

Sudan University of Science and Technology

College of Graduate Study

**Relationship between Gestational Age and Placenta Thickness
during Third Trimester**

العلاقة بين سمك المشيمة وعمر الجنين في الفترة الثالثة للحمل

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

By:

Ibrahim Ali Mahdi Hamid

Supervisor:

Dr. Asma Ibrahim Ahmed Elamin

2016

الآية

قال الله تعالى:

بسم الله الرحمن الرحيم

(عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ)

سورة العلق الآية (5)

Dedication

This thesis is dedicated to:-

-The soul of my parents.

- My dearest wife

-My sweet daughter and my sons.

-My all family.

- My friends.

Acknowledgements

I am deeply indebted to my supervisor Dr. Asma Ibrahim Ahmed Alamin for her support , guidance and valuable idea helped me to complete this work.

I also appreciated the help and support provided to me by my colleagues in ultrasound department at Saudi Maternity Hospital Omdurman.

I like to thanks my friends those who supported me to accomplish this work.

I wish to thanks my teachers those who are cause of my success.

Abstract

The purpose of this study to estimate the correlation between placenta thickness (PT) and fetal age(FA) in normal pregnant women. The study was done on 50 normal pregnant in third trimester. The data used in the study collected in Saudi Maternity Hospital in Omdurman during 2016. The used ultrasound machine with a frequency 3.5MHz convex probe. The results of the study showed that there is a positive correlation between placenta thickness and gestational age (GA) .It was found that the placental thickness gradually increased with the increase of gestational age. where the placental thickness in millimeters coincide almost exactly the gestational age in weeks special from early weeks of third trimester to the 35th week of gestation .the study showed the maximum placental thickness of 50 millimeters was recorded at 32 weeks gestation.

It is recommended further studies to estimate the fetal age by using placental thickness for different nationalities or with abnormal pregnancies.

ملخص الدراسة

هدف هذه الدراسة تقدير عمر الجنين عن طريق دراسة العلاقة بين سمك المشيمة وعمر الجنين . وقد أجريت هذه الدراسة على خمسين سيدة سودانية في الفترة الثالثة من الحمل . وقد تم جمع هذه البيانات في قسم الموجات فوق الصوتية بالمستشفى السعودي لامراض النساء والتوليد بمدينة أم درمان في العام 2016م . وذلك باستخدام جهاز الموجات فوق الصوتية مستخدم مسبار الكشف عن طريق البطن وقد كان التردد 3.5 ميغا هرتز. وقد خلصت هذه الدراسة الى وجود علاقة خطية موجبة بين سمك المشيمة وعمر الجنين وأن سمك المشيمة يزداد تدريجيا مع ازدياد عمر الجنين. وأن سمك المشيمة بالمليمترات يتطابق مع عمر الجنين بالأسابيع خاصة من الأسابيع الأولى للفترة الثالثة من الحمل حتى الإِسبوع الخامس والثلاثين من الحمل. وقد وجدت هذه الدراسة أن أعلى سمك للمشيمة كان 50 ملليمتر وقد سجل في الأسبوع الثاني والثلاثين من الحمل. كما يوصى بإجراء دراسات أخرى لتقييم عمر الجنين باستخدام سمك المشيمة على مجموعة من الحوامل من جنسيات مختلفة او حوامل لديهم مشاكل في الحمل.

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List of abbreviation

PT	Placental thickness
GA	Gestational age
LMP	Last menstrual period
US	Ultrasound
BPD	Biparietal diameter
FL	Femur length
AC	Abdominal circumference
HC	Head circumference
FA	Fetal age
HCG	Human chorionic gonadotropin
IgG	Gamma globulins
D	Day
W	Week

Chapter one

Introduction

Chapter one

Introduction

1:1 Introduction:

The placenta is a fetal organ which provides the physiological link between pregnant woman and the fetus. The placenta is highly vascularized organ and its main functions are to exchange of metabolic, gaseous products between maternal and fetus blood stream and production of hormones.

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 echo texture of the placenta is clearly apparent at sonography. (Peter, 2007).

It is usually 2-4 cm thick and weight about 600 gram (about 1/6 of the weight of the baby). It is technically defined as the apposition or fusion of fetal organs to maternal tissue for the purpose of physiologic exchange ([http//Wikipedia](http://Wikipedia)).

The estimation of the 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), biparietal diameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC)... Placenta thickness measured at the level of the umbilical cord insertion and can be used as a new parameter to estimate gestational age of the fetus. (peter,2007).

Placenta thickness appears to be a promising parameter for estimation of gestational age of intra uterine fetus. This is due to increase in placental thickness with gestational age...Several studies have reported an increase the placental thickness with gestational age. The studies reported was confirmed the placental thickness as an indication of gestational age of fetus. ([http//Wikipedia](http://Wikipedia)).

The aim of this study was to investigate the placental thickness as a parameter for estimating the gestational age of fetus in normal singleton pregnancies among Sudanese women.

The diagnostic ultrasound is safe and no confirmed biological effect on patient or instruments operators caused by exposure at intensities typical of present diagnostic ultrasound instruments have been reported.

1.2 Problem of the study:

Estimation of fetus age using biparietal diameter (BPD), femur length (FL), head circumference (HC), abdominal circumference (AC), during third trimester is affected by fetal movement. In this study is a try to estimate the fetus age by using placental characteristics that which help in normal deliveries .

1.3 Objective:

1-3-1 Main Objective:

To determine the relationship between placental thickness and fetal age in third trimester.

1-3-2: Specific Objective:

- To study the possibility of used ultrasound of placental thickness to determine the fetal age in third trimester.
- To Correlate the accuracy of assessment of age by placental thickness comparing with femur length. Biparietal diameter, abdominal circumference and last menstrual period .

1-4: Overview of the study:

The study will consist of five chapters:

- Chapter one will include introduction .
- Chapter two will include back ground + literature review.
- Chapter three will include the methods and materials .
- Chapter four will include the results.
- Chapter five will include the discussion, conclusion and recommendation followed by references and appendices.

Chapter Two

Chapter two

2.1 Anatomy of placenta:-

2.1.1 Component of placenta:-

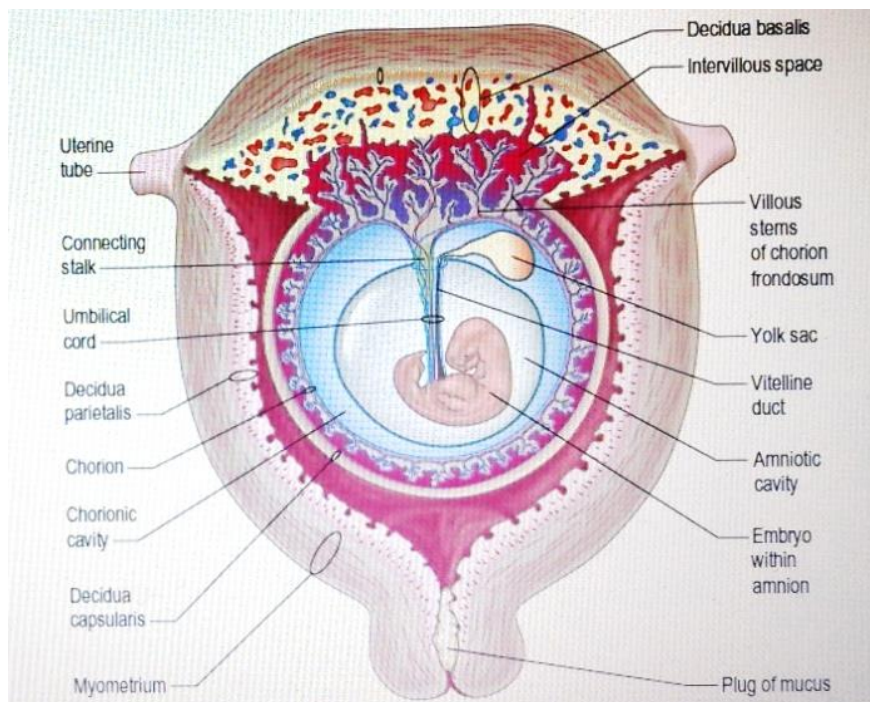
The placenta connects the fetus to the uterine wall, and is the organ by means of which the nutritive, respiratory, and excretory functions of the fetus are carried on. It is composed of fetal and maternal portion:-

2-1-1-1 Fetal portion: the fetal portion of the placenta consists of the villi of the chorion frondosum. These branch repeatedly, and increase enormously in size. These greatly ramified villi are suspended in the intervillous space and are bathed in maternal blood, which is conveyed to the space by the uterine arteries and carried away by the uterine veins. A branch of an umbilical artery enters each villus and ends in a capillary plexus from which the blood is drained by a tributary of the umbilical vein. The vessels of the villus are surrounded by the thin layer of mesoderm consisting of gelatinous connective tissue, which is covered by two strata of ectodermal cells derived from the trophoblast. The deeper stratum, next the mesodermic tissue, represents the cytotrophoblast or layer of Langhans; the superficial, in contact with the maternal blood, the syncytiotrophoblast. After the fifth month the two strata of cells are replaced by a single layer of somewhat flattened cells (Henry Gray pdf, Anatomy of human body).

