Foetal Weight Determination using Sonographic Measurement of Placenta Thickness

Ebbi Donald Robinson
Braithwaite Memorial Specialist Hospital, Port Harcourt, Rivers State, Nigeria.

***Correspondence**: drebbirobinson@yahoo.co.uk*

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ABSTRACT

Introduction: *Placental evaluation by ultrasound has been used to characterize placental position, morphologic changes and maturity. The placenta is a foetal organ with important metabolic, endocrine and immunologic functions. It also plays a vital role in protecting the foetus from noxious agents. Foetal weight can be sonologically estimatedusing a single or combination of foetal growth parameters such as crown-rump length (CRL), biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femoral length (FL). Notwithstanding, the above mentioned useful parameters, the placental thickness measurement is another useful single parameter infoetal weight estimation. Therefore, this will offer radiologistalternative means of determining foetal weight among pregnant women by sonographically measuring the placenta thickness. This will enhance effective pregnancy managementby clinicians.*

Method: *Foetal weight determination using sonographic measurement of placenta thickness is a cross sectional prospective study carried out among antenatal women referred to the department of Radiology in Braithwaite memorial specialist hospital, Port Harcourt for routine ultrasound scan.*

Three hundred and seventy-five (375) pregnant women referred for routine obstetric scan that fulfilled the inclusion criteria were examined using LOGIQ P6 PRO GE Healthcare 3D machinefitted with a 3.5MHz curvilinear probe. The placental thickness (mm) was measured at the level of cord insertion, its mid portion or its widest diameter for the second and third trimesters while the foetal weight was obtained from the ultrasound machine after measuring AC and FL. Pearson correlation and linear regression analysis were used to correlate between obtained variables.

Result: *The mean placenta thicknesses in the second and third trimesters were 22.68±3.28mm and 34.83±4.57mm respectively. The estimated foetal weights in grams (mean with standard deviation) in the second and third trimesters were 418.50±240.01 and 2309.70±779.50. A positive statistical correlation was observed between foetal weight and sonographic placenta thickness yielding a Pearson's correlation coefficient (r) of 0.769 and 0.856 for the second and third trimesters respectively within a p value of 0.01.*

Conclusion: *Sonographic measurement of placenta thickness can be used to estimate the foetal weight in the second and third*

trimesters. This will assist clinicians in the monitoring of foetal weight during pregnancy. Therefore, placental thickness measurement should be another useful parameter in estimating foetalweight.

***Keywords**: Foetal Weight, Placental Thickness, Ultrasonography, Braithwaite Memorial Specialist Hospital.*

INTRODUCTION

The placenta is a discoid shaped hemochorial foetal organ which provides both anatomic and physiologic connection between a pregnant woman and the fetus[1]. Therefore, it forms the maternal- fetal interface for exchange of oxygen and nutrients as well as metabolic waste as there is no direct link between the foetal and maternal blood[2].The placenta plays very with important metabolic, endocrine and immunologic roles as well as protecting the foetus from noxious agents[2,3,4]. 'Placenta nutrient transport across the foetal maternal interface depends on the placental size, morphology (exchange zone surface area and tissue thickness), nutrient transporter capacity/availabilityas well as the utero- and foeto-placental blood flow'[5].

At about the fifth week of gestation the placenta develops from the chorionic villi at the implantation site and by the ninth or tenth week[1,6,7], the diffuse granular echo pattern of the placenta is clearly visible sonographically[8,9].Meanwhile,it reaches its ultimate thickness and shape in the 16th week of gestation and continues to grow in diameter until the end of the third trimester[10].

