Sudan University of Science and Technology

College of Graduate Studies

Study of Relationship between the Umbilical Artery Resistive Index and Fetal Growth.

دراسة العلاقة بين مؤشر ممانعة سريان الدم في الشريان السري ونمو الجنين

A thesis Submitted for Partial Fulfillment for the requirement of M.sc Degree in Medical Diagnostic Ultrasound

By:

Raya Hassan Siddieg Elamin

Supervisor:

Dr. Ahmed Mostafa Abukonna

November 2018

Dedication

This research is dedicated to the soul of my parents, my dearly husband for his support and understanding throughout the period of my research, and to my lovely family.

Acknowledgements

I would like to offer my thanks and gratitude to my supervisor Dr. Ahmed Abukonna who had kindly supervised this dissertation and had shown every encouragement and support during the preliminary and final setup of the work.

Many thanks extend to sonologist of the Ultrasound department of AlribatUniversity hospital; Ahmed Elhaj and to Dr.Abdelhaleem Mohammed Ziyada in obstetric department of AlamalAlwatany Hospital for doing their best effort to complete this work.

.

Abstract

The clinical application of ultrasound in obstetrics includes confirmation of pregnancy and multiple gestation and estimation of fetal weight, localization of placenta and monitoring of fetal wellbeing. The aim of this study was to find out the relationship between the umbilical artery resistive index and the estimated fetal weight and gestational age at third trimester.

The study conducted at Alamal and Ribat University Hospital, 50 women with singleton pregnancy in the third trimester examined by ultrasound using curvilinear probe range of frequency between 3.5- 6MHz, to find out the estimated fetal weight using three fetal biometry(bipartitely diameter. Abdominal circumference, and femur length) then Doppler technique was applied to measure the umbilical artery resistive index.

The results revealed that there was a significant negative correlation between the gestational age and the umbilical artery resistive index. Furthermore, inverse correlation between the fetal weight and umbilical artery resistive index was observed. It is of greater benefits to use Doppler ultrasound examination in third trimester of pregnancy to estimate fetal weight for helping the obstetrician in deciding what type of delivery will be used and to identify if the newborn need nursery admission.

المستخلص

يشتمل التطبيق العلمي لإستخدام الموجات فوق الصوتية في طب التوليد التثبت من وجود الحمل أو وجود حمل متعدد ومعرفة عمر الجنين التقديري وتحديد موقع المشيمة وأيضاً لمراقبة ومتابعة صحة الجنين. أجريت هذه الدراسة بغرض دراسة العلاقة بين وزن الطفل التقديري وممانعة الشريان السري لسريان الدم وعمر الجنين في الشهور الأخيرة للحمل.

أجريت الدراسة بمستشفي الأمل الوطني ومستشفي الرباط الجامعي.50 إمرأة حامل بحمل أُحادي طبيعي في الشهور الثلاثة الأخيرة تم فحصهن باستخدام أجهزة موجات صوتية بماسح ذو تردد موجي بين 3.5 إالي 6 ميقا هيرتز لتحديد وزن الجنين داخل الرحم بعد أخذ ثلاثة قياسات مختلفة للحصول على متوسط الوزن وقد شملت القياسات أبعاد جداري الرأس العظمي ومحيط البطن وطول عظم الفخذ ومن ثم استخدمت تقنية الدوبلار لقراءة مؤشر ممانعة سريان الدم في الشريان السري.

كشفت الدراسة أن هنالك علاقة عكسية بين عمر الجنين وممانعة سريان الدم في الشريان السري أي أنه كلما زاد عمر الجنين قلت ممانعة الشريان السري لسريان الدم ووجد أيضاً أنه كلما زادت ممانعة الشريان السري لسريان الدم كلما قل الوزن المتوقع للجنين. يمكن الإستفادة من تقنية الدوبلار لتحديد وزن الطفل للمساعدة في تحديد نوعية الولادة خاصة في فترة الحمل في الشهور الثلاثة الأخيرة وذلك لتقليل مخاطر وفيات الأطفال وتحديد حاجة المولود إلي العناية بعد الولادة.

Table of contents

List of tables

List of figures

Abbreviations

AC	abdominal circumference.
BPD	bi parietal dimension
CRL	crown rump length.
EDV	end diastolic velocity.
EFW	estimated fetal weight.
FL	femur length.
FW	fetal weight.
GA	gestational age.
HC	head circumference.
IUGR	intrauterine growth restriction.
ICU	intensive care unit.
LAG	large for gestational age.
LBW	low birth weight.
LMP	last menstrual period.
MHZ	mega hertz.
PI	pulsatility index.
PSV	peak systolic velocity.
RI	resistive index.
S/D	systolic diastolic ratio.
SGA	small for gestational age.
SPSS	statistical package for the social sciences.
TAV	time average velocity.
UAI	umbilical artery indices.
USA	united state of America.
UA-RI	umbilical artery –resistive index.

Chapter one

Introduction

1.1 Introduction:

Ultrasound has been in clinical use in the field of obstetric since 1978, with advances in technology, there has been improvement in resolution, allowing for far better imaging of fetus. This together with new developments in the field of screening for pregnancy disorders has led to a change in the clinical application of ultrasound in the care of routine low risk pregnant women (Kim et al., 2018). Currently, Doppler ultrasound, an evolved noninvasive technique, is widely used to assess blood flow in both fetal and maternal hemodynamic circulatory function. Due to its feasibility and safety, this newinnovation has now become an effective instrument for fetal surveillance(Chanprapaph et al., 2000).

The umbilical artery, the very important vessel of the fetus, was the first vessel to be assessed and has since become the most widely investigated component of the fetal circulation. The unique umbilicalartery waveform can easily be detected by real time ultrasound associated with pulse wave Dopplerultrasound (Doppler duplex system)(Chanprapaph et al., 2000). Based on the knowledge that umbilical arterial resistance isincreased in the fetus with uteroplacental insufficiency secondary to various causes, the umbilical artery waveforms, reflecting the resistance in fetoplacental circulation, has been used extensively for fetalsurveillance, especially in high-risk pregnancy. It is established that an increase in umbilical resistance expressed by Doppler indices is well associated with fetal hypoxia and acidosis, especially in fetus with growth restriction. It is essential that each institution should have its own baseline data to apply to its population in evaluation of fetal dynamic status(Maulik et al., 1991).

Abnormal Doppler flow patterns will help predict which growth retarded fetuses at a greater risk for a poor outcome. In high risk pregnancies this will help

reduce the number of antenatal examinations and the number of cesarean delivers for suspected fetal distress.

Accurate prenatal estimation of fetal weight (EFW) in late pregnancy is extremely useful in the management of labour and delivery.Permittingobstetricians to make decisions about instrumental vaginal delivery.Trial of labour after caesarean section for patients suspected of having amacrocosmic fetus(Baum et al., 2002).

Extreme change in umbilical circulation may reflect severe anomalies, such as reversed end-diastolic flow (REDF) in the umbilical artery in early pregnancy, which, though rare, mostly occurs in association with major fetal vascular anomalies and cardiac defects, particularly tetralogy of Fallot with absent pulmonary valve syndrome, patent ductusarteriosus, cardiac septal defect, and even trisomy 18 or trisomy 13(Berg et al., 2007).

Several published studies have shown the trend of hemodynamic change of fetal circulation in the early stage of gestation (Kehila et al., 2017). Thus, it is important to establish a database and note the change in trend for Sudanese pregnant women. The purpose of this study was to investigate the relationship between umbilical artery flow and fetal growth in normal pregnancy in the Sudanese population.

1.2 Problem of the study:

Increase in umbilical resistance expressed by Doppler indices is well associated with fetal hypoxia and acidosis, especially in fetus with growth restriction. It is essential that each institution should have its own baseline data to apply to its population in evaluation of fetal dynamic status. However, the relationship between gestational age and Doppler waveform indices in Sudanese population has not been sufficiently established.

1.3 Objectives of the study:

1.3.1 General objective:

To study the relationship of the umbilical artery resistive index measured by Doppler ultrasound, and the fetal weight and gestational age in the third trimester pregnancy.

