IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 2 Ser. 8 (February. 2019), PP 12-24
www.iosrjournals.org

Evaluation of fetal weight with respect to placental thickness and gestational age using ultrasonography.

Dr.R.Rajesh Gowtham[1](resident), Dr K. Praveen Sharma [2](Associate professor)
,
Dr. N. Paarthipan[3](Professor), Dr. C.R. Seena[4](Prof and HOD).
[1]*Department of radio-diagnosis, Saveetha medical college and hospital, Saveethauniversity) India*
[2]*Department of radio-diagnosis, Saveetha medical college and hospital, Saveethauniversity) India*
[3]*Department of radio-diagnosis, Saveetha medical college and hospital, Saveethauniversity) India*
[4]*Department of radio-diagnosis, Saveetha medical college and hospital, Saveethauniversity) India*
Corresponding Author: Dr.R.RajeshGowtham

Abstract: *The placental thickness can be a useful sonographic parameter. It tends to gradually increase with gestational age in a linear fashion (~ 1 mm per week) and therefore the thickness in mm can approximate the gestational age (in weeks). Placental thickness appears to be a promising parameter for estimation of gestational age of the fetus as was also shown in animal studies.There was a strong positive correlation between placental thickness and gestational age. The measurement of the placental thickness is an important parameter for estimation of fetal age along with other parameters especially in the late mid trimester and early third trimester, where the exact duration of pregnancy is not known and other sonographic parameters also become less reliable .*

Date of Submission: 30-01-2019 Date of acceptance:16-02-2019

I. Introduction

The placental thickness can be a useful sonographic parameter. It tends to gradually increase with gestational age in a linear fashion (~ 1 mm per week) and therefore the thickness in mm can approximate the gestational age (in weeks). Placental thickness appears to be a promising parameter for estimation of gestational age of the fetus as was also shown in animal studies.There was a strong positive correlation between placental thickness and gestational age. The measurement of the placental thickness is an important parameter for estimation of fetal age along with other parameters especially in the late mid trimester and earlythird trimester, where the exact duration of pregnancy is not known and other sonographic parameters also become less reliable.

II. Material And Methods

A cross-sectional study was conducted for a period of one year on all the antenatal mothers at the radiology department of Saveetha Medical college and Hospital. All women with singleton pregnancies, women with confirmed last menstrual period, women of 11 to 40 weeks of gestation who were referred to radio diagnosis department for antenatal checkup were included in the study. Patients with Patients with PIH, Anaemia, Diabetes mellitus, hydropsfetalis, intra uterine growth restriction, congenital malformations, twins, polyhydramnios, placental anomalies, placenta praevia, poor visualization of placenta were excluded from the study. Atotal of 50 antenatal mothers were included in the study. The placental thickness in mm was measured at the level of cord insertion site. The transducer was oriented to scan perpendicular to both the chorionic and basal plates as tangential scan will distort the measurement of the thickness of the placenta. All the other routine parameters like BPD, HC,AC and FL were also measured.

Study Design: Cross-sectional study.
Study Location: Department of radiology, /Saveetha medical college and hospital, Chennai.
Study Duration: June 2017 to May 2018.
Sample size: 50 patients.
Subjects & selection method: The study population A cross-sectional study was conducted for a period of one year on all the antenatal mothers at the radiology department of Saveetha Medical college and Hospital. All women with singleton pregnancies, women with confirmed last menstrual period, women of 11 to 40 weeks of gestation who were referred to radio diagnosis department for antenatal checkup were included in the study. Patients with Patients with PIH, Anaemia, Diabetes mellitus, hydropsfetalis, intra uterine growth restriction,

congenital malformations, twins, polyhydramnios, placental anomalies, placenta praevia, poor visualization of placenta were excluded from the study. Atotal of 50 antenatal mothers were included in the study. The placental thickness in mm was measured at the level of cord insertion site. The transducer was oriented to scan perpendicular to both the chorionic and basal plates as tangential scan will distort the measurement of thethickness of the placenta. All the other routine parameters like BPD, HC,AC and FL were also measured.

Inclusion criteria:

1. 1.Singleton pregnancies
2. 2.Women with confirmed last menstrual period.
3. Women of 11 to 40 weeks of gestation who are referred to radio diagnosis department for antenatal checkup

Exclusion criteria:

1. PIH
2. Anaemia.
3. Diabetes mellitus.
4. Hydropsfetalis
5. Intra uterine growth restriction.
6. Congenital malformations
7. Twins
8. Polyhydramnios
9. Placental anomalies
10. Placenta praevia
11. Poor visualization of placenta.

Procedure methodology

All the patients were scanned with a moderately distended bladder in supine position. The transducer was placed on the skin surface after applying the couple agent.

The placental thickness in mm was measured at the level of cord insertion site. The transducer was oriented to scan perpendicular to both the chorionic and basal plates as tangential scan will distort the measurement of the thickness of the placenta.

III. Result:

Table 1: Age wise distribution of the antenatal mothers

Age group (in years)	Frequency	Percentage	Mean	SD
20 – 25	34	68%	24.2	3.2
26 – 30	14	28%		
>30	2	4%		
Total	50	100%		

Table 1 shows the age wise distribution of the antenatal mothers. It is seen from the table that majority of our study subjects were in the age group between 20 and 25 years with a mean age of 24.2 years. The minimum age in our study subjects was 20 and the maximum age was 32 years.

Fig 1: Age wise distribution of the antenatal mothers

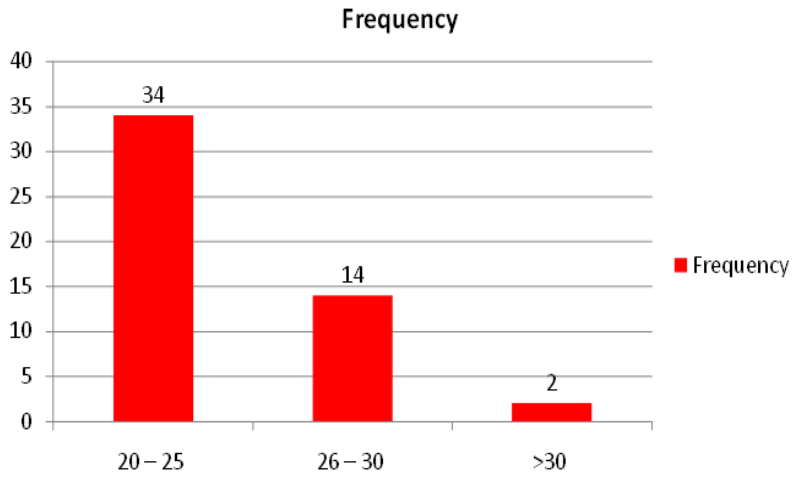

Table 2: Distribution of the study subjects based on their gestational age

Gestational age (in weeks)	Frequency	Percentage	Mean	SD
</= 20	7	14%	25.9	4.8
21 – 25	18	36%		
26 – 30	17	34%		
>30	8	16%		
Total	50	100%		

Table 2 shows the distribution of the study subjects based on their gestational age. It is seen from the table that majority of the subjects had the gestational age between 21 – 30 weeks, which means most of them were in the 2nd and early 3rd trimester. The mean gestational age for our study population was 25.9 weeks.

