INTRODUCTION

The estimation of pregnancy dates is important for the mother, who wants to know when to expect the birth of her baby, and for her health care provider, so they may choose the way in which to perform various screening tests and assessments. The three basic methods used to help estimate gestational age (GA) are menstrual history, clinical examination, and ultrasonography ***(Mongelli et al., 2005)***.

Naegle's rule is the most common method of pregnancy dating. The Expected date of delivery (EDD) is calculated by counting back three months from the menstrual period and adding seven days. Inaccuracy occurs because many women do not have regular 28-day cycles or conceive on day 14, and many others are not certain of the date of their last period. In addition, early pregnancy bleeding or recent use of hormonal contraceptives may lead to an incorrect assumption of the date of ovulation ***(Mackenzie et al., 2008)***.

Fetal biometry is a methodology devoted to the measurement of the several parts of fetal anatomy and their growth. Frequently used parameters are:

Gestational sac diameter *(GSD):* Usually visible on ultrasound scan at about five weeks after the last menstrual period.

Crown-rump length *(CRL):* by seven weeks, the embryo is seen in the gestational sac.

Biparietal diameter *(BPD):* used from 12th week onwords. The measurement of BPD in second trimester (16-20 weeks) routine scan is performed in all good antenatal care centers.

Femur Length *(FL):* used in the second and third trimesters of pregnancy.

Head circumference*:* used in the third trimester.

Abdominal circumference*:* more used for monitoring fetal growth than the assessment of gestational age. In the third trimester used for estimation of fetal weight

(Shehzad et al., 2006).

Types of twins:

1- Fraternal twins or Dizygotic twins: result when two oocytes are simultaneously released from the ovary and fertilized by two separate spermatozoa. Both zygotes have different genetic constitutions. They may be of the same or different sexes.

2- Identical twins or Monozygotic twins: originate by the fertilization of a single ovum by a single sperm and thereafter by division of the zygote into two at a variable stage of early embryonic development. Monozygotic twins most commonly originate at about one week of embryonic age. Each embryo will have its own amniotic sac but both will develop in a single chorionic sac. The placenta is common to both twins. The second origin is a division of cells in the early embryo at two or three days of age, and each embryo develops its own amniotic and chorionic sacs, while the placentae may be separate or fused. The third and least common origin of monozygotic twins is by late division of embryonic cells at 9-15 days of age. The resulting twins share common amniotic and chorionic sacs.

(Walters, 1995)

Management of twin pregnancy begins when the diagnosis has been made. Clinically it may be brought to attention because of a family history of twins, because of hyperemesis in early pregnancy, or unexpected increased uterine size on pelvic or abdominal palpation. Later in the second trimester, an apparent excess of fetal parts and more than two fetal poles may be palpable abdominally. Auscultation may reveal the presence of two fetal heart rates. The definitive diagnosis is made by ultrasound examination ***(Walters, 1995).***

There is no significant difference in BPD between uncomplicated singleton and twin pregnancies. Twin femur length growth patterns are similar to singleton throughout gestation. The sonographic prediction of chorionicity and amnionicity in twins should be systemically approached by determining the number of placentas visualized and the sex of each fetus and then by assessing the membranes that divide the sacs. There are three features that provide the certain diagnosis about the mono-or dichorionicity of a twin pregnancy.

These features are (1) thickness of the intertwin membrane, (2) the number of layers visualized in the membrane, and (3) assessment of the junction of the membrane with the placental site. In dichorionic diamniotic pregnancy, the dividing membrane is thick and either three or four layers. In monochorionic diamniotic pregnancy, the dividing membrane is thin and only two layers **(*Chitkara and Berkowitz, 2002*).**

The transverse cerebellar diameter (TCD) has been one of the most reliable ultrasound parameters for growth especially early gestation. The TCD was the only parameter that correlated with gestational age by the end of the second trimester ***(Pinar et al., 2002)*.**

There is relative preservation of normal cerebellar growth in growth-restricted fetuses and a similar rate of growth in singleton and multifetal gestations. The transverse cerebellar diameter therefore represents an independent biometric parameter that can be used in both singleton and multifetal pregnancies to assess normal and deviant fetal growth ***(Goldstein and Albert, 1995)***.

AIM OF THE WORK

To compare the accuracy of Transcerebellar diameter (TCD) measurement with Biparietal diameter (BPD) in twin and singleton pregnancies with established menstrual dates.

