Sudan University of Sciences and Technology

College of Graduate Studies

Estimation of Gestation Age by Cerebellum Diameter Using Ultrasonography

تقدير عمر الجنين بقطر المخيخ باستخدام التصوير بالموجات فوق الصوتية

A thesis Submitted for the Requirement of Partial Fulfillment of M.Sc Degree in Medical Diagnostic Ultrasound

By

Elzubier Hag Ali Elzubier Al khider

Supervisor

Dr. BabikerAbd Elwahab Awad Alla

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الآيــــة

بسم الله الرحمن الرحيم

قال تعالى:

[وَوَصَّيْنَا الإِنْسَانَ بِوَالِدَيْهِ إِحْسَانًا حَمَلَتْهُ أُمُّهُ كُرْهًا وَوَضَعَتْهُ كُرْهًا وَحَمْلُهُ وَفِصَالُهُ ثَلاثُونَ شَهْرًا حَتَّى إِذَا بَلَغَ أَشُدَّهُ وَبَلَغَ أَرْبَعِينَ سَنَةً قَالَ رَبِّ أَوْزِعْنِي أَنْ أَشْكُرَ نِعْمَتَكَ الَّتِي أَنْعَمْتَ عَلَيَّ وَعَلَى وَالِدَيَّ وَأَنْ أَعْمَلَ صَالِحًا تَرْضَاهُ وَأَصْلِحْ لِي فِي ذُرِّيَّتِي إِنِّي تُبْتُ إِلَيْكَ وَإِنِّي مِنَ الْمُسْلِمِينَ).

سورة الأحقاف، الآية.15

Dedication:

To my parents

To my brothers and sisters

To my wife

Acknowledgement

I am deeply grateful to God who gave me patience and power to complete this thesis; then to My Supervisor : Dr Babiker Abd Elwahab, Dr Awdia Gribe Alla and my classmate Marzoug Ahmed Ali .

Abstract

This a descriptive crossectional study which aimed to Estimate of Gestation age by Cerebellum Diameter using Ultrasonography carried out in Ribat Teaching hospital, Khartoum state - Sudan, from November 2016 to May 2017. There were 49 pregnant ladies selected conventionally scanned by Siemens ultrasound machine, all cases were normal pregnancy in second or third trimester, any female had pregnancy in first trimester or with fetal anomaly was excluded from this study.

Transabdominal scaning was performed for all cases to evaluate transverse cerebellum diameter (TCD), biparietal diameter (BPD), femur length (FL), head circumference (HC), abdominal circumference(AC). Collected data was analyzed using statistical package for the social sciences (SPSS).

Study resulted that; mean value of the TCD was 35.102 ± 367mm, mean of BPD was 70.435mm ± 18.2mm, mean of FL52.949 mm+/- 18.2mm, mean of HC was 251.348 ± 73.2971mm and mean of AC 228.382mm ± 81.5224mm. Study showed that there was a direct linear correlation between gestational age and TCD, BPD, FL, AC and HC, in which gestational age increased by 0.5254 week /mm, 0.38 week/ mm, 0.3957 week/mm, 0.0784 week/ mm , 0.0813 week/mm respectively. Also study showed that there was significant strong positive correlation between TCD with BPD, FL, AC, HC 0.955, 0.948, 0.914,0.866 respectively at PV= 0.000.

Study Recommended that pregnant women who in second or third trimester should be measured gestational age using Trans Cerebellum diameter as another parameter.

مستخلص الدراسة

هذ الدراسه وصفيه مقطعيه ,هدف هذ الدراسه هو تقدير عمر الجنين بقطر المخيخ باستخدام الموجات فوق الصوتيه ,جمعت هذ البيانات بواسطه جهاز موجات فوق الصوتيه سيمانس من ولايه الخرطوم مستشفى الرباط الجامعي من شهر نوفمبر 2016 حتى شهر مايو 2017. البيانات جمعت من 49 سيده حامل كل حالات البحث طبيعيه في الترم الثاني او الثالث من الحمل ,اي حاله من الترم الاول او تحوي جنين مشوه خلقيا استبعدت من البحث,.نتائج البحث بينت ان متوسط قطر المخيخ ,قطر الجمجمه ,طول عظمه الفخذ ,محيط الجمجمه ,محيط البطن 35.102 +\- .367مم ,70.435+\-18.2 مم, 52.949+\-18.2 مم, 251.348 +\-73.2971مم ,228.382مم.وايضا الدراسه وضحت انه يوجد علاقه خطيه بين عمر الجنين مع قطر المخيخ ,قطر الجمجمه , طول عظمه الفخذ ,محيط الجمجمه ,محيط البطن في هذ العلاقه العمر للجنين يزيد بمقدار 0.52.54 اسبوع \مم,0.38 اسبوع \مم , 0.3957اسبوع\مم ,0.0784اسبوع\مم ,0.0813 اسبوع \مم بالترتيب .وايضا هذ الدراسه توضح انه يوجد علاقه قويه موجبه مقبوله احصائيا بين قطر المخيح مع قطر الجمجمه ,طول عظمه الفخذ ,محيط الجمجمه ,محيط البطن 0.866 ,0.914 ,0.948 ,0.955 بالترتيب عند نقطه احتمال 0.000.وايضا يوجد علاقه قويه موجبه بين عمر الجنين مع قطر المخيخ وقطر الجمجمه وطول عظمه الفخذ ومحيط الجمجمه وايضا محيط البطن 0.807 , 0.867 , 0.980 , 0.981 , 0.952 عند نقطه احتمال 0.000.

اوصت الدراسه ان الحوامل في الترم الثاني والثالث من حملهن يجب ان نستخدم سمك المخيخ في تحديد عمر الجنين اضافه لغيره من القياسات المستخدمه.

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Abbreviations

AC	Abdominal circumference
BPD	Biperietal diameter
CSP	Cavum septi pellucidi
CPC	Choroid plexus cyst
CD	Cerebellum diameter
FL	Femur length
GA	Gestational age
HC	Head circumference
MRI	Magnetic resonant imaging
OFD	Occipitofrontal diameter
TGC	Time gain compensation
3-D	Three dimensional

Introduction

1-1 Introduction

Diagnostic ultrasound had been used in obstetric nearly 30 years Although generally consider safe. There is continuing study and research to confirm this. It's a very important technique for examining pregnant women and can be used when clinically in decated at any time during pregnancy, (Palmer ,1995)

Prediction of gestational age (GA) based on sonographic fetal parameters is perhaps the cornerstone in modern obstetrics and continues to remain an important component in the management of pregnancies with fetuses who have growth disturbances. The cerebellar diameter (CD) serves as a reliable predictor of GA in the fetus and is a standard against which aberrations in other fetal parameters can be compared, especially when the GA cannot be determined by the date of the last menstrual period or an early pregnancy scan, (Hata, 1989 and Reece, 1987)

There is study evidence an association between the dimensions of the fetal cerebellum, especially the CD and GA, Furthermore, it has been shown that there is a close relationship between CD and GA (correlation coefficient (r) = 0.94 and $p < 0.001$), with CD increases linearly from 15 to 40 weeks.

Therefore, based on our findings and taking into account the present state of the art on this issue, the CD fetal ultrasound could be a predictive biometric parameter of GA in the last two trimesters of a pregnancy. The present data offer the normal range of cerebral measurements throughout gestation. These values may allow intrauterine assessment of the development of the cerebellum as well as the posterior fossa. (Mustafa et al 2013) The cerebellum on ultrasound is s dumb-bell-shaped and consist of two circular hemispheres and separated centerally by the more Hyperechoic triangular shaped vermis. The CD has been used as one of the parameters in estimating fetal gestational age in second trimester ; it has been shown that the CD in millimeters is numerically equivalent to number of weeks of gestation of the pregnancy in second trimester.(Choudleing and Thilaganathan, 2004) But as any anatomical structures in the body, many diseases can alter the normal anatomical configuration of the cerebellum make it difficult to use it for CD measurement and thus estimating the fetal age. . (Mustafa et al 2013).

