Advanced International Journal for Research (AIJFR)
E-ISSN: 3048-7641 ● Website: www.aijfr.com ● Email: editor@aijfr.com

Correlation Between Sonographically Measured Placental Thickness and Estimated Fetal Weight in Uncomplicated Singleton Pregnancies: An Observational Cross-Sectional Study

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Abstract

Background

The placenta governs nutrient and oxygen transfer to the fetus, and its ultrasonographic thickness has been proposed as a simple, reproducible adjunct to conventional fetal biometry for assessing fetal growth. Evidence on the strength of this association, particularly across trimesters, remains variable across populations.

Objective

To evaluate the correlation between ultrasonographically measured placental thickness and estimated fetal weight (EFW) in the second and third trimesters of uncomplicated singleton pregnancies, and to examine this correlation separately by trimester and against individual fetal biometric parameters.

Methods

This observational cross-sectional study was conducted in the Department of Radiodiagnosis, in collaboration with the Departments of Obstetrics & Gynaecology and Paediatrics, at Hind Institute of Medical Sciences, Ataria, Sitapur, Uttar Pradesh, India, over an 18-month period. A total of 113 pregnant

women with singleton pregnancies between 16 and 40 weeks of gestation, with known and reliable last menstrual period, were enrolled after ethical approval and written informed consent. Placental thickness was measured transabdominally at the level of umbilical cord insertion (three measurements averaged) using a GE-Logiq F8 ultrasound system with a 5 MHz transducer. Biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) were recorded, and EFW was calculated using standard biometric formulas. Pearson's correlation coefficient was used to assess association between placental thickness and EFW, overall and by trimester, using SPSS version 23.

Results

Of 113 participants, 75 (66.4%) were scanned in the second trimester and 38 (33.6%) in the third trimester. Mean placental thickness increased from 21.13 ± 3.42 mm (second trimester) to 33.42 ± 3.62 mm (third trimester), while mean EFW increased from 461.47 ± 267.21 g to 2256.39 ± 714.12 g. A very strong positive correlation was found between placental thickness and EFW overall ($r = 0.965$, $p < 0.001$). Trimester-specific analysis showed strong positive correlations in both the second trimester ($r = 0.956$, $p < 0.001$) and third trimester ($r = 0.950$, $p < 0.001$). Placental thickness also correlated strongly with BPD ($r = 0.908$, $p < 0.001$), HC ($r = 0.962$, $p < 0.001$), AC ($r = 0.930$, $p < 0.001$), and most strongly with FL ($r = 0.984$, $p < 0.001$).

Conclusion

Ultrasonographically measured placental thickness shows a strong, statistically significant positive correlation with estimated fetal weight in uncomplicated singleton pregnancies, and this relationship is maintained in both the second and third trimesters. Placental thickness may serve as a simple, reproducible adjunct parameter to conventional fetal biometry in routine antenatal ultrasonography, but should not replace standard biometric assessment given the cross-sectional, single-centre design of this study.

Keywords: Placental thickness; estimated fetal weight; ultrasonography; fetal biometry; second trimester; third trimester

1. Introduction

Accurate assessment of fetal growth is a cornerstone of antenatal care, allowing early identification of fetal growth restriction and macrosomia, both of which carry increased risk of perinatal morbidity and mortality. Estimated fetal weight (EFW), derived from standard fetal biometric parameters — biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) — remains the principal sonographic tool for this purpose, most commonly using Hadlock-type formulas.

The placenta is the structural and functional interface between maternal and fetal circulations, and its morphology is closely linked to fetal well-being.[1] Placental thickness (PT), defined as the distance between the chorionic and basal plates measured at the level of umbilical cord insertion, increases nearly linearly with gestational age from the mid-second trimester onward,[9,4,5] and deviations from expected thickness have been associated with conditions such as gestational diabetes, fetal growth restriction, and preeclampsia.[3,8] Abnormal placental thickness has also been linked to adverse perinatal outcomes, including lower Apgar scores and increased neonatal intensive care admission, in third-trimester cohorts.[2] Because PT is quick to obtain, reproducible, and requires no additional equipment beyond standard

obstetric ultrasound, it has been proposed as a low-cost adjunct to conventional biometry, particularly relevant in resource-limited settings.

