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Correlation of Biparietal Diameter (BPD) with Menstrual Gestational Age in the Third Trimester: A Cross-Sectional Study

Samer Fadhel Alwazni *
Department of Surgery, College of Medicine, Wasit University, Wasit, Iraq

العلاقة بين قطر الرأس بين الجدارين (*BPD*) وعمر الحمل خلال الثلث الثالث من الحمل: دراسة مقطعية

سامر فاضل الوزني *
قسم الجراحة، كلية الطب، جامعة واسط، الكوت، واسط، العراق

*Corresponding author: salwazni@uowasit.edu.iq

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Abstract:

Background: Gestational age (GA) is a key factor to optimal prenatal care and proper GA assessment is essential. Biparietal diameter (BPD) is one of the commonly used ultrasonographic measurements to estimate GA, but its accuracy decreases with advancing gestation. **Objective**: To assess the correlation between BPD and menstrual GA, based on last menstrual period (LMP) in the 3rd trimester and to investigate the effect of fetal lie, placental position and maternal age on the discrepancy between the two. This was a cross-sectional study performed in a private ultrasound clinic in Al-Kut, Iraq from April to July 2024. 75 singleton pregnant women were enrolled at 21-40 weeks of gestation. BPD was measured using a 3.5 MHz curvilinear probe (Philips HD 11XE) in the transthalamic plane. The differences between USG and LMP were classified into six types (A–F). **Results**: Most of the cases (39%) had a difference of between 1 and 7 days (Category B) and 29% had a difference of between 8 and 14 days (Category C). In general, age of the mother was correlated with the extent of the discrepancy between the two measurements, with the best correlation found in women aged 21-30 years. Anterior position of placenta produced the least variability while posterior position produced more measurement error. The most accurate BPD estimates were obtained from the case of longitudinal cephalic presentation. **Conclusion**: BPD is a good GA estimation tool during the third trimester, but its performance reduces as gestation increases. It is strongly recommended that BPD be used in conjunction with other complementary biometric indices as well as maternal/fetal factors.

Keywords: biparietal diameter, gestational age, ultrasonography, last menstrual period, third trimester, fetal biometry, Iraq.

الملخص

الخلفية :يُعد عمر الحمل (GA) عاملاً رئيسياً للرعاية المثلى قبل الولادة، لذا فإن التقييم الدقيق لعمر الحمل أمر ضروري. يعتبر القطر ثنائي الجبهة (BPD) أحد قياسات الموجات فوق الصوتية الشائعة الاستخدام

لتقدير عمر الحمل، لكن دقته تنخفض مع تقدم الحمل. **الهدف :**تقييم الارتباط بين القطر ثنائي الجبهة (BPD)وعمر الحمل بناءً على آخر دورة شهرية (LMP) في الثلث الثالث من الحمل، واستقصاء تأثير وضعية الجنين، ووضع المشيمة، وعمر الأم على التباين بينهما. **الطريقة :**أجريت هذه الدراسة المقطعية في عيادة خاصة للموجات فوق الصوتية في الكوت، العراق، في الفترة من أبريل إلى يوليو 2024. تم إدراج 75 امرأة حامل بجنين واحد في الأسبوع 21-40 من الحمل. تم قياس القطر ثنائي الجبهة (BPD) باستخدام مسبار منحني بتردد 3.5 ميجاهرتز (Philips HD 11XE) في المستوى عبر المهاد. تم تصنيف الاختلافات بين الموجات فوق الصوتية وآخر دورة شهرية إلى ست فئات.(A-F) **النتائج :**معظم الحالات (39%) كان لديها فرق يتراوح بين 1 و7 أيام (الفئةB)، و29% كان لديهن فرق يتراوح بين 8 و14 يوماً (الفئةC) .بشكل عام، ارتبط عمر الأم بمدى التباين بين القياسين، حيث وُجد أفضل ارتباط لدى النساء في الفئة العمرية 21-30 عاماً. أدت الوضعية الأمامية للمشيمة إلى أقل قدر من التباين، بينما أدت الوضعية الخلفية إلى مزيد من أخطاء القياس. تم الحصول على أدق تقديرات للقطر ثنائي الجبهة (BPD) في حالات الوضع الطولي الرأسي للجنين. **الاستنتاج :**يُعد القطر ثنائي الجبهة (BPD) أداة جيدة لتقدير عمر الحمل خلال الثلث الثالث، لكن أداءه يقل مع زيادة تقدم الحمل. يوصى بشدة باستخدام القطر ثنائي الجبهة (BPD) جنباً إلى جنب مع مؤشرات قياسات حيوية أخرى مكملة بالإضافة إلى العوامل المتعلقة بالأم والجنين.

