# PREDICTION OF LOW BIRTH WEIGHT INFANTS FROM ULTRASOUND MEASUREMENT OF PLACENTAL DIAMETER AND PLACENTAL THICKNESS.

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**Background:** The aim of the study was to help to predict low birth weight infants by measuring placental diameter and thickness.
**Subjects and Methods:** A prospective study was conducted of 70 consecutive singleton pregnancies to evaluate placental diameter and thickness by ultrasonographic measurement at 36 weeks gestation. The individual data were fitted to a logistic regression analysis.
**Results:** A "warning limit" of a placental diameter of 18 cm and placental thickness of 2 cm at 36 weeks gestation were calculated to predict low birth weight infants.
**Conclusion:** Ultrasonographic placental diameter and thickness measurements appears to be of prognostic value in identifying the subsequent occurrence of fetal growth retardation.
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**Keywords:** Placental diameter, placental thickness, placental volume, low birth weight infants.

Despite careful antenatal surveillance involving scrupulous examination, an issue of considerable disappointment is that the majority of low birth weight (LBW) infants are not diagnosed until delivery. LBW infants are susceptible to hypoxia and fetal distress, long-term handicap and fetal death. Compounding the problem of the LBW infant is the need to identify the fetus failing to reach its growth potential, although its biometry may exceed the standard 10th centile. This suggests that an early detection of intrauterine growth retardation will be beneficial to obstetric and neonatal care. Studies have shown that diminished placental size precedes fetal growth retardation.[1] Recently, attempts made to predict small-for-date infants from placental volume at the second trimester did not yield satisfactory result,[2] however, the fact that small placental size is associated with low birth weight has become established.[1-4] The controversy lies in the accuracy of predicting LBW infants from placental volume measured by ultrasonography, especially when estimates of placental volume rely on modified mathematical formulas for objects that resemble the placental surface area.[1-4] The present study was therefore aimed at assessing placental diameter, placental thickness measured by ultrasound scan and estimated placental volume at the 36 weeks of gestation to predict small-for-date infants.

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## Subjects and Methods

An unselected group of 100 pregnant women who initially attended King Khalid University Hospital for delivery between January and June 2001 was recruited for this prospective trial. All data on maternal age, parity, gravidity, maternal weight at the time of registration, maternal height, gestational age, the estimation of their expected date of delivery which was correlated sonographically and their past obstetric history were collected.

The placental site was determined in two-dimensional real-time mode by means of a transabdominal 3.5 MHZ volume transducer (Aloka SSD–2000, Alcoa Co., Japan). Thirty subjects were excluded because the placenta was located posteriorly. In the remaining 70, the placenta was located anteriorly, and they were studied serially throughout pregnancy at 18-24 and 36 weeks. Placental diameter was calculated by taking the length of the chorionic surface in transverse direction. The placental thickness were taken at the level of umbilical cord insertion in longtudinal direction. The fetal weight was estimated by measurement of the biparietal diameter (BPD), abdominal circumference (AC) and the femur length (FL), adopting the formula devised by Hadlock.[5]

Postpartum fetal sex weight, mode of delivery, placental weight, diameter and thickness were taken. Because of the poor attendance of the women for ultrasonography at 18 and 24 weeks, we had insufficient data to construct placental diameter and thickness at that particular gestational age, so the statistical calculations were done with measurement obtained at 36 weeks gestational age only. An abnormal outcome of pregnancy was defined as a birth weight below the 10th percentile of Kloosterman's birthweight chart,[6] or birth weight less than 2,500 g.[7]

Descriptive statistics such as mean and standard deviation were used to summarize continuous maternal variables. Proportions and percentages were used for categorical variables. The body mass index (BMI) of the mothers was derived from weight and height using the usual formula. The BMI was categorized into normal (20-24.99), overweight (25-29.99), and obese (30 and above), respectively. Placental volume was assumed spherical in shape and therefore the mathematical formula: $4/3\ \pi\ r^2h$ for a sphere where r = radius, h= height, and $\pi$ = constant given as 3.14 was used for its estimation. The birth weight was categorized into low and normal based on birth weight less than 2500 g and 2500 g and above, respectively.

