



بسم الله الرحمن الرحيم



Sudan University of Science and Technology
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Sonographic Estimation of Gestational Age and Fetal Weight Using Umbilical Cord Diameter.

تقدير عمر الحمل الجنيني والوزن الجنيني باستخدام قطر الحبل
السري بالموجات فوق الصوتية

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

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الآية

بسم الله الرحمن الرحيم

قال الله تعالى:

(إِنَّ اللَّهَ عِنْدَهُ عِلْمُ السَّاعَةِ وَيُنزِلُ الْغَيْثَ وَيَعْلَمُ مَا فِي الْأَرْحَامِ^ط وَمَا تَدْرِي نَفْسٌ مَّاذَا تَكْسِبُ غَدًا^ط وَمَا تَدْرِي نَفْسٌ بِأَيِّ أَرْضٍ تَمُوتُ^ج إِنَّ اللَّهَ عَلِيمٌ خَبِيرٌ^م)

سورة لقمان الآية (34)

Dedication

To the spring that never stop giving

My mother dear

To the fountain of patience, optimism and hope

To the big heart

My dearest father

To whose love flows in my veins

My brothers and sisters

To the people who paved our way of science and knowledge

All our teachers distinguished

To the taste of the most beautiful moments

With my friends

I guide this research

ACKNOWLEDGMENT

My great thanks to my supervisor: Dr Caroline Edward Ayad for contact supervision in exhaustible & unlimited help my thanks extend to my all colleagues whose help me to collect the data and help me to complete this study.

ABSTRACT

Ultrasound has been used for evaluate of the gestational age of the fetus. Umbilical cord diameter is not used in estimation the GA routinely.

The main objective of this study was to determine the GA by Ultrasound measuring the umbilical cord diameter in second and third trimester of pregnancy .As well as to compare between GA by umbilical cord diameter, BPD, FL, AC and FW.

The across sectional study was conducted at 50 pregnant woman from Alban jaded hospital and Alhekma health center come for rotein follow up of BPD,FL,AC ,FW and UCD. Using gray scale. Those measured transverse section of UC. Also taken maternal age, parity and gravity. From December 2016 to March 2017.

The study show that It strong relation between GA by UCD and GA by BPD, FL, AC and FW.

And the mean of BPD mm 67.5, FL mm 48.4,AC mm 238.9, FW gm 1608.7

And the mean of GA BPD weak 27.3, GA FL week 27.8,GA AC weak 27.9,UC d114.2, UCd2 12.1

The SD of BPD mm 20.1, FL mm 16.7, AC mm 80.1, FW gm 1169.8

The SD of GA BPD weak 7.5, GA FL weak 7.1, GA AC weak 7.1, UCd1 3.8,UCd2 3.4

The result showed that there is a strong relationship between age of fetus by UCD and age of fetus by BPD, FL, AC and FW

Where rate of age increases by BPD 4 mm per 5 mm for first diameter and 3mm per 5mm for second diameter.

Increased equally by 4 mm per 5 mm between UCD and FL, AC for UCD1, UCD2

And between UCD1 and UCD2 and FW found the FW increased by , 002 gm per 5mm.

The study concluded that UCD should be used for assessment of GA.

ملخص الدراسة

تم استخدام الموجات فوق الصوتية لتحديد عمر الجنين . قطر الحبل السري لم يستخدم في القياسات الاعتيادية.الهدف من هذه الدراسة هو تحديد عمر الجنين باستخدام قطر الحبل السري في الثلث الثاني والثالث من الحمل والمقارنة بين عمر الجنين بالحبل السري مع العمر بواسطة عرض عظمتي الجدار وطول الفخذ ومحيط البطن و وزن الجنين أجريت الدراسة الوصفية على 50 امرأة حامل من مستشفى البان جديد و مركز صحي الحكمة. في الفترة من ديسمبر 2016 وحتى مارس 2017

كما أخذت في الدراسة عمر الحامل و عدد الانجاب و عدد الاجهاضات ولم يكن لتلك المتغيرات أهمية و أثر في الدراسة.

اظهرت النتائج ان هناك علاقة قوية بين عمر الجنين بواسطة قطر الحبل السري الأول وعمر الجنين بواسطة عرض عظمتي الجدار للرأس وعظمة الفخذ ومحيط البطن و وزن الجنين .

حيث يزيد عمر الجنين بواسطة عرض عظمة جدار الراس بمعدل 4.ملم لكل 5 ملم للقطر الاول وبمعدل 3.ملم لكل 5 ملم للقطر الثاني.

وبين قطر الحبل السري وعظمة الفخذ ومحيط البطن يزيد القطر الأول و الثاني بالتساوي بمعدل 4. ملم لكل 5 ملم

وبين القطرين و وزن الجنين وجدت ان وزن الجنين يزيد بمعدل 0.002.جم لكل 5 ملم وجد أن الوسط الحسابي لعمر الأم 28.2 ولعرض عظمة جدار الرأس 67.5 ولعظمة الفخذ 48.4 ومحيط البطن 238.9 ولوزن الجنين 1608.7 ولعمر الجنين بالأسابيع بواسطة عرض عظمة جدار الرأس 27.3 وعظمة الفخذ 27.8 ومحيط البطن 27.9 والوسط الحسابي للقطر الأول 14.2 والقطر الثاني 12.1

والانحراف المعياري لعرض عظمة جدار الرأس 5.5 ولعظمة الفخذ 20.1 ومحيط البطن 16.7 ولوزن الجنين 1169.8

ولعمر الجنين بالاسابيع بواسطة عظمة جدار الرأس 7.5 وعظمة الفخذ 7.1 ومحيط البطن 7.1 وللقطر الأول 3.8 والقطر الثاني 3.4

بناء على تلك النتائج يمكن استخدام قطر الحبل السري في تحديد عمر الجنين.

Table of Contents	
الآية	I
Dedication	II
Acknowledgment	III
Abstract	IV
ملخص الدراسة	V
Table of content	VI
List Of Table	VIII
List Of Figure	IX
List Of Abbreviations	XI
CHAPTER :INTRODICTION	
1.1 Introduction.....	1
1.2. The problem of the study	3
1.3 Objective of the study	3
1.3.1 General objective	3
1.3.2. Specific objectives.....	3
1.4. Over veiw of the study.....	3
CHAPTER TWO:LITERATURE REVIEW	
2.1 Anatomy.....	4
2.1.1Cord insertion	8
2.1.2 Umbilical Cord Doppler	9
2.2 Major blood vessels	10
2.3 complication of umbilical cord:.....	11
2.3.1Cord Length.....	11
2.3.2Umbilical Cord Cysts.....	13
2-3-3Umbilical Cord Twist:	15
2.3.4Discordant umblical Arteries.....	16
2.3.5Two Vessel Umbilical Cord.....	17
2.3.6Umbilical Cord Hematoma.....	19

2.3.7Aneurysm of the Umbilical Artery and Vein.....	20
2.3.8Cord Hemangioma.....	20
2.3.9Velamentous Cord Insertion (VCI).....	20
2.3.10Vasa Previa.....	22
2.4 Background studies.....	26
CHAPTER THREE: METHODOLOGY	
3.1 Material	28
3.2 Type of the study.....	28
3.3 Area of the study	28
3.4 Duration of the study	28
3.5 Population of the study	28
3.6 Sample size and sampling procedure.....	28
3.7 Inclusion criteria	29
3.8 Exclusion criteria	29
3.9 The study variables	29
3.10 Data collection and Instrumentation.....	30
3.11 The method of data analysis used in the study	30
3.12 Data presentation	30
3.13 Ethical considerations	30
3.14 ultrasound technique.....	30
CHAPTER FOUR: RESULT AND ANALYSIS	
Result and analysis.....	34
CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATION	
5.1 Discussion	44
5.2 Conclusion	46
5.3 Recommendation:	47
References.....	48
Appendix.....	

LIST OF TABLE

Table NO	Titles	page
4-1	Frequency distribution of mother age	34
4-2	Frequency distribution of parity	35
4-3	Frequency distribution of gravity	36
4-4	Descriptive statistic of minimum ,maximum ,mean &Std. Deviation for age of mother , BPD,FL,AC per mm and fetal weight, GA by BPD ,FL,AC per weeks	37
4-5	Correlation between GA per BPD, FL, AC, fetal weight and umbilical cord measurement (d1and d2)	41
4-6	Correlation between measurement of BPD, FL, AC mm and umbilical cord measurement (d1and d2)	43

LIST OF FIGURE

Fig NO	Item	page
1-2	Ultrasound of normal three-vessel umbilical cord.	5
2-2	A. Color Doppler ultrasound of two umbilical arteries. B. single umbilical artery .	6
2-3	A. Transverse view showing normal three-vessel B. . single umbilical artery .	7
2-4	A. Insertion of the umbilical cord into the fetal abdomen. B. Transverse section of the normal umbilical cord .	9
2.5	Diminished umbilical cord artery diastolic flow.	10
2-6	The relationship between the umbilical vein and the ductus venosus.	11
2.7	First trimester - amniotic cavity diameter equivalent to the crown-rump length.	13
2.8	First trimester umbilical cord cyst .	14
2.9	Straight umbilical cord.	16
2.10	Discordant umbilical arteries.	17
2.11	Two-vessel umbilical cord: a only the right umbilical artery is present: b in the amniotic fluid.	18
2.12	Two-vessel umbilical cord.	19
2.13	Fundal velamentous cord insertion of a bilobate placenta.	21
2.14	Placental cord insertion in the third trimester.	22
2.15	Color Doppler of a vasa previa.	23
2.16	Posterior succenturiate placental lobe associated with a type II vasa previa.	24

2.17	Color Doppler of a feeding vessel to a succenturiate placental lobe.	24
3.1	Measurement the BPD	31
3.2	Measurement the FL	31
3.3	Measurement the AC	32
4.1	Frequency distribution of mother age	34
4.2	Frequency distribution of number of parity	35
4.3	Frequency distribution of gravity	36
4.4	Relationship between fetal weight and UCd1 and UCd2	37
4.5	Relationship between GA BPD and UCd1 and UCd2	38
4.6	Relationship between GA FL and UCd1 and UCd2	38
4.7	Relationship between GA AC and UCd1 and UCd2	39
4.8	Relationship between BPD mm and UCd1 and UCd2	39
4.9	Relationship between FL mm and UCd1 and UCd2	40
4.10	Relationship between AC mm and UCd1 and UCd2	40

LIST OF ABBREVIATIONS

US	Ultrasound
GA	Gestational Age
BPD	Bi parietal Diameter
FL	Femur Length
HC	Head circumference
AC	Abdominal circumference
FW	Fetal weight
UCD	Umbilical cord diameter
SUA	Single umbilical artery
LMP	Last menstrual period
MM	Millimeters
SPSS	Statistically package for social sciences
IUGR	Intra uterine growth retardation
IVF	In vitro fertilization
EDD	Expected date of delivery
S	Systolic
D	Diastolic
VCI	Velamentous cord insertion
MA	Mather Age
Y	year

CHAPTER ONE

Introduction

CHAPTER ONE

INTRODUCTION

1.1 Introduction:

The umbilical cord: Essential link to the placenta, Normally inserts into the center of the placenta and mid line portion of the anterior abdominal wall of the fetus (umbilicus), umbilical vein carries oxygenated blood, umbilical arteries return venous blood back to the placenta, formed by the fusion of the yolk stalk and body stalk (allantoic duct), amniotic membrane covers the umbilical cord and blends in to the fetal in the umbilicus, composed of one vein and two arteries surrounded by myxomatous connective tissue (Whartonjelly). (Steven M, 2011).

Development of cord forms between the 7-8 menstrual weeks when the longitudinal and transverse folding of the trilaminar embryonic disc opposes the body stalk and the yolk stalk. Remnants of body stalk and yolk stalk which may be the source of cord cysts include the allantoic and omphalo mesenteric duct. (Devin Dean, 2005).

Gestation lasts for about 40 weeks (280 days) with the GA being calculated from the first day of onset of the woman's last menstrual period (LMP).