1-2 proplem of study :

the accuracy of some of these parameters is affected by growth abnormalities.

There for finding sudanese index will facilitate the use of cerebellar diameter (CD) as routine parameter for GA estimation.

1-3 objectives:

1-3-1 general objective:

To Estimation of Gestation age by Cerebellum Diameter Using Ultrasound .

1-3-2 specific objectives:

To measure CD in second and third trimester.

To compare between GA by CD with GA by BPD.

1-4 overview of study:

This study falls in to five chapters, capter one was an introduction which include proplem of the study ,objective of the study and over veiw of the study, while chapter two includes literature review and previous study, chapter three deals with material used to collect the data and the method of data collection and analysis ,chapter four presented the result of the study and finally chapter five includs discusion of the result ,conclusion and recommendations.

Literature Review

2-1 Embryology of the brain:

Knowledge of fetal gestational age is particularly important when evaluating anatomy in early pregnancy. In this chapter we use menstrual ageand gestational age to mean “age from last menses,” as typically used clinically and with ultrasound studies. We convert published ages to menstrual age by adding 2 weeks to the conceptual age. Central nervous system development starts at about the fifth menstrual week, when cells destined to form the notochord infiltrate into the embryonic disc. This notochord tissue induces overlying embryonic tissue to thicken and ultimately fold over and fuse as the neural tube. The fusion starts in the midtrunk of the embryo and subsequently extends to the cranial and caudal ends The anterior end, the rostral neuropore, closes by about menstrual weeks, and the caudal end closes about week later. By the sixth week, the cephalic end enlarges and flexes to become the brain.By to 15 menstrual weeks, almost all structures are in their final form(Carol M Rumack, 2011).

Exceptions are the corpus callosum, cerebellar vermis, neuronal migrationfrom the periventricular germinal matrix, development of the sulciand gyri, and myelination.These latter structures and processes start developing from about 15 weeks onward. The corpus callosum is formed by 20 weeks. As it develops, the corpus callosum induces the formation of the two septi pellucidi and the intervening space, which is the cavum septi pellucidiand cavum vergae. The cerebellumand vermisdevelop as proliferations into the cephalic part of a thin dorsal membrane (area membranacea) that forms the dorsal aspect of the rhombencephalic neural tube.The enclosed part of the hindbrain neural tube is the rhombencephalic cavity. This cavity enlarges rapidly in early pregnancy, forming a conspicuous dorsal cystlike space that should not be mistaken for abnormality The cerebellar hemispheres grow into this membrane from the sides, and the vermis arises from its cephalic aspect. The lower part of the rhombencephalic membrane below the vermis eventually fenestrates to form the foramina of Magendie and Luschka. This membranous part can bulge to a variable extent, forming Blake's pouch.With high-resolution equipment, Blake's pouch can be seen in most fetuses, where it is often mistaken for arachnoid strands. The cerebellum and vermis are essentially formed by 22 weeks (Carol M Rumack, 2011).

Care must be taken to avoid mistaking the incompletely developed vermis for vermian dysplasia/hypoplasia. Midsagittal views with ultrasound, especially 3D midsagittal scans, and MRI can show the normal development of the vermis, the fourth ventricle with pointed fastigial point (dorsal pointed apex of fourth ventricle), and the vermian fissures, as well as overall size of vermis and the normal brainstem-vermis angle of less than 10 degrees. All these elements are used to evaluate normal vermian development. The cortex also undergoes complex development at the neuronal cellular level. The cells that will become the brain cells (neurons)at the outer surface of the cortex undergo complex development in three overlapping phases: proliferation, migration, and organization. In general, neuron development starts at about 5 weeks and is largely finished by 28 weeks. Neurons derive and proliferate from stem cells located in the germinal matrix by the ependyma-lined ventricles. These stem cells proliferate and differentiate into glial cells and neurons. The glial cells send processes to the cortical surface, creating a scaffold along which the neurons then migrate to the cortex. To accommodate the accumulating neurons, the cortex undergoes folding into gyri and sulci. Failure of normal migration results in heterotopia(collections of neurons in abnormal locations) and abnormal or absent cortical convolutions (pachygyria or type 1 lissencephaly) (Carol M Rumack, 2011).

A normally functioning outermost layer of the cortex serves to stop neuron migration and prevents overmigration of neurons into the meninges. Failure of this stopping function results in neurons migrating beyond the normal limits of the cortex into the meninges and subarachnoid space. This gives the brain surface a finely granular texture called cobblestone lissencephaly. Once the neurons arrive at the cortex, they organize local connections and send axons remotely, thereby forming large tracts or commissuressuch as the corpus callosum to connect the hemispheres. All these elements require the normal function of many genes working together, and the process is easily disrupted by intrinsic and extrinsic insults, such as fetal and maternal metabolic disorders, hypoxia, infections, and teratogens (Carol M Rumack, 2011).

2-2 anatomy of the brain:

The brain is a component of the central nervous system .During development the brain can be divided into five continuous parts From rostral (or cranial) to caudal they are: the telencephalon (cerebrum), which becomes the large cerebral hemispheres, the surface of which consists of elevations (gyri) and depressions (sulci) and is partially separated by a deep longitudinal fissure, and which fill the area of the skull above the tentorium cerebelli and are subdivided into lobes due to their position. the diencephalon, which is hidden from view in the adult brain by the cerebral hemispheres, consists of the thalamus, hypothalamus, and other related structures, and is considered to be the most rostral part of the brainstem; the mesencephalon (midbrain), which is the first part of the brainstem seen when an intact adult brain is examined, and is at the junction between and in both the middle and posterior cranial fossae; the metencephalon, which gives rise to the cerebellum (consisting of two lateral hemispheres and a midline part in the posterior cranial fossa below the tentorium cerebelli) and the pons (anterior to the cerebellum, a bulging part of the brainstem in the most anterior part of the posterior cranial fossa against the clivus and dorsum sellae); the myelencephalon (medulla oblongata), the caudal most part of the brainstem, which ends at the foramen magnum or the uppermost rootlets of the first cervical nerve and to which cranial nerves VI to XII are attached (Richardl Drake et al,2007).

2-3 Sonographic Anatomy:

The early embryo is best examined transvaginally. The cephalic end is identifiable by about 8 weeks By 10 to 11 weeks, bones of the vault show minera lization. At this age, the brain mantle is very thin. The ventricles are large and filled with choroid, which provides nourishment for the developing brain. large, echo-free space behind the hindbrain represents the rhombencephalic cavity,which decreases in size as the cerebellum begins to form. This normal echo-free space appears especially large and prominent in firsttrimester scanning and should not be mistaken for abnormality. After about 13 to 14 weeks, most of the cerebral structures can be identified ultrasonographically. Three standard transaxial planes or views (thalamic, ventricular, cerebellar) can lead to the detection of more than 95% of sonographically detectable cerebral anomalies. These three views form a useful starting point, but the examination should not be limited to these views alone. The entire brain should be examined, using whatever projections are needed to show all the structures The transvaginal approach can be employed when the head is deep in the pelvis and allows a better view of the brain. The thalamic viewused to measure the biparietal and occipitofrontal diameters (BPD and OFD). It displays the thalamus, third ventricle, fornices, basal ganglia, insula, and ambient cistern.The ventricular view is slightly higher than the thalamic view and shows the bodies and, more importantly, the atrium of the lateral ventricle as well as the interhemispheric fissure.The atrium of the lateral ventricle is at the base of the occipital horn, where it joins with the temporal horn and the body of the ventricle (Richardl Drake, 2007).