الكلمات المفتاحية: القطر ثنائي الجبهة، عمر الحمل، التصوير بالموجات فوق الصوتية، آخر دورة شهرية، الثلث الثالث من الحمل، القياسات الحيوية للجنين، العراق.

1. Introduction

The estimation of gestational age (GA) and the estimated date of delivery (EDD) are an integral part of antenatal care. Clinicians rely on reliable GA data to keep monitoring fetuses, plan interventions, interpret biochemical screening results and time delivery [1]. There are two common approaches used in clinical practice: the calculation of the due date from the last menstrual period (LMP), and estimating the due date using obstetric ultrasonography (USG).

While LMP based dating is easy and widely available, it relies on correct memory of the woman's last period and consistency in her cycle. Previous studies have repeatedly demonstrated that between 10% and 45% of women cannot reliably report their LMP due to irregular cycles, recent use of oral contraceptives or intermenstrual bleeding [4]. If the difference between LMP and early USG is more than 1 week, the USG estimate should be used as the preferred one, as it is superior [4].

The biparietal diameter (BPD) stands out as one of the most established indices when it comes to ultrasonographic biometric parameters, being measured from the outer aspect of the near parietal bone to the inner aspect of the far parietal bone at the point of cavum septum pellucidum [11]. Hadlock et al. showed that the 95% confidence interval for BPD based GA is ±1 week between 14 and 21 weeks [1]. Measurement variability ±2 SD is progressive and increases from approximately 2.1 weeks at 20–26 weeks to 4.1 weeks at 32–42 weeks [2] indicating an increasing influence of the individual fetal growth trajectories.

In addition to gestational dating, BPD is also used in the assessment of central nervous system abnormalities, in screening for intrauterine growth restriction (IUGR), and to monitor fetal well-being [5]. Cephalic index (CI = BPD / fronto-occipital diameter × 100) helps to identify the dolichocephalic and brachycephalic head shapes that can be a confounder in the GA based on BPD [6]. Population-specific BPD reference charts are important because other factors, such as ethnicity, maternal nutrition status and sociodemographic factors, can affect fetal head dimensions [6].

Although there has been a large volume of literature regarding the accuracy of BPD in early and mid-pregnancy, the data of the Iraqi population, especially the Wasit governorate, is still very limited. The aim of this study was therefore to estimate the level of agreement between

BPD derived and LMP derived GA in the third trimester and to explore the factors affecting the accuracy of the measurements.

1.1 objectives of the Study

To draw a correlation between fetal BPD and GA within the gestation period (21-40 weeks) in the local Iraqi population.

To assess the magnitude of difference between the BPD derived and LMP derived GA during the third trimester.

To check how accurate the BPD is in patients according to maternal age, fetal lie, and placental position.

2. Materials and Methods

The current study was a cross-sectional study using consecutive sampling that was conducted in Dr. Samer Al-Wazni private ultrasound clinic, Al-Kut, Wasit, Iraq, from April to July 2024. The study was conducted after obtaining permission from the College of Medicine, Wasit University.

2.1 Participants

A consecutive sample of 75 women with normal pregnancies referred for a routine obstetric ultrasound examination between 21 and 40 weeks of gestation was obtained. All participants gave informed consent in writing.

2.2 Inclusion Criteria

History of regular menstrual periods (26–33 days) for at least 3 months before becoming pregnant, and known and reliable LMP.

- Singleton, live IUP.
- Maternal age 17–45 years.

– Fundal height in line with gestational age on clinical assessment.

A live delivery of a baby weighing ≥ 2500 g within 1 week of EDD.

No congenital abnormality of the fetus.

2.3 Exclusion Criteria

Anomalies of the head shape: brachycephaly, dolichocephaly or anencephaly.

More than one pregnancy, low amniotic fluid, high amniotic fluid or intrauterine growth retardation.

- Chronic diseases of the mother that affect fetal size (DM, hypertension, renal disease).
- History of tobacco, alcohol or drug use; oral contraceptives use within 3 months of conception.
- Structural abnormalities of the uterus (fibroids, bicornuate uterus).
- Previous low birth-weight baby; age < 16 or > 45 years; maternal height < 140 cm.

2.4 Ultrasound Technique

All scans were done with a Philips HD 11XE ultrasound machine with a 3.5 MHz curvilinear transabdominal probe. First it was confirmed that fetal lie and curvature of the spine were present. After that, the transducer was turned perpendicular to the fetal spine and pushed forward to get a transverse plane at the same transthalamic level, which is a symmetric oval section that shows the falx cerebri in the middle, cavum septum pellucidum anteriorly and thalami posteriorly. BPD was taken as the distance between the outer margin of the proximal parietal bone and the inner margin of the distal parietal bone ('outer to inner' method).

