Sudan University of Science and Technology
College of Graduate studies

Estimation of Gestational Age in Pregnant Women Using Trans Cerebellar Diameter by Ultrasonography

تقيم عمر الجنين باستخدام ابعاد المخيخ عند النساء الحوامل باستخدام الموجات فوق الصوتية

A Thesis Submitted for Partial Fulfillment of the M.SC Degree in Ultrasound Image

By:

NimaYousif Mohamed Idris

Supervisor

Dr. Asma Ibrahim Ahmed Elamin

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DEDICATION

To my father and mother

To my brothers

ACKNOWLEDGEMENT

My deepest appreciation and sincerest gratitude To my god for giving me a health to complete this thesis and still giving me more and more.

To our staff of M.sc degree for their efforts all through the duration of study.

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List of abbreviations

GA	Gestational age
CD	Cerebellar diameter
BPD	Biparietal diameter
HC	Head circumference
AC	Abdominal circumference
FL	Femur length
LMP	last menstrual period
NTD,s	Neural tube defects
TAS	Trans abdominal scan
EVS	Endo vaginal scan
CRL	Crown rump length
ABS	Amniotic pand syndrome
LBWC	limb body wall complex
CPC	Choroid plexus cyst
CSF	Cerebro spinal fluid
TCD	Transvers cerebellar diameter
OFD	Occipitofrontal diameter

Abstract

This adescreptivecrossectional study which was aimed to know the gestational age using cerebellar diameter in Khartoum state . The study was done in alshiakhalifadul delivery hospital and tayba hospital, , at duration from September -to December, 2016. About 50 patients were randomly dy selected, aged from 18 years and above. Trans- abdominal ultrasound scanning by 3.5 MHz probes was performed.

The results of this thesis states that the cerebelar diameters mean values were (3.19) cm.

The study also concludes that, there statistically, significantly (Sig. = 0.000) strong positive relation (0.86) between (gestational age using last menstrual period) and cerebellar diameter, and hence the gestational age is 6.169±0.533 week increases per a cm in cerebellar diameter, showing 0.74% variation in the gestational age, can be explained by the cerebellar diameter. While there is statistically, significantly (Sig. = 0.000) strong positive relation (0.92) between (gestational age using biperietal diameter) and cerebellar diameter, and hence the gestational age is 6.605±0.399 week increases per a cm in cerebellar diameter, showing 0.85% variation in the gestational age, can be explained by the cerebellar diameter.

المستخلص

اجريت هذه الدراسة الوصفيه من اجل تقيم عمر الجنين بإستخدام ابعاد المخيخ للنساء الحوامل في السودان .اقيمت هذه الدراسة بمستشفى الشيخ علي فضل للولاده ومستشفى طيبة التخصصي في امدرمان .في الفتره من سيبتمر الي ديسمبر 2016م.تم اخذ عدد 50 حاله من عمر 17 سنه فما فوق بعد التاكد من عدم معناتهم من أي امراض مزمنه .وتم فحصهم بالموجات فوق الصوتيه على البطن

وجدت الدراسه ان متوسط ابعاد المخيخ 3.19سم واثبتت الدراسه كذلك ان ابعاد المخيخ تزيد بزياده عمر الجنين بحساب اخر دوره شهريه بمعدل 6.169+-0.533اسبوع لكل سم .وكذلك خلصت الى ان ابعاد المخيخ تزيد بزياده عمر الجنين بحستب ابعاد رأس الجنين بمعدل 6.605+-0.399اسبوع لكل سم

Chapter One
Introduction

Chapter One

1.1 Introduction

Diagnostic ultrasound had been used in obstetric nearly 30 years. Althoughgenerallyconsider safe. There is continuing study and research to confirm this. It's a very important technique for examiningpregnant 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 transverse cerebellar diameter (TCD) 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 TCD and GA, Furthermore, it has been shown that there is a close relationship between TCD and GA (correlation coefficient (r) = 0.94 and $p < 0.001$), with TCD 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 TCD 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 TCD ahs been used as one of the parameters in estimating fetal gestational age in second trimester ; it has been shown that the TCD 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 TCD measurement and thus estimating the fetal age.

1.2 Problem of the study:

In addition to traditional biometry including biperietaldiameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL), the accuracy of GA estimation of GA using this parameter in late trimester all the time was low, however the accuracy of some of these parameters is affected by growth abnormalities.

1.3.general Objective

Estinmation of gestational age in pregnant women using transverse cerebellar diameter by ultrasound .

1.3.1Specific objective to:

- Measuretransverse cerebellar diameter(TCD) in second and third trimester.

Correlate between transversecerebellar diameter (TCD) and gestational age (G.A) using last menstrual period (LMP).