Chapter (1)

PHYSICS OF ULTRASOUND

Sound is a mechanical wave, which requires a medium in which to travel. More accurately, it is a series of pressure waves propagating through a medium. One cycle of the acoustic wave is composed of a complete positive and negative pressure change. The wavelength is the distance traveled during one cycle, the frequency of the wave is measured in cycles per second or Herz (Cycles/s, Hz,) For humans audible sound ranges between 16 Hz and 20.000 Hz (20 kilo Hertz). The hearing range of other species can be much higher than 20 KHz and is inaudible for us. These higher wave frequencies are referred to as "ultrasound" ***(Hoffmann et al., 2008).***

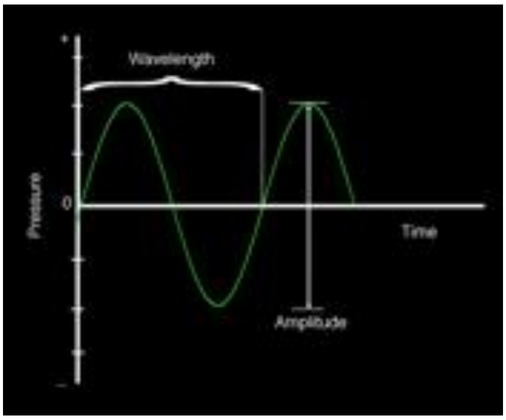

Fig. (1): A schematic drawing of wave length, pressure and amplitude. Quoted from ***(Hoffmann, et al., 2008)***

Nature of Ultrasound:

Ultrasound is sound possessing a frequency above 20KHz, the upper limit four human hearing. Ultrasound consists of a mechanical vibration of the particles or molecules of a material. Although each particle moves small distances from its resting position, the vibrational energy is propagated as a wave traveling from particle to particle through the material. Sound waves are classified as being longitudinal or transverse, depending on whether the vibration of each particle is parallel or transverse to the direction of propagation. Although all materials can support the propagation of longitudinal sound waves, only solids can support transverse sound waves. From the acoustical point of view, soft tissues behave as liquids; thus, compact bone is the only tissue capable of supporting transverse sound waves ***(Ziskin, 1993)*****.**

The parameters of an ultrasound wave include frequency, pressure, wavelength, velocity, power, and intensity. Frequency is the number of complete oscillations that each particle undergoes each second. Frequencies employed in diagnositic ultrasonographic (US) applications range from 1 to 30 MHz and possibly higher. In general, the higher the frequency, the smaller is the beam divergence and the narrower is the beam width ***(Kremkau, et al., 1989)*****.**

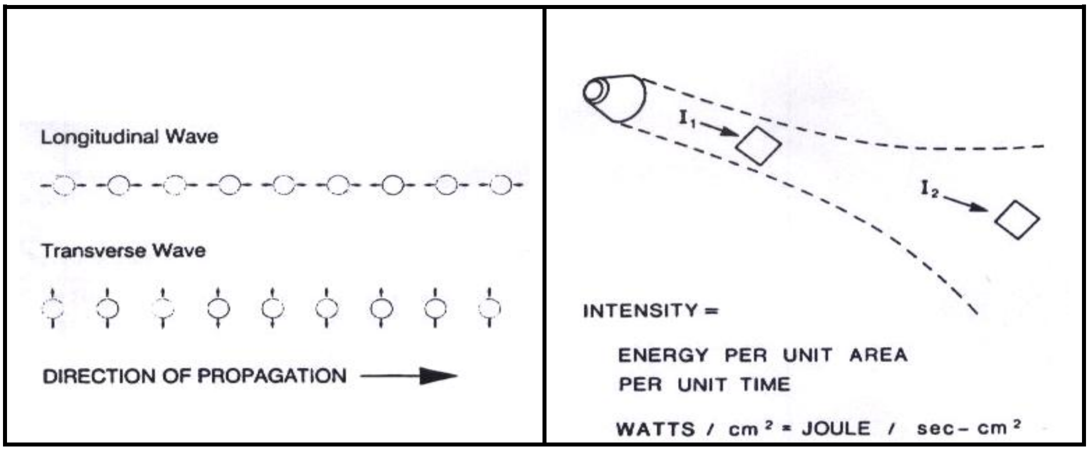

Fig. (2): ***(Left)*** Diagram illustrates types of sound waves. Sound waves are classified by their relationship to the direction of the propagation of energy. In longitudinal waves, the particles vibrate in the same direction, and in transverse waves, they vibrate perpendicular to the propagation. ***(Right)*** Diagram illustrates intensity within a sound beam. Intensity (1) changes, depending on the beam width. Where the beam diverges, the energy is spread over a larger area and the intensity is smaller. Quoted from ***(Ziskin, 1993)***.

