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ORIGINAL RESEARCH

Correlation of Placental Weight and Amniotic Fluid Volume in the First Half of Pregnancy

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ABSTRACT
Aim: The aim of this study was to evaluate the correlation between placental weight and amniotic fluid volume during the first half of pregnancy (up to 20 weeks of gestation), with the objective of understanding their interrelationship and clinical implications for fetal development. **Material and Methods:** This prospective observational study was conducted at a tertiary care teaching hospital and included 125 pregnant women between 11 -20 weeks of gestation. Inclusion criteria encompassed singleton pregnancies with no known maternal comorbidities. Placental weight was estimated using ultrasonographic measurements of placental thickness and surface area, validated in a subset through direct post-delivery measurements. Amniotic fluid volume was measured using either the amniotic fluid index (AFI) or single deepest pocket (SDP), depending on gestational age. Fetal biometric parameters, placental location and echotexture, and uterine artery Doppler studies were also recorded. **Results:** The mean gestational age was 16.22 ± 2.13 weeks, with an average placental weight of 168.4 ± 22.9 grams and mean placental thickness of 22.5 ± 3.4 mm. The average AFI was 13.6 ± 2.4 cm and SDP was 4.5 ± 0.8 cm, indicating normal amniotic fluid levels. A moderate positive correlation was found between placental weight and AFI ($r = 0.542$, $p < 0.001$) as well as SDP ($r = 0.508$, $p < 0.001$). A stronger correlation was observed between placental weight and gestational age ($r = 0.681$, $p < 0.001$), while AFI and gestational age also showed a mild to moderate correlation ($r = 0.413$, $p < 0.01$). These findings suggest that placental mass has a significant role in the regulation of amniotic fluid volume during early gestation. **Conclusion:** A significant positive correlation exists between placental weight and amniotic fluid volume in the first half of pregnancy. The results underscore the importance of early placental development in maintaining optimal intrauterine conditions. Ultrasonographic evaluation of placental mass and fluid volume can serve as early indicators of fetal well-being and may help identify pregnancies at risk of complications.
Keywords: Placental weight, Amniotic fluid volume, AFI, SDP, Early pregnancy ultrasound.

INTRODUCTION

The assessment of fetal well-being in the early stages of gestation relies heavily on a thorough understanding of placental morphology and amniotic fluid dynamics. These two parameters—placental weight and amniotic fluid volume (AFV)—are central to supporting intrauterine growth and ensuring physiological development. The placenta, as a vital organ of exchange, and the amniotic fluid, as a medium of protection and nourishment, play integrative roles in early fetal development. Investigating the relationship between placental weight and AFV during the first half of pregnancy provides critical insight into the intrauterine environment and helps in identifying potential deviations that may be predictive of adverse perinatal outcomes.Fetal growth trajectories are significantly influenced by the structure and function of the

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placenta. A healthy placenta not only mediates optimal nutrient and oxygen transfer but also adapts to varying gestational demands. Variations in placental size have been linked with alterations in fetal weight and overall growth outcomes, particularly in multiple gestations where chorionicity further complicates fetal development patterns.[1,2] These associations underline the importance of assessing placental parameters even in early pregnancy. Furthermore, placental weight has been found to correlate with both birth weight and perinatal survival, reinforcing its utility as a prognostic marker.[3]

In parallel, the volume of amniotic fluid reflects fetal renal function, lung development, and membrane integrity. In the early gestational period, AFV is primarily derived from maternal plasma, transitioning later to include significant contributions from fetal urine and pulmonary secretions. As such, its regulation is complex and multifactorial. Abnormalities in amniotic fluid, whether oligohydramnios or polyhydramnios, have been implicated in adverse pregnancy outcomes, ranging from fetal anomalies and growth restriction to premature delivery and stillbirth.[4,5] AFV is widely considered a dynamic indicator of fetal well-being. The maintenance of an optimal range is critical, as both excess and deficiency pose risks to fetal development. Isolated oligohydramnios in particular presents a clinical challenge due to its ambiguous etiology and uncertain prognostic significance in early gestation. Understanding whether variations in AFV correlate with placental development during the first half of pregnancy may provide new perspectives on placental insufficiency or compensatory mechanisms.[5,6]

