Original Article

DOI: 10.7860/IJARS/2017/25487:2244

Radiology Section

Ultrasonographic Measurement of Placental Thickness and its Correlation with Femur Length

SURESH K K, AJEY R BHAGWAT

ABSTRACT

Introduction: Placenta is a materno-foetal organ which is a reflection of health and size of the foetus. Placental Thickness (PT)) can be used as a new parameter to estimate the gestational age of the foetus.

Aim: To study the placental thickness (mm) at the level of umbilical cord insertion and its correlation with femur length (wks) in normal pregnancy from 12 to 24 weeks of gestation.

Materials and Methods: This was a cross-sectional study consisting of 100 normal antenatal women who were referred to the Department of Radio Diagnosis between the period of 2014–2016. All the subjects were enrolled with detailed oral and written consents. Normal singleton pregnancies of gestational ages from 12 to 24 wks were included in the study. Placental thickness was calculated by averaging the three best measurements for each case at the level of umbilical cord insertion. Pearson's correlation coefficient and regression equation were applied with value of $p < 0.05$ was considered statistically significant.

Results: Total 100 normal singleton pregnancies from 12 to 24 weeks of gestation, age ranged between 18 years to 37 years. Anterior placenta was noted to be the most common location. Lateral location of the placenta was found to be more accurate in measuring the placental thickness, however anterior, posterior and fundal locations also showed significant correlation. PT taken at individual weeks of gestation almost matched with GA and FL with few negative correlation in some weeks in which PT was less than 1 mm with respect to gestation in weeks. There was statistically strong positive correlation between PT with FL was found ($r=0.982$, $p<0.001$).

Conclusion: It was observed that PT (in mm) correlated well with FL (in weeks) from 12 to 24 wks of gestation. Also the thickness of the placenta and growth pattern did not vary relative to the placental locations.

Keywords: Gestational age, Normal singleton pregnancies, Placental locations, Placental growth

INTRODUCTION

A normal pregnancy is a retrospective term in good condition at term between 38 and 42 weeks. The criteria of a normal pregnancy is the delivery of a single baby, with foetal weight of 2.5 kg or more and with no maternal complication [1].

While interpreting biochemical test results like, evaluation of foetal growth, risk assessment of various foetal anomalies, expanded maternal serum biomarkers, gestational age plays very important role, which in turn help the to obstetrician to take appropriate measures that would optimise outcome of foetal [2].

There are significant antenatal implications of using ultrasonography. It provides a safe and non-invasive means for the evaluation of the placenta whose normal and abnormal size, appearance and growth pattern can be delineated.

The placenta is a foetal organ which provides the physiologic link between a pregnant woman and the foetus with important metabolic, endocrine and immunologic functions besides being responsible for nutrition, respiration and excretion for the foetus, acting as a barrier; it has a role in protecting the foetus from noxious agents [3]. Placental size is a reflection of health and size of the foetus.

The placenta develops from the chorionic villi at the implantation site at about the fifth week of gestation and by the ninth or tenth week, it is clearly apparent at sonography as diffuse granular echo texture. It reaches its maximum growth at term [4,5].

Technically, it would define as the apposition or fusion of foetal organs to maternal tissue for the purpose of physiologic exchange. It is typically 2-4 cm thick and weighs around 600 grams [6]. With the new advances in grey scale and Doppler sonography, we are able to study the placental sonographic appearance and its relationship to uteroplacental blood flow measurement and intrauterine growth.

Ultrasonography (USG) facilitates the assessment of the placenta and the finding of placental abnormalities using different parameters such as placental thickness and special techniques such as 3D power Doppler [7-11].

To forecast the adverse pregnancy outcome, in recent studies, they given more emphasis on 3D measurement technique of placenta. Though, this technique is comparatively new, which desires complex clinical setting and gives conflicting results regarding its reliability in measuring placenta [12].

More than two decades, ultrasound had been used to measure the placental thickness because of its clinical useful way, relatively very simple to use and reliable [7,8,10].

