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Estimation of Gestational Age in Second and Third Trimester By Placental Thickness using Ultrasonography

تقدير عمر الجنين في الثلثين الثاني والثالث للحمل بواسطة سمك المشيمة باستخدام الموجات فوق الصوتية

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

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Dedication

This research is dedicated to

My Family

Acknowledgement

I am extremely grateful to my husband:

Ali Alhag Mohammed

For his patience and hard work in guidance, encouragement and continuous support.

Special vote of thanks to my supervisor:

Dr. Mohamed Elfadil

I wish to state my thanks to my parents, my friends and anyone who gives me good advice to do this work.

Abstract

The study aimed to estimate the correlation between the placenta thickness and gestational age . the study was done on 50 normal pregnant Sudanese women in 2nd and 3rd trimesters. The data used in the study were collected from deprtment of ultrasound in alsuadi hospital, madani hospital, and bashair hospital during June 2016. The used ultrasound device was sonoscape and mindray –digiprince DP-20", 3.5MHz convex probe. It was found that the placenta thickness increase with gestational age and there is statistically significant positive correlation between PT and gestational age. it is recommended that uses the placental thickness as a parameter in estimating gestational age need further testing in order to be applicable and installed in ultrasound machine . it is also recommended to estimate the gestational age using placenta thickness with abnormal pregnancies.

ملخص الدراسة

تهدف الدراسة الى تقدير عمر الجنين عن طريق دراسة العلاقة بين سمك المشيمة وعمر الجنين. اجريت الدراسة على خمسين سيدة سودانية في الفترة الثانية والثالثة للحمل وذلك عن طريق أخذ صورة بالموجات فوق الصوتية بالمستشفى السعودي ومستشفى مدني ومستشفى بشائر خلال شهر يونيو 2016.

الاجهزة المستخدمة في التصوير كانت سونوسكاب وميندراي وكان التردد المستخدم 3.5 ميقا هيرتز وقد خلصت الدراسة الى وجود علاقة خطية موجبة بين سمك المشيمة وعمر الجنين وان سمك المشيمة يزيد مع زيادة فترة الحمل . يوصى باجراء دراسات اضافية يستخدم فيها سمك المشيمة لتقدير عمر الجنين في الفترة الثانية والثالثة للحمل. كما يوصى باجراء دراسات اخرى لتقييم عمر الجنين باستخدام سمك المشيمة على مجموعة حوامل لديهم مشاكل في الحمل.

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List of abbreviation

PT	Placenta Thickness.
ILAIT	Last Menstrual Period
U/S	Ultrasound.
BPD	Biparietal Diameter.
AC	Abdominal Circumference.
HC	Head Circumference.
FL	Femur Length.
(HLA-G)	Human Leukocyte Antigcn-G .
IgG	Gamma Globulins.
HCG	Human Chorionic Gonadotropin.
VUE	Villitis Of Unknown Etiology

Chapter One

Introduction

Chapter One
Introduction

1.1 Introduction

The early developing embryo is surrounded by amnion and chorion. Villi cover the entire surface of the chorion up to about 8 weeks of gestation. The villi, which are the basic structures of the placenta, initially form by 4 or 5 weeks' gestation. The villi next to the decidua capsulitis degenerate, forming the chorion leave. The villi contiguous with the decidua basalis become the chorion frondosum and later the placenta, Placental length is approximately six times its maximal width at 18 to 20 weeks' gestation. The mean thickness of the placenta in millimeters in the first half of pregnancy closely approximates the gestational age in weeks ,If the placenta thickness is greater than 4 cm (40 mm) before 24 weeks, an abnormality should be suspected. These abnormalities include ischemic-thrombotic damage, intraplacental hemorrhage, chorioangioma, and fetal hydrops(Rumack … et al.,2011) .The placenta is an organthat develops in uterus during pregnancy. It is unique characteristic of higher mammals. In human it is athick mass, about 7in. (18cm)in diameter,liberally supplied with blood vessels. It usually weighs about 1 to2 pounds (about 1/6 of the weight of the baby). The placenta is attached to uterus, and fetus is connected to the placenta by the umbilicalcord(http//Wikipedia). The placenta develops from the chorionic villi at the implantation site at about the fifth week of gestation and by the ninth or tenth week the diffuse granular echotexture of the placenta is clearly apparent at sonography (peterW.callen, 2007).accurate estimation of fetal age is important for appropriate antenatal management.The estimation of fetal age by ultrasound is based to know the relationship between fetal age

and weight. Several sonographically derived fetal parameters used to date pregnancy include fetal crown-rump length (CRL)bipariatal diameter (BPD), head circumference (HC), femur length (FL) and abdominalcircumference (AC). Placental thickness measured at the level of the umbilical cord insertion and can be used as anew parameter to estimate gestational age of fetus (perer, 2007).

This study to investigate placental thickness asa parameter for estimating gestational age of fetus in normalsingleton pregnancies in Sudanese women.

1.2 Problem statement

Investigation the relationship between the placental thickness and gestational age in normal singleton Sudanesefetuses,and to increase the accuracy of estimated gestational age by deriving formula that uses the placental thickness as aparameter in calculating gestational age.

1.3 Justification:

This study will help detect the relationship between placental thickness and fetal age; also help to assess the formula that uses the placental thickness as aparameter in calculating gestational age.

1.4 Research question:

- How can we measure the placental thickness by US?
- How can we determine the fetal age in 2nd & 3rd trimester by US?
- Can we detect the relationship between placental thickness & fetal age?

1.5 Objectives:

1.5.1 General Objectives:

- To determine the relationship between placental thickness and fetal age in 2nd and 3rd trimester.

1.5.2 Specific Objectives:

- To correlate between placental thickness and average gestation age determined by FL, BPD, LMP.
- Toestimate the possibility of placental thickness to determine the fetal age in 2nd and 3rd trimester.
- Toevaluate the accuracy of assessment the age by placental thickness comparing with FL, BPDand LMP.

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1.6 Overview of the study:

Chapter one consist introduction, objectives of the research then concluded with the scope of the study

Chapter two will consist:

- literature review
- Anatomy
- Physiology
- Pathology
- Ultrasound

Chapter three:

Deal with the material & methods

Chapter four:

Include result presentation

Chapter five:

Deal with the discussion, conclusion & recommendation.

Chapter Two

Chapter Two

2.1 Placenta:

2.1.1 Anatomy of placenta:

2.1.1.1 Components f placenta:

The placenta is a fetomaternal organ that has two components:

- A fetal part that develops from the chorionic sac.

- A maternal part that is derived from the endometrium.

The fetal part of the placenta (villous chorion) is attached to the maternal part of the placenta (decidua basalis) by the cytotrophoblastic shell, the external layer of trophoblastic cells on the maternal surface of the placenta. The chorionic villi attach firmly to the decidua basalis through the cytotrophoblastic shell and anchor the chorionic sac to the decidua basalis. Endometrial arteries and veins pass freely through gaps in the cytotrophoblastic shell and open into the intervillous space.

Shortly after birth, the placenta and fetal membranes are expelled from the uterus as the afterbirth. (moore, presaud, 2008).

The Decidua refers to the gravid endometrium, the functional layer of the endometrium in a pregnant woman that separates from the remainder of the uterus after parturition (childbirth). The three regions of the deciduas are named according to their relation to the implantation site :

The deciduas basalis is the part of the decidua deep to the corcepts that forms the maternal part of the placenta.

The decidua capsulitis is the superficial part of the decidua overlying the conceptus.

The decidua parietalis all the remaining parts of the decidua.

In response to increasing progesterone levels in the maternal blood, the connective tissue cells of the decidua enlarge to form pale-staining decidual

cells. These cells enlarge as glycogen and lipid accumulate in their cytoplasm. The cellular and vascular changes occurring in the endometrium as the blastocyst implants constitute the decidual reaction. Many decidual cells degenerate near the chorionic sac in the region of the syncytiotrophoblast and, together with maternal blood and uterine secretions, provide a rich source of nutrition for the embryo. The full significance of decidual cells is not understood, but it has also been suggested that they protect the maternal tissue against uncontrolled invasion by the syncytiotrophoblast and that they may be involved in hormone production. Decidual regions, clearly recognizable during ultrasonography, are important in diagnosing early pregnancy.
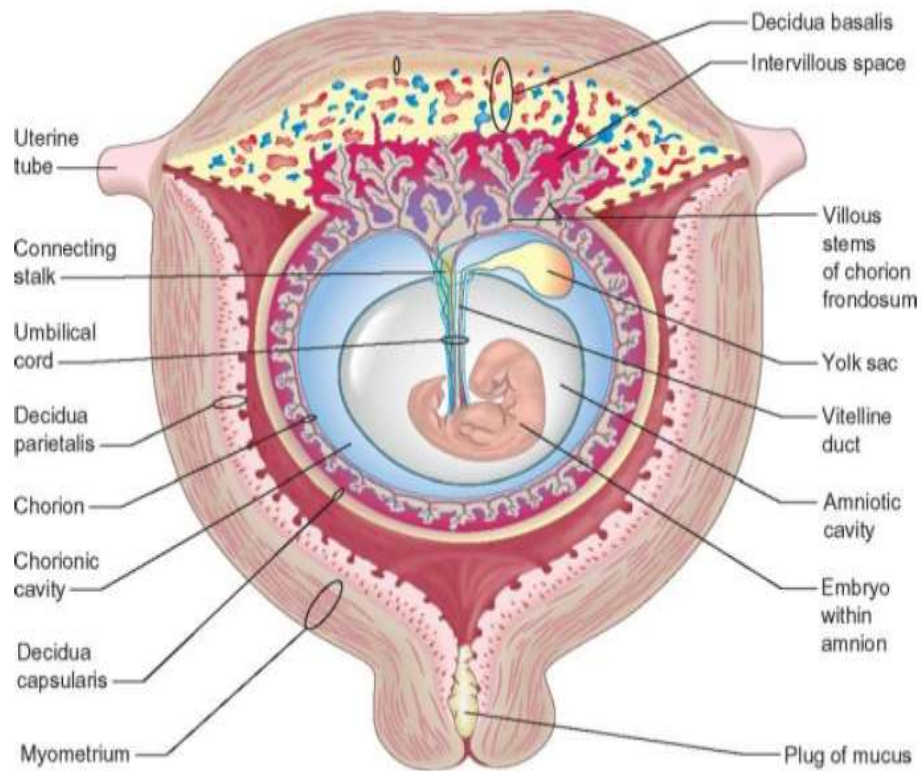
Fig(2.1)The gravid utrerus in second month adapted from" Susan, 2008"