Unfortunately, calculation of the GA based on LMP is often inaccurate as many women, especially those with a history of irregular menstrual periods prior to conception, are often unsure of the date of onset of their LMP.

US imaging is now a commonly used modality to estimate the GA by measuring fetal parameters such as BPD, FL, HC and AC.

Differences in techniques of measurement tend to diminish the accuracy of US measurement of fetal parameters as estimators of GA. Estimation of GA based on BPD in the third trimester of pregnancy, for instance, is generally

unreliable because BPD is affected by shape and size of the head. (Lee W et al, 2000).

Measurement of HC as a predictor of GA compensates for the deficiencies of BPD due to shape of the head but HC measurement often appears technically more difficult and carries a higher degree of observer bias. (Malhotra N, 1999).

Furthermore, measurement of FL for dating at later stages in pregnancy is considered unreliable as the femur, in some cases, appear foreshortened and therefore, May not give accurate GA in cases of dwarfism.

Measurement of AC in the later stage of pregnancy has been touted as the single most important fetal dimension. It is however, more reflective of fetal size/weight than gestational age. In small for date fetuses, for instance, AC may not be a reliable estimator of GA. (Lee W et al, 2000).

BPD is accurate to GA by ± 10 days and ± 21 days in the third trimester. Similarly the FL is accurate to GA by ± 6 days in the second trimester while in the third trimester, it is accurate to GA by ± 14 days (Karki DB et al, 2006) (Cromi A et al, 2007).

However from 20 weeks of gestation, it is more reliable to use the mean values of BPD, FL, HC and AC because the use of a single parameter such as BPD becomes relatively unreliable. (Chattergee MS et al, 2013). (Predanic M, 2005).

The purpose of my study is to use ultrasound to measure the umbilical cord diameter among population of healthy Sudanese women in khartoum and determine if there correlation between umbilical cord size and GA of their fetus.

1.2.The problem of the study:

There is no known normal range for umbilical cord diameter and cross sectional area locally in the literature reviewed. More accurate methods to determine GA are still needed as pregnant advance in age. Other GA estimation parameters such as: AC in a practitioner dependent, FL may fail some time due to un sharpness or foreshortening of femur bone but umbilical cord is easy to assess and measure at any GA of pregnant.

1.3Objective of the study:

1.3.1 General objective:

To assess the relationship between the umbilical cord diameter and gestation age among Sudanese pregnant women at Khartoum.

1.3.2. Specific objectives:

- To estimate fetal gestation age by umbilical cord diameter.
- To create a nomogram for umbilical cord diameter.
- To correlate the umbilical cord size with other fetal parameter.
- To correlate the umbilical cord size in normal Sudanese pregnant women at Khartoum with the standard measurement.

1.4 Over view of the study:

This study consist of five chapters with chapter one is an introduction which include (problem and objective of the study), chapter two is an literature review which include (Anatomy, Physiology, Pathology) and background study. Chapter three about research methodology. Chapter four deals with result and chapter five include (discussion, conclusion ,recommendation, reference and appendices.

CHAPTRE TWO

Literature review

CHAPTER TWO

LITERATURE REVIEW

2-1 Anatomy:

The umbilical cord is first visualized by US at 8 weeks as a straight, rather thick structure. At this point, the length of the umbilical cord is approximately equal to the crown rump length. Although it is not possible to directly measure by US, the umbilical cord usually continues to be the same length as the fetus throughout pregnancy. The diameter of the umbilical cord is normally less than 2 cm. The umbilical cord develops up to 40 spiral turns as it elongates during gestation. The umbilical cord twists toward the left more frequently than to the right. Coiling is thought to aid in protecting the cord by resisting compression of the vessels.

The development of cord length and twist are also dependent upon tensile forces placed upon the cord by fetal movements. Therefore, there must be adequate fluid space and fetal activity to ensure normal length and coiling of the umbilical cord. Normally, the umbilical cord contains two arteries and one vein. (Fig. 1–2). Although, early in development there are two umbilical veins, the right umbilical vein atrophies and the left umbilical vein persists. The umbilical vein carries oxygenated blood returning from the placenta and connects with the left portal vein in the liver. The umbilical arteries are continuous with the internal iliac arteries and carry deoxygenated blood from the fetus toward the placenta. The presence of two umbilical arteries may be confirmed by visualizing a short axis view of the umbilical cord and identifying two arteries and one vein or by visualizing vessels on each side, lateral to the fetal bladder on US (Fig. 2-2A and B). The vessels within the cord are surrounded by Wharton jelly, a gelatinous connective tissue that

helps protect the umbilical vessels from compression .pregnancies (Fig. 2-3A and B). (John F, 2008).



Fig 1-2 Ultrasound of normal three-vessel umbilical cord with both arteries and a single vein seen in long axis.
(John F, 2008).

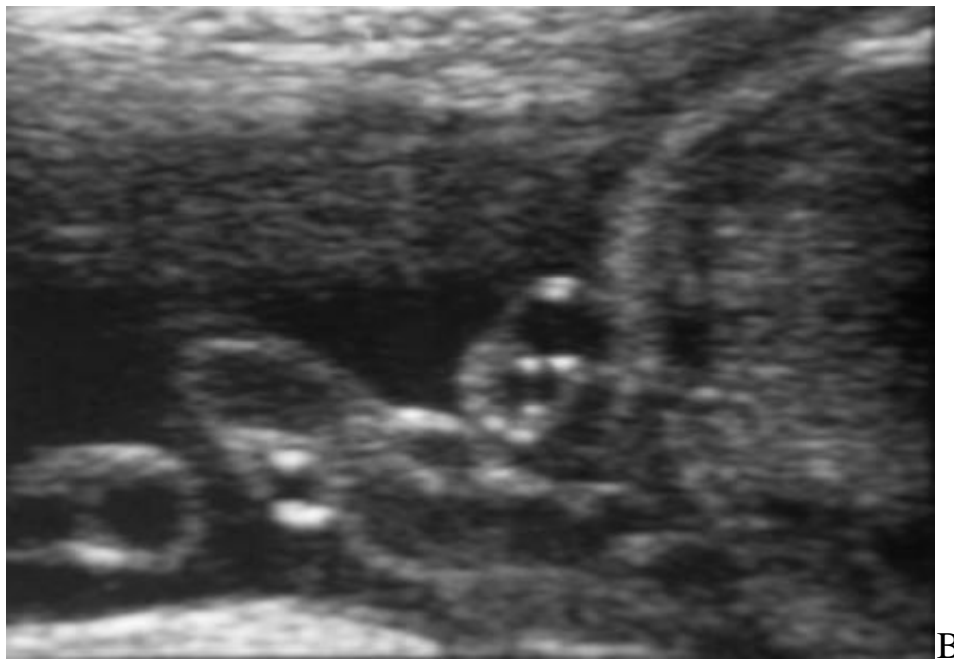
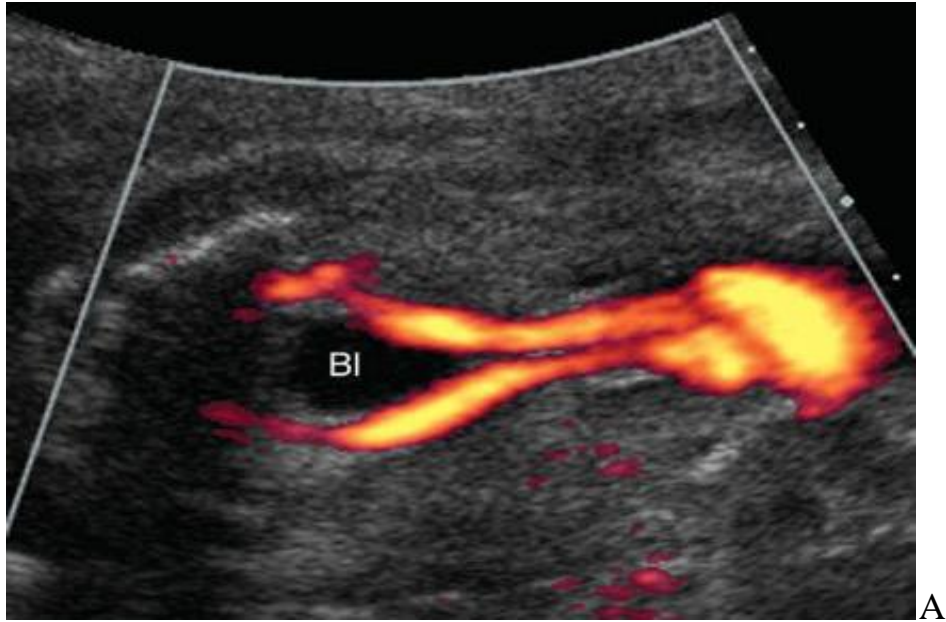
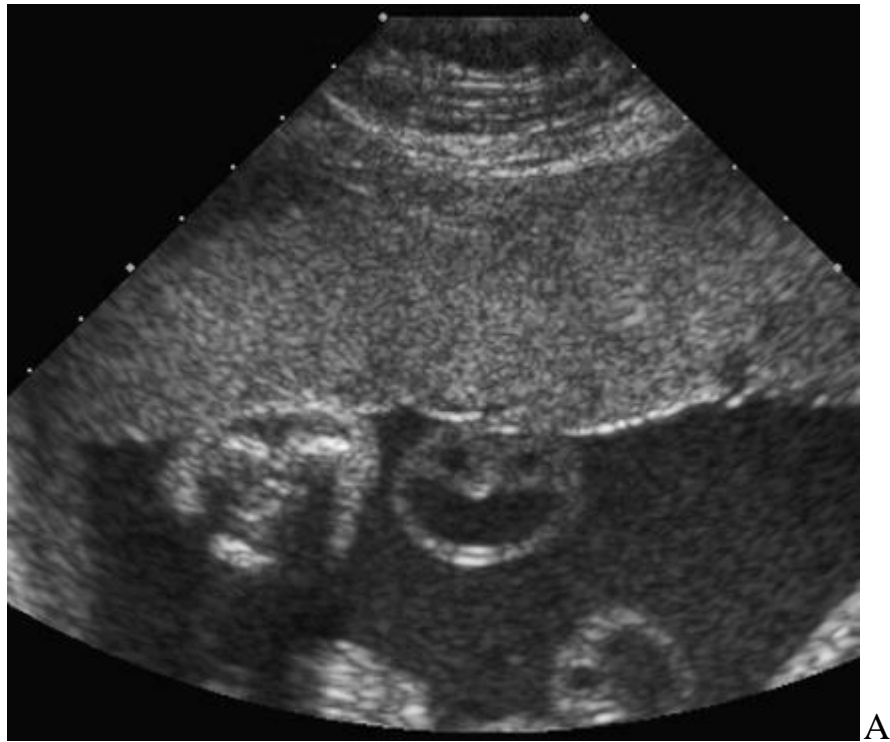


Fig 2-2 A. Color Doppler ultrasound showing two umbilical arteries flanking the fluid-filled fetal bladder (BI). B. In a separate case, a single umbilical artery is shown adjacent to the bladder.

(John F, 2008).



A



B

Fig 2-3A. Transverse view showing normal three-vessel umbilical cord (two arteries and one vein). B. An example of a single umbilical artery (arrow) with a two-vessel cord seen on this ultrasound image.

(John F, 2008)

2-1-1Cord insertion:

Slide caudally to the site of insertion of the umbilical cord (Fig2-4A). Within the cord it self, the two umbilical arteries can be observed leaving the fetal abdomen just superior to the fetal bladder and immediately inferior to where the single umbilical vein enters. If any doubt remains, color Doppler can be used to confirm arterial flow in both umbilical arteries as they pass on either side of the fetal bladder. Vessel number can also be evaluated from a transverse section of the cord in the amniotic fluid (Fig. 2-4B) although this is frequently difficult before 22 weeks of gestation. Confirming normal cord insertion is important in the exclusion of abdominal wall defects, the most common of which are omphalocele and gastroschisis. (TrishChudleigh B, 2004).



