Ultrasonographic Measurement of Placental Thickness and its Correlation with Femur Length

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

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 1mm with respective 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 are delivery of a single baby, with fetal 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 to obstetrician to take appropriate measures that would optimize outcome of foetal [2].

Significant antenatal implications by using ultrasonography which provides a safe and non-invasive means can evaluate of the placenta whose normal and abnormal size, appearance and growth pattern.

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

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 fetal 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.
Ultrasoundography (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 give 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].

Ultrasoundography (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 fetus.

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

Diseases and abnormalities affecting fetus; 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 fetus. Hence, the present study was undertaken to evaluate the relationship between placental thickness and femur length of the fetus.

**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 visualization of the placenta, Last Menstrual Period (LMP) not known or irregular, 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 the USG.

**Scanning Technique [16]**

Patient was made to lie in the supine position. Fetus will be examined for viability, fetal 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 fetuses 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 fetus by taking various growth parameters by the ultrasound machine [6].

Fetal parameters were taken to rule out intrauterine growth restriction. Fetal weight was calculated using the Shepard formula [17]. The placenta was identified as a hyper echoic area separated from fetus 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 1mm 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 Granum’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]
4. **Lateral Placenta:** Placenta located laterally and extending equally into anterior and posterior walls [Table/Fig-5].

**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 2 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 in the second trimesters [Table/Fig-7].

**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 analyzed using SPSS software v.20.0 and Microsoft Excel.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Placental Position</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anterior</td>
</tr>
<tr>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>&lt;20</td>
<td>6</td>
</tr>
<tr>
<td>21-25</td>
<td>26</td>
</tr>
<tr>
<td>26-30</td>
<td>7</td>
</tr>
<tr>
<td>&gt;30</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
</tr>
</tbody>
</table>

**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].

<table>
<thead>
<tr>
<th>Placental Location</th>
<th>Femur Length</th>
<th>Placental Thickness</th>
<th>Coefficient of Correlation ($r$)</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>18.45</td>
<td>18.66</td>
<td>0.984</td>
<td>$&lt;0.0001^*$</td>
</tr>
<tr>
<td>Posterior</td>
<td>18.96</td>
<td>19.43</td>
<td>0.970</td>
<td>$&lt;0.0001^*$</td>
</tr>
<tr>
<td>Fundal</td>
<td>17.24</td>
<td>17.60</td>
<td>0.990</td>
<td>$&lt;0.0001^*$</td>
</tr>
<tr>
<td>Lateral</td>
<td>13.90</td>
<td>14.05</td>
<td>1.00</td>
<td>$&lt;0.0001^*$</td>
</tr>
</tbody>
</table>

[Table/Fig-7]: Correlation of femur length and placental thickness by placental location.

Note: *Significant at 5% level of significance

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean</th>
<th>SD</th>
<th>Coefficient of Correlation ($r$)</th>
<th>$p$-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femur Length</td>
<td>18.24</td>
<td>3.64</td>
<td>0.982</td>
<td>$&lt;0.0001^*$</td>
</tr>
<tr>
<td>Placental Thickness</td>
<td>18.58</td>
<td>3.73</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

The regression equation is:-

$$Y = 0.959 \times PT + 0.419$$

Pearson’s correlation shows that, there was statistically positive correlation of femur length with placental thickness in 12$^{th}$ 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.

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 delineated. 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 fetal spine, changing the fetal position and taking the measurements, proper technique of visualization 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 fetal 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 1mm.

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 sequelled 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


