ULTRASONOGRAPHY
IN
OBSTETRICS AND GYNECOLOGY

ESSAY

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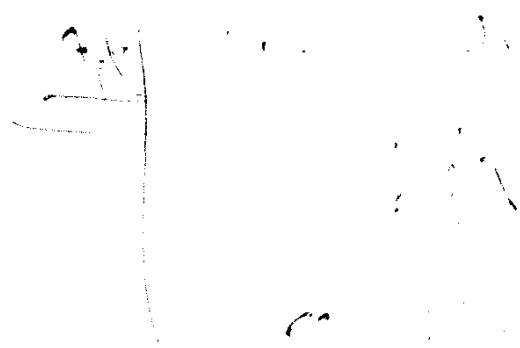

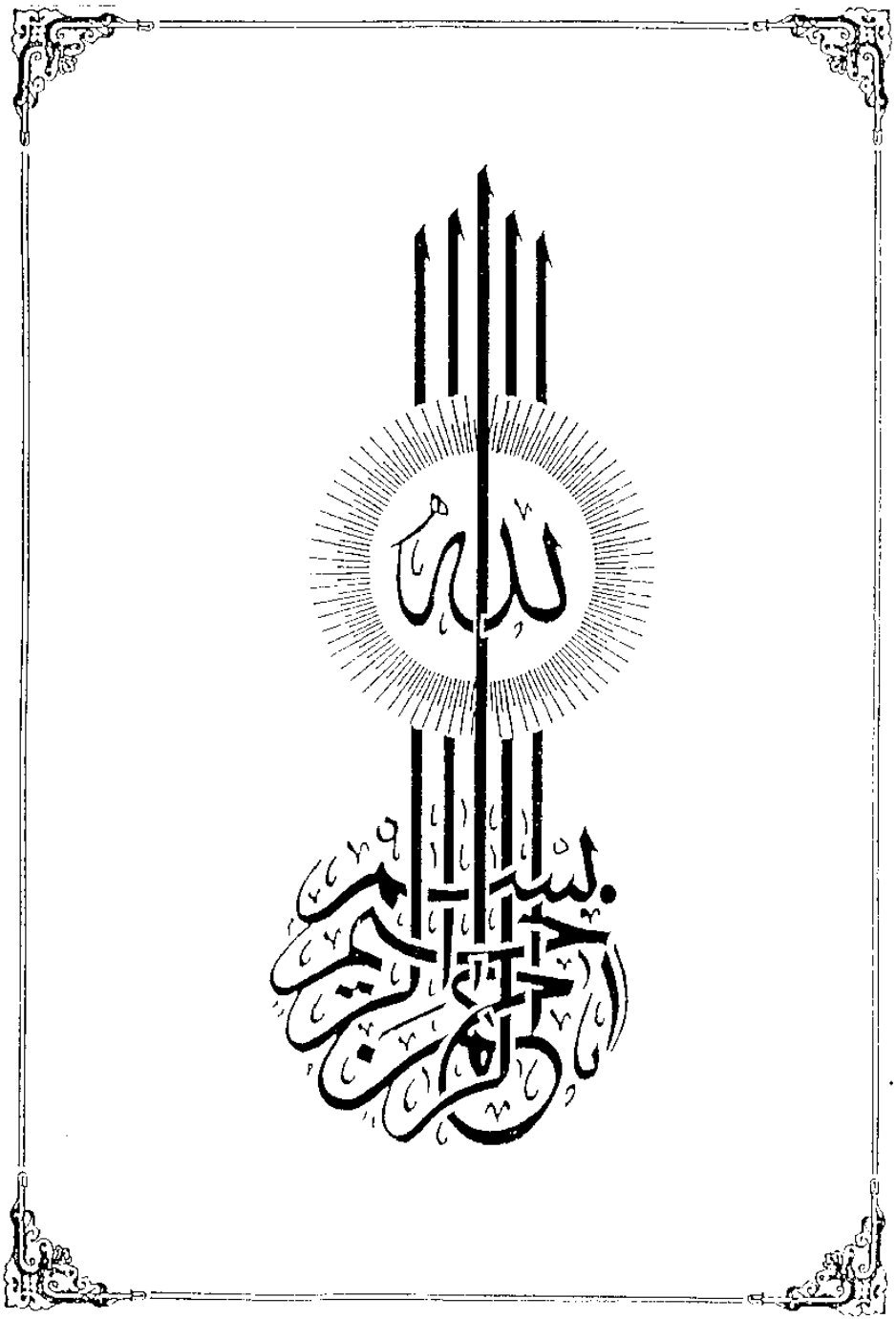

CONTENTS

INTRODUCTION

Ultrasonic echoscopy is rapidly becoming accepted as a standard method of examining the abdominal organs. There are so many departments using this equipment and so many different types of machines commercially available *(Robinson et al.; 1972)* .