1.3.2 Specific objectives:

- To create reference value of umbilical artery resistive index in third trimester pregnancy.
- To estimate fetal weight using fetometrics values.
- To find the relationship between the umbilical artery resistive index and the fetal weight in singleton pregnancies.

1.4 Overview of the study:

This study constructed on five chapters, chapter one is an introduction, problem of the study, general and specific objectives, significant of study and overview of the study. Chapter two is literature review which includes theoretical background and previous studies. Chapter three describes the material and method, that used to conducted this study. Chapter four includes result presentation as table and graph. Chapter five was includes the discussion, conclusion and recommendation, in addition to references and appendixes.

Chapter two

Theoretical Background

2.1 Pregnancy:

Is the time during which one or more off spring develop inside a woman, and occur by sexual intercourse or assisted reproductive technology. Child birth typically occurs around 40 weeks from the last menstrual period (LMP); this is just over nine months. And when measured from fertilization it is about 38 weeks.An embryo is the developing off spring during the first eight weeks following fertilization, after which the term fetus is used until birth. Pregnancy is typically divided into three trimesters, the first trimester is from week one through 12 and includes conception, which when the sperm fertilized the egg then travels down the fallopian tube and attaches to the inside of the embryo and placenta, the second trimester is from week 13^{th} through 28^{th}, and the third trimester is from 29 week through 40 week(Hobbins, 2008).

2.2 Umbilical cord :

The umbilical cord develops when the embryonic disc bulges into the amniotic cavity with the result that the junction between the embryonic disc and the amnion (the amnion-ectodermal junction) is carried into the ventral aspect of the embryo and its line of reflection becomes oval shaped and is called the primitive umbilical ring. By the 5^{th} weeks, the primitive umbilical ring constricts changing the primitive umbilical ringing to a tubular sheath of amnion called the primitive umbilical cord. Rapid enlargement of the amniotic cavity soon occurs and results into excessive lengthening of the umbilical cord flexing movements of the embryo and coils in the amniotic cavity(Chanprapaph et al., 2000).

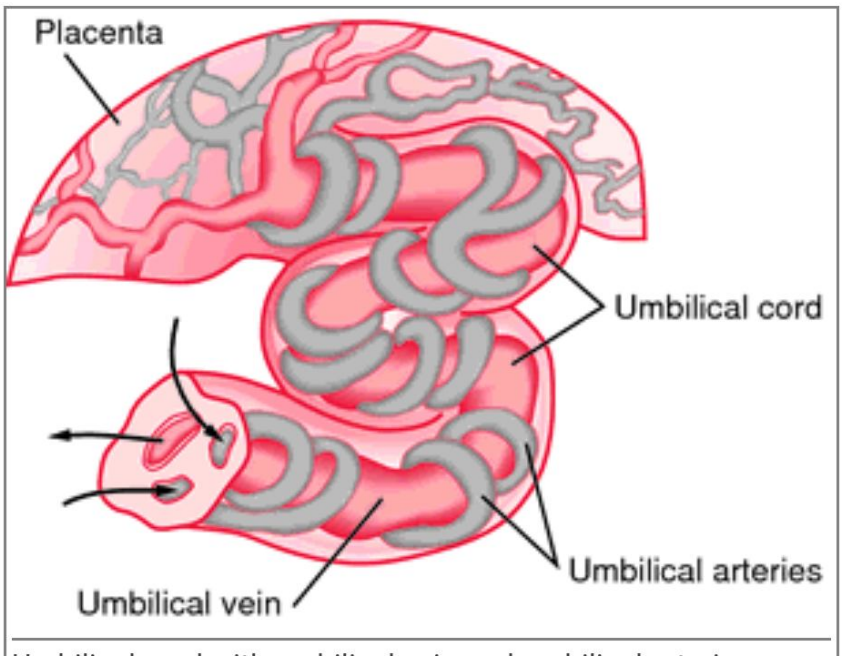


Figure 2-1: shows diagram of Umbilical cord (Mckinney, 2000)

When the membranes of the amniotic cavity come into contact with those of the chorionic cavity and the two extra-embryonic mesoderm layers that cover both membranes, fuse. With the flexing movements of the embryo, the amnion encircles the body stalk, the ductusomphalo-entericus and the umbilical vessels, thus circumscribing the elements of the umbilical cord. In the early stage (at around the 8th week) the umbilical cord is in the form of a very thick and short section with the following structures:

The ductusomphalo-entericus which connects the primitive intestines with the umbilical vesicle and two vitelline vessels (vasa omphalomesenterica, 2 arteries and 2 veins). (Asim et al, 2004)The umbilical vesicle is located in the chorionic cavity (exocoelom = extra-embryonic coelom). The body stalks with the allantoises, the umbilical vessels (2 arteries and 1 vein). During the development it gets shifted ventrally in order to finally fuse with the stem of the umbilical vesicle. The umbilical coelom that connects the extra-embryonic coelom with the intra-embryonic coelom(Chudleigh, 2004).

The umbilical cord connects the placenta with the ventral aspect of the embryo. It is a soft tortuous cord which measures 50-60 cm long and about 1 cm in diameter. It contains three umbilical vessels (one vein and two arteries) embedded in gelatinous material called Wharton's Jelly. The umbilical vein has a wider lumen and a thinner wall than the umbilical arteries(Chudleigh, 2004).

2.3 Connection of umbilical cord to fetal circulatory system:

The umbilical cord enters the fetus via the abdomen, at the point which (after separation) will become the umbilicus (or navel). Within the fetus, the umbilical vein continuous towards the transverse fissure of the liver, where it spilts into two. One of these branches joins with the hepatic portal vein (connecting to its left branch), which carries blood into the liver. The second branch (known as the ductusvenosus) allows the majority of the incoming blood (approximately 80%) to bypass the liver and flow via the left hepatic vein into the inferior vena cava, which c**a**rries blood towards the heart. The two umbilical arteries branch from the internal iliac arteries, and pass on either side of the urinary bladder before term ones(Mari and Hanif, 2008).

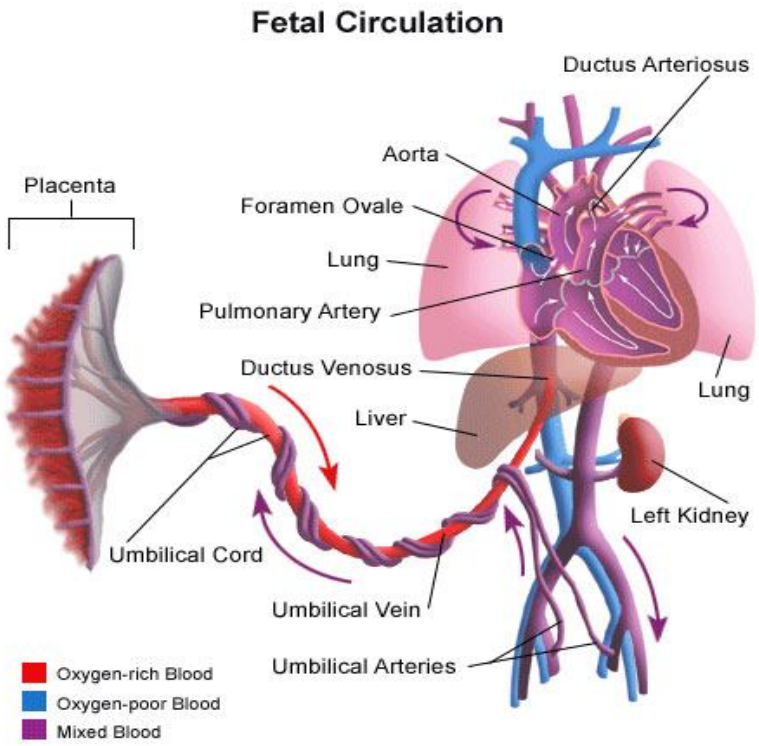


Figure 2.2: shows the fetal circulation (http/www.developmental Anatomy/.sa.org).

Within the child, the umbilical vein and ductusvenosus close up, and degenerate into fibrous remnants known as the round ligament of the liver and the ligamentumvenosum respectively. Part of each umbilical artery close up (degenerating into what are known as the medial umbilical ligaments), while the remaining sections are retained as part of the circulatory system. After birth, the umbilical cord is clamped or tied and is then cut. The stump of the cord that remains attached to the baby withers and falls off after a few days, leaving the circular depression in the abdomen known as the navel(Mari and Hanif, 2008).

