Prediction of fetal growth by measuring the placental thickness using ultrasonography

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Abstract: Ultrasound growth parameters including Femur Length (FL), and Biparietal Diameter (BPD) are widely used in Sudan for determining the fetal age. The Abdomen Circumference (AC) is also used along with BPD in determining fetal weight. Measuring placental thickness along with these parameters could be of great value. The main objective of this study was to determine the normal thickness of placenta during second and third trimesters in Sudanese pregnant ladies in order to predict the growth of the fetus, and to understand the relation between the placental thickness and growth parameters (BPD and FL). Fifty three pregnant Sudanese ladies were included in this study. All were normal cases of ages between 20 and 43 years old, in the second and third trimesters checking for antenatal routine ultrasound examinations at Military and Omdurman Maternal hospitals. Patients with history of Diabetes, Hydrops, Hypertension or liability to fetal anomalies were excluded from the study. The BPD, and FL, were measured and then correlated with Gestational Age (GA) for each lady; the placental thickness was measured in the longitudinal section at the insertion of umbilical cord using ultrasonography. The placental thickness was found in the normal mean range of values (20.7±2.1 and 36.2±4.7), in second and third trimester respectively. Normal values of placental thickness in normal Sudanese pregnant ladies with singleton fetuses are in the range of 25 to 45mm in the 3rd trimester, and between 18 to 24mm in the second trimester. A linear relationship between placental thickness and BPD, FL and gestational ages acquired by them in both 2nd and 3rd trimesters. No significant differences were found between ages derived from FL and BPD and PT, and a linear relationship was noted with the maternal age. An equation for gestational age prediction using PT was established. Placenta Thickness had a great value in prediction of fetal health and growth parameters sonographically.

Keywords: Placental Thickness, Gestational Age, Femur Length, BPD

1. Introduction

The human placenta is concerned with the exchanges that occur between the maternal and fetal organisms. It has two basic components: the maternal and fetal portions. The placenta originates from the fetal portion (Chorion Frondosum) and maternal portion (Endometrium) more specifically from the Decidua Basalis. Placental function begins around the 4th week of pregnancy, with the formation of the first anatomical elements necessary to ensure physiological exchanges [1]. Diseases and abnormalities affecting fetus; can be indicated by an abnormal size of the placenta during the second and third trimesters. A very small placenta may be associated with growth restriction. More than 3cm thickness before 20 weeks, and more than 5cm before 40 weeks are considered abnormal.[2] An excessively large placenta may be associated with infection, anemia or Triploidy and there are usually other markers of fetal compromise [2].

Primary maternal Cytomegalovirus infection and fetal disease are associated with sonographically thickened placentas, These observations suggest that many of the manifestations of fetal ,and neonatal diseases are caused by placental insufficiency.[3]Sonographically thick placenta is associated with increased perinatal risk with increased mortality related to fetal anomalies and higher rates of both

small for gestational age, and large, for gestational age infants at term.[4]Placental thickness of less than 2.5 cm is associated with intrauterine growth retardation while thick placentas are associated with maternal Diabetes Mellitus, fetal hydrops and intrauterine fetal infections[5].Fetal growth parameters, such as Biparietal diameter (BPD), and abdominal circumference (AC), are used in the sonographic estimation of gestational age ,and weight, of the fetus in the second and third trimesters. Femur length has been established as an accurate parameter for estimating gestational age ,in the second ,and third trimesters while fetal weight can be estimated by Sherpard's method using only BPD and AC [6,7] These growth parameters, are adversely affected by insufficient nutrients reaching the fetus through the placenta. In these fetuses the placenta is often thin. The objectives of this study, were to determine the normal thickness of placenta during second and third trimesters in Sudanese ladies in order to predict the health of the fetus as well as to correlate between placental thickness and average gestational age determined by Biparietal Diameter (BPD) and Femur Length (FL),the objectives also included deriving an equation that uses the placental thickness as a variable in gestational age calculation and establish a reference value for the placental thickness in normal Sudanese pregnant ladies which can aid in early detection of placental abnormalities and fetal abnormalities related with placental thickness. The available literature and previous studies were established in different societies, with different ethnic groups and races, a matter which made it imprecise to generalize the value of placental thickness according to these studies, and to the best of our knowledge, no standard value was mentioned for Sudanese maternal ladies regarding placental thickness (PT).