The atrium is an important landmark at which ventricular size is measured. The cerebellar viewis obtained by rotating the transducer into a suboccipitobregmatic plane centered on the thalamus to show the cerebellar hemispheres. This view shows the cerebellum, cisterna magna, cavum septi pellucidi(CSP), and frequently the anterior horns of the lateral ventricles. Cerebellar measurements may be used to determine gestational age if the head has undergone molding. The cisterna magna is the cerebrospinal fluid space between the cerebellum and the occipital bone. It is the distance between the cerebellar vermis and inner surface of the occipital bone measured on an axial plane that includes the anterior end of the CSP and the midplane of the cerebellum posteriorly. The cisterna magna should be noted at every study and normally measures 2 to 10 mm. Its obliteration suggests a Chiari II malformation,a common finding in spina bifida (Richardl Drake, 2007).

Its excessive enlargement is termed mega–cisterna magna,which may be normal if found in isolation, but also increases risks of abnormalities such as trisomy 18and cerebral dysfunction. Additional sonographic views and projections that exploit the normal windows provided by the fontanelles and sutures can be helpful in clarifying brain anatomy and development. The median (midsagittal) view through the metopic suture–anterior fontanelle–sagittal suture shows midline structures such as the corpus callosum and occasionally the cerebellar vermis and brainstem. The posterolateral mastoid fontanelles provide effective access to the cerebellum and occipital lobes and ventricles. The sulci and gyri undergo predictable development patterns that can be assessed as early as 18 weeks. Special views to optimize sulcal development can be helpful in detecting abnormal development such as lissencephaly Multiplanar three-dimensional (3-D) imaging can be utilized to reconstruct axial and median views to assess the brain from any perspective. Midsagittal reconstructions are especially helpful in evaluating abnormalities of the corpus callosum and cerebellum. Head shape and ossification should be noted at all these views. Although ultrasound is the mainstay of a prenatal examination, MRI is useful as a problem-solving technique when questions remain after the ultrasound scan. Currently, MRI provides excellent anatomic images after about 22 weeks' gestation and is superior in evaluating the character of brain tissue and the periphery of the brain, where ultrasound visibility is limited. However, MRI has limitations in showing cerebral calcifications and small cysts (Richardl Drake, 2007).

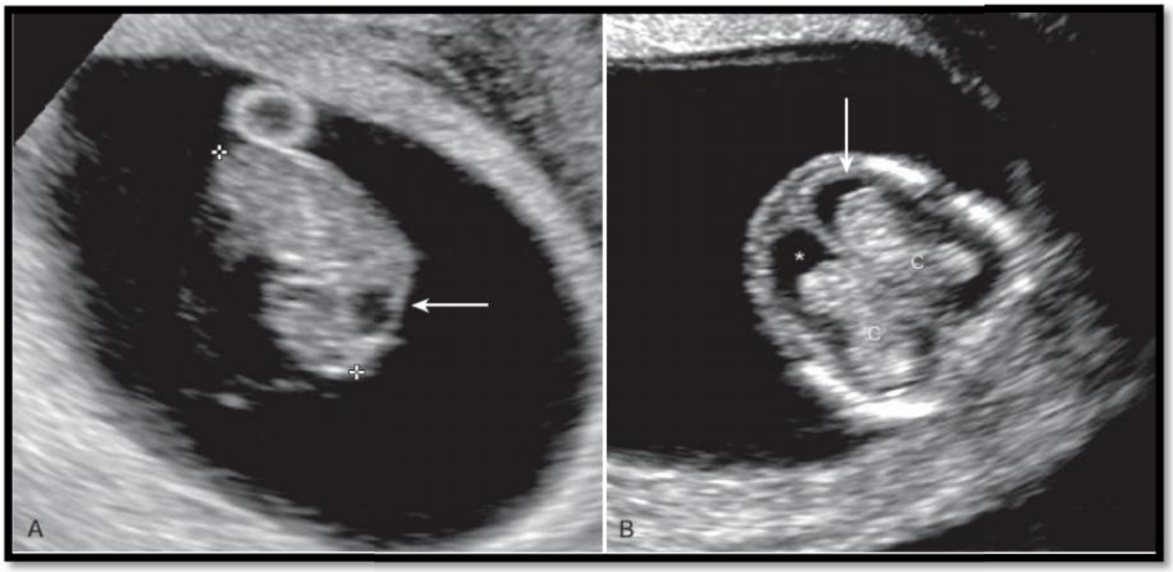

FIGURE 2-1 Early normal fetal head images obtained with transvaginal probe. A, At 9 menstrual weeksthe head is clearly differentiated from the trunk and limb buds. The intracranial cystic structure is the fetal rhombencephalic cavity (arrow), a normal space that eventually becomes the fourth ventricle. B, Scan at weeks.Note that the cerebral cortex is very thin (at tip of arrow).The choroid plexuses (C)are very large and fill the ventricles (*) from side to side. Ossification is already visible in the skull bones (Richardl Drake ,2007).

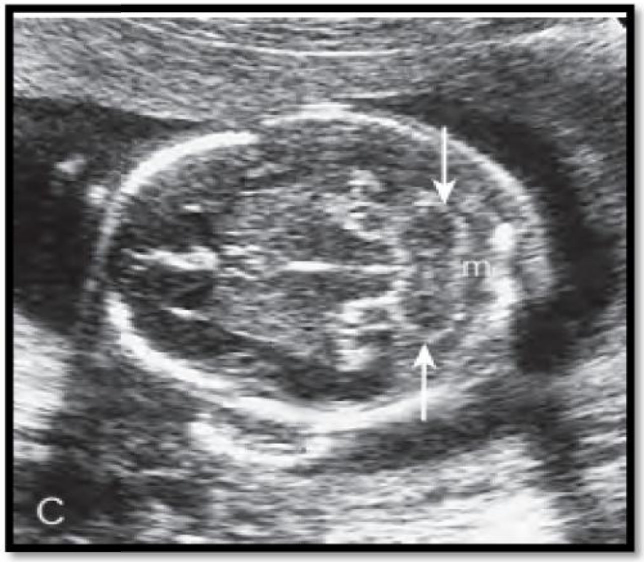

FIGURE 2-2 Cerebellar view at 18 menstrual weeks is obtained by rotating the transducer from the thalamic view so that the cerebellar hemispheres (arrows)in the posterior fossa come into view, connected in the midline by the slightly more echogenic vermis. The cisterna magna (m)is visible between the cerebellum and the occipital bone. Also visible in this view are the thalamus, third ventricle, anterior horns, and cavum septi pellucid (Richardl Drake ,2007).

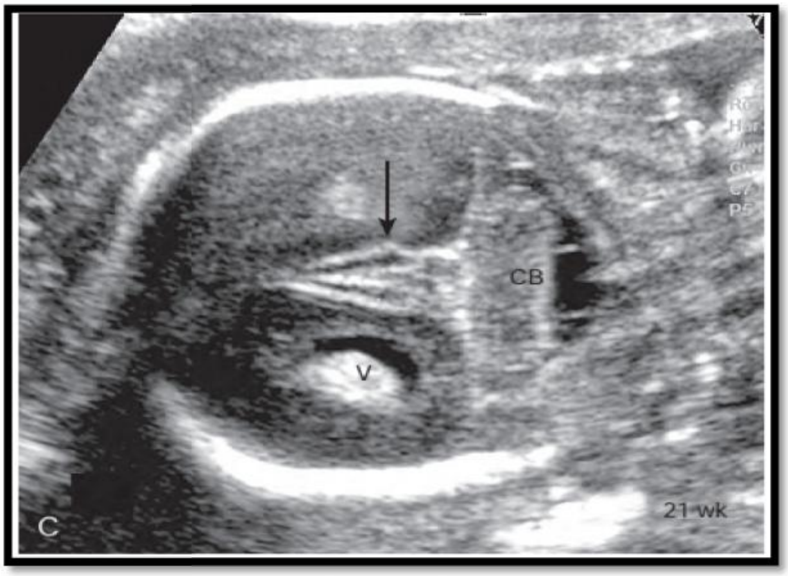

FIGURE 2-3 Coronal view through the occipital lobes at 21 weeksshows the calcarine sulcus (arrow)of the upper occipital lobe; the lower calcarine sulcus has not developed as far yet. This slight side-to-side variation is normal. CB,Cerebellum (Richardl Drake,2007).