Fig 2: Distribution of the study subjects based on their gestational age

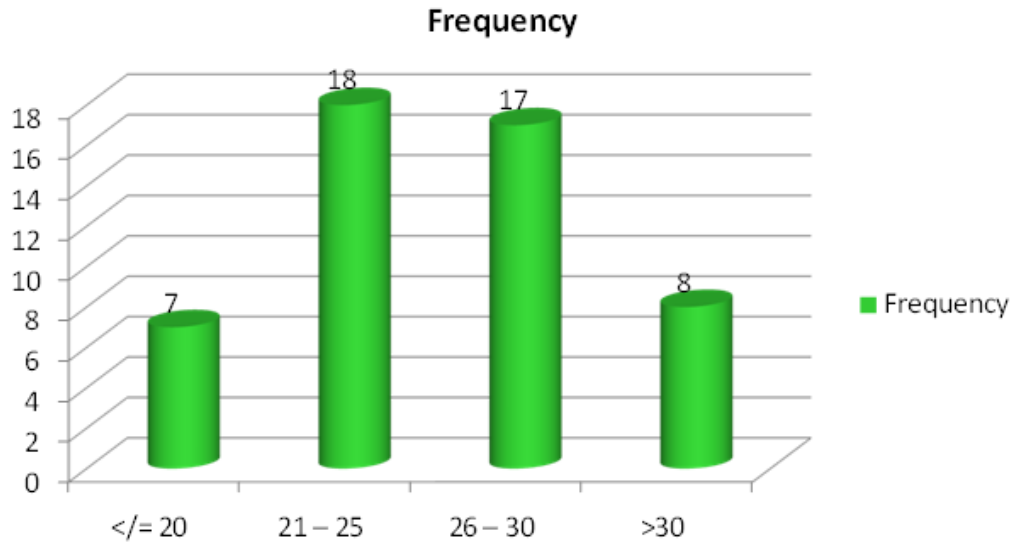

Table 3: Distribution of the study subjects based on the position of placenta

Placental position	Frequency	Percentage
Anterior	28	56%
Posterior	15	30%
Fundal	5	10%
Lateral	2	4%
Total	50	100%

Table 3 shows the distribution of the study subjects based on their position of placenta detected through the ultrasonogram. It is seen from the table that majority of the subjects placental position was found to be anterior followed by posterior. Only 10% and 4% of the study subjects had the placental position as fundal and lateral respectively.

Fig 3: Distribution of the study subjects based on the position of placenta

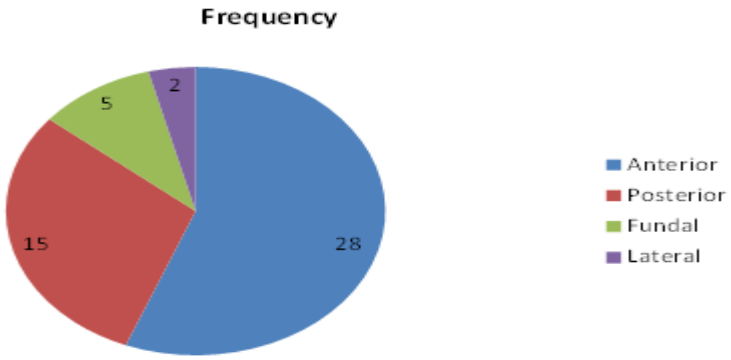

Table 4: Mean and SD of the various foetal parameters measured in USG based on the gestational age

Gestational age	BPD (mean ± SD)	HC (mean ± SD)	AC (mean ± SD)	FL (mean ± SD)
</= 20	5.08 ± 0.29	19.2 ± 1.0	16.6 ± 1.3	3.5 ± 0.51
21 – 25	6.0 ± 0.78	20.7 ± 2.0	18.7 ± 2.1	4.2 ± 0.52
26 – 30	7.1 ± 0.71	26.9 ± 1.1	24.9 ± 1.3	5.5 ± 0.48
>30	7.7 ± 0.67	30.5 ± 1.4	28.9 ± 1.7	6.4 ± 0.54

Table 4 shows the mean and SD of the various foetal parameters measured through ultrasonogram based on their gestational age. It is depicted from the table that all the foetal parameters like biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and the femur length (FL) were appropriate for the gestational age.

Fig 4: Mean and SD of the various foetal parameters measured in USG based on the gestational age

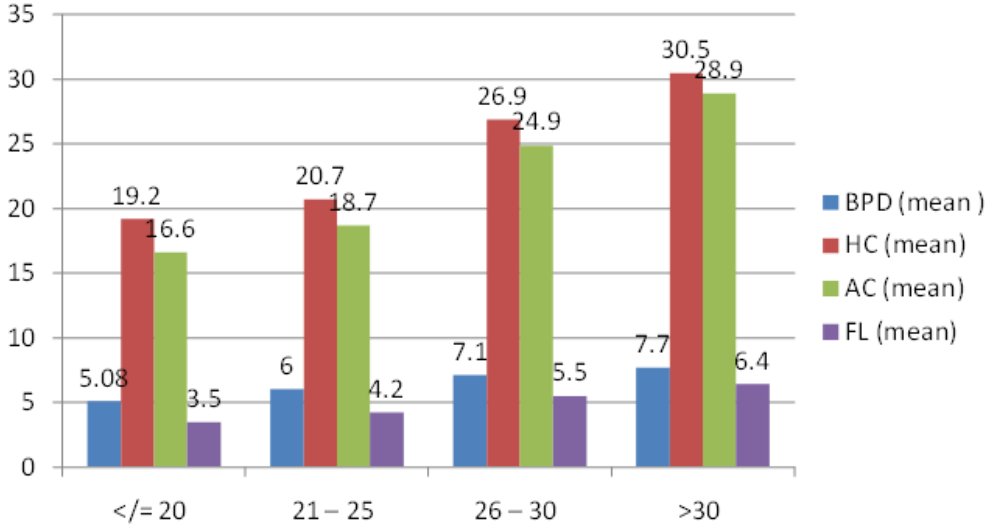

Table 5: Gestational age wise placental thickness among the study subjects

Gestational age (in weeks)	No of cases (n=50)	Mean	SD	P value
19	2	1.96	0.31	<.0001
20	5	2.13	0.33	
21	6	2.25	0.41	
22	5	2.58	0.12	
23	4	2.48	0.21	
24	2	2.69	0.33	
25	1	2.37	-	
26	1	2.67	-	
27	1	2.72	-	
28	4	2.87	0.35	
29	6	3.18	0.41	
30	5	3.54	0.28	
32	3	3.62	0.31	
34	2	3.71	0.15	
35	3	3.70	0.56	

P value derived by applying student T test

Table 5 shows the association between gestational age and the placental thickness. It is inferred from the table that there exist a statistical significant association between gestational age and the placental thickness, as gestational age increases the placental thickness shows a gradual increase.

Fig 5: Gestational age wise mean placental thickness among the study subjects

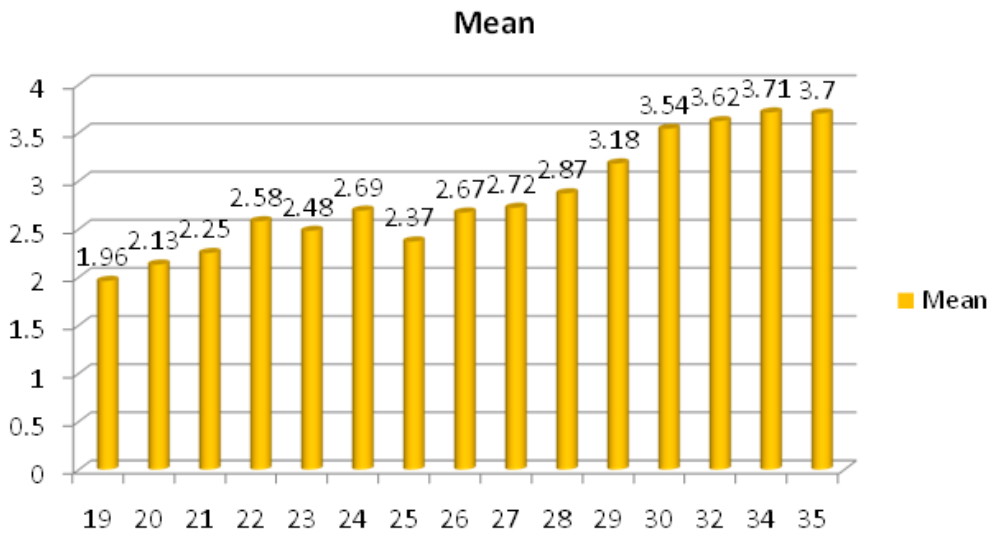

Table 6: Correlation between gestational age and placental thickness

Correlations			
		Gestational age	Placental thickness
Gestational age	Pearson Correlation	1	.787**
	Sig. (2-tailed)		.000
	N	50	50
Placental thickness	Pearson Correlation	.787**	1
	Sig. (2-tailed)	.000	
	N	50	50
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 6 shows the correlation between gestational age and the placental thickness. The pearsons correlation shows a strong positive correlation between the gestational age and the placental thickness and the correlation between the two parameters found to be statistically significant ($p<.01$).