Fig 2-4 A. Insertion of the umbilical cord into the fetal abdomen. Note the direction of the two arteries within the fetal abdomen. B. Transverse section of the normal umbilical cord at 24 weeks demonstrating the presence of two arteries and vein (Trishchudleigh, B, 2004).

2-1-2 Umbilical Cord Doppler:

Fetal well being can be evaluated using pulsed Doppler of the umbilical cord by measuring the S/D ratio. The S/D ratio assesses the vascular resistance in the placenta by taking a sample of the umbilical artery. It can be performed any where along the length of the cord. Normally, the S/D ratio will decrease with advancing gestation. Therefore, an elevated S/D ratio is

associated with increased placental resistance and an increase in the risk of perinatal mortality and morbidity . Absence or reversal of diastolic flow in the umbilical artery is considered irregular and is associated with an increased incidence of intrauterine growth restriction (IUGR) and oligohydramnios (Fig.2-5). (Steven M, 2011).



Fig 2.5 Diminished umbilical cord artery diastolic flow. Spectral Doppler of the umbilical artery in a 35-week fetus demonstrates diminished diastolic flow (arrows) with an elevated S/D ratio of 3.50 (arrowhead and calipers).

(Malhotra N, et al 1999).

2-2 Major blood vessels:

Return flow to a transverse section of the fetal abdomen and follow the umbilical vein into the liver. Note it runs through the liver at approximately 45° to the fetal spine. The umbilical vein, together with the extra hepatic portal vein, enters the portal sinus, which gives rise to the left portal vein, the right portal vein and the ductus venosus (Fig2-6). Most of the blood that is being returned to the fetus from the placenta passes through the ductus venosus to the right atrium. (Trish Chudleigh, B, 2004).

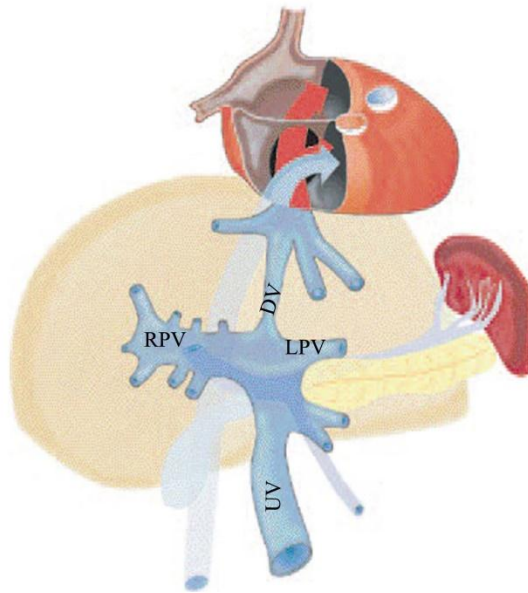


Fig 2-6 The relationship between the umbilical vein and the ductus venosus.
 DV, ductus venosus; LPV, left portal vein; RPV, right portal vein; UV,
 umbilical vein(Trishchudleigh, 2004).

2-3 complication of umbilical cord:

Many umbilical cord abnormalities can be detected Sonographically and have important prognostic implications for perinatal morbidity and mortality. Abnormalities of the cord may be associated with fetal anomalies, chromosomal abnormalities, and potential complications during pregnancy. Several cord lesions are reported in association with adverse perinatal outcomes. Knowledge of normal umbilical cord development and anatomy, and awareness of common abnormalities of the cord is therefore important for accurate prenatal diagnosis and assessment.

2-3-1Cord Length:

The umbilical cord is derived from the allantois and stalk of the yolk sac. The average length of the umbilical cord is 59 cm with a range of 22 to 130 cm (Purola E et al, 1968).

The two factors that determine umbilical cord length are sufficient space in the amniotic cavity for movement and the tensile force applied to the umbilical cord during fetal movements. (Moessinger AC et al ,1982).

If embryo/fetal movement is impeded, the tensile stretch placed on the cord will be less and the eventual cord length will be shorter. For example, the umbilical cord length in twins is generally shorter than for singletons. (Soernes T et al, 1987).

.In fetal rats, the exposure to alcohol during prenatal development is associated with a shortened umbilical cord. (Barron S et al, 1986).

In abnormal pregnancies the frequency and velocity of fetal movements decrease. This would explain the reduction in cord length in fetuses who subsequently die in utero. However, if the reason for the intrauterine demise was acute, cord length would not be affected. Cord length is longer in fetuses with polyhydramnios.

For the first half of the first trimester the amniotic cavity diameter and crown-rump length approximate one another (Fig.2.7). Hence, crown-rump length and cord length are roughly equivalent .(Hill LM et al, 1994).

After 10 weeks' gestation amniotic fluid volume increases rapidly due to the initiation of fetal voiding .(Hill LM et al, 1994).

· As a result, the amniotic cavity increases in size and the cord length becomes longer than the crown-rump length.

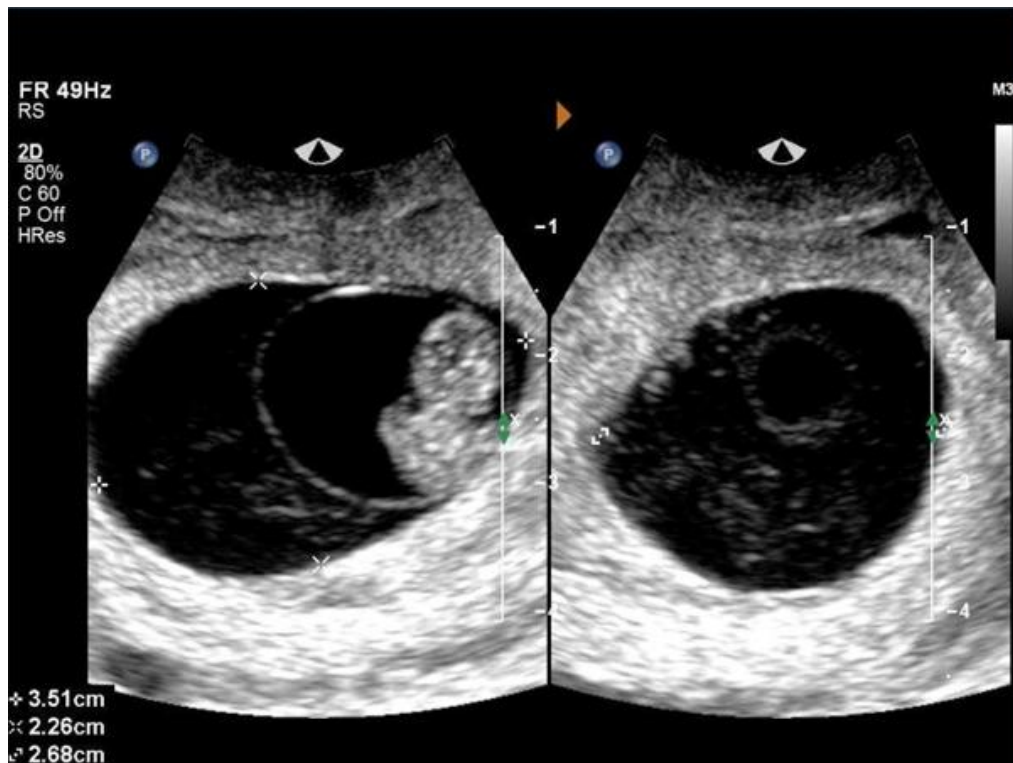


Fig 2.7. First trimester - amniotic cavity diameter equivalent to the crown-rump length.(Hill LM et al, 1994).

2-3-2 Umbilical Cord Cysts:

Umbilical cord cysts (Fig.2.8) are derived from either the allantois (i.e. urachus), the omphalo mesenteric duct, or focal edema of Wharton's jelly (pseudocysts). The former two have an epithelial lining and the latter does not. Pseudocysts are far more common than umbilical cord cysts. In general, an allantoic cyst is centrally located and will, therefore, widely separate the umbilical arteries. Since a pseudocyst results from edema of Wharton's jelly, the umbilical vessels may course through the cyst. Because of their etiology, allantoic and omphalo mesenteric duct cysts are usually found near the fetal end of the umbilical cord. While umbilical cord cysts are usually small, cysts of > 5 cm have been reported. If an umbilical cord cyst is large enough, it may compress the umbilical arteries and result in intrauterine growth restriction or fetal distress .(Moessinger AC et al ,1982).

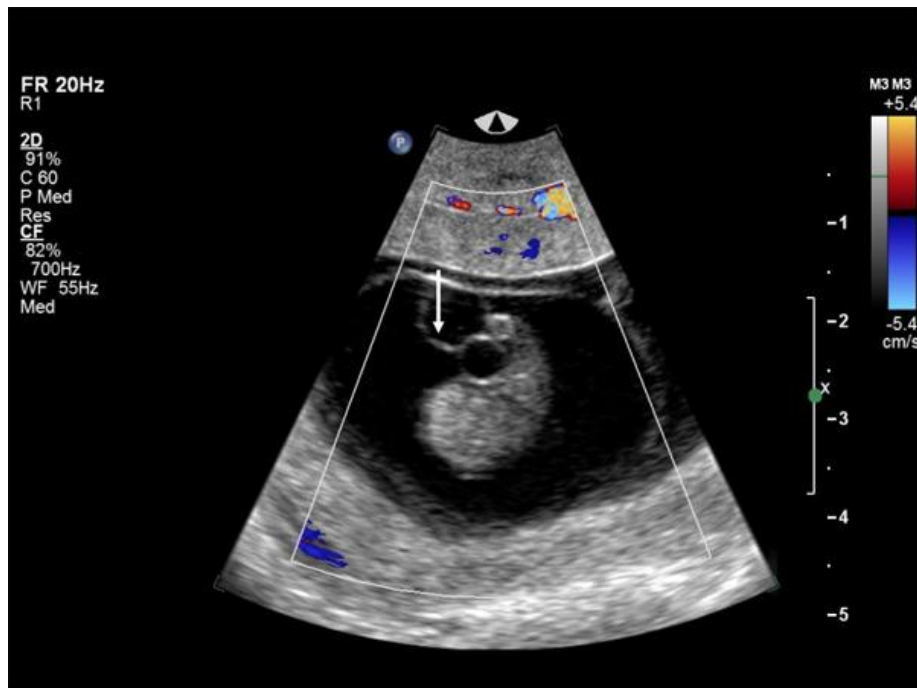


Fig 2.8. First trimester umbilical cord cyst (arrow).(Hill LM et al ,1994).

The prevalence of umbilical cord cysts between 7 and 13 weeks' gestation is 3%²⁹ First trimester umbilical cord cysts that subsequently resolve prior to the second trimester are probably pseudocysts. It has been hypothesized that their formation may be due to increased hydrostatic pressure associated with the initiation of cord coiling and physiologic mid-gut herniation. They have not been associated with an increase in karyotypic abnormalities:

However, the presence of multiple first trimester umbilical cord cysts is associated with an increased rate of adverse pregnancy outcome. Ghezzi et al reported only 1 of 6 pregnancies with multiple umbilical cysts resulted in a normal term pregnancy. Of the remaining 5 cases, there were 2 miscarriages 2 fetuses with trisomy 18 and fetus with an obstructive uropathy.

Allantoic cysts of the umbilical cord have been associated with omphalocele and a patent urachus. Pseudocysts that persist into the second trimester have been associated with an increased risk of karyotypic

abnormalities (specifically trisomy 18), an increase in structural abnormalities have also been reported. (Soernes T et al, 1986).

2-3-3 Umbilical Cord Twist:

Umbilical cord coiling results from intrinsic properties within the umbilical cord (i.e., growth of the vessels and the differential blood flow within the umbilical arteries) and fetal movement. Left twists outnumber right twists by 7 to 1. The right umbilical artery is usually larger than the left, explaining the increased frequency of left twists. The smooth muscle in the umbilical artery wall that coils around the vessel and may also play a role in the coiling of the umbilical cord. If the smooth muscle fibers are absent, or if the intravascular pressure is decreased, coiling of the umbilical cord will be reduced or not occur.