2-4 Ultrasound Physics:

All diagnostic ultrasound applications are based on the detection and display of acoustic energy reflected from interfaces within the body. These interactions provide the information needed to generate high-resolution, gray-scale images of the body, as well as display information related to blood flow (Peter H. Kevin M. Abigail T, 2010).

2-4-1 Wavelength and Frequency:

Sound is the result of mechanical energy traveling through matter as a wave producing alternating compression and rarefaction. Pressure waves are propagated by limited physical displacement of the material through which the sound is being transmitted. A plot of these changes in pressure is a sinusoidal waveform, in which the Y axis indicates the pressure at a given point and the X axis indicates time. Changes in pressure with time defied the basic units of measurement for sound. The distance between corresponding points on the time pressure curve is defined as the wavelength (λ), and the time (T) to complete a single cycle is called the period. The number of complete cycles in a unit of time is the frequency (f) of the sound. Frequency and period are inversely related. If the period (T) is expressed in seconds, f = 1/T, or f = T × sec–1. The unit of acoustic frequency is the hertz (Hz); 1 Hz = 1 cycle per second. High frequencies are expressed in kilohertz (kHz; 1 kHz = 1000 Hz) or megahertz (MHz; 1 MHz = 1,000,000 Hz). In nature, acoustic frequencies span a range from less than 1 Hz to more than 100,000 Hz (100 kHz) (Peter, 2010).

Human hearing is limited to the lower part of this range, extending from 20 to 20,000 Hz. Ultrasound differs from audible sound only in its frequency, and it is 500 to 1000 times higher than the sound we normally hear. Sound frequencies used for diagnostic applications typically range from 2 to 15 MHz, although frequencies as high as 50 to 60 MHz are under investigation for certain specialized imaging applications. In general, the frequencies used for ultrasound imaging are higher than those used for Doppler (Peter, 2010).

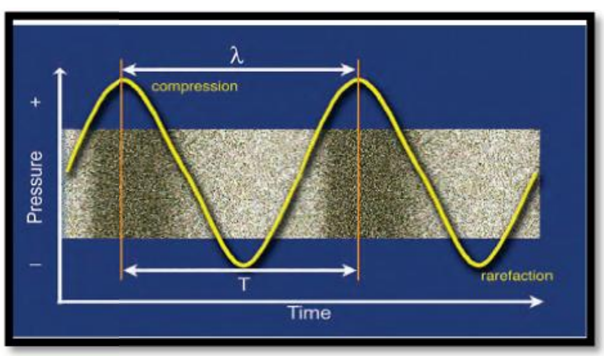

Figure 2-4 Shows sound wave(Peter, 2010)

2-4-2 Propagation of Sound:

In most clinical applications of ultrasound, brief bursts or pulses of energy are transmitted into the body and propagated through tissue. Acoustic pressure waves can travel in a direction perpendicular to the direction of the particles being displaced (transverse waves), but in tissue and fluids, sound propagation is along the direction of particle movement (longitudinal waves). The speed at which the pressure wave moves through tissue varies greatly and is affected by the physical properties of the tissue. Propagation velocity is largely determined by the resistance of the medium to compression, which in turn is influenced by the density of the medium and its stiffness or elasticity. Propagation velocity is increased by increasing stiffness and reduced by decreasing density. In the body, propagation velocity may be regarded as constant for a given tissue and is not affected by the frequency or wavelength of the sound (Peter, 2010).

2-4-3 Distance Measurement:

Propagation velocity is a particularly important value in clinical ultrasound and is critical in determining the distance of a reflecting interface from the transducer. Much of the information used to generate an ultrasound scan is based on the precise measurement of time and employs the principles of echo-ranging. If an ultrasound pulse is transmitted into the body and the time until an echo returns is measured, it is simple to calculate the depth of the interface that generated the echo, provided the propagation velocity of sound for the tissue is known (Peter, 2010).

2-4-4 Acoustic impedance (Z):

Is determined by product of the density (ρ) of the medium propagating the sound and the propagation velocity (c) of sound in that medium ($Z = \rho c$). Interfaces with large acoustic impedance differences, such as interfaces of tissue with air or bone, reflect almost all the incident energy. Interfaces composed of substances with smaller differences in acoustic impedance, such as a muscle and fat interface, reflect only part of the incident energy (Peter, 2010).

2-4-6 Reflection:

The way ultrasound is reflected when it strikes an acoustic interface is determined by the size and surface features of the interface. If large and relatively smooth, the interface reflects sound much as a mirror reflects light. Such interfaces are called specular reflectors because they behave as "mirrors for sound." The amount of energy reflected by an acoustic interface can be expressed as a fraction of the incident energy; this is termed the reflection coefficient (R). If a specular reflector is perpendicular to the incident sound beam, the amount of energy reflected is determined by the following relationship: $R = (Z2-Z1)2 / (Z2 + Z1)2$ where Z1 and Z2 are the acoustic impedances of the media forming the interface. Because ultrasound scanners only detect reflections that return to the transducer, display of specular interfaces is highly dependent on the angle of insonation (exposure to ultrasound waves). Specular reflectors will return echoes to the transducer only if the sound beam is perpendicular to the interface(Peter, 2010).

If the interface is not at a 90-degree angle to the sound beam, it will be reflected away from the transducer, and the echo will not be detected. Most echoes in the body do not arise from specular reflectors but rather from much smaller interfaces within solid organs. In this case the acoustic interfaces involve structures with individual dimensions much smaller than the wavelength of the incident sound. The echoes from these interfaces are scattered in all directions. Such reflectors are called diffuse reflectors and account for the echoes that form the characteristic echo patterns seen in solid organs and tissues. The constructive and destructive interference of sound scattered by diffuse reflectors results in the production of ultrasound speckle, a feature of tissue texture of sonograms of solid organs. For some diagnostic applications, the nature of the reflecting structures creates important conflicts. For example, most vessel walls behave as specular reflectors that require insonation at a 90-degree angle for best imaging, whereas Doppler imaging requires an angle of less than 90 degrees between the sound beam and the vessel (Peter, 2010).

2-4-7 Refraction:

Another event that can occur when sound passes from a tissue with one acoustic propagation velocity to a tissue with a higher or lower sound velocity is a change in the direction of the sound wave. This change in direction of propagation is called refraction and is governed by Snell's law:

$\text{Sin}1/\ \text{Sin}\ 2 = C_1/C_2$ Where 1 is the angle of incidence of the sound approaching the interface, 2 is the angle of refraction, and c_1 and c_2 are the propagation velocities of sound in the media forming the interface (Peter, 2010).

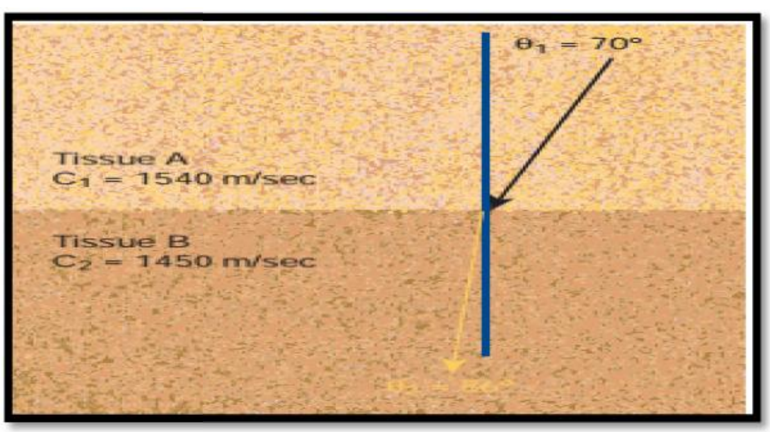

Figure 2-5 Shows Refraction (Peter, 2010).