2.4 Anatomy of fetus in utero

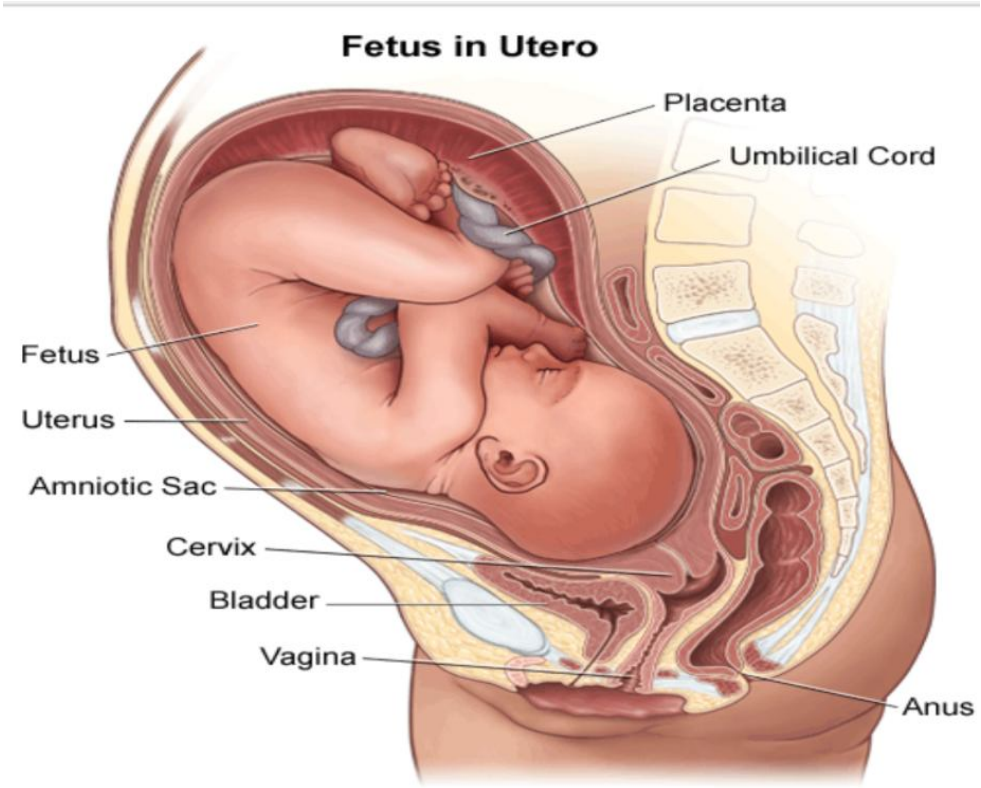


Figure 2-3 show fetus in utero(www.hopkins medicine.org)

2.5 Placenta:

Placenta is essentially a fetal organ and represents the link between the developing fetus and the mother. In the human placenta trophoblast erodes into the deciduas so that endothelium of the maternal blood vessels is destroyed and maternal blood is indirect contact with the chorion. Because of that placenta enables the fetus to take oxygen and nutritients from the maternal blood and serves as the excretory organ for carbon dioxide and other waste products of fetal metabolites. As well as that the placenta forms a barrier against the transfer of infection to the fetus and secretes a large amount of hormones in maternal circulation(Bethune et al., 2013).

Many clinical problems are attributed to the placenta despite the fact that they cannot always be explained on pathologic explanation. As placenta has attained its final thickness and shape at the end of the fourth gestational month, this is an ideal time to perform initial ultrasound examination (Bethune et al., 2013).

2.6 Developmental and anatomy of placenta:

While the trophoblastic cords from the blastocyst are attaching to the uterus, blood capillaries grow into the cords from the vascular system of the newly forming embryo. By the 16^{th} day after fertilization, blood also beings to be pumped by the heart of the embryo itself. Simultaneously, blood sinuses supplied with blood from the mother develop around the outsides of the trophoblastic cords. The trophoblact cells send out more and more projections, which become placental villi into which fetal capillaries grow. Thus, the villi carrying fetal blood are surrounded by sinuses that contain maternal blood(Bethune et al., 2013).

The final structure of the placenta that the fetus's blood flows throw two umbilical arteries, then into the capillaries of the villi, and the finally back throw a single umbilical vein into the fetus. At the same time the mother's blood flows from her uterine arteries into large maternal sinuses that surround the villi and then back into the uterine veins of the mother. The total surface area of the villi of mature placenta is only a few square meters—many times less than the area of the pulmonary membrane in the lungs. Nevertheless, nutrients and other substances pass throw this placental membrane mainly by diffusion in much the same manner that diffusion occurs throw the alveolar membranes of the lungs and the capillary membranes elsewhere in the body (Bethune et al., 2013).

2.7 Gestational age (GA):

Is defined in weeks beginning from the first day of LMP prior to conception, accurate determination of GA is fundamental to obstetric care and is important in avortety of situations.A simple, but uniform approach the evaluation of gestational age should be performed in all fetuses. The ultrasound assessment of fetal age is based on the earliest ultrasound study, provided the measurements is technically adequate, early in gestational fetal measurement have the least variability and therefore, are most likely to predict fetal age. In the first trimester, the crown rump length (CRL)is used to estimate gestational age .whereas in the second and third trimester's fetal head (BPD and HC), body (AC) and extremity (FL) are used to assess gestational age (McGregor et al., 2017).

2.8 Arterial resistivity index (RI):

The arterial resistivity index also called resistance index is a measure of pulsatility blood flow that reflects the resistance the blood flow caused by micro vascular bed distal to the site of measurement. And there is formula to calculate:

RI = systole – diastole/systole.

When RI is zero mean that, continuous flow, and when RI is equal 1(one) that means there is systolic flow but no diastolic flow.The RI is altered not by vascular resistance alone but by the complication of vascular resistance and vascular complication. RI is used in ultrasound testing of umbilical artery for placental in sufficiency, also commonly used to monitor renal status, especially following renal transplant(Bude and Rubin, 1999).

2.9 Umbilical artery Doppler:

UA Doppler assessment is used in surveillance of fetal wellbeing in the third trimester of pregnancy; it has been shown to reduce prenatal mortality and morbidity in high risk obstetric situation (Maulik et al., 1991).

Doppler ultrasound indices measured at the fetal end, the free loop and the placenta end of the umbilical cord are different with the impedance highest at the fetal end. The changes in the indices are likely to be seen at the fetal end first. Ideally the measurements should be made in the free cord(Maulik et al., 1991).

The waveform of the umbilical artery usually has a (saw tooth) pattern with flow always in the forward direction .An abnormal waveform shows absent or reversed diastolic flow. Before the 15th week, absent diastolic flow may be anormal finding.The commonly parameters used are:

- Umbilical arterial S/D ratio (systolic velocity/diastolic velocity).
- PulsatilityIndex (PI)=PSV-EDV/TAV
- (PeakSystolic Velocity-End Diastolic Velocity/TimeAverageVelocity)

Resistive Index (RI) =PSV-EDS/PSV

- (Peak systolic velocity-end diastolic velocity/peak systolic velocity).
- RI should not exceed 0, 60 at 30 eek of gestation (Hobbins, 2008).

