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THEORETICAL AND PRACTICAL ASPECTS REGARDING ULTRASOUND THERAPY ON LIVE TISSUE

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Summarry

In this work we present the theoretical and practical aspects regarding the use of ultrasound therapy on the human organism (live tissue). This is a biomechanics paper that is centered around the determination of the application limit of ultrasound frequencies upon the human organism over which the heterogeneity of tissue structures could get worse.

Ultrasound action is achieved by acoustic pressure upon the live tissue in the human organism. As they pass through a tissue, high frequency ultrasound waves lose energy or are absorbed through reflection and refraction, spread out in the molecular structures. The application of ultrasound waves in therapy is based on sinusoidal perturbations of plane waves, so that at a frequency $f = \omega/2\pi$, wave number $k = \omega/c=2\pi/\lambda$, corresponds a perturbation given by the wave length $\lambda = c.T = c/f$,with c being the sound frequency.

The wave length λ is chosen in regards to the size of the tissue molecules, in such way that the loss of energy in the tissue be as great as possible. Practically, the wave length λ is chosen as a third part of the size of the tissue molecules. At a wave length λ larger than the size of the tissue molecules, the energy loss takes place through absorbtion, and, as such, a termic transfer being achieved because of the frequency of the particles currently in vibration.

1.INTRODUCTION

Ultrasounds are wave phenomena, being mechanical waves.

For the propagation of ultrasounds, an environment is needed.

Ultrasounds differ from other mechanical vibrations due to their extremely high frequencies, making them undiscernable to the human ear. This frequency is over 16 Khz.

Due to the fact that a part of the vibration energy is transmitted to the surrounding environment, putting it's particles in vibration, a perturbation is born. This perturbation is transmitted closely through a plastic environment, alternatively taking the shape of a compression or expansion.

The way in wich the perturbation is produced depends on the elastic environment that differs from case to case. Sound waves that have very high frequencies are used in ultrasound therapy.

2. BASIC THEORETICAL PHENOMNA AND FOUNDATIONS IN ULTRASOUND THERAPY

Plane longitudinal waves are propagated in elastic environments.The muscular, boney, adipose and blood tissues of the human organism are the same kind of environment.

The differential ecuasion of the wave is: (1)

Where c2 is the speed of sound in mid air.C=343,8 m/s in air at 20 degrees Celsius.C4 represents a constant that depends on the characteristics of the elastic

environment- the phase speed or the speed of sound in propagation.The general solution to the differential ecuation (1) is:

$$P= \Psi(ct-x) + \Psi 2\ 2(ct+x) \quad (2)$$

Where Ψ1(ct-x) and Ψ2(ct+x) are sinusoidal, exponential functions, etc.

The shape of these ecuations depends on the physical situation of the environment where the perturbation is made. The term Ψ1(ct-x) represents the wave propagation in the direction of positive x's, characterizing the progressive wave. The term Ψ2(ct+x) represents the wave propagation in the direction of negative x's and characterisez the wave that turns back towards the source of sound.

In the case of the human organism at ultrasound therapy, the term Ψ2(ct+x) is usually canceled so that ecuation (2) can be written as:

$$\rho = P1ejk(ct-x) + P2ejk(ct+x) \quad (3)$$

Where P1 is the pressure amplitude of the plain wave with the frequency $f=\omega/2\pi$ that is being propagated with the speed "C", and P2 is the corresponding amplitude of a reversible plain wave. The wave number K is given by the following ecuation:

$$k=\omega/c=2\pi/\lambda \quad (4)$$

where λ is the wave length that represents the distance in the direction of propagation of the periodical wave between two successive points with the perturbation in the same phase:

$$\lambda = CT= c/f \quad (5)$$

- where T is the movement period and f is the frequency.

In ultrasound therapy the basic phenomena that takes place is the Doppler effect. This consists in the variation of frequency of a refractant wave on a surface with mobile discontinuity. Starting from an ultrasonic wave of frequency fe (issued wave,issued frequency) that is moving with the speed C in a propagation environment, that encounters a separation surface, it will reflect and refract, the frequency of the reflected wave being Ff.May υ be the angle between the incident fascicle and the speed of the reflexion surface, then the difference between the incident frequencies and reflectant frequencies is:

$$\Delta F = 2fe(\upsilon/c) \cos \alpha \quad (5)$$

$$\Delta f = Fc – Ff = Fd \quad (6)$$

where Fd is the Doppler deviation.

