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Perspective

Application of Ultrasound Needed to be Much More Explored in the Medical and Pharmaceutical Field

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Presently I have been undergoing ultrasound therapy, so I thought to study on this topic and to share some of my findings. I was quite surprised that there is not much research on this topic. The first practical application of ultrasound is recorded during the World War I in detecting of submarines. The application of ultrasound in medicine began in fifties of last century. The field of ultrasonic-enhanced drug delivery has expanded tremendously during the past decade, and we expect that this trend will continue as our understanding and technology increases.

Therapeutic application of ultrasound is generally found in the range of frequencies 0.7-3.0 MHz However high-frequency (> 3MHz) ultrasound can also be used in medical applications for transdermal drug delivery goes back many decades, although low-frequency ultrasound (20 – 100 kHz) for transdermal delivery is still in its relative infancy. Low-frequency ultrasound can also be used for transdermal delivery of drugs which is referred to as low-frequency sonophoresis (LFS), has been shown to promote skin permeation to a wide variety of therapeutic agents, including both hydrophilic molecules and macromolecules.

In ultrasound therapy, ultrasound wave is used in the treatment to get relief from chronic pain conditions, it also promote tissue healing in musculoskeletal disorders like tennis elbow, osteoarthritis of knee, lower limb conditions, ankle sprain, carpal tunnel syndrome, chronic lower back pain or in any other muscular sprain or strain. There are two different types of therapy: Thermal and Mechanical, in both the cases sound waves are generated by a transducer head to penetrate into deeper soft tissues. Thermal ultrasound therapy uses more continuous transmission of sound waves. The sound wave cause microscopic vibrations in the deep tissue molecules, increasing heat and friction. The warming effect encourages healing in the soft tissue by increasing the cell metabolism, it is used in case of myofacial pain, or muscular strain or sprain, whereas mechanical ultrasound therapy uses pulses of waves to penetrate tissues. Mechanical therapy has also a minor warming effect on the tissue. It also can causes expansion and contraction of the tiny gas bubbles of the soft tissues. This helps to decrease the inflammatory response, reducing tissue swelling and thus decreasing pain. Ultrasound therapy is contraindicated in local malignancy, metal implants, and vascular abnormalities and directly on the abdomen of pregnant women.

Even if there are some interesting exceptions, ultrasound is not a promising tool to get relief from most of the pain conditions. There is a strident bizarre due to lack of quality research to include it in the mainstream therapy. Ultrasound can promisingly be used in advancement of drug delivery technologies. The mechanism behind enhanced delivery of therapeutics is sonoporation, the formation of openings in the vasculature anticancer drug and gene delivery to various types of tissue. A new focused ultrasound approach- low energy, rapid short pulsed ultrasound can open the blood brain barrier using microbubbles and delivery of drugs become more uniform and safer.

Ultrasound is the transmission of sound waves through a medium at frequencies above audible frequencies i.e., above 20, 000 Hz or 20 KHz. Ultrasonic waves can be reflected, refracted, focused, and absorbed like light waves but unlikely they are actual movement of molecules as the medium is compressed under high pressure and expanded at low pressure, and thus it can act physically upon bio-molecules and cells. They are absorbed relatively little by

water, flesh and other tissues. Therefore, ultrasound can "see" into the body (e.g., diagnostic ultrasound) and can be used to transmit energy into the body at precise locations. This safe, non-invasive and painless transmission of energy into the body is the key to ultrasonic-activated drug delivery.

Diagnostic ultrasound or sonography is an imaging method that uses high-frequency sound waves to produce images of structures within our body. The images can provide valuable information for diagnosing, to examine a baby in pregnant women and the brain and hips in infants and treating a variety of diseases and conditions. It doesn't use radiation as in case of X-ray and is a noninvasive medical test that helps physicians to diagnose and treat medical conditions.

Ultrasound can be used in Ultrasonic drug delivery or acoustic drug delivery to enhance the transport of molecules into or through biological tissue. The ultrasound source (or transducer) is pulsed on and off, and moved in a defined pattern to sonicate the tissue of interest. It has an ever-increasing role in the delivery of therapeutic agents including genetic material, proteins, and chemotherapeutic agents. Cavitating gas bodies such as microbubbles are the mediators through which the energy of relatively non-interactive pressure waves is concentrated to produce forces that permeabilize cell membranes and disrupt the vesicles that carry drugs. Attaching the DNA directly to the microbubbles or to gas-containing liposomes enhances gene uptake even further. Hence the use of ultrasound should be much more explored for the advancement in drug delivery technologies.

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