2.1.2 Placental Development:

The early developing embryo is surrounded by amnion and chorion. Villi cover the entire surface of the chorion up to about 8 weeks of gestation . The villi, which are the basic structures of the placenta, initially form by 4 or 5 weeks' gestation. The villi next to the decidua capsularis degenerate, forming the chorion leave. The villi contiguous with the decidua basalis become the chorion frondosum and later the placenta. The fetal side of the placenta consists of the chorionic plate and chorionic villi. The maternal side consists of the decidua basalis, which open up into large cisterns, the intervillous spaces. The fetal villi are immersed in maternal blood located in the intervillous spaces. Anchoring villi develop from the chorionic plate.(Pijnenborg R, Vercruysse L. ,2008) These attachto the decidua basalis, holding the placenta in place.(Moore KL ,1982)(Kanne JP, et al, 2005)By the end of pregnancy, the villi have a surface area of 12 to 14 square meters.(Jauniaux E, et al ,2006)
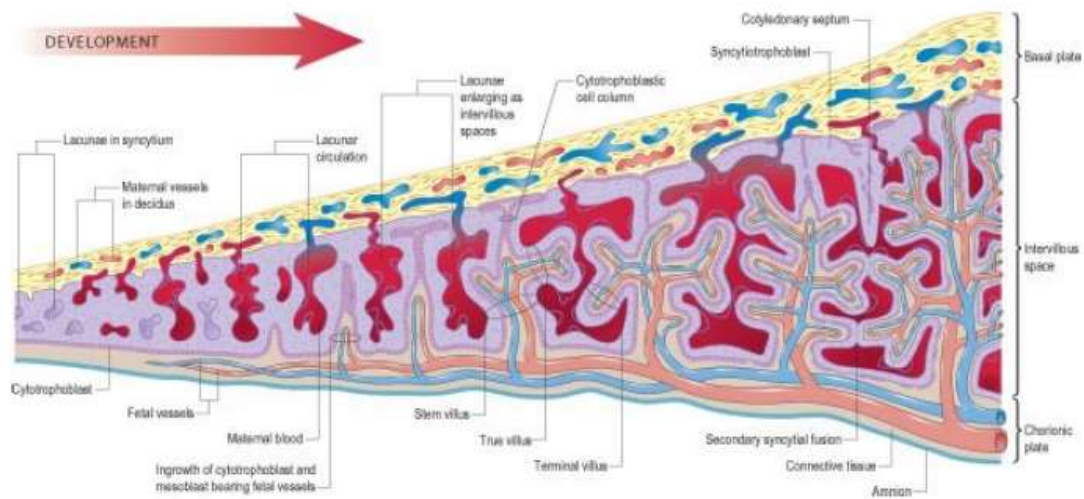
1. Fig (2.2) Placental development is shown from left to right. Adapted from " Susan, 2008"

2.1.3physiology of the Placenta:

The placenta has three main functions:

Metabolism (e.g., synthesis of glycogen) Transport of gases and nutrients Endocrine secretion (e.g., human chorionic gonadotropin [hCG])

These comprehensive activities are essential for maintaining pregnancy and promoting normal fetal development.

2.1.3.1 Placental Metabolism:

The placenta, particularly during early pregnancy, synthesizes glycogen, cholesterol, and fatty acids, which serve as sources of nutrients and energy for the embryo/fetus. Many of its metabolic activities are undoubtedly critical for its other two major placental activities (transport and endocrine secretion).

2.1.3.2 Placental Transfer:

The transport of substances in both directions between the fetal and maternal blood is facilitated by the great surface area of the placental membrane. Almost all materials are transported across the placental membrane by one of the following four main transport mechanisms: simple diffusion, facilitated diffusion, active transport, and pinocytosis (moore, presaud, 2008).

Passive transport by simple diffusion is usually characteristic of substances moving from areas of higher to lower concentration until equilibrium is established. In facilitated diffusion, there is transport through electrical gradients. Active transport against a concentration gradient requires energy. Such systems may involve carrier molecules that temporarily combine with the substances to be transported. Pinocytosis is a form of endocytosis in which the material being engulfed is a small amount

of extracellular fluid. This method of transport is usually reserved for large molecules. Some proteins are transferred very slowly through the placenta by pinocytosis.

2.1.4 Placental appearance:

The placenta in the first and second trimesters is slightly more echogenic than the surrounding myometrium (fig 2.3). The attachment site, or base of the placenta, should be clearly delineated from the underlying myometrium. The edges of the placenta usually have a small sinus, the marginal sinus of the placenta , where intervillous blood drains into the maternal venous circulation. This structure should not be confused with placental separation. As the placenta matures, areas of echogenicity within the placenta are visualized (Fig 2.4)

Fig (2.3) At 18 weeks, note the uniformly echogenic appearance of the placenta and a uterine contraction deviating the placenta." adapted from carol m. rumack *[et al.]*,2011.

(Fig 2.4)Increasing echogenicity in the placenta as it matures Carol M. Rumack *[et al.],*2011

2.1.5 placental size:

Placental length is approximately six times its maximal width at 18 to 20 weeks' gestation. The mean thickness of the placenta in millimeters in the first half of pregnancy closely approximates the gestational age in weeks.(Tongsong T, Boonyanurak, 2004) If the placenta thickness is greater than 4 cm (40 mm) before 24 weeks, an abnormality should be suspected. These abnormalities include ischemic-thrombotic damage, intraplacental hemorrhage, chorioangioma, and fetal hydrops The placenta dramatically increases in size until approximately 15 to 17 weeks' gestation. From this point, there is a fourfold increase in placental size until delivery, whereas the fetus has a 50-fold increase in size until delivery.(Mi Hafner E,et al, 2001)dtrimester placental volume is associated with maternal nutritional status, birth weight, and pregnancy outcome.(Thame M, et al,2000, Wolf H, et al,1989).

A very small placenta may be associated with growth retardation.

More than 3cm thickness before 20 weeks and more than 5cm before 40 weeks is consider abnormal.

An excessively large placenta may be associated with infection, anemia or triploidy and there are usually other markers of fetal compromise. (Smith NC and smith A P M2006).

Primary maternal CMV(cytomegalovirus) infection and fetal or neonatal disease are associated with sonographically thickened placentas ,which respond to disease administration of fetal and neonatal disease are caused by placental insufficiency (La Torre et al,2006)

Sonographaically thick placenta is associated perinatal risk with increased mortality related to fetal anomalies and higher rates of both small for gestational age infants at term. (Elchalal et al,2000).

2.1.6 Placental Localization:

The placenta is best identified by scanning the uterus longitudinally and is easily recognized by its more echogenic pattern compared with that of the underlying myometrium. Careful inspection will demonstrate the chorionic plate as a bright linear echo between the homogeneous echoes of the body of the placenta and the amniotic fluid (Fig. 2.2). The actual internal os might be difficult to identify transabdominally but its position can be assumed by visualizing the slight dimple at the upper end of the cervical canal. The cervical canal is best imaged by placing the probe in the midline, with its lower end just above the symphysis, slight dextrorotation may be necessary. The cervical canal lies directly posterior to the bladder,typically at about 45ͦto the horizontal. The placenta can be fundal, anterior, posterior or lateral, in which case it will be visualized on both the anterior and posterior walls of the uterus. It might lie completely within the upper part of the uterus, with its lower edge >5 cm from the internal os – such a position is usually described as 'upper' or 'not low'. If the leading edge of the placenta lies