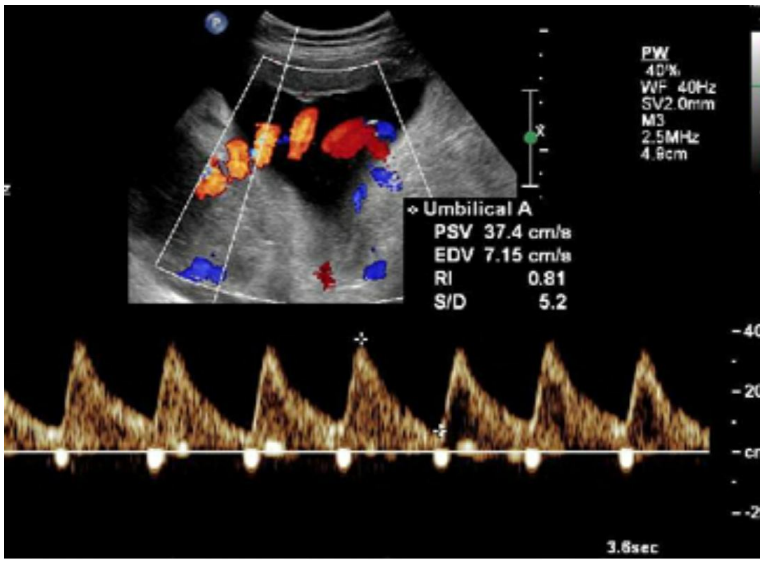


Figure 2-4Doppler ultrasounds of umbilical arteries

(www.ultrasoundpedia.com)

2.10 Estimation of fetal weight by ultrasonic examination:

The estimation of fetal weight (EFW) by ultrasound is routinely used in clinical practice.Parameters used to estimate the birth weight is attractive to clinicians as they are important variables affecting prenatal mortality. Studies have revealed that estimation with multiple parameters may be more accurate as compared to that with a singleparameter.Fetal biparietaldiameter (BPD), head circumference (HC), femur length (FL) and abdominal circumference (AC) are essential parameter for the estimation of prenatal fetal weight(Chang et al., 2014).

2.10.1Bi-parietal diameter (BPD):

(Is one of basic biometric parameters used to assess fetal size, and should be measured on an axial plane that traverses the thalami and cavum septum pellucidum.The transducer must be perpendicular to the central axis of the head and thus the hemispheres and calvaria should appear symmetric. The calipers should be placed at the outer edge of the near calvarial wall to inner edge of the far calvarial wall. The cerebellar hemispheres should not be in the plane of the image (Baum et al., 2002).

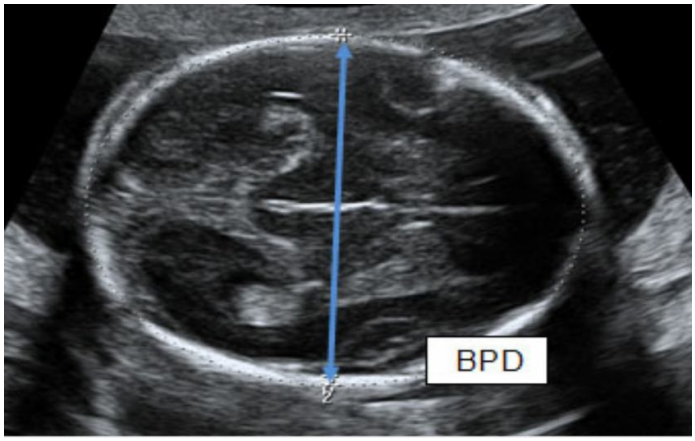


Figure 2-5Bi-parietal diameters (BPD) measurement
(www.brochures.mater.org.au.)

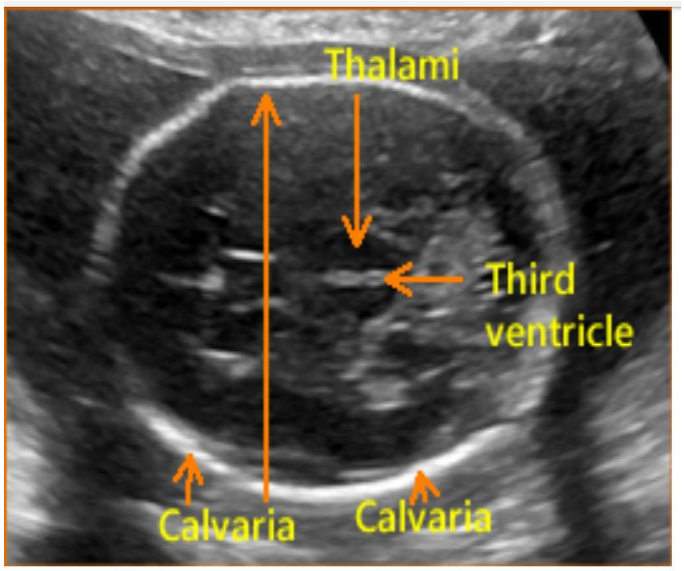


Figure 2-6sonographic axial plain of fetus head (www.obimages.net)

2.10.2 Fetal abdominal circumference (AC):

Transverse section through the upper abdomen, which should demonstrate fetal land marks, fetal stomach, umbilical vein and portal sinus.AC measurement should not be taken on a foreshortened abdomen and the calipers should be on the skin surface(Bethune et al., 2013).

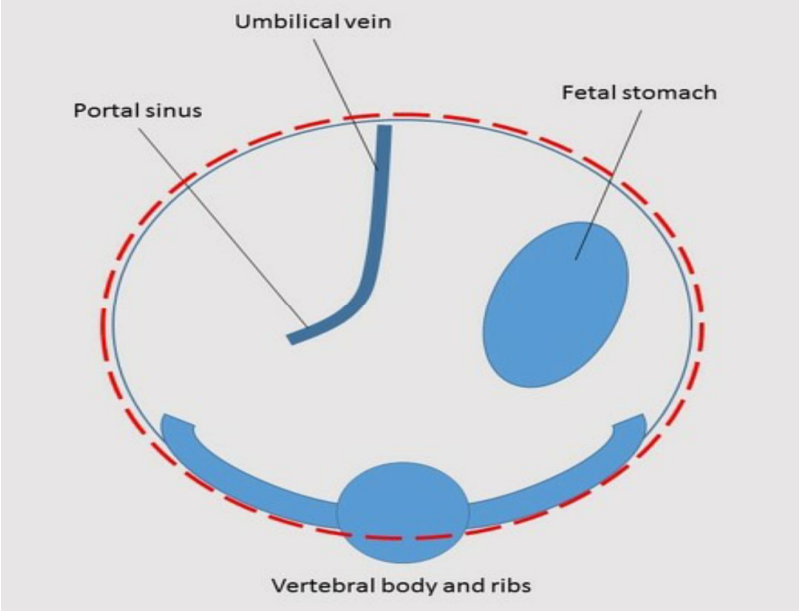


Figure 2-7 diagram show of fetal abdominal circumference (www.radiopedia.org)

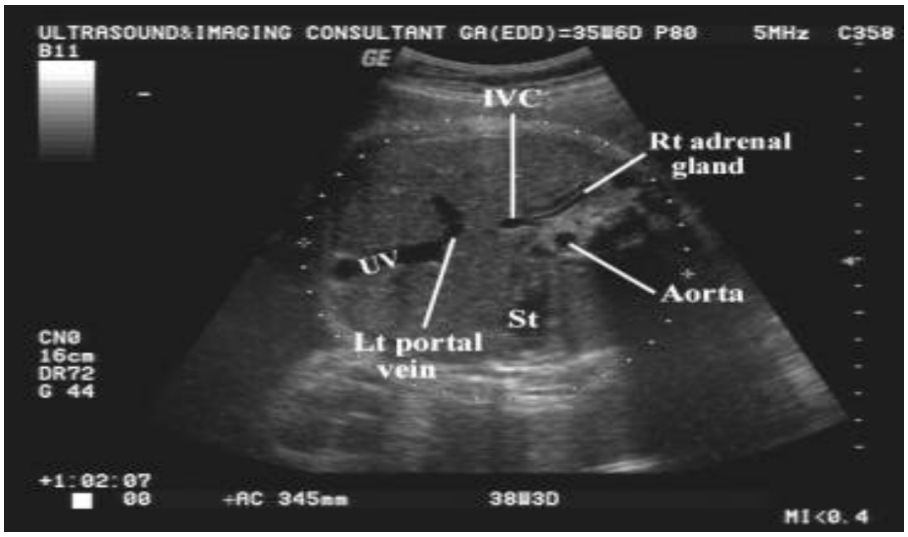


Figure 2-8sonographic appearance of abdominal circumference (www.fetalultrasound.com)

2.10.3 Femur length:

Transducer should be aligned along the bone so that the beam is perpendicular to the shaft; measured ends should be blunt and not pointed. The length is measured from blunt end to blunt end parallel to shaft. Measure the femoral diaphysis, but not the ossification center (Ott, 2006).