The surveillance windows for the scans were: 12–14 weeks (early anomaly scan), 18–20 weeks (targeted anomaly scan), 28–32 weeks (growth scan), and 32–40 weeks (growth scan) at 2–3-week intervals.

2.5 Statistical Analysis

Microsoft Excel 2013 (Microsoft Corporation, Redmond, WA, USA) was used to record and analyse the data. Frequencies and percentages are used to represent categorical variables.

Because BPD-derived GA and LMP-derived GA results were compared, there were six categories (A–F) of discrepancies (days apart).

3. Results

A total of 75 pregnant women (mean maternal age 27.9 ± 2.41 years; 17–45 years) were included in this study. Most of the ultrasound examinations (90.8%) were conducted in late pregnancy and 41.9% of the subjects were self-referred.

3.1 Gestational Age Discrepancy (Table 1)

Table 1 is a summary of the distribution of discrepancies between the GA estimated by BPD (USG) and the GA calculated by LMP. Category B (1–7 days) was the largest group (n = 29; 39%), followed by Category C (8–14 days; n = 22; 29%) and Category D (15–21 days; n = 14; 19%). With only 4% in complete concordance (Category A) and only 9% with discrepancies more than three weeks (Categories E and F), there was a significant lack of agreement.

Table 1. Distribution of differences in gestational age calculation between USG-BPD and LMP

Category	Difference in GA Calculation	No. of Cases	Percentage (%)
A	None (0 days)	3	4%
B	1 – 7 days	29	39%
C	8 – 14 days	22	29%
D	15 – 21 days	14	19%
E	22 – 28 days	4	5%
F	29 – 35 days	3	4%
Total		75	100%

3.2 Influence of Maternal Age (Table 2)

There was greater agreement between BPD-derived and LMP-derived GA in women 21-30 years old, and highest number of discrepancies in maternal age categories B and C, with women 41-50 years old having the highest proportions of discrepancy categories D and E, reflecting greater variability in measurement with greater maternal age.

Table 2. Relationship between maternal age and gestational age discrepancy categories

Age (yrs)	A	B	C	D	E	F
11–20	1 (1.3%)	7 (9.4%)	4 (5.3%)	–	–	–
21–30	2 (2.7%)	17 (23%)	9 (12%)	12 (16.3%)	1 (1.3%)	3 (4%)
31–40	–	5 (6.6%)	8 (10.5%)	1 (1.3%)	1 (1.3%)	–
41–50	–	–	1 (1.3%)	1 (1.3%)	2 (2.7%)	–
Total	3 (4%)	29 (39%)	22 (29%)	14 (19%)	4 (5%)	3 (4%)

3.3 Influence of Placental Position (Table 3)

There was a higher degree of variability, with posterior implantations (n = 32; 42.8%) being the most common site and Category B (18.8%) and D (9.5%) being the most common posterior implantations. There was a similar distribution of anterior placentation between Categories B (17.5%) and C (17.1%) which suggests a relatively stable BPD value.

Table 3. Effect of placental position on gestational age discrepancy categories

Placental Position	A	B	C	D	E	F
Anterior	1 (1.3%)	13 (17.5%)	13 (17.1%)	6 (8.1%)	3 (3.7%)	–
Posterior	2 (2.7%)	14 (18.8%)	8 (10.5%)	7 (9.5%)	–	1 (1.3%)
Fundal	–	2 (2.7%)	–	1 (1.3%)	–	2 (2.6%)
Anteriofundal	–	–	1 (1.3%)	–	1 (1.3%)	–
Total	3 (4%)	29 (39%)	22 (29%)	14 (19%)	4 (5%)	3 (4%)

3.4 Influence of Fetal Lie (Table 4)

The fetal lies in discrepancy were predominantly longitudinal for all categories with 35% of Category B and 23.7% of Category C cases. The greater scatter observed for non-cephalic presentations (breech and transverse) was further evidence for the technical difficulties in determining the BPD in non-cephalic presentations, especially in Categories C and D.