Ultrasound has been used to characterize placental position, morphologic changes and maturity[11-13]. The Placental thickness is obtained by sonographicallymeasuring the placenta from the echogenic chorionic plate to the placental myometrial interface, excluding the myometrium and subplacental veins[14-18]. On the other hand the identification of the site of cord insertion which is usually central but could be slightly eccentric in position is important in obtaining correct measurements[19, 20]. The site of the cord insertion can be sonologically identified as hypoechoic areas closest to the chorionic plate in the thickest portion of the placenta with a "v shape" or as linear echoes emanating at right angles from the surface of the placenta[1, 20]. The placenta should also be measured during a relaxed phase of the uterus[11] as uterine contraction can spuriously increase its thickness[11]. It is reported that distension of the intervillous spaces by maternal blood during contraction accounts for this increase in thickness[21]. Therefore, placental tissue, fetal blood as well as maternal blood determine placental thickness[21].

Foetal growth parameters such as crown-rump length, biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femoral length (FL) can be used to sonologically estimate foetal weight. The Sherpard's method employs the BPD and AC with a deviation of 295g from the actual birth weight[22];whereasthe Campbell and Wilkins method can be used to evaluate foetal birth weight as a single parameter method that uses the abdominal circumference alone[23]. This method is employed by some schools of thought, of

which its reliability and accuracy has paucity of documentation.

Being the fraternal channel of nutrition between the fetus and the mother[24], it greatly influences fetal birth weight and thus is thought that abnormalities of placental growth may precede abnormalities[24] in fetal growth whereas abnormalities of the fetus or mother will affect the placenta[3,7,24,25].

A study was conducted by Afrakhteh and colleagues[26] to evaluate the correlation between placental thickness and birth weight during the second and third trimesters with 250 singleton pregnant women presenting at the antenatal clinic. The study documented a mean birth and of 305.56±657.0 and 551.7±104.8 grams respectively and placental thickness of trimesters and changes between them were 21.68±4.52, 36.26±6.46 and 14.67±5.67mm in second and third respectively. This sentence should be re-worked. The study concluded that there is a significant positive correlation between placental thickness and birth weight in the second and third trimesters (r=0.15,p=0.03;r=0.14,p=0.04 respectively).

METHODOLOGY

Data and Study Area

This is a cross sectional descriptive study of the foetal weight determination using sonographic measurement of placenta thickness among pregnant women visiting Braithwaite Memorial Specialist Hospital carried out over duration of 10 months in the ultrasound suite of the Radiology Department of Braithwaite Memorial Specialist Hospital Port Harcourt, Rivers State, South-South of Nigeria.

Following approval from the ethical committee of the hospital, three hundred and seventy-five (375) pregnant women referred for routine obstetric scan that fulfilled the inclusion criteria being a Singleton pregnancy with Knowledge of last menstrual period and history of regular menstruation were examined using LOGIQ P6 PRO GE Healthcare 2D machinefitted with a 3.5MHz curvilinear probe.

Informed consent was obtained from subjects. The age, weight, height and Last Normal Menstrual Period (LMP) of the subjects were documented prior to transabdominal ultrasound evaluation. A real time gray scale evaluation of the pregnant uterus was done after moderate bladder distension with patient's prior intake of about 500mls of water 30 minutes to one hour before examination. The examination was done with the patient in supine position on the examination couch. While lying supine on the couch, patient was kindly requested to expose her body from the xiphisternum to the pubic symphysis. An acoustic gel was carefully applied to the anterior abdomen and suprapubic area to obliterate air interface between the transducer and skin. The transducer was oriented to scan perpendicular to both the chorionic and basal plates as tangential scans will distort the measurement of the thickness of the placenta.

The placental thickness in millimeter (mm) is measured at the level of cord insertion site or its mid portion or widest diameter as shown in figure 1 and 2 for anteriorly and posteriorly located placentas respectively. The foetal weight was automatically generated and displayed on the monitor by

the machine when the femur length and abdominal circumference were obtained as contained by the software package of the machine. This is a composite fetal measurement of more than one parameter. Therefore, any two of the parameters- BPD, HC, and FL plus AC can determine the foetal weight. After obtaining and documenting the required measurements, the applied acoustic gel was gently cleaned off the patient with a towel.