Ultrasonography (USG) is commonly used to estimate the gestational age by measuring the foetal dimensions like the Biparietal Diameter (BPD), the Abdominal Circumference (AC), the Head Circumference (HC) and the Femur Length (FL).

As ultrasonograph is purely dependent on the observer's technical skills, it may be prone to observer bias. And also, there were different measurement techniques and problem of position, it may reduce the accuracy of the estimation of gestational age [13].

As increase in placental thickness with gestational age, it seems to be a potential parameter for assessment of gestational age of the foetus.

To find out normal development and functional placenta, placental thickness justify as a good forecaster for foetal growth and birth weight especially in second trimester.

Diseases and abnormalities affecting foetus; can be indicated by an abnormal size of the placenta during the second trimester.

Studies have reported the use of placental thickness as an indicator of gestational age [14-15]. Placental thickness measured at the level of the umbilical cord insertion can be used as a new parameter to estimate gestational age of the foetus. Hence, the present study was undertaken to evaluate the relationship between placental thickness and femur length of the foetus.

MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Radiology, Shri BM Patil Medical College Hospital and Research Center, Bijapur, India. A total of 100 normal singleton pregnancies from 12 to 24 weeks of gestation and fulfills inclusive and exclusive criteria, who gave their written informed consent were selected randomly and were taken as subjects for present study during 2014 to 2016. Institutional ethical clearance was obtained prior to beginning of study. Patients with maternal disease, gestational diabetes, hypertension, anemia, foetal anomalies, twin pregnancy, placenta previa, posterior placenta, placental anomalies and poor visualisation of the placenta, Last Menstrual Period (LMP) not known or irregular and intrauterine growth restriction were excluded from the study.

The grey scale real time ultrasonographic examinations were performed using PHILIPS HD 11 XE and SEIMENS ACCUSON X 700. Detailed history, consent, general physical and obstetrical examinations were done by the USG.

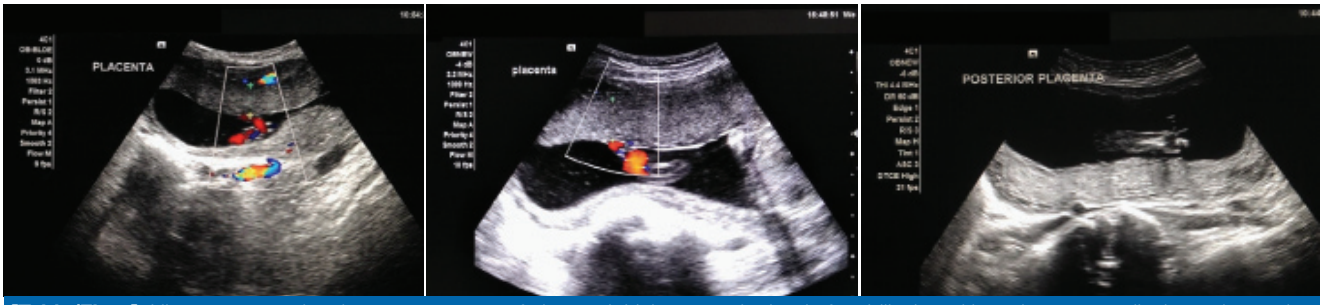
Scanning Technique [16]

Patient was made to lie in the supine position. Foetus will be examined for viability, foetal congenital abnormalities and various growth parameters. To rule out oligohydramnios and polyhydramnios, amniotic fluid volume is measured by taking Amniotic Fluid Index (AFI). Adnexa were looked for the presence of any mass. The foetuses were observed for gestational age estimation using FL in the second trimester. From various combinations of measurements, based on Hadlock tables and using regression equations, the composite average of the gestational age was estimated for each foetus by taking various growth parameters by the ultrasound machine [6]. Foetal parameters were taken to rule out intrauterine growth restriction. Foetal weight was calculated using the Shepard formula [17]. The placenta was identified as a hyper-echoic area separated from foetus by a hypo echoic area of amniotic fluid. At the level of cord insertion, straight line was drawn up to the maternal surface of the placenta and thus thickness will be measured the maximum thickness was noted in the cross section. Umbilical artery color Doppler was used for further reconfirmation of the site of insertion. Each placenta was measured to a 1 mm precision, at its greatest thickness, which was perpendicular to the uterine wall. The uterine myometrium and the retroplacental veins were excluded [Table/Fig-1]. Placental grading according to Granuum's scale was done [18].