2-1-1-2 Maternal Portion:-

The maternal portion of the placenta is formed by the decidua placentalis containing the intervillous space. As already explained, this space is produced by the enlargement and intercommunication of the spaces in the trophoblastic network. The changes involve the disappearance of the greater portion of the stratum compactum, but the deeper part of this layer persists and is condensed to form what is known as the basal plate. Between this plate and the uterine muscular fibres are the stratum spongiosum and the boundary layer; through these and the basal plate the uterine arteries and veins pass to and from the

intervillous space. The endothelial lining of the uterine vessels ceases at the point where they terminate in the intervillous space which is lined by the syncytiotrophoblast. Portions of the stratum compactum persist and are condensed to form a series of septa, which extend from the basal plate through the thickness of the placenta and subdivide it into the lobules or cotyledons seen on the uterine surface of the detached placenta. (Fig 2-1).



Fig(2-1)The gravid uterus in the second month(Susan ,2008).

2. 1.2 Development of the placenta:-

Formation of the human placenta requires a developmental progression which proceeds in a specific order over time; it is specified by the trophoblast, but dependent on the maternal environment for its correct expression. Immunological rejection of the semi-allogenic conceptus does not occur because the syncytiotrophoblast expresses neither Class I nor Class II MHC antigens. By contrast, the invading extravillous trophoblast expresses human leukocyte antigen-G (HLA-G) and -C, which interact with receptors on the uterine NK cells.

As the blastocyst implants, the syncytiotrophoblast invades the uterine tissues, including the glands and walls of maternal blood vessels, and increases rapidly in thickness over the embryonic pole. A progressively thinner layer covers the rest of the wall towards the abembryonic pole. Microvillus-lined clefts and lacunar spaces develop in the syncytiotrophoblastic envelope (days 9–11 of pregnancy) and establish communications with one another. Initially, many of these spaces contain maternal blood derived from dilated uterine capillaries and veins, as the walls of the vessels are partially destroyed. As the conceptus grows, the lacunar spaces enlarge, and become confluent to form an intervillous space. (Susan, 2008).

The projections of syncytiotrophoblast into the maternal decidua are called primary villi. They are invaded first with cytotrophoblast and then with extraembryonic mesenchyme (days 13–15) to form secondary placental villi. Fetal capillaries develop in the mesenchymal core of the villi. The cytotrophoblast within the villi continues to grow through the invading syncytiotrophoblast and makes direct contact with the decidua basalis, forming anchoring villi. Further cytotrophoblast proliferation occurs laterally so that neighbouring outgrowths meet to form a spherical cytotrophoblastic shell around the conceptus (Fig 2-2). Lateral projections from the main stem villus form true and terminal villi. (Susan, 2008).

As secondary villi form, single mononuclear cells become detached from the distal cytotrophoblast and infiltrate the maternal decidua.

These cells are the third line of the original trophoblastic cells. They are found both within and around the spiral arteries in the central area of the placenta and gradually extend laterally, reaching the periphery of the placenta around mid-gestation. They normally extend into the inner third of the uterine myometrium within the central region of the placental bed, but the extent of invasion is progressively shallower towards the periphery. At the same time,

cytotrophoblast from the spherical shell penetrates into and migrates along the inner walls of maternal spiral arteries (endovascular extravillous trophoblast) so that by the 18th week it has reached the inner myometrial segments. The interstitially migrating cells invade the spiral arteries from their adventitia. The vessels lose their elastic lamina and consequently their responsiveness to circulating vasoactive compounds. The smooth muscle and associated elastic and collagenous matrix is replaced with non-resistive fibrinoid, an arrangement that permits an expansion of the vessels and as much as a 20-fold increase in the flow of blood into the intervillous space. In normal pregnancies the transformation of spiral arteries into utero-placental arteries is completed around mid gestation. The main aim of these vascular changes appears to be to optimize the distribution of maternal blood into a low-resistance uterine vascular network. (Susan, 2008).

Common pregnancy pathologies, including intrauterine growth restriction, pre-eclampsia and spontaneous abortion, are all associated with incomplete vascular remodelling, which probably reflects a failure of penetration by extravillous trophoblast. (Susan, 2008).

With the onset of the embryonic heartbeat, a primitive circulation exists between the embryo and the yolk sac, succeeded later by that between the embryo and the placenta. The formed placenta is composed of a chorionic plate on its fetal aspect and a basal plate on the maternal aspect, and an intervening intervillous space containing villous stems with branches in contact with maternal blood (Fig2-2).

Since maternal blood bathes the surfaces of the chorion which bound the intervillous space, the human placenta is defined as haemochorial.

Different grades of fusion exist between the maternal and fetal tissues in many other mammals (e.g. epitheliochorial, syndesmochorial, endotheliochorial).

The chorion is vascularized by the allantoic blood vessels of the body stalk, and so the human placenta is also termed chorioallantoic (whereas in some mammals a choriovitelline placenta either exists alone or supplements the chorio-allantoic variety). In addition, the human placenta is defined as discoidal (in contrast to other shapes in other mammals) and deciduate because maternal tissue is shed with the placenta and membranes at parturition as part of the after birth. (Susan, 2008).

2.1.2.1 Growth of placenta:-

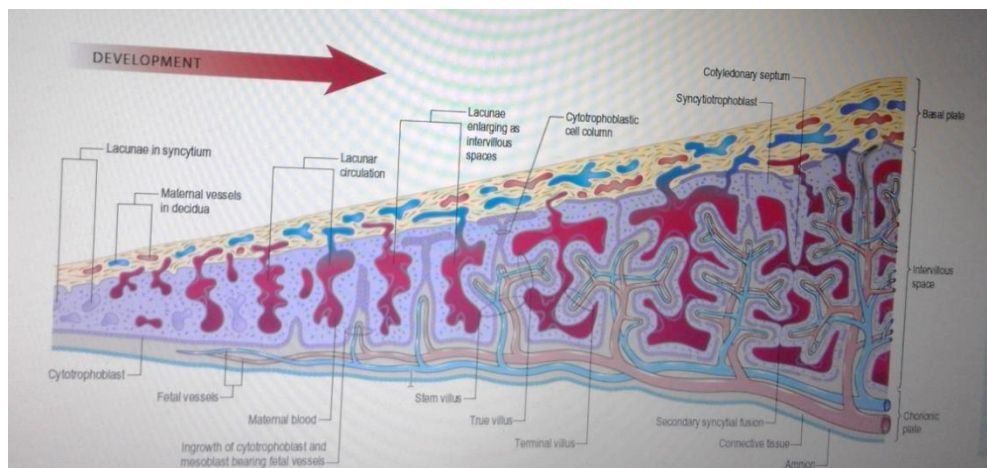
Expansion of the entire conceptus is accompanied by radial growth of the villi and, simultaneously, an integrated tangential growth and expansion of the trophoblastic shell. Eventually each villous stem forms a complex that consists of a single trunk attached by its base to the chorion, from which second and third order branches (intermediate and terminal villi) arise distally. Terminal villi are specialized for exchange between fetal and maternal circulations; each one starts as a syncytial outgrowth and is invaded by cytotrophoblastic cells, which then develop a core of fetal mesenchyme as the villus continues to grow.

The core is vascularized by fetal capillaries (i.e. each villus passes through primary, secondary and tertiary grades of histological differentiation).

The germinal cytotrophoblast continues to add cells that fuse with the overlying syncytium and so contribute to the expansion of the haemochorial interface. Terminal villi continue to form and branch within the confines of the definitive placenta throughout gestation, projecting in all directions into the intervillous space (Fig 2-2). (Susan, 2008).

From the third week until about the second month of pregnancy, the entire chorion is covered with villous stems. They are thus continuous peripherally with the trophoblastic shell, which is in close apposition with both the decidua capsularis and the decidua basalis. The villi large and small decidual cells scattered in a connective tissue framework that supports an extensive

venous plexus. From the third month onwards the basal plate develops placental or cotyledonary septa, which are ingrowths of the cytotrophoblast covered with syncytium that grow toward but do not fuse with the chorionic plate (Fig2-2). The septa circumscribe the maternal surface of the placenta into 15–30 lobes, often termed cotyledons. Each cotyledon surrounds a limited portion of the intervillous space associated with a villous trunk from the chorionic plate. From the fourth month these septa are supported by tissue from the decidua basalis. Throughout the second half of pregnancy the basal plate becomes thinned and progressively modified: there is a relative diminution of the decidual elements, increasing deposition of fibrinoid, and admixture of fetal and maternal derivatives .