2. Materials and Methods

2.1. Area, Duration, and Sample Selection

The Study was conducted at Omdurman Military Hospital and Omdurman Maternal Hospital. Khartoum-Sudan, during the period from August 2011 to November 2011.This study, has adopted the analytical descriptive pattern. All 50 cases included in this study were normal mothers. Their ages were from20 to 43 years old came for antenatal routine scanning. The cases of high risk, including 1UGR, Hypertension, Diabetes Mellitus; fetal anomalies, and multiple pregnancies, were excluded.The equipment used,was Ultrasound machine "Mindray- Digiprince DP-6600" with a 3.5 MHz convex transducer and "Toshiba power vision 6000", with 3.5MHz convex Transducer.

2.2. Scanning Technique

The Patients were examined in the supine position, and ultrasound coupling gel was applied. The fetuses were scanned for viability and congenital anatomical defects, and the gestational age was estimated using growth parameters. The growth parameters used in estimating gestational age,

were BPD and FL in the second and third trimesters, using the Hadlock equation. The composite average of the gestational age estimation by the growth parameters were then taken for each foetus. The placenta was localized in a longitudinal section, and placental thickness was then measured near the insertion of the umbilical cord. The collected data were evaluated and the gestational ages obtained from femur length, (FL), Biparital diameter (BPD) and Average gestation age were correlated with the age determined by the placental thickness at P=0.000. Data were analyzed, using Excel 2007 statistical analyzing program and, SPSS programme version 16. For ethical considerations, the patients were selected according to inclusion criteria, and no patient identification or details were published.

3. Results

After the application of regression analysis figures, the results of analyzing the whole data (both the second and third trimester) were as follows:

Table 1. The data collected in the third and second trimesters

Variables	Mean	STDV	Coefficient of Variables.
Maternal Age	28.7	5.9	20.7
BPD (mm)	76.4	18.5	24.2
BPD GA (wks)	31.5	7.1	22.7
FL(mm)	60.3	19.4	32.1
FLGA (wks)	31.2	7.8	25
Average GA	31.3	7.4	23.5
PT(mm)	32.7	7.8	23.9
GA By PT (wks)	31.3	7.2	23.1

Table 2. The data collected in the second trimester

Variables	Mean	STDV±
Maternal Age	26.8	4.6
BPD (mm)	47	11.4
BPD GA (wks)	20.3	3.3
FL(mm)	30.4	10.1
FLGA (wks)	19.3	3.2
Average GA	19.7	3.1
PT(mm)	20.7	2.1
GA By PT(wks)	19.7	2.8

Table 3. The data collected in the third trimester

Variables	Mean	STDV±
Maternal Age	29.2	6.2
BPD (mm)	85	8.6
BPD GA (wks)	34.8	3.9
FL(mm)	69	10.6
FLGA (wks)	34.7	4.6
Average GA	34.7	4
PT(mm)	36.2	4.7
GA By PT (wks)	34.7	3.8

Table (4). *Paired Samples Correlations significant at P=0.000*

Paired Samples Correlations			
	N	Correlation	Sig.
AGA2 & PTGA2	12	.908	.000
AGA & PTGA	41	.943	.000
AGA total & PTGA total	53	.979	.000

