

Biothermal physics

Fifth lecture

Heat Therapy

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introduction

- **Thermotherapy** is the application of heat from any of its various sources to the body for therapeutic effects.
- Heat therapy works by *improving circulation and blood flow to a particular area due to increased temperature.*
- Increasing the temperature of the afflicted area even slightly can *soothe discomfort and increase muscle flexibility.*
- Heat therapy can relax and soothe muscles and heal damaged tissue.

Types of heat therapy

- There are two different types of heat therapy:
 - Dry heat.
 - Moist heat.
- Both types of heat therapy should aim for “**warm**” as the ideal temperature instead of “**hot.**”
- ✓ **Dry heat (or “conducted heat therapy”)** includes sources like heating pads, dry heating packs, and even saunas. This heat is easy to apply.
- ✓ **Moist heat (or “convection heat”)** includes sources like steamed towels, moist heating packs, or hot baths. Moist heat may be slightly more effective as well as require less application time for the same result
- ✓ Thermotherapy consists of application of heat or cold (cryotherapy) for the purpose of changing the cutaneous, intra-articular and core temperature of soft tissue with the intention of improving the symptoms of certain conditions.
- ✓ Cryotherapy and thermotherapy are useful adjuncts for the treatment of musculoskeletal injuries and soft tissue injuries. Using ice or heat as a therapeutic intervention decreases pain in joint and muscle as well as soft tissues and they have opposite effects on tissue metabolism, blood flow,

inflammation, edema and connective tissue extensibility. Thermotherapy can be used in rehabilitation facilities or at home

Purpose of heat therapy

- ✓ The goal of thermotherapy is to alter tissue temperature in a targeted region over time for the purpose of inducing a desired biological response.

Heat

- ✓ By increasing the temperature of the skin/soft tissue, the blood flow increases by *vasodilatation*.
- ✓ The metabolic rate and the tissue extensibility will also increase.
- ✓ Heat increases oxygen uptake and accelerates tissue healing, it also increases the activity of destructive enzymes, such as collagenase, and increases the catabolic rate.

Cold

- ✓ By decreasing the temperature of the skin/soft tissue, the blood flow decreases by *vasoconstriction*.
- ✓ The tissue metabolism will decrease just like the neuronal excitability, inflammation, conduction rate and tissue extensibility.
- ✓ At joint temperatures of 30°C or lower, the activity of cartilage degrading enzymes, including collagenase, elastase, hyaluronidase, and protease, is inhibited.
- ✓ The decreased metabolic rate limits further injury and aids the tissue in surviving the cellular hypoxia that occurs after injury.

Application

Heat:

- ✓ Heating of superficial tissues can be achieved using **hot packs, wax baths, towels, sunlight, saunas, heat wraps, steam baths/rooms.**

- ✓ We can also get the heat in the deeper tissues through **electrotherapy (ultrasound, shockwave and infrared radiation)**.

Cold:

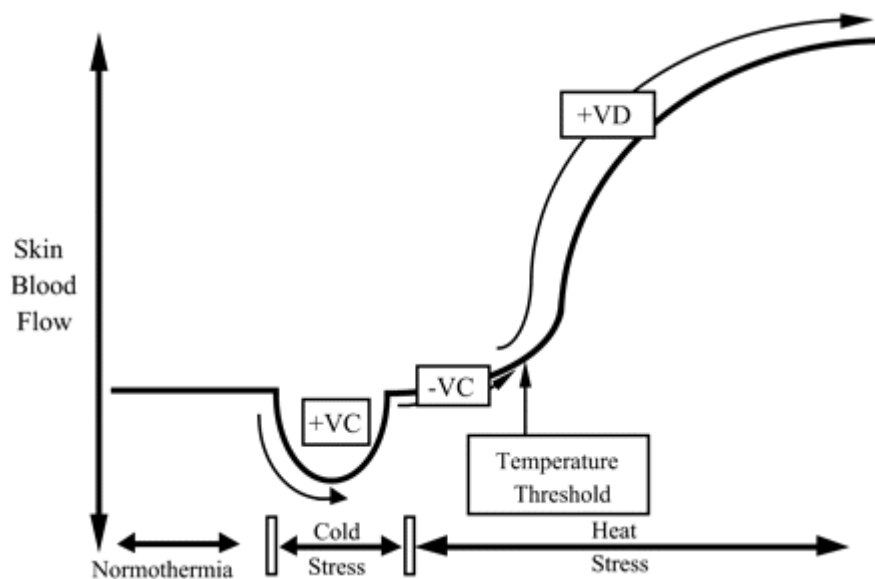
- ✓ Cooling is achieved using **ice packs, ice baths, cooling gel packs, cold air and sprays**.