2-5 Ultrasound Protocol in measure transverse cerebellar diameter :

Preparation: Preparation of the patient. The bladder must be full. Give 4 or 5 glasses of fluid and examine after one hour (do not allow the patient to micturate). Alternatively. fill the bladder through a urethral catheter with sterile normal saline: stop when the patient feels uncomfortable. Avoid catheterization if possible because of the risk of infection. Position of the patient:The patient is usually scanned while lying comfortably on her back (supine). It may be necessary to rotate the patient after the preliminary scans. Apply coupling agent liberally to the lower abdomen: it is not usually necessary to cover the pubic hair but, if required, apply freely. Choice of transducer: Use a 3.5 MHz transducer. Use a 5 MHz transducer for 3.5 MHz 5 MHz thin women. Setting the correct gain: Position the transducer longitudinally over the full bladder and adjust the gain to produce the best image (Palmer,1995) .

2-6 previous studies:

Transverse cerebellar diammeter. A marker for estimation of gestational age. This study was carried out on 50 antenatal patients between 14-40 weeks of pregnancy. Mean TCD was 17.32 mm in 14-20 wk. 26.63 mm in 21-30 wk. 40.73 mm in 31-40 wk. This study show significant relationship between TCD are GA. (Prabat Goel etc, 2010, India)

Gestational age estimation using transcerebellar diameter with grading of fetal cerebella growth. This study was carried out 292 pregnant woman 14-40 week, of pregnancy. The median GA and TCD were 20 weeks and 22 mm for grade 1, 32 weeks and 30 mm for grade 2, and 36 weeks and 38 mm for grade 3. Regression analysis indicated strange. Relationship between TCD and gestational age. (Anirban Das Gupta, 2012).

Estimational Gestational age by cerebellum Diameter by using ultrasound in Sudanese pregnant women. This study carried out 50 pregnancy study showed significant correlation between GA- LMP & GA – BPD, GA-FL, GA-CD which were 0.937, 0.925, 80.858 respectively, the result of study showed that the mean value of CD was 3.20 ± 0.88 cm where BpD was 6.85 ± 1.60 cm, also fL was 2.26 ± 1.56 cm. The average GA using CD was a 26.47 ± 5.46 weeks versus 26.37 ± 6.33 weeks, using Lmp, there is no significant difference between the LMP calculation of GA and GA estimated using CD. The result also showed that GA increases by 6.2 weeks/cm of CD. It conclude that CD can be used to estimate the GA with an accuracy more than 74% i.e. the CD can explain more that 74% of the changes occur in the GA. (Mona Gadeen Ali Gadeen, Sudan, 2015).

Material and Methods

3-1Material

3-1-1 Machine used:

Data of this study was collected by scanning the patient using ultrasound machine (simens, model :MCMD01AA) equipped with 2-6 MHZ curvilinear transducer using coupling gel with Sony printer with thermal paper.

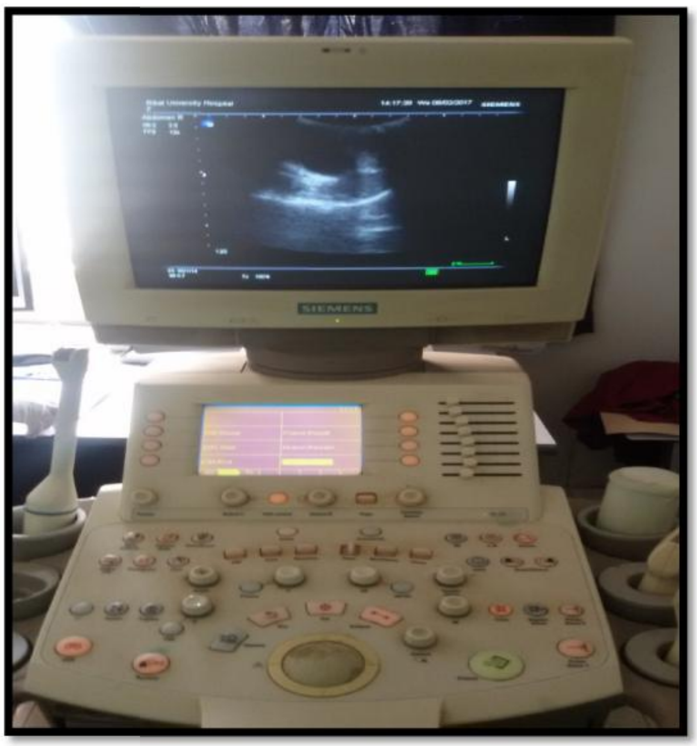

Figure (3-1) Shows equipped with machine(simens, model :MCMD01AA) equipped with 2-6 MHZ curvilinear transducer which used in this study.

3-1-2 Design of the study:

This study was across sectional descriptive study was collected from population were coming to hospital for follow up of pregnancy.

3-1-3 Population of the study:

The population of this study were women with normal pregnancy.

3-1-4 Sample size and type:

This study consisted of populations randomly 50 female.

3-1-5 Place and duration of the study:

This study was carried out in the period from November 2016 to march 2017 in Khartoum state at Ribat Teaching hospital.

3-1-6 Included and Excluded:

This study included any pregnancy female in second or third trimmers and excluded any pregnancy female in first or her fetal containing fetal anomaly.

3-2 Methods:

3-2-1 data collection:

Using a special data collection sheet , sample of 50 populations with normal pregnancy.

3-2-2 sonographic technique :

Preparation: Preparation of the patient. The bladder must be full. Give 4 or 5 glasses of fluid and examine after one hour (do not allow the patient to micturate). Alternatively. fill the bladder through a urethral catheter with sterile normal saline: stop when the patient feels uncomfortable. Avoid catheterization if possible because of the risk of infection. Position of the patient**:**The patient is usually scanned while lying comfortably on her back (supine). It may be necessary to rotate the patient after the preliminary scans. Apply coupling agent liberally to the lower abdomen: it is not usually necessary to cover the pubic hair but, if required, apply freely. Choice of transducer: Use a 2-6 MHz transducer. Use a 5 MHz transducer for 2-6 MHz 5 MHz thin women. Setting the correct gain: Position the transducer longitudinally over the full bladder and adjust the gain to produce the best image (Palmer,1995) .

Start with a longitudinal scan over the right upper abdomen and then follow with a transverse scan. Next, rotate the patient to the left lateral decubitus position, to visualize the right kidney in this coronal view Palmer 1995).

3-3 data analysis:

The data of this study was analyzed by using Microsoft excel and SPSS program.

3-4 Ethical consideration:

The ethical approval was granted from the hospital and the radiology department; which include commitment of no disclose of any information concerning the patient identification.

Result

Table (4.1) Descriptive statistic shows minimum, maximum ,mean and std deviation of age, parity, TCD , BPD, AC,FL,HC, and gestational age per weeks

	N	Minimum	Maximum	Mean	Std. Deviation
age	49	17	37	29.67	4.884
TCD	49	14.2	62.3	35.102	13.3676
BPD	49	34.1	97.3	70.435	19.0490
AC	49	80.0	404.4	228.382	81.5224
FL	49	19.1	88.8	52.949	18.2721
HC	49	99.5	349.2	251.348	73.2971
GA	49	16	39	27.96	7.379
Valid N (listwise)	49				

Table (4-2): this table show correlation between TCD with GA and BPD ,FL ,AC and HC.

		TCD	BPD	FL	AC	HC	GA
TCD	Pearson Correlation	1	.955**	.948**	.914**	.866**	.952**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	49	49	49	49	49	49
BPD	Pearson Correlation	.955**	1	.972**	.883**	.854**	.981**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	49	49	49	49	49	49
FL	Pearson Correlation	.948**	.972**	1	.858**	.816**	.980**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	49	49	49	49	49	49
AC	Pearson Correlation	.914**	.883**	.858**	1	.929**	.867**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	49	49	49	49	49	49
HC	Pearson Correlation	.866**	.854**	.816**	.929**	1	.807**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	49	49	49	49	49	49
GA	Pearson Correlation	.952**	.981**	.980**	.867**	.807**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	49	49	49	49	49	49
**. Correlation is significant at the 0.01 level (2-tailed).							