AGA2= Average Gestational Age in Second trimester.PTGA2=   Placental Thickness Gestational age in Second trimester.AGA= Average Gestational Age in Third trimester. PTGA= Placental Thickness Gestational age in Third trimester.AGA total=Average Gestational Age in both second &Third trimester. PTGA total=Placental Thickness Gestational age in both Second & Third trimester.
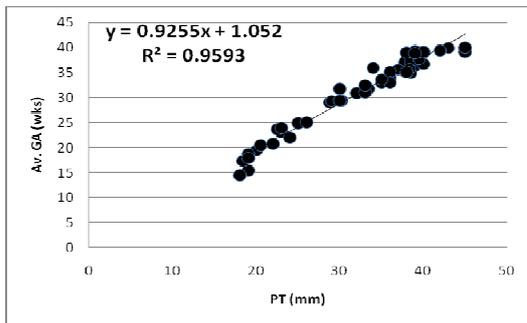
Fig 1. *The relation between Average Gestational age (Av.GA) "Y axis" by weeks and Placental thicness (PT) in millimeters "X axis".R^2=0.9593.*
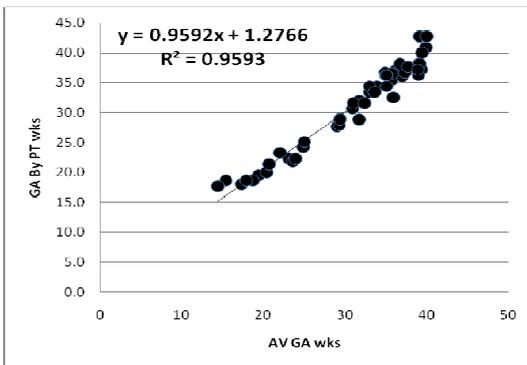
Fig 2. *The relation between Gestational age taken by placental thickness "in the Y axis"   and Average gestational age from BPD and FL "in the X axis".*
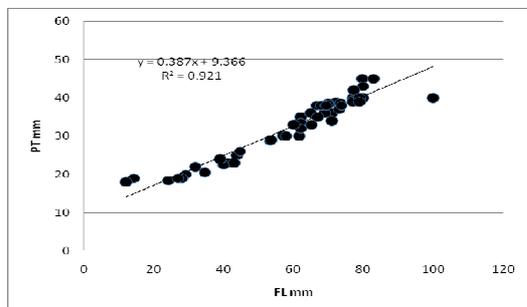
Fig 3. *The Linear relationship between placental thickness "in the Y axis" and Femur Length (FL) "in the X axis". R^2=0.921,as the femur length increased the PT is also increased by 0.387.*
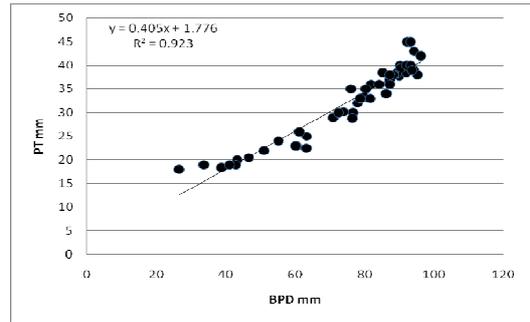
Fig 4. *The relation between placental thickness "in the Y axis" and Biparietal Diameter BPD"in the X axis". R^2=0.923 as the BPD increased ,the PT is also increased by 0.0.405 starting from1.776.*
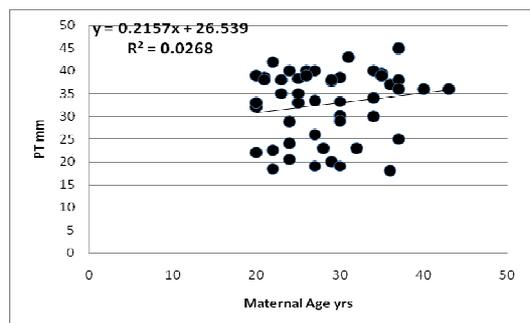
Fig 5. *The relation between placental thickness (PT) in millimeters (in the Y axis), and Maternal age in Years (in the X axis).R^2=0.0268*
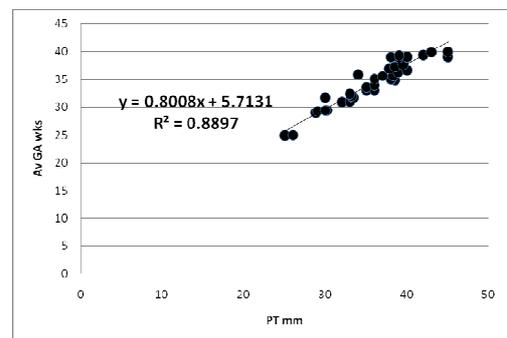
Fig 6. *The Linear relation between average Gestational age taken by BPD ans FL, "in the Y axis"   and placental thickness "in the X axis". (third trimester)*