Umbilical cord coiling is typically established by the end of the first trimester. However, 30% of women with a non-coiling umbilical cord at 20 weeks' gestation were found to have a normally coiled umbilical cord later in gestation five percent of 3-vessel umbilical cords and 15% of cords with a single umbilical artery do not have any twists. (Barron S et al, 1986).

The coiling of the umbilical cord increases its turgor making it more resistant to compression. Non coiled umbilical cords (Fig.2.9) have been associated with an increased risk of intra partum fetal heart rate decelerations, fetal distress, operative delivery, and intrauterine death. It has not yet been determined if a reduction in the number of coils, as well as a complete absence of coils, places a fetus at risk. (Machin GA et al, 2000).

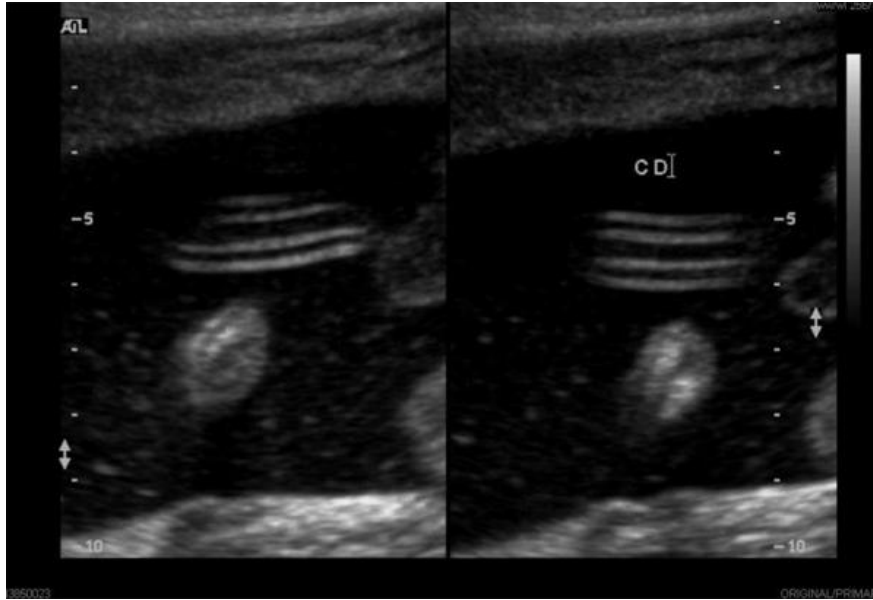


Fig 2.9. Straight umbilical cord.(Machin GA et al.,2000).

Over coiling of the umbilical cord can result in a slowing of blood flow with the potential for venous thrombosis. Over coiling is associated with an increase in intrauterine growth restriction, an increase in fetal demise, and twice the frequency of velamentous cord insertions. It has been hypothesized that stillbirths of unknown etiology may be caused by abnormal coiling of the umbilical cord .(Machin GA et al,2000).

2-3-4Discordant Umbilical Arteries:

A 1 mm difference in the diameter of umbilical arteries has been considered discordant (Fig2.10). This degree of discrepancy occurs once in approximately every 72 pregnancies. The resistance index is higher in the smaller vessel. A discrepancy in the size of the umbilical arteries is associated with abnormal placental cord insertions (marginal and velamentous) and an increase in placental abnormalities (succenturiate, bipartate placentas, and placental infarcts). An absence of the hyrtl anastomosis between umbilical arteries may prevent the different pressures within the arteries from being equalized. Differences in the S/D ratio between umbilical arteries of 29% to 10% have been recorded between the

second trimester and term, respectively. The decreasing differences in resistance between umbilical arteries as gestation advances may be due to the maturation of the hyrtl anastomosis (Ogita S et al, 1989).



Fig 2.10. Discordant umbilical arteries (Ogita S et al, 1989).

2-3-5 Two Vessel Umbilical Cord:

The umbilical arteries originate from the left and right common iliac arteries. The incidence of a single umbilical artery is 0.1% in embryo and 0.6% to 1% at term. Autopsy series generally have a two-fold higher incidence. This discrepancy is consistent with the theory of umbilical artery atrophy resulting in a single umbilical artery. The rate of a single umbilical artery in twins is 4.6%.

The transabdominal sonographic visualization rate of the number of vessels in the umbilical cord increases significantly from 15 to 17 weeks' gestation (74.1% to 97.6%; $p < 0.001$). In addition to gestational age, maternal body habitus, a reduction in amniotic fluid volume, and the position of the umbilical cord within the amniotic cavity affect the success of identifying the number of vessels in the umbilical cord.

Umbilical artery fusion may occur along the umbilical cord. Hence, both a 2-vessel, as well as a 3-vessel, umbilical cord may be visualized in the same patient. Intermittent fusion of the umbilical arteries does not have the same affect on neonatal outcome as a uniform single umbilical artery (Battaglia C et al, 1992).

The number of vessels around the fetal bladder (Fig2.11) does not reflect the number of vessels in a free loop of umbilical cord in every case. And (Fig2.12)(BattageC et al, 1992).

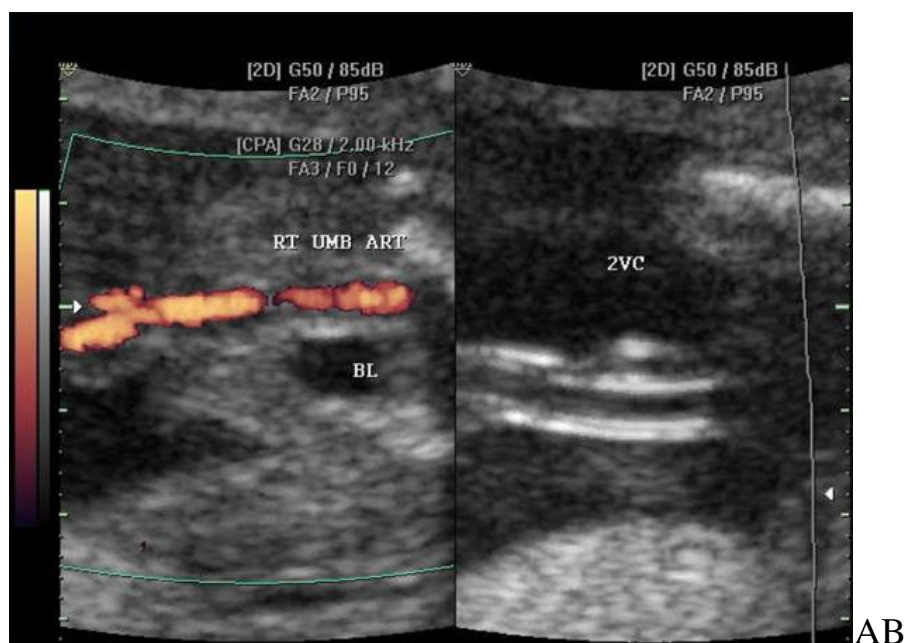


Fig 2.11 Two-vessel umbilical cord A only the right umbilical artery is present B in the amniotic fluid.(Battage C et al ,1992).



Fig 2.12. Two-vessel umbilical cord.(Battage C et al, 1992)

There is less Wharton's jelly surrounding a single umbilical artery. This may result in the higher vulnerability of the umbilical cord to compression in the third trimester.

If a single umbilical artery is the only abnormality detected, body weight, length, head circumference. (Bryan EM et al, 1974).

2-3-6 Umbilical Cord Hematoma:

Umbilical cord hematomas may occur spontaneously or iatrogenically after an intrauterine procedure (i.e. amniocentesis or percutaneous umbilical blood sampling). Spontaneous hematomas are estimated to occur one in every 500 deliveries. They are usually located at the fetal end of the umbilical cord and are due to the rupture of the umbilical vein (Ghidini A et al, 1990). While most umbilical cord hematomas are small, larger hematomas have

been associated with an increase in perinatal mortality(Sepulveda W et al ,1999).

2-3-7Aneurysm of the Umbilical Artery and Vein:

An umbilical artery aneurysm is a rare, but potentially lethal anomaly. The turbulent flow within the aneurysm can be appreciated with color Doppler. Vascular compression by an umbilical cord aneurysm may result in a sudden intrauterine fetal demise. Once fetal viability has been attained, an early delivery should, therefore, be planned when fetal lung maturity has been confirmed, or if there are signs of distress.

An aneurysm of the umbilical vein may result in a cord hematoma, fetal anemia, non-immune hydrops and sudden intrauterine fetal death (Lacro RV et al ,1987).

2-3-8Cord Hemangioma:

The two primary tumors of the umbilical cord are hemangiomas and teratomas. Both are quite rare. Umbilical cord hemangiomas are echogenic. As a result, the differential diagnosis would include a cord hematoma or a teratoma. Umbilical cord edema is characteristic for a hemangioma; it may extend for quite a distance beyond the region of the hemangioma. The presence of calcifications within an echogenic cord mass would suggest a diagnosis of a teratoma rather than a hemangioma. Mechanical compression of the umbilical vessels by the hemangioma may result in fetal compromise. A cord hemangioma may bleed, resulting in fetal anemia and secondary hydrops . (Froehlich LA et al ,1973).

2-3-9Velamentous Cord Insertion (VCI):

Velamentous cord insertion occurs when the umbilical vessels enter the membranes before reaching the placenta (Fig2.13). Since the fetal vessels are

only surrounded by amnion and devoid of Wharton's jelly, the risk of compression, thrombosis, and rupture are increased. VCI occurs in 0.48% of singletons; 5% of dichorionic twins; 9% of monochorionic twins, and 28% of triplets. A velamentous cord insertion has been associated with an increased prevalence of fetal heart rate abnormalities in labor, emergency cesarean section, low birth weight, and preterm delivery. (Hasegawa J et al ,2006).

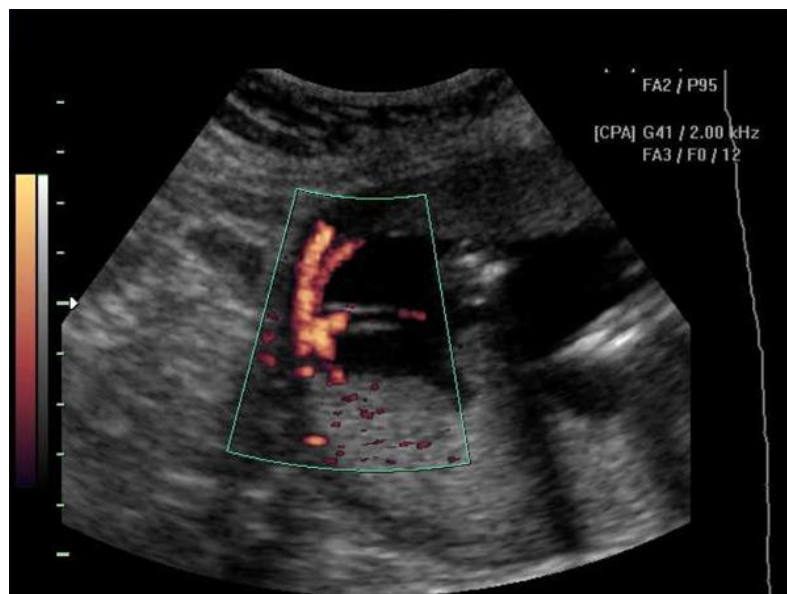


Fig 2.13 Fundal velamentous cord insertion of a bilobate placenta(Hasegawa J et al, 2006)

The detection of the placental cord insertion is influenced by placental location and gestational age. Pretorius and co-workers detected 67% of cord insertions at 15 to 20 weeks' gestation and 30% between 36 and 40 weeks (Fig.2.14). Hasegawa et al reported a 62.5% sensitivity for detecting VCI with a 100% positive predictive value at 18 weeks' gestation. VCI in the lower uterine segment has a significantly higher rate ($p < 0.01$) of non-reassuring fetal heart rate patterns. In addition, the length of the abnormal vessel is longer in the lower uterine segment. It has been hypothesized that this is due to the development of the lower uterine segment as gestational

age advances. In one series the length of the velamentous vessel was 10.6 cm in the lower uterine segment and 4.7 cm in the upper third of the uterus ($p = 0.024$) (Hasegawa J et al ,2006).