within 5 cm of the internal os and/or appears to cover the internal os then its position should be described as 'low' and/or 'covering the os'. The term 'placenta praevia' should only be used after 28 weeks . It is unnecessary to ask women to attend with a full bladder at the time of the 20–22 week scan as the majority will have an obviously fundal placenta. It is frequently possible to visualize the lower placental edge and the internal os, thus making the diagnosis of alow-lying placenta possible even with a partially filled bladder. If such views are suboptimal and a low lying placenta is suspected, then a transvaginal examination should be performed or the woman should be scanned with a full bladder.(Chudleigh T. ,Thilaganathan B-2004) .
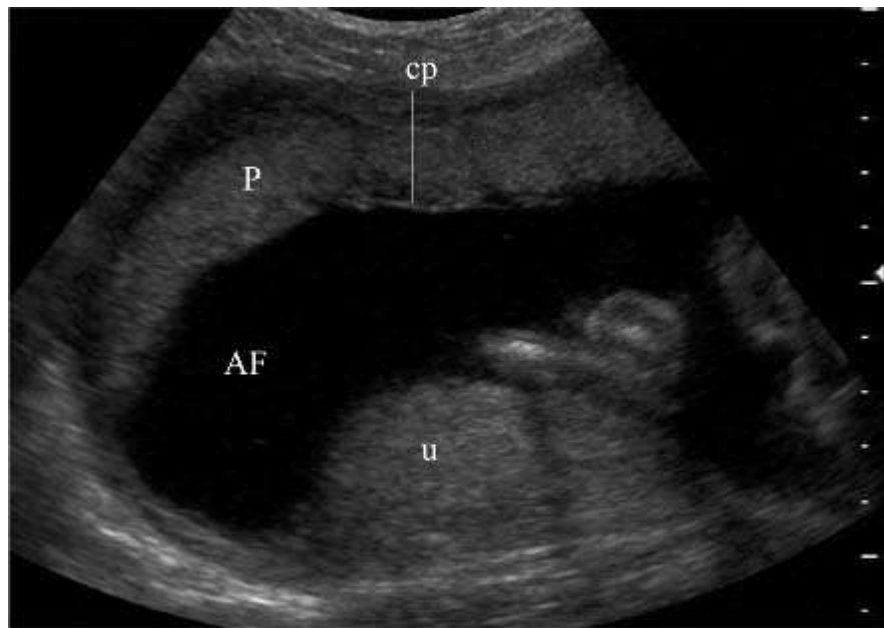
Fig (2.5) Localizing the placenta from a longitudinal, midline section of the uterus. Note the homogeneous echo pattern of the anterior wall placenta (P) and the bright echoes produced from the chorionic plate (cp) that demarcates the interface between the placenta and the amniotic fluid (AF). Posterior uterine wall (u)."adapted from Chudleigh T. , Thilaganathan 2004

2.1.7 Placental Circulation:

The placenta is a unique vascular organ that receives blood supplies from both the maternal and the fetal systems and thus has two separate circulatory systems for blood: (1) the maternal-placental (uteroplacental) blood circulation, and (2) the fetal-placental (fetoplacental) blood circulation.

2.1.7.1 Maternal-placental blood circulation:

The uteroplacntal circulation starts with the maternal blood flow into the intervillous space through deciual spiral arteries. Exchange of oxygen and nutrients take place as the maternal blood flows around terminal villi in the intervillous space. The in-flowing maternal arterial blood pushes deoxygenated blood into the endometrial and then uterine veins back to the maternal circulation .

2.1.7.2 Fetal Placental Circulation

The fetal-placental circulation allows the umbilical arteries to carry deoxygenated and nutrient-depleted fetal blood from the fetus to the villous core fetal vessels. After the exchange of oxygen and nutrients, the umbilical vein carries fresh oxygenated and nutrient-rich blood circulating back to the fetal systemic circulation. At term, maternal blood flow to the placenta is approximately 600-700 ml/minute. It is estimated that the surface area of syncytiotrophoblasts is approximately 12m2 and the length of fetal capillaries of a fully developed placenta is approximately 320 kilometers at term. The functional unit of maternal-fetal exchange of oxygen and nutrients occur in the terminal villi. No intermingling of maternal and fetal blood occurs in the placenta .

2.1.8 Placental Grading

This is a classification of the normal changes that occur in the placenta during the course of a pregnancy; it is often known as Grannum grading, after its author. It used to be thought that a Grannum grade III placenta was associated with mature fetal lungs and placental dysfunction. This concept has been largely rejected and Placental grading is rarely used. It is included here for completeness and because it illustrates the varying appearances of the normal placenta. Figure 9.7 illustrates the Grannum grading criteria and Figure 9.8 the ultrasound appearances associated with a Grannum grade III placenta.
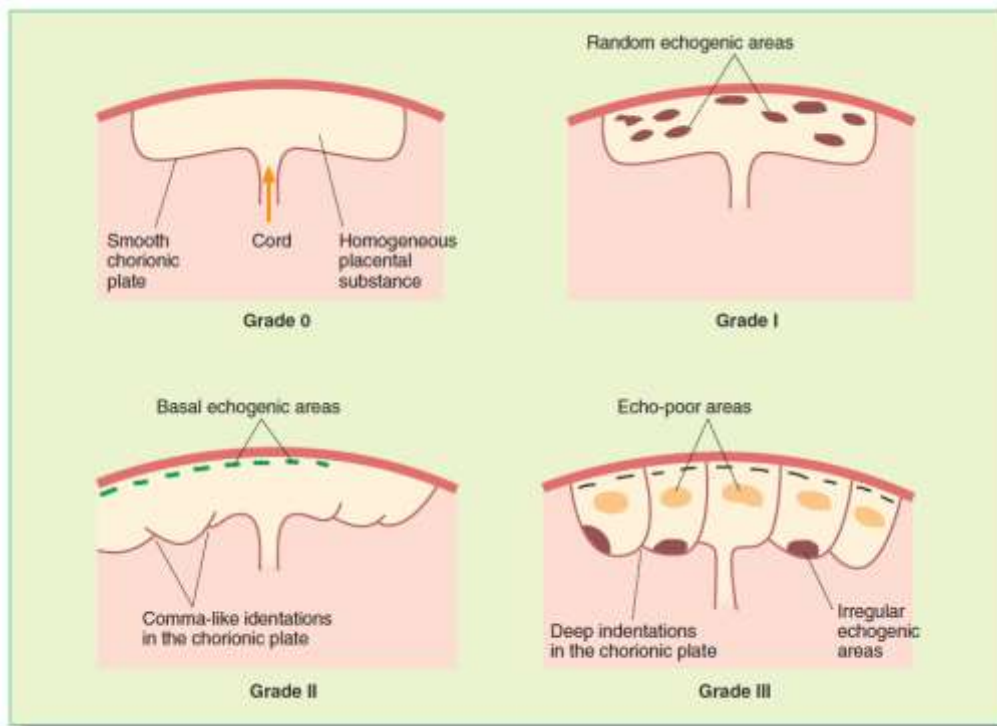
Fig (2.6) the ultrasound appearances of placental grading (adapted from Grannum et al 1982).

Fig (2.7) Grannum grade III anterior placenta at 38weeks' gestation. Rumack *[et al.]*,2011

2.1.9placental abnormalities:

There are a number of placental shape abnormalities, some quite rare.

2.1.9.1Circumvallate placenta

In circumvallate placenta the membranes of the chorion leave, instead of inserting at the margin of the placental disc, insert more toward the center of the disc. Circumvallate placenta has the sonographic appearance of a rolled edge of membranes at the placental edge inserting toward the center of the placental chorionic disc(fig 2.8)(Rumack … et al.,2011)

Fig (2.8) Transabdominal sonogram in the early third trimester shows rolled edges of the placenta (arrows). Carol M. Rumack [et al.],2011,

2.1.9.2 Succenturiate lobe.

Succenturiate lobes, or accessory lobes, of the placenta can be a single lobe or multiple lobes in addition to the main placental lobe Given that placental tissue is present in the accessory lobe, there must be arterial and venous connections to the main portion of the placenta(Rumack et al.,2011)

(Fig 2.9)Transabdominal sonogram of a third-trimester pregnancy shows a portion of placenta (arrow) separate from the main placental disc (succenturate lobe) adapted from **Carol M.** Rumack [et al.],2011,

2.1.9.3 Bilobed Placenta

Bilobed placentas consist of two similarly sized placental lobes separated by intervening membranes (fig 2.11). There must be some vascular connection between the lobes, and the umbilical cord may insert between the lobes in the membranes.
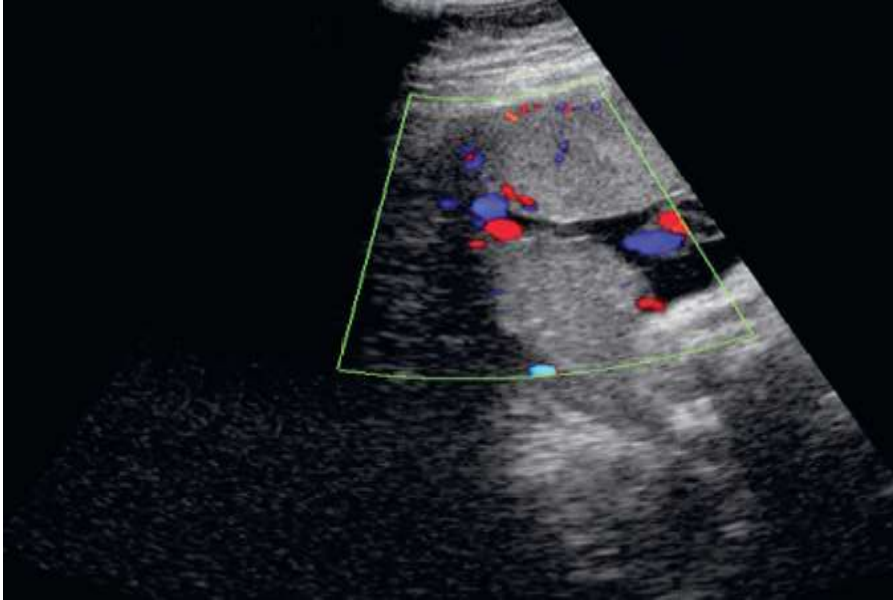
Fig (2.10)Transabdominal sonogram of a third-trimester bilobed placenta. Both placental discs are ofcomparable size (arrows).(bilobed placenta)) adapted from Rumack *[et al.]*,2011