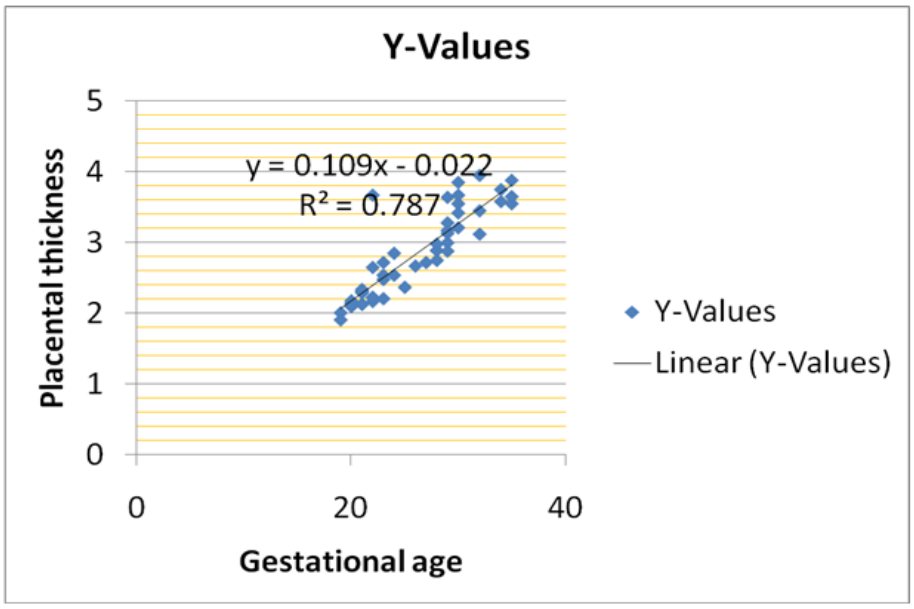

Fig 6: Linear regression between gestational age and placental thickness

Fig 7: Linear regression between gestational age and BPD

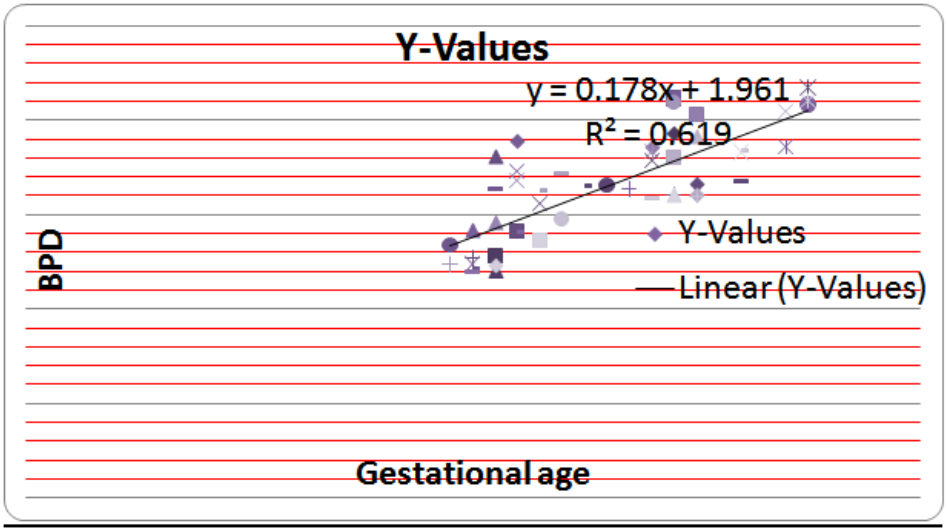

Fig 8: Linear regression between gestational age and AC

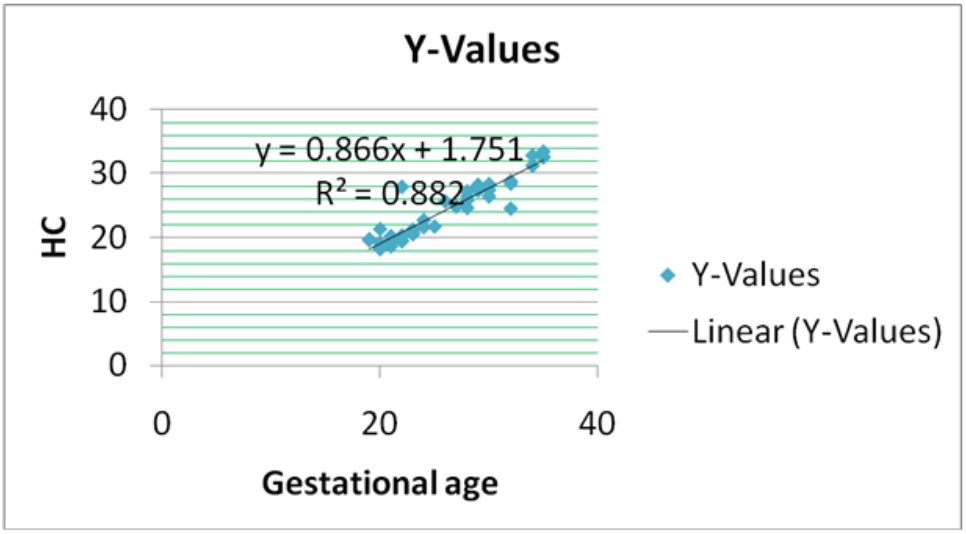

Fig 9: Linear regression between gestational age and AC

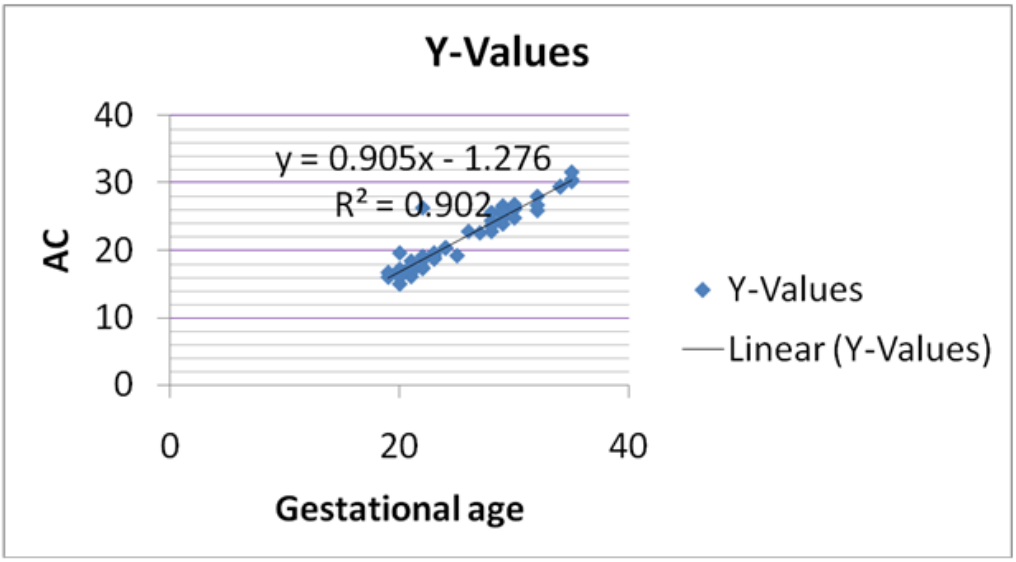

Fig 10: Linear regression between gestational age and FL

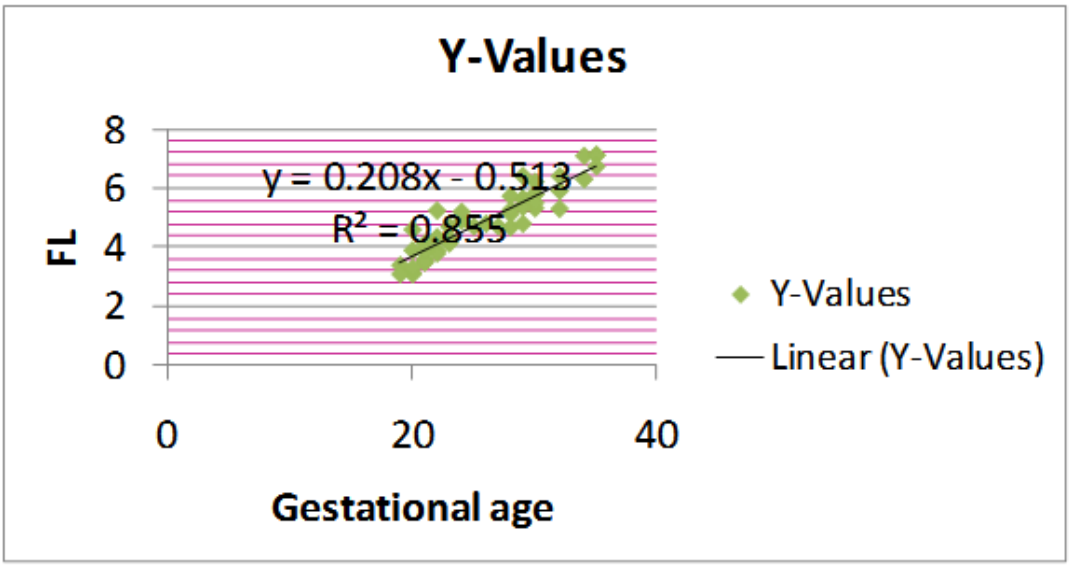

Fig 6 -10 shows the linear regression between the gestational age and the other foetal parameters used to assess the gestational age and it is seen from the graphs that there is a perfect linear regression between BPD, HC, AC and FL with gestational age and similar to these parameters a perfect linear regression exist between gestational age and the placental thickness.

Table 7: Correlation between placental thickness and foetal weight

Correlations			
		Placental thickness	Foetal weight
Placental thickness	Pearson Correlation	1	.809**
	Sig. (2-tailed)		.000
	N	50	50
Foetal weight	Pearson Correlation	.809**	1
	Sig. (2-tailed)	.000	
	N	50	50
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 7 shows the correlation between placental thickness and foetal weight. It is seen from the table that there is a strong positive correlation between the two parameters as the thickness of the placenta increases the foetal weight increases. This correlation was found to be statistically significant (P<.01).