Fig 2.14. Placental cord insertion in the third trimester.(Hasegawa J et al, 2006).

2-3-10 Vasa Previa:

Vasa previa occurs when fetal vessels extend over the region of the internal cervical os (Fig.2.15). Its incidence is between once in every 1200 to 5000 deliveries. A velamentous cord insertion, succenturiate placental lobe or bilobate placenta have fetal vessels traversing the membranes and may result in a vasa previa. A marginal placenta previa, a low-lying placenta, multiple gestations, and pregnancies resulting from in-vitro fertilization (IVF) have also been associated with vasa previa. (Hill LM et al, 2001).



Fig 2.15. Color Doppler of a vasa previa.(Hill LM et al ,2001)

A velamentous cord insertion occurs in 14% of IVF pregnancies, in contrast to 1% of spontaneous pregnancy. In one study the incidence of vasa previa after IVF was 1:293 deliveries, in contrast to a rate of 1:6068 deliveries in the general population. It has been hypothesized that the increase in the placental abnormalities with IVF pregnancies may be related to the improper orientation of the blastocyst at the time of implantation. (HillLM et al, 2001)

When there is a vasa previa, spontaneous rupture of the membranes may lacerate the fetal vessels, resulting in rapid fetal exsanguination. In the past, vasa previa has been associated with a substantial perinatal mortality. Several series have shown that the antenatal detection of vasa previa is possible. In one series the perinatal mortality decreased from 56% without, to 3% with prenatal diagnosis.(Froehlich LA et al, 1973).

Catanzarite et al classified vasa previa into two types. In Type I there is a single placental lobe with a velamentous cord insertion. In Type II fetal vessels cross the internal cervical os connecting two separate placental lobes (Figs. 2.16&2.17). The sonographic determination of the umbilical cord

insertion into the placenta during the routine second trimester ultrasound examination will exclude a Type I vasa previa. In order to detect Type II vasa previa, the area over the cervix must be evaluated with color Doppler and transvaginal sonography when necessary.(Froehlich LA et al, 1973).



Fig 2.16 Posterior succenturiate (arrow) placental lobe associated with a type II vasa previa.(Froehlich LA et al, 1973).

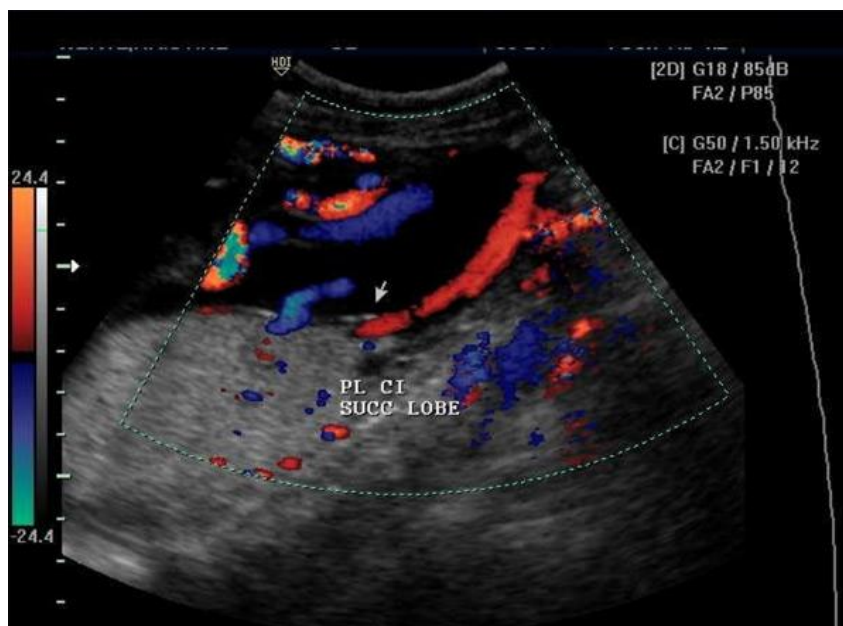


Fig 2.17. Color Doppler of a feeding vessel to a succenturiate placental lobe. (Froehlich LA et al, 1973)

Lee and co-workers have reported that aberrant vessels extending over the cervix in the second or early third trimester may regress by term. While the umbilical cord insertion is generally fixed, aberrant vessels within the membranes could move because of the differential growth between the lower uterine segment and placenta.

While three-dimensional power Doppler may help to appreciate the spatial relationship between the aberrant fetal vessels and the internal cervical os, two-dimensional transvaginal sonography is sufficient to make a diagnosis of vasa previa. (Chénerd E et al ,1990).

2-4 Background studies:

Elsafi A et al said : Gestational age can be predicted and can be depicted by the following equations: $GA = (1.380 \times \text{UCD length} + 8.160)$ and $GA = (1.545 \times \text{UCD width} + 5.943)$. There was unsubstantial relation between UCD and maternal age. A linear relationship was found between parity and the UCD depth and width. Using paired T-test indicates that the GA calculated from FL was accurate, there was no significant difference detected between the LMP age and the estimated one and UCD depth, width, but BPD showed significant difference at $p = 0.005$. Measuring UCD is useful for the assessment of gestational age. It has a role in obstetric care in the second and third trimester of pregnancy, and these equations can be used to estimate the gestational age instead of BPD and FL. (Elsafi A et al, 2014).

The study by charless et al said: The mean umbilical cord diameter and cross-sectional area were $14.5\text{mm} \pm 7.2\text{mm}$ and $201.6\text{mm} \pm 139.5\text{mm}^2$ respectively. Umbilical cord growth rate of $1.0\text{mm}/\text{week}$ was noted between the 14th and 35th week of pregnancy. There were significant correlations ($p < 0.001$) between umbilical cord size and other fetal parameters for GA estimation.

Umbilical cord size had strong linear relationship with common fetal GA estimation parameters and could be used to compliment these parameters for GA estimation. (CharlessEze et al, 2014).

The study by Begum et al show: A positive significant better correlation was found with umbilical cord diameter than cross sectional area with foetal anthropometric parameters. (Begum K et al , 2016).

The summarizer of study by Togni et al :A statistically significant correlation was observed between the cord cross-sectional area and gestational age ($r=0.376$, $P<0.001$, CI 95% [0.276; 0.467]).

The reference values of the cross-sectional area of umbilical cord increased according to gestational age until the 33rd week and are related to parameters of fetal growth. (Togni FA et al, 2007).

The study by Ghezzi et al said: The measurement of the umbilical cord diameter in the first trimester is correlated with the growth of the embryo and may be a marker for identifying a subset of fetuses at risk of spontaneous miscarriage. (Ghezzi F et al ,2011).

CHAPTER THREE

METHODOLOGY

CHAPTER THREE

METHODOLOGY

3-1Material:

- The equipment include Sono scape machine with transducer 3.5 Mhz. curve liner.
- 50 pregnant women in second and third trimester.

3.2. Type of the study:

This is across sectional study.

3.3.Area of the study:

The study will be conducted in khartoum state, Sudan in the ultrasound departments of :

1. Alban gaded hospital.
2. ALhekma health center.

3.4. Duration of the study:

From December 2016 to March 2017.

3.5.Population of the study:

Normal pregnant sudanese women who come to the area of the syudy, during the specific duration of the study.

3.6 Sample size and sampling procedure:

Sampling of study will be conducted of 50 pregnant women, selection of participation through simple random sampling, and then the data will be collected from the participants.

The procedure will obtained using a formula for sample size:

$$N = \frac{n}{1 + d^2}$$

n: is the sample size.

N: is the total population size obtained from Ante natal clinic of khartoum state.

d: tolerable error (5%)

3.7. Inclusion criteria:

- Singleton gestation.
- Viable fetus.
- Gestational age from 13 weeks and above.
- Normal amount of amniotic fluid.
- Un ruptured membrane.

3.8. Exclusion criteria:

- Diabets mellitas.
- Multiple pregnancy.
- Hypertension of any etiology.
- Anomalous fetus.

3.9. The study variables:

The study of population will be assessed against the following variables:

- BPD in mm.
- FL in mm.
- AC mm.
- Fetal weigh.
- Umblical cord diameter in mm.
- Maternal age.
- Parity and gravidity status.
- Gestational age.

3.10. Data collection and Instrumentation:

The data will be collected using a data collection sheet.

3.11. The method of data analysis used in the study:

The data will be analyzed by using SPSS (statistical package for social science).

3.12. Data presentation:

Data presented by tables and figures.

3.13. Ethical considerations:

No part of this study relies on data which normally be collected from routine scanning. All patients will be informed, that the result of examination will form part of research project. No patient identification or individual patient detail will be published, and all specific information relating to patient's identities will be protected in the same way.

3.14. ultrasound technique:

Transabdominal scan with convex probe 2.5 to 5 MHz will be used to obtain measurement for study.

Sonographic umbilical cord measurement to get the cross-sectional area of the umbilical cord, across sectional plane to the cord, adjacent to its insertion into the fetal abdominal wall, within a maximum distance of 5 cm were taken, using the elliptical calipers of the scanner, measuring from the outer to outer borders of the cord.

Other fetal anthropometric parameters which include BPD and FL will be measured. The landmark for measuring the BPD and FL include the following:

1-BPD: It is measured in a plane in which the thalami and cavum septum pellucidum should be identified as landmarks, measurement are made from

the outside of near skull to the inside of the distal skull echoes.(WWW.Pregnancy-bliss-co.uk/SUA-and-multiple-soft-markers.Html.Accessed on 21.5.2016 10:15 am.) (Fig 3.1)

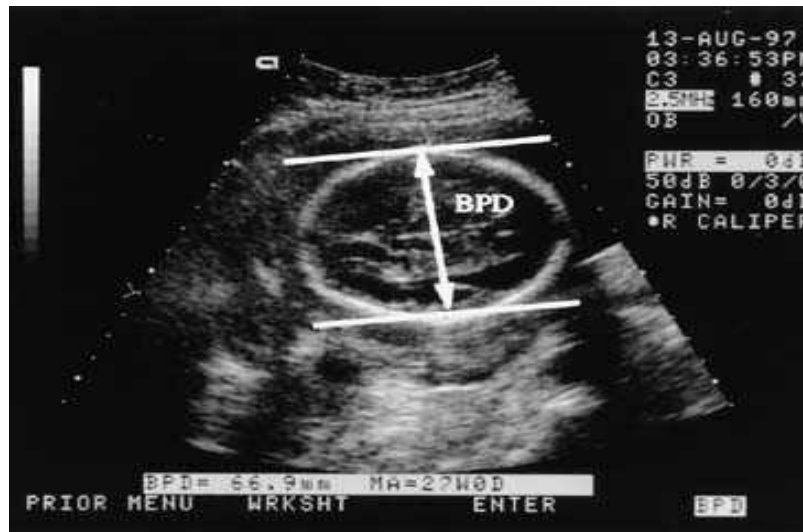


Fig 3.1 Measurement the BPD

2-FL: Is obtained by taking measurement along an axis that shows both the round, echogenic, cartilaginous femoral head and femoral condyles using elliptical calipers.(Fig 3.2)

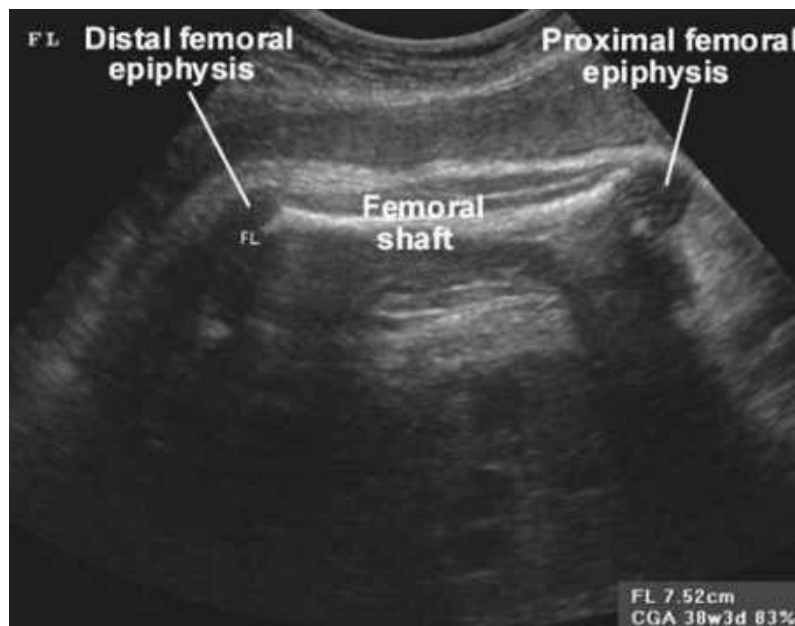


Fig 3.2 Measurement the femour length

3-AC: Is one of the basic biometric parameters used to assess fetal size. AC together with BPD, HC, and FL are computed to produce an estimate of FW. In the second trimester this may be extrapolated to an estimate of gestational age and an estimated date of delivery (EDD).