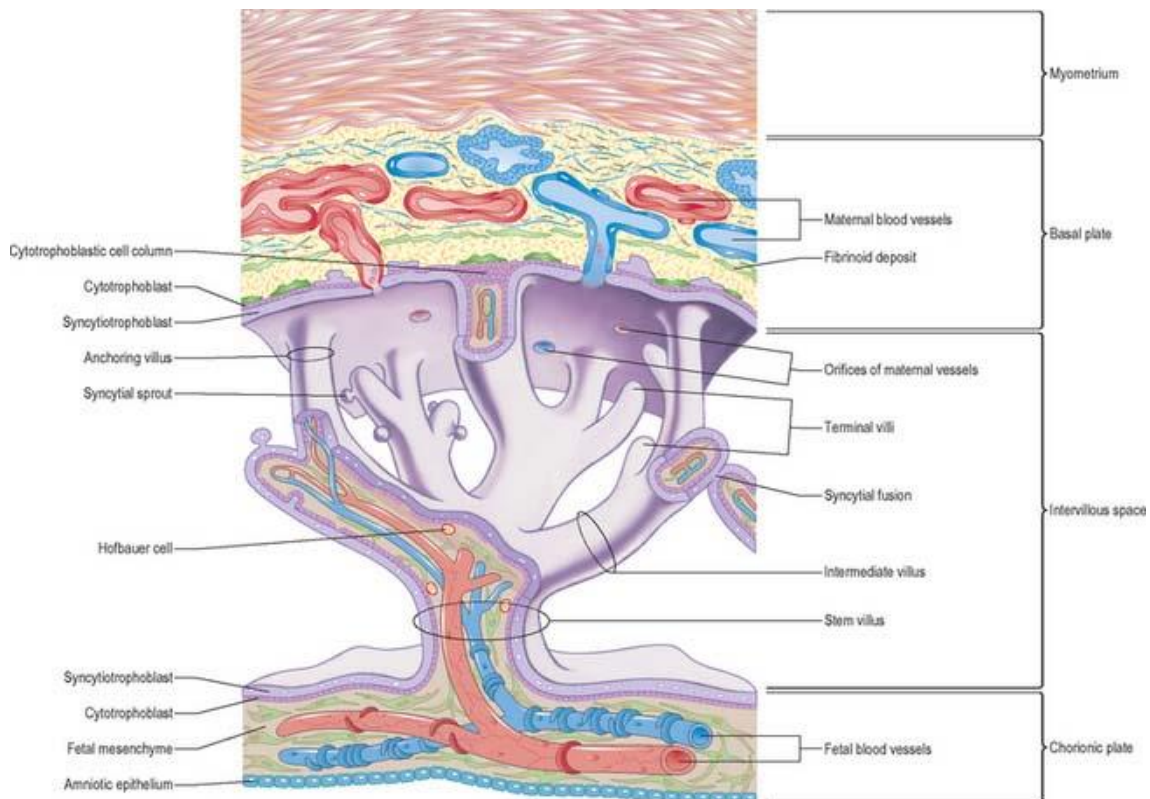


Fig(2-2)Placental development is shown from left to right. (Susan,2008).

2.1.2.2 Chorionic plate:

Amniotic epithelium, on the stromal side of which is a connective tissue layer carrying the main branches of the umbilical vessels (Fig2.2 and Fig2.3). Subjacent to this is a diminishing layer of cytotrophoblast and then the inner syncytial wall of the intervillous space. The connective tissue layer is formed by fusion between the mesenchyme-covered surfaces of amnion and chorion: it is more fibrous and less cellular than Wharton's (Susan, 2008). Jelly (of the umbilical cord), except near the larger vessels. The umbilical vessels radiate and branch from the cord attachment, with variations in the

branching pattern, until they reach the bases of the trunks of the villous stems and then arborize within the intermediate and terminal villi. There are no anastomoses between vascular trees of adjacent stems. The two umbilical arteries are normally joined at, or just before they enter the chorionic plate is covered on its fetal aspect by the chorionic plate, by some form of substantial transverse anastomoses (Hyrtl's anastomosis). (Susan, 2008).



Fig(2.3)The placental tissues from the chorionic plate(fetal side) to the basal plate or decidua basalis(maternal side),(Susan,2008)

2.1.2.3 Basal plate:-

The basal plate, from fetal to maternal aspect, forms the outer wall of the intervillous space. The trophoblast and adjacent deciduas are enmeshed in layers of fibrinoid and basement membrane-like extracellular matrix to form a complex junctional zone. In different places the basal plate may contain syncytium, cytotrophoblast or fibrinoid matrix, remnants of the cytotrophoblastic shell, and, at the site of implantation, areas of necrotic maternal decidua (the so-called Nitabuch's stria) (2.2 and 2.3). Nitabuch's

stria and the decidua basalis contain cytotrophoblast and multinucleate trophoblast giant cells derived from the mononuclear cytotrophoblast population, which infiltrate the decidua basalis during the first 18 weeks of pregnancy. (Susan, 2008).

These cells penetrate as far as the inner one-third of the myometrium, but can often be observed at or near the decidual–myometrial junction.

They are not found in the decidua parietalis or the adjacent myometrium, from which it may be inferred that the placental-bed giant cell represents a differentiative end stage in the extravillous trophoblast lineage. The striae of fibrinoid are irregularly interconnected and variable in prominence. Strands pass from Nitabuch's stria into the adjacent decidua which contains basal remnants of the endometrial glands and large and small decidual cells scattered in a connective tissue framework that supports an extensive venous plexus.

From the third month onwards the basal plate develops placental or cotyledonary septa, which are ingrowths of the cytotrophoblast covered with syncytium that grow toward but do not fuse with the chorionic plate (Fig. 2.2). The septa circumscribe the maternal surface of the placenta into 15–30 lobes, often termed cotyledons. Each cotyledon surrounds a limited portion of the intervillous space associated with a villous trunk from the chorionic plate. From the fourth month these septa are supported by tissue from the decidua basalis. Throughout the second half of pregnancy the basal plate becomes thinned and progressively modified: there is a relative diminution of the decidual elements, increasing deposition of fibrinoid, and admixture of fetal and maternal derivatives. (Susan, 2008).

2.1.2.4 Intervillous space:-

The intervillous space contains the main trunks of the villous stems and their arborizations into intermediate and terminal villi (Figs 2.2 and 2.3). A villous

trunk and its branches may be regarded as the essential structural, functional and growth unit of the developing placenta.(Susan, 2008).

At term, from the inner myometrium to the intervillous space, the walls of most spiral arteries consist of fibrinoid matrix within which cytotrophoblast is embedded. This arrangement allows expansion of the arterial diameter (and so slows the rate of arterial inflow and reduces the perfusion pressure) independent of the local action of vasoconstrictive agents. Endothelial cells, where present, are often hypertrophic. The veins that drain the blood away from the intervillous space pierce the basal plate and join tributaries of the uterine veins. The presence of a marginal venous sinus, which hitherto has been described as a constant feature occupying the peripheral margin of the placenta and communicating freely with the intervillous space, has not been confirmed. Recent anatomic and in vivo studies have shown that human placentation is in fact not truly haemochorial in early pregnancy (Jauniaux et al 2003). From the time of implantation, the extravillous trophoblast not only invades the uterine tissues but also forms a continuous shell at the level of the decidua. The cells of this shell not only anchor the placenta to the maternal tissue but also form plugs in the tips of the utero-placental arteries (Burton et al 1999). The shell and the plugs act like a labyrinthine interface that filters maternal blood, permitting a slow seepage of plasma but no true blood flow into the intervillous space. This is supplemented by secretions from the uterine glands, which are discharged into the intervillous space until at least 10 weeks (Burton et al 2002). The comparison of these anatomical features with physiological data obtained in utero reveals that the architecture of the human first trimester gestational sac is designed to limit fetal exposure to oxygen to that which is strictly necessary for its development, this creates a physiological placental hypoxia which may protect the developing embryo against the deleterious and teratogenic effects of oxygen, and also a uterine O₂ gradient which exerts a regulatory effect on placental tissue development and

function. In particular it influences cytotrophoblast proliferation and differentiation along the invasive pathway and villous vasculogenesis. At the end of the first trimester the trophoblastic plugs are progressively dislocated, allowing maternal blood to flow progressively more freely and continuously within the intervillous space. During the transitional phase of 10–14 weeks gestation, two thirds of the primitive placenta disappears, the chorionic cavity is obliterated by the growth of the amniotic sac, and maternal blood flows progressively throughout the entire placenta (Jauniaux et al 2003). These events bring the maternal blood closer to the fetal tissues, facilitating nutrient and gaseous exchange between the maternal and fetal circulations. (Susan, 2008).

