USES OF ULTRASONOGRAPHY AND ULTRASONIC WAVES IN ORTHOPAEDICS; DIAGNOSIS AND TREATMENT

ESSAY

Submitted for partial fulfilment of
Master Degree
in Orthopaedic Surgery

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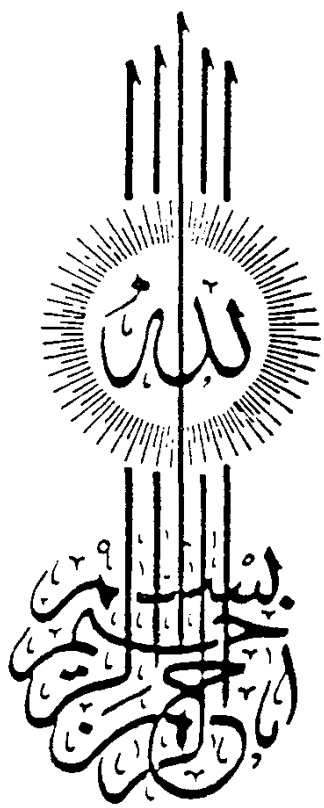

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا
عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ .

صدق الله العظيم
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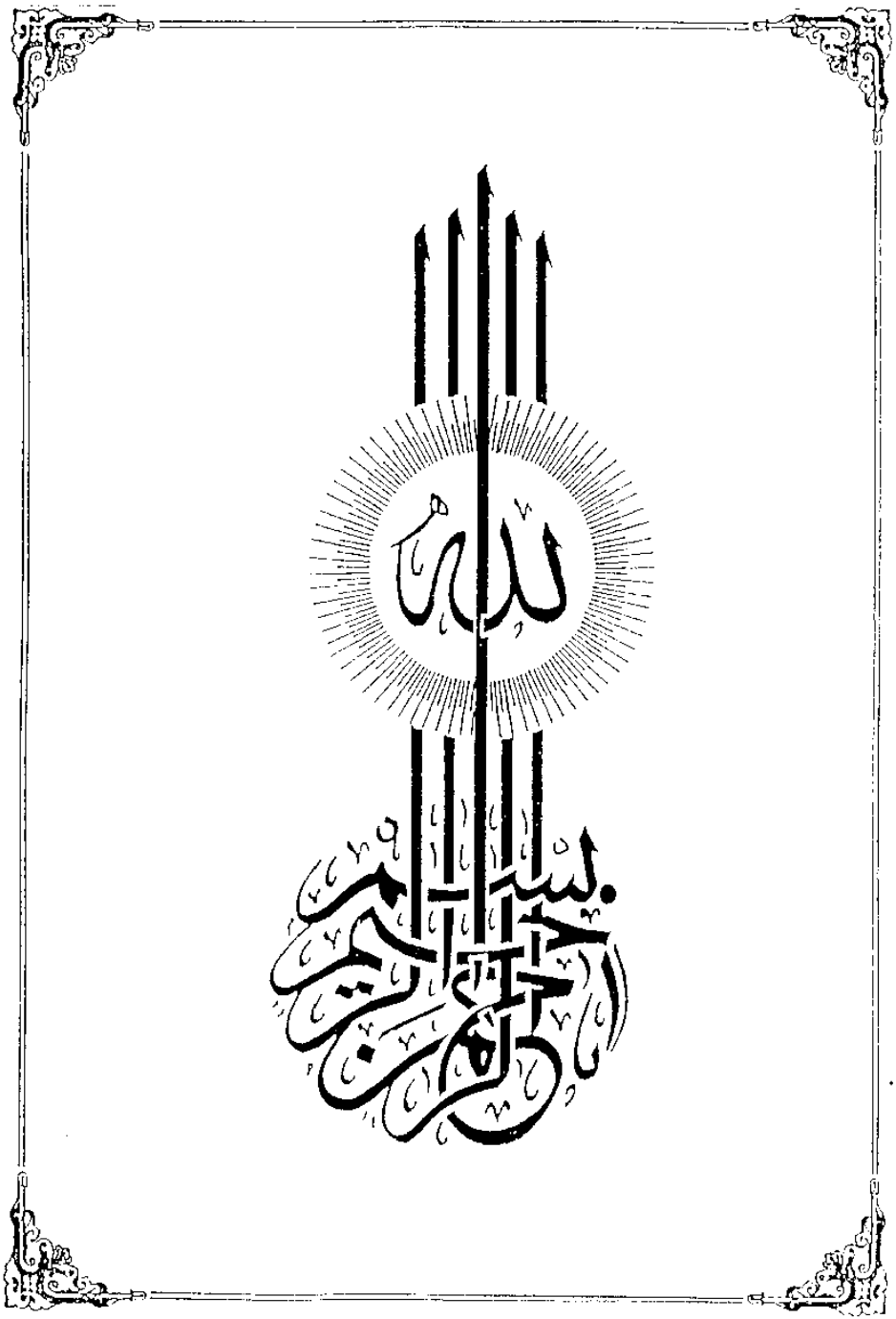

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The ultrasonic waves are a form of diathermy that often used to obtain specific therapeutic effects.

It was found that ultrasonic waves absorb inflammatory exudate, releive pain and releive muscle spasm. It is absorbed best in bony and musculer tissues and has a particular value in the treatment of many musculo-skeletal disorders.