Placental Position

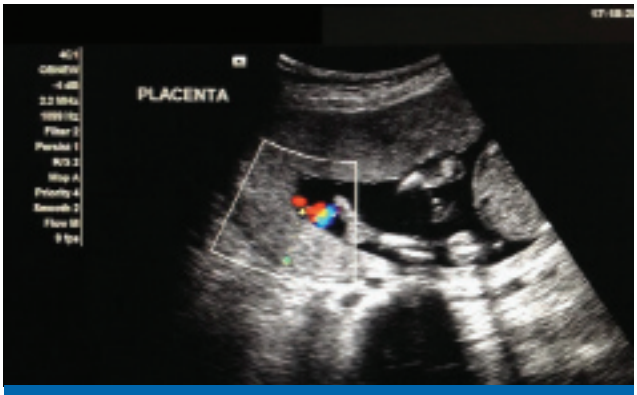
Normal placental insertion covers most of one endometrial surface and usually extends from one endometrial surface to another minimally. Different placental positions are as follows:-

1. **Anterior Placenta:** Placenta located anteriorly and extending into lateral walls or fundus minimally [Table/Fig-2].
2. **Posterior Placenta:** Placenta located posteriorly and extending into lateral walls or fundus minimally [Table/Fig-3].
3. **Fundal Placenta:** Placenta located predominantly in the fundus and extending into anterior or posterior walls minimally [Table/Fig-4]



[Table/Fig-1]: Ultrasonogram showing measurement of placental thickness at the level of umbilical cord insertion, perpendicular to the uterine wall excluding the uterine myometrium and retroplacental veins. **[Table/Fig-2]:** Ultrasonogram showing anterior location of placenta. **[Table/Fig-3]:** Ultrasonogram showing posterior location of placenta. (Images from left to right)

4. **Lateral Placenta:** Placenta located laterally and extending equally into anterior and posterior walls [Table/Fig-5].



[Table/Fig-4]: Ultrasonogram showing fundal location of placenta.

[Table/Fig-5]: Ultrasonogram showing lateral location of placenta.

STATISTICAL ANALYSIS

Descriptive statistics such as mean, SD and percentage was used.Bivariate correlation analysis using Pearson's correlation coefficient (r) was used to test the strength and direction of relationships between the interval levels of variables. If the p-value is > 0.05, then the results will be considered to be not significant. Data were analysed using SPSS software version 20.0 and Microsoft Excel.

RESULTS

Among the study group of 100 normal antenatal women, majority 57(57%) were in the age group of 21 – 25 years, followed by less than 21-23 years (23%), 26-30 years -18 (18%) and the subjects aged more than 30 were minimum in number i.e., 2(2%). The mean age was 23.41 and SD 3.33.

Among the study group of 100 normal antenatal women,most of the women in the 20 weeks of gestation i.e., 14 (14%) women, 10(10%) were in 15 weeks, 9 (9%) were in 13,14,17,21,23 weeks, 7 (7%) were in 22 weeks, 5 (5%) were in 19 and 24 weeks, 4 (4%) were in 12 and 16 weeks. The mean gestational age was 18.38 and SD 3.58.

Among the study group of 100 normal antenatal women, anterior placenta was noted in 39 cases (39%), posterior in 35 cases (35%), fundal in 24 cases (24%) and lateral in two cases (2%).

It was observed that, posterior location (60.9%) of the placenta is most common in <20 years age group, followed by fundal (50%) and lateral (50%) in > 30 years age group, and anterior (45.6%) in 21 – 25 years age groups [Table/Fig-6].

Pearson's correlation analysis revealed that, there was a significant strong positive correlation between femur length and placental thickness by location of placenta in the second trimesters [Table/Fig-7].