Foetal parameters such as placenta thickness, CRL, BPD, HC, FL and AC as well as foetal weight were collated. Other variables such as age, height and weight obtained from each patient were also collated. All obtained variables were collated, documented and entered into Microsoft Excel Spreadsheet and subsequently transferred into Statistical Package for the Social Sciences (SPSS) windows version 20.0 statistical software for analysis.

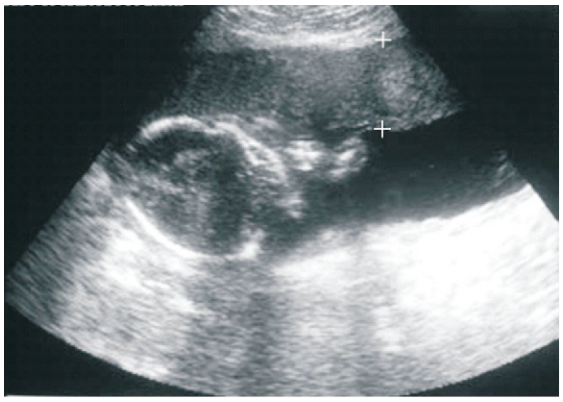

Figure 1: A grey scale image showing the placenta thickness measured at its widest diameter in an anteriorly located placenta.

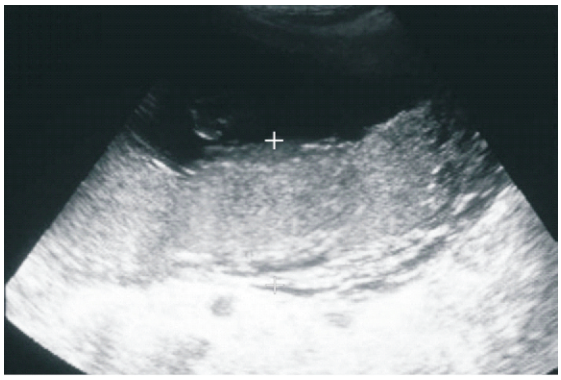

Figure 2: A grey scale image of a posteriorly located placenta showing its measurement at its widest diameter.

RESULTS

Figure 3 show the age of participants which range from 18-41 years with a mean age (±standard deviation) of the subjects is 28.26□8.4 years. The mean placenta thicknesses in the second and third trimesters were 22.68□3.28mm and 34.83□4.57mm respectively while the composite second and third trimester mean placenta thickness is 29.94□7.24mm. The maximum mean placenta thickness of 40.35□0.29mm was recorded at 39 weeks gestation as shown in table 1.

The estimated mean foetal weights in grams (with standard deviation) in the second and third trimesters were 418.50±240.01 and 2309.70±779.50 as shown in table 2 while the composite foetal weight was 1548.18±1117.13.Table 3 showed a positive correlation between sonographic placenta thickness and foetal weight yielding a Pearson's correlation coefficient (r) of 0.769 and 0.856 for the second and third trimesters respectively with a p value of 0.01.

Linear Regression Analysis yielded equations 1, 2 and 3, where y is estimated foetal weight in grams and *x* is placenta thickness in millimetre (Figures 3, 4 and 5).

Y = 50 x± 500 (r=0.769; p =0.01) equation 1 (second trimester)
Y = 160x±3200 (r=0.856; p =0.01) equation 2 (third trimester)
Y = 100x± 10000 (r=0.940; p =0.01) equation 3 (second and third trimester combined)