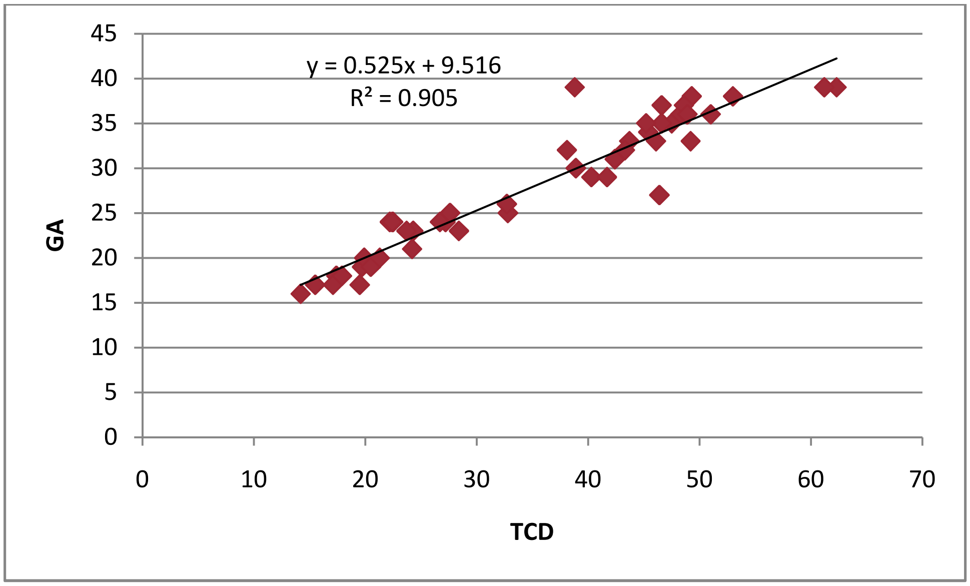

Figure (4.1) scatter plot shows relationship between GA per week and TCD by mm

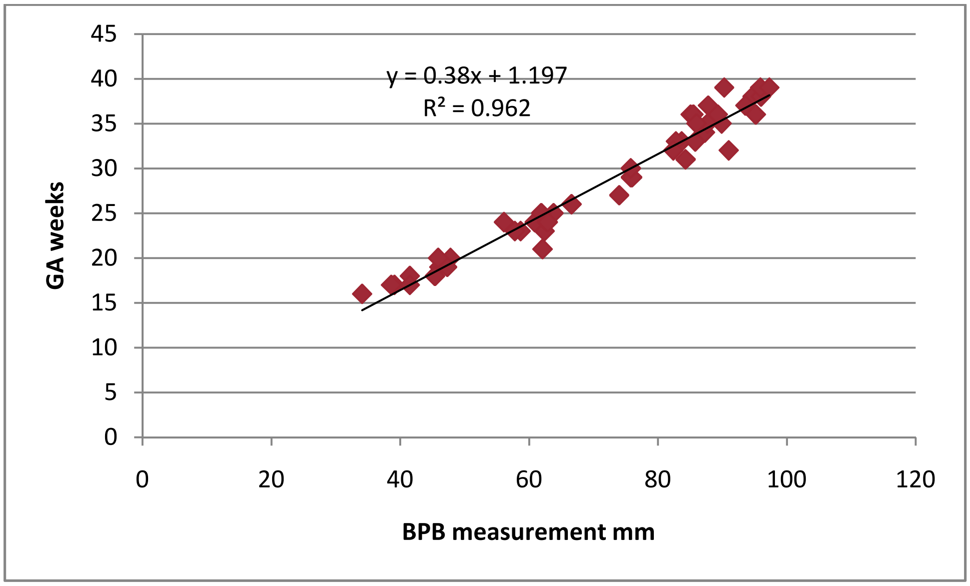

Figure (4.2) scatter plot shows relationship between GA per week and BPD mm

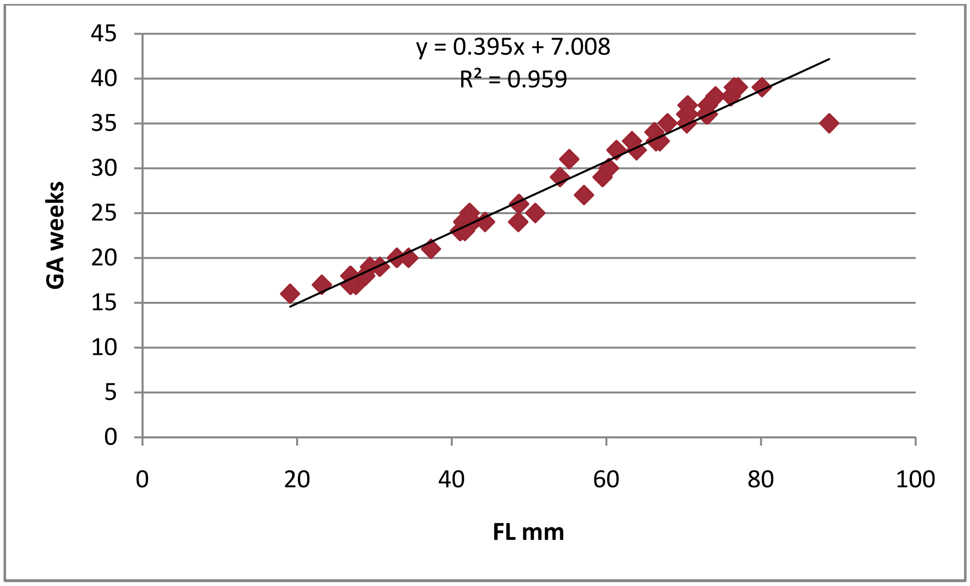

Figure (4.3) scatter plot shows relationship between GA per week and FL mm

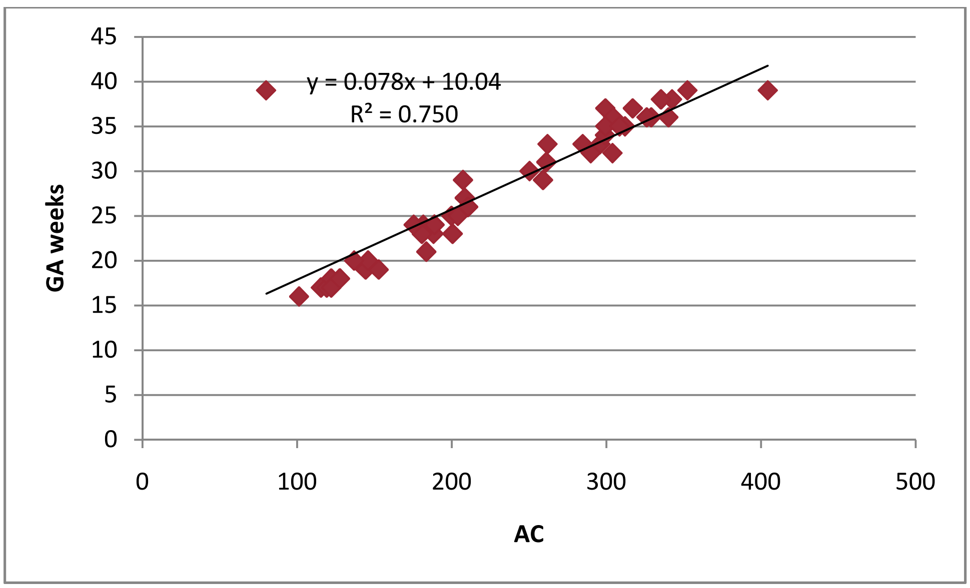

Figure (4.4) scatter plot shows relationship between GA per week and AC mm

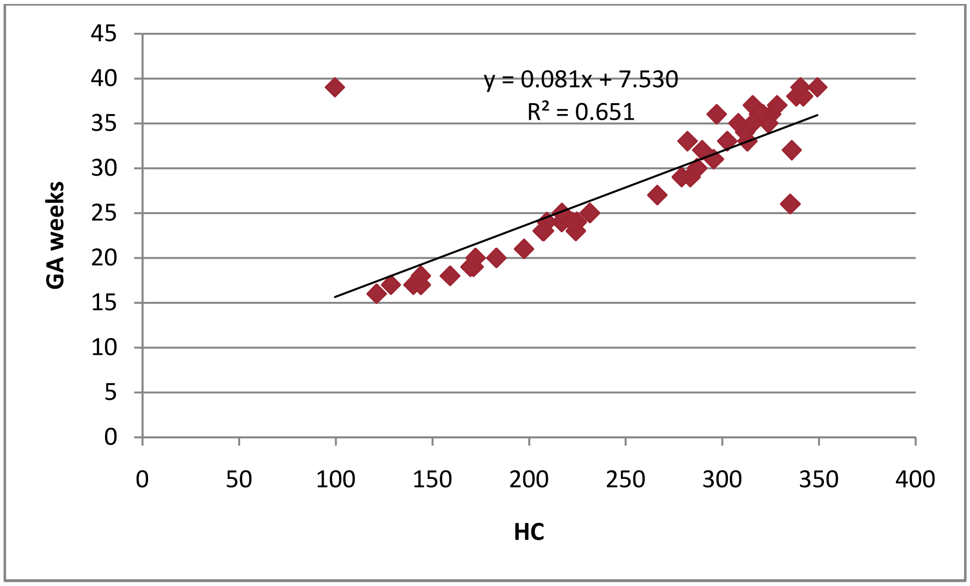

Figure (4.5) scatter plot shows relationship between GA per week and HC mm

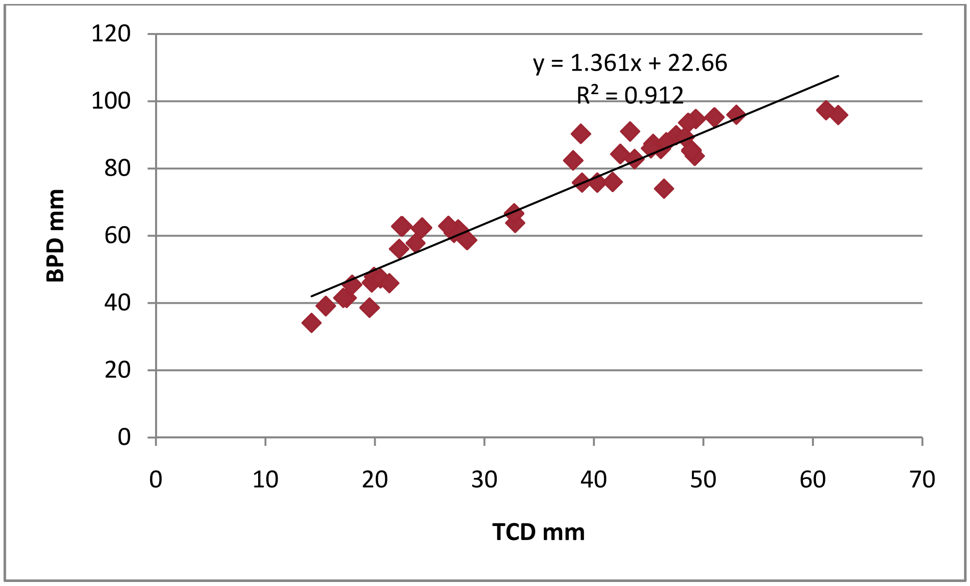

Figure (4.6) scatter plot shows relationship between BPD per mm and TCD per mm

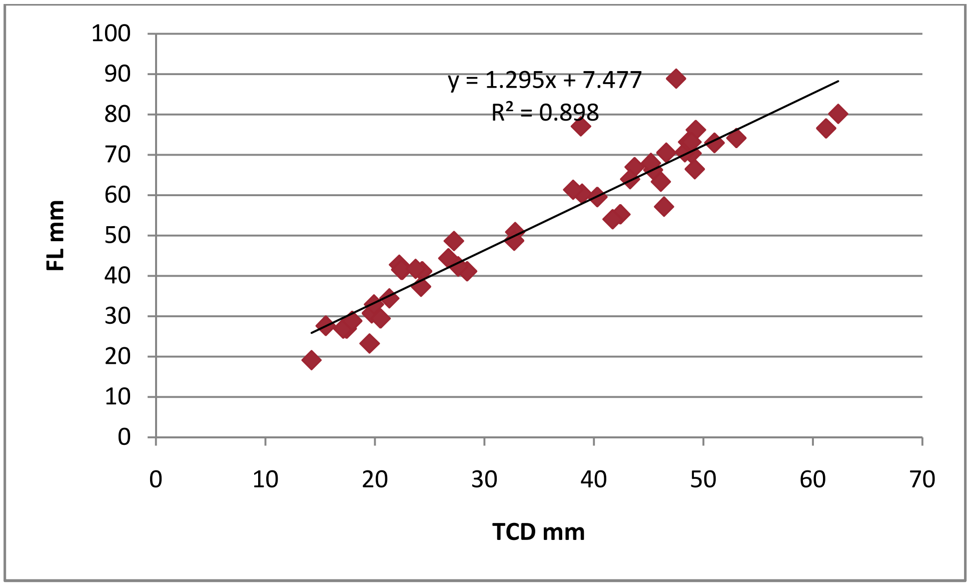

Figure (4.7) scatter plot shows relationship between FL per mm and TCD per mm

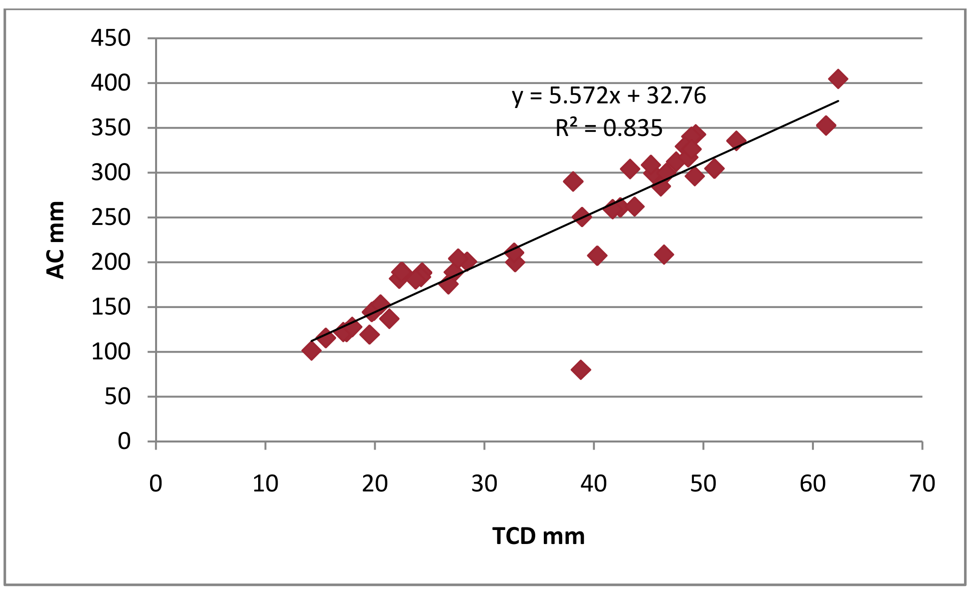

Figure (4.8) scatter plot shows relationship between AC per mm and TCD per mm

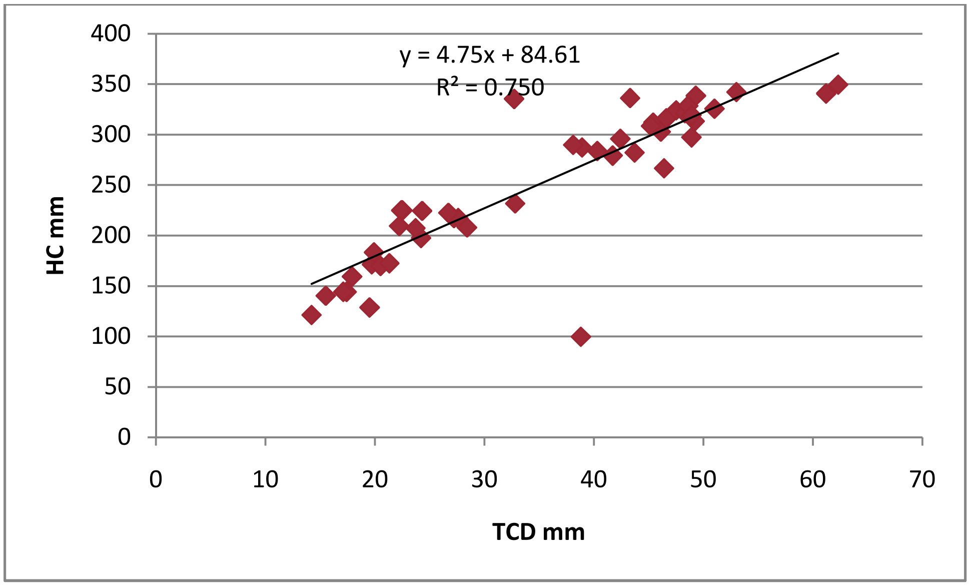

Figure (4.9) scatter plot shows relationship between HC per mm and TCD per mm

Discussion, Conclusion and Recommendations

5-1 Discussion :

The main objective of this study was to estimate the gestational age using the cerebellum diameter in the second and third trimester using the known BPD and FL as a reference in estimating the accurate GA.

Regarding Table (4-1) The age of maternal included in this study range from 17- 37 years old with the main age 29.67 years.

The main value of the TCD 35.102mm +/- 13.36mm ,BPD70.435mm +/- 18.2 19.04mm,FL52.949 mm+/- 18.2mm, HC 251.348+/-73.2971mm and AC 228.382mm+/- 81.5224mm.

Concerning Table (4-2) this study showed that there is significant strong positive correlation between TCD with BPD,FL,AC,HC 0.955, 0.948,0.914,0.866 respectively at PV= 0.000, this study agree with mona gadeen(2015).