Pearson's correlation analysis revealed that, there was a significant positive correlation between placental thickness

Age (years)	Placental Position							
	Anterior		Posterior		Fundal		Lateral	
	N	%	N	%	N	%	N	%
<20	6	26.1%	14	60.9%	3	13.0%	0	0.0%
21-25	26	45.6%	17	29.8%	13	22.8%	1	1.8%
26-30	7	38.9%	4	22.2%	7	38.9%	0	0.0%
>30	0	0.0%	0	0.0%	1	50%	1	50%
Total	39	39.0%	35	35.0%	24	24.0%	2	2.0%

[Table/Fig-6]: Placental location in different age groups.

and femur length in the second trimesters (r=0.982, p<0.0001) [Table/Fig-8].

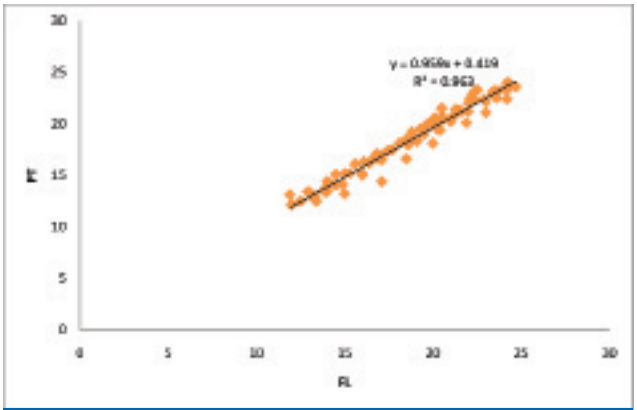
Regression analysis yielded the following linear equations of relationship between femur length and placental thickness (PT) in mm. The good of fit was 96.3% which indicates that the model fits the data extremely well [Table/Fig-9].

Placental Location	Femur Length		Placental Thickness		Coefficient of Correlation (r)	p-value
	Mean	SD	Mean	SD		
Anterior	18.45	3.37	18.66	3.45	0.984	<0.0001*
Posterior	18.95	3.53	19.43	3.48	0.970	<0.0001*
Fundal	17.24	4.06	17.60	4.28	0.990	<0.0001*
Lateral	13.90	0.42	14.05	0.21	1.00	<0.0001*

[Table/Fig-7]: Correlation of femur length and placental thickness by placental location.
Note: *Significant at 5% level of significance

Parameters	Mean	SD	Coefficient of Correlation (r)	p-value
Femur Length	18.24	3.64	0.982	<0.0001*
Placental Thickness	18.58	3.73		

[Table/Fig-8]: Correlation of parameter femur length with placental thickness.



[Table/Fig-9]: Regression analysis of relationship between femur length and placental thickness (PT) in mm.

The regression equation is:-

Y = 0.959 * PT + 0.419

Pearson's correlation shows that, there was statistically positive correlation of femur length with placental thickness in 12th week of gestation only [Table/Fig-10].

DISCUSSION

In our study, placenta was first identifiable at 8 – 9 menstrual weeks as a focal thickening of the chorio-decidual reaction. Interface of the placental – myometrial can be identified correctly, which should also preclude the illusion of placental thickening induced by focal myometrial thickening.

Gestational Age (weeks)	Femur Length		Placental Thickness		Coefficient of Correlation (r)	p-value
	Mean	SD	Mean	SD		
12	12.25	0.17	12.12	0.25	0.96	0.04*
13	13.17	0.31	13.38	0.85	0.13	0.73
14	13.97	0.30	14.21	0.35	0.351	0.35
15	15.09	0.65	15.64	0.97	-0.163	0.65
16	16.32	0.09	16.38	0.19	0.414	0.59
17	16.96	0.39	17.50	0.63	-0.181	0.64
18	18.27	0.24	18.72	0.39	0.733	0.098
19	18.86	0.56	19.22	0.59	-0.293	0.63
20	20.28	0.44	20.58	0.58	0.301	0.296
21	21.12	0.57	21.38	0.94	0.53	0.142
22	22.53	0.38	22.63	0.47	0.22	0.64
23	23.12	0.47	23.68	0.55	0.06	0.88
24	23.76	0.22	24.32	0.22	-0.295	0.63

[Table/Fig-10]: Correlation of femur length and placental thickness by gestational age (in wks).
Note: *Significant at 5% level of significance

Measurement of the placental thickness at any point, except near its edge yields the same results because of the placenta is passive structure lacking the capacity to expand focally, whereas, placental thickness appear focally increased over uterine contractions. The myometrium and sub-placental veins were excluded in the study [6].