Table 4. Effect of fetal lie on gestational age discrepancy categories

Fetal Lie	A	B	C	D	E	F
Longitudinal (cephalic)	3 (4%)	26 (35%)	18 (23.7%)	12 (16.3%)	3 (3.7%)	2 (2.6%)
Longitudinal (breech)	–	2 (2.7%)	1 (1.3%)	2 (2.6%)	1 (1.3%)	1 (1.3%)
Transverse (left head)	–	–	2 (2.6%)	–	–	–
Transverse (right head)	–	1 (1.3%)	1 (1.3%)	–	–	–
Total	3 (4%)	29 (39%)	22 (29%)	14 (19%)	4 (5%)	3 (4%)

4. Discussion

This study compared the differences between the BPD and LMP-based GA estimates in 75 pregnant Iraqi women who visited a single ultrasound clinic during the second and third

trimesters [see comment: conflicts with title]. The percentage of discrepancies of ≤14 days was around 68%, a figure that is consistent with a large proportion of the international studies, and the 32% discrepancies reported show that BPD is a limited dating method during late pregnancy as previously described.

As seen in Table 1, the majority (39%) were category B (1-7 days) and were similar to what was seen by Naseem et al. [12] who reported that majority of discrepancies in the third trimester were within 1 week. The number of cases in categories D–F steadily decreased, as reported by Benson and Doubilet [2] with the interval becoming wider in their 32-42 week group (4.1 weeks) than in their 20-26 week group (2.1 weeks). The smaller proportion of zero discrepancy cases (4%; Category A) is due to the inherent biological variability in fetal head growth, which is accentuated during the third trimester.

The findings of the association between maternal age and GA discrepancy (Table 2) is a novel contribution of this study. There was greater concordance for women between the ages of 21 and 30 years, and increasing discrepancies for women between the ages of 31 and 50 years. The pattern observed is similar to that observed by Aggarwal & Sharma [13] who found that maternal age above 35 years was independently associated with increased prevalence of obstetric complications such as impaired uteroplacental blood flow, suboptimal fetal nutrition and asymmetric fetal growth restriction, all of which have the potential to influence fetal head dimensions and increase the difference between predicted and actual GA.

There was a significant impact on the accuracy of measurements from placental position (Table 3). Anterior placentation had lowest discrepancy in Categories B and C, confirming the results of Askr et al. [14] who found increased accuracy for BPD and TCD measurements when placentas were anterior. The technical explanation is clear: with an anterior placenta, the fetus' cranium is directly exposed to the sound, causing minimal attenuation and beam-deflection artefacts. Posterior placentas, however, require the operator to examine the fetal head through a deeper tissue plane which involves bowel loops, and this adds to the variability of the measurements.

The most operationally important determinant of the quality of BPD measurement was fetal lie (Table 4). The longitudinal cephalic position gave the best visualization of the transthalamic plane with the highest consistency within both Categories B (35%) and C (23.7%). Breech and transverse presentations interfered with the normal measurement plane, added beam angulation and elevated the incidence of cases in higher discrepancy categories. These findings are consistent with Al-Mlah et al. [15], who found that non-cephalic presentations were independently associated with increased measurement errors of BPD, especially after 31 weeks of gestation.

Together, the results indicate that there is a consensus that BPD alone is not enough for late pregnancy assessment of gestational age. Attempts have been made by Hadlock et al. [1] and later authors to use composite biometric equations that minimize the error of the single parameter by combining head circumference (HC), abdominal circumference (AC), and femur length (FL). Since BPD is technically suboptimal, TCD has been suggested as an alternative, as it is relatively independent of head shape and fetal position [14]. This multi-parameter approach is supported by our data especially in the case of older mothers, posterior placentas and fetal non-cephalic lie.

5. Conclusion

In conclusion, BPD is a clinically useful biometric parameter in the assessment of third trimester gestational age in Iraqi population with most cases revealing discrepancies of one week or less. Its accuracy, however, slowly decreases as gestation progresses, and is also influenced by three other variables, all of which are independent and important:

1. As maternal age increases (over 30 years), there is a greater BPD-LMP discrepancy, which may be attributed to age related changes in uteroplacental function and fetal growth trajectory.
2. The acoustic attenuation due to posterior implantation is higher, which is responsible for more variations in measurements than with anterior placenta.

Non-cephalic presentations (breech and transverse) of the fetus significantly reduce the accuracy of BPD-derived gestational age estimation and introduce increased errors of gestational age in the transthalamic plane.

The results of this work highlight the importance of having (i) population specific BPD reference charts for the Iraqi population, (ii) systematic use of composite biometric formulas (BPD + HC + AC + FL) in third trimester scanning, (iii) ancillary use of TCD in technically challenging cases, and (iv) formal assessment of fetal maturity by sonographic grading when precise GA could not be determined by the use of standard biometry alone. Further research is needed with larger, multicentric samples to obtain normative curves for the BPD in Iraq and to confirm the complementary use of TCD in all gestation periods.

Conflicts of Interest

The authors declare no conflicts of interest.

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