AN INTRODUCTION TO SONOGRAPHY AND ITS APPLICATION IN URO-GENITAL DISORDER

THESIS

SUBMITTED IN PARTIAL FULFILLMENT

FOR THE MASTER DEGREE IN UROLOGY

By

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1984

A C K N O L E D G E M E N T

I would like to express my sincere thanks to all the staff members of Urology Department, Faculty of Medicine, Ain Shams University, for their encouragement.

I would also like to express my deepest gratitude to Prof. Dr. Awny Atalla, for his gentle guidance and remarks. Indeed it is a pleasure to work under his supervision .

بسم الله الرحمن الرحيم

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INTRODUCTION

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Ultrasound is still a rapidly developing diagnostic method. Diagnostic accuracy is steadily increasing largely due to the rapid advance in ultrasonic technology with availability of improved detail, real time scanning and more accurate methods of recording information. It is still complementary to other diagnostic procedures, but it is now appreciated that diagnostic ultrasound particularly with reference to the genito-urinary tract can often give as much information as other diagnostic techniques, which are either more hazardous, time consuming, or costly or which are only available in selected centres.

Due to the marked advance of sonography in relation to the diagnosis of genito-urinary diseases, it becomes important, if not necessary, to every urologist to have a good idea about sonography and its interpretation. As this idea will not be complete without studying basic ultrasound, this essay is aimed to, partly, to the study of the basic knowledges about the nature, generation, parameters, display methods and hazards of ultrasound.

HISTORICAL REVIEW

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Bats and diving animals have used ultrasound as an echo-locating technique for comunication for an Eon. Man has used audible sound as an important means of comunica- for a shorter period. The potentialities of higher fre- quency soudn waves were not investigated until the last half century. This was largely due to man's inability to generate and detect high frequency waves.

Diagnostic ultrasound had its foundation in the Rayleigh "Theory of sound" published in 1877. Curie's discoveries of piezo-electricity in 1880 provided the mechanism by which the sonic theory would be applied to medical diagno- sis (Hassani, 1976).

In 1912 the " Titanic" disaster drew "Langevin's" atten- tion to the necessity for a technique to detect underwater obstruction (Holms, 1974). This need became much greater during World Wad I when German submarines threatened the allied powers with defeat. The first trials were by gene- rating high frequency oscilltions in water by a submerged condenser, and detecting the echoes by a microphone.

They later realised that a quartz crystal would be more sensitive as a detector, and later that a similar crystal would be more effective as a generator. Langevin lived to see the intensive development of his technique by many navies into the Sound Navigation and Ranging system (SONAR), that played an important role in anti-submarine wareface in the second World War (Hassani, 1976).

As many other discoveries and inventions that were developed rapidly and intensively for military purposes and destruction, the time came when the twist happened, and ultrasound is now being used for the benifit of humanity as a new tool in medical diagnosis.

Just prior to World War II , Dussik attempted the first application of ultrasound in medical diagnosis,and his work recieved a great stimulus from the World War II, due to the marked development of radar and sonar technology .

Doglas Howry began his work to visualise soft tissues at 1947 . At 1950, he and Dr. Bliss produced their first cross-sectional images. In 1951 he developed the principle of compound scanning, the combination of circular, angular or linear scanning patterns, to improve the image quality (Holms, 1974).

The first report on the application of diagnostic ultrasound to the kidneys was given at 1954 by Holms and associates who demostrated a renal cyst with the aid of this new diagnostic principle (Kristensen and Holm, 1972).

By the 1960's a series of studies on animals was carried out to varify the anatomic accuracy of the ultrasonic pictures, by comparing them with cross-sections obtained from the bodies of frozen animals after deep anaesthesia (Holms, 1974).

Ultrasonic scanning is now an accepted tool in medical diagnosis, especially in the investigation of renal diseases, because of the relatively superficial location of the kidneys and their charecteristic configuration.

Unlike other diagnostic techniques ultrasonic visualisation of the kidneys is independant of renal function and so it is ideally suited for investigation of patients with renal failure.

Part 1: Basic Sonography.

Definitions

DEFINITIONS
RELATED TO ULTRASOUND

A. FREQUENCY:

Frequency is the number of vibrations, or oscillations of the viberating particle per unit of time. It is expressed by the term Hertz (cycle per second)

The viberation of air molecule back and forth over the same path is termed viberatory movement. So the frequency is determined as

$$F = 1 / T$$

where (T) is the period of the motion (Sandra and Ansert , 1978). (Fig . 1).

Audible sound has a frequency ranging between 20 - 20,000 Hertz. Ultrasound is also a mechanical viberational energy (acoustic energy) generated at a frequency above the level of human hearing i.e., 20,000 Hertz, (Barnett and Morley, 1982).

For medical purposes frequencies range from 0.5 - 20 MHz (MHz: Megahertz = Million cycle/sec.), (Devey and Wells, 1978).

The ultrasound beam is in many ways similar to a beam of light . It obeys the laws of optics, and can unlike X - ray be foucused , reflected or refracted .

The velocity of ultrasound in a given medium is constant, and as

$$V = \lambda \times F$$

where (V) : Velocity of ultrasound in the medium (cm/sec).

(F) : Frequency of the ultrasound wave (cycle/sec).

(λ) : The wave lengh.

the frequency is invrsely proportional to the wave length, (Baker, 1974).

B. SIMPLE HARMONIC MOTION:

If a particle, such as an air molecule, is viberating about its equilibrium, or resting position, the distance the particle is moved away from its equilibrium position is proportional to the disturbing force, (Force is the product of the mass of the particle times the acceleration of the perticle, or

$$F = m \quad a$$ (Newton's 2nd, Law).

if this particle is viberating about its equilibrium position at a constant rate, it is said to be in Simple Harmonic Motion along with the applied forces.

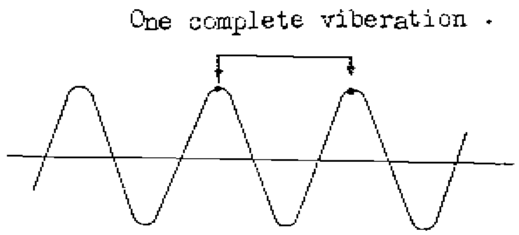

Fig. 1- Frequency is the number of viberations of the viberating particle per a unit of time .

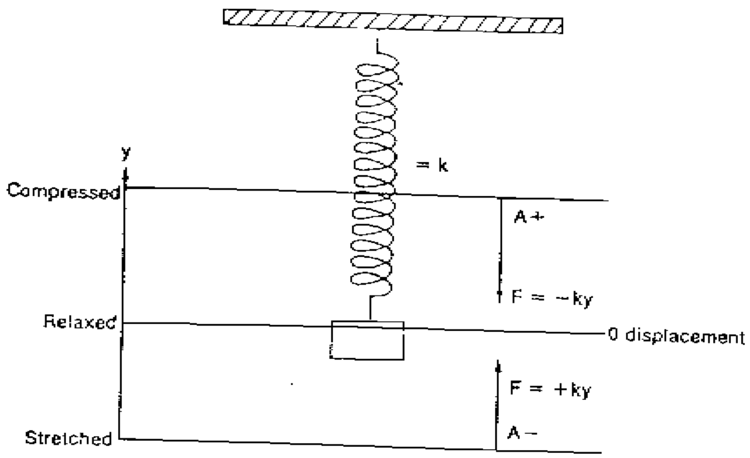

Fig. 2. Model for demonstration of simple harmonic motion.