Anterior location: In our study the majority of the placenta was anterior in location. Anterior located placenta was reliable in measurement as the placental – myometrial surface was clearly delinated. If the length of the placental insertion is long then the placenta is usually extended from one endometrial surface to another (antero-fundal, antero-lateral) while the short placental thickness were limited to one endometrial surface (anterior) [6].

Anterior placenta showed significant correlation with the placental thickness from 12 – 24 weeks of gestation with the p-value of <0.0001.

Posterior location: In our study next common location of the placenta was posterior. Care was taken at the time of the measurement to reduce the reverberation artefact from the foetal spine, changing the foetal position and taking the measurements, proper technique of visualisation was done [6].

Posterior placenta also showed significant correlation with the placental thickness from 12 – 24 weeks of gestation with the p-value of <0.0001.

Fundal location: Fundal placenta also showed significant correlation with the placental thickness from 12 – 24 weeks of gestation with the p-value of <0.0001.

Lateral location: We found that lateral location of the placenta was more accurate in determining the placental thickness

compared to other location and had a strong correlation of PT with GA and FL. Lateral placenta also showed significant correlation with the placental thickness from 12 – 24 weeks of gestation with the p-value of <0.0001.

In our observational study placental location did not show any significant variation in the placental thickness (PT). Similar observations also found in other study [6,19].

Placental Location

In the present study, it was found that majority of the placenta were anterior in location (39%) followed by posterior (35%), fundal (24%) and lateral (2%) locations. however thickness of the placenta did not vary relative to the placental location. Similar findings were observed in other study also, whereas in some study shows that, majority of placenta was posterior [6, 19-20].

Placental Location in Different Age Groups

In our study we observed that, posterior location (60.9%) of the placenta is most common in <20 years age group, followed by fundal (50%) and lateral (50%) in > 30 years age group, and anterior (45.6%) in 21 – 25 years age groups.

In our study, it was observed significant positive correlation between placental thickness and femur length in the second trimesters; with all parameters having identical relationships with placental thickness. Similar results were correlating with other study also. In the study conducted by Ridhi Adhikari et al., observed that, significant positive correlation between placental thickness and FL, BPD and AC in the second and third trimesters [21]. Baghel P et al., observed at 24 weeks of gestation the mean placental thickness was 24.5 mm which is closely correlating with the gestational age [22]. It also showed correlation placental thickness with BPD, FL and AC. They concluded as linear direct relationship of the placental thickness with gestational age in 24 weeks. The study conducted by Natwar Lal Agrawal illustrated that, there was kind of linear relationship between gestational age with placental thickness and FL which provides correct parameter for estimating foetal gestational age for 21 to 25 weeks. Further, they also made conclusion that, even though in absence knowledge of LMP, PT plays important role as a reliable parameter in assessment of gestational age [23].

Placental thickness not correlating with gestational age (in weeks)

In our study, FL correlated well with GA in 12 weeks only except for 15th, 17th, 19th, 24th week which showed negative correlation with decrease in thickness which was less than 1 mm.

Mital P et al., study has reported comparable observation that, PT was a little higher than GA by 1-4 mm for 10 to 21 weeks of gestation, for 22 to 35 weeks almost matched GA in weeks, PT was lesser than GA by 1-2 mm for more than 35 weeks [14].

Jain et al., study has observed that, PT was higher than GA by 1-5 mm for 10 to 25 weeks, they were found that GA was matched approximately equally between 27 and 33 weeks, followed by somewhat lesser than GA by 1-3 mm for more than 33 weeks [15].