Fig 11: Linear regression between placental thickness and foetal weight

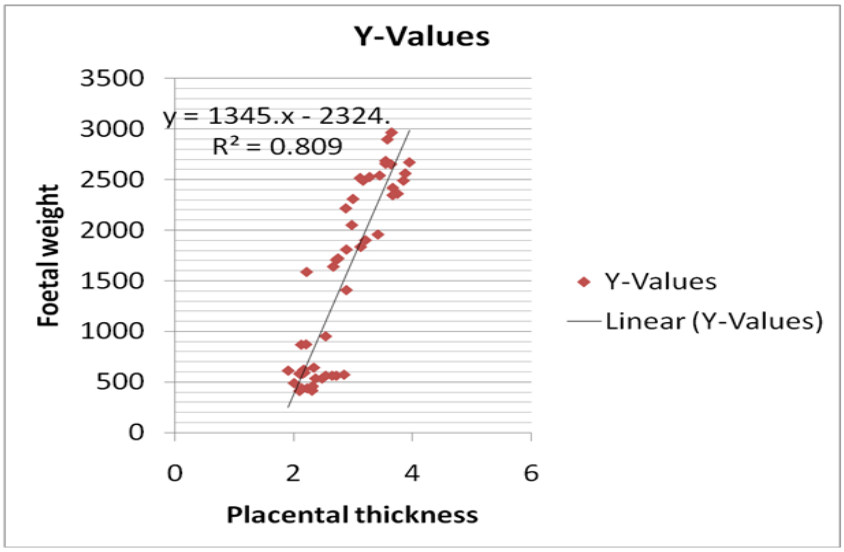

Fig 12: Linear regression between BPD and foetal weight

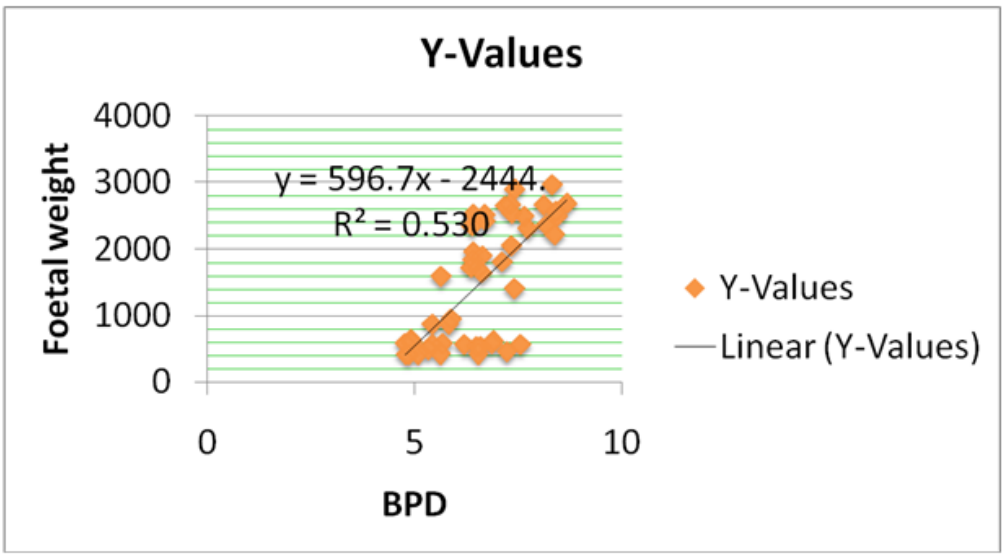

Fig 13: Linear regression between HC and foetal weight

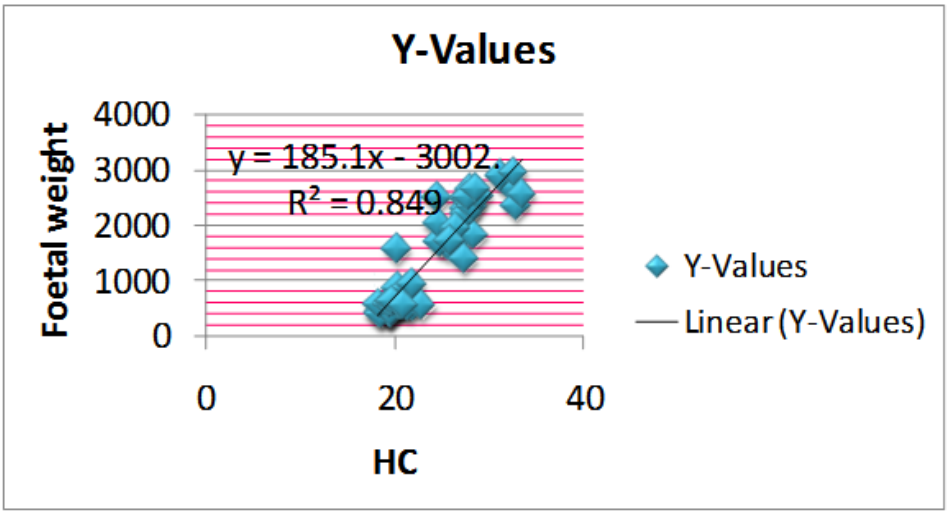

Fig 14: Linear regression between AC and foetal weight

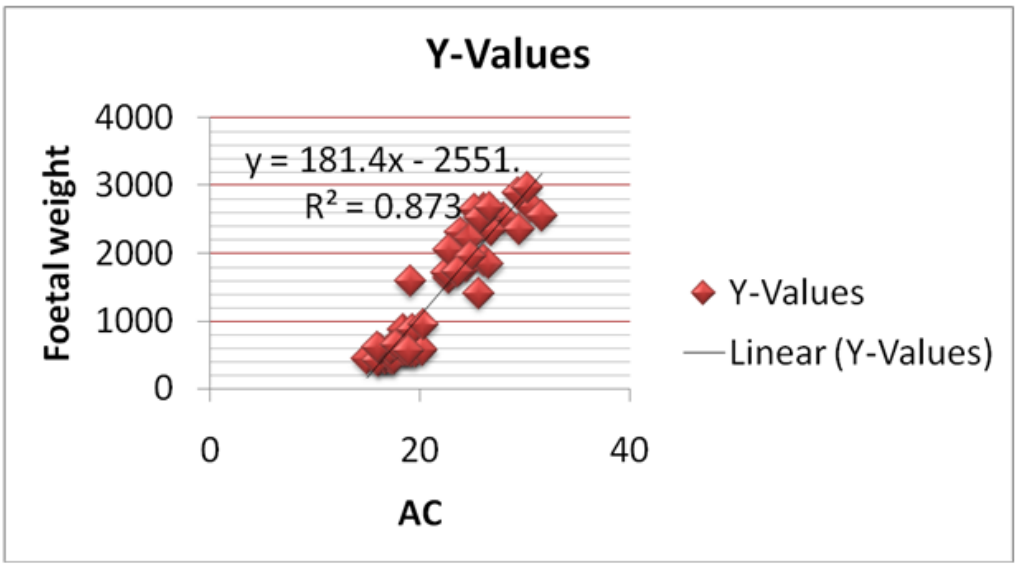

Fig 15: Linear regression between FL and foetal weight

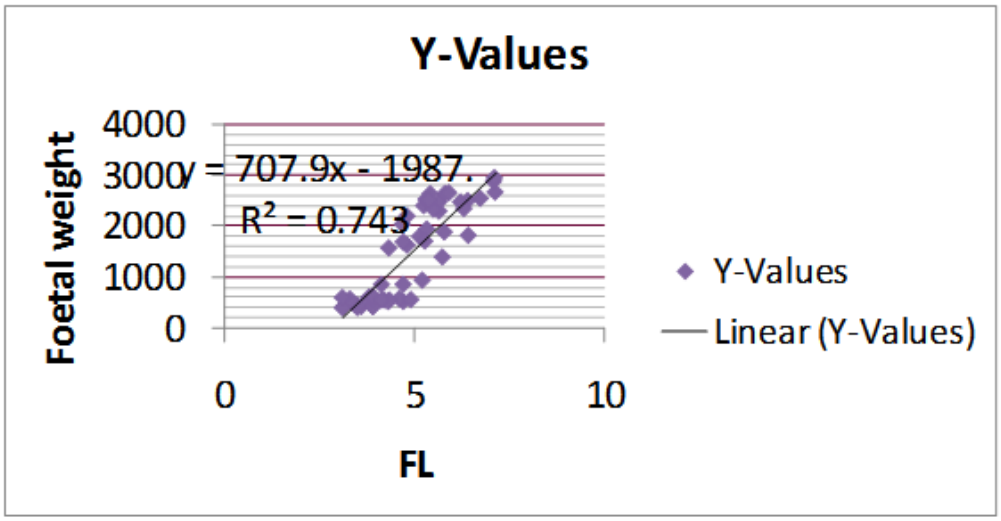

Fig 11 -15 shows the linear regression between the foetal weight and the other foetal parameters used to assess the foetal weight and it is seen from the graphs that there is a perfect linear regression between BPD, HC, AC and FL with foetal weight and similar to these parameters a perfect linear regression exist between foetal weight and the placental thickness.

IV. Discussion:

Determination of GA is important because it provides valuable information regarding the wellbeing or potential problems of the fetus and directly affects the medical treatment plan for the fetus. Placenta has been noted to increase as pregnancy advances in age.[78]

From the present study we found a perfect linear correlation between the gestational age and the placental thickness and also between the placental thicknessand the foetal weight. The linear equation between the gestational age and the placental thickness which we derived in our study was

Placental thickness = 0.109+0.022 x gestational age

and similarly the equation between the foetal weight and placental thickness was

Foetal weight = 1345 + 232 x placental thickness

A study done by P.Mittaletalamong 600 antenatal cases of all gestational ages (more than 10wks of gestation) excluded the patients with PIH, IUGR, DM, HydropsFetalis, congenital malformation and twins. After estimating the fetal age by CRL, BPD, FL, HC, AC, Placental Thickness was measured in each case.[79] Itwas observed that the placental thickness gradually increased from 15mm at 11wks of gestational age to 37.5mm at 39wks.From the 22nd week to 35th week of gestation the placental thickness coincide almost exactly with the gestational age in weeks. Another study done by Anupamajain et al(2001) in which he analyzed 500 normal antenatal cases of more than 10weeks gestation. Mean values of placental thickness was calculated for different gestational ages. It was observed that the mean placental thickness increased from 15mm at 10weeks to 36mm at 39weeks of gestation. Placental thickness matched almost equally from 27weeks to 33weeks of gestation.[80]