Also this study showed significant positive correlation between GA with TCD BPD,FL,AC,HC 0.952,0.981,0.980,0.867,0.807 respectively at PV 0.000 ,this study agree with prapat goel (2010).

This result indicates that gestational age can be estimated using TCD with correlation almost similar to the classic parameter.

Figure (4-2), (4-3), (4-4) ,(4-5) ,(4-6) the study showed that there is a direct linear association between the gestational age with TCD, BPD, FL, AC , HC , in this correlation gestational age increased by 0.5254 week /mm, 0.38 week/ mm, 0.3957 week/mm, 0.0784 week/ mm , 0.0813 week/mm respectively.

Figure (4-7), (4-8), (4-9) ,(4-10) the study showed that there is a direct linear association between the TCD with BPD,FL, AC, HC, in this correlation TCD increased by 1.361mm/mm, 1.2954 mm/mm, 5.5728 mm/mm , 4.75 mm/mm respectively.

Measurement can be used for significant important in the accuracy of gestational age estimation in growth restricted fetuses.

5-2 Conclusion

The study concluded that range of maternal age 17 -37 years . The mean value of the TCD was 35.102+/- 367mm , BPD70.435mm +/-18.2mm ,FL52.949 mm+/- 18.2mm, HC 251.348+/-73.2971mm and AC 228.382mm+/- 81.5224mm.

the study showed that there is a direct linear association between the gestational age with TCD, BPD, FL, AC , HC , in this correlation gestational age increased by 0.5254 week /mm, 0.38 week/ mm, 0.3957 week/mm, 0.0784 week/ mm , 0.0813 week/mm respectively.

this study showed that there is significant strong positive correlation between TCD with BPD,FL,AC,HC 0.955, 0.948,0.914,0.866 respectively at PV= 0.000. Also this study showed significant positive correlation between GA with TCD BPD ,FL ,AC, HC 0.952, 0.981 ,0.980 ,0.867 ,0.807 respectively at PV 0.000.

5-3 Recommendations

Pregnant women who in second or third trimester should be measured gestational age using Trans Cerebellum diameter as another parameter.