Tongsong and Boonyanurak, in their study, it was found that an increase in PT from 8.4±2.5 mm to 21.8±3.3 mm at from 8 to 20 weeks of gestation [24].

Ohagwu CC et al., showed an increase in PT from 10±1.2 mm at 10 weeks to 43±5.3 mm at 40 weeks of gestation [25].

In the second trimester, the measurements obtained by Ohagwu CC et al., were about 5-7 mm higher and observed that PT in millimeter sequalled GA only at 10 and 11 weeks of gestation and observed no trend thereafter [25].

Mital P et al., Jain et al., and Tongsong and Boonyanurak studies all showed increase in the placental thickness by 1 – 5 mm in second trimester [14,15,24].

In the study conducted by Aditi Tiwari et al., which showed placental thickness was higher by 1-4 mm than the GA upto 21 weeks, later from 22 weeks it was lower by 1- 2 mm [26].

In our study also we have come across similar situation and observed placental thickness (PT) was directly matching the Gestational Age (GA), Femur Length (FL) with variation of less than 1 mm except in few weeks of gestation which was correlating with Aditi Tiwari et al., from 22 to 24 weeks of gestation. It was evident that placental thickness (PT) is in a linear relationship with gestational age (GA) [26].

We observed that there was strong positive correlation between femur length with placental thickness (p<0.0001) and mean placental thickness of 18.58 mm in second trimester. In our study we concluded that the placental thickness was correlating well with FL, with the placental thickness almost matching the gestational weeks with variation of less than 1mm in diameter.

LIMITATIONS

- A cross-sectional study design was used with relatively smaller sample size. So we need to correlate placental thickness with the gestational age in large population group.
- In the present study we measured placental thickness only once in each subject by single observer.
- Different population groups may show different placental thicknesses. So a population specific reference data may be required for accurate correlation.

CONCLUSIONS

In our study placental thickness correlated well with the femur length in second trimester (12 to 24 weeks) which was linear and direct. The relationship of placental thickness with femur length (FL) is matching from 12 to 24 weeks of gestation. The

thickness of the placenta and its growth pattern did not vary relative to the placental location.

REFERENCES

[1] DC Dutta. Textbook of Obstetrics. 8th edition. Konar H, editor. New Delhi: Jaypee Brothers Medical Publishers Private Ltd; 2015:106 p.

[2] Mary E. Norton, Scoutt L, Feldstein VA. Ultrasonography in Obstetrics and Gynaecology. 5th edition. Callen P W, editor. Philadelphia, PA: Elsevier, a division of Reed Elsevier India Limited; 2002:225–65

[3] Daftary SN, Chakravathi S. Holland and Brews- Manual of obstetrics. 16th ed. New Delhi: B.I Churchill Livingstone Pvt Ltd. 1998:23-32.

[4] Elsayes KM, Trout AT, Friedkin AM, Liu PS, Bude RO, Platt JF, et al. Imaging of the placenta: a multimodality pictorial review. *Radiographics*. 2009;29(5):1371–91.

[5] Cunningham FG, Leveno KJ, Bloom SL, Hauth JC. Williams obstetrics. 22nd ed. New York, NY: McGraw Hill; 2005. 36-38.

[6] Filly R, Hoddick WK, Mahony BS, Callen PW, Filly RA et al. Placental thickness. *J Ultrasound Med*. 1985;4(9):479–82.

[7] Elchalal U, Ezra Y, Levi Y, Bar-Oz B, Yanai N, Intrator O, et al. Sonographically thick placenta: a marker for increased perinatal risk-a prospective cross-sectional study. *Placenta*. 2000;21(2–3):268–72.

[8] Chen M, Leung KY, Lee CP, Tang MHY, Ho PC. Placental volume measured by three-dimensional ultrasound in the prediction of fetal alpha(0)-thalassemia: a preliminary report. *Ultrasound Obstet Gynecol*. 2006;28(2):166–72.

[9] Clapp JF 3rd, Rizk KH, Appleby-Wineberg SK, Crass JR. Second-trimester placental volumes predict birth weight at term. *J Soc Gynecol Investig*. 1995;2(1):19–22.