Ultrasound imaging plays a central role in evaluating both the placenta and AFV. Standardized obstetric ultrasonography allows for the accurate assessment of placental location, thickness, and morphology, alongside the estimation of amniotic fluid through measurements such as the amniotic fluid index (AFI) or the single deepest pocket (SDP) method. These non-invasive techniques offer clinicians a valuable window into fetal health, especially when applied in combination during early prenatal visits.[4,7,8] Early placental development is known to follow a predictable pattern, and deviations in placental size may reflect pathological conditions such as impaired trophoblast invasion or abnormal vascular remodeling. Given that these placental abnormalities may also impact the production or regulation of amniotic fluid, the hypothesis of a correlational relationship between placental weight and AFV is both biologically plausible and clinically significant. Such a correlation could aid in the early detection of compromised pregnancies and allow for more tailored monitoring protocols. Moreover, the periviable period, typically defined as 20 to 25 weeks of gestation, represents a critical threshold in fetal viability, where the adequacy of placental function and fluid volume can decisively affect outcomes in cases of preterm birth or intrauterine stress. However, less is understood about the earlier stages—before 20 weeks—where foundational growth processes are already at play. Establishing normative correlations between placental weight and AFV during this period could not only enrich diagnostic frameworks but also support the development of gestation-specific reference charts that are currently lacking.[7]

In recent decades, advancements in imaging technology and evidence-based obstetric practice guidelines have improved the precision of fetal monitoring. The collaborative recommendations from professional societies such as AIUM, ACOG, and SMFM now endorse routine ultrasonographic surveillance as a part of early pregnancy care.[8] With increasing emphasis on first-trimester screening and second-trimester anatomical surveys, it becomes both relevant and feasible to investigate early correlations between key intrauterine indicators.

MATERIAL AND METHODS

This prospective observational study was conducted in the Department of Obstetrics and Gynecology at a tertiary care teaching hospital. The primary objective of the study was to evaluate the correlation between placental weight and amniotic fluid volume during the first half of pregnancy (up to 20 weeks of gestation).A total of 125 pregnant women were enrolled in the study based on the following inclusion and exclusion criteria.

Inclusion Criteria

- Singleton pregnancy.
- Gestational age between 11 and 20 weeks confirmed by crown-rump length (CRL) or biparietal diameter (BPD).
- No known maternal comorbidities (e.g., diabetes mellitus, hypertension).
- Willingness to participate and provide written informed consent.

Exclusion Criteria

- Multiple pregnancies.
- Major fetal anomalies detected on ultrasonography.
- History of recurrent pregnancy loss or placental abnormalities.
- Presence of chronic maternal illness or congenital uterine anomaly.

Methodology

All 125 participants underwent routine antenatal ultrasonography between 11 -20 weeks of gestation. Gestational age was primarily determined using first-trimester ultrasonographic parameters, especially crown-rump length (CRL), and corroborated with the last menstrual period (LMP) to ensure accurate dating. Placental weight was estimated non-invasively using ultrasonographic measurements of placental thickness

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at the site of maximum attachment and the surface area of the placenta. These values were analyzed using a standardized algorithm to approximate placental mass. In a subset of 18 patients who underwent spontaneous miscarriage or elective termination during this gestational window, the actual placental weight was obtained and used to validate the sonographic estimations.

Amniotic fluid volume (AFV) was assessed transabdominally, depending on gestational age, using either the single deepest pocket (SDP) method or the amniotic fluid index (AFI). The patient was positioned semi-recumbently to optimize imaging conditions, and all measurements were taken thrice to ensure accuracy, with the average value used for analysis.

Additional maternal and fetal parameters were also recorded to explore potential associations. These included maternal age, body mass index (BMI), gravidity, parity, and baseline hemoglobin levels. Fetal biometric measurements such as biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL) were also collected to assess fetal growth parameters during the first half of gestation. Placental location (anterior, posterior, fundal, or low-lying) and placental echotexture were documented, as they may influence placental function and development. Uterine artery Doppler studies were performed in selected cases to assess uteroplacental blood flow resistance, and any abnormalities such as notching or elevated pulsatility index (PI) were noted.

All ultrasonographic examinations were conducted using a high-resolution real-time ultrasound machine (GE Voluson E8) by a single experienced sonologist to eliminate interobserver variability. The machine was calibrated before each session, and all scans adhered to standardized protocols to ensure uniformity in data acquisition. The repeated measurement method was employed for all sonographic values, and the mean of three readings was considered for final analysis to minimize measurement errors.