- Estimate gestational age (G.A) by transverse cerebellar diameter(TCD).
- Estimategestational age (G.A) by transverse cerebellar diameter(TCD) andbiperietal diameter (BPD).
- Find significant deference between (GA) using transverse cerebellum diameter(TCD) and last menstrual period (LMP),

transverse cerebellum diameter (TCD) and biperietal diameter (BPD.

- Find the relation between transverse cerebellum diameter (TCD) and biperietal diameter (BPD).

1.4 Significant of study

This study will highlight the application of cerebellum diameter as one of the crucial factor in gestational age estimation for Sudanese pregnant lady. And hence it will provide a Sudanese index that can be incorporated in an indigenous equation, which will fit their ethnic diversity.

1.5 Overview of study

This study is consist of five chapters. Chapter one is an introduction, which include problem of the study, statement of the objective and Significant of the study

Chapter two include comprehensive scholarly literature review and anatomical background concerning the previous studies.

Chapter three deals with the material and methods.

Chapter fourinclude result, and finally Chapter five include discussion of the results, conclusion and recommendation followed by references and appendices.

Chapter Tow
Literature Review

Chapter tow

Literature review

2.1 anatomy of the Cerebellar

The cerebellum develops from the alar plates of the metencephalonn. Thedorsolateral part of the alar plates bends medially to form the right and left “rhombic lips” which will form the cerebellum.

The rhombiclip shave two parts, an intra-ventricular part which projects partly into the lumen of 4thventricle and an extra-ventricular part which projects above the attachment of the roof plate

Immediately below the mesencephalon the two rhombic lops approach each other in the midline, become compressed and form a “cerebellar plate”.

When the embryo is 12 week old, the cerebellum plate differentiates into a small median part called the “vermis” and two lateral expansions called the “cerebellar hemisphere”. A deep fissure soon arises and separates a part of the cerebellar called the flocculo-nodular lobe from the remaining part of the cerebellar, (Rumack 2011)

Flocculo-nodular lobe is the most primitive part of the cerebellar and is connected with the vestibular system.As development proceeds, many other fissures appear give the cerebellum it’s adult appearance (El-Rakhawy 2000)

2.1.1 Cerebellum:

The cerebellum lies within the posterior cranial fossa beneath the tentorium cerebelli. It is situated posterior to the pons and the medulla oblongata. It consists of two hemispheres connected by a median portion, the vermis. The cerebellum is connected to the midbrain by the superior cerebellar peduncles, to the pons by the middle cerebellar peduncles, and to the medulla by the inferior cerebellar peduncle. (Snell 2007)

The surface layer of each cerebellar hemisphere, called the cortex, is composed of gray matter. The cerebellar cortex is thrown into folds, or folia, separated by closely set transverse fissures. Certain masses of gray matter are found in the interior of the cerebellum, embedded in the white matter; the largest of these is known as the dentate nucleus, (Rumack 2011)

The cerebellum plays an important role in the control of muscle tone and the coordination of muscle movement on the same side of the body, (Rumack 2011)

2.1.2 Fetal head Shapes:

The shape and echogenicity of the fetal skull or calvarium may be abnormal and provide clues for the diagnosis of central nervous system and skeletal anomalies, and syndromes. The normal skull produces a high amplitude echo which is very echogenic compared to the brain. Diminished echogenicity of the fetal skull is most commonly seen with osteogenesis imperfecta and hypophosphatasia respectively (Nahum 2000).

Abnormal skull mineralization should be suspected if the falxcerebri appears to be as or more echogenic than the skull. Poor or absent calvarial ossification is also associated with “superb” imaging of brain anatomy due to lower sound attenuation and fewer bone-related artifacts which normally hamper good visualization of the brain nearest the transducer. The sonographer should be alerted to a mineralization abnormality if the brain is seen with unusual clarity. Other findings associated with poor mineralization of the skull include increased compressibility of the fetal head and increased acoustic transmission. Normal skull sutures can be seen as short breaks in the skull echo. The coronal suture is routinely seen in the BPD image between the temporal

and frontal bones. The general shape of the normal fetal head in the axial plane in the 2nd/3rd trimester should appear smooth and oval (BPD/HC image). In the 1st trimester (10-14 weeks LMP), the head appears more spherical than oval since brain development and growth has not yet influenced the shape of the head.