3.ULTRASOUND THERAPY – APPLICATIONS:

Ultrasounds are characterized by specific acoustic impedance,acoustic energy density and acoustic intensity. As specified by some authors, from a cumulative biological effects point of view,the applications of ultrasounds in medicine are made at intensities under 0,5 W/cm2,that do not produce morphological modifications in the cells. Intensities between 1-5 W/cm2 determine an acceleration of biological processes and intensities of over 5 W/cm2 produce irreversible modifications in cells.

The main therapeutic applications of ultrasounds are in:

-degenerative diseases of the bone and muscle

-treatment of the nervous system

-psychyatry

-neurosurgery

-decalcifiation of blood vesels and cardiac valves

-producing aerosols for treating bronchies by inhalation of pulverized liquid substances

-stomatology, teeth cleansing, etc.

The ultrasound diagnosis is based on the interaction between acoustic and live tissues. As in any wave fascicle,ultrasounds in tissue suffer reflection and refraction phenomena as well as absorbtion and diffraction phenomena, making it easy to obtain ultrasound images.Both in ultrasound treatment as well as in ultrasound diagnostic processes, ultrasound broadcasters with continuous or intermittent emission are used. Continous broadcasters use the Doppler effect for environments with different acoustic impedance. At the Clinic Recovery hospital in Baile Felix, ultrasound treatments are applied depending on the frequency. The 3 MHz frequency is used for superficial tissues like the hand and mandibulary articulation, the largest part of the energy being absorbed by 1-2 cm of superficial tissue. The lower frequency fascicles are used when deeper penetration is wanted. The discontinuities in ultrasound absorbtion produce the accumulation of localized heat.Large modifications in absorbtion are present at the interference level of bone and soft tissue and can generate temperature increases of up to 5 degrees Celsius. The heat is lost from the tissue as a result of conduction and cooling effects of local sangvin flux. From a biological point of view, small intensities of upto 0,5 W/cm2 present with a growth effect in cellular respiration activity, oxidative processes, glicolitic activation ferment activation and blocking of permeability in cellular membranes. The growth in permeability of tegumentary cells through massive masocite discharge with high histamine production offers the possibility of applying, through the skin of some tegumentary-applied substances.

Medium doses of ultrasounds help the local cellular metabolism to grow, produce vasodilatation with local tegumentary hiperemy with resorbtive and vasculotrophic effects. Through the vibratory action of ultrasounds upon the tendonous and muscular proprioceptors, the miorelaxant effect is produced.

Through the selective electric stimulation of unconductional pain fibres, and through the stimulation of some cerebral areas from the mezencefalic grey substance with a role of an inhibitory system of pain, alangetic effects of ultrasounds are produced.These days,three dosage steps are used in a therapeutical purpose: small doses (I= 0,05 – 0,4 W/cm2),medium doses (0,5 – 0,8 W/cm2) and high doses (0,9 – 1,2 W/cm2).

When the simpaticolic action of the ultrasound is pursued, the neuroreflex treatment is put into use as a way to influence the vegetative nervous system. For the neuroreflexive applications, small intensities of 0,2-0,3-0,4 W/cm2 are used.In acute stages of diseases, reduced doses of ultrasounds are recommended, while in cronic stages, larger doses can be prescribed.

4.CONCLUSIONS

1.Ultrasound therapy is easyer, with fast, non-painfull applications in certain affections of the human organism.

2.The aria of applications in non-conventional therapeutics is large and continuously growing.

3.With the recognition domain being large, there is further room for modern reaserch regarding ways of applying ultrasounds.

4.The results of research obtained at the Clinic Recovery Hospital in Baile Felix in some pathology domains recommend the further evolution of ultrasound therapy and aprofounded study of the effects of sound upon the human organism.

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