2.1.9.4 Placental lakes

These lie within the bulk of the placenta and are filled with slowly moving blood (Fig.2.12). They probably represent the intervillous space in an area lacking fetal villi. Although there is a relationship between the presence of placental lakes and uteroplacental insufficiency, it is so weak to be of little apparent significance. .(Chudleigh T, Thilaganathan B.2004).
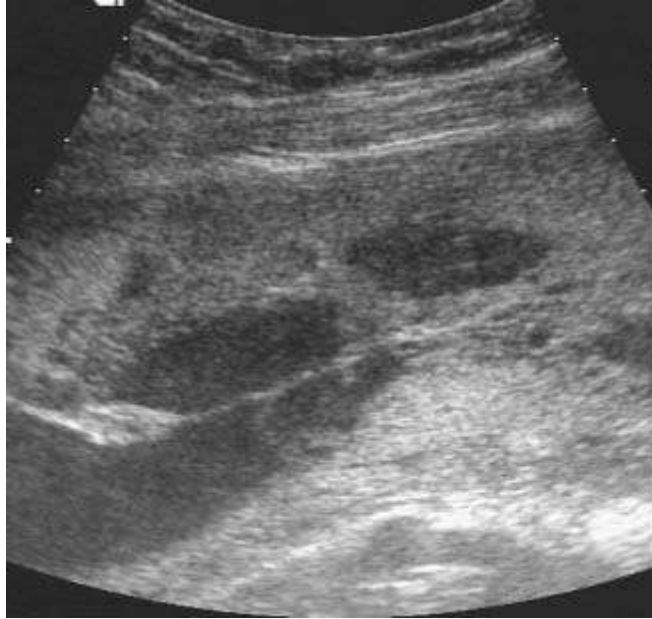
Figure (2.11) Placental lakes in an anterior placenta. Note the lakes lie within the bulk of the placenta.."adapted from Chudleigh T. , Thilaganathan B., 2004

2.1.9.5 Placental cysts

These are found immediately beneath the chorionic plate (Fig 2.13). The smaller ones are blood vessels viewed in cross-section. The larger ones are distinct entities caused by the deposition of fibrin in the intervillous space. They have no apparent significance. .(Chudleigh T, Thilaganathan B.2004)
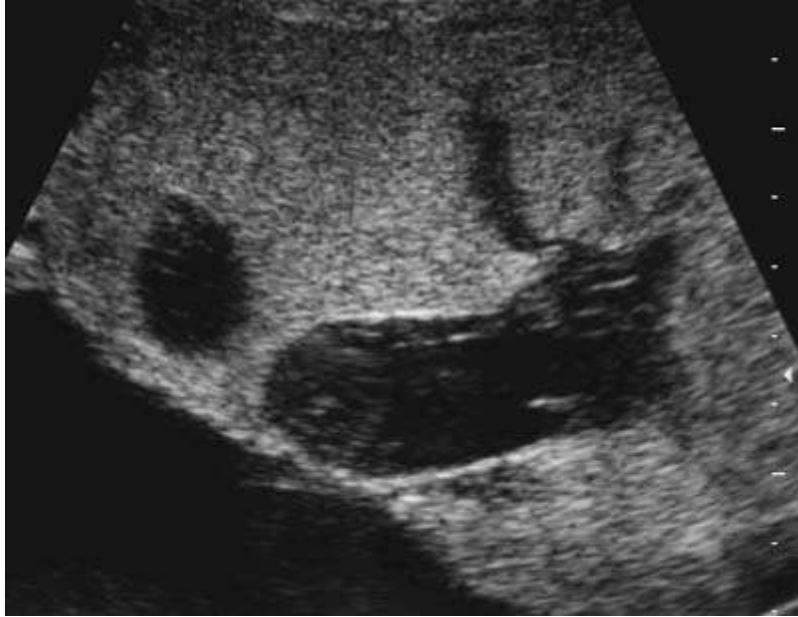
Fig (2.12) Placental cyst. Note the position of the mass, immediately beneath the chorionic plate. .."adapted from Chudleigh T. , Thilaganathan B., 2004

2.1.9.6 placenta previa:

The term "placenta previa" refers to a placenta that is "previous" to the fetus in the birth canal. The incidence at delivery is approximately 0.5% of all pregnancies. Bleeding in the second and third trimesters is the hallmark of placenta previa. This bleeding can be life threatening to the mother and fetus. With expectant management and cesarean delivery, both maternal and perinatal mortality have decreased over the past 40 years. Accurate diagnosis of placenta previa is vital to improve the outcome for mother and neonate. The differentiation of placental positions has historically been performed by digital assessment of the lower uterine segment and placenta through the cervix. Using this potentially hazardous method of evaluation, placental position was classified as complete placenta previa, partial placenta previa, incomplete placenta previa, marginal placenta previa, low-lying placenta, and placenta distant from the internal cervical os. These classifications do

not directly apply to the ultrasound examination of placental position relative to the cervix. The use of ultrasound to evaluate the position of the placenta in the uterus has both improved knowledge of the placenta within the uterus and simplified terminology withrespect to placental position (Fig2.14). Complete placenta Previa describes the situation in which the internal cervical is totally covered by the placenta. Marginal placenta previa denotes placental tissue at the edge of or encroaching on the internal cervical os. A low placenta is one in which the placental edge is within 2 cm, but not covering any portion, of the internal cervical os. Transabdominal scanning can be used to visualize the internal cervical os and to determine the relation of the placenta to the cervix in most cases . (Rumack … et al.,2011)

(Fig2.13)Complete placenta previa (arrow). The maternal cervix is demarcated by the calipers. adapted from Rumack *[et al.]*,2011

2.1.9.7 Placenta accreta:

The normal placenta invades the inner third of the myometrium. At delivery, the placenta separates at the decidual plane, with an abrupt cessation of intraplacental flow as the myometrium contracts. A placenta that is abnormally adherent to the uterine wall after delivery is termed placenta accreta. Placenta increta occurs if the placenta invades the myometrium more deeply, and placenta percreta refers to a placenta that at least in part protrudes through the uterine serosa. Placenta accreta, increta, and percreta are serious complications of pregnancy associated with maternal blood loss, need for hysterectomy, and retained products of conception. With ultrasound, placenta accreta can be identified antenatally so that delivery plans can be made prospectively, improving the outcome for mother and child. (Rumack … et al.,2011)

Fig (2.14)Placenta accreta with placental lakes. , Transabdominal sonogram of a third-trimester placenta shows aPlacental (venous) lake. . adapted from Rumack *[et al.]*,2011

2.1.9.8 PLACENTAL ABRUPTION:

About 3% of the pregnant population will bleed after 28 weeks' gestation. Approximately one-third of these women will have suffered a placental abruption, in which all or some of the placenta separates from the underlying myometrium before the fetus has been delivered. If this is a major abruption, it is usually clinically apparent because of abdominal pain and a peculiar 'woody hardness' to the uterus. Ultrasound has no place in the diagnosis of major abruption, although it might be needed to determine whether the fetus is still alive.(Chudleigh T, Thilaganathan B.2004).

2.1.9.9 Chorioangioma

This is a very rare vascular tumor of the placenta . Such tumors vary both in appearance and in size and occasionally appear to be separate from the placenta. They are usually benign and, if less than 5 cm in diameter, rarely cause a problem. Larger tumors are very vascular and can act as a fetal arteriovenous anastomosis. In this situation, a fetal hyperdynamic circulation can result in highoutput cardiac failure with subsequent polyhydramnios and hydrops fetalis. (Chudleigh T, Thilaganathan B.2004).

2.2 Assessment of gestational age:

The first trimester examination is performed either within the routine obestetric visit of pregnant women or as aresult of the patient complaining of bleeding or pain. Accordingly ,sonography has following emergency clinical questions to answer;where is pregnancy localized (is intrautrine or ectopic),is the embryo / fetus alive and what is probability of consequent demise of aliving embryo /fetus ??

The oher goel of first trimester sonography are estimation of menestral age of pregnancy , assessment of multible pregnancy evaluation of nuchal thickening and nasal bone and screening at 14 weeks.

2.2.1 Importance of accurate gestational age assessment :

Accurate 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.(Hall MH,Carr-Hill RA-1985) 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 postterm by menstrual history alone would be misdiagnosed.(Kramer Mset al 1988) 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 amniocentesis, 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 miscalculations 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.