Because the particles along a sound wave do not move in synchrony, particles near to the origin of the sound wave begin vibrating before more distant particles. Sound velocity is the rate at which the vibratory energy is transmitted in a specified direction of propagation. Velocity is a vector quantity, which means that the direction as well as the magnitude must be specified. When the direction of propagation is not specified, the proper term is speed. Acoustic speed is greater in materials that are more rigid or less compressible. Acoustic speed in water and in soft tissues is five times greater than that in air, and that in bone and metals is approximately five times greater yet. Acoustic speed in average soft tissue is 1540 m/sec, which is the figure used by manufacturers in the calibration of internal distance measurements ***(McDicken, et al., 1981)*****.**

Power and intensity are measures of the "strength" of an ultrasound wave. Power is the total amount of energy passing through a surface per unit time and is expressed in watts. Without attenuation, the power remains constant, regardless of the distance a sound beam travels. Intensity is the concentration of energy per unit time, that is, the energy per unit area per unit time, and is expressed in watts per square centimeter. Intensity changes, depending on the width of the ultrasound beam. Therefore, in sound beams that are focused, the intensity is greatest at the focus where the beam width is the narrowest. In pulsed ultrasound beams, the greatest intensity value occurs during the pulse and is zero between pulses ***(Wells, et al., 1977)*****.**

Production of sound:

In the audible range, sound is usually produced mechanically by means of a loudspeaker. Loudspeakers can not vibrate enough to produce ultrasonic frequencies. Consequently, the generation of ultrasound had to await the discovery of piezoelectric crystals. Most crystals do not possess the property of piezoelectricity. The most important natural crystal 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 crystals offer advantage of greater sensitivity and shorter pulse duration also these crystals posses better mechanical properties and are easier to fabricate than quartz. The piezoelectric effect is the generation of an electric voltage when a crystal is compressed. If the crystal is stretched a voltage of the opposite polarity is generated. The reverse piezoelectric effect is the compression or expansion of a crystal induced by the application of a voltage. In medical application, these crystals are cut into thin wafers (less than 1 mm in thickness) and are mounted on a transducer probe ***(Ziskin, 1991)*.**

Types of sound waves:

When a sound wave travels through air, water or soft tissue the particles in the medium are displaced in a direction that is parallel to the direction of travel of the sound wave, this is called a longitudinal wave. Only longitudinal waves can be transmitted through soft tissues. It is possible in some media to generate sound waves in which the direction of vibration of particles is perpendicular to the direction of travel of the wave. These are called transverse waves in the body they can propagate through bones ***(Zagzebski, 1994)*.**

Sound field:

The oscillations emitted by the transducer can be couples into the tissue, where they will propagate as waves. This region of propagation, or sound field, consist of two major parts called the near field and the far field. Within the near field, the diameter of the sound beam is relatively constant, but the intensity of the beam (The sound pressure) varies greatly at different points in the field. These fluctuations are unavoidable and are frequently disruptive. In the far field the beam diverges rapidly, but the intensity of the beam is uniform providing the constant sound pressure needed for reliable diagnostic imaging. To improve the image quality, the beam is focused so that the focal zone coincides with the area of greatest diagnostic interest. The beam can be focused electronically to place the focal point within the near, intermediate, or far a portion of the image, as desired ***(Merz, 1994)***.

Sound Transmission Through Tissue:

Attenuation: The intensity of a sound beam constantly decreases as it travels through tissue. This decrease in intensity is called attenuation it is due to three factors.

1) Divergence of the sound beam.

2) Absorption of sound energy by the tissue, and

3) Reflection of the sound out of the beam

(Ziskin, 1991)

1- **Divergence:** As a sound beam diverges, its energy is spread over a larger cross – sectional area, because intensity is proportional to energy per unit area, it decreases in proportion to the divergence of the beam.