2.1.3 Placenta circulation:-

The placenta is a vascular organ, genetically part maternal and part fetal. It enables maternal and fetal blood to flow close by one another, separated only by permeable membranes. Maternal and fetal blood do not mix (<http://Wikipedia/placenta>).

2.1.3.1 Maternal- placental blood circulation:-

During the pregnancy the uterine circulation constantly adapts in order to be adequate for the growing metabolic needs of the embryo. Via the spiral arteries (80 -100 mm Hg) that come from the uterine arteries (Aa. uterinae), maternal blood gets into the intervillous spaces in a region delimited by the anchoring villi. Subsequently the blood leaves the intervillous spaces via the uterine veins that are arranged in the periphery of the intervillous space. The flow of the placental blood amounts to 600 cm³/min and the pressure in the spiral arteries to 70 mm Hg. In the intervillous spaces the pressure falls to only 10 mm Hg. The blood in the intervillous space is exchanged 2-3 times per minute. (<http://Wikipedia/placenta>).

2.1.3.2 Fetal placental circulation:-

The villus capillaries are branches of the umbilical vessels. Fetal blood comes via the two Aa .umbilicales in the villi and leaves the placenta through a single navel vein, the vena umbilicalis. Their supply amounts to approximately 40% of the fetal heart blood volume per minute. The blood pressure in the arteria umbilicalis amounts to 50 mmHg and the blood flows through finer vessels that cross through the chorionic plate to the capillaries in the villi where the arterial blood pressure falls to 30 mmHg. In the umbilical vein the pressure is 20 mm Hg. The pressure in the fetal vessels and their villus branches always lies over that of the intervillous space. This protects the fetal vessels from collapse.(<https://en.wikipedia.org/wiki>)

2.1.3.3 Umbilical cord:-

The **umbilical cord** forms as the yolk sac shrinks and the amnion expands to envelop the tissues on the underside of the embryo. The umbilical cord usually attaches near the center of the placenta. When fully formed, it is between 1 and 2 cm (0.4 and 0.8 in.) in diameter and approximately 55 cm (2 ft) long. On average, the umbilical cords of male fetuses are approximately 5 cm (2 in.) longer than those of female fetuses.(Kent.Van De Graaff pdf).

The umbilical cord contains two umbilical arteries, which carry deoxygenated blood from the embryo toward the placenta, and one umbilical vein, which carries oxygenated blood from the placenta to the embryo. These vessels are surrounded by embryonic connective tissue called mucoid connective tissue (Wharton's jelly).(Kent.VanDeGraaff pdf).

The umbilical cord has a helical, or screwlike, form that keeps it from kinking. The spiraling occurs because the umbilical vein grows faster and longer than the umbilical arteries. In about one-fifth of all deliveries, the cord is looped once around the baby's neck. If drawn tightly, the cord may cause death or serious perinatal problems.(Kent Van De Graff- Human anatomy 6thed).

2:1:4 The placental membrane:-

The placental membrane is composed of structure that consists of the extrafetal tissues separating the maternal and fetal blood. In the first trimester it consists of the syncytiotrophoblasts the cytotrophoblast(Langhans' cell), the villus mesenchyma(in which numerous ovoid Hofbauer cells that exhibit macrophage properties are found) and the fetal capillary wall.

During the 4th month the cytotrophoblast disappears from the villus wall and the thickness of the barrier decreases (rough 12m² towards the end of the pregnancy). In the 5th month the fetal vessels have multiplied their branches and gotten closer to the villus surface. During the 6th month the nuclei of the syncytiotrophoblast group together in the so-called proliferation knots. The other zones of the syncytiotrophoblast lack nuclei and are adjacent to the capillaries(exchange zones). (<http://Wikipedia/placenta>).

2:2 Physiology of the placenta:-

The placenta has many important functions but there are three main function:-

-Metabolism.

-Secretion of hormones.

-Transport of nutrient and gases.

2.2.1 Placental Metabolism:-

The placenta plays an important role particularly during early pregnancy in the synthesis of glycogen, cholesterol ,fatty acid, hormones and metabolises a number of substances and can release metabolic products into maternal and/or fetal circulation to increase metabolic demands of the developing fetus through gestation. (<http://Wikipediew/ placenta>).

2.2.2 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.

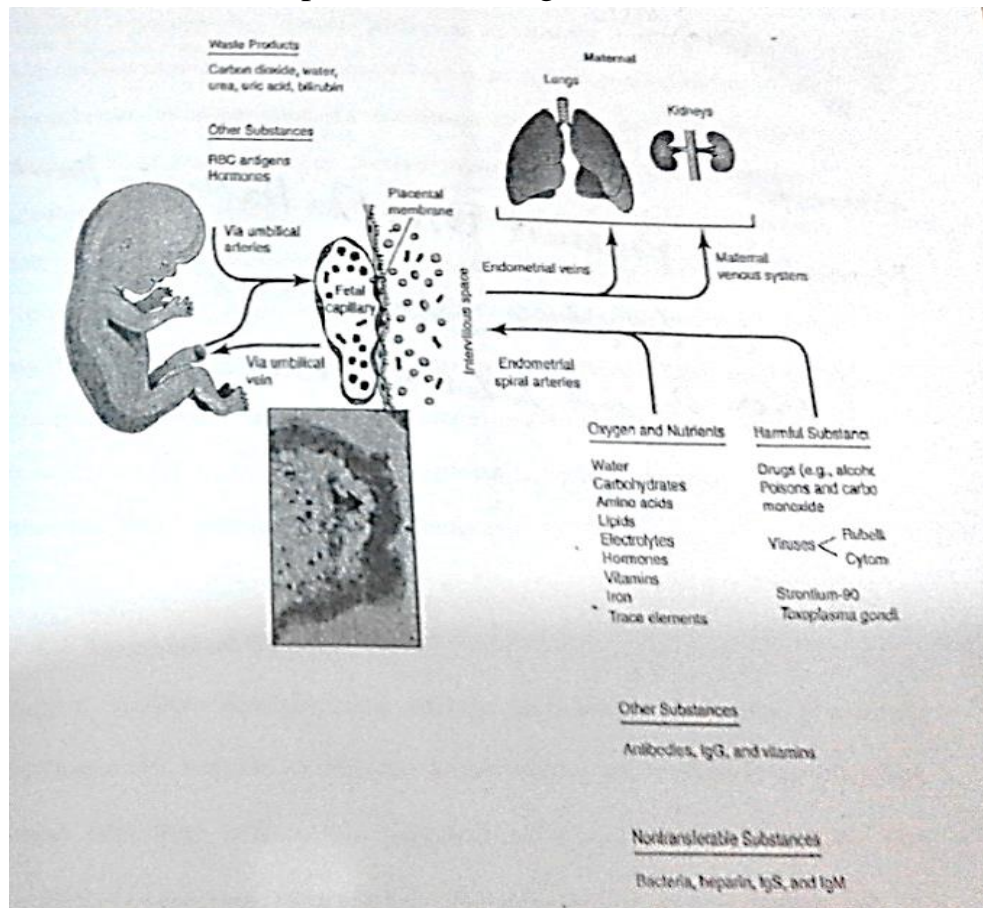
Nutrients and drugs transfer across the placenta are by passive diffusion, facilitate diffusion, active transport and pinocytosis. Passive transport (without energy consumption). (<http:// Wikipedia/ placenta>).

*Simple diffusion: non-polar molecules and fat-dissolvable substances follow concentration gradients. They diffuse from the side with the higher concentration to the side with the lower concentration, until a balanced condition is achieved, whereby no energy is used up in this process (e.g., diffusion of oxygen, carbon dioxide, fats and alcohol). Water enters the placenta through specialized pores (osmosis).

*Simplified transport (facilitated diffusion): transition from the side with higher concentration to the one with lower concentration with the help of transport molecules (e.g., glucose). (<http://Wikipedia/placenta>).

Active transport: Transport through the cellular membrane against a concentration gradient using energy (Na^+/K^+ or Ca^{++})

Endocytosis (Exocytosis): Macro-molecules are captured by microvilli and absorbed in the cells or repelled (immunoglobulin).



Fig(2 .4)Diagrammatic illustration of transfer across the placental membrane(barrier).The external tissues, across which transport of substances between the mother and fetus occurs, collectively constitute the placental membrane, (<http://Wikipedia/placenta>).