Durnwaldetalanalyzed 167 singleton viable pregnancies. Women with suspected abruption, placentaprevia, fibroid, uterine and fetal anomalies, abnormal fluid volume were excluded. Placental thickness was measured at mid point ofplacental mass. Placental thickness was measured at the fundal, anterior, posterior implantation sites. The purpose of the study was to identify differences in sonagraphic placental thickness with advancing gestation and based on implantation site. It was observed that there was step wise increase in placental thickness with increasing gestation (15.8mm, 27.1mm, 37.6mm for 1st, 2nd, 3rd trimester respectively).In the third trimester the placental thickness of posterior andfundal placenta was significantly greater than anterior placenta.[81] Parity and BMI doesn't affect placental thickness. Tongsong T etal(2004) established a nomogram for placental thickness for each week ofgestational age ranged from 9 to 37weeks. By regression analysis, placental thickness (in mm) = gestational age in weeks x 1.4 – 5.6 (r = 0.82).Thisnomogram may be a useful aid in the early detection of placental abnormalities like hydropsfetalis. (Hb Bart's disease).[82]Muhammad Haneefetalstudied 100 cases of gestational age of more than 12weeks.[83] Placental thickness increased from 16mm at 12weeks to 39mm at 40weeks. Ghosh UK etalanalyzed 120 uncomplicated pregnancies of 32 to 40weeks of gestation. Placental diameter and thickness were measured. Placental diameter increased with advancing pregnancy where as placental thickness decreased with increasing gestational age. in75% of cases a single ultrasound measurement of placental thickness can predict gestational age within $\pm$ 14days in the last 8weeks of pregnancy.[84]W.K.Hoddicketalreviewed sonograms of 200single ton pregnancies. Placental thickness was measured and correlated with menstrual age. Placental thickness increased with advancing menstrual age. At no stage of pregnancy was the normal placenta greater than 4cm in thickness.[85]