Sonographic technique Transverse section through the upper abdomen, which should demonstrate the following fetal landmarks:

- fetal stomach.
- umbilical vein.
- portal sinus.

AC measurement should not be taken on a foreshortened abdomen and the calipers should be on the skin surface (skin surface should be visible).

The kidneys and cord insertion should not be visible. The umbilical vein should not be seen up to the skin line. The gallbladder may sometimes be seen. (<https://radiopaedia.org/articles/fetal-abdominal-circumferenc>) (Fig 3.3)

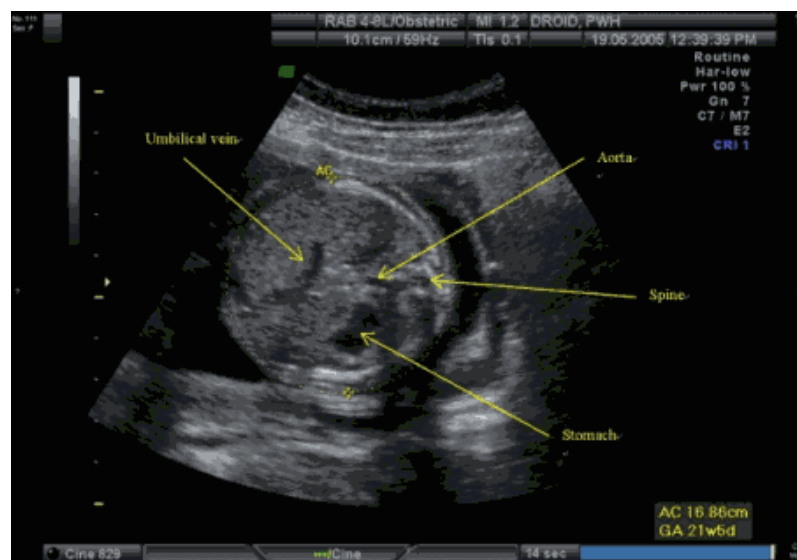


Fig 3.3 measurement the AC

4-FW: These four us measurement are the ones used most frequently to estimate FW:

HC, BPD, FL and AC

These four measurements are entered into a mathematical formula that's used to calculate the estimated fetal weight. There are many different formulas for weight estimation, and even the best ones have a 15% margin of error in 85% of all fetuses. In other words, about one in seven fetuses will weigh 15% more or less than estimated.

In addition to these four measurements there are also other measurements of the fetus that can be done during an ultrasound examination. (<http://www.babymed.com/ultrasound/ultrasound-fetal-weight-estimation>).

CHAPTER FOUR

Result and analysis

CHAPTER FOUR

RESULT AND ANALYSIS

Table (4.1) frequency distribution of mother age

Age of mother	Frequency	Percent	Valid Percent	Cumulative Percent
15-25 years	16	32.0	32.0	32.0
26-35 years	28	56.0	56.0	88.0
36-45 years	6	12.0	12.0	100.0
Total	50	100.0	100.0	

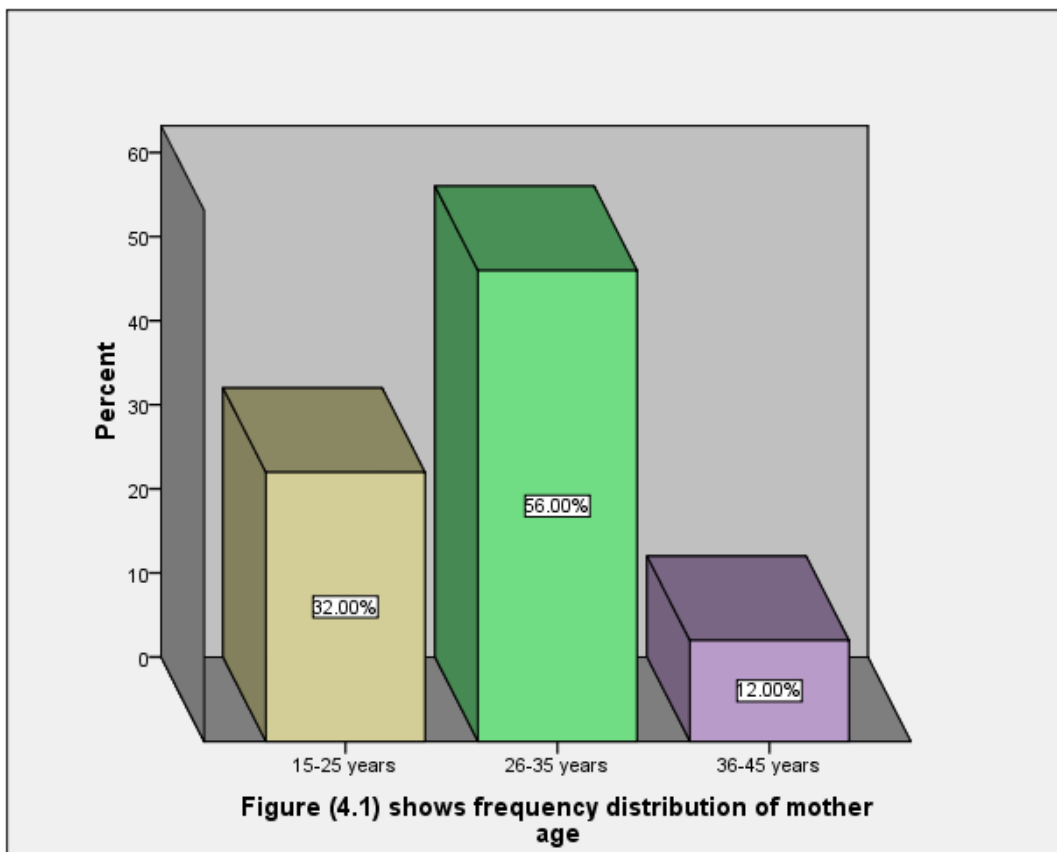


Table (4.2) frequency distribution of parity

Parity	Frequency	Percent	Valid Percent	Cumulative Percent
0	22	44.0	44.0	44.0
1	18	36.0	36.0	80.0
2	9	18.0	18.0	98.0
3	1	2.0	2.0	100.0
Total	50	100.0	100.0	

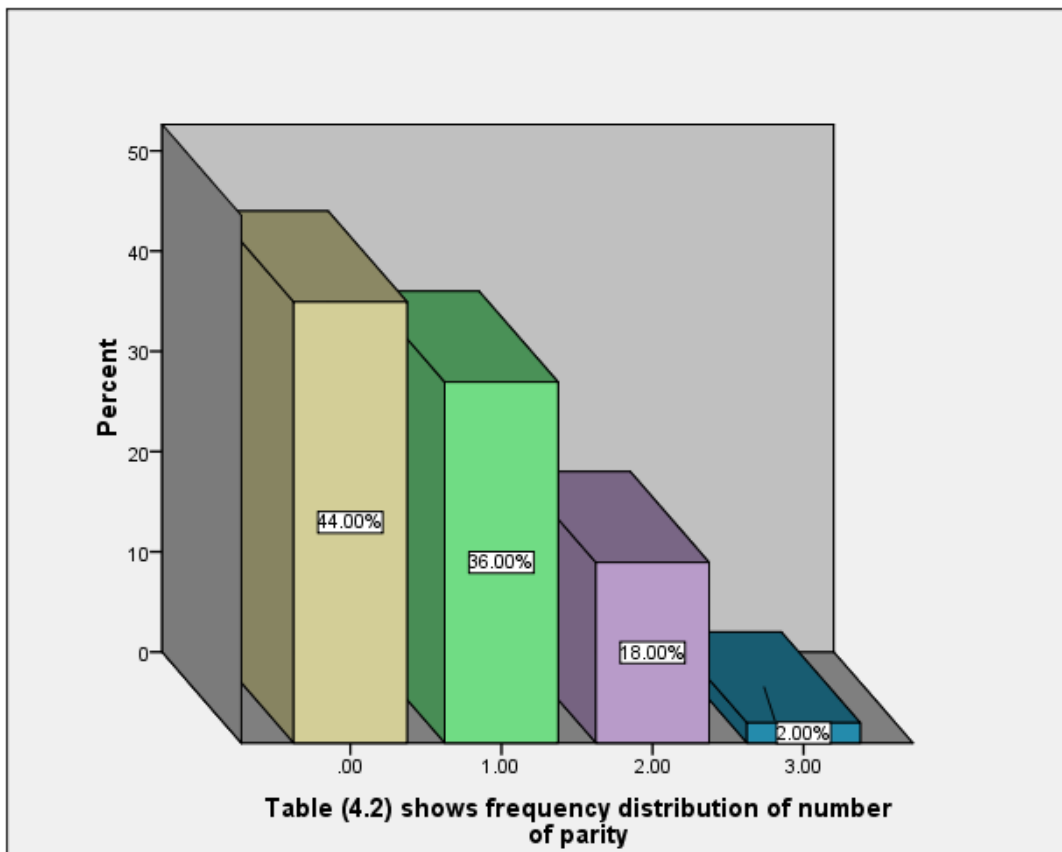


Table (4.3) frequency distribution of gravidity

Gravid	Frequency	Percent	Valid Percent	Cumulative Percent
0	1	2.0	2.0	2.0
1	12	24.0	24.0	26.0
2	14	28.0	28.0	54.0
3	11	22.0	22.0	76.0
4	7	14.0	14.0	90.0
5	1	2.0	2.0	92.0
7	2	4.0	4.0	96.0
8	2	4.0	4.0	100.0
Total	50	100.0	100.0	

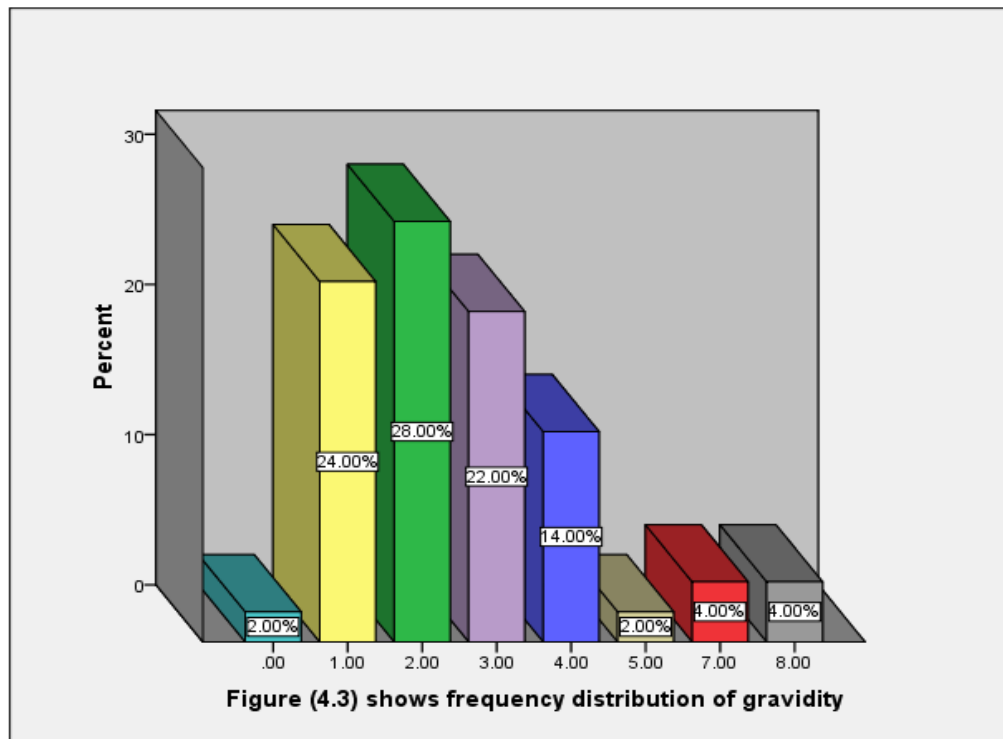


Table (4.4) descriptive statistic shows minimum, maximum, mean &Std. Deviation for age of mother, BPD, FL, AC per mm and fetal weight, GA by BPD, FL, AC per weeks