2.2.2.1 Transfer of Gases:-

Exchange of gases, such as oxygen, carbon dioxide, and carbon monoxide, is accomplished by simple diffusion. At term, the fetus extracts 20 to 30 ml of oxygen per minute from the maternal circulation and even a short-term interruption of the oxygen supply is fatal to the fetus. Placental blood flow is critical to oxygen supply, since the amount of oxygen reaching the fetus primarily depends on delivery, not diffusion.⁹<http://Wikipedia/placenta>).

2.2.2.2 Nutritional Substances:-

Nutrient constitute the bulk of substances transferred from the mother to the embryo/fetus. Water is rapidly exchanged by simple diffusion and in increasing amounts at pregnancy advanced .glucose produced by the mother and placenta is quickly transferred to the embryo/fetus by facilitated diffusion. There is a little or no transfer of maternal cholesterol, triglycerides, or phospholipids. Although there is transport of free fatty acids, the amount transferred appears to be relatively small. Amino acids are actively transported across placental membrane and are essential for fetal growth. For most amino acids, the plasma concentrations in the fetus are higher than in the mother. Vitamins cross the placenta membrane and are essential for normal development. Water- soluble vitamins cross the placenta membrane more quickly than fat - soluble ones. (Moore,presaud,2008).

2.2.2.3 Electrolytes:-

Sodium and chloride ions are mainly transferred across the placenta by passive diffusion, although active transport may have a role. Calcium ions, iron.

2.2.2.4 Immunity:-

IgG antibodies can pass through the human placenta, there by providing protection to the fetus in utero. This transfer of antibodies begins as early as the 20th week of gestational age, and certainly by the 24th week this passive immunity lingers for several months after birth, thus providing the newborn with a carbon copy of the mother's long-term humoral immunity to see the

infant through the crucial first months of extrauterine life. IgM, however, cannot cross the placenta, which is why some infections acquired during pregnancy can be hazardous for the fetus. Furthermore, the placenta functions as a selective maternal-fetal barrier against transmission of microbes. However, insufficiency in this function may still cause mother-to-child transmission of infectious diseases. (<http://Wikipedia.org/wiki/placenta>).

2:2:2:5 Waste Products:-

Waste products excreted from the fetus such as urea, uric acid, and creatinine are transferred to the maternal blood by diffusion across the placenta. (<http://Wikipedia.org/wiki/placenta>).

2:2:2:6 Drugs and Drug Metabolites:-

Most drugs and drug metabolites cross the placenta by simple diffusion, the exception being those with a structural similarity to amino acids, such as methyldopa and antimetabolites. Some drugs cause major congenital anomalies. Fetal drug addiction may occur after maternal use of drugs such as heroin and 50% to 75% of these newborns experience withdrawal symptoms. Because psychic dependence on these drugs is not developed during the fetal period, no liability to subsequent narcotic addiction exists in the infant after withdrawal is complete. Most drugs used for the management of labor readily cross the placenta membrane. Depending on the dose and its timing in relation to delivery, these drugs may cause respiratory depression of the newborn infant. All sedatives and analgesics affect the fetus to some degree. Neuromuscular blocking agents that may be used during operative obstetrics cross the placenta in only small amount. Drugs taken by the mother can affect the embryo/fetus directly or indirectly by interfering with maternal or placental metabolism. (Moore, presaud, 2008).

Inhaled anesthetics can also cross the placental membrane and affect fetal breathing if used during parturition. The amount of drug or metabolite reaching the placenta is controlled by the maternal blood level and blood flow

through the placenta. Infectious Agents: Cytomegalovirus, rubella, and coxsackie viruses, and viruses associated with variola, varicella, measles and poliomyelitis may pass through the placental membrane and cause fetal infection in some cases such as the rubella virus, congenital anomalies such as cataracts may be produced. Microorganisms such as treponema pallidum which causes syphilis, and toxoplasma gondii which produces destructive changes in the brain and eyes, also cross the placental membrane, often causing congenital anomalies and/or death of the embryo or fetus.(Moore,presaud,2008).

2.2.2.7 Placental Endocrine Synthesis and Secretion:-

The placenta secretes hormones that are important during pregnancy. These hormones include: - Human chorionic gonadotropin, Human placental lactogen ,Estrogen , Progesterone.

Human chorionic gonadotropin (HCG) is the first placental hormone produced, which can be found in maternal blood and urine as early as the first missed menstrual period (shortly after implantation has occurred) through about the hundredth day of pregnancy. ([http//Wikipedia/placenta](http://Wikipedia/placenta)).

This is the hormone analyzed by a pregnancy test; a false-negative result from a pregnancy test may be obtained before or after this period. Women's blood serum will be completely negative for HCG by one to two weeks after birth. HCG testing is proof that all placental tissue is delivered. HCG is present only during pregnancy because it is secreted by the placenta, which is present only during pregnancy([http/Wikipedia/placenta](http://Wikipedia/placenta)).

HCG also ensures that the corpus luteum continues to secrete progesterone and estrogen. Progesterone is very important during pregnancy because, when its secretion decreases, the endometrial lining will slough off and pregnancy will be lost. HCG suppresses the maternal immunologic response so the placenta is not rejected. ([http//wikipedia/ placenta](http://wikipedia/ placenta)).

Human placental lactogen is lactogenic and promotes mammary gland growth in preparation for lactation in the mother. It also regulates maternal glucose, protein, and fat levels so they are always available to the fetus.

Estrogen stimulates the development of secondary female sex characteristics. It contributes to the woman's mammary gland development in preparation for lactation and stimulates uterine growth to accommodate the growing fetus.

Progesterone is necessary to maintain the endometrial lining of the uterus during pregnancy. This hormone prevents pre-term labor by reducing myometrial contractions. Levels of progesterone are high during pregnancy (<http://en.Wikipedia.org/wiki/placenta>).

2:3 Placental Measurements:-

There are a variety of diagnostic and morphological measurements that can be made of the placenta during pregnancy and at term.

In humans, the placenta averages 22 cm in length and 2–2.5 cm in thickness; it typically weighs 500g and is a dark-reddish color due to the large quantities of blood contained within. (<http://Wikipedia/placenta>).

Simple measurements of overall placental diameter, thickness and volume:

- **Placental diameter** - is measured in the transverse section by calculating the maximum dimensions of the chorionic surface.
- **Placental thickness** - is measured at its mid-portion from the chorionic plate to the basilar plate, on a longitudinal plane (less than 4 cm at term). Excludes any abnormalities (fibroids, myometrial contractions, or venous lakes). The placental thickness approximates in millimeters to the weeks of gestation.
- **Placental volume** - is measured by a range of different methods and calculations, more recently with three dimensional ultrasound.

(<http://en.wikipedia.org/placenta>).

2.4 Ultrasonography of placenta:-

The normal anatomy of the placenta and the retroplacental area can be well defined with gray scale sonography. The placenta has a characteristic granular echo pattern, with strong echoes emanating from the chorionic plate. After 37 weeks, strong echoes representing calcification may appear; this is a normal physiologic process.

2.4.1 Ultrasonography Technique and physics:-

The patient is usually scanned while lying comfortable on her back (supine). Should be has a full, but not over – distended bladder, a 3.5MHz convex probe used. multiple longitudinal and transverse scans will be necessary to demonstrate the placenta completely. Placental thickness measured in a representative portion perpendicular to the chorionic plate at the level of the cord insertion. (Manual of diagnostic ultrasound . Edited by P.E.S. Palmer).

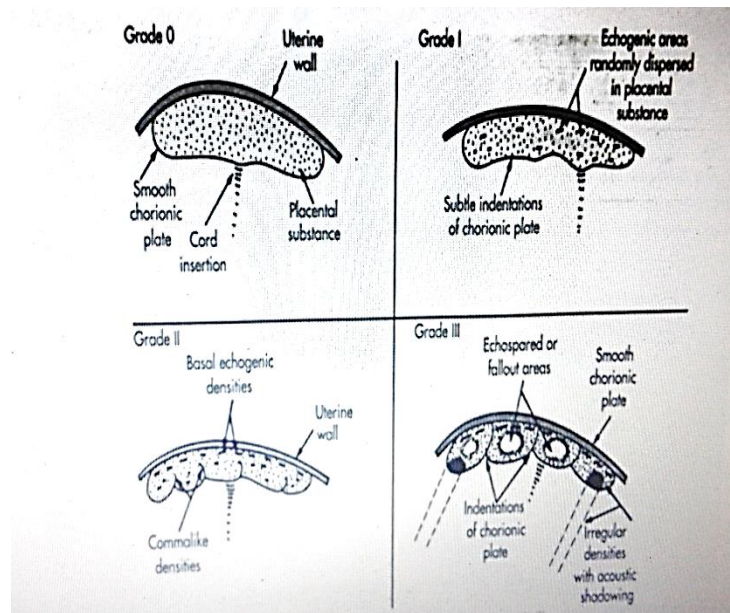
2.4.2 Placenta grading:-

Grade 0: Placental body is homogeneous. The amniochorionic plate is even throughout. Late 1st trimester-early 2nd trimester

Grade I: Placental body shows a few echogenic densities ranging from 2-4 mm in diameter. Chorionic plate shows small indentations. Mid 2nd trimester early 3rd trimester (~18-29 wks). (El amin M Y A,2012,).