In variable analysis, the association of each maternal and placental variables with low or normal birth weight was examined. The chi-squared test was used to investigate the significance of association between two categorical variables while Student *t*-test was used to compare the means of continuous variables between infants with low and normal birth weights. Variables that were significant at the 10% probability level were included in the logistic regression model in which birth weight was the dependent variable. The statistical significance of the variables in the model was examined using the Wald statistics.

## Results

There were only 12 babies with birth weight less than 2500 g out of the 70 babies in this study, giving a low birth rate of 17.1% or 171 per 1000 births. Table 1 shows the summary statistics of the maternal variables of these infants in relation to birth weight. The women were on the average 29.3 years old, (SD=5.6 years) and those in the low birth weight category (<2500 g) were younger than the normal, but the difference was not statistically significant ($P$>0.1). The height and weight of the mothers were similar in the two birth weight categories. Parity, abortion and body mass were not statistically significantly associated with birth weight (>0.9).

The placental parameters at 36 weeks and at delivery are presented in Table 2. The statistics showed statistically significant differences in the placental thickness, diameter and estimated volume at delivery ($P$<0.001), but at 36 weeks, the placental diameter just failed to reach the 5% level of statistical significance. Also neither the mode of delivery nor sex of the baby was statistically related to birth weight ($P$>0.1).

The univariable analysis suggested placental diameter at 36 weeks, placental thickness and estimated placental volume as independent and statistically significant variables associated with low birth weight. These variables were included in the logistic regression model. The logistic regression analysis suggested that placental volume was the only statistically significant variable for the prediction of low birth weight having adjusted for placental diameter and placental thickness. The logistic regression coefficient for placental volume as predictor variable of small-for-date infants were

$\beta_0 = -2.3871$ and $\beta_1 = 0.0044$, where $\beta_0$ and $\beta_1$ are the constant and regression coefficient, respectively. However, a second logistic regression analysis was carried out

TABLE 1. *Comparison of summary statistics of maternal variables at time of registration between low and normal birth weight.*

| Maternal variables | All | Birth weight <2500 gms | Birth weight >2500 gms | *P*-value |
|---|---|---|---|---|
| Age (years) | | | | |
| Mean | 29.29 | 27.58 | 29.64 | |
| SD | 5.55 | 4.06 | 5.78 | 0.246 |
| No. | 70 | 12 | 58 | |
| Weight (kgs) | | | | |
| Mean | 68.7 | 68.83 | 68.72 | |
| SD | 10.6 | 8.13 | 11.06 | 0.974 |
| No. | 70 | 12 | 58 | |
| Height (cm) | | | | |
| Mean | 159.2 | 157.67 | 4.14 | |
| SD | 4.2 | 159.48 | 4.21 | 0.177 |
| No. | 70 | | | |
| Parity no. (%) | | | | |
| 0-1 | 29 | 5 | 24 | |
| 2+ | 41 | 7 | 34 | 0.985 |
| Abortion | | | | |
| 0 | | 6 | 34 | |
| 1 | | 3 | 12 | 0.860 |
| 2+ | | 3 | 12 | |
| Body Mass Index | | | | |
| Normal | | 3 | 19 | |
| Overweight or obese | | 9 | 38 | 0.573 |

TABLE 2. *Comparison of placental measurements at 36 weeks, delivery between low and normal birthweight.*

| Placental variables | | Birth weight <2500 gms | Birth weight >2500 gms | *P*-value |
|---|---|---|---|---|
| At 36 weeks | | | | |
| Placental thickness | Means | 2.25 | 3.48 | |
| | SD | 1.22 | 0.80 | <0.0001 |
| | No. | 12 | 58 | |
| Placental diameter | Means | 16.43 | 18.17 | |
| | SD | 1.72 | 2.30 | 0.057 |
| | No. | 7 | 58 | |
| Placental volume | Means | 667.41 | 923.47 | |
| | SD | 171.28 | 330.16 | 0.049 |
| | No. | 7 | 58 | |
| At delivery | | | | |
| Placental thickness | Means | 2.17 | 2.98 | |
| | SD | 0.39 | 0.51 | 0.0001 |
| | No. | 12 | 58 | |
| Placental diameter | Means | 15.83 | 18.38 | |
| | SD | 2.21 | 2.49 | 0.002 |
| | No. | 12 | 58 | |
| Placental volume | Means | 441.36 | 818.96 | |
| | SD | 172.69 | 293.01 | 0.0001 |
| | No. | 12 | 58 | |
| Mode of delivery | | | | |
| Caesarean section | | 8 | 49 | |
| Vaginal | | 4 | 8 | 0.109 |
| Sex of baby | | | | |
| Male | | 5 | 24 | |
| Female | | 7 | 34 | 0.828 |