2-2 Physiology

The strongest clues to the function of the cerebellum have come from examining the consequences of damage to it. Animals and humans with cerebellar dysfunction show, above all, problems with motor control, on the same side of the body as the damaged part of the cerebellum. They continue to be able to generate motor activity, but it loses precision, producing erratic, uncoordinated, or incorrectly timed movements. A standard test of cerebellar function is to reach with the tip of the finger for a target at arm's length: A healthy person will move the fingertip in a rapid straight trajectory, whereas a person with cerebellar damage will reach slowly and erratically, with many mid-course corrections. Deficits in non-motor functions are more difficult to detect. Thus, the general conclusion reached decades ago is that the basic function of the cerebellum is to calibrate the detailed form of a movement, not to initiate movements or to decide which movements to execute *Rapp B (2001).*

Prior to the 1990s the function of the cerebellum was almost universally believed to be purely motor-related, but newer findings have brought that view into question. Functional imaging studies have shown cerebellar activation in relation to language, attention, and mental imagery; correlation studies have shown interactions between the cerebellum and non-motor areas of the cerebral cortex; and a variety of non-motor symptoms have been recognized in people with damage that appears to be confined to the cerebellum. In particular, the cerebellar cognitive

affective syndrome has been described in adults and children. Estimates based on functional mapping of the cerebellum using functional MRI suggest that more than half of the cerebellar cortex is interconnected with association zones of the cerebral cortex*Ghez C, Fahn S (1985)*..

that the function of the cerebellum is best understood not in terms of what behaviors it is involved in, but rather in terms of what neural computations it performs; the cerebellum consists of a large number of more or less independent modules, all with the same geometrically regular internal structure, and therefore all, it is presumed, performing the same computation. If the input and output connections of a module are with motor areas (as many are), then the module will be involved in motor behavior; but, if the connections are with areas involved in non-motor cognition, the module will show other types of behavioral correlates. Thus the cerebellum has been implicated in the regulation of many differing functional traits such as affection, emotion and behavior. The cerebellum, Doya proposes, is best understood as predictive action selection based on "internal models" of the environment or a device for supervised learning, in contrast to the basal ganglia, which perform reinforcement learning, and the cerebral cortex, which performs unsupervised learning *Levisohn L, Cronin-Golomb A, Schmahmann JD (May 2000)*..

2-3 Ultrasound physics

Sound is a mechanical wave that travels in a straight line Requires a medium through which to travel

Rarefactions Compressions

Sound has Energy: or work, in Joules (1 J = 1 kgm2/s2 ,Power is rate of energy, in Watts (1 W = 1 J/s) and intensity: is pressure, force per unit area, in Pascals (1 P = 1 N/m2)

• Sound intensity/energy/power changes over many orders of magnitude.

• We use logarithmic measures, called decibels (dB). A dB is a dimensionless measure. It is a ratio.

2-3-1Ultrasound Image Formation:

Ultrasound scanhead produces “pulses” of ultrasound wavesThese waves travel within the body and interact with various organsThe reflected waves return to the scanhead and are processed by the ultrasound machineAn image which represents these reflections is formed on the monitor ,scanhead composed of Matching Layerhas acoustic impedance between that of tissue and the piezoelectric elementsreduces the reflection of ultrasound at the scanhead surface, Piezoelectric Elementsproduce a voltage when deformed by an applied pressurequartz, ceramics, man-made material ,Damping Materialreduces “ringing” of the elementhelps to produce very short pulses.

2-4 ultrasound technology of fetus:

is the use of ultrasound scans in pregnancy. Since its introduction in the late 1950’s ultrasonography has become a very useful diagnostic tool in Obstetrics.

Currently used equipments are known as real-time scanners, with which a continous picture of the moving fetus can be depicted on a monitor screen. Very high frequency sound waves of between 3.5 to 7.0 megahertz (i.e. 3.5 to 7 million cycles per second) are generally used for this purpose.

They are emitted from a transducer which is placed in contact with the maternal abdomen, and is moved to "look at" (likened to a light shined from a torch) any particular content of the uterus. Repetitive arrays of ultrasound beams scan the fetus in thin slices and are reflected back onto the same transducer.

The information obtained from different reflections are recomposed back into a picture on the monitor screen (a sonogram, or ultrasonogram). Movements such as fetal heart beat and malformations in the feus can be assessed and measurements can be made accurately on the images displayed on the screen. Such measurements form the cornerstone in the assessment of gestational age, size and growth in the fetus.

A full bladder is often required for the procedure when abdominal scanning is done in early pregnency. There may be some discomfort from pressure on the full bladder. The conducting gel is non-staining but may feel slightly cold and wet. There is no sensation at all from the ultrasound waves.