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Age of mother	50	17.00	39.00	28.2400	5.50903
BPD mm	50	33.00	96.70	67.5460	20.19883
FL mm	50	16.70	74.40	48.4100	16.71552
AC mm	50	93	374	238.92	80.153
Fetal weight	50	107	3860	1608.72	1169.848
GA BPD week	50	15.00	41.43	27.3800	7.54631
GA FL week	50	15.71	40.00	27.8000	7.18362
GA AC week	50	15.14	40.00	27.9314	7.19904
UC d1	50	6.20	21.60	14.2680	3.82096
UC d2	50	6.00	20.80	12.1480	3.40073
Valid N (listwise)	50				

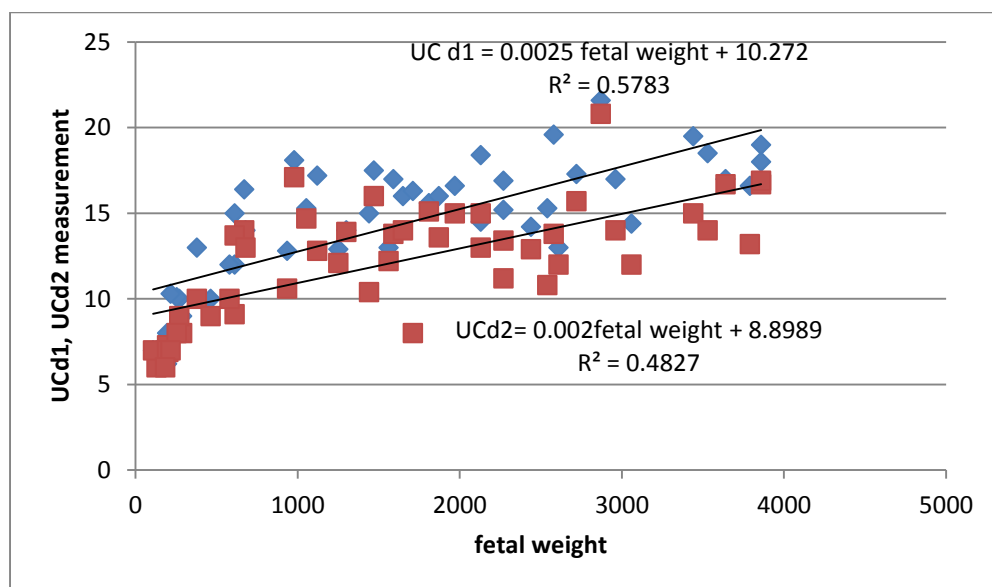


Figure (4.4) scatter plot shows relationship between fetal weight and UCd1 and UCd2