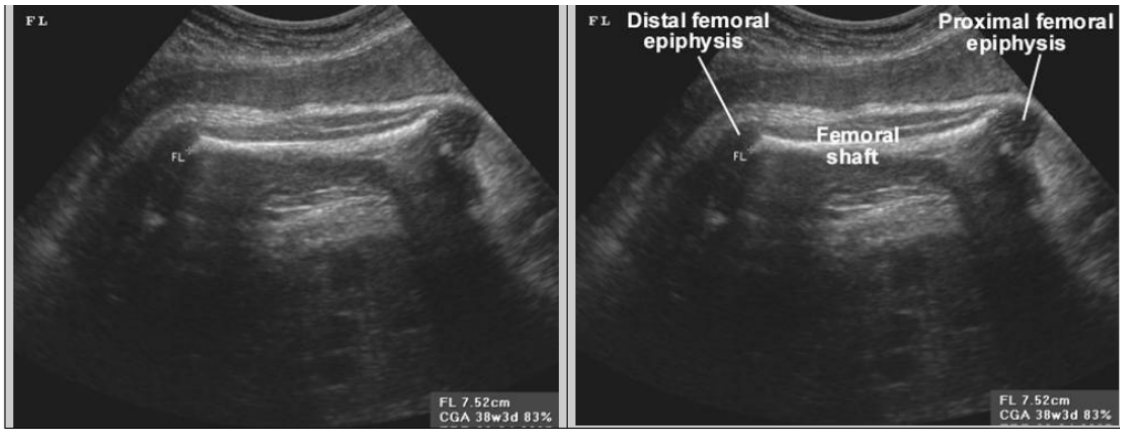


Figure 2-9sonographic measurement of femur length (www.fetalultrasound.com)

2.10.4 Small for gestational age

Small for gestational age is a term used to describe a baby who is smaller than the usual amount for the number of weeks of pregnancy.SGA babies usually have birth weight below the 10th percentile for babies of the same gestational age, most SGA babies are small because of fetal growth problems that occur during pregnancy .many babies with SGA have a condition called intrauterine growth restriction (IUGR). IUGR occurs when the fetus does not receive the necessary nutrients and oxygen needed for proper growth. One of the factors that contribute to SGA is decreased blood flow in the uterus and placenta (Xu et al., 2008).

2.10.5 Large for gestational age:

LAG is defined as a weight, length, or head circumference that lies above the 90th percentile for that gestational age. Some experts consider a baby to be big when it weighs more than 8pounds 13ounces (4000g) at birth, and others say a baby is big if it weighs more than 9pounds 15 ounces (4,500g)(Xu et al., 2008).

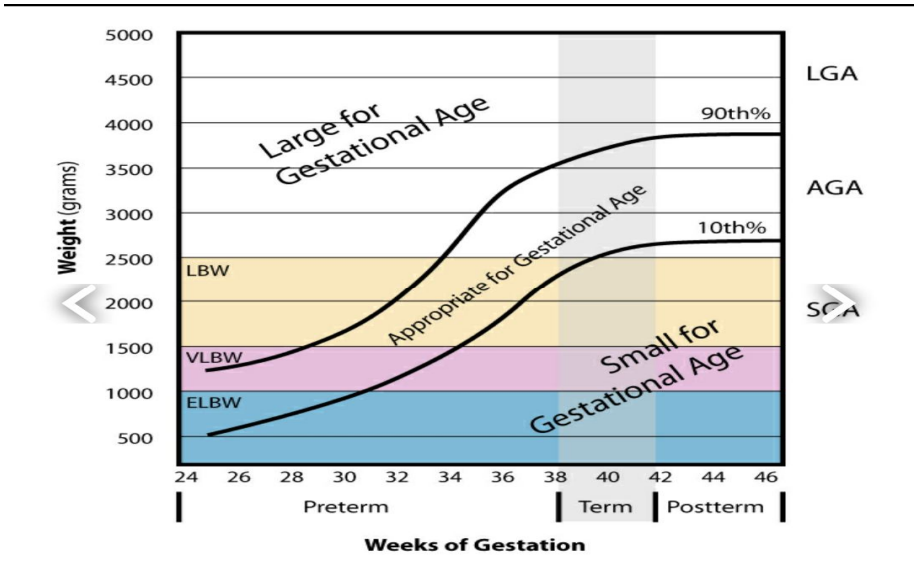


Figure 2-10: show large and small for gestational age percentile.

(www.en.m.wikipedia.org)

2.10.6 Normal fetal weight in the 3rd trimesters:

During the final months of pregnancy and according to the American Pregnancy Association, a fetus weight around 2 pound at 27 weeks, 4 to 4.5 pound by 32 weeks and grow up to between 6.75 pound to 10 pound if have a full term delivery(Holmlund et al., 2017).

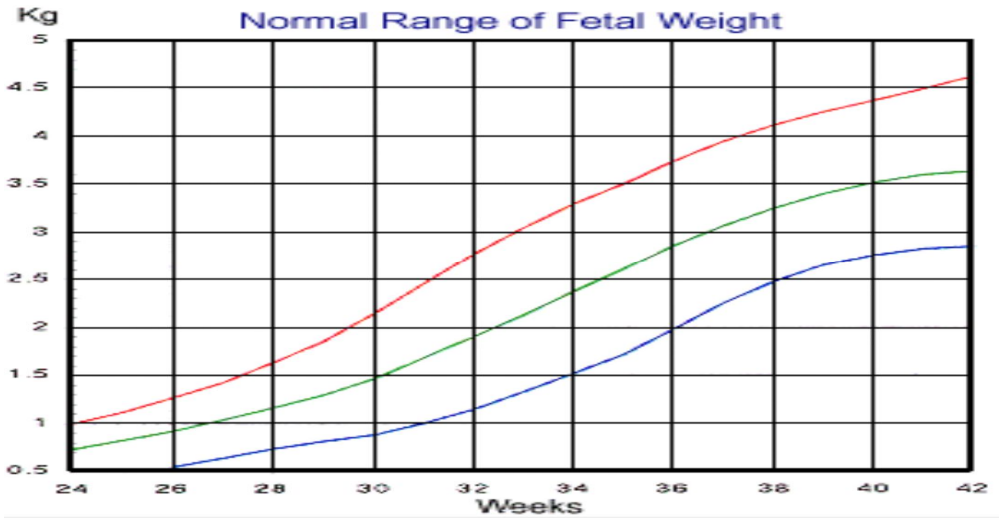


Figure 2-11: Normal range of fetal weight (ultrasoundservices.com.au)

2.11 Previous studies:

Gertrud S. etal 1988 studied the sonographic estimation of fetal weight and Doppler analysis of umbilical artery velocimetry in the prediction of intrauterine growth retardation .this study were published in American journal of obstetrics and gynecology .volume 158.issue 5 May 1988.The study was under taken to examine whether Doppler velocimetry studies of umbilical artery give a better or an earlier prediction of intrauterine growth retardation (IUGR) than do sonographic estimation of fetal weight .They concluded that sonographicbiometry is a more sensitive technique for identifying IUGR, but that the umbilical artery waveforms are a valuable adjunct for improving the diagnostic accuracy for the prenatal detection of IUGR.

BaschatAA,et al 2000 studied the umbilical artery Doppler screening for detection of the small fetus in need of ante partum surveillance .They aimed to test the hypothesis that umbilical artery Doppler velocimtryidentifies fetuses who are small for gestational age and in need of antenatal surveillance .their results were that only the umbilical artery systolic/diastolic ratio predicted prenatal outcome in the group of fetuses who were presumed to be small for gestational age .And they concluded that antenatal surveillance may be un necessary in fetuses with suspected intrauterine growth restriction if the umbilical artery systolic/diastolic ratio and amniotic fluid volume are normal.