Grannumetalin the ultrasonographic study of placenta have shown that there is gradual decrease in the thickness of placenta as the placenta matures.[86]Bleker et al have shown that the surface area of the placenta increases linearly.[87]Nyberg and Finberg also reported that as a rule of thumb, placental thickness in mm parallels gestational age in weeks.[88]Habib FA studied placental diameter and thickness byultrasound at 36weeks of gestation in 70 singleton pregnancies a warning limit of placental diameter of 18cms and placental thickness of 2cm at 36weeks of gestation were calculated to predict the low birth weight in infants. Ultra sonagraphic placental thickness appears to be of prognostic value in identifying the subsequent occurrence of IUGR.[89]

Elchalal U etalanalyzed 561 normal single ton pregnancies to establish the correlation of sonographically thick placenta with perinatal mortality and morbidity.[90] Thick placenta was determined as placenta that was above the 90th percentile. A linear increase of placental thickness was found to correlate with gestational age throughout pregnancy. Sonographically thick placenta is associated with increased perinatal risk with increased mortality related to fetal anomalies andhigher rates of both SGA and LGA infants at term. Tongsong T et al evaluated the efficacy of placental thickness at mid pregnancy in predicting fetal Hb Bart's

disease in pregnancy at risk. Placental thickness of more than 13mm was considered abnormal for 18 to 21weeks of gestation. Mean placental thickness for normal pregnancy and pregnancies with Hb Bart's fetuses were significantly different. For couple at risk, if placental thickness is normal thenthe risk of having Hb Bart's fetus is markedly decreased. [82]

GhoshAetalmeasured placental thickness by ultrasound at 10 to 21weeks of gestation in 231pregnancies at risk for homozygous Alpha thalassemia. The sensitivity in detecting the affected pregnancies after 12weeks was 0.95 and by 18weeks it reached 1.Thus the selection of pregnancies at risk by measurement of placental thickness will reduce the number of invasive diagnostic procedures. [91]

The results of the above mentioned studies are almost in par with the present study showing a linear relationship between the gestational age and placental thickness and between the placental thickness and the foetal weight.

There was a fairly steady increase in placental thickness and estimated fetal weight with gestational age. This relationship exists in the second and third trimesters; the period during which most of the fetal weight is gained. A featureof this observed relationship was the wide variations of placental thickness corresponding to particular fetal weight. We think that it could be as a result of uncertainties involved in measuring maximum placental thickness. A slight obliquity of the scanner probe can exaggerate measurements. This makes it unsuitable to be used routinely to predict fetal weight during obstetric ultrasound.

Previous studies have suggested that low-birth weight infants can be predicted from ultrasound measurements of placental diameter and thickness, and that diminished placental size precedes fetal growth restriction.[92,93] The cause of diminished placental size is still being debated but there is a link between small placentas and preeclampsia, chromosomal abnormalities, severe maternal diabetes mellitus, chronic fetal infection and intrauterine growth restriction. There havebeen suggestions that uterine artery doppler in the second trimester may in addition to measurement of placental diameter and thickness help in predicting low-birth weight infants. Several investigators have suggested that diminished fetal growth may be a consequence of hemodynamic compromise.[94,95] In our study, we did not carry out doppler investigation of the umbilical vessels to ascertain the relationship between blood flow and fetal weight estimates. This is obviously a limitation which we suggest further studies should include. This will show how blood flow disturbances relate to placental size and fetal weight.

V. Conclusion

The result of this study shows a strong positive correlation between gestational age and placental thickness and also between placental thickness and estimated fetal weight. Thus, placental thickness can be used as a fairly accurate indicator for estimating the gestational age and of normality of fetal weight, but because of wide variations in placental thickness corresponding to particular fetal weight a more thorough search should be undertaken when a fetus is considered to be at risk. Also in our study the thickness of placenta did not show any variation with the location of placenta. Abnormal placental thickness in the early stages helps to detect IUGR, hydropsfoetalis and diabetes mellitus. Hence placental thickness is considered as a useful index in determining the gestational age as well as in estimating the foetalweight.

References

[1]. Ohagwu CC, Abu PO, Ezeokeke UO, Ugwu AC. Relationship between placental thickness and growth parameters in normal Nigerian foetuses. Afr J Biotechnol2009; 8(2):133-38.

[2]. Kliman HJ: Trophoblast to human placenta. Encyclopedia of Reproduction, vol 4. Edited by Knobil E, Neill JD. San Diego, Academic Press, 1999: 834-46

[3]. Kliman HJ. The placenta revealed. Am J Pathol.1993; 143(2): 332–36.

[4]. Ohagwu CC, Oshiotse Abu P, EffiongUdoh B. Placental thickness: a sonographic indicator of gestational age in normal singleton pregnancies in Nigerian women. Internet Journal of Medical Update. 2009;4(2):9–14.

[5]. Wolf H, Oosting H, Treffers PE. A longitudinal study of the relationship between placental and fetal growth as measured by ultrasonography. Am J Obstet Gynecol. 1989;161(5):1140-45

[6]. Sadler T. Third month to birth. The fetus and placenta Lang man's Medical Embryology, 9th ed.: Lippincott Williams & Wilkins; 9th Bk&Cdr edition (March 26, 2003); 2003.

[7]. Habib FA. Prediction of low birth weight infants from ultrasound measurement of placental diameter and thickness. Ann Saudi Med. 2002; 22(5-6):312-14.

[8]. Grannum PA, Berkowitz RL &Hobbins JC. The ultrasonic changes in the maturing placenta and their relation to fetal pulmonary maturity. Am J Obstet Gynecol. 1979; 133(8):915-22.

[9]. Rodgers J. L. and Nicewander W. A. Thirteen ways to look at the correlation coefficient. The American Statistician 1988;42(1): 59–66.

[10]. Paula CF, Ruano R, Campos JA, Zugaib M. Placental volumes measured by 3-dimensional ultrasonography in normal pregnancies from 12 to 40 weeks' gestation. J Ultrasound Med. 2008;27:1583-90.

[11]. Maldonado AL, Araujo JE, Mendonça DS, Nardozza LM, Moron AF, Ajzen SA. Ultrasound determination of gestational age using placental thickness in female dogs: an experimental study. Vet Med Int. 2012;2012:850-67.

[12]. Karthikeyan T, Subramaniam RK, Johnon W. Placental thickness and its correlation to gestational age and fetal growth parameter---crossectionalultasonographic study .J ClinDiagn Res. 2012;6:1732-36

