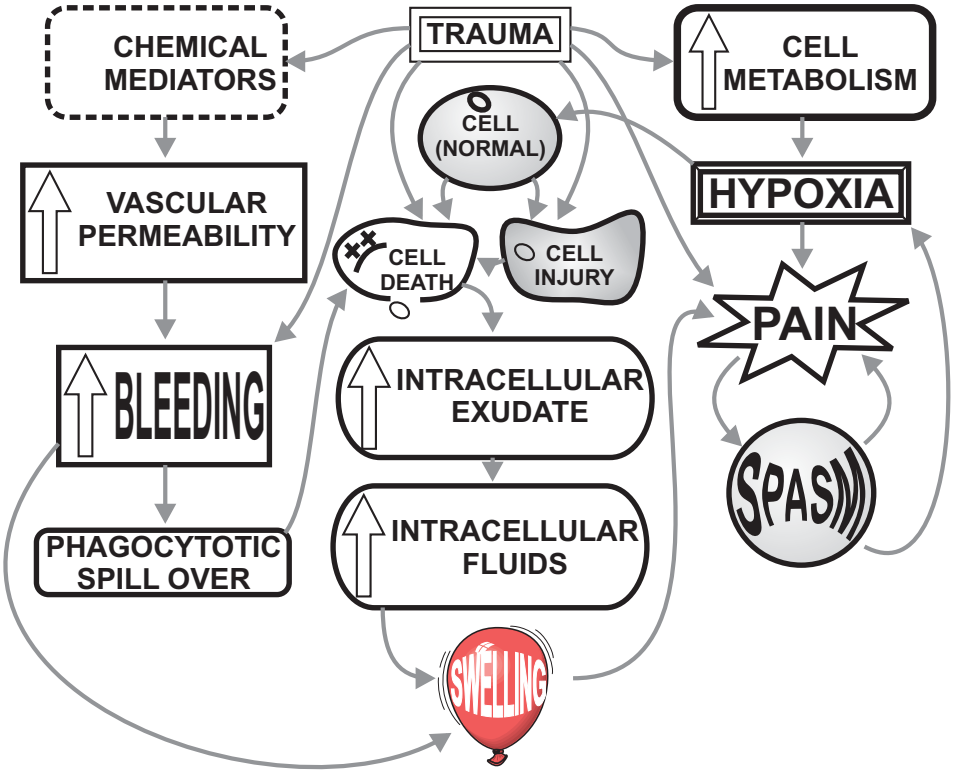




In summary, immediate cold application following musculoskeletal trauma due to injury or surgery will decrease pain, decrease reflexive muscle spasm, decrease localized bleeding, swelling and edema, decrease the initial inflammatory response and minimize secondary or hypoxic cell injury. Clinically, early intervention of cold therapy will lessen and minimize the negative physiologic response of musculoskeletal trauma, whether due to injury or surgery, thereby enhancing the healing process and the rate of functional recovery.



TISSUE RESPONSE TO INJURY



GLOSSARY

Edema	An abnormal excess accumulation of serous fluid in connective tissue.
Exudate	Exuded matter, the material composed of serum, fibrin, and white blood cells that escapes from blood vessels or cells into a superficial lesion or area of inflammation.
Histamine	A compound that is found in tissues that causes dilatation of capillaries, and plays a major role in allergic reactions.
Hypoxia	A deficiency of oxygen reaching the tissues of the body.
Interstitial	Situated within but not restricted to or characteristic of a particular organ or tissue - used especially of fibrous tissue.
Ischemia	Localized tissue anemia due to obstruction of the inflow of arterial blood (as by the narrowing of arteries by spasm or disease).
Leukocytes	Any of the white or colorless nucleated blood cells that occur in numbers of 5,000 to 10,000 in each cubic millimeter of normal human blood and are classified into granulocytes and agranulocytes.
Lumen	The cavity of a tubular organ (blood vessel).
Phagocytosis	The process of ingestion of particulate material by white blood cells.
Vasoconstriction	Narrowing of the lumen of blood vessels.
Vasodilatation	Widening of the lumen of blood vessels.