Clinical Significance of Discordance Between Fetal Biparietal Diameter and Femur Length

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OBJECTIVE: To investigate if fetal biometric discordance (FBD) between biparietal diameter (BPD) and femur length (FL) has an association with estimated fetal weight (EFW), fetal birth weight (FBW) and gestational age (GA) at delivery.

STUDY DESIGN: Records of 1496 women with singleton pregnancies who attended to our institution for pregnancy follow-up between January 1st 2009 and January 1st 2010 were retrospectively analyzed. Fetuses with FBD lasting until delivery were identified. Degree of discordance (DOD) was defined as the variation between BPD and FL in terms of days. DOD at the time of initial diagnosis of FBD (DOD-ID) and before delivery (DOD-BD), initial GA at diagnosis of discordance (GADD), GA at delivery, EFW and fetal birth weight (FBW) were determined for each fetus. Correlation and linear regression analysis was used to determine associations between study parameters.

RESULTS: GADD positively correlated with FBW (r:0.497, p<0.001) and gestational age at delivery (r:0.313, p=0.001), and negatively correlated with preterm delivery(PD) (r: -0.404, p<0.001). DOD before delivery positively correlated with difference between EFW prior to delivery and actual FBW (r:0.491, p<0.001).

CONCLUSIONS: Fetal biometric discordance, especially when diagnosed early in pregnancy is associated with increase in preterm and low birth weight deliveries. Also, increase in DOD-BD may result in FBW miscalculations.

Key Words: Fetal biometry, Biparietal diameter, Femur length, Estimated fetal weight, Low birth weight, Preterm delivery

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Introduction

Fetal biometric measurement with ultrasound (US) is the most commonly utilized method in determining an accurate gestational age (GA), estimating fetal size and monitoring fetal growth. Biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC) and femur length (FL) measurements are usually obtained during prenatal US scans, starting from the second trimester of pregnancy until delivery. These measurements are then compared with fetal biometric nomograms derived for each gestational week.[1]

Discordance between fetal biometric measurements are occasionally noted during routine pregnancy follow up. However, little is known about the possible effect of this finding on otherwise healthy pregnancies. The aim of this study is to investigate the effect of BPD-FL discordance on fetal outcome parameters such as estimated fetal weight (EFW), fetal birth weight (FBW) and GA at delivery.

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Material and Method

This study was conducted after gaining scientific and ethical approval from the institutional review board (Date 30.09.2010/No:57). Records of 1496 women with singleton pregnancies who attended to our institution for pregnancy follow-up between January 1st 2009 and January 1st 2010 were retrospectively analyzed. Patients with maternal risk factors such as extremes of maternal age (<18 and >40 years), low maternal weight (<50 kg), smoking beyond the first trimester of pregnancy, previous cesarean section, hypertension, pre-existing or gestational diabetes, as well as fetal risk factors such as abnormal first or second trimester screening tests, perinatal infections (TORCH), congenital malformations and chromosomal anomalies were excluded from the study.

Fetal biometric measurements were performed by four experienced obstetric sonographers (IG, NA, CD and OA) with a standard technique,[2] using G.E. LOGIQ S6 US device (General Electric Medical Systems, Milwaukee, WI, USA) with a 5 MHz curvilinear abdominal probe. Corresponding

GA for BPD and FL was expressed in completed days, according to Hadlock nomograms.[1] Estimated fetal weight (EFW) was calculated for each fetus prior to delivery, using the Hadlock 1 formulation, involving BPD, HC, AC, and FL measurements.[1] Fetal biometric discordance (FBD) was defined as presence of at least 7 days of variation between BPD and FL measurements, with one of the parameters being within 7 days of GA according to first trimester crown-rump length measurement (CRL). Fetuses with FBD lasting until delivery were identified. With these criteria, 201 