2.2.2 Assessing gestational age using last menstrualperiod :

Traditionally, the first day of the last menstrual period (LMP)has been used as a reference point, with a predicted delivery date 280 days later. The estimated date of confinement (EDC) can also be calculated by Nägele's rule by subtracting three months and adding seven days to the first day of the last normal menstrual period. However, there are inherent problems in assessing gestational age using the menstrual cycle. One obstacle in using the LMP is the varying length of the follicular phase and the fact that many women do not have regular menstrual cycles. Walker et al evaluated 75 ovulatory

cycles using luteinizing hormone levels as a biochemical marker and found that ovulation occurred within a wide range of 8–31 days after the LMP)(Walker EM,Lewis M,CooperW, et al 1988).Similarl y, Chia zz al collected over 30,000 recorded menstrual cycles from 2316 women and found that only 77% of women have average cycle lengths between 25 and 31 days(Chiazze L Jr,et al 1968). Another barrier in using a menstrual history is that many women do not routinely document or remember their LMP. Campbell et al demonstrated that of more than 4000 pregnant women, 45% were not certain about their LMP as a result of poor recall, irregular cycles, bleeding in early pregnancy or oral contraceptive use within two months of conception.(Campbell S , et al 1985).

2.2.3 Clinical method for determining gestational age :

Other methods used to assess gestational age have included uterine size assessment, time at quickening and fundal height measurements. However, these clinical methods are often suboptimal. Robinson noted that uterine size determination by bimanual examination produced incorrect assessments by more than two weeks in over 30% of patients.(Roninson Hp ,1993) Similarly, fundal height estimation does not provide a reliable guide to predicting gestational age. Beazly et al found up to eight weeks variation in gestational age for any particular fundal height measurement during the second and third trimesters.(Beazley JM, Underhill RA 1970) In addition, quickening, or initial perception of fetal movement can vary greatly among women. While these modalities may be useful adjuncts, they are unreliable as the sole tool for theprecise dating of a pregnancy.

2.2.4 Ultrasound assessment of gestational age :

In recent years, ultrasound assessment of gestational age has become an integral part of obstetric practice.(Kalish RB,Chervenak FA2002).Correspondingly, prediction of gestational age is a central element of obstetric ultrasonography. Fetal biometry has been used to predict gestational age since the time of A-mode ultrasound.(Campbell S ,1969) Currently, the sonographic estimation is derived from calculations based on fetal measurements and serves as an indirect indicator of gestational age. Over the past three decades, numerous equations regarding the relationship between fetal biometric parameters and gestational age have been described and have proven early antenatal ultrasound to be an objective and accurate means of establishing gestational age.(Hadlock FP et al 1984) (Persson PH weldner BM 1986)

2.2.5 First trimester ultrasound:

Ultrasound assessment of gestational age is most accurate in the first trimester of pregnancy. During this time, biological variation in fetal size is minimal. The gestational sac is the earliest unequivocal sonographic sign of pregnancy.(Goldstein I, et al 1991) (Bernaschek G,et al1988) Historically, gestational sac size and volume had been used as a means to estimate gestational age.(Koorn El ,Kaufman M1967) (donald I,abdulla U,1967) This structure sonographically resembles a fluid filled sac surrounded by a bright echogenic ring, the developing chorionic villi, within the endometrial cavity. This sac can be visualized as early as five menstrual weeks using transvaginal sonography.(Hellman LM et al,1979)(De Cripingy LC,et al ,1989) More recently, reliable, with a prediction error up to two weeks. Another imprecise yet often used modality is the sonographic visualization of distinct developing structures.(Steinkampf MP ,1997) During the fifth

menstrual week, the yolk sac, the earliest embryonic structure detectable by sonography, can be visualized prior to the appearance of the fetal pole. And, by the end of the sixth menstrual week, a fetal pole with cardiac activity should be present. Subsequently, the presence of limb buds and midgut herniation can be seen at approximately 8 weeks gestation. However, these developmental landmarks can only provide rough estimates to the actual fetal age. In 1973, Robinson reported using the crown-rump length (CRL) for determining gestational age.(Ropinson HP ,Fleming JEE 1975)Since that time, ultrasound equipment, techniques and prediction formulas have substantially improved and allow for more rapid and precise measurement of the crown rump length and determination of gestational age.(Daya s. 1993)(Mac Gregor SN 1987)For the best results, the fetus should be imaged in a longitudinal plane. The greatest embryonic length should be measured by placing the calipers at the head and rump of the fetus. Three adequate CRL measurements should be taken and the average used for gestational age determination.(Filly RA,Hadlock FP,2000) The accuracy of the CRL measurement has been well documented in the medical literature. Specifically, gestational age can be estimated safely with a maximal error of three to five days in the first trimester.(Wisser J etal 1994) (drumm JE , etal ,1976)In summary, first trimester ultrasound is a useful and reliable tool in the assessment of gestational age. In particular, sonographic measurement of the CRL during the first trimester is the best parameter for estimating gestational age and is accurate within five days of the actual conception date.

Fig (2.15)Thelongitudinal axis of fetus using trans abdominal method.Ultrasound image demonstrating the fetal crown-rump length measurement in the first trimester "adapted from Trish Chudleigh and Basky 2008

2.2.6 Second trimester ultrasound:

Although routine ultrasonography at 18–20 weeks gestation is controversial,(Ewigman BG,et al 1993) it is practiced bymanyobstetricians in the United States.(Chervenak FA , Mc Cullough L,1994) In addition to screening for fetal anomalies, sonographic gestational age assessment may be of clinical value in that it has been shown to decrease the incidence of post term as well as preterm diagnoses and thus the administration of tocolytics.(Romero R , et al 1993) (Taiple P , et al 2001) In addition, uncertain gestational age has been associated with higher perinatal mortality rates and an increase of low birth weight and spontaneous preterm delivery.

2.2.7 Ultrasound Parameters

When choosing the optimal parameter for estimating gestational age, it is essential that the structure has little biologic variation, is growing at a rapid pace, and can be measured with a high degree of reproducibility.(Compbell

S 1993) In the past, the biparietal diameter (BPD) had been described as a reliable method of determining gestational age.While the BPD was the first fetal parameter to be clinically utilized in the determination of fetal age in the second trimester, more recent studies have evaluated the use several other biometric parameters including head circumference (HC), abdominal circumference (AC), femur length (FL), foot length,ear size, orbital diameters, cerebellum diameter(Hadlock Faet al ,1982) and others. In a large study by Chervenak et al that evaluated pregnancies conceived by in vitro fertilization and thus had known conception dates, head circumference was found to be the best predictor of gestational age compared with other commonly used parameters (Table 2-1). This finding is in agreement with that ofHadlock,10 Ott11 and Benson48 who compared the performance of HC, BPD, FL and AC in different populations.(Benson CB ,Doubilet PM, 1991).

Table 2-1: Comparison of ste regression in estimation of fet age for singletons using different second trimester biometric parameters by Chervenak et al:

Biometric parameters	Random error (days)
HC	3.77
AC	3.96
BPD	4.26
FL	4.35
HC+AC	3.44
HC+FL	3.55
HC+AC+FL	3.35

(Adapted from Chervenak FA, Skupski DW, Romero R, et al. How accurate is fetal biometry inthe assessment of fetal age? American Journal of Obstetrics and Gynecology 1998; 178:678–87)

The head circumference should be measured in a plane that is perpendicular to the parietal bones and traverses the third ventricle and thalami (Fig. 2.17) The image should also demonstrate smooth and symmetrical calvaria and the presence of a cavum septum pellucidum. The calipers should be placed on the outer edges of the calvaria and a computer-generated ellipse should be adjusted to fit around the fetal head without including the scalp.

Fig (2.16): Ultrasound image demonstrating the head circumference measurement in a second trimester fetus " Asim Kurjak & A Chervenak , 2004

The biparietal diameter can be taken in the same plane by placing the calipers on the outer edge of the proximal calvarium wall and on the inner edge of the distal calvarium wall. The BPD, while highly correlated with HC, is less accurate as a predictor of gestational age as a result of variation in head shape.(Manning FA,1999).
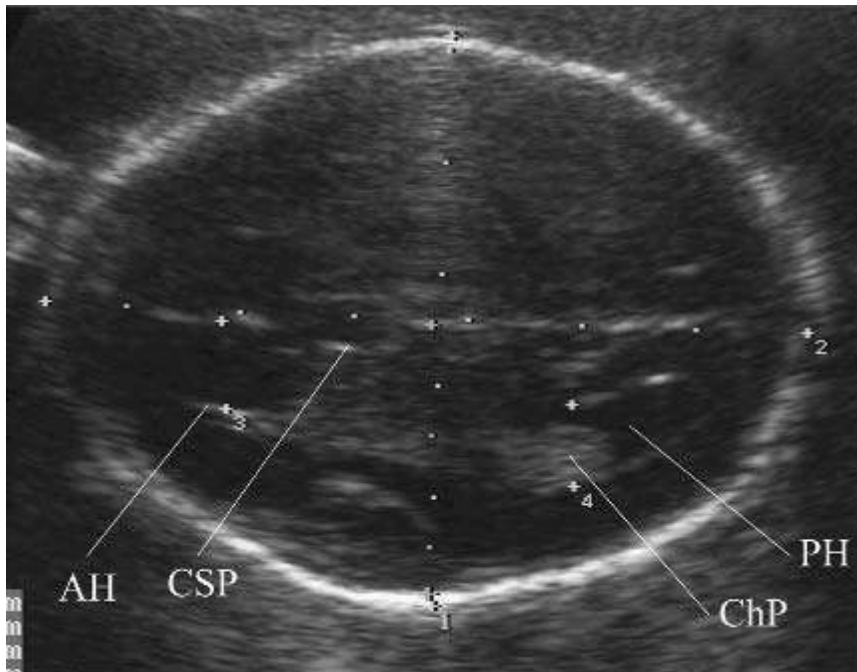
Fig 2.17. Transverse section of the fetal head with the callipers placed on the outer border of both the proximal and distal parietal bones (diameter 1). The measurement therefore produces an 'outer to outer' BPD measurement. The occipitofrontal diameter has also been measured in this image (diameter 2). Note the placement of the calipers to produce an 'outer to outer' OFD measurement. Measurements of the anterior and posterior horns of the distal lateral ventricle and distal hemisphere have also been taken (diameters 3, 4 and 1, respectively)." Teish Chudleigh T. , Thilaganathan B., 2004