(Owen et al., 2003) conducted study with the aim to establish whether there is a relationship between estimated fetal weight(EFW) and umbilical artery Doppler waveform impedance indices in the third trimester .In their study with the title Is there a relationship between estimated fetal weight and umbilical artery Doppler impedance indices, this study was published in ultrasound in obstetrics and gynecology volume 22,issue2.Their method were that the pulsatility index(PI)and S/D(systolic/diastolic)ratio were obtained together with the EFW from 274 low risk pregnancies. Measurements were made at fortnightly intervals from 30 weeks gestation until delivery ,a relationship between the two impedance indices and EFW was sought at gestational age ranges of 30-32,33-35,36-38 and 39-41 weeks .their results were that therewere918 pairs of PI(with S/D)and EFW available for analysis the mean of impedance indices decreased with advancing gestational age .And there was no clinical relevant correlation between impedance indices and EFW with in any of the gestational age ranges.

Lesley M.E.et- al in 12-August 2005 has studied under title umbilical artery Doppler studies in small for gestational age babies reflect disease severity, published in BJOG international journal of obstetrics and gynecology. Volume 107-issuse 7, their objectives were to determine whether abnormal umbilical artery Doppler studies were independently associated with newborn morbidity

.and whether small for gestational age babies with normal umbilical artery Doppler studies had small mothers and allow rate of newborn malnutrition and morbidity the study was reflected that small for GA babies with normal (UAI), 53 (49%) had low ponderal indices, were hypoglycemic 38(35%) required admission to newborn nursery.

The study had concluded that, abnormal (UAI) Doppler reflected earlier onset and more sever growth restriction and are not independently associated with newborn morbidity.

Small for gestational age babies with normal Doppler studies have high rate of newborn nursery admission**.**

Young JiByun.et al 2009 .Published in yonsei medical journal, under the title umbilical artery Doppler study as a predictive marker of prenatal outcome in preterm small for gestational age infants. Their aim was to evaluate the merit of umbilical artery Doppler study as a predictive marker of perinatal outcome in preterm small for gestational age (SGA) infants. They found that the gestational age (GA) at the time of diagnosis of SGA the mean GA at delivery and the mean birth weight showed statistically significant difference among three groups .Also poor perinatal outcome was significantly increased in infants with abnormal S/D ratio .and they concluded that antenatal umbilical artery Doppler velocimetry is shown as a significantly efficient marker in predicting perinatal outcome in preterm SGA infants.

Chia –peichang et al 2014 published in Taiwanese journal of obstetrics and gynecology volume 53 issue 2June 2014 under the title umbilical artery Doppler velocimetry in normal pregnancies from 11 to 13gestational weeks.They aimed to investigate the relationship between umbilical artery flow and gestational age GA at 11-13 weeks in normal pregnancy in Taiwanese population . They measured the velocity of systolic / diastolic and pulsatility index PI of the umbilical artery and the mean velocity of the umbilical vein .their conclusions were that the S-wave velocity of the umbilical artery

increased with GA .By contrast the PI of the umbilical artery showed a decreasing trend with GA.

(Kehila et al., 2017)studied the correlation between umbilical resistive index and fetal growth .Pilot study which were published in journal of obstetrics gynaecol Res 2017 .they aimed to investigate normal pregnancies to determine whether there is a relationship between umbilical resistance and fetal growth. They used routine prenatal ultrasonography to estimate fetal growth ,and measure umbilical resistance index (RI).These data were used to find the relationship between the fetal growth and umbilical artery resistive index RI. They found the mean RI was 0.62+_0.07 and mean percentage weight gain relative to the estimated weight on the third trimester ultrasound was 8.86+_3.8% per week .There was an inverse linear relationship between umbilical artery RI and fetal growth .They concluded that in normal pregnancies there seems to be a linear relationship between umbilical RI measured at 31-34 weeks of gestation and average fetal growth in the third trimester .The greater the resistive index the lower the weight gain.

Chapter three

Materials and methods

3.1 Materials:

3.1.1 Ultrasound machines:

Tow ultrasound machines in different ultrasound centers were used in this study, the machine that used in Alribat ultrasound department is sonline 60s, which made by Siemens medical solutions USA (model:MCMD01AA. Model No IP747501. It has three probes; curvilinear 3-5MHz, linear6-12MHz andendovaginal probe .The ultrasound machine that used in Alamal department was Mindray diagnostic ultrasound system (Model:DC30, model No: Gb-68000484 manufacture date was November 2016). It has two probes convex 3-5 MHz and transvaginal 5-7.5 MHz.

3.1.2 Subjects:

50singleton pregnant women in the third trimesters were enrolled in the study. Women with multiple pregnancies, fetal with anomalies, diabetes and hypertension were excluded. Permission from hospitals was taken as well as verbal permission from the patients.

3.2 Methods:

3.2.1 Study design:

This study was experimental prospective observations.

3.2.2 Study area:

The study was conducted in Khartoum state at Alribat University Hospital and Alamal Hospital at ultrasound department.

3.2.3 Duration of the study:

This study was done in the period from May 2018 to October 2018.

3.2.4 Methods of measurement of fetal weight and gestational age:

After the patient lying down we asked her about the last menstrual period (LMP).Then we used trans-abdominal curvilinear probe C 5-6 MHZ frequency, to locate the fetal head and measure the bipariatal dimension (BPD) from the outer edge to inner edge of calvarias. Then the abdominal circumference (AC) was located at the level of the umbilical vein and stomach and measured it. Finally the femur length (FL) was measured from the blunt end to the blunt end of the femur. All these measurement were computed to get average of estimated fetal weight (EFW) per grams and gestational age per weeks.

3.2.5 Umbilical artery Doppler measurement:

A free loop of umbilical cord was located with B- mode ultrasonography for simplicity and consistency of measurement. The umbilical artery was identified using color Doppler interrogation. Pulsed Doppler with agate size of 2mm was applied. Spectral peak average intensities were set below 100m/wcm2.doppler velocities were recorded in the absence of fetal movement or uterine contraction. The PSV, EDV, PI, RI, S/D ratio were measured from three consecutive uniform umbilical arterial waveform and the mean for each parameter were documented.

3.2.6 Data collection and variables:

Data were collected using master data sheet with the variables; gestational age, umbilical artery resistive index (RI) and estimated fetal weight (EFW) per grams these variables used to achieve the result of this study.

3.2.Data analysis:

This data were analyzed using an excel Microsoft office program and (SPSS), data were presented as mean and standard deviation as well as correlation analysis.

Chapter four

Results

4.1 Results:

Table 4-1 show descriptive statistics of GA, UA-RI and fetal weight

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
GA	50	27	40	34.30	3.593
UA-RI	50	.05	.67	.5724	.08698
FW/Gram	50	969	3930	2459.28	814.928

Table4-2show the correlations between GA, UA-RI and Fetal weight

Correlations				
		GA	UA-RI	FW/Gram
GA	Pearson Correlation	1	-.627**	.959**
	Sig. (2-tailed)		.000	.000
	N	50	50	50
UA-RI	Pearson Correlation	-.627**	1	-.634**
	Sig. (2-tailed)	.000		.000
	N	50	50	50
FW/Gram	Pearson Correlation	.959**	-.634**	1
	Sig. (2-tailed)	.000	.000	
	N	50	50	50
**. Correlation is significant at the 0.01 level (2-tailed).				

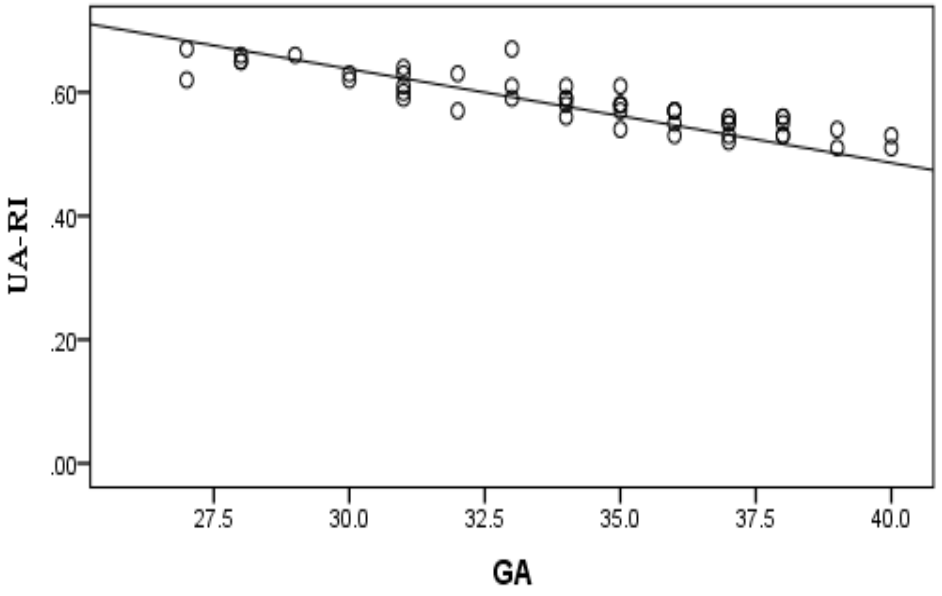


Figure 4-1Scatter diagram of gestational age and umbilical artery resistive index.