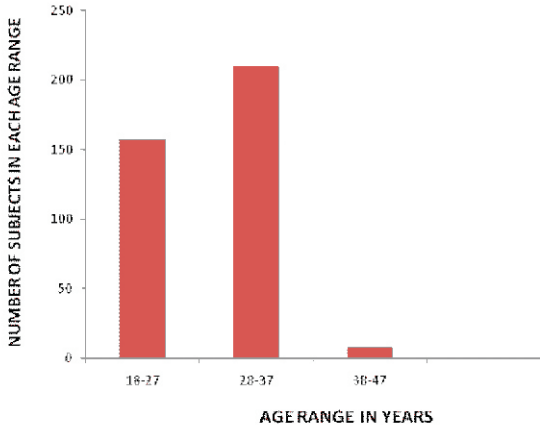

Figure 3: Age Distribution of patients

Table 1: Mean placenta thickness according to gestational age

Second trimester				
Foetal parameter	**Foetal parameter (mm)**	**Gestational AGE (GA) in weeks**	**Number of respondents**	**Placenta thickness (mm)**
BPD	24.50 ± 0.99	14	7	16.06 ± 1.71
BPD	29.20 ± 0.62	15	11	17.50 ± 0.76
BPD	35.00 ± 0.54	16	8	18.39 ± 0.70
BPD	35.60 ± 0.34	17	11	20.04 ± 1.53
FL	27.90 ± 0.56	18	10	21.18 ± 1.03
FL	29.80 ± 0.72	19	12	22.27 ± 1.36
FL	33.30 ± 0.40	20	18	23.48 ± 1.06
FL	35.30 ± 0.48	21	15	23.03 ± 0.98
FL	38.40 ± 0.44	22	9	25.23 ± 0.89
FL	40.40 ± 0.62	23	14	26.00 ± 1.09
FL	44.00 ± 0.96	24	12	24.26 ± 1.23
FL	45.90 ± 1.00	25	14	25.52 ± 2.23
FL	48.00± 0.70	26	10	.. ..
Mean placenta thickness 22.68 ± 3.28 (n= 151)				
Third trimester				
FL	51.30 ± 0.42	27	11	27.71 ± 1.95
FL	52.90 ± 0.63	28	14	28.74 ± 2.71
FL	56.20 ± 0.25	29	20	29.51 ± 2.71
FL	57.80 ± 0.42	30	14	30.89 ± 2.16
FL	60.04 ± 0.38	31	18	31.14 ± 1.51
FL	62.00 ± 0.95	32	20	32.17 ± 1.67
FL	64.90 ± 0.57	33	17	36.19 ± 0.72
FL	65.90 ± 0.66	34	21	36.96 ± 0.28
FL	68.30 ± 0.64	35	15	37.27 ± 1.20
FL	70.30 ± 0.84	36	18	38.97 ± 1.29
FL	73.30 ± 0.26	37	17	39.60 ± 1.48
FL	74.20 ± 1.20	38	13	39.73 ± 1.53
FL	76.50 ± 0.10	39	15	40.35 ± 1.45
FL	78.60 ± 0.30	40	11	38.29 ± 1.58
Mean placenta thickness 34.83 ± 4.57 (n= 224)				