Statistical analysis

Data were entered in Microsoft Excel and analyzed using SPSS version 26.0. Correlation between placental weight and amniotic fluid volume was assessed using Pearson's correlation coefficient. A p-value < 0.05 was considered statistically significant. Descriptive statistics were used for demographic variables and mean values of placental weight and AFV were computed with standard deviations.

RESULTS

Table 1: Baseline Characteristics of Study Participants

The study included a total of 125 pregnant women with a mean maternal age of 26.84 ± 4.12 years, indicating a relatively young reproductive age group. The average body mass index (BMI) was 23.67 ± 2.89 kg/m², placing most participants within the normal weight range, which minimizes the confounding effects of obesity on placental and amniotic fluid parameters. In terms of gravidity, 58 women (46.40%) were primigravida, while 67 (53.60%) were multigravida, showing a fairly balanced distribution. Likewise, nulliparous women formed 51.20% of the study cohort, with multiparous women accounting for 48.80%, which helps diversify maternal parity in the analysis. The average hemoglobin level was 11.78 ± 1.14 g/dL, suggesting that most women had acceptable hemoglobin values, although a few cases may have been borderline anemic, a common finding in early pregnancy in developing regions.

Table 2: Distribution of Gestational Age and Placental Characteristics

The mean gestational age of participants at the time of evaluation was 16.22 ± 2.13 weeks, well within the study's targeted first half of pregnancy. The estimated placental weight based on ultrasound calculations was 168.4 ± 22.9 grams, providing a baseline reference for placental growth at this stage. The mean placental thickness measured 22.5 ± 3.4 mm, which is within expected limits for gestational age and supports its utility as a surrogate marker of placental mass. Regarding placental location, the majority were either anterior (40.00%) or posterior (36.80%), with fundal (16.80%) and low-lying (6.40%) locations being less common. Importantly, homogenous placental echotexture was noted in 89.60% of cases, indicating normal maturation, while 10.40% showed heterogenous echotexture, which may be associated with early placental changes or variations in intervillous blood flow.

Table 3: Amniotic Fluid Volume and Fetal Biometric Parameters

The mean amniotic fluid index (AFI) was found to be 13.6 ± 2.4 cm, and the single deepest pocket (SDP) averaged 4.5 ± 0.8 cm, both indicating that most pregnancies had normal amniotic fluid volumes. These values fall within accepted normal ranges for the early second trimester, ensuring valid comparison with placental characteristics. In terms of fetal biometry, the mean biparietal diameter (BPD) was 34.2 ± 3.1 mm, head circumference (HC) was 116.3 ± 9.5 mm, abdominal circumference (AC) was 94.7 ± 8.2 mm, and femur length (FL) was 19.4 ± 2.6 mm, all of which aligned with expected growth trajectories for 11–20 weeks of gestation. These measurements confirmed accurate gestational dating and healthy fetal development in most subjects.

Table 4: Uterine Artery Doppler Findings

Out of the 125 cases, 40 women underwent uterine artery Doppler evaluation, primarily those suspected of impaired uteroplacental perfusion or with marginal placental parameters. Among these, 31 cases

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(77.50%) exhibited normal uterine artery flow, whereas 9 cases (22.50%) had abnormal Doppler findings, such as persistent diastolic notching or elevated pulsatility index (PI). The mean PI recorded was 1.21 ± 0.18, which is within the normal range for early second trimester, though the presence of abnormal flow in nearly one-fourth of assessed cases underscores the need for monitoring uteroplacental circulation even in early gestation, particularly where placental or fluid anomalies are suspected.

Table 5: Correlation between Placental Weight and Amniotic Fluid Volume

Statistical analysis revealed a moderate positive correlation between placental weight and amniotic fluid index (AFI) ($r = 0.542$, $p < 0.001$) as well as between placental weight and single deepest pocket (SDP) ($r = 0.508$, $p < 0.001$), suggesting that an increase in placental weight tends to be associated with an increase in amniotic fluid volume. This supports the hypothesis that a well-developing placenta contributes positively to the regulation of amniotic fluid dynamics. A stronger correlation was found between placental weight and gestational age ($r = 0.681$, $p < 0.001$), reflecting the natural progression of placental growth as pregnancy advances. Additionally, a mild to moderate positive correlation was observed between AFI and gestational age ($r = 0.413$, $p < 0.01$), indicating that amniotic fluid volume also increases with gestational age, although not as strongly as placental mass does. These findings reinforce the importance of placental development in maintaining an optimal intrauterine environment during early pregnancy.