Of the many technologic developments of the past quarter century , non has become as thoroughly integrated into the practice of obstetrics and gynecology as diagnostic ultrasonography . It is based on technology developed for military purposes in world war II , but its potential applicability to the solving of the mysteries of the uterus and its contents was first recognized by Ian Donald , who played the major role in disseminating and popularizing a new religion . Other "apostles" rose up and joined the movement *(Pitkin et al.; 1991)* .

There is no doubt that sonar has to offer obstetrics and gynecology , but also obstetrics and gynecology has to offer it in the wider field of medical diagnosis . It is clear that our branch of midicine has provided sonar with its first real breakthrough *(Donald et al., 1969)* .

Before gynecologists came on the scene it is true that work was being done on an increasing scale in the fields of neurology , ophthalmology and cardiology , but the technical difficulties of applying sonar on a wide and varied front mede the going hard . The real punch has come in the course of the last 10 years , during which gynecologists have increasingly interested themselves in its applications *(Donald et al.; 1969)*.

Ideally , development of technology should include the consideration of several important questions, with reasonably firm answers required before its incorporation into clinical use . As the first priority , is it safe ? Then , what are its uses and limitations ? Finally , what is the cost and is it cost - effective ? In the case of ultrasonography , as indeed with other technologic developments in medicine , this sequence was not followed . Instead , the technique was introduced and adopted widely , no doubt influenced by the commercial interests of the makers and users of the equipment , before there was much in the way of logical consideration of these essential questions *(Fitkin et al.; 1991)* .

AIM OF THE WORK

THE AIM OF THIS WORK IS TO CLARIFY THE ROLE OF ULTRASONOGRAPHY IN OBSTETRICS AND GYNECOLOGY .

CHAPTER 1

HISTORICAL REVIEW

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The history of ultrasonic is relatively short one *(Donald et al.; 1969)* .

In 1880 (15 years before the discovery of x - rays), Pierre and Jaques Curie discovered the piezoelectric properties of crystals and demonstrated that an electric charge will develop when mechanical energy is applied across their surface *(Gottesfeld et al.; 1978)* .

It was necessary for engineering practice first to catch up and to introduce to us the echo sounding technique for the detection of flows in metals with the same principle, though miniaturized , as had been developed in the 1914 - 1918 war for the detection of German U - boats lurking within the depth of the ocean *(Donald et al.; 1969)* .

Medical sonar has thus benefitted from the availability of industrial equipment which rapidly grew to a position of every day usage *(Donaldet al.; 1969)* .

Dussik (1942) in Austria began by trying to measure the transmission of ultrasonic energy through the intact brain but he failed *(Donaldet al.; 1969)* .

The use of "reflectoscope" (the first ultrasonic instrument) dates back to 1945 *(Donaldet al.; 1969)* .

The echo information supplied by a single scanning beam is difficult to unravel unless it is depicted in two dimensions at least , the first two dimensional sonograms were produced by Howry and Bliss in 1950 *(Donald et al.; 1969)* .

By the original pioneer work in the United States by Wild , Howry , Reid and Bliss in the early 1950's soft tissue studies became possible , but their experiments were carried out on animals and corpses *(Donald et al.; 1969)* .

Donald was able to cut a lot of the corners which they had first to round and used high - frequency ultrasonic waves for detecting changes in the texture of living tissues *(Donold et al.; 1969)* .

Much of the original work with diagnostic ultrasound in the field of obstetrics and gynecology was undertaken by Donald in Scotland *(Donald and Abdulla 1967 ; Donald et al., 1969)* .