The author recommends that the Government should introduce the modern ultrasound machines and increase the training institutes of ultrasound and computer programs for increasing the sonologists skills and experience.

The author recommended that the government should be increasing the specialist hospitals for obstetrics and gynecology.

According to the high cost of scientific research which the researcher was faced, the government should appeal universities in Sudan and companies to support the researchers in order to improve plans of treating and management of such diseases.

Further studies should be carried out in this field on many aspects such as increasing the number of patients, to show the correlation between gestational age and Trans Cerebellum diameter..

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Appendix A

Image 1: ultrasound image for 35 years ,show GA 37 week TCD measure 48.9 mm

Image 2: ultrasound image for 20 years, show GA 24 week week TCD measure 22.4 mm

Image 3: ultrasound image for 23 years, show GA 30week week TCD measure 41.7 mm

image4: ultrasound ima ge for 28 years, show GA 23 week week TCD measure 23.3 mm

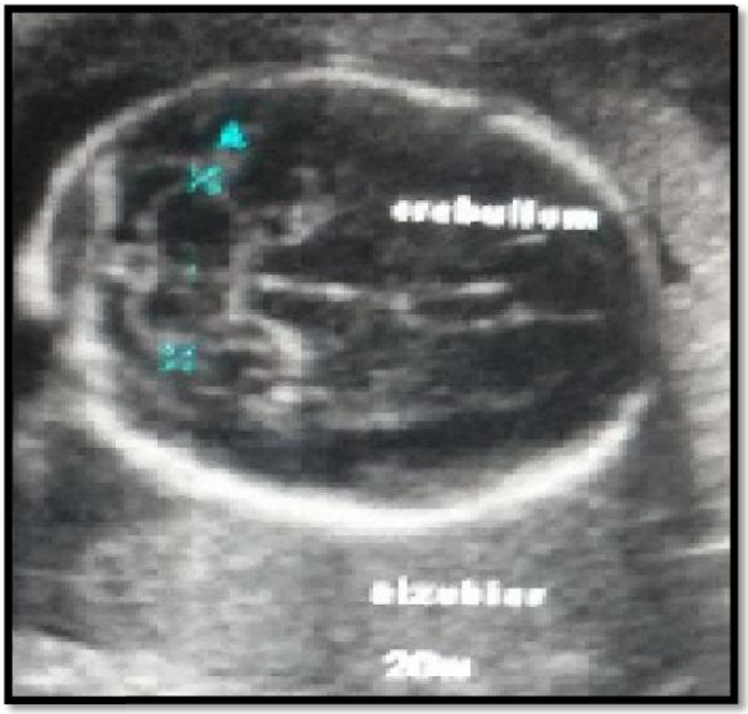

Image 5: ultrasound image for 33 years, show GA 33 week week TCD measure 46.1 mm

Image 6: ultrasound image for 18 years, show GA 24 week week TCD measure 22 mm

Appendix B

Sudan University for Sciences and technology

College of Graduate studies

Estimation of Gestation age by Transverse Cerebellum Diameter Using Ultrasonography

Data collection sheet

1. Maternal age : ……………….

2. Ethnic group : …………………

3. Occupation : Student ☐ housewife ☐ work ☐

4. Date ☐

5. Socioeconomic status : low ☐ Medium ☐ High ☐

6. Bleeding during the pregnancy : Yes ☐ No ☐

7. chronic illness : Yes ☐ No ☐

8. Caesarian section : Yes ☐ No ☐

9- GA ( ) TCD ( ) BPD ( ) FL ( ) HC ( ) AC ( ) .