Multiple parameters have been shown to improve the accuracy of gestational age assessment. Along with head circumference, the addition of one parameter (AC or FL) or two parameters (AC and FL) is slightly superior to head circumference alone in the prediction of fetal age. Table 2-1 demonstrates the relative error associated with the use of different biometric parameters. The use of multiple parameters also reduces the effect of outliers caused by biologic phenomena (i.e. congenital anomalies or growth

variation) or technical error in measurement of a single structure. Still, with multiple parameters, it is important to take the images in the proper plane and place the calipers appropriately. For example, when assessing FL, the long axis of the femur should be aligned with the transducer measuring only the osseous portions of the diaphysis and metaphysis of the proximal femur. While not included in the FL measurement, the proximal epiphyseal cartilage (future greater trochanter) and the distal femoral epiphyseal cartilage (future distal femoral condyle) should be visualized to assure that the entire osseous femur can be measured without foreshortening or elongation (Fig.2.19).

Similarly, the AC must be measured appropriately in order to obtain an accurate estimate(Goldstein RB,1987). The image should taken in a plane slightly superior to the umbilicus at the greatest transverse abdominal diameter, with the liver, stomach, spleen and junction of the right and left portal veins visualized (Fig.2.20).

Figure 2.18: Ultrasound image demonstrating the femur length measurement in a second trimester fetus" Asim Kurjak & A Chervenak , 2004

Fig 2.19: Ultrasound image demonstrating the abdominal circumference measurement in a second trimester fetus" Asim Kurjak & A Chervenak , Donald school 2004

Most modern ultrasound machines are equipped with computer software that will automatically calculate the estimated gestational age based on the entered measurements. Using a large singleton in vitro fertilization (IVF) population from 14–22 weeks, Chervenak et al derived an optimal gestational age prediction formula using stepwise linear regression with a standard deviation (SD) of 3.5 days between the predicted and true gestational age. This formula was compared it to 38 previously published equations. Nearly all equations produced a prediction within one SD of gestational age is applicable and accurate across populations and institutions. Clinically, when a discrepancy greater than seven days (2SD) exists between the menstrual and ultrasound dating in the second trimester, the biometric prediction should be given preference.(" Asim Kurjak & A Chervenak , 2004)

2.2.8 Third trimester ultrasound

While ultrasound has proven to be useful in the assessment of gestational age in the first and second trimesters, accuracy in the third trimester is not as reliable. Biologic variation can be a major factor that affects accuracy in gestational age prediction, and this variability greatly increases with advancing pregnancy. Doubilet and Benson evaluated late third trimester ultrasound examinations of women who had also received a first trimester exam and found the disparity in gestational age assessments to be three weeks or greater. Thus, third trimester sonographic estimates of gestational age should be used with caution, if at all (Asim Kurjak & A Chervenak ,2004)

2.3 Previous Studies:

Mr. Christopher Chukwuemeka Ohagwu 2008, Perform study to investigate placental thickness as a parameter for estimating gestational age in normal singleton pregnancies in Nigerian women. 730 Nigerian women with normal singleton pregnancies who were attending antenatal clinic at Federal Medical Centre, Makurdi, Nigeria were studied by transabdominal ultrasound between February, 2007 and January, 2008. Sonography was carried out using Sonoscape SSI 600 ultrasound machine with 3.5MHz transducer. Gestational age was estimated by crown-rump length (CRL), biparietal diameter (BPD), femur length (FL) and abdominal circumference (AC) and the composite average recorded while placental thickness was measured at the point of insertion of the umbilical cord. Mean placental thickness with standard deviation was calculated for each gestational age. Correlation analysis was used to determine the relationship between placental thickness and gestational age while regression analysis yielded mathematical relationships between placental thickness and gestation age. The maximum mean placental thickness of 45.1 ±6.4mm was recorded at 39 weeks gestation. There was a fairly linear increase in mean placental thickness with gestation age. There was significant and strong positive correlation between placental thickness and gestational age. Placental thickness appears promising as an accurate indicator of gestational age in singleton pregnancies in Nigerian Women. (African Journal of Biotechnology, 2009).

.P Mital, N Hooja, K Mehndiratta.2002, perform study to evaluating placental thickness, which measured at the insertion of the umbilical cord, to be as a parameter for estimating gestational age of the fetus. Materials and Methods: The study was conducted on 600 normal antenatal women of all

gestational ages (10 weeks of gestation) attending Antenatal Clinic at the Department of Obstetrics and Gynecology, S.M.S. Medical College, Jaipur (Rajasthan) from August 2001 to February 2002. USG was done by using Toshiba Canasee II machine with a 3.75 MElz sector probe. After estimating the fetal age by CRL, BPD, HC, AC, and FL, the placental thickness with standard deviation was calculated for all gestational ages. Results: It was observed that the placental thickness gradually increased from 15 mm at 11 weeks of gestation to 37.5 mm at 39 weeks. From the 22nd week to the 35th week of gestation the placental thickness coincide almost exactly with the gestational age in weeks. Conclusion: To conclude, the measurement of the placental thickness is an important parameter for estimation of fetal age along with other parameters especially in the late mid trimester and early third trimester, where the exact duration of pregnancy is not known.(Indian journal of radiology and imaging, 2002).

Mohammad Tahir Sheikh perform study to evaluating the placental thickness, measured at or close to the insertion of the umbilical cord, as a parameter for estimating gestational age of the fetus. Materials & Methods: The study was conducted on 100 normal antenatal women of all gestational ages (>13 weeks of gestation) attending Afro-Asian Institute of Medical Sciences, Lahore, Pakistan, and Tahir Medical Centre, Lahore, Pakistan, from February 2005 to October 2005. USG was done by using abdominal ultrasound machines, Toshiba Nemio 20 & Honda HS 200 at Afro-Asian Institute of Medical Sciences and with Belson 200 at Tahir Medical Centre with convex probe 3.5-5 MHz. After estimating the fetal age by BPD & FL, the placental thickness was measured in millimeters in each case. Results: It was observed that the placental thickness gradually increased from the start of the 2nd trimester to the 37th week of gestation. From the 21st week to the

35th week of gestation, the placental thicknes scoincide almost exactly the gestational age in weeks. Conclusion: Measurement of placental thickness is an important parameter for estimation of fetal age along with other parameters. (http:// sustech.edu).

Chapter Three
Method and Material

Chapter Three

Method and Material

3.1 Method:

Study design: this has adopted the analytical descriptive pattern

3.1.1 Inclusion criteria:

All 50 cases included in this study were normal pregnant women between age of 20 to 42 years old came to the ultrasound department for antenatal routine scanning.

3.1.2 Exclusion criteria:

The cases found to be of high risk including IUGR, Hypertension, diapetes mellitus, fetal anomalies, and multiplepregnancies were excluded.

3.1.3 Study area:

Madani-sudan , madani hospital

Khartoum –Sudan, Saudi hospital,bashair hospital

3.1.4 Study duration:

The study was conducted in 3 monthsJune 2016 to august 2016

3.2 Material

3.2.1 The equipment used includes:

At madani hospital: ultrasound machine used was" mindray –digiprince DP-6600" with a 3.5 MHz convex transducer.

At basair hospital and suadi hospital:

Ultrasound machine used was "sonoscape " eith 3.5MHz convex transducer.

3.2.2 Data collection:

All data collection during study was collected in sheets of paper (data collecting sheet) which were designed especially for the study and U/S images.

3.2.3 Technique:

Patients were examined in supine position and ultrasound coupling gel was applied.

The feoetuses were scanned for viability and congenital anatomical defect and gestational age was estimated using BPD.