Grade II: Chorionic plate shows marked indentations, creating comma-like densities which extend into the placental substance but do not reach the basal plate. The echogenic densities within the placental also increase in size and number. The basal layer comes punctuated with linear echoes which are enlarged with their long axis parallel to the basal layer. Late 3rd trimester (~30 wks to delivery)(El amin M Y A ,2012).

Grade III: Complete indentations of chorionic plate through to the basilar plate creating cotyledon (portions of placenta separated by the indentations). 39 wks post dates.



Fig(2.5) General demonstrate how the placenta ades. It can be used to assist in evaluating readiness or need for delivery (From Grannum PA,BerkowitsRL, Hobbins JC:The ultrasonic changes in the maturing placenta and their relation to fetal maturity.Am j Obestet Gynecol 133:916,1979.).

2.5 Previous study:-

*CC Ohagwu. Po Abu. BE Udoh. The study is aimed 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 ± 6.4 mm 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 Online,2009).

*Anna J, Lee, Michael Bethune , Hiscock . Richard J MBBS Franzcog, Franzco, COGU. They sought to determine the normal sonographically measured placental thickness in millimeters at the second-trimester scan (18 weeks to 22 weeks 6 days) and determine whether the measurement should be adjusted for gestational age and the placental site. They conducted a cross-sectional observational pilot study involving 114 consecutive patients with singleton pregnancies presenting for routine second-trimester sonography

between 18 weeks and 22 weeks 6 days. And the result is the unadjusted overall mean placental thickness was 24.6 (SD, 7.29) mm. The placental thickness was normally distributed. On multivariable analysis, the predicted mean thickness was 6.6 mm (95% confidence interval, 4.4 to 8.8 mm; $P < .001$) less in anterior compared to posterior or fundal placentas and increased by 0.6 mm (95% confidence interval, -0.5 to 1.7 mm; $P = .27$) for each week increase in gestation after 18 weeks. Their conclusions: The placental position and possibly gestational age need to be considered when determining placental thickness. Anterior placentas are approximately 7 mm thinner than posterior or fundal placentas. Anterior placentas of greater than 33 mm and posterior placentas of greater than 40 mm should be considered abnormally thick. (J Clin Ultrasound. 2004).

*El amin M Y A, (2012) Studied the relationship between placental thickness and fetal age in Sudanese women, she found that the placental thickness increase with gestational age. She also found that there is significant positive correlation between placental thickness and LMP, biparietal diameter (BPD), femur length (FL). Her study showed linear regression between placental thickness and LMB, biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL). (Sudan University of Science and Technology- Khartoum.)

*Hammad Y H, (2008) Performed a study to evaluate placental thickness in third trimester in Sudanese women, his result showed linear relationship between placental thickness in mm and gestational age in weeks. He found that placental thickness increased with the fetal age. He concluded that the measurement of the placental thickness is an important parameter for estimating gestational age in normal singleton pregnancies along with other parameters. (Sudan University of Science and Technology – Khartoum.)

Chapter Three

Material and Methods

Chapter Three

Material and methods

3.1 Material:-

3-1-1 Patient:

- **Sample size:**

The study will consist of 50 case.

- **Included criteria:-**

The patient were scanned in third trimester at differe gestaional ages which include 28 till 37 weeks.

- **Excluded criteria:-**

The period below 28 weeks or above 37 weeks.

Pregnant which has history of diabetes mellitus or hypertensive.

Multiple pregnancy.

Pregnant which has history of intrauterine growth retardation.

Pregnant which has history of fetal mass or anomaly.

Pregnant which has history of placental mass or anomaly.

Pregnant which has history of uterine or adenexal mass.

- **Main aged:**

From 19 to 43 years.

3-1-2 Machine:

The ultrasound is SonoScope A6 with ultrasdound probe 3.5 MHz.

3.1.3Period of study:-

The data was collected during 2016.

3.1.4 Area of study:-

Saudi Hospital / Omdurman.

3.2Method:-

3.2.1 Technique:

Patient position and preparation: The patient is usually scanned while lying comfortable on her back (supine). Should be has a full, but not over – distended bladder, a 3.5MH convex probe used. Multiple longitudinal and transverse scans will be necessary to demonstrate the placenta completely.

Placental thickness measured in a representative portion perpendicular to the chorionic plate at the level of the cord insertion. (Manual of diagnostic ultrasound. Edited by P.E.S.Palmer) and then measurement were compared with growth parameter.

3-2-2 Statistical methods:

The data of this study was collected by data collecting sheet and analyzed using SPSS.

3.2.3 Method of scanning:

Three fetal biometric parameters were done which include biparietal diameter (BPD), abdominal circumference(AC), femur length (FL).First the placental thickness was measured at core insertion by using ultrasound and then measurement were compared with growth parameter.

Chapter Four

Results

Chapter Four Results

Table 4.1 show statistical parameters of all patients:

	Minimum	Maximum	Mean	Std. Deviation
Age	19	43	28.02	6.657
LMP	1.1	6.1	3.094	1.0509
EDD	1.11	73.40	9.3376	10.72153
FL	37.4	90.0	69.384	8.6945
PT	24.8	52.0	36.171	5.9504
GA	22.2	41.2	34.986	3.5943

Table 4.2 frequency distribution of Parity:

Parity	Frequency	Percent	Valid Percent	Cumulative Percent
0	16	4.1	5.7	5.7
1	12	24.5	34.3	40.0
2	5	10.2	14.3	54.3
3	4	8.2	11.4	65.7
4	4	8.2	11.4	77.1
5	5	10.2	14.3	91.4
6	1	2.0	2.9	94.3
7	1	2.0	2.9	97.1
9	1	2.0	2.9	100.0

Table 4.3 frequency distribution of type of delivery:

Type of delivery		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ND	28	57.1	82.4	82.4
	CS	6	12.2	17.6	100.0
	Prime	16	31.7	100.0	

Table 4.4 frequency distribution of position:

Position		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ant	27	55.1	55.1	55.1
	Post	16	32.7	32.7	87.8
	Fundal	6	12.2	12.2	100.0

Figure 4.2 show frequency distribution of type of delivery:

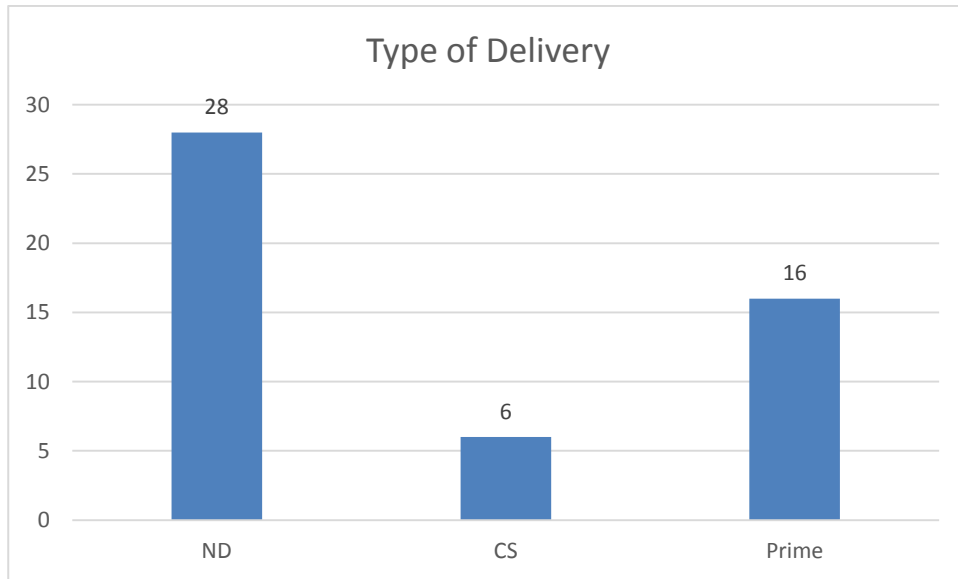


Figure 4.3 show frequency distribution of position:

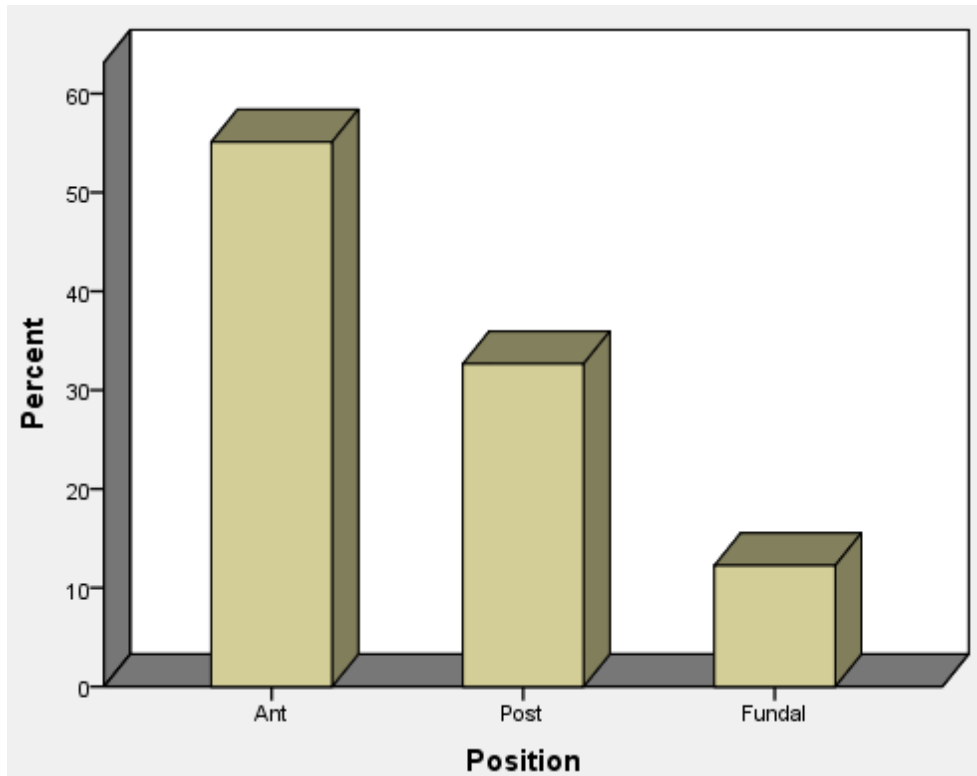


Figure 4.4 show correlation between the PT and LMP

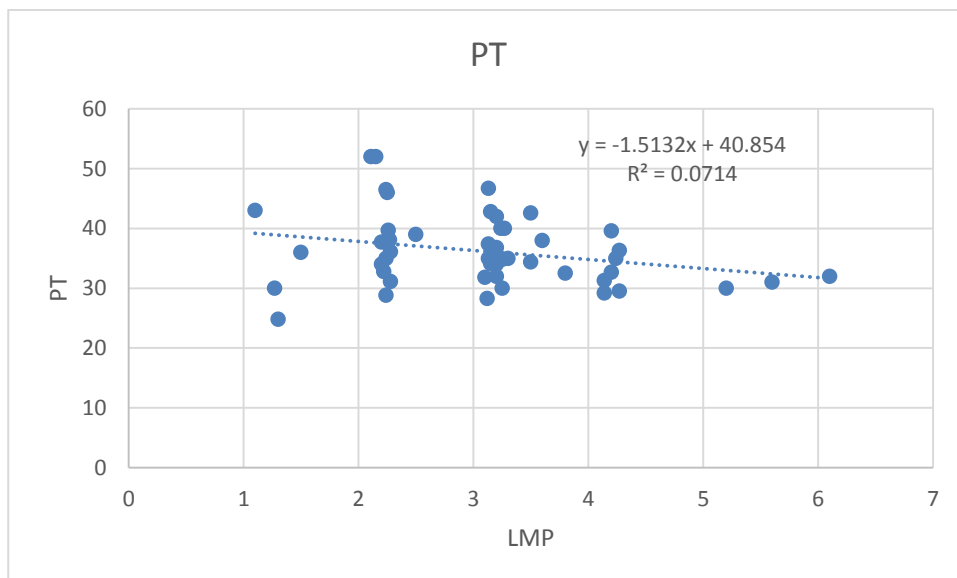


Figure 4.5 show correlation between the PT and GA

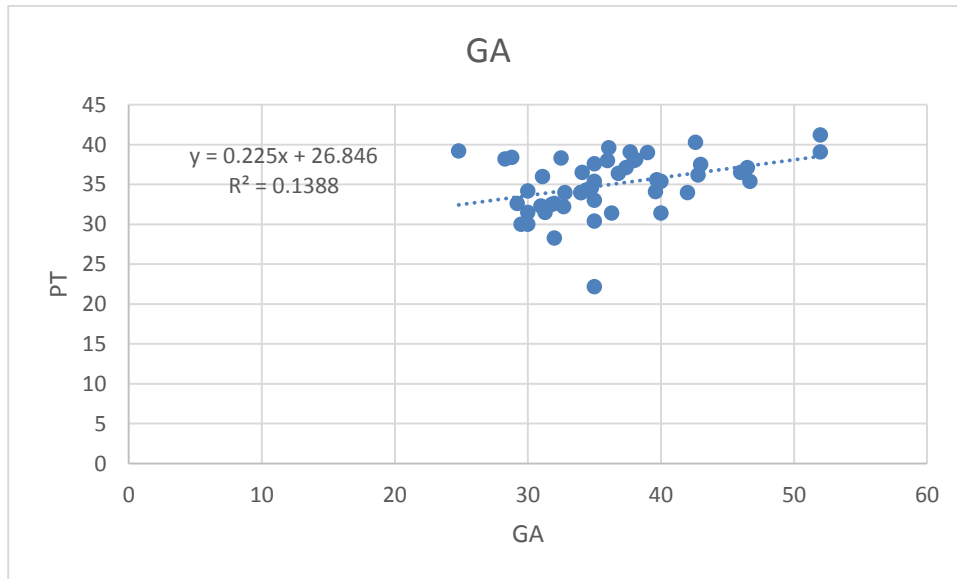


Figure 4.6 show correlation between the PT and FL

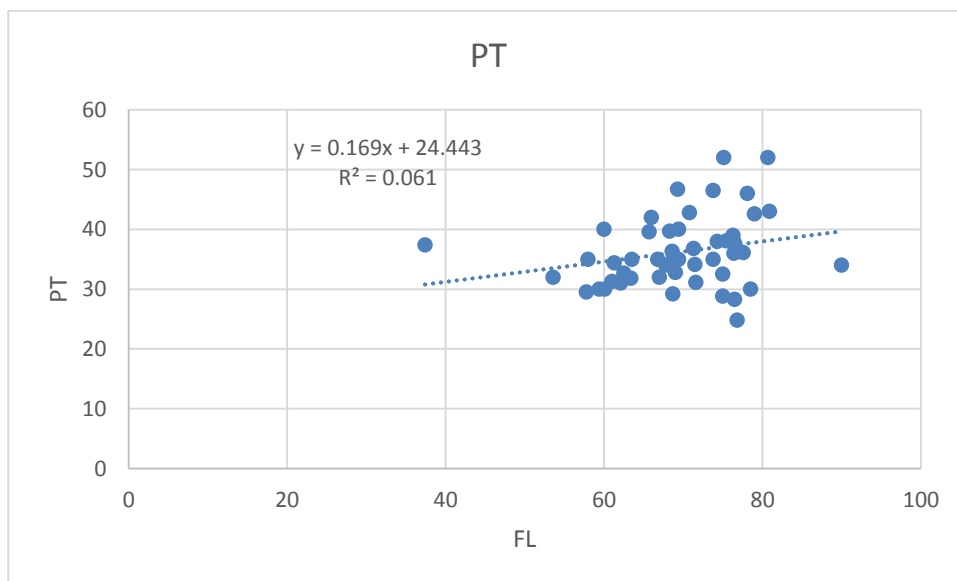


Figure 4.7 show correlation between the GA and FL

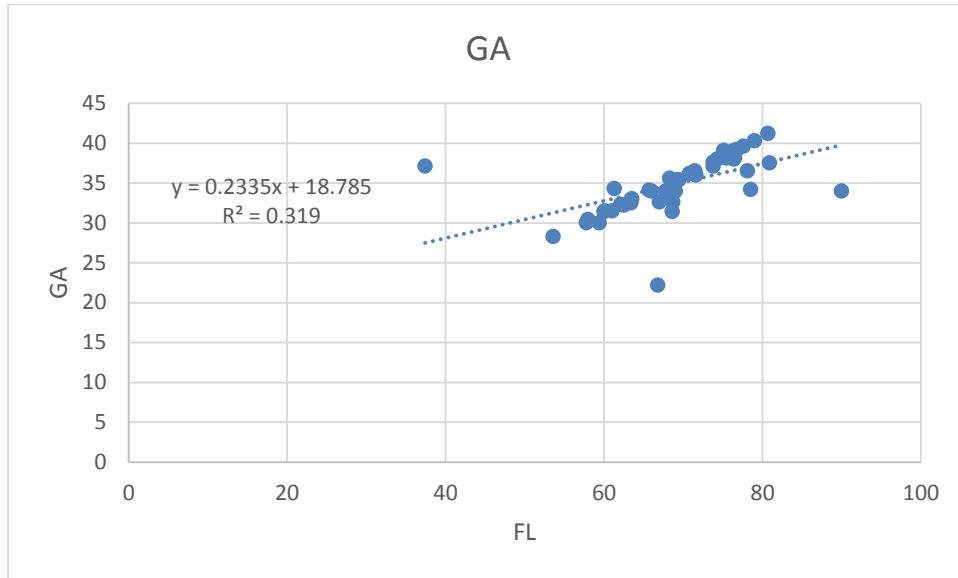
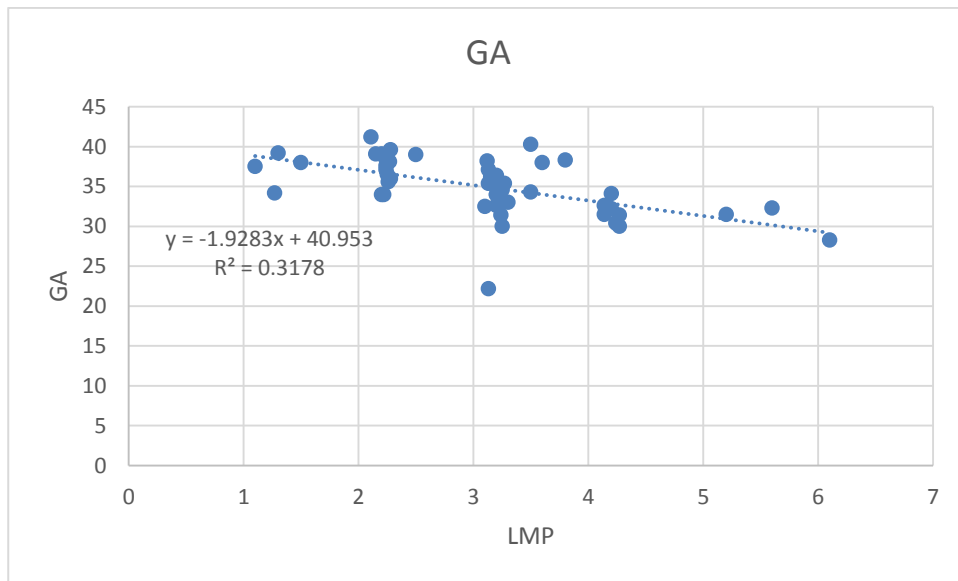


Figure 4.8 show correlation between the GA and LMP



CHAPTER FIVE

Discussion, Conclusion & Recommendation

Discussion

The study assessed the relationship between placental thickness (in mm) and gestational age (in weeks) by USG in normal Sudanese pregnant women. 50 pregnant women in third trimester scanned using transabdominal scanning. The study showed that there is linear relationship between placental thickness and gestational age , table (4 -1) show statistical parameter of all patients for AGE ,LMP, EDD, FL, PT and GA, were the Age 28.02 ± 6.657 , for LMP 3.09 ± 1.05 , EDD 9.33 ± 10.72 , FL 69.38 ± 8.69 , PT 36.17 ± 5.95 and GA 34.98 ± 3.59 . table (4-2) show the parity, the value 0 was more frequency with prime (16), then 5 with frequency 5, table (4-3) show the type of delivery were the normal delivery was 28, CS 6 and the first time 16 as shown in Fig (4-2). Table (4-4) show frequency distribution of position were the anterior were the 27 posterior 16 and fundal 6 as shown in Fig (4-3). There is strong positive correlation between them .these results establish that there is a firmly fixed increase in placental thickness with the increase of fetal age.