Fig 7. *The Linear relation between Gestational age taken by placental thickness "in the Y axis"   and Average gestational age from BPD and FL "in the X axis". (third trimester)*
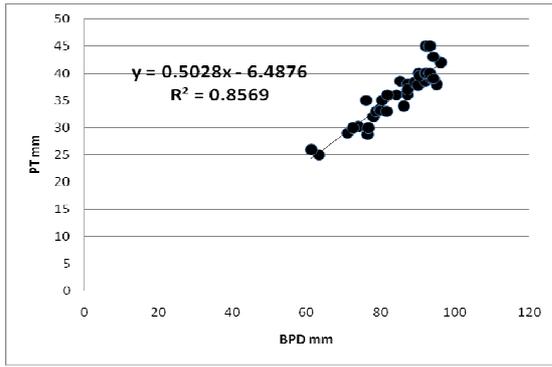
Fig 8. *The relation between placental thickness "in the Y axis" and Biparietal Diameter BPD "in the X axis". (third trimester)*
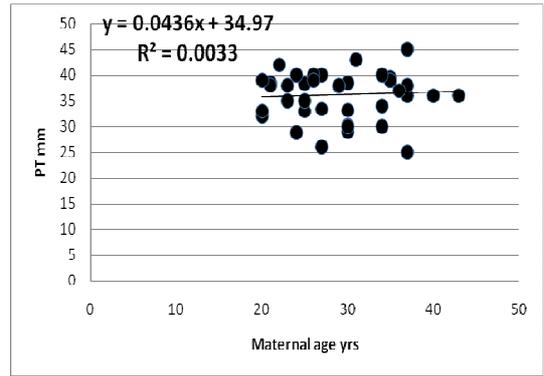

Fig 12. *The relation between placental "in the Y axis" and maternal age "in the X axis". (third trimester).*
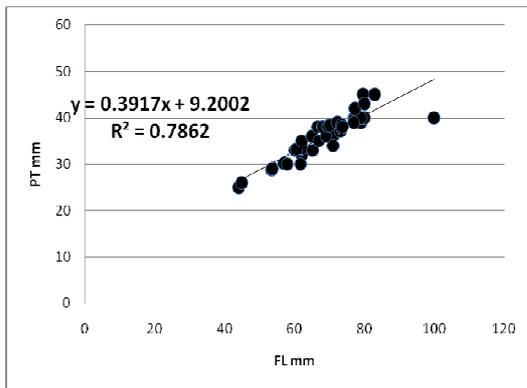

Fig 9. *The relation between placental thickness "in the Y axis" and Femur Length (FL) "in the X axis". (third trimester).*
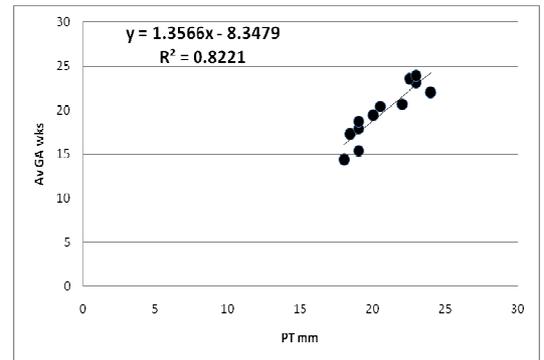