Table 2: Mean placenta thickness and estimated foetal weight

Second Trimester			
Gestational Age (weeks)	**Number of respondents**	**Placenta Thickness (mm)**	**Mean Foetal Weight (gm)**
14	7	16.06 ± 1.71	123.00 ± 6.86
15	11	17.50 ± 0.76	142.20 ± 8.18
16	8	18.39 ± 0.70	158.50 ± 12.05
17	11	20.04 ± 1.53	183.55 ± 10.23
18	10	21.18 ± 1.03	220.60 ± 14.32
19	12	22.27 ± 1.36	254.92 ± 18.25
20	18	23.48 ± 1.06	344.50 ± 34.53
21	15	23.03 ± 0.98	407.20 ± 26.31
22	9	25.23 ± 0.89	487.00 ± 30.16
23	14	26.00 ± 1.09	542.57 ± 42.17
24	12	24.26 ± 1.23	707.83 ± 74.49
25	14	25.52 ± 2.23	756.42 ± 65.52
26	10	26.49 ± 1.77	884.50 ± 33.51
Mean placenta thickness 22.68 ±3.28 Mean Foetal Weight 418.50 ± 240.01 (n= 151)			
Third Trimester			
27	11	27.71 ± 1.95	1083.78 ± 93.53
28	14	28.74 ± 2.71	1301.50 ± 54.77
29	20	29.51 ± 2.71	1343.30 ± 65.34
30	14	30.89 ± 2.16	1560.23 ± 101.93
31	18	31.14 ± 1.51	1904.65 ± 149.75
32	20	32.17 ± 1.67	1892.38 ± 153.19
33	17	36.19 ± 0.72	2208.81 ± 152.77
34	21	36.96 ± 0.28	2295.15 ± 236.60
35	15	37.27 ± 1.20	2780.64 ± 252.57
36	18	38.97 ± 1.29	2975.65 ± 227.81
37	17	39.60 ± 1.48	3102.69 ± 211.86
38	13	39.73 ± 1.53	3320.00 ± 153.19
39	15	40.35 ± 1.45	3630.00 ± 81.70
40	11	38.29 ± 1.58	3760.00 ± 46.15
Mean Placenta Thickness 34.83 ± 4.57 Mean Foetal Weight 2309.70 ± 779.50 (n= 224)			

Table 3: Pearson's correlation values between placenta thicknesses and estimated foetal weight

Second Trimester				
Number of respondents	Mean Placenta thickness(mm)	Estimated Mean Foetal Weight (g)	Pearson's Correlation Coefficient (r)	*P-value*
n= 151	22.68 ± 3.28	418.50 ± 240.01	0.769**	0.01
Third trimester				
n= 224	34.83 ± 4.57	2309.70 ± 779.50	0.856**	0.01
Second and third trimesters combined				
n=375	29.94 ± 7.24	1548.18± 1117.13	.940**	0.01

Pearson Correlation Performed.
**. Correlation is significant at the 0.01 level (2-tailed)

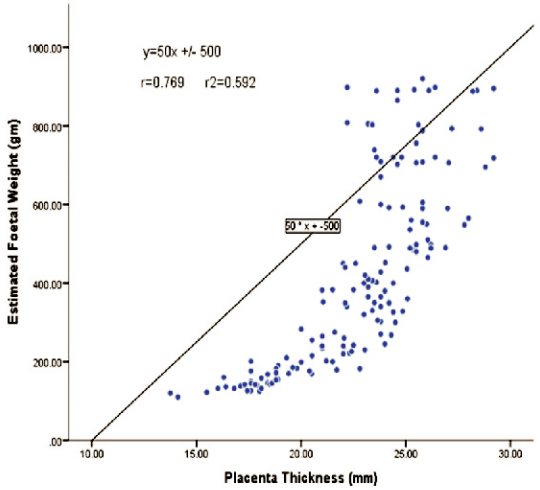

Figure 4: Scatter Plot Graph of Estimated Foetal Weight against Placenta Thickness in the Second Trimester

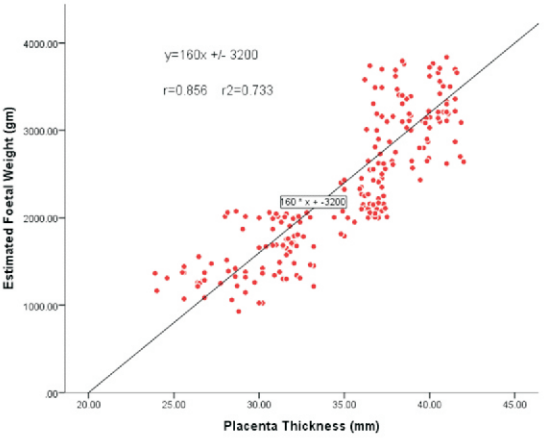

Figure 5: Scatter plot graph of estimated foetal weight against placenta thickness in the third trimester