[10] Hafner E, Metzenbauer M, Hofinger D, Munkel M, Gassner R, Schuchter K, et al. Placental growth from the first to the second trimester of pregnancy in SGA-foetuses and pre-eclamptic pregnancies compared to normal foetuses. *Placenta*. 2003;24(4):336–42.

[11] Kinare AS, Natekar AS, Chinchwadkar MC, Yajnik CS, Coyaji KJ, Fall CH, et al. Low mid pregnancy placental volume in rural Indian women: A cause for low birth weight? *Am J Obstet Gynecol*. 2000;182(2):443–48.

[12] Suri S, Muttukrishna S, Jauniaux E. 2D-Ultrasound and endocrinologic evaluation of placentation in early pregnancy and its relationship to fetal birthweight in normal pregnancies and pre-eclampsia. *Placenta*. 2013;34(9):745–50.

[13] Malhotra N, Kumar P. Ultrasound in Obstetrics and Gynaecology. 3rd edition. Mumbai: Jaypee Brothers Medical Publishers Private Ltd. 1999. 92-98-200-388 p.

[14] Mital P, Hooja N, Mehndiratta K. Placental thickness: a sonographic parameter for estimating gestational age of the fetus. *Indian J Radiol Imaging*. 2002;12(4):553.

[15] Jain A, Kumar G, Agarwal U, Kharakwal S. Placental thickness–a sonographic indicator of gestational age. *J Obs Gyne India*. 2001;51(3):48–49.

[16] Mumal N, K SP, Urmila S, Anita R, Mehrotra S. Ultrasonographic measurement of placental thickness and its correlation with gestational age – a cross-sectional ultrasonographic study. *Int J Adv Res*. 2014;2(6):354–60.

[17] Shepard M, Richard V, Berkowitz R, Warsof S, Hobbins J. An evaluation of two equations for predicting foetal weight by ultrasound. *Am J Obs Gynecol*. 1987;156:80–85.

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

[19] Modn IJ, Revs R. Placental thickness as a sonological parameter for estimating gestational age. 2015;653–66.

[20] Kaushal L, Patil A, Kocherla K. Evaluation of placental thickness as a sonological indicator for estimation of gestational age of foetus in normal singleton pregnancy. *Int J Res Med Sci*. 2015;3(5):1213.

[21] Adhikari R, Deka PK, Tayal A, Chettri PK. Ultrasonographic evaluation of placental thickness in normal singleton pregnancies for estimation of gestation age. *Int J Med Imaging*. 2015;3(6):143–47.

[22] Baghel P. Correlation of placental thickness estimated by – ultrasonography with gestational age and fetal outcome. *Indian J Neonatal Med Res*. 2014;3(3):19–24.

[23] Agrawal NL. Comparative study between placental thickness and Femur Length for estimation of gestational age of fetus by real time ultrasonographic measurement. *Indian J Appl Res*. 2015;5(12):299–300.

[24] Tongsong T, Boonyanurak P. Placental thickness in the first half of pregnancy. *J Clin Ultrasound*. 2004;32(5):231–34.

[25] Ohagwu CC, Abu PO, Ezeokeke UO. Relationship between placental thickness and growth parameters in normal Nigerian foetuses. *African J Biotechnol.* 2009;8(2):133–38.

[26] Tiwari A, Chandnani K. A study to evaluate gestational age with the help of placental thickness. *Int J Reprod Contraception, Obstet Gynecol*. 2013;2(4):503.

AUTHOR(S):

1. Dr. Suresh K K
2. Dr. Ajey R Bhagwat

PARTICULARS OF CONTRIBUTORS:

1. Junior Resident, Department of Radiology, Shri BM Patil Medical College, BLDE University, Bijapur, Karnataka, India.
2. Associate Professor, Department of Radiology, Shri BM Patil Medical College, BLDE University, Bijapur, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Suresh K K,
Junior Resident, Department of Radiology,
Shri BM Patil Medical College, BLDE University,
Bijapur, Karnataka-586103, India.
E-mail: devakiram.radio@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Publishing: **Jan 01, 2017**