Fig 13. *The relation between average Gestational age taken by BPD and FL, "in the Y axis" and placental thickness "in the X axis". (second trimester)*
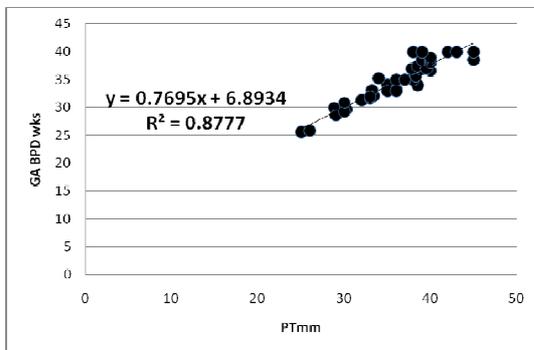

Fig 10. *The relation between Gestational age taken by BPD "in the Y axis" and placental thickness "in the X axis". (third trimester).*
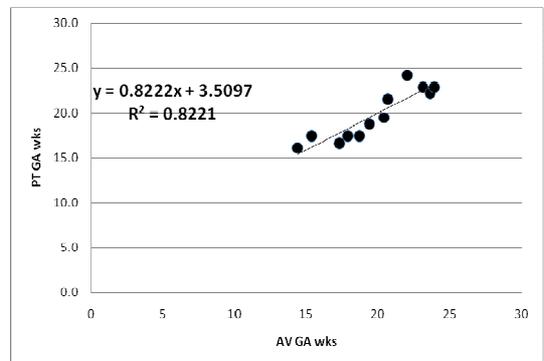

Fig 14. *The relation between Gestational age taken by placental thickness "in the Y axis" and Average gestational age from BPD and FL "in the X axis". (second trimester)*
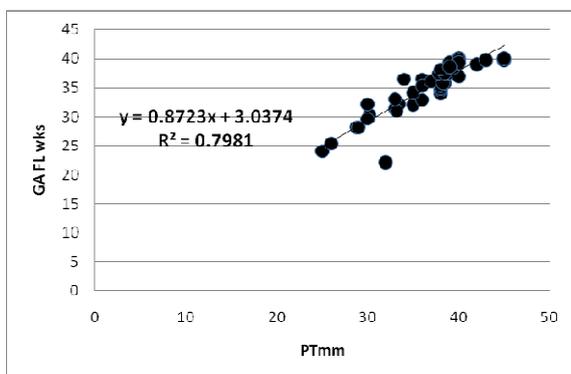

Fig 11. *The relation between Gestational age taken by FL "in the Y axis" and placental thickness "in the X axis". (third trimester).*
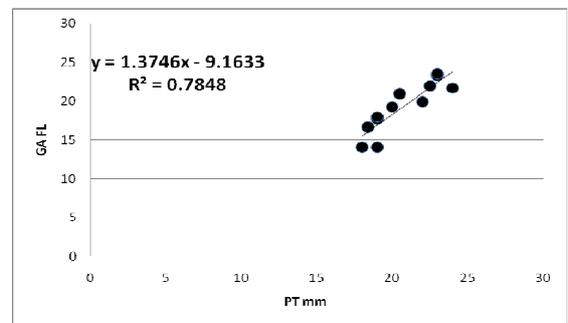