AIM OF WORK

The aim of this work is:

- To evaluate the role of ultrasonography as a guide in diagnosis of orthopaedic disorders.
- To evaluate the role of ultrasonic waves as a therapcutic method of orthopaedic disorders.

These could be acheived through review of litrature under the following headings:

1- Physical principles of ultrasound.
2- Instrumentation.
3- The role of ultrasonography in diagnosis of orthopaedic disorders.
   a- General application.
   b- Regional application.
4- The role of ultrasonic waves in the treatment of orthopaedic disorders.

PHYSICAL PRINCIPLES OF ULTRASOUND

* THE NATURE OF ULTRASOUND:

Audible sound ranges in frquency between 16,000 - 20,000 cycles/second. Ultrasound is defined as any sound with a frequency of greater than 20,000 cycles/second. (1)

Ultrasound is a form of energy consists of mechanical vibrations occuring at a frequency too high to be detacted by the human ear. The Ultrasound used in medical purposes has a frequency ranges between 1-15 MHZ. (2)

The term hertz is the unit of frequency. It equals one cycle per second. One kilo hertz (1 KHZ) equals 1000 cycles/second and one megahertz (1 MHZ) equals one milion cycles/second i.e. one milion hertz.

The ultrasound waves consist of to and fro movement of the particles which propagated in the form of longitudinal compressional waves and need some material media capable of being compressed, through which they travel. (4)

Production of ultrasound:

Ultrasound is produced and detected by crystals that possess a piezo-electric property.

Piezo-electricity is a natural phenomenon found in certain crystalline substances such as quartz, when subjected to fercible alteration in shape, they generate small voltage between their surfaces (direct piezo-electric). A reverse action occurs when momentary strong electric voltages are applied across these crystals. They undergo slight alteration in shape and vibrate or ring and as a result send up pressure waves which are if sufficient high in frequency, pass outwards as ultrasound into the medium in contact with the crystals. (1)

The most important natural crystals possessing this property is quartz. Although quartz has been used in ultrasonic generators for many years, it is now being replaced almost entirely by synthetic ceramic crystals such as barium titanate and lead zirconate. In medical application these crystals are cut into thin wafers (less than 1 mm in thickness) and are mounted on a transducer probe.

Technically speaking, a transducer is a device that converts one form of energy into another.

In ultrasonics, the piezo-electric crystals are the actual transducer since they convert electric energy into sound energy

and vice versa. However in common parlance, the crystal and its housing are referred to as transducer. (5)

Ultrasound may be generated in pulses of microsecond length at a repetition rate of 500 - 1000 pulses/second, or may be generated as a continuous beam. (2)

INTERACTION OF ULTRASOUND AND TISSUE:

When an ultrasound pulse is sent into the tissues of the body, it undergoes continuous modifications, the most significant change is attenuation which is a progressive weakening of the sound beem as it travels through body tissues. This occurs through three processes that are absorption, reflection and scattering.

Absorption is the conversion of sound into heat. It is directly proportional to the frequency of the sound.(6)

In addition to the frequency, the amount of absorption depends on the tissue through which the sound travels.

In general, the more rigid the tissue, the greater the absorption. Bone absorbs approximately ten times more than

most soft tissues and these in turn absorb approximately ten times more than body fluids such as blood. (5)

Reflection is the redirection of the ultrasound back towards its source giving rise to echoes and this form the basis of diagnostic ultrasound scanning. (6)

Scattering occurs when the sound beam encounters on interface which is irregular and smaller than the sound beam. A small percentage of the beam is scattered in all directions. (6)

EFFECTS OF ULTRASOUND:

1) Heat production:

Which is the most common and most important effect of ultrasound. This results from the energy utilized in overcoming the frictional forces when the particles of a medium are caused to vibrate.

2) Mechanical effects:

Which are manifested in the agitation of the particles in the material. This vibratory motion of the particles can become sufficiently large that structural damage can result.

3) Cavitation:

Which is the general term for production and dynamic behaviour of gas bubbles in an ultrasonically irradiated medium. Cavitation is classified as either stable or transient. In stable cavitation, the bubbles once formed persist and oscillate radially in resonance with the sound pressure vibrations. Oscillations of the gas bubbles may produce high shearing forces in the nearby surrounding areas. In transient cavitation the bubbles continually grow in size till they become unstable and collapse, resulting in tissue damage.

4) Biologic effects:

(Which may be either reversible or irreversible.)

At diagnostic intensities there are no known effects.

At high intensities the following effects may occur:

- Protein denaturation.
- Enzyme inactivation.
- Membrane permeability changes.
- Cell membrane rupture.
- Alterationin muscle ultrastructure.
- Chromosome breakage.
- Nerve block.
- Motor paralysis.
- Liver necrosis.
- Cataract.
- Brain damage.
- Foetal developmental anomalies. (3)

INSTRUMENTATION

INSTRUMENTATION

As mentioned previously, whenever sound enters the body, some of the sound is scattered and reflected backwards and the reminder is transmitted through.

Both the reflected echoes and transmitted sound can be detected and analysed to obtain medical informations.

The returning echoes are converted by the transducer into an electric signals which are processed and amplified in order to produce an adaquate display on an oscilloscope. An oscilloscope is frequently called cathode ray tube (CRT) (5)

Depending on the manner in which the amplified signal is applied to CRT, any one of several modes or displays can be obtained. (5)

SCANNING MODES:

The reflected echoes may be displayed by A-mode, B-mode, B-scan or M-mode.