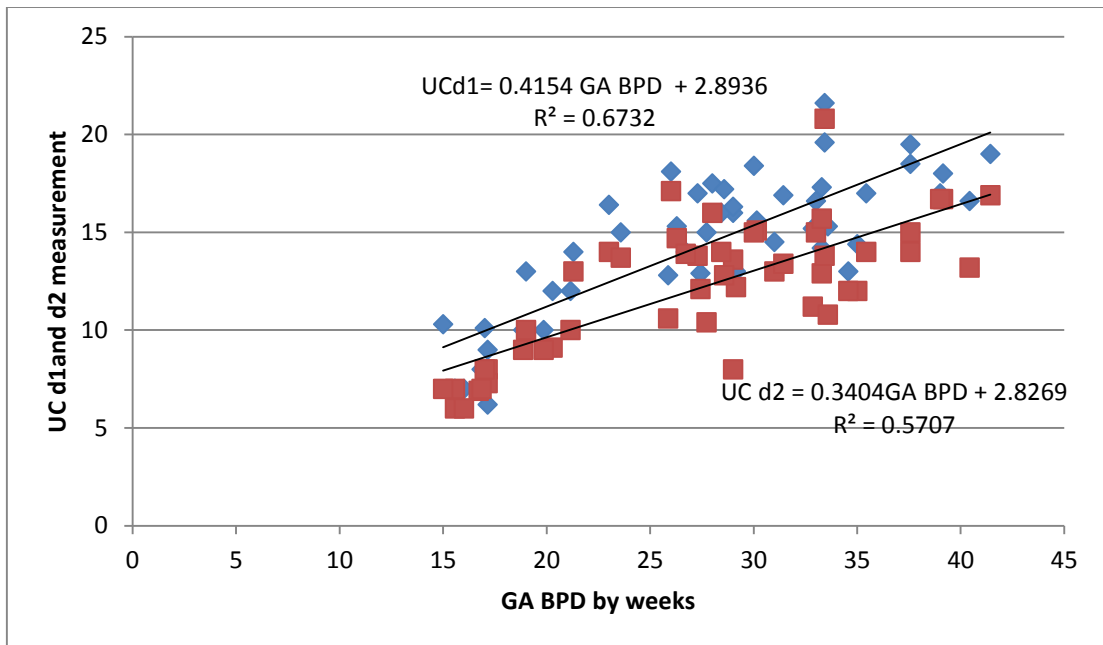


Figure (4.5) scatter plot shows relationship between GA BPD and UCd1 and UCd2

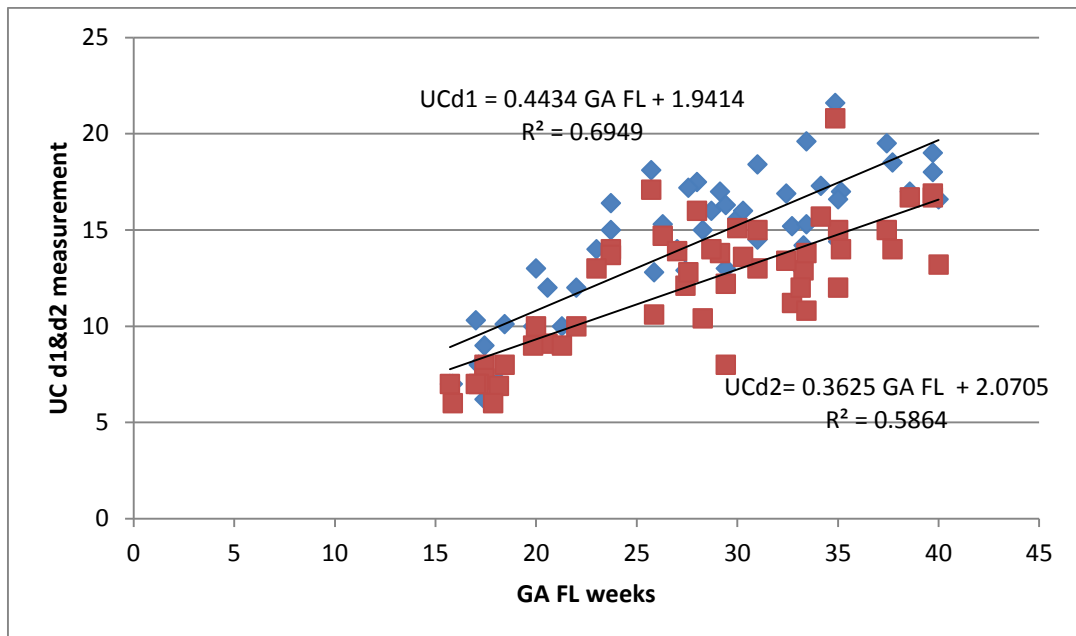


Figure (4.6) scatter plot shows relationship between GA FL and UCd1 and UCd2

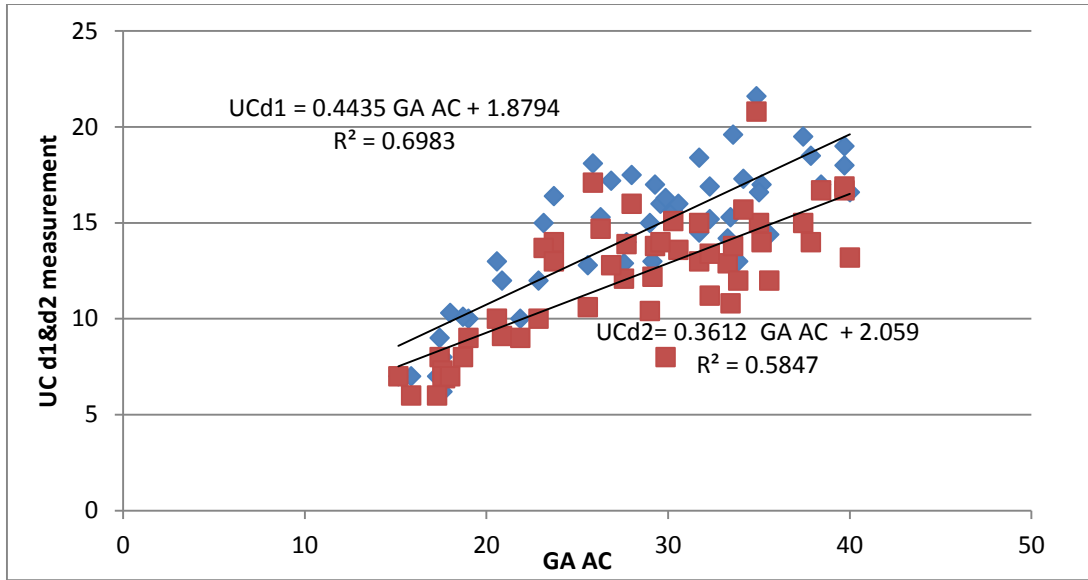


Figure (4.7) scatter plot shows relationship between GA AC and UCd1 and UCd2

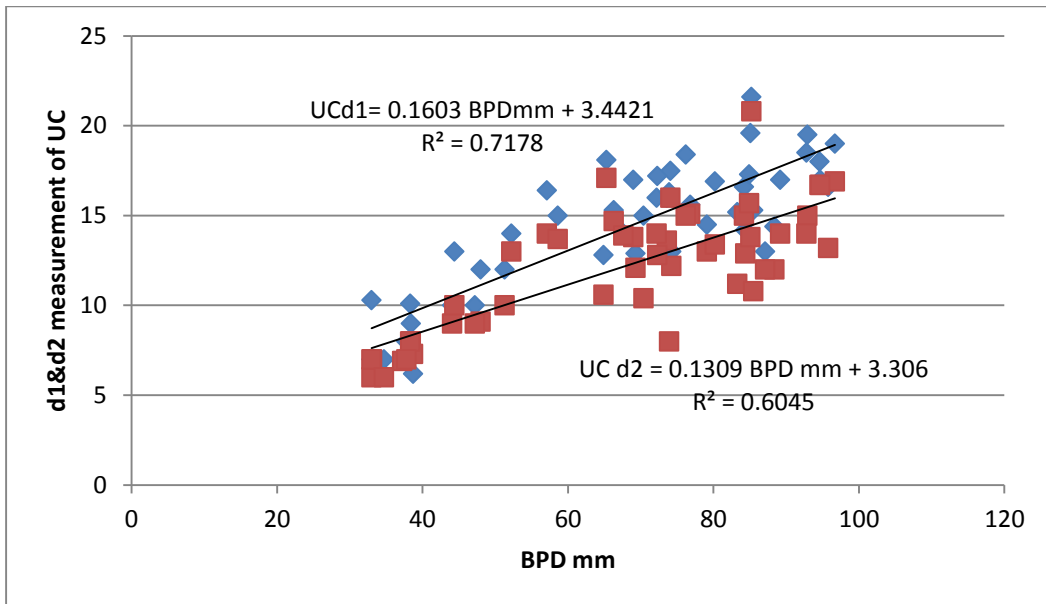


Figure (4.8) scatter plot shows relationship between BPD mm and UCd1 and UCd2

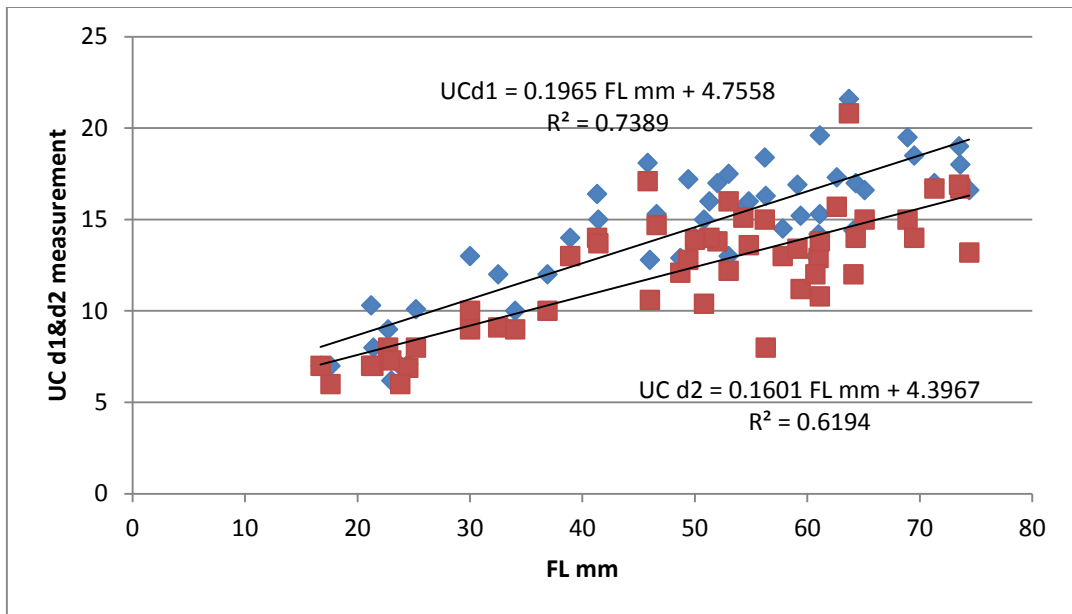


Figure (4.9) scatter plot shows relationship between FL mm and UCd1 and UCd2

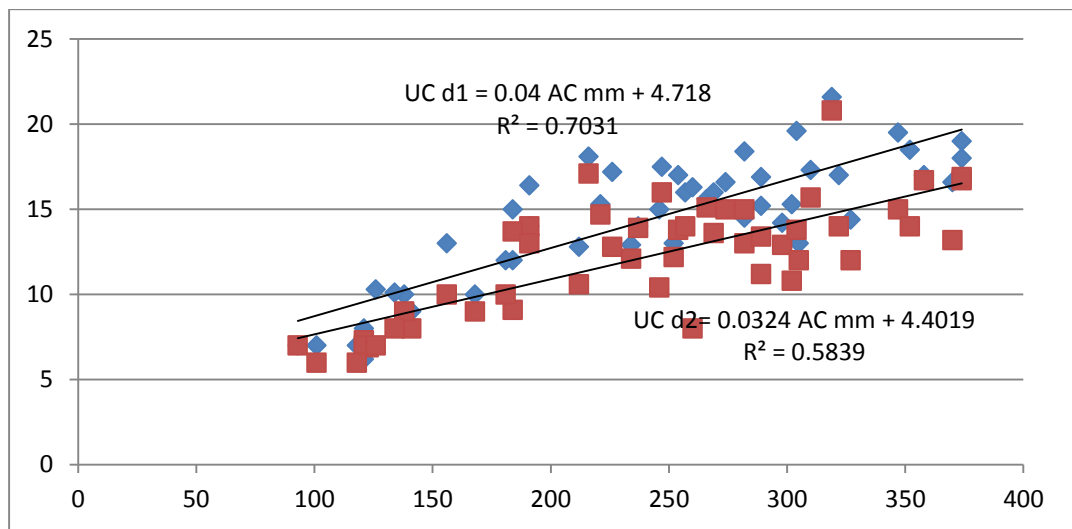


Figure (4.10) scatter plot shows relationship between AC mm and UCd1 and UCd2

Table (4.5) correlation between GA per BPD, FL, AC, fetal weight and umbilical cord measurement (d1 and d2)

		d1 UC	d2 UC	Fetal weight	GABPD weeks	GAFL weeks	GAAC weeks
d1 UC	Pearson Correlation	1	.893**	.760**	.820**	.834**	.836**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	50	50	50	50	50	50
d2 UC	Pearson Correlation	.893**	1	.695**	.755**	.766**	.765**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	50	50	50	50	50	50
Fetal weight	Pearson Correlation	.760**	.695**	1	.973**	.974**	.973**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	50	50	50	50	50	50
GABPD weeks	Pearson Correlation	.820**	.755**	.973**	1	.995**	.992**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	50	50	50	50	50	50
GAFL weeks	Pearson Correlation	.834**	.766**	.974**	.995**	1	.998**
	Sig. (2-tailed)	.000	.000	.000	.000		.000

	N	50	50	50	50	50	50
GAAC weeks	Pearson Correlation	.836**	.765**	.973**	.992**	.998**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	50	50	50	50	50	50
**. Correlation is significant at the 0.01 level (2-tailed).							

Table (4.6) correlation between measurement of BPD, FL, AC mm and umbilical cord measurement (d1 and d2)

		d1 UC	d2 UC	BPD mm	FL mm	AC mm
d1 UC	Pearson Correlation	1	.893**	.847**	.860**	.838**
	Sig. (2-tailed)		.000	.000	.000	.000
	N	50	50	50	50	50
d2 UC	Pearson Correlation	.893**	1	.778**	.787**	.764**
	Sig. (2-tailed)	.000		.000	.000	.000
	N	50	50	50	50	50
BPDmm	Pearson Correlation	.847**	.778**	1	.994**	.986**
	Sig. (2-tailed)	.000	.000		.000	.000
	N	50	50	50	50	50
FL mm	Pearson Correlation	.860**	.787**	.994**	1	.988**
	Sig. (2-tailed)	.000	.000	.000		.000
	N	50	50	50	50	50
AC mm	Pearson Correlation	.838**	.764**	.986**	.988**	1
	Sig. (2-tailed)	.000	.000	.000	.000	
	N	50	50	50	50	50
**. Correlation is significant at the 0.01 level (2-tailed).						

CHAPTER FIVE

Discussion

CHAPTER FIVE

DISCUSSION

5-1 Discussion

This study was conducted to assess the GA by fetal UCD using U/S. This study include 50 pregnant woman in second and third trimester were enrolled to measure of two diameters of UC, Compare of GA by BPD, FL, AC, Fetal weight also include the maternal age and number of parity, the result was as follow.

The maximum frequency distribution of mother age is 56% at groups 26-35 table (4-1).

The maximum frequency distribution of parity is 44% in the 0 parity table (4-2).

The maximum frequency distribution of gravity is 28% in two gravid table (4-3).

The mean deviation of UCD1=14.2 +-3.8, and mean deviation of UCD2=12.1+-3.4 at table (4-4).

There is a direct linear relationship between fetal weigh (gm), (BPD, FL and AC) week. And UCD.

Fetal weigh affect to UCD1 by percent.57% $UCD1 = 0.003 \text{ fetal weight} + 10.272$, UCD2 by, 48% $UCD2 = 0.002 \text{ fetal weigh} + 8.9$ fig (4-4)

$BPD + 2.823$ fig (4-5).

FL affected by ,7% UCD1, $UCD1 = 0.004 \text{ GA FL} + 1.9$ and by, 4 % in UCD2 $UCD2 = 0.004 \text{ GA FL} + 2.07$ fig (4-6)

AC affect UCD1 BY, 7% $UCD1 = 0.004 \text{ GA AC} + 1.9$. And by, 6 % with UCD2 $UCD2 = 0.004 \text{ GA AC} + 2.05$ fig (4-7).

And there is direct linear relation between (BPD , FL and AC) mm and UCD

BPD affected by, 7 D1, $UCD1 = 2BPD \text{ mm} + 3.4$ and D2 by, 6 $UCD2 = 1BPD \text{ mm} + 3.3$ fig (4-8).

FL $UCD1 = 2FL \text{ mm} + 4.8r^2 = 7UCD2 = 2FL \text{ mm} + 4.4r^2 = 6$ fig (4-9).

AC affected the $UCD1$ BY, 7% $UCD1 = .04 AC \text{ mm} + 4.7$ and by, 6% in d2 $UCD2 = .03 AC \text{ mm} + 4.4$ fig (4-10).

These equations can be used to estimate the gestational age instead of BPD, FL and AC.

The result also showed strong correlation between fetal weigh, (BPD, FL and AC) by week and D1, D2. Whis good significant $p = .000$ at table (4-5).

But the previous study of Elsafi ea tal did not agree with me the result of these study was show significant difference at $p = 0.005$ with $t = 2.9$

NO significant difference between GA by LMP, GA FL both UCD.

5-2 Conclusion :

- Umbilical cord is a fetal life line contain two arteries and one vein.
- Umbilical cord diameter increase with increasing age of fetus.
- There is no correlation between age of mother, parity and gravity.
- GA by UCD was accurate same as BPD, FL AC.
- UCD use to determine fetal weight as BPD, FL AC.

5-3 Recommendation:

1. Umbilical cord diameter should be used to calculate the fetal age.
2. The umbilical cord to every pregnant should be checked because cord abnormality may lead to fetal mortality.
3. More researches are suggested to explain the relationship between IUGR or macrosomia and mother age.

References

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Appendix

APPENDIX(i)



Image (1) Ultrasound appearance of UC 25 weeks, MA 22 Y



Image (2) Ultrasound appearance of UC 24weeks, MA 36 Y



Image (3) Ultrasound appearance of UC 32weeks ,MA 17 Y



Image (4) Ultrasound appearance of UC 32weeks ,MA 26 Y



Image (5) Ultrasound appearance of UC 26weeks ,MA 33 Y



Image (7) Ultrasound appearance of UC 28weeks ,MA 27 Y



Image (6) Ultrasound appearance of UC 29weeks , MA 18 Y



Image (8) Ultrasound appearance of UC 32weeks ,MA 38 Y



Image (9) Ultrasound appearance of UC 25weeks ,MA 19 Y



Image (11) Ultrasound appearance of UC 26weeks ,MA 35 Y



Image (10) Ultrasound appearance of UC 25weeks, MA 29 Y



Image (12) Ultrasound appearance of UC 37 weeks ,MA 34 Y



Image (13) Ultrasound appearance of UC 25weeks, MA 21 Y



Image (14) Ultrasound appearance of UC 33weeks, MA 24 Y

APPENDIX(ii)

AL-Sudan University

Sonographic Assessment of gestational age by
umbilical cord

Data Collection Sheet

- i. Date:.....
- ii. Patient No:.....
- iii. Maternal age:.....
- iv. Gravidity:.....
- v. Parity status:.....
- vi. BPD (mm):.....
- vii. FL(mm):.....
- viii. Mean gestational age:.....
- ix. AC(mm):.....
- x. FW(gm):.....
- xi. Umbilical cord diameter(mm):..