[13]. Imtiaz J, Shahida Z, Sameera R, Naushaba M, Elizabeth M, Breda M, Omrana P, Linda L, Robert L. Dating gestational age by last menstrual period, symphysis fundal height and ultrasound in urban Parkistan. Int J Gynaecol Obstet. 2010;110(3):231–234.
[14]. Rudy ES. Diagnostic Ultrasound Applied to Obstetrics and Gynaecology. 2nd ed. New York: Wiley Publishers; 2000. pp. 91–111.
[15]. Robinson HP. Sonar measurements of fetal crown rump length as a means of assessing maturity in first trimester of pregnancy. Br Med J. 1973;4:28–31
[16]. Davis RO, Cutter GR, Goldenberg RL, Hoffman HJ, Cliver SP, Brumfield CG. Fetal biparietal diameter, head circumference, abdominal circumference and femur length. A comparison by race and sex. J Reprod Med. 1993;38:201–6.
[17]. L'ubuský M, Mícková I, Procházka M, Dzvincuk P, Malá K, Cízek L, et al. Discrepancy of ultrasound biometric parameters of the head (HC – head circumference, BPD – Biparietal diameter) and femur length in relation to sex of the fetus and duration of pregnancy. CeskaGynekol. 2006;71:169–72.
[18]. Gianluigi P, Kypros N, Renato X, Philippe J. Handbook of Fetal Abnormalities. New York: PentoXimanes Publishers, ISU Educational Committee Centrus; 2002. Diagnosis of fetal abnormalities, the 18-23 weeks scan; p. 56.
[19]. Hobbs K, Kennedy A, Dubray M, Bigler ED, Petersen PB, McMahon W, et al. A retrospective fetal ultrasound study of brain size in autism. Biol Psychiatry. 2007;62:1048–55.
[20]. Karki DB, Sharmqa UK, Rauniyar RK. Study of accuracy of commonly used fetal parameters for estimation of gestational age. JNMA J Nepal Med Assoc. 2006;45:233–7.
[21]. Mital P, Hooja N, Mehndiratta K. Placental thickness: A sonographic parameter for estimating gestational age of the fetus. Indian J Radiol Imaging. 2002;12:553–4.
[22]. Hanretty KP. Obstetrics Illustrated. 6th ed. Endiburgh: Churchill Livingstone; 2003. pp. 9–12.
[23]. Sepulveda, W., Rojas, I., Robert, J. A., Schnapp, C. and Alcalde, J. L. (2003) Prenatal detection of velamentous insertion of the umbilical cord: a prospective color Doppler ultrasound study. Ultrasound in Obstetrics and Gynecology, 21:564-569.
[24]. Wang, Y., Lewis, D. F., Gu, Y., Zhang, Y., Alexander, J. S. and Granger, D. N. (2004) Placental Trophoblast-Derived Factors Diminish Endothelial Barrier Function. Journal of Clinical Endocrinology and Metabolism, 89: 2421-2428.
[25]. Machin, G. A., Ackerman, J. and Gilbert-Barness, E. (2000) Abnormal umbilical cord coiling is associated with adverse perinatal outcomes. Pediatric and Developmental Pathology, 3: 465-
[26]. Valsamakis, G., Kanaka-Gantenbein, C., Malamitsi-Puchner, A. and Mastorakos, G. (2006) Causes of intrauterine growth restriction and postnatal development of the metabolic syndrome. Annals of the New York Academy of Sciences, 1092: 138-147.
[27]. Van den Broek, N., Ntonya, C., Kayira, E., White, S. and Neilson, J. P. (2005) Preterm birth in rural Malawi: high incidence in ultrasound-dated population. Human Reproduction, 20: 3235-3237.
[28]. Paria, B. C., Lim, H., Das, S. K., Reese, J. and Dey, S. K. (2000) Molecular Signaling in Uterine Receptivity for Implantation. Cell & Developmental Biology, 11:67-76.
[29]. Rana, J., Ebert, G. A. and Kappy, K. A (1995) Adverse perinatal outcome in patients with an abnormal umbilical coiling index. Obstetrics and Gynecology, 85:573-577
[30]. Quin, Y., Lau, T. K., and Rogers, M. S. (2002) Second-trimester ultrasonographic assessment of the umbilical coiling index. Ultrasound in Obstetrics and Gynecology, 20:458-463.
[31]. Roh, C. R., Budhraja, V., Kim, H. S., Nelson, D. M. and Sadovsky, Y. (2005) Microarray-based identification of differently expressed genes in hypoxic human term trophoblast and in placental villi of pregnancies with growth restricted foetuses. Placenta 26:319-328
[32]. Genbacex O., McMaster M. T., Lazic J., Nedeljkovic S., Cvetkovic M. and Fisher S. J. (2000) Concordant in situ and in vitro data show that maternal cigarette smoking negatively regulates placental cytotrophoblast passage through the cell cycle. Reproductive Toxicology, 14: 495-506.
[33]. Lanari M., Lazzarotto T., Papa I., Venturi V. and Bronzetti G. (2001) Neonatal aortic arch thrombosis as a result of congenital cytomegalovirus infection. Pediatrics, 108:E114.
[34]. Petraglia F. (1996) Endocrine role of the placenta and related membranes. European Journal Endocrinology, 135: 166-167.
[35]. Gudmundsson S., Korszun P., Olofsson P. and Dubiel M. (2003) New score indicating placental vascular resistance. Acta Obstetrics et Gynecology Scandinavica, 82(9):807-12.
[36]. Reagan, P. B. and Salsberry, P. J. (2005) Race and ethnic differences in determinants of preterm birth in the USA: broadening the social context. Social Sience and Medicine, 60:2217-2228.
[37]. Yetter, J. F. (1998) Examination of the Placenta, American Academy of Family Physicians, 57(5):1045-1054.
[38]. Salafia, C. and Vintziloes, A. M. (1999) Why all placentae should be examined by a pathologist. American Journal of Obstetrics and Gynaecology, 163 (4pt 1):1282-1293.
[39]. Kaplan, C.G. (1995) Forensic aspect of the placenta. Prospect of Pediatric Pathology, 19:20-42.
[40]. Borton, C. (2006) Placenta and Placental problems. Patient Plus, 20:159.
[41]. Leibschang J., Marcickiewicz J., Chazan B. and Troszyński M. (1983) Clinical value of the foeto-placental ratio. ProblemyMedycymyWiekuRozwojowego, 12:174-180.
[42]. Tabibzadeh, S. and Babaknia, A. (1995). The signals and molecular pathways Involved in implantation, a symbiotic interaction between blastocyst and endometrium involving adhesion and tissue invasion. Human Reproduction, 10 (6): 1579-1602.
[43]. Aplin, J. D. (1991) Implantation, Trophoblast Differentiation and Haemochorial Placentation - Mechanistic Evidence in vivo and in vitro. Journal of Cell Science, 99 (Pt4): 681-692.
[44]. Vicovac, L., Jones, C. J. and Aplin, J. D. (1995) Trophoblast differentiation during formation of anchoring villi in a model of the early human placenta In Vitro Placenta, 16 (1): 41-56.
[45]. Loke, Y. W. (1990) Experimenting With Human ExtravillousTrophoblast - a Personal View. American Journal of Reproductive Immunology, 24 (1): 22-28.
[46]. Hanley, M. L., Anath, C. V., Shen-Schwrz, S., Smulian, J. C., Yuling, L. and Veintzileos, A. M. (2002) Placental cord insertion and birth weight discordancy in twin gestation. Obstetrics and Gynecology, 99:477-482.
[47]. Borton, C. (2006) Placenta and Placental problems. Patient Plus, 20:159.
[48]. Gupta, S., Faridi, M. M. A. and Krishnan, J. (2006) Umbilical Coiling Index. Journal of Gynecology, India, 56 (4): 315-319.
[49]. Hadlock, F. B., Deter, R. and Harris, R. B. (1983) Computer assisted analysis of foetal age in the third trimester using multiple foetal growth parameters. Journal of Clinical Ultrasound, 11:313-320.
[50]. Crawford JM. Vascular anatomy ofthe human placenta. Am J ObstetGynecol 1962; 84: 1543.
[51]. Fadl S, Moshiri M, Fligner CL, Katz DS, Dighe M. Placental Imaging: Normal Appearance with Review of Pathologic Findings. Radiographics : a review publication of the Radiological Society of North America, Inc. 37 (3): 979-998.
[52]. Grannum P.A.T, Berkowitz R.L, Hobbins J.C. The ultrasonic changes in the maturing placenta and their relation to fetal pulmonic maturity. Am J ObstetGynecol 1979; 133(4): 915-922.