TABLE 3. *Regression coefficient in the logistic model for predicting low birthweight from placental parameters at 36 weeks of gestation.*

| | Regression coefficient | | | | |
|---|---|---|---|---|---|
| Variables | ß | S-E (ß) | Wald stat. | O.R. | 95% CI |
| Constant | -8.8845 | 3.44 | 6.66 | | |
| Placental diameter | 0.3994 | 0.1976 | 4.08 | 1.49 | 1.01-2-20 |
| Placental thickness | 1.2482 | 0.4641 | 7.23 | 3.48 | 1.40-8.65 |

*Overall prediction rate=88.6%.*

including the placental diameter and placental thickness as independent variables. The result revealed that these variables have the same prediction power as when only the placental volume was a predictor. The regression coefficient are shown in Table 3. Because placental diameter and thickness are measured directly, it was decided to retain this logistic model with those two variables as predictors. For the practical purpose of prediction, placental diameter and thickness at 36 weeks of gestation were treated as a continuous variables in the logistic regression model for predicting low birth weight or small-for-date infants. The estimates of regression parameters presented in Table 3 revealed this model gave a correct classification of birth weights 88.6% of the time. This logistic model suggests the probability of normal birth weight may be obtained from the expression:

$$y = \frac{1}{1 + e^{-z}}$$

where $z$ = –8.8845+0.3994 (placental diameter) +1.2482 (placental thickness).

For a woman with placental diameter = 12, placental thickness = 2, then:

$z$ = –8.8845+0.3994 (12)+1.12482 (2) = –1.5953

$y$ = 0.17, if thickness increases to 3 and diameter remains same, y = 0.41.

For a woman with placental diameter = 18 cm, placental thickness = 2 cm,

$y$ = 0.69, this increases to 0.88 if thickness increases to 3 cm and placental diameter remains at 18 cm. This shows that the probability of a normal birth weight increases with increase in placental thickness and diameter.

## Discussion

This study shows that placental diameter and thickness measurements are valuable parameters for predicting low birth weight infants. This slightly deviates from previous reports which have recommended the use of placental volume, and period of measurement which was usually the second trimester.[2-4] None of the methods were adopted routinely. Three-dimensional sonographic measurement of the placental volume alone has also been reported as not being a satisfactory technique for predicting small-for-gestational age infants.[2] This study also considered predicting small-for-date infants from placental volume but this was found to have the same predictive of 88.6% as when placental diameter and thickness were used as predictor variables. This was not surprising since the placental volume was estimated from the placental diameter and thickness. However, to reduce the labor of mathematical calculations, it was decided to retain the model predicting small-for-date infants from placental diameter and placental thickness which are measured directly by ultrasound. This model shows that an increase in placental diameter and placental thickness correspond with an increase in the probability of normal birth weight infants.

It is interesting to observe that a placental diameter of less than 18 cm and a placental thickness of less than 2 cm at 36 weeks' gestation could be highly sensitive cut-off points for detecting LBW infants. Although serial fetal and placental measurements were not performed in the present study because of the poor attendance of the women, the present study suggests that retardation of placental growth precedes fetal growth retardation. Maternal variable such as age, parity, body mass index, as shown, do not associate significantly with LBW infants. The failure of these variables to reach statistically significant level could be due to the small sample size in this study. A larger study could therefore throw more light on the reasons.

In conclusion, the measurement of placental diameter and thickness in all sonographic assessment of pregnancy, in addition to the routine use of uterine artery Doppler in the second trimester,[8] may become a valuable additional tool to help increase our ability in predicting low birth weight infants.

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