There was significant positive correlation between the placental thickness and (last menstrual period and femoral length).which can give by the equations:

$$Y\{LMP\}=1.513X\{PT\text{ mm}\}\pm 40.85.$$

$$Y\{FL\}=0,169X\{PT\text{ mm}\}\pm 24.44$$

Conclusion

To conclude we can say that the measurement of placental thickness is an important parameter for estimation of fetal age. The study found that the parity show that the prime pregnancy was higher frequency, the patient with a normal delivery was a higher frequency than CS delivery. Anterior position was higher than posterior and lately the fundal position.

The study showed there was significant and strong positive correlation between placental thickness and the progressive in gestational age in third trimester

Also the study showed significant positive correlation between placental thickness and (LMP and FL) which can give these equations:

Recommendation

- More studies are required and table establishment is need to be programmed in ultrasound scanner instrumentation based on this new parameter in calculation the gestational age.
- It is recommended further studies for different nationalities or abnormal pregnancies.

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Appendix Images



Transabdominal ultrasound image for 27 years old pregnant woman

PT=46.5mm GA= 37w 1d



Transabdominal ultrasound image for 39 years old pregnant woman

PT=37.7mm GA=39w 1d



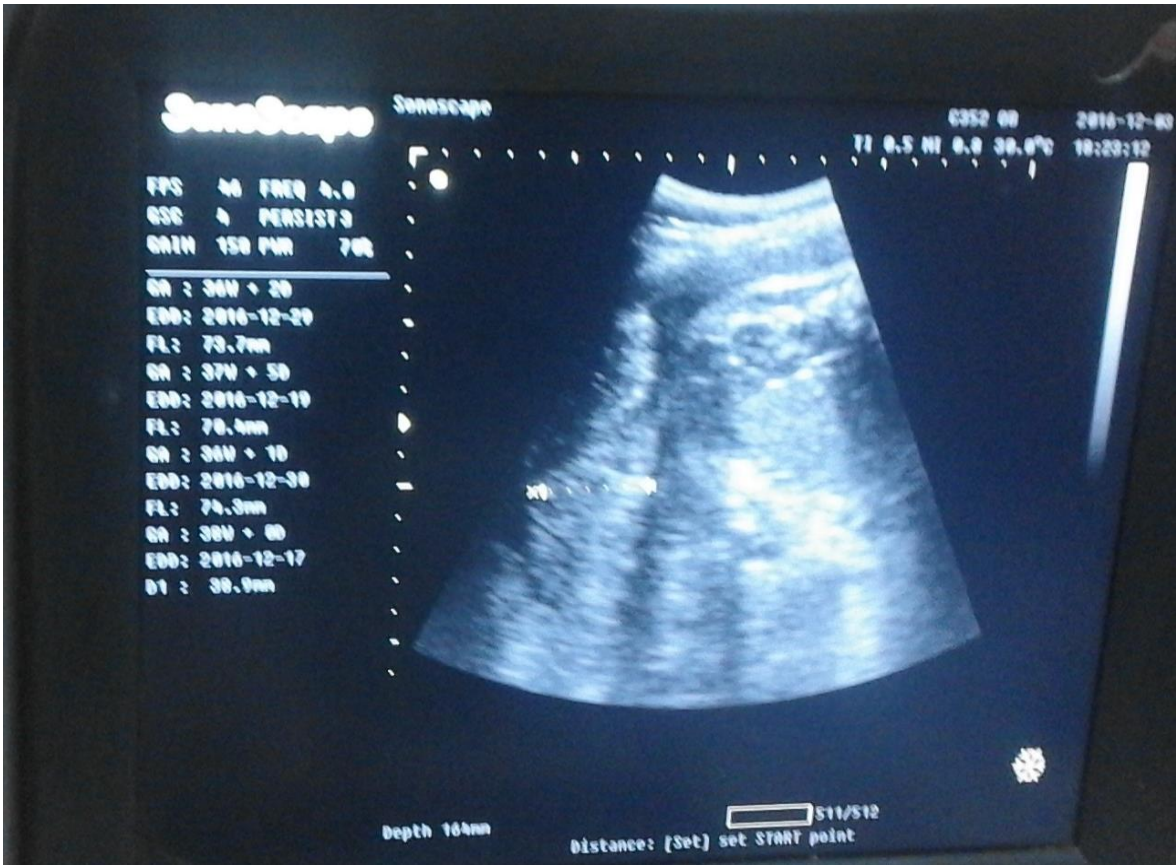
Ultrasound image for 23 years old pregnant woman PT=29.2mm GA=32w 6d



Ultrasound image for 35 years old pregnant woman PT=36.1mm GA=39w 6d



Ultrasound image for 43 years old pregnant woman PT=36.8mm GA=36w 4d



Ultrasound image for 35 years old pregnant woman PT=38.9mm GA=38w