Physiological effects of shortwave diathermy

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The ReGear is as induction cable device where the shortwave diathermy is applied through an induction cable, covered by a nylon garment. This type of shortwave diathermy heats tissues that are good electrical conductors, such as blood vessels and muscle. Adipose tissue receives little heating by induction fields because an electrical current is not actually going through the tissues. Induction diathermy is now the most common form of shortwave unit currently being marketed.

Electromagnetic fields arise from the cable, causing ions (an atom or group of atoms that has lost one or more electrons) to oscillate and create an eddy current (a circular current of fluid, often moving against the main flow). Friction caused by the movement of the ions produces heat. The amount of heat produced depends on the amount of electromagnetic field (EMF) and the distance between the source and type of tissues. The majority of the heat is produced near the source and just below the fat/muscle interface. The more fat there is, the less the rate and magnitude of the muscle heating.

High frequency electromagnetic energy (greater than 10 MHz) passing through the patient's body is absorbed by the tissues. The friction causes the movement of ions thus producing the heat and its effects. Ions in the treatment field are attracted to either the positive or negative pole on the ions. The negatively charged pole is attracted to the positive pole and the positively charged pole is attracted to the negative pole. Some of the molecules have ions that only move within the cell membrane, causing a dipole reaction in which the ions in the membrane align themselves along the charges (creating eddy currents). The heating effects of the diathermy occur as a result of friction between the moving ions and the surrounding tissues are similar to those of therapeutic ultrasound.

Non-thermal effects

Non thermal effects include:

- reduction of intracellular edema
- triggering of collagen synthesis
- increased microvascular perfusion
- activation of fibroblast growth factors (leading to wound healing)
- increased macrophage activity

Thermal Effects

Thermal effects include (over the area of the diathermy drum or induction coil):

- increased extensibility of collagen fibers in tendons and joint capsules
- reduced viscosity of fluid element within the tissues
- decreased joint stiffness
- reduced muscle spasm
- diminished pain perception
- increased metabolism
- increased blood flow
- vasodilation
- relaxation
- increased membrane filtration and diffusion
- changes in some enzyme reactions

Injury response process

The healing properties of shortwave diathermy are similar to those of other forms of heat application, but tend to occur deep in the tissues (like ultrasound). Heating is based on the treatment intensity, number of pulses per second and pulse width.

Inflammation

Nonthermal effects of shortwave diathermy are assumed to alter the rate of diffusion (the random movement of molecules or ions or small particles in solution or suspension toward a uniform distribution throughout the available volume) across the cell membrane. The thermal effects increase the rate of metabolism. An inductive shortwave diathermy preferentially heats tissues high in protein, such as muscle. A 10°C increase in intramuscular temperature will approximately double the rate of cell metabolism.

The cellular effects of shortwave diathermy in concert with increased blood flow result in increased delivery and concentration of white blood cells. Increased cell membrane permeability assists in the removal of cellular debris and metabolic toxins that may have collected in the area.

Blood and Fluid Dynamics

The heat produced by shortwave diathermy application results in a vasodilation that increases blood flow, increases capillary pressure, increases oxygen perfusion and increases capillary filtration. Due to the increased blood flow, increased fibroblastic activity. Increased collagen deposition, and new capillary growth are stimulated deep in the tissues. The depth of effective heating and volume of tissue affected also makes shortwave diathermy useful in the resolution of a hematoma (localized mass of extravasted blood that is relatively or completely confined in an organ or tissue, a space or a potential space: the blood is usually clotted and depending on how long is has been there, may manifest various degrees of organization and decolorization).

Tissue Elasticity

Shortwave diathermy is capable of reaching temperatures over 4°C at a depth of 3cm. Tissue elongation is established by altering the viscoelastic properties of collagen rich structures by increasing the temperature and applying an external force (stretching or joint mobilization). Tissues heated with shortwave diathermy obtain decay at a rate of three times slower than thermal therapeutic ultrasound.

Single treatments of heat and stretch are not sufficient for elongating tissues, however; single treatments of shortwave diathermy and joint mobilizations have demonstrated increased range of motion over 10 degrees in the shoulder.

Wound healing

Shortwave diathermy increases white blood cell infiltration and increases phagocytosis (phagocytosis is where neutrofils and macrophages engulf cellular debris left over from inflammation. Think of it like the old Packman video game. The yellow circle-shaped guy chases ghosts around a screen. When the little yellow guy reaches a ghost, he eats the ghost. The little guy is the neutrofils and macrophages and the ghosts are cellular debris). This results in more rapid healing and decreased need for pain medication. The number and quality of mature collagen bundles are increased in the treated area, the result of increased adenosine triphosphate* (ATP) activity, and the proportion of necrosed muscle fibers decreases. * Adenosine triphosphate (an important source of energy for intracellular metabolism).

Optimal heating

One source indicates that tissue temperature must be raised to a level of 40-45°C for a minimum of 5 min for most thermal effects to occur. Evidently temperatures at 45°C or higher can cause tissue damage. (Incidentally in our lab at BYU we have never raised deep tissue temperature higher than 43°C.)

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