2-5 Fetal biometry:

The Crown-rump length (CRL)

This measurement can be made between 7 to 13 weeks and gives very accurate estimation of the gestational age. Dating with the CRL can be within 3-4 days of the last menstrual period. (Table) An important point to note is that when the due date has been set by an accurately measured CRL, it should not be changed by a subsequent scan. For example, if another scan done 6 or 8 weeks later says that one should have a new due date which is further away, one should not normally change the date but should rather interpret the finding as that the baby is not growing at the expected rate.

b) **The Biparietal diameter** (BPD)

The diameter between the 2 sides of the head. This is measured after 13 weeks. It increases from about 2.4 cm at 13 weeks to about 9.5 cm at term. Different babies of the same weight can have different head size, therefore dating in the later part of pregnancy is generally considered unreliable. Dating using the BPD should be done as early as is feasible.

c) **The Femur length** (FL)

Measures the longest bone in the body and reflects the longitudinal growth of the fetus. Its usefulness is similar to the BPD. It increases from about 1.5 cm at 14 weeks to about 7.8 cm at term. Similar to the BPD, dating using the FL should be done as early as is feasible.

d) **The Abdominal circumference** (AC)

The single most important measurement to make in late pregnancy. It reflects more of fetal size and weight rather than age. Serial measurements are useful in monitoring growth of the fetus.

AC measurements should not be used for dating a fetus (www.webmd.com/baby/fetal-ultrasound*)*.

2.6. Previous study:

Mona, 2016, studied the 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 aim of the study was to estimate fetal age by measuring cerebellar diameter (CD) in second and third trimester using ultrasound. The data of this study collected from 50 pregnant ladies selected conveniently in Omdurman delivery hospital from July 2015 to December 2015. The result of this study showed a significant correlation between the GA-LMP and GA-BPD, GA-FL and GA-CD which ware 0.937, 0.925, and 0.858 respectively. The result of this study showed that the mean value of the CD was 3.20±0.88 cm, where BPD was 6.85±1.60 cm also FL was 5.26±1.56 cm. The average GA using CD was a 26.47±5.46 week 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 than 74% of the changes occur in the GA, (Mona, 2016).

Mustafa et al 2013, studied an association between the dimensions of the fetal cerebellum, especially the TCD and GA is a close relationship between TCD and GA (correlation coefficient (r) = 0.94 and $p < 0.001$), with TCD 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 TCD 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).

Orji and Adeyekun, 2014, studied Ultrasound estimation of foetal gestational age by transcerebellar diameter in healthy pregnant nigerian women. Ultrasonography has application in advanced obstetric practice through relatively detailed assessment of foetal anatomy and accurate assessment of gestational age (GA), especially during the first half of pregnancy. Foetal trans-cerebellar diameter (TCD) is an emerging parameter for gestational age determination among Africans. *AIM*: This study was carried out to establish baseline data for TCD at various corresponding gestational ages in Nigerian women, and evaluate the correlation between these two parameters. *Materials and methods:* Four hundred and fifty healthy singleton pregnant women, referred for antenatal scans were prospectively studied, following informed consent. Main inclusion criterion was certain last menstrual dates. A SONOACE χ ultrasound scanner, with a curvilinear probe and 3.5 MHz transducer, was used to measure the TCD. Data analysis was done and statistical significance set at $p \leq 0.05$. *results*: TCD of the fetuses studied ranged from 11.9 mm (at 13 weeks) to 59.3mm (at 41 weeks) with a mean value 34.2 ± 14.1mm.There was significant correlation between TCD and menstrual gestational age ($r = 0.984$; $p = 0.000$). TCD has a predictive accuracy of 96.9% with a standard error of ± 10 days. They conclude that A normogram of fetal TCD throughout gestation is established for Nigerian Africans (Orji and Adeyekun, 2014).

Hall 1985, studied assessment of gestational age is fundamental in managing both low and high risk pregnancies. In particular, uncertain gestational age has been associated with adverse pregnancy outcomes including low birth weight, spontaneous preterm delivery and perinatal mortality, independent of maternal characteristics. Making appropriate

management decisions and delivering optimal obstetric care necessitates accurate appraisal of gestational age. For example, proper diagnosis and management of preterm labor and post-term pregnancy requires an accurate estimation of fetal age. Many pregnancies considered to be preterm or postterm are wrongly classified. Unnecessary testing such as fetal monitoring and unwarranted interventions including induction for supposed postterm pregnancies may lead to an increased risk of maternal and neonatal morbidity. In addition, pregnancies erroneously thought to be preterm may be subject to avoidable and expensive hospitalization stays as well as excessive and potentially dangerous medication use including tocolytic therapy. In one study by Kramer et al that assessed over 11,000 pregnant women who underwent early ultrasound, one-fourth of all infants who would be classified as premature and one-eighth of all infants who would be classified as post term by menstrual history alone would be misdiagnosed.

Accurate pregnancy dating may also assist obstetricians in appropriately counseling women who are at imminent risk of a preterm delivery about likely neonatal outcomes. Precise knowledge of gestational age is also essential in the evaluation of fetal growth and the detection of intrauterine growth restriction. During the third trimester, fundal height assessment may be helpful in determining appropriate fetal growth by comparing the measurement to a known gestational age. In addition, dating a pregnancy is imperative for scheduling invasive diagnostic tests such as chorionic villus sampling or amnio-centesis, as appropriate timing can influence the safety of the procedure. Certainty of gestational age is also important in the interpretation of biochemical serum screening test results and may help avoid undue parental anxiety from miscal-culations and superfluous invasive procedures, which may increase the risk of pregnancy loss.

Assessment of gestational age is also crucial for counseling patients regarding the option of pregnancy termination (Hall 1985).

Gupta et al 2012, studied, gestational age estimation using transcerebellar diameter with grading of fetal cerebellar growth. The transverse cerebellar diameter (TCD) serves as a reliable predictor of gestational age (GA) of 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. Aim: The aim of this study was to derive a regression equation and evaluate the relationship between transverse cerebellar diameter and gestational age, which will be helpful in assessing the fetal gestational age and also to evaluate the grades of cerebellum and to see its growth. Materials & methods: The prospective study was carried out in 292 pregnant women between 14-40 weeks of pregnancy attending the Konaseema Institute of Medical Sciences & Research Foundation, Amalapuram for routine ultrasound examination. Transverse cerebellar diameter was measured and cerebellum was graded using ultrasonography. Results: Fetal cerebella were found to be in 29%, 10% and 61% cases as grade I, II and III respectively. The grade changed from I to III progressively with advancing gestation. The median GA and TCD were 20 wks and 22 min for grade I, 32 wks and 30 mm for grade II and 36 wks and 38 mm for grade III. Conclusion: Regression analysis indicated a strong relationship between TCD and gestational age indicating TCD is a good marker for estimation of gestational age (Gupta, et al 2012).

Chapter Three
Methodology

Chapter Three

Methodology

3.1 Material and method :

3-1-1 Study population:

The targets populations of this study are all pregnant ladies attending for fallow up (ultrasound exam) in second and third trimester singleton pregnancy without head abnormality.

Exclusion criteria:

Smokers (motivation of teratogenic effect to fetuses).

Diabetes mellitus (as it change growth).

Clinical complications in the current pregnancy such as arterial hypertension (change of fetus growth retardation).

3-1-2 machine:

Ultrasound examinations were performed on the high-resolution Phillips ultrasound medical system, ultrasound unit equipped with a 3.5 MHz convex probe.

3-2 Method of data:

The GA assessment was based on an early pregnancy scan (second and third trimesters) or by certain dates (date of last menstrual period) if no antenatal scan was available. Dates were considered certain if it was recorded as such in the maternal notes.

3-2-1 technique :

Fetal CD was measured using the method described by Goldestein et al. to locate the cerebellum in the posterior fossa by means of rotation of the transducer to approximately 30º from the plane that identifies the thalamus, the cavity of the septum pellucidum, third ventricle and cistern magna, positioning the calibers on the outer margins of the cerebellar hemispheres. (Mustafa et al 2013)

A single CD measurement was used for each fetus studied. The measurement of CD was obtained by placing electronic calipers at the outer margins of the cerebellum. The landmarks of the thalami, cavum, septumpellucidum and third ventricle were identified thereby slightly rotating the transducer below the thalamicplane. The posterior fosse is revealed with the characteristic butterfly like appearance of cerebellum. In all cases cerebellum was seen as two lobules on either side of the midline in the

3-3 Study area and duration:

This study will be achieved in Omdurman delivery hospital and was conducted from July 2015 to December 2015

3.4 Sample size and type

The data of this study was collected from 50 pregnant lady in second and third trimester selected conveniently

3-5 Variable of data collection:

The data was collected by the following:

- Last menstrual period (LMP)
- Date of exam
- Cerebellum diameter (CD)
- Biperietal diameter (BPD)

3-5-1 Data analysis:

The data was analyzed by using SPSS & Excel package version 17 for quantitative data to find out indicators aimed by this study. Correlations between fetal CD and GA were determined for the whole sample.

Chapter Four

Results

Chapter Four

Results

Table (4-1): Distribution of cerebellar diameter (CD) in second and third trimester:

	Minimum	Maximum	Mean	Std. Deviation
CD	1.70	5.57	3.1980	.88033

Table (4-2): Correlation between gestational age (G.A) using last menstrual period (LMP) and cerebellar diameter (CD):

		CD	GA by LMP
CD	Pearson Correlation	1	.858**
	Sig. (2-tailed)		.000

**. Correlation is significant at the 0.01 level (2-tailed).

Table (4-3): Regression of gestational age (G.A) using last menstrual period (LMP) on the cerebellar diameter (CD):

Model	Unstandardized Coefficients		t	Sig.
	B	Std. Error		
(Constant)	6.648	1.766	3.766	.000
CD	6.169	.533	11.582	.000

R Square
.736

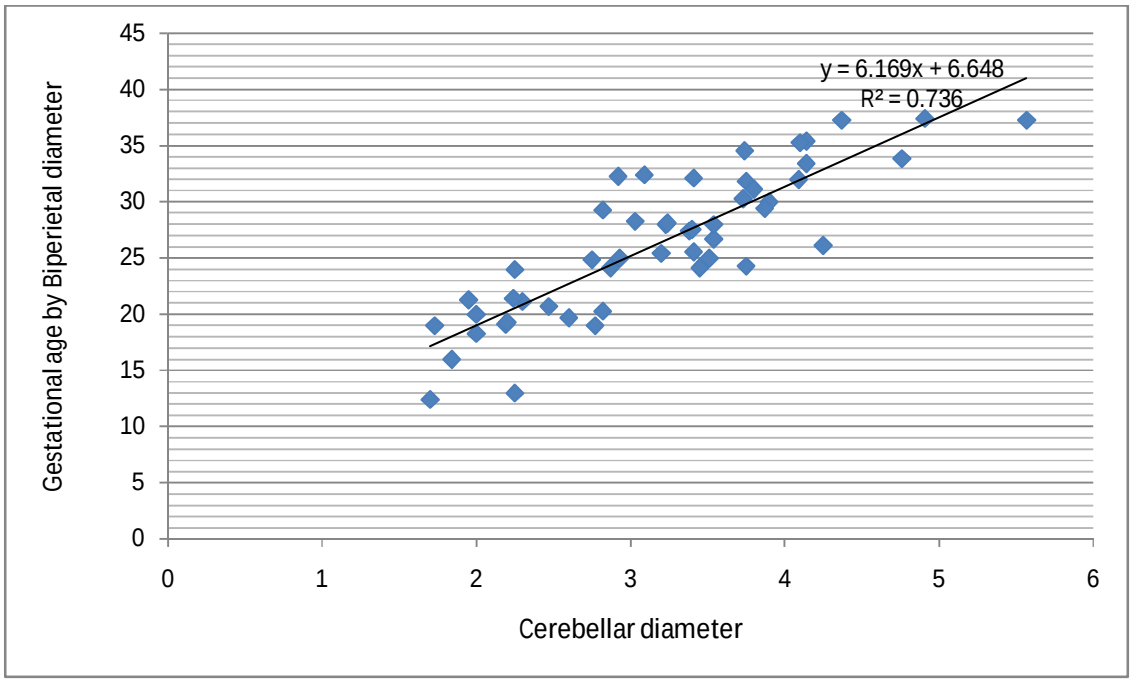

Figure (4-1): Regression of gestational age using last menstrual period on gestational cerebellar diameter:

Table (4-4): Correlation between gestational age (G.A) using biperietal diameter (BPD) and cerebellar diameter (CD):

		CD	GA by BPD
CD	Pearson Correlation	1	.922**
	Sig. (2-tailed)		.000

**. Correlation is significant at the 0.01 level (2-tailed).

Table (4-5): Regression of gestational age (G.A) using biperietal diameter (BPD) on the cerebellar diameter (CD):

Model		Unstandardized Coefficients		t	Sig.
		B	Std. Error		
1	(Constant)	6.650	1.323	5.027	.000
	CD	6.605	.399	16.550	.000

R Square
.851

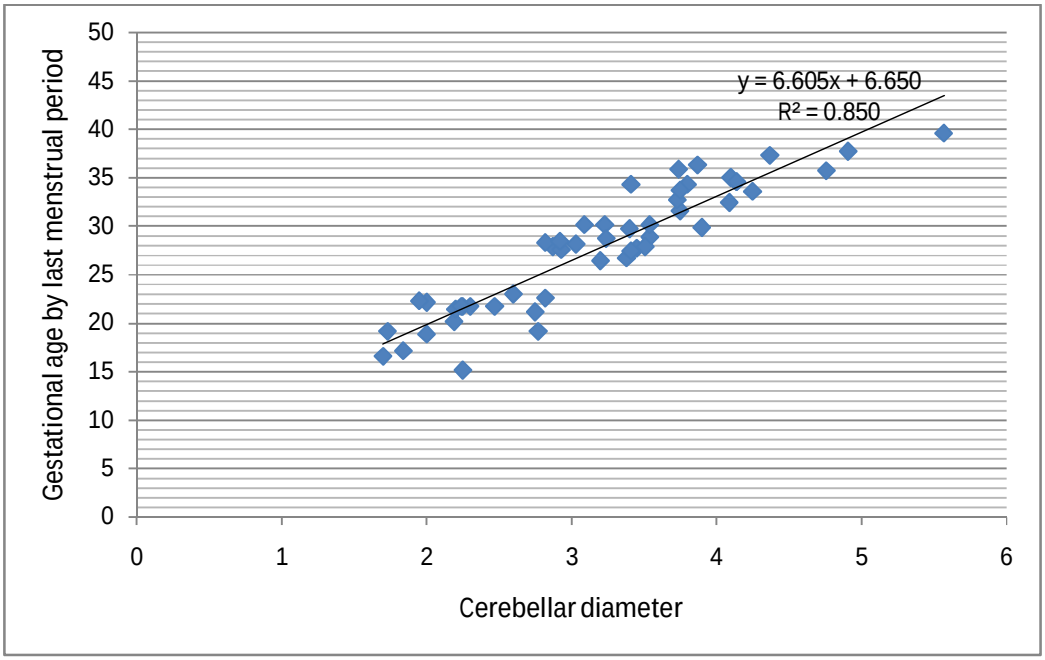

Figure (4-2): Regression of gestational age using biperietal diameter on the cerebellar diameter

Table (4-6): Paired Samples distribution for gestational age (GA) using last menstrual period (LMP) and biperietal diameter (BPD):

	Mean	N	Std. Deviation	Std. Error Mean
GA by BPD	27.7734	50	6.30368	.89148
GA by LMP	26.3778	50	6.32855	.89499

Table (4-7): Paired Samples test of difference between gestational age (GA) using last menstrual period (LMP) and biperietal diameter (BPD):

	Paired Differences			t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean			
GA by BPD – GA by LMP	1.39560	2.40765	.34049	4.099	49	.000

	Correlation	Sig.
Pair 1 GAbyBPD&GAbyLMP	.927	.000

Chapter five

Discussion, Conclusion and Recommendations

Chapter five

Discussion, Conclusion and Recommendations

5.1 Discussion

Statistical Methods: associative and comparative analytical method considered using the SPSS statistical program based descriptive statistics and comparative and association hypothesis tests (0.05 sig. level), to estimate gestational age using the cerebellar diameter in second and third trimester and demonstrate the differences between gestational age by last menstrual period and gestational age by biperietal diameter.

The t-test and correlation coefficient used to study the hypothesis which states the study demonstrates there are no significant differences in mean gestational age of (LMP and BPD).

The table4-1 provides us with the necessary information to the distribution of cerebellar diameter in second and third trimester, that is (3.198±0.88cm) with minimum (1.70cm) and maximum (5.57cm) values.

Shown from table (4-2) that the Correlation coefficients between (gestational age using last menstrual period) and is cerebellar diameter (0.858), with corresponding significance values of Pearson Correlation Coefficients (0.000) demonstrating statistically significant strongly positive relation between (CD) and (G. A. by LMP).

The table (4-3) and figure (4-1) provides us with the necessary information to predict age using last menstrual period from the cerebellar diameter and determine whether cerebellar diameter contributes statistically significantly to the gestational age and showed that ("Sig." = 0.000 << 0.05) which indicates that there is a statistically significant correlation between cerebellar diameter and gestational age. Furthermore, we can use the values in the "B" column (the gestational age is 6.169±0.533 week increases per a cm in cerebellar diameter).

The table provides also the R^2 value. The R^2 value indicates how much of the total variation in the gestational age, can be explained by the cerebellar diameter. In this case is 0.74%, which is high.

Shown from table (4-4) that the Correlation coefficients between (gestational age (G.A) using biperietal diameter) and cerebellar diameter is (0.922), with corresponding significance values of Pearson Correlation Coefficients (0.000) demonstrating statistically significant very strong positive relation between (G. A. by BPD) and (CD).

The table (4-5) and figure (4-2) provides us with the necessary information to predict gestational age from the cerebellar diameter and determine whether cerebellar diameter contributes statistically significantly to the gestational age and showed that ("Sig." = 0.000 << 0.05) which indicates that there is a statistically significant correlation between gestational age and cerebellar diameter. Furthermore, we can use the values in the "B" column (the gestational age is 6.605±0.399 week increases per a cm in cerebellar diameter).

The table provides also the *R2* value. The R^2 value indicates how much of the total variation in the gestational age, can be explained by the cerebellar diameter. In this case is 0.85%, which is high.

The tables (4-6)and(4-7) shown that the compared means of (gestational age (GA) using last menstrual period (LMP) and biperietal diameter (BPD, with corresponding significance values of pared sample t-test (0.000) which implies, statistically significant differences between two methods to (estimate the gestational age), but they are statistically significant (Sig. = 0.000) strongly positive related (0.927).

5-2: Conclusion

This is an experimental study conducted to estimate the gestational age using cerebellar diameter by ultrasound in Sudanese pregnant ladies

The data of this thesis was collected by doing trans-abdominal ultrasound scanning using 3.5 MHz transducers. About 50 patients, with age from ( ) years, and above were randomly selected whom have not any symptoms related maternal pathology or intrauterine fetal anomalies, at duration from September – to December, 2016.

The results of this thesis states that cerebellar transverse diameter, and mean values were (3.1980) cm.

The study also concludes that, there is linear increase in the prostate volume in relation to increase in the patient's age, weight, height, and body mass indexes by 0.09 ml/year, 0.11 ml/kg, 0.04 ml/cm, and 0.3 ml/kg/m2 respectively.

Moreover the normal prostate volume has mid-grey level echogenicity (83.7%), and homogenious in texture (95.7).

Also, the study finds out that the prostate volume didn't affected by the marital status of the patients.

5.3 Recommendations

- To create CD chart for Sudanese fetus, a large sample of population should be recruited for the study and is performed to be more than 500 graved women with singleton pregnancy in 2^{nd} and 3^{rd} trimesters.
- Also further study can be done to find the accuracy of the head measurements together and separate in the second trimester then third trimester to compare the accuracy in each trimester.
- An ultrasound machine with high spatial resolution is highly recommended to carry out such large study so as to minimize the inaccuracy in putting the calibers in the outer margins of the cerebellum in obtaining the CD
- CD should be programmed in all ultrasound machines to have a good benchmark for comparison.
- Further study to show the sonographic diagnosis of intrauterine growth retardation (IUGR) by fetal cerebellum diameter (CD) to abdomen circumference (AC) ratio is recommended.

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Appendix

Appendix A

Master data sheet

No	exam date	AGE (yea)	Parity	LMP	CD (cm)	BPD (cm)	GA by BPD	\GA by LMP

Appendix (B)

Ultrasound Images

Image (1): Short axis view of fetal head in 31weak and 6 days of gestation, cerebellar diameter 3,75

Image (2): Short axis view of fetal head in 26weak and 5days of gestation, cerebellar diameter 3,54

Image (3): Short axis view of fetal head in 26 Weak and 5 Days of gestation, cerebellar diameter 5,57

Image (3): Short axis view of fetal head in 27 Weak and 3 Days of gestation, cerebellar diameter 3,38

Image (5): Short axis view of fetal head in 25Weak and 3Days of gestation, cerebellar diameter 3,2

Image (6): Short axis view of fetal head in 20weak of gestation, cerebellar diameter 2,0

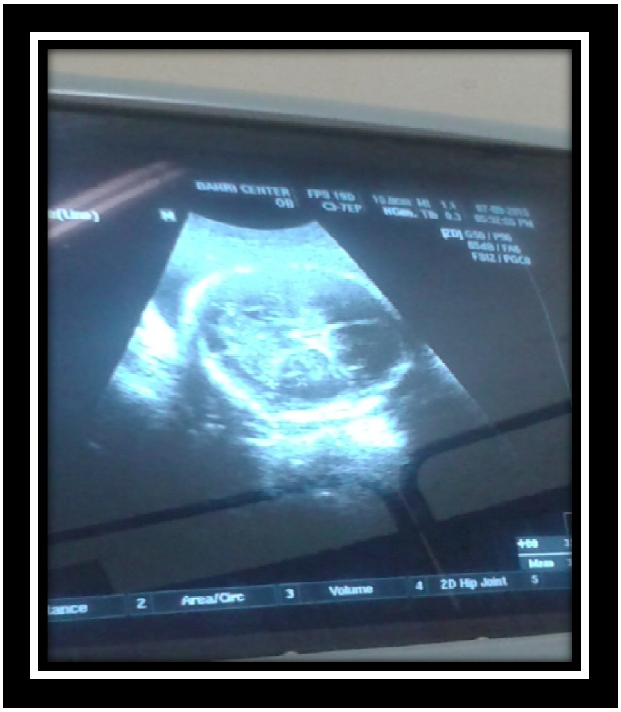

Image (7): Short axis view of fetal head in 28Weak of gestation, cerebellar diameter 3, 23

Image (8): Short axis view of fetalhead in 21Weakn and2Days gestation, cerebellar diameter 1,95