Table 4-3 shows the regression between GA and UA-RI.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constan)	1.093	.094		11.637	.000
GA	-.015	.003	-.627	-5.571	.000

a. Dependent Variable: UA-RI

UA-RI = -.015*Age + 1.093

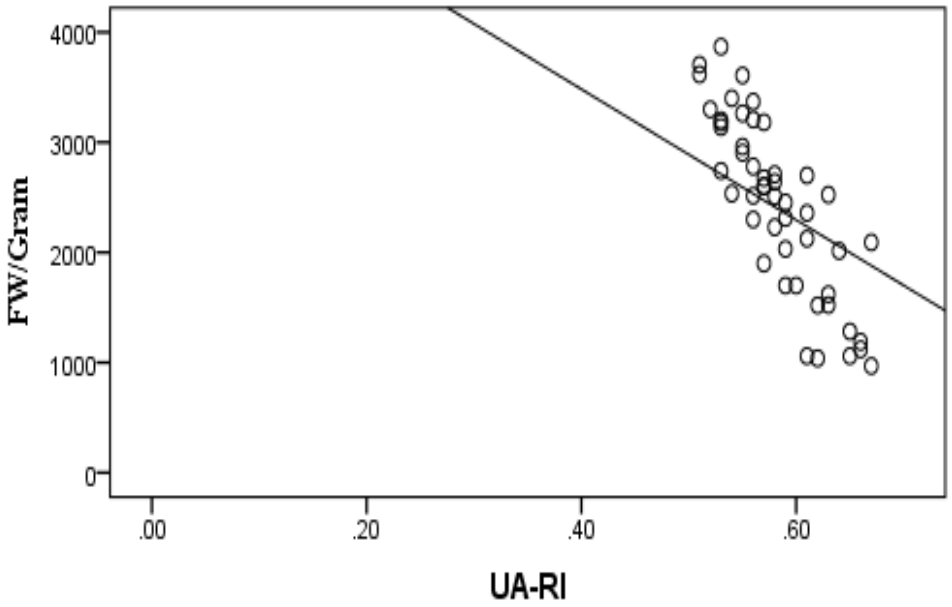


Figure: 4-2 show scatter diagram of UA-RI and fetal weight

Table: 4-4 shows the regression of fetal weight and umbilical artery resistive index.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.739	.031		23.948	.000
	FW/Gram	-6.763	.000	-.634	-5.675	.000

a. Dependent Variable: UA-RI

UA-RI = -6.763*FW + 0.739

Chapter Five

Discussion, conclusions and Recommendations

5.1 Discussion:

Growth is a functional measure of fetal condition and hence a better determination of fetal status than pure biometry .the most important aspect of management is the correct assessment of whether an affected fetus requires premature delivery.

Fetal weight estimation by ultrasound is related to three measurement .Bi-parietal dimension(BPD)reflects brain size, abdominalcircumference (AC) reflecting the nutrition status of the fetus and the femur length (FL) reflecting the height or length. Umbilical artery Doppler is an important tool to predict prenatal mortality and trend of complications in high risk pregnancies. It is a non –invasive procedure which enable us to assess the efficiency of placenta circulation .Fetus with abnormal Doppler results are at a significantly higher risk for early delivery,low birth weight (LBW),low Apgar score and neonatal ICU admission (Anshul et al., 2010).

In this study (50) pregnant women in the third trimester were examined by ultrasound with minimum GA 27 weeks, maximum GA 40 weeks and the mean GA was34.3 weeks.The umbilical artery resistive index (UA-RI) were that the minimum value was0 .50 and the maximum value was0.67 with the mean value 0.5724 and the STD was 0.08698.The fetal weight (FW) per grams, the minimum weight was 969 gram and the maximum weight was 3930 gram the mean weight was 2459.2 grams, as shown in table (4-1).

In this study the researcher aimed to find the relationship between the umbilical artery resistive indexes and estimated fetal weight and gestational age.

Table (4-2) showed the inverse or negative correlation between the gestational age (GA) and the umbilical artery resistive index (UA-RI).This means that when the gestational age increased the umbilical artery resistive index

decreased. This finding was consistent with (Owen et al., 2003)who said that the mean of umbilical artery impedance indices decreased with advancing gestational age.

Also as shown in table (4-2) the relationship between the umbilical artery resistive index (UA-RI) And the fetal weight was inverse or negative correlation at p-value 0.01.which means that when the resistive index of the umbilical artery increased the estimated fetal weights were decreased .and this results were consistent with (Kehila et al., 2017)who studied the correlation between the umbilical artery RI and fetal growth and he found that the greater the resistive index the lower the weight gain.

The scatter diagram in figure (4-1) showed the inverse or negative correlation of gestational age GA with the dependent variable umbilical artery resistive index (UA-RI).This results were consistent with (Chia-peichang, etal2014).

The inverse correlation between the fetal weight and the umbilical artery resistive index were revealed in the scatter diagram in figure (4-2).

5.2 Conclusion:

In normal Sudanese pregnant women in the third trimester, thereis an inverse relationship between the umbilical artery resistive indexes UA-RI. And estimated fetal weight EFW and gestational age GA.The greater the UA-RI the lower the fetal weight.Increasing the gestational age decreases the umbilical artery resistive index.

5.3 Recommendations:

- From these results the researcher noticed that Doppler ultrasound in the third trimester of pregnancy has a value in predicting fetal weight and other fetal abnormality.
- All ultrasound machines should have Doppler software program specially that used in obstetrics department.
- More learning and training for sonographer about Doppler technique and its role in obstetric and importance for fetal and maternal health.
- Doppler studies should be included as a routine exam in the third trimester of pregnancy.
- Type of delivery can be decided according to fetal weight and size.
- Correlation of uterine artery resistive index and fetal weight gain.

References:

ANSHUL, D., NEELU, S. & SUNEETA, G. 2010. Significance of umbilical artery Doppler velocimetry in the perinatal outcome of the growth restricted fetuses. *The Journal of Obstetrics and Gynecology of India,* 60**,** 38-43.

BAUM, J. D., GUSSMAN, D. & WIRTH III, J. C. 2002. Clinical and patient estimation of fetal weight vs. ultrasound estimation. *Obstetrical & gynecological survey,* 57**,** 558-559.

BERG, C., THOMSEN, Y., GEIPEL, A., GERMER, U. & GEMBRUCH, U. 2007. Reversed end-diastolic flow in the umbilical artery at 10–14 weeks of gestation is associated with absent pulmonary valve syndrome. *Ultrasound in Obstetrics and Gynecology,* 30**,** 254-258.

BETHUNE, M., ALIBRAHIM, E., DAVIES, B. & YONG, E. 2013. A pictorial guide for the second trimester ultrasound. *Australas J Ultrasound Med,* 16**,** 98-113.

BUDE, R. O. & RUBIN, J. M. 1999. Relationship between the resistive index and vascular compliance and resistance. *Radiology,* 211**,** 411-417.

CHANG, C.-P., WANG, H.-I., WANG, P.-H., YANG, M.-J., CHANG, C.-M., JUANG, C.-M., CHEN, Y.-J., HORNG, H.-C., TSENG, J.-Y. & YEN, M.-S. 2014. Umbilical artery Doppler velocimetry in normal pregnancies from 11+ 0 to 13+ 6 gestational weeks: A Taiwanese study. *Taiwanese Journal of Obstetrics and Gynecology,* 53**,** 193-196.