[53]. Petrusha RA, Golde SH, Platt LD. Real time ultrasound of the placenta in assessment of fetal putaionic maturity. Am J ObstetGynecol 1982a; 142: 463.
[54]. Petrusha RA, Platt LD. Relationship of placental grade to gestational age. Am J ObstetGynecol 1982c; 144: 733.
[55]. Kazzi GM, Gross TL, Rosen MG, Jaatoul-Kazzi NY. The ralationship of placental grade, fetal lung maturity, and neonatal outcome in normal and complicated pregnancies. Am J ObstetGynecol 1984; 148: 54.
[56]. Cavanaugh, D., and Talisman, M. R. Prematurity and the obstetrician, New York, 1969. Applton-Century-Crofts, pp. 1- 3.
[57]. Gluck L., Kulovich M V., and Borer R D. Diagnosis of the respiratory distress syndrome by amniocentesis. Am J ObstetGynecol 1971; 109: 440.
[58]. Sabbagha R, and Salvino C. Report on third trimester amniocentesis at Prentice Women's Hospital of Northwestern University Medical School, Chicago, Illinois, in Antenatal Diagnosis: Report of a Consensus Development Conference, Bethesda, Maryland, March 5-7,1979, National bistitutesofHealth, pp. 11-61.
[59]. Quinlan RW, Cruz AM, Buhi WC, Martin M. Changes in placental ultrasonic appearance. 1. Licidence of grade III changes in the placenta in correlation to fetal pulmonary maturity. Am J ObstetGynecol 1982; 144: 468-470.
[60]. Spirt RA, Gordon LP. The placenta as an indicator of fetal maturity: fact and fancy. Seminars in Ultrasound. 1984; 5: 290-297.
[61]. Harman CR, Manning FA, Steams E, et al. The correlation of ultrasonic placental grading and fetal pulmonary maturation in five hundred sixty-three pregnancies. Am J ObstetGynecol, l982; 143: 941-943.
[62]. Hollander HJ & Mast H. totrauterineDickenmessungen der PlazentmittelsUltraschallsbeinormalenSchwangerschaften und beinormalenSchwangerschaften und beiRhtokompatibilitat. Geburtsh. Frauenheilk. 1968; 28: 662-673.
[63]. Tabsh KMA. Correlation of real time ultrasonic placental grading with amniotic fluid lecithmy^sphingomyelin ratio. Am J ObstetGynecol 1983; 145: 504.
[64]. Hoddick WK, Mahony BS, Callen PW, Filly RA. Placental thickness. J Ultrasound Med 1985; 4: 479-482.
[65]. MuIler, L.M.M. A comparative study of the ultrasonographic and morphologic appearance of the normal and abnormal human placenta.Dissertation for Ph.D. degree, Faculty of Medicine, University of Stellenbosch, South Africa, 1986.
[66]. Ko TS, Tseng LH, Hsu PM, Hwa HL, Lee TY and Chuang SM. Ultrasonographic scanning of placental thickness and the prenatal diagnosis of homozygous alpha-thalassaemia 1 in the second trimester. Prenatal diagnosis 1995; 15: 7-10.
[67]. Ghosh A, Tang MH, Lam YH et al."Ultrasound measurement of theplacental thickness to detect pregnancies affected by homozygousalpha thalassemia-1." Lancet. 1994; 344: 988-989
[68]. Ichiro miwa,Masakatsusase,MayumiTorii,HiromiSanai,Yasuhiko Nakamura and Kazuyuki Ueda "A Thick placenta:a predictor of adverse pregnancy outcomes''
[69]. Betlye Wilson (2008). Sonogragraphy of the placenta and umbilical cord. Radiologic Technologist; 79(4).
[70]. Kariki D B, Sharmqa U K, Rauniyar R K. (2006). Study of the accuracy of commonly used fetal parameters of estimating GA. Journal of the Nepal Medical association; 45(162): 233 237.
[71]. TheeraTongsong ,PongrakBoonyanurak. "Placental thickness in the first half of pregnancy." J Clin Ultrasound. 2004; 32: 5: 231-234.
[72]. Molteni RA, Stys SJ, Battaglia FC. Relationship of fetal and placental weight in human beings: fetal/placental weight ratios at various gestational ages and birth weight distributions. J Reprod Med. 1978;21:327–34.
[73]. Robertson CM, Svenson LW, Kyle JM. Birth weight by gestational age for Alberta liveborn infants, 1985 through 1998. J ObstetGynaecol Can. 2002;24:138–48.
[74]. Fox GE, Van Wesep R, Resau JH, Sun CJ. The effect of immersion formaldehyde fixation on human placental weight. Arch Pathol Lab Med. 1991;115:726–8.
[75]. Eriksson J, Forsen T, Tuomilehto J, Osmond C, Barker D. Foetal and childhood growth and hypertension in adult life. Hypertension. 2000;36:790–4.
[76]. Leary SD, Godfrey KM, Greenaway LJ, Davill VA, Fall CH. Contribution of the umbilical cord and membranes to untrimmed placental weight. Placenta. 2003;24:276–8.
[77]. Benirschke K. Examination of the placenta, prepared for the collaborative study on cerebral palsy, mental retardation, and other neurological and sensory disorders of infancy and childhood. Bethesda, MD: National Institute of Neurological Diseases and Blindness, US Department of Health, Education, and Welfare; 1961.
[78]. Imtiaz J, Shahida Z, Sameera R, Naushaba M, Elizabeth M, Breda M, Omrana P, Linda L, Robert L. Dating gestational age by last menstrual period, symphysis fundal height and ultrasound in urban Parkistan. Int J Gynaecol Obstet. 2010;110(3):231–234.
[79]. P.Mittal.Hooja,K, K Mahndiratta: Placental Thickness – A Sonographic Parameter for Gestatational age Estimation. Indian J Radiolimag 2002, 12:4:553 -554.
[80]. AnupamaJain,GaneshKumar,Agarwal et al:Placental Thickness – A Sonographic indicator of Gestational age,J of Obs&Gyn of India,vol51,no 3,48 -49,2001.
[81]. Durnwald C, Mercer B; Ultrasonic estimation of placental thickness with advancing gestational age. Am J of Obs&Gyn, vol.191, Issue6, P S178, Dec 2004.
[82]. Tongsong T, Boonyanuark P: Placental thickness in 1st half of Pregnancy.JClinUltrasound.Jun 2004; 32(5):231-4.
[83]. Muhammad HanifKatri: GA estimation by Placental thickness.J of Surg Pakistan, Mar2005; 10(1); 5-7.
[84]. U.K.Ghosh, Iliyas, Sharma; Gestational age determination by ultrasonic placental measurement.J of Obs&Gyn of India, vol 40, no.3, P347-48, June 1990.
[85]. HoddickWK,MahoneyBS,CallenPw,J of Ultrasound medicine,4:479;1985.
[86]. Grannum PAT, Hobbins JC, Radiol Clinical North America; 20:353, 1982.
[87]. Bleker OP, Kloosterman, Am J of Obs Gyn.127:655, 1977.
[88]. Nyberg DA, Finberg Hj: The Placenta and Umblical cord. In Newburg DA, Mahony BS, Pretorius DH, eds Diagnostic of Ultrasound of Fetal Anomalies St.Louis: Mosby year book 1990:623-675.
[89]. HabibFA.Prediction of LBW infants from Placental Diameter and Thickness. Ann Saudi Med.2002 Sep –Nov; 22(5-6):312-4.
[90]. Elchalal U, Levi Y: Sonographically thick Placenta a marker for perinatal risk.Placenta, 2000 Vol 21, P268-72.
[91]. Ghosh A, Tang MH, Lam et al: Ultrasonic Placental Thickness to detect Pregnancies affected by Alpha Thalassemia.Lancet, 1994 Oct 8; 344:988-9.
[92]. Habib FA. Prediction of low birth weight infants from ultrasound measurement of placental diameter and placental thickness. Ann Saudi Med. 2002; 22(5- 6):312-14.
[93]. Wolf H, Oosting H, Treffers PE. A longitudinal study of the relationship between placental fetal growth measured by ultrasonography. Am J Obstet Gynecol. 1989;161:1140-5.
[94]. Chauhan SP, Lutton PM, Bailey KJ, Guerrieri JP, Morrison JC. Intrapartum clinical, Sonographic, and parous patients' estimates of newborn birth weight. Obstet Gynecol. 1992;79:956-58.

[95]. Baum JD,Gssman D, Stone P. Clinical and patient estimation of fetal weight vs. ultrasound estimation. J Reprod Med. 2002;47:194-98

Dr. R.Rajesh Gowtham. "Evaluation of fetal weight with respect to placental thickness and gestational age using ultrasonography." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 18, no. 2, 2019, pp 12-24.