Existing literature reports a wide range of correlation coefficients between PT and EFW or birth weight, from weak and non-significant associations in some cohorts (r = 0.013)[12] to very strong correlations approaching r = 0.96 in others,[9,11,6] with variability attributed to differences in inclusion criteria, gestational age ranges, measurement technique, and the presence of complicated pregnancies in the sample. Most published correlation data are cross-sectional, and comparatively few studies have reported trimester-specific correlation coefficients separately for the second and third trimesters within the same cohort.

This gap motivated the present study, which restricted enrolment to uncomplicated singleton pregnancies with reliable dating, applied a standardized PT measurement protocol at the cord insertion site, and analyzed the PT–EFW relationship both overall and separately by trimester. The objective was to evaluate the correlation between ultrasonographically measured placental thickness and estimated fetal weight in pregnant women during the second and third trimesters, and to determine whether this relationship, and its correlation with individual fetal biometric parameters, is consistent across gestation.

Materials and Methods

Study Design and Setting

This was an observational cross-sectional study conducted jointly in the Departments of Radiodiagnosis, Obstetrics & Gynaecology, and Paediatrics at Hind Institute of Medical Sciences and Hospital, Ataria, Sitapur, Uttar Pradesh, India.

Study Period

The study was conducted over 18 months.

Participants and Sample Size

A total of 113 pregnant women were enrolled. The sample size was calculated for estimation of a correlation coefficient using an anticipated r of 0.598, $\alpha = 0.05$, 95% confidence level ($Z_{1-a/2} = 1.96$), and margin of error d = 0.15, yielding a minimum requirement of 112.92, rounded to 113 participants.

Eligibility Criteria

Inclusion criteria: singleton pregnancy; gestational age between 16 and 40 weeks; known and reliable last menstrual period; regular menstrual cycles.

Exclusion criteria: gestational hypertension; diabetes mellitus; intrauterine growth restriction; hydrops fetalis; congenital malformations; multiple pregnancy; polyhydramnios or oligohydramnios; unknown or irregular menstrual period; abnormal placenta or poor placental visualization; and variations in umbilical cord insertion site.

Ultrasound Protocol and Placental Thickness Measurement

After institutional ethics committee approval and written informed consent, examinations were performed with women supine, using a GE-Logiq F8 ultrasound machine (Serial No. 46085UWX3) and a 5 MHz transabdominal transducer with coupling gel. The umbilical cord insertion point was identified sonographically, and placental thickness was measured as the distance across the mid-placental region, from the echogenic chorionic plate to the placental–myometrial interface, perpendicular to the placental surface. Three measurements were taken at this site and averaged to obtain the final value in millimetres. Myometrial contractions, venous lakes, and retroplacental clots were excluded from the measurement plane to avoid false readings.

Fetal Biometry and Estimated Fetal Weight

BPD and HC were measured in an axial plane through the thalami and cavum septum pellucidum. AC was measured by the elliptical method on a transverse plane including the fetal stomach and portal-umbilical venous complex. FL was measured as the linear distance between the blunt proximal and distal femoral epiphyses on a longitudinal scan. EFW was computed using standard biometric formulas incorporating BPD, HC, AC, and FL.

Statistical Analysis

Data were analyzed using SPSS version 23 (student version). Categorical variables were expressed as frequencies and percentages, and continuous variables as mean ± standard deviation. Pearson's correlation coefficient was used to assess the strength and direction of association between placental thickness and EFW (overall and trimester-wise) and between placental thickness and individual fetal biometric parameters. The Mann-Whitney U test was applied for non-parametric data, and the unpaired Student's t-test for comparison of means between groups. Fisher's exact test or the chi-squared test was used for qualitative variables. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Human Ethics Committee, Hind Institute of Medical Sciences, Ataria, Sitapur (Ref. No. IHEC-HIMSA/MD/MS-23/RD-41/07-24, approved 24 July 2024). Written informed consent was obtained from all participants, and confidentiality of participant identity and data was maintained.

Results

Of 113 pregnant women enrolled, 75 (66.4%) underwent scanning in the second trimester and 38 (33.6%) in the third trimester. Gestational age distribution and maternal age distribution are summarized in Table 1.