Fig 15. *The relation between Gestational age taken by FL "in the Y axis" and placental thickness "in the X axis". (second trimester).*
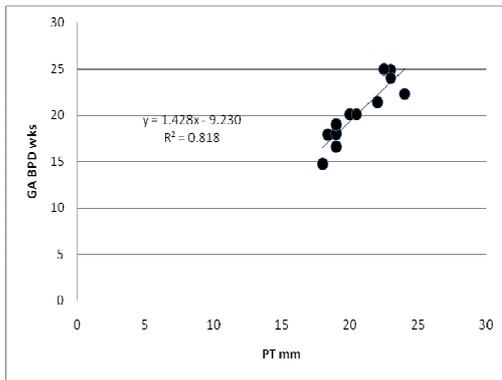
Fig 16. The relation between Gestational age taken by BPD "in the Y axis" and placental thickness "in the X axis". (second trimester).
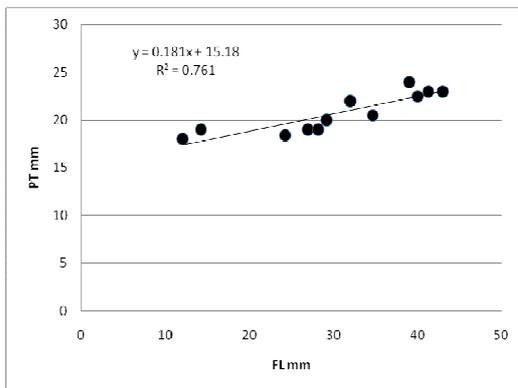

Fig 17. The relation between placental thickness "in the Y axis" and Femur Length (FL) "in the X axis". (second trimester).
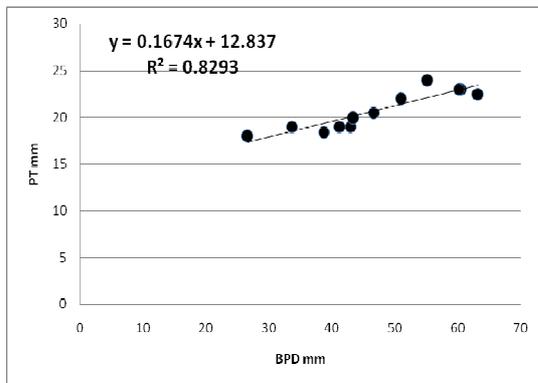

Fig 18. The relation between placental thickness "in the Y axis" and Biparietal Diameter BPD "in the X axis". (third trimester)
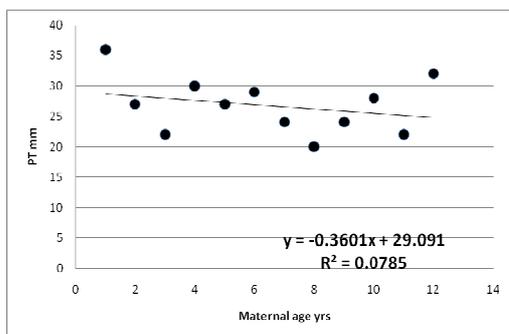

Fig 19. The relation between placental "in the Y axis" and maternal age "in the X axis". (second trimester).

4. Discussion

Monitoring fetal growth and assessing its predictors have important place in antenatal care management. Accurate prediction of gestational age, and birth weight, is clinically important.

The results presented above, showed the evaluated data including Maternal Age, BPD (mm), BPD GA (wks), FL (mm), FLGA (wks), Average GA, PT (mm), GA By PT (wks). (Tables 1, 2, 3) presented the mean and standard deviations in the total sample (second and third trimester), the second trimester alone and the third trimester alone.

(Table 4) presented the Average Gestational Age ,and Placental Thickness in Second trimester, third trimester, and both second and third trimesters(total) it showed a significant relation at P=0.000 between the GA and PT.

The results also indicated that there is a linear relationship between placental thickness, Average Gestational age (R^2=0.9593) (Fig.1,2) and growth parameters including Biparietal diameter (BPD) and Femur length (FL) it showed the linear relationship between the variables R^2=0.923 and 0.921 respectively,as the FL and BPD increased the PT is also increased by 0.389 and 0.405 respectively during both second and third trimesters.(fig.3,4).The maternal age has also relation with PT, R^2=0.0268 as presented in fig.5.The rest of the charts clearly showed the linear relationship between the placental thickness and the BPD and FL in mm in the second and third trimesters. The data of analysed in the third trimester alone showed a linear relationship between the PT, and FL, BPD as well as it was also linearly correlated in the second trimester group(figures 6-11),and (figures 13-18)

Equations were established to predict the AGA when measuring the PT .The relation during both 2nd and 3rd trimesters was as follows:

{y (Average Gestational age) = 0.9255 x (placental thickness) + 1.052} and an R^2=0.9593.