CHANPRAPAPH, P., WANAPITAK, C. & TONGSONG, T. 2000. Umbilical artery Doppler waveform indices in normal pregnancies. *Thai J Obstet Gynaecol,* 12**,** 103-107.

CHUDLEIGH, P., BASKY THILAGANATHAN 2004. *Obstetric ultrasound: how, why and when,* Churchill Livingstone.

HOBBINS, J. C. 2008. *Obstetric ultrasound: artistry in practice,* John Wiley & Sons.

HOLMLUND, S., NTAGANIRA, J., EDVARDSSON, K., LAN, P. T., SEMASAKA SENGOMA, J. P., AHMAN, A., SMALL, R. & MOGREN, I. 2017. Improved maternity care if midwives learn to perform ultrasound: a qualitative study of Rwandan midwives' experiences and views of obstetric ultrasound. *Glob Health Action,* 10**,** 1350451.

KEHILA, M., TOUHAMI, O., HMID, R. B., ABOUDA, H. S., ABDELJELIL, K., AYACHI, A., MOURALI, M., KHAIRI, H. & CHANOUFI, M. B. 2017. Correlation between umbilical resistance index and fetal growth: Pilot study. *J Obstet Gynaecol Res,* 43**,** 820-824.

KIM, E. T., SINGH, K., MORAN, A., ARMBRUSTER, D. & KOZUKI, N. 2018. Obstetric ultrasound use in low and middle income countries: a narrative review. *Reprod Health,* 15**,** 129.

MARI, G. & HANIF, F. Fetal Doppler: umbilical artery, middle cerebral artery, and venous system. Seminars in perinatology, 2008. Elsevier, 253-257.

MAULIK, D., YARLAGADDA, P., YOUNGBLOOD, J. P. & CISTON, P. 1991. Comparative efficacy of umbilical arterial Doppler indices for predicting adverse perinatal outcome. *American Journal of Obstetrics & Gynecology,* 164**,** 1434-1440.

MCGREGOR, K., MYAT MIN, A., KARUNKONKOWIT, N., KEEREECHAREON, S., TYROSVOUTIS, M. E., TUN, N. W., RIJKEN, M. J., HOOGENBOOM, G., BOEL, M., CHOTIVANICH, K., NOSTEN, F. & MCGREADY, R. 2017. Obstetric ultrasound aids prompt referral of gestational trophoblastic disease in marginalized populations on the Thailand-Myanmar border. *Glob Health Action,* 10**,** 1296727.

OTT, W. J. 2006. Sonographic diagnosis of fetal growth restriction. *Clin Obstet Gynecol,* 49**,** 295-307.

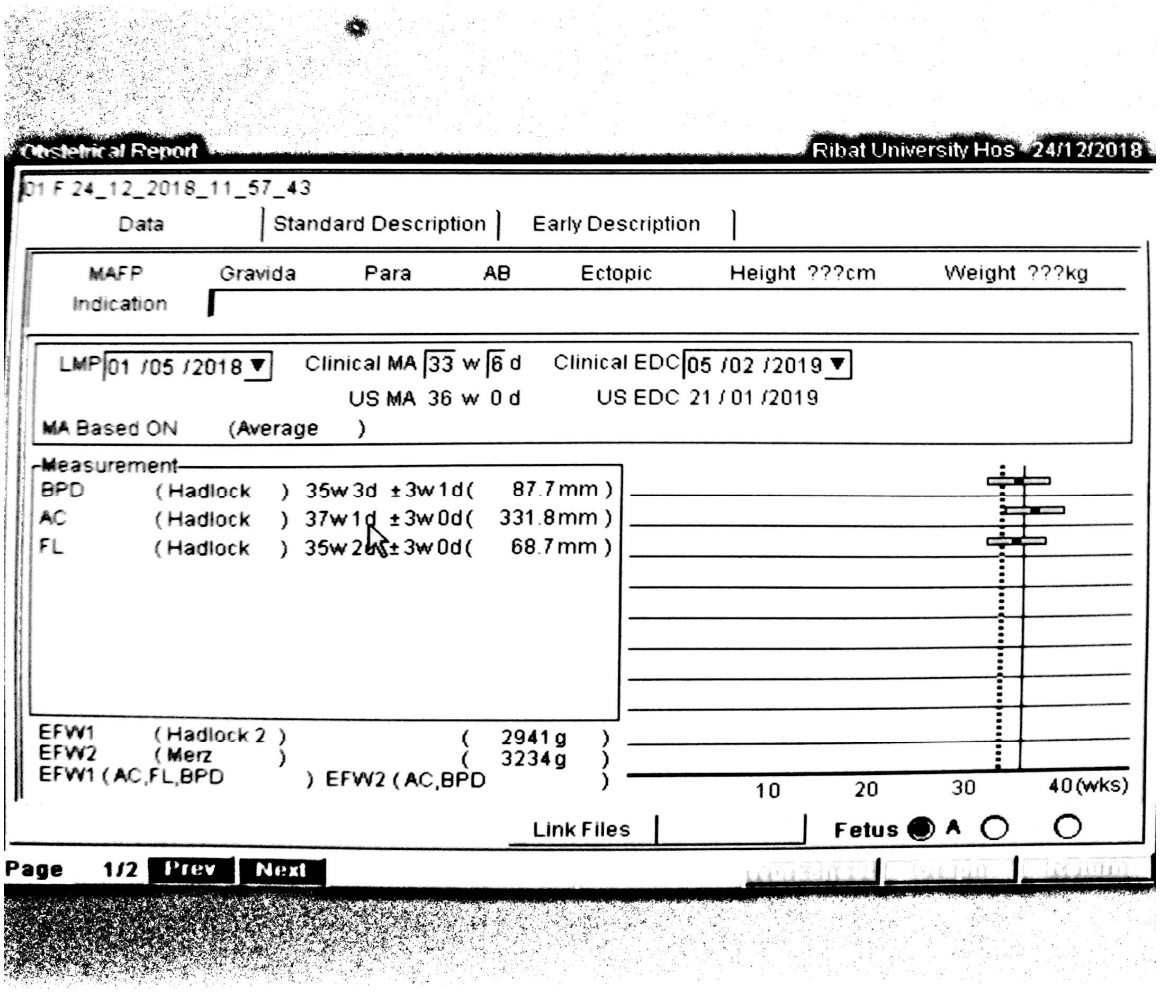
OWEN, P., MURPHY, J. & FARRELL, T. 2003. Is there a relationship between estimated fetal weight and umbilical artery Doppler impedance indices? *Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology,* 22**,** 157-159.

XU, H., DAI, W. P., WANG, C. J., TIAN, L. X., TANG, H. M. & SUN, F. Q. 2008. [Prediction of fetal hypoxia by measuring middle cerebral and umbilical artery resistance index in fetuses with umbilical cord around the neck in late pregnancy]. *Nan Fang Yi Ke Da Xue Xue Bao,* 28**,** 2207-9.

Study of the relationship between the umbilical artery resistive index and fetal weight and gestational age.

Data sheet

	GA	Umbilical Artery Resistive Index(RI)	Fetal wt
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			


Obstetrical Report
Ribat University Hos 24/12/2018
01 F 24_12_2018_11_57_43
Data
Standard Description
Early Description
MAFP
Gravida
Para
AB
Ectopic
Height ???cm
Weight ???kg
Indication
LMP 01 /05 /2018
Clinical MA 33 w 6 d
Clinical EDC 05 /02 /2019
US MA 36 w 0 d
US EDC 21 / 01 /2019
MA Based ON (Average)
Measurement
BPD (Hadlock) 35w 3d ±3w 1d(87.7mm)
AC (Hadlock) 37w 1d ±3w 0d(331.8mm)
FL (Hadlock) 35w 2d ±3w 0d(68.7mm)
EFW1 (Hadlock 2) (2941g)
EFW2 (Merz) (3234g)
EFW1 (AC,FL,BPD) EFW2 (AC,BPD)
10
20
30
40 (wks)
Link Files
Fetus A
Page 1/2
Prev
Next


mindray
Umb A PS 31.89 cm/s
Umb A ED 14.88 cm/s
Umb A HR 137(1) Bpm
Umb A RI 0.53
Umb A PI 0.77
Umb A S/D 2.14
53/53
6.6/6.6