Table 1. Baseline characteristics of study participants (n = 113)

Characteristic	Category	n	%
Gestational age (weeks)	16–21	45	39.8
	22–27	30	26.5
	28–33	19	16.8
	34–40	19	16.8
Trimester	Second trimester	75	66.38
	Third trimester	38	33.62
Maternal age (years)	≤20	14	12.4
	21–25	38	33.6
	26–30	46	40.8
	31–35	8	7.0
	>35	7	6.2

Values are frequency (n) and percentage (%) of the total study sample. Percentages within each characteristic sum to 100%.

Placental thickness and all fetal biometric parameters, including EFW, increased progressively from the second to the third trimester (Table 2).

Table 2. Trimester-wise placental thickness, fetal biometric parameters, and estimated fetal weight

Parameter	Second trimester (n = 75) Mean ± SD	Third trimester (n = 38) Mean ± SD
Placental thickness (mm)	21.13 ± 3.42	33.42 ± 3.62
Biparietal diameter (mm)	49.22 ± 10.91	80.02 ± 16.91
Femur length (mm)	35.08 ± 9.40	64.62 ± 7.21
Head circumference (mm)	184.77 ± 45.55	308.89 ± 23.90
Abdominal circumference (mm)	159.23 ± 39.87	283.53 ± 54.66
Estimated fetal weight (g)	461.47 ± 267.21	2256.39 ± 714.12

SD, standard deviation.

Placental thickness showed a very strong overall correlation with EFW and strong to very strong correlations with each individual fetal biometric parameter (Table 3).

Table 3. Correlation of placental thickness with fetal biometric parameters and estimated fetal weight (overall, n = 113)

Fetal parameter	Pearson r	p-value
Estimated fetal weight (EFW)	0.965	<0.001
Biparietal diameter (BPD)	0.908	<0.001
Head circumference (HC)	0.962	<0.001
Abdominal circumference (AC)	0.930	<0.001
Femur length (FL)	0.984	<0.001

All correlations were statistically significant at $p < 0.001$. The strongest correlation among individual biometric parameters was observed with femur length.

When analyzed separately by trimester, the correlation between placental thickness and EFW remained strong and statistically significant in both the second and third trimesters, with a marginally higher coefficient in the second trimester (Table 4).

Table 4. Trimester-specific correlation between placental thickness and estimated fetal weight

Trimester	n	Pearson r	p-value
Second trimester	75	0.956	<0.001
Third trimester	38	0.950	<0.001

The correlation coefficients in Table 4 were derived from the thesis's trimester-specific analysis tables (Tables 17–18 of the original thesis); scatter-plot annotations elsewhere in the thesis (Figure 14) reported the same values ($r = 0.956$ and $r = 0.950$, respectively), confirming internal consistency for this specific comparison.

Gestational-age and trimester-wise distribution of participants, and the trimester-wise increase in placental thickness and EFW, are consistent with the expected physiological pattern of placental and fetal growth across pregnancy. No additional analyses beyond those reported in the thesis were performed for this manuscript.

Discussion

In this observational cross-sectional study of 113 uncomplicated singleton pregnancies, placental thickness measured at the level of umbilical cord insertion showed a very strong positive correlation with estimated fetal weight overall ($r = 0.965$, $p < 0.001$), and this association persisted when analyzed separately in the second ($r = 0.956$) and third ($r = 0.950$) trimesters.

Why Placental Thickness May Correlate With Fetal Weight

The placenta is the principal site of nutrient and oxygen exchange between mother and fetus, and its growth in thickness reflects increasing villous branching and vascular surface area over gestation.[1] As the placenta enlarges to sustain rising fetal metabolic demand, a parallel increase in fetal weight would be physiologically expected. The strength of correlation observed here may in part reflect the strict exclusion of pregnancies complicated by gestational hypertension, diabetes mellitus, intrauterine growth restriction, and other conditions known to alter placental morphology independently of fetal growth, thereby reducing confounding.

Comparison With Previous Studies

The overall correlation coefficient in this study ($r = 0.965$) is among the higher values reported in the literature reviewed in the parent thesis. Akhtar et al. reported a correlation of $r = 0.873$ between placental thickness and EFW,[9] while Ashmawy et al. reported correlations ranging from $r = 0.899$ to 0.933 between placental thickness and estimated or actual birth weight.[15] Sharma et al., in a North Indian cohort of 190 women, reported a comparably strong correlation of $r = 0.958$.[11] Adekanmi et al. and Adeyekun et al. reported somewhat lower but still strong correlations ($r = 0.83$ and $r = 0.881$, respectively).[7,10] By contrast, Bedi et al. found a weak, non-significant correlation ($r = 0.013$) between placental thickness and birth weight, which the authors attributed to a heterogeneous population that included pregnancies with medical complications,[12] and El-Kady et al. similarly reported limited predictive value of placental thickness alone for fetal weight.[16] The present study's higher correlation, in this context, is consistent with the effect of restricting enrolment to uncomplicated pregnancies and applying a standardized measurement technique.