While the derived equation from only 3rd trimester was:

{y (Average Gestational age) = 0.8008 x (placental thickness) + 5.7131} and an R^2=0.8897.

That means that the derived formulas were even more accurate when the second trimester was involved with the 3rd in the analysis. However the derived formula from only analyzing 2nd trimester was as follows:

{y (Average Gestational age) 1.3566 x (placental thickness) – 8.3479} and an R^2=0.8221.

There was a linear relation between maternal age and placental thickness, in the total sample (third and second trimesters) third trimester alone, second trimester alone (fig.5, 12, 19).The results also agreed with those from the study done by Ohagwu et al 2008 [5], in Nigeria, which stated that there was a fairly linear increase in placental thickness with gestational age.

These results, indicated that the placental thickness can be used as a parameter for evaluation of gestational age, especially after Ohagwu et al, found the linear correlation even with the AC "Abdominal Circumference", which is a

very important parameter in calculating fetal weight, which means that the placental thickness might be the earliest sign of fetal anomalies.

The mean placental thickness calculated during the third trimester, was (34.7 ± 3.8), and a maximum thickness of 45mm at the 40th week of gestation. The minimum thickness recorded during 3rd trimester was 25mm, at 24.9 weeks gestation which approximately equals 24 weeks + 6 days. While the mean placental thickness calculated during the second trimester was (19.7 ± 2.8), and a maximum thickness of 24mm, at 22 weeks of gestation. The minimum thickness recorded during 2nd trimester was 18mm, at 14.4 weeks of gestation which is approximately equal to 14 weeks + 3 days.

Depending on the data collected ,the study concluded that a thickness of less than 25mm during the third trimester is considered less than normal, and might be an indication of Intrauterine growth retardation, and thickness of more than 45mm ,is considered thicker than normal; which might be an indication of maternal Diabetes, Hypertension, fetal Hydrops, and other abnormalities.

There was a linear relationship between placental thickness and gestational age calculated from both Biparietal Diameter and Femur Length and Maternal age

The equations derived from both second and third trimesters, can be used in estimating gestational ages using placental thickness as a parameter.

Normal values of placental thickness in normal Sudanese singleton fetuses were in range of 25 to 45mm in the 3rd trimester, and between 18 to 24mm, in the second trimester.

In any evaluation of fetal growth, an accurately determined gestational age is of extreme importance. Determination of gestational age from ultrasound biometry performed in the first half of pregnancy is more accurate than menstrual dates [6]. Fetal size has been measured using three growth parameters including Fetal Biparietal Diameter (BPD) and Head Circumference (HC), fetal nutritional status: Abdominal Circumference (AC); and Fetal Length: Femur Length (FL). These three measurements have been combined in various ways, to estimate fetal weight and growth. The most commonly used equations for estimated fetal weight are the Hadlock Formula and the Shephard Formula [7].This study showed that there are significant relations between FL, BPD, and PT, therefore using PT will be of great value in fetus size and growth assessment.

The etiology of Intrauterine Growth Restriction (IUGR) based on timing, and intrauterine environmental issues, may be fetuses that have suffered from decreased placental supply in the last 4 to 6 weeks of pregnancy resulting in a reduction of the fetal fat stores. These infants are asymmetrically growth-restricted, with an overall weight that is small for their length. [8]The maternal circumstances,

characteristics ,including weight, height, parity, and ethnic group are all strongly correlated with birth weight at term[9] .Maternal path physiology of vascular disease decreases utero placental perfusion and may be responsible for as many as 25% to 30% of all IUGR infants and predisposes to fetal IUGR [10]

Regarding these findings; it is highly recommended to use placental thickness for prediction of fetus growth.

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