Table 1: Baseline Characteristics of Study Participants (n = 125)

Parameter	Mean ± SD / n (%)
Maternal Age (years)	26.84 ± 4.12
BMI (kg/m²)	23.67 ± 2.89
Gravidity	
Primigravida	58 (46.40%)
Multigravida	67 (53.60%)
Parity	
Nulliparous	64 (51.20%)
Multiparous	61 (48.80%)
Hemoglobin (g/dL)	11.78 ± 1.14

Table 2: Distribution of Gestational Age and Placental Characteristics

Parameter	Mean ± SD / n (%)
Gestational Age (weeks)	16.22 ± 2.13
Placental Weight (estimated, g)	168.4 ± 22.9
Placental Thickness (mm)	22.5 ± 3.4
Placental Location	
Anterior	50 (40.00%)
Posterior	46 (36.80%)
Fundal	21 (16.80%)
Low-lying	8 (6.40%)
Placental Echotexture	
Homogenous	112 (89.60%)
Heterogenous	13 (10.40%)

Table 3: Amniotic Fluid Volume and Fetal Biometric Parameters

Parameter	Mean ± SD
Amniotic Fluid Index (AFI, cm)	13.6 ± 2.4
Single Deepest Pocket (SDP, cm)	4.5 ± 0.8
Biparietal Diameter (BPD, mm)	34.2 ± 3.1
Head Circumference (HC, mm)	116.3 ± 9.5
Abdominal Circumference (AC, mm)	94.7 ± 8.2
Femur Length (FL, mm)	19.4 ± 2.6

Table 4: Uterine Artery Doppler Findings (n = 40 cases assessed)

Parameter	n (%)
Normal Doppler flow	31 (77.50%)
Abnormal Doppler (Notching/↑PI)	9 (22.50%)
Mean Pulsatility Index (PI)	1.21 ± 0.18

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Table 5: Correlation between Placental Weight and Amniotic Fluid Volume

Correlation Pair	Pearson's r	p-value	Interpretation
Placental Weight vs AFI	0.542	<0.001	Moderate positive correlation
Placental Weight vs SDP	0.508	<0.001	Moderate positive correlation
Placental Weight vs Gestational Age	0.681	<0.001	Strong positive correlation
AFI vs Gestational Age	0.413	<0.01	Mild to moderate correlation

DISCUSSION

The baseline characteristics in Table 1 reflect a representative sample of 125 pregnant women in early gestation, with a mean maternal age of 26.84 ± 4.12 years and average BMI of 23.67 ± 2.89 kg/m². This age and weight profile is conducive to healthy placental development, minimizing confounding variables such as advanced maternal age or obesity, which are known to impair placental vascularization and trophoblast invasion. The nearly equal distribution of primigravida (46.40%) and multigravida (53.60%) women, along with parity spread (51.20% nulliparous vs. 48.80% multiparous), supports heterogeneity in maternal history, enhancing the generalizability of outcomes. Hemoglobin levels averaged 11.78 ± 1.14 g/dL, suggesting overall adequate oxygen-carrying capacity, though borderline anemia in some cases may subtly influence uteroplacental perfusion, as highlighted by Abrams et al. 1995, who underscored maternal hematological health as a contributor to fetal growth via placental function.[9]

Table 2 reports a mean gestational age of 16.22 ± 2.13 weeks, aligning with the early second trimester window. The average placental weight was 168.4 ± 22.9 grams and mean placental thickness was 22.5 ± 3.4 mm—both consistent with reference values for this gestational range. Normal echotexture was present in 89.60% of cases, while 10.40% showed heterogeneous appearance, a potential early sign of intervillous thrombi or suboptimal perfusion. These findings resonate with Lind and Hytten 1970, who linked placental weight during early gestation with the ability to support fetal growth. Placental location was predominantly anterior (40.00%) and posterior (36.80%), with smaller proportions of fundal (16.80%) and low-lying (6.40%) sites, though location was not found to significantly impact fluid parameters in this cohort. Nonetheless, abnormal echotexture warrants vigilance, as it could reflect evolving placental pathology, especially in resource-limited settings.[10]

