

Therapeutic Application of Ultrasound

Ultrasound was identified during World War II when the use of SONAR was observed to heat and damage underwater life. This finding led to the use of ultrasound in the clinic to heat biological tissues, including muscle, tendons, ligaments, and fascia. These tissues all have high collagen content, creating a lower threshold for heating the material.

Ultrasound creates sound waves that compress the material to which it is applied. It is defined as a sound greater than 20,000 cycles per second (Hz). Therapeutic ultrasound has a frequency of between 0.7 MHz and 3.3 MHz. These frequencies are able to reach tissue depths of two to five centimeters. The sound waves travel through the transducer head (the part of ultrasound that contacts the tissue), which in turn converts the electrical energy to sound energy.

In non-thermal ultrasound, this energy produces waves which exert pressure on the cell walls, caused by cavitation and microstreaming. Cavitation can be described as the effects of the sound waves on the fluid within the cell. Bubbles form and begin to expand and contract, causing increased diffusion across the membrane and increased cellular activity.

Acoustic microstreaming is the result of pressure forming in the fluid surrounding a cell, which facilitates components required for tissue healing.

During thermal ultrasound, sound waves cause tissue vibration that creates heat in the treatment field. Secondary effects from the production of heat include increasing blood flow to tissue, which delivers important nutrients and removes waste.

Effects of Ultrasound

Ultrasound may have different effects on tissues depending on the parameters set during treatment.

Thermal effects of ultrasound include any type of heating characteristic, and is used for the reduction or control of pain, muscle spasms (by heating the myoneural junction), increased circulation and soft tissue extensibility, and altering nerve conduction velocity (how fast a signal travels from the brain or spinal cord to a given muscle).

Thermal effects usually last for 5-10 minutes following treatment, so any subsequent treatment is applied shortly after, such as stretching or soft tissue mobilization (massage).

Non-thermal effects include those characteristics where heating the area is not the goal of treatment (although there is always some residual heat effect during any ultrasound therapies). Goals of non-thermal, or pulsed, ultrasound

involve essential components of tissue healing including edema reduction, pain modulation, and increased capillary density which in turn increases local circulation.

Clinical Applications

Among other clinical applications, ultrasound is most commonly used in cases of soft tissue shortening and pain control in the traumatic brain injury (TBI) population. The therapist uses a coupling medium, typically gel or water, when applying ultrasound to the treatment area.

Many individuals with brain injuries often present with tightening of muscles due to inactivity, poor positioning, muscle imbalance, and abnormal tone. Abnormal tone decreases an individual's ability to move muscles through the full range of motion and often leads to contractures. In this situation, ultrasound can apply deep heat to the muscles with limited range, as well as stimulate the golgi tendon organs to activate the protective relaxation reflex.



The use of ultrasound has been shown to be effective in treating shortened muscles, both in research and in clinical settings. However, as stated, the treatment window following ultrasound is short and must be taken advantage of to achieve results. Ultrasound should be used in conjunction with range of motion exercises, orthotics, and/or active exercises as able.

Pain is also a common issue among individuals with TBI. It can stem from a variety of sources, and while it is wise to treat the source of pain, ultrasound can aid in controlling pain during treatment sessions to achieve functional outcomes, independence, and comfort. The non-thermal effects of ultrasound have the greatest effect on pain modulation.

Precautions and Contraindications

As with any treatment, there are precautions and contraindications of which the therapist must be mindful.

Precautions are based on the individual being treated, and clinical judgment should be utilized in these situations. Precautions for ultrasound include impaired sensation, cognition, and communication due to risk of burning with the

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use of thermal ultrasound. Other precautions include acute inflammation, use in close proximity of epiphyseal (“growth”) plates, fractures, and breast implants.

Contraindications, or situations where ultrasound should NOT be used, include direct application over implanted stimulators, cancerous lesions, anterior neck triangle, eyes and reproductive organs, local infections (sepsis, osteomyelitis), metal in the treatment field, pregnancy, growth plates, central nervous system tissue, joint cement, and plastic components.

Conclusion

Therapists have a metaphorical “tool box” when treating individuals with TBI. Ultrasound is just one tool in the box, and can be used in various situations to increase functional outcomes for individuals with physical impairments and functional limitations.

The clinician should be well versed in the rationale and treatment methods of ultrasound before utilizing it in the field and should use ultrasound in addition to evidence-based therapy and other modalities as necessary. ❖

References:

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