Examples:

- **cryotherapy (ice application)** as an effective treatment for soft tissue injuries. It reduces the swelling, and it will improve the range of motion.
- **Exercise in warm water**, usually called **hydrotherapy**, is a popular and effective treatment with a pain relief effect for many patients with painful neurologic or musculoskeletal conditions.

Mechanism of Action

- Skin blood flow is controlled by two branches of the sympathetic nervous system:
 - ✓ a noradrenergic vasoconstrictor system and a cholinergic active vasodilator system. These dual sympathetic neural control mechanisms affect the major aspects of thermoregulatory responses over most of the human body's surface.



VC = vasoconstriction, VD = vasodilatation.

- ✓ During periods of hypothermia, falling core and skin temperatures lead to reflexive increases in sympathetic active vasoconstrictor nerve activity to reduce skin blood flow and conserve body heat.
- ✓ During periods of heat stress, increasing core and skin temperatures lead to reflexive increases in sympathetic active vasodilator nerve activity to increase skin blood flow.
- ✓ The effect of heat on pain is mediated **by heat sensitive calcium channels**. These channels respond to heat **by increasing intracellular calcium**. This generates action potentials that increases stimulation of **sensory nerves** and causes the feeling of heat in the brain.
- ✓ These channels are part of a family of receptors called **TRPV receptors**. TRPV1 and TRPV2 channels are **sensitive to noxious heat**, while TRPV4 **channels are sensitive to normal physiological heat**.
- ✓ Their multiple binding sites allow a number of factors to activate these channels. Once activated, they can also inhibit the activity of purine pain receptors. These receptors, called P2X2 and P2Y2 receptors, **are mediated pain receptors and are located in the peripheral small nerve endings**.

Treatment

- ✓ The treatment depends on the **type of application** and the **type of disease**.
- ✓ There are 3 phases of the healing process: the **inflammatory phase**, the **proliferation phase** and the **remodeling phase**.
- ✓ **The first phase, known as the inflammatory phase**, protects the injured area from further injury while the body contains the damaged tissue. During this phase, cryotherapy can help to reduce swelling. Never use heat during this phase because heat increases the blood flow into the injured

area and increases the amount of swelling. The inflammatory phase has a duration of 2 days.

✓ **During the second phase, the proliferation phase**, new tissue and scar tissue are formed. Heat can now be applied to the injured area to facilitate the healing process.

✓ **The third and final phase, the remodeling phase**, is the process of returning to health: the restoration of structure and function of injured or diseased tissues. The healing process includes blood clotting, tissue mending, scarring and bone healing. Heat therapy can also be used during this phase.

✓ **Sources of Heat in Treatment**

Source	Form of energy	Heat transmitter
Hot-water bottle	Long infrared rays (non-penetrating)	By conduction
Hot compress		By conduction
Hot-water bath		By conduction
Hot-air bath		By convection
Steam bath		By convection
Electric heating pad	Long infrared rays (non-penetrating)	By conduction and radiation
Infrared generator	Long and short infrared rays (penetrating)	By radiation
Incandescent light bulb (heat lamp)	Visible rays Short infrared rays (penetrating)	By radiation
Carbon arc lamp Sun	Short infrared rays Visible rays Ultraviolet rays	By radiation
Diathermy apparatus	High-frequency oscillations (300-meter wave)	By electric oscillations
Short-wave diathermy apparatus	Short radio waves (3 to 30 meters)	By electric oscillations