2- **Absorption:** Absorption is the transfer of energy from the sound beam to the tissue. The energy removed is used primarily in overcoming the internal frictional forces of the tissue and is ultimately degraded into heat production. The greater the sound frequency, the more rapidly the tissue molecules must move and the greater the energy expended in overcoming friction. Thus absorption is proportional to frequency. In addition to frequency, the amount of absorption depends on the viscosity of the tissue through which the sound travels. In general the more rigid the tissue and the higher the collagen content, the greater the absorption. Bone absorpes approximately 10 times more than most soft tissues and these in turn absorb approximately ten times more than body fluid such as blood and amniotic fluid ***(Ziskin, 1991)*.**

3- **Reflection:** Whenever a sound beam reaches a large boundary between two tissues, some of the sound is reflected backwards and the remainder is transmitted through the boundary. This mirror like type of reflection is called specular. The amounts of sound that are reflected and transmitted and the directions in which they travel are determined by certain properties of the two tissues and by the angle at which the incident sound beam strikes the boundary. The amount of sound reflected is proportional to the difference in the acoustic impedances of the two tissues ***(Ziskin, 1991).***

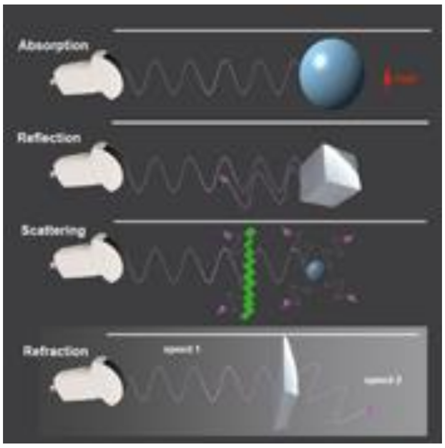

Fig. (3): Absorption, reflection, refraction, scatter between the unhomogeneos border of two different media. Quoted from ***(Ziskin, 1991)***.

Types of reflections:

1- **Specular:** Or mirror like reflections arise from flat or smooth rounded surface specular echoes are characterized by being sharp and well defined. In obstetric scanning specular echoes arise from structures such as vault of the skull.

2- **Scattered reflections:** They arise either from irregular or ill-defined structures. They are less well defined and usually weaker than specular type because of the resultant echoes are dispersed in a number of different directions only a small proportions passing backwards along the path of the ultrasonic beam. Examples of organs which generate scattered echoes are the myometrium and placenta. Scattering is a major source of diagnostic information in ultrasonography. Subtle changes in image brightness and texture which are due to regional variations in ultrasonic scatter level are interpreted clinically as variations in relative echogenicity of an imaged region ***(Zagzebski, 1994)***.

Resolution:

Is the minimum distance between two point targets required to register each point as a distinct entity. The resolution of any wave form is directly related to the frequency of oscillation. The higher frequency sound usually has better resolution but its intensity falls off rapidly as it passes through a medium. There are two types of resolution to consider in using ultrasound as a diagnostic probe.

1- **Axial Resolution:** The resolution between interfaces which lie behind one anther along axis of ultrasound beam.

2- **Lateral Resolution:** Is the resolution across ultrasound beam i.e. two points located perpendicular to the beam axis.

(Thaler and Bruck, 1991)

Acoustic Impedance:

Is the resistance offered by a tissue to the passage of sound and is represented by (Z). It can also be shown to equal the product of the density and the acoustic speed of the tissue Z = PV where (P) is the tissue density and (V) is the acoustic speed. The acoustic impedance of air is extremely small compared to that of any other tissue or materials. Therefore, an air tissue boundary presents such a large difference in acoustic impedance that virtually all of the sound incident on this boundary is reflected this has several important consequences for diagnostic ultrasound. The first consequence is that some coupling agent, such as aquasonic, must be applied to the surface of the skin so that no air exists between the transducer and the skin. The second consequence is that gas within the gastrointestinal tract also blocks any further penetration of a sound beam. Therefore in order to examine any structure lying beneath a gas containing intestinal loop, one must move the transducer to a different position to bypass the gas ***(Ziskin, 1991)*.**

Ultrasound Modes:

The most important mode for the ultrasound-beginner is the B-mode. B-mode stands for 'brightness mode' and provides structural information utilizing different shades of gray (or different 'brightness') in a two- dimensional image ***(Hoffmann et al., 2008)*.**