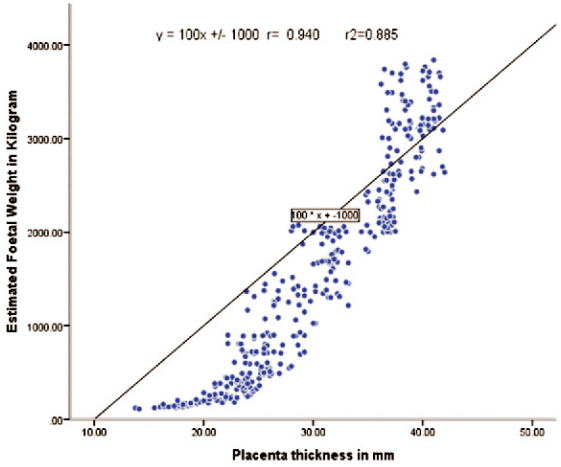

Figure 6: Scatter plot graph of estimated foetal weight against placenta thickness in the second and third trimesters combined.

DISCUSSION

Ultrasonography is the most readily available, reliable, safest and cost effective imaging modality among others in the evaluation of the placenta. The exchange of nutrients, metabolic products and gases[2], between the maternal blood and foetus occurs through the placenta, thus it serves as an effective interface between the mother and the foetus[2]. This has made the evaluation of the placenta a veritable tool for assessing, monitoring and predicting pregnancy outcome by clinicians.

During the period of pregnancy the size of the placenta also increases in order to keep up with the metabolic demands of the fetus. Therefore, this implies that placenta thickness could be of value in dating and monitoring the overall outcome of pregnancies as well as assessing need for pragmatic intervention. Alongside routine foetal biometric parameters, various studies have establish a relationship between

placenta thickness in one part and gestational age, estimated foetal weight among others in the other part[21].

Studies have shown that thick placentas are associated with maternal diabetes mellitus, foetal hydrops and intrauterine fetal infections while thin placentas less than 25mm in thickness are associated with intrauterine growth retardation[13,27].

In this study the mean placenta thickness (± standard deviation) in the second and third trimesters were 22.68±3.28mm and 34.83±4.57mm respectively while the composite mean placenta thickness is 28.85±8.19mm. In a similar study in Nigeria by Ohagwuet al[27] the mean placenta thickness in the second and third trimesters were, 25.2±5.6mm and 38.4±7.1mm respectively.

This study has shown a positive statistically correlation between Sonographic placenta thickness and foetal weight with a Pearson's correlation coefficient (r) of 0.769 and 0.856 for the second and third trimesters respectively. This is in accordance with other documented Nigerian studies conducted by Abu and colleagues[28] and that carried out by Adeyekunet al[29]. It is also in consonance with the study conducted by Afrakhtek et al[26] with 250 pregnant women (in Tajrish Tehran Iran) and Daskalakis et al[30] (in Athens Greece) which are studies performed outside this country.

The correlation observed in this study is more in the third trimester while the composite evaluation shows higher statistical correlation when compared to the individual trimesters. However, the index study has shown that mean placenta thickness have a linear correlation with foetal weight. Thus, measurement of placenta thickness may be used as a parameter to estimate the foetalweight in cases where there is difficulty in obtaining other foetal dating parameters (like FL, AC, BPD, CRL and HC) or as a means of further evaluation.

CONCLUSION

In this study, the mean placenta thicknesses mean with (standard deviation in the second and third trimesters were 22.68±3.28mm and 34.83±4.57mm respectively whereas the estimated mean foetal weights in grams (with standard deviation) in the second and third trimesters were 418.50±240.01 and 2309.70±779.50.The mean placenta thickness showed a linear correlation withfoetal weight in this study.

Therefore, this implies that Sonographic measurement of placenta thickness is a pertinent tool for assessing foetal weight as well as foetal well being however; further robust studies are advised to affirm this finding.

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