Table 3 findings indicate normal amniotic fluid status across the study cohort, with an average amniotic fluid index (AFI) of 13.6 ± 2.4 cm and single deepest pocket (SDP) of 4.5 ± 0.8 cm—both well within accepted thresholds for early second trimester. These measurements are consistent with normative data reported by Hughes and Magann 2017, who regarded AFI between 8–18 cm as physiologic.[11] Additionally, biometric parameters—biparietal diameter (34.2 ± 3.1 mm), head circumference (116.3 ± 9.5 mm), abdominal circumference (94.7 ± 8.2 mm), and femur length (19.4 ± 2.6 mm)—confirm proper gestational dating and fetal development. These dimensions align with standard fetal growth charts and validate that both fluid volume and placental function were adequate to support ongoing growth, as also noted by Dubil and Magann 2013 in their discussions on AFV as a fetal wellbeing marker.[12]

Uterine artery Doppler findings from Table 4 provide a functional assessment of uteroplacental circulation. Among 40 women assessed, 77.50% (n=31) showed normal flow, while 22.50% (n=9) exhibited abnormal flow patterns such as persistent diastolic notching or elevated pulsatility index (mean PI: 1.21 ± 0.18). These values are within acceptable early pregnancy limits but are of concern when deviations are present, as such abnormalities may precede placental insufficiency or hypertensive disorders later in pregnancy. Dashe et al. 2018 and Kehl et al. 2016 support the integration of uterine Doppler as an early tool to flag risk, especially when placental mass or fluid trends are borderline. Furthermore, Doppler abnormalities in a subset of this population reinforce the idea that structural placental parameters alone may not always reflect functional sufficiency.[13,14]

The most salient findings are presented in Table 5, which reveals a statistically significant positive correlation between placental weight and both AFI ($r = 0.542$, $p < 0.001$) and SDP ($r = 0.508$, $p < 0.001$). This indicates that greater placental mass corresponds with increased amniotic fluid volume, likely reflecting better vascularization and transplacental fluid transport. A strong correlation was also observed between placental weight and gestational age ($r = 0.681$, $p < 0.001$), emphasizing the physiological progression of placental growth over time. Additionally, a milder yet significant correlation between AFI and gestational age ($r = 0.413$, $p < 0.01$) highlights the expected increase in fluid volume as the fetus matures, although fluid trends appear to track more closely with placental development than gestational age per se.

These results are consistent with the findings of Hughes et al. 2020, who validated the accuracy of AFI and SDP in categorizing true amniotic volumes across gestation.[15] They also support the physiological model proposed by Sherer 2002, which described amniotic fluid homeostasis as a dynamic interplay between fetal urine production, placental function, and maternal-fetal exchange.[16] Emerging molecular research by Feng et al. 2021 and Suzuki et al. 2023 further strengthens this model by illustrating how trophoblastic signaling and immune modulation impact both placental mass and fluid balance,

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potentially influencing these correlations.[17,18] Moreover, Szydełko-Gorzkowicz et al. 2022 proposed a role for placental hormones like kisspeptin in modulating pregnancy complications, which may also have implications on fluid dynamics and vascular tone.[19]

In clinical context, these findings underscore the importance of routine assessment of placental morphology and amniotic fluid volumes in early pregnancy. Not only can such parameters provide insight into fetal well-being, but their interrelationship also serves as a powerful indicator of placental health and functionality. The study further aligns with reports by Choi et al. 2021 and Nagesh Gowda et al. 2023, who observed that environmental, seasonal, and pathological factors can disrupt this balance and lead to adverse outcomes. Therefore, early identification of aberrations in either placental weight or fluid volume may allow for timely intervention and improved pregnancy surveillance.[20,21]

CONCLUSION

This study demonstrates a significant positive correlation between placental weight and amniotic fluid volume during the first half of pregnancy, highlighting the placenta's essential role in regulating intrauterine conditions. Findings suggest that increased placental mass is associated with higher amniotic fluid indices, indicating better fetal support and development. Early ultrasonographic assessment of placental characteristics and fluid volume can serve as valuable predictors of pregnancy health. Integrating these parameters into routine antenatal care may aid in early identification of potential complications.

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