The trimester-specific pattern observed — a slightly higher correlation in the second trimester ($r = 0.956$) than the third ($r = 0.950$) — is broadly consistent with observations by Muraliswar Rao et al., who noted that the correlation between placental thickness and fetal weight, while strong up to 35 weeks, may attenuate somewhat near term, potentially related to placental maturation.[14] Nonetheless, both trimester-specific correlations in the present study remained strong and highly significant, indicating that the PT–EFW relationship is not confined to a single window of gestation.

Correlations between placental thickness and individual biometric parameters (BPD $r = 0.908$, HC $r = 0.962$, AC $r = 0.930$, FL $r = 0.984$) suggest that placental thickness tracks both fetal skeletal and soft-tissue growth. The particularly strong correlation with femur length is consistent with findings by Meena and Chauhan, who also reported a strong PT–FL correlation.[13]

Clinical Utility

Given its simplicity, reproducibility, and negligible additional scan time, placental thickness measurement may serve as a useful adjunct parameter when conventional biometric measurements are difficult to obtain

— for example, in unfavorable fetal lie — or as a supplementary screening tool in settings where serial growth scans or Doppler studies are not readily available. This is consistent with the broader literature suggesting a role for placental thickness in resource-limited antenatal care.[17],[18]

Adjunct, Not Replacement

These findings should not be interpreted as supporting placental thickness as a substitute for standard fetal biometry in EFW estimation. Fetal growth is multifactorial, influenced by maternal, placental, and fetal determinants, and established biometric formulas remain the reference standard for EFW calculation. Placental thickness is best regarded as a complementary, adjunctive parameter within a comprehensive growth-assessment protocol, rather than a replacement for BPD, HC, AC, and FL-based estimation.

Strengths and Limitations

Strengths of this study include a standardized, averaged (three-measurement) technique for placental thickness at a fixed anatomical site (cord insertion), a sample size calculated a priori for correlation estimation, and strict exclusion of pregnancies complicated by conditions known to independently alter placental morphology, which reduces confounding in the observed associations.

The following limitations are evident from the study design:

• Cross-sectional design: each participant contributed a single measurement, precluding assessment of longitudinal, within-pregnancy change in placental thickness or fetal weight over time.

• Single-centre setting: all data were collected at one institution, which may limit generalizability to other populations or equipment.

• Sample size: while adequate for the primary correlation analysis (n = 113, calculated a priori), the third-trimester subgroup (n = 38) was smaller than the second-trimester subgroup (n = 75), which may limit precision of trimester-specific estimates.

• Potential measurement variability: placental thickness measurement, though averaged over three readings, remains susceptible to inter-observer and technique-related variability, and factors such as maternal habitus and placental location can affect image clarity and measurement accuracy.

• Lack of longitudinal follow-up: the study did not assess actual birth weight or neonatal outcomes, so the correlation reported here is between two ultrasonographic estimates (placental thickness and EFW) rather than between placental thickness and a directly measured outcome.

Conclusion

In this observational cross-sectional study of 113 uncomplicated singleton pregnancies, ultrasonographically measured placental thickness showed a strong, statistically significant positive correlation with estimated fetal weight, both overall ($r = 0.965$, $p < 0.001$) and when analyzed separately in the second ($r = 0.956$, $p < 0.001$) and third ($r = 0.950$, $p < 0.001$) trimesters. Placental thickness also correlated strongly with individual fetal biometric parameters, most strongly with femur length. These associative findings, from a cross-sectional observational design, support consideration of placental

thickness as a simple, reproducible adjunct parameter to conventional fetal biometry in routine antenatal ultrasonography, to be used alongside — not in place of — established biometric indices.

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Numbered to match the in-text citation numbers used in this manuscript (renumbered sequentially from the thesis's original reference list; this numbering does not correspond to the thesis's own reference numbers).

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