The principles of the use of ultrasound in obstetrical and gynecological diagnosis were fully discribed by Donald , MacVicar and Brown (1958) *(Campbell et al.; 1968)* .Other "apostles" rose up and joined the movement : Taylor , Thompson , Gottesfeld and Holmes in the United States *(Toylor etal.; 1964 ; Thompson et al.; 1965 ; Gottesfeld et al.; 1966 ; Gottesfeld et al.; 1967)* , Campbell in Scotland and England (Campbell ,1968 ; Campbell , 1969 ; Campbell and Dewhurst , 1971) , and Robinson in Australia *(Robinson , 1973)* .

CHAPTER 2

PHYSICS OF ULTRASOUND

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Sound is the orderly transmission of mechanical vibrations through a medium . The number of this vibrations per second is the frequency (f) *(Chudleigh and Pearce , 1986)* .

The human ear capable of hearing frequencies of between 16,000 and 20,000 cycles per second .The unit of frequency is the Hertz (Hz) , which is equal to one cycle per second . One million Hertz equals one Mega Herz (MHz) .Ultrasound by definition is beyond the range of audible sound and therefore has a frequency greater than 20,000 Hz *(Ziskin , 1991)* .

The atomic and molecular structure of a medium will determine both the velocity and wave characteristics of any transmitted mechanical wave (sound) *(Ziskin 1991)* .

The speed of Sound :

The speed with which ultrasound passes through a medium depends upon the density and the elasticity of the medium . The more dense or rigid the medium , The greater the velocity of ultrasound *(Chudleigh and Pearce , 1986)* .

A fixed relation-ship between acoustic speed , wavelength and frequency exists as follows :

$$V = f \lambda$$

Where V is the speed of sound in conducting material (meters / second) , f is the frequency (Hertz) , and λ is the wave length (meters) . If the acoustic speed within any given meterial is constant , then as the frequency increases , the wavelength decreases . Thus spatial resolution improves with increasing frequency *(Ziskin 1991)* .

The depth of a structure within the body is estimated from the velocity , and the time taken for the ultrasound beam to travel to the structure and back again (go - return time) from the formula :

depth = velocity / go - return time x $^{1}/_{2}$ *(Chidleigh and Pearce, 1986)* .

Intensity of Sound :

Intensity is the measure of the "strength" of a sound wave. Consider an imaginary plane positioned perpendicular to a sound wave . Power is then defined as the rate at which energy passes this plane . The unit of power is the watt . Intensity is defined as power per cross - sectional area and is expressed as watts per square centimeter (W/cm^2) *(Ziskin , 1991)* .

Production of Ultrasound :

Ultrasound waves are produced by applying a short pulse of electricity to a piezoelectric crystal . This causes the crystal to change its width . The change in width causes the particles of the adjacent medium to vibrate .

These vibrations are propagated through the medium as a pulsed , sinusoidal wave *(Chudleigh and Pearce , 1986)* .

The generation of ultrasound had to await the discovery of piezo - electric crystals . Piezo - electric crystals are able to respond faithfully to applied electric signals at high frequencies to produce ultrasonic waves , and they likewise are able to convert accurately ultrasound waves into corresponding electric signals . The most important natural crystals possessing this property is quartz . Although quartz has been used in ultrasonic generators for many years , it has now been replaced in medical devices almost entirely by synthetic ceramic crystals such as barium titanate and lead zirconate titanate (PZT) , because these synthetic crystals possess bettor mechanical properties and are easier to fabricate than quartz *(Ziskin , 1991)* .

Transducers 27

The piezo - electric crystal (togather with its housing) is

known as a transducer .It acts both as a transmitter and receiver of ultrasound *(Chudleigh and Pearce , 1986)* .

Types of Transducers :

Transducer probes come in a variety of shapes and sizes , each of which is designed for a particular application . Some of the more common types are cylinderical , flat , perivascular , aspiration and multielement transducer arrays . The cylindrical or pencil - shaped transducer is designed for those examinations requiring scanning or searching for a particular structure .

The flat transducer , in the shape of a disk , is useful for prolonged monitoring since it can be taped to the skin and need not to be held throughout the examination period .

The perivascular type is a cuff that is mounted around an exposed artery or vein at the time of surgery . Very small transducers can be mede and mounted on catheter tips , which can then be inserted into blood vessels or the ureters , allowing close inspection of these structures . The aspiration transducer is essentially a flat transducer with a central aperture through which a hypodermic needle can be inserted . This transducer allows simultanous viewing of the needle tip location and surrounding anatomic structures and is useful for amniocentesis . Various multielement transducer arrays are presently availble . In these probes , as many as 64 or more