3.2.4 Ethical clearance:

The procedures of the scanning with ultrasound was explained to the patient and the purpose of study.
 Permission from the hospital and the department
The data of study were kept in confidentiality

Chapter Four

Results

Chapter Four

Results

Table 4.1: comparison between fetal parameter and statistics

	Mean	Median	STD	Min	Max
Age	26.26	25	5.921	20	45
Bpd mm	79.48	78	17.186	35	97
Bpd Ga WKs	31.86	35	6.984	15	39
FL mm	60.92	67	16.333	20	87
FL ga WKs	31.8	34.5	6.785	15	40
Lmp Ga	31.76	35	7.405	13	40
Average Age WKs	31.9	35	6.834	15	40
Pt mm	32.98	36	7.02	15	40
GA By Pt WKs	34.08213	36.81979	7.090196	15.8776	41.1701

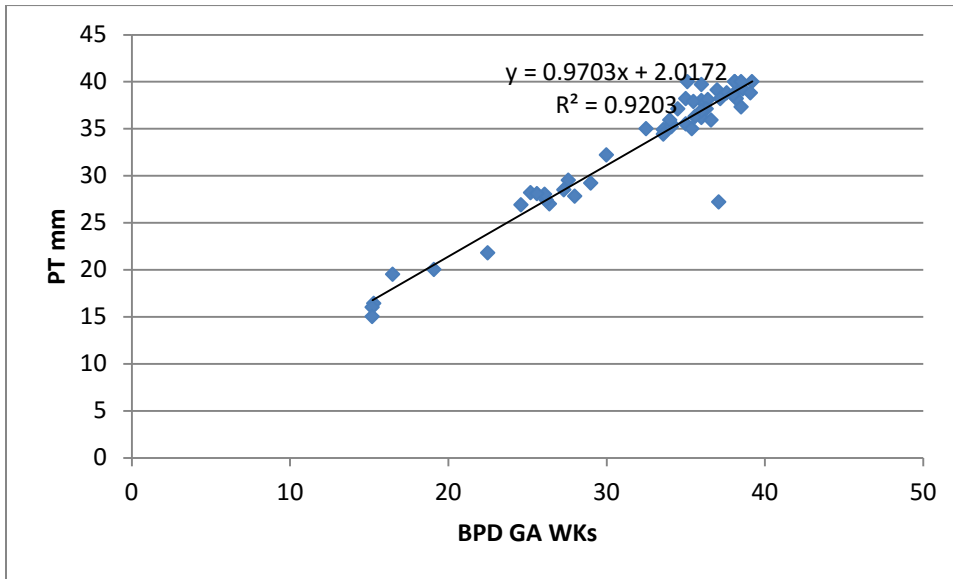Fig (4.1): relationship between placental thickness and gestational age in weeks taken by Bipariatal diameter

Fig (4.2): relationship between placental thickness and gestational age in weeks taken by femur length
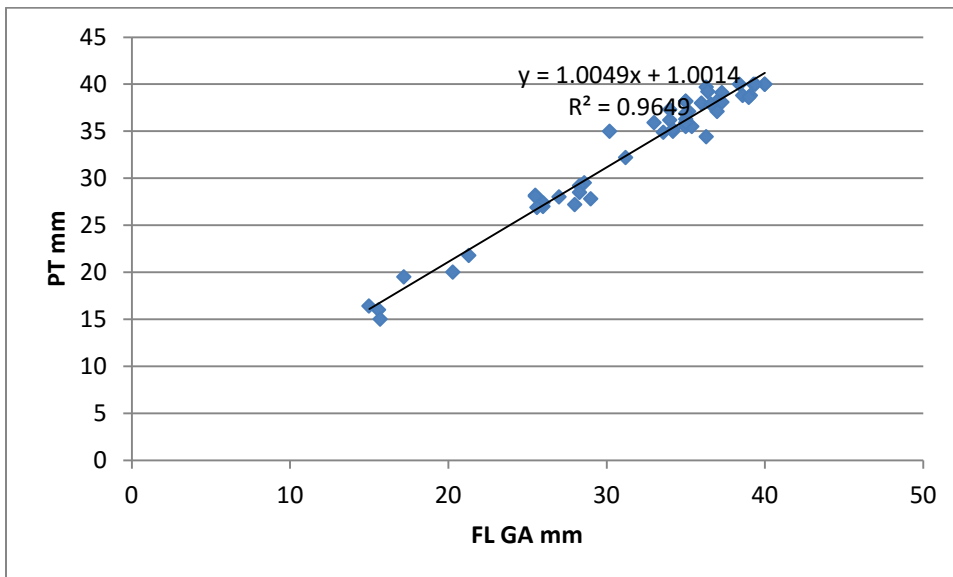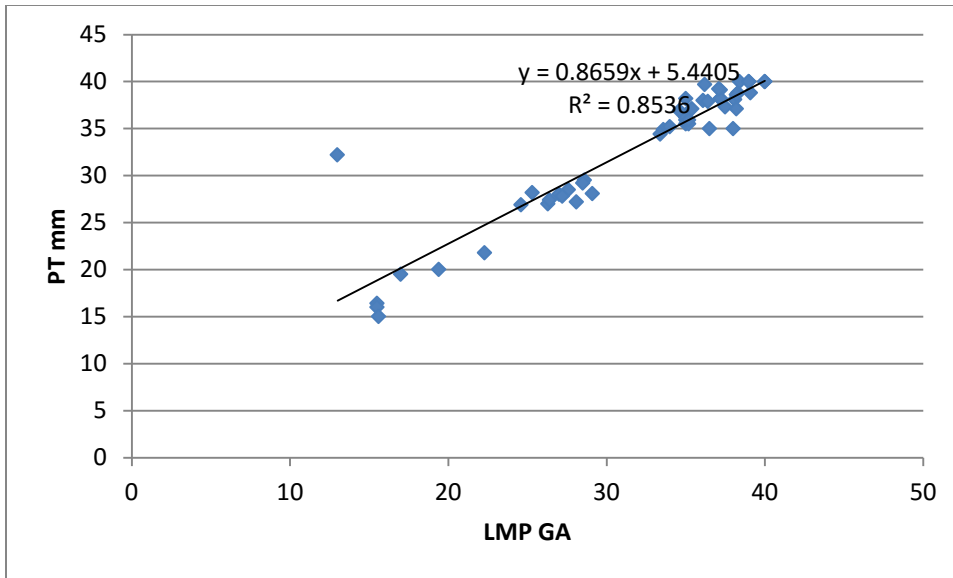
Fig(4.3): relationship between placental thickness and gestational age in weeks taken by last menstrual period
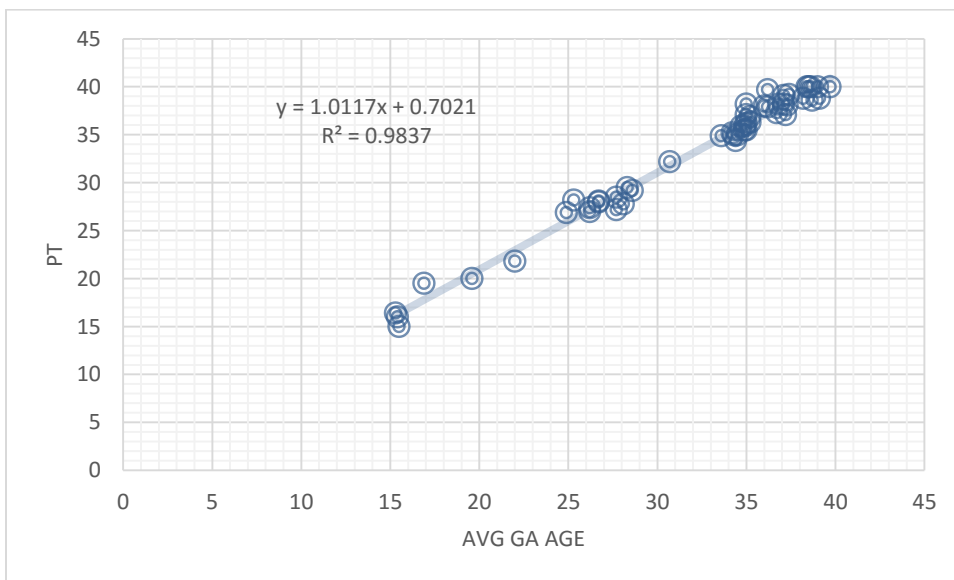
Fig(4.4): relationship between the placental thickness and average gestational age
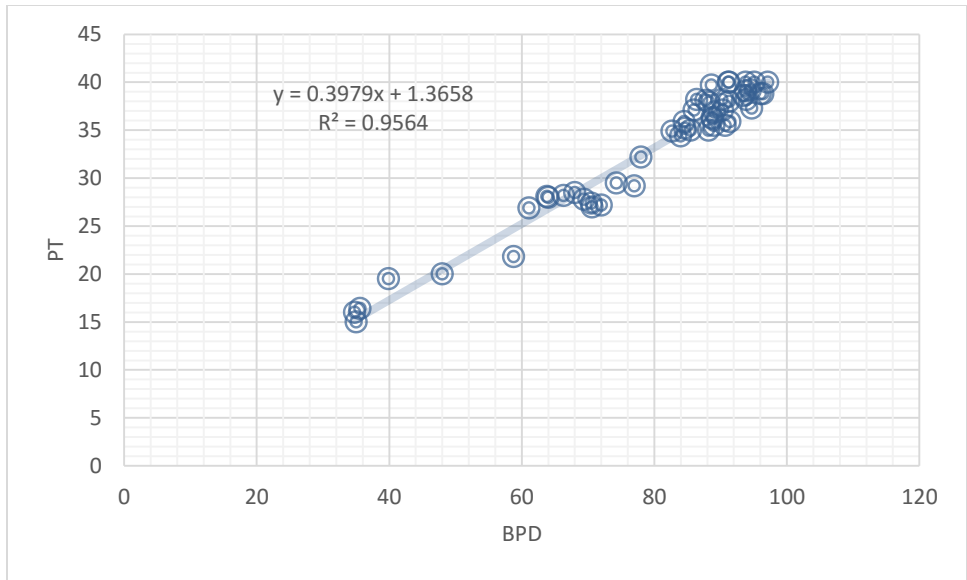
Fig(4.5): linear relationship between the placental thickness and Bipariatal diameter in mm

Fig (4.6): linear relationship between the placental thickness and femur length in mm

Fig (4.7):relationship between the average gestational age from BPD , FL ,and LMP with that from the placental thickness

Fig(4.8):relationship between the maternal age and placental thickness

Chapter Five

Discussion, Conclusion and Recommendation

Chapter Five

Discussion, Conclusion and Recommendation

5.1 Discussion

The result presented above, indicate that there is alinear correlation between placental thickness and growth parameter (bipariatal diameter (bpd) , femur length and last menstrual period)during both second and third trimester .(fig(4.1) (4.2)(4.3))
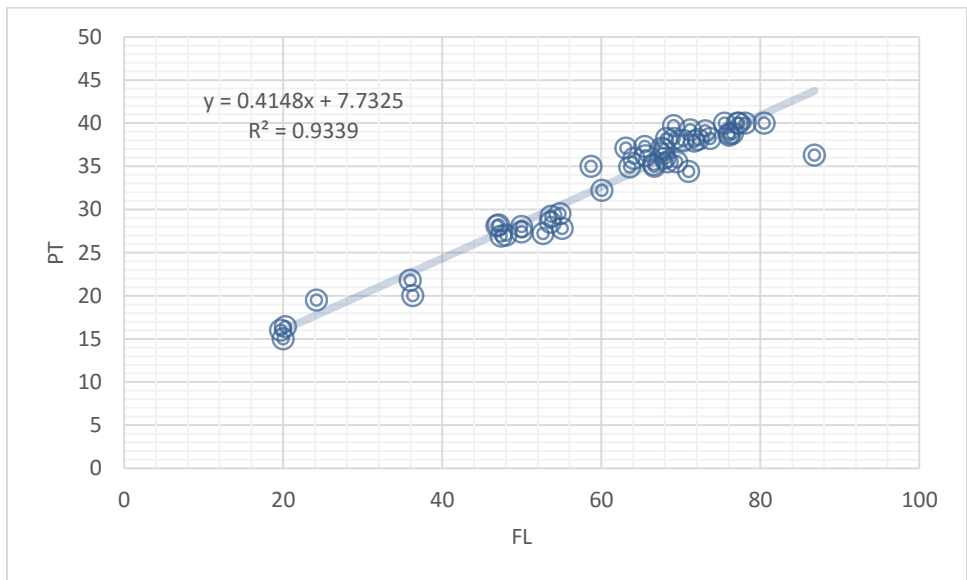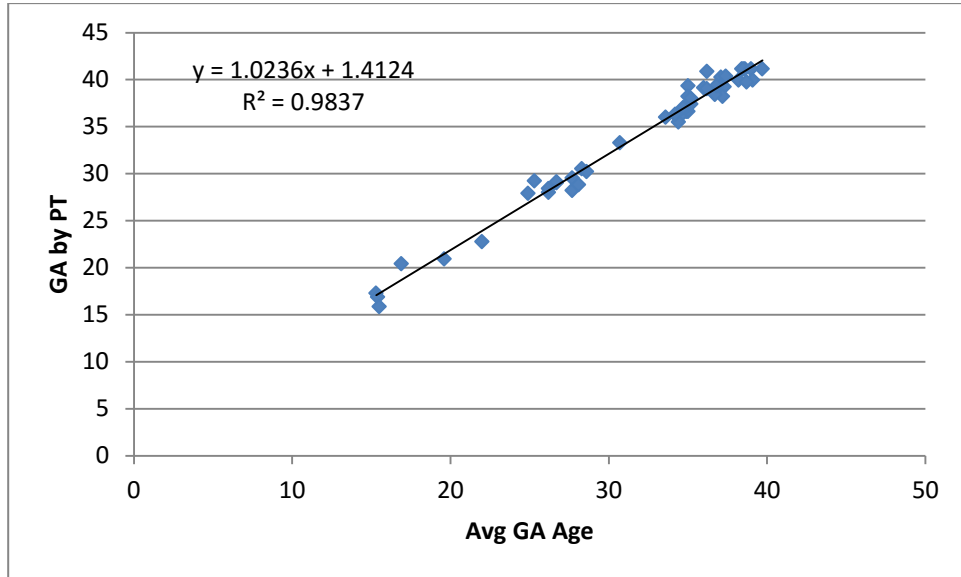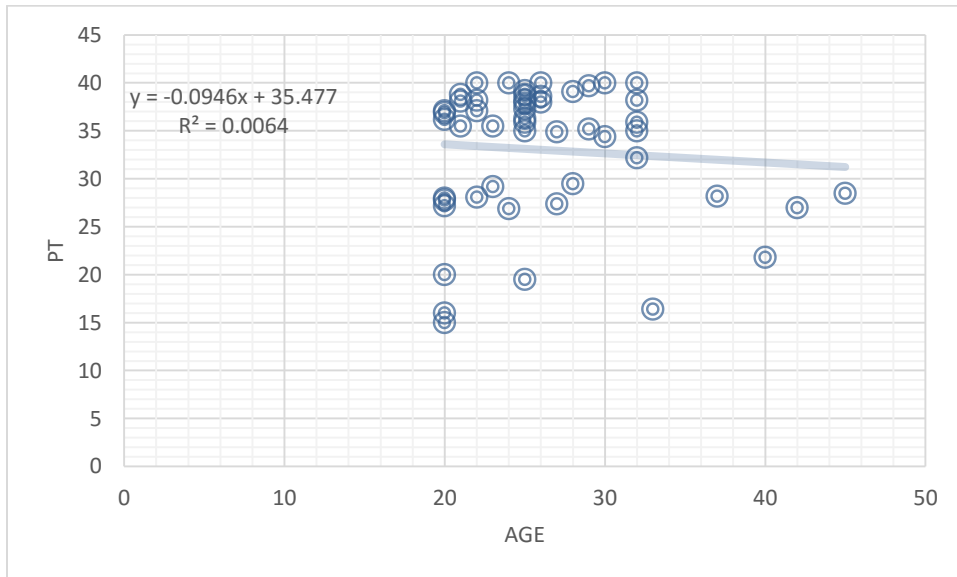
After analyzing the total number of data a linear relationship between the placental thickness and average gestational age taken from femur length, bipariatal diameter and last menstrual period-was revealed.(fig 4.4)

The relation during both 2nd and 3rd trimesters was as follows:{y (average gestational age in weeks)=1.0117×(placental thickness)+0.7021} and an R=0.9837

There is linear relationship between the placental thickness and BPD, and FL in mm in both second and third trimesters. Fig(4.5)(4.6)

And when it used the first formula, it calculated the gestational age using the placental thickness as a parameter, and then when comparing the average gestational age from BPD , FL ,and LMP with that from the placental thickness it also clearly showed a linear relationship.(fig 4.7)

However there is no correlation between maternal age and placental thickness in both second and third trimesters.(fig 4.8)

These results agreed with the ones from (P Mital et al august 2001);which was a study done in S.Msmedical college,Jaipur(rajasthan ,it was observed that the placental thickness gradually increase with gestational age in weeks .

The result also agreed with those from study in October 2008 Ohagwu et al ,in Nigeria which stated that there was fiarly linear increase in placental thickness with gestational age.

Also agreed with those from Mohammed tahir sheikh in February 2005 in pakistan which stated that the placental thickness coincide almost exactly the gestational age .

These result indicate that the placental thickness can be used as aparameter for evaluation of gestational age especially after ohagwu et alfound the linear correlation even with AC (abdominal circumference) whiclh is very important parameter in calculating fetal weight ,which means that the placental thickness might be the earliest sign of fetal anomalies .

The mean placental thickness calculated was (32.98)and the maximum thickness of 40 mm at 40 weeks of gestation. The minimum thickness was 15 at 15 weeks of gestation.

5.2 Conclusion:

There was fairly linear relationship between placental thickness and gestational age calculated from bipariatal diameter, femur length and last menstrual period.

The equation derived from both second and third trimester :{y (average gestational age in weeks)=1.0117×(placental thickness)+0.7021} and an R=0.9837 can be used in estimating gestational age using placental thickness as a parameter .

There was no correlation between maternal age and placental thickness in second or third trimesters.

5.3 Recommendations:

The formula :{y (average gestational age in weeks)=1.0117×(placental thickness)+0.7021} and an R=0.9837 should be used to calculate gestational age along with other equation from growth parameter .

The derived formula that uses the placental thickness as a parameter in estimating gestational age need further testing in order to be applicable and installed in ultrasound machine.

Estimate the gestational age by using placenta thickness with abnormal pregnancies is recommended for further studies.

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Appendix

Ultrasound Images

fig(1): measurement of placental thickness in fundal placenta (two stars) was 38.8 mm for 38 wks gestational age

fig(2): measurement of placental thickness in anterior placenta (two stars) was 29mm for 28.5wks gestational age

fig(3): measurement of placental thickness in anterior placenta (two stars) was 24.6mm for 25wks gestational age

fig(4): measurement of placental thickness in anterior placenta (two stars) was 27.6mm for 27wks gestational age

fig(5): measurement of placental thickness in posterior placenta (two stars) was 38.6mm for 39wks gestational age

fig(6): measurement of placental thickness in posterior placenta (two stars) was 31.2mm for 31wks gestational age

fig(7): measurement of placental thickness in anterior placenta (two stars) was 27.2mm for 27wks gestational age

fig(8): measurement of placental thickness in anterior placenta (two stars) was 41mm for 39.5wks gestational age

fig(8): measurement of placental thickness in anterior placenta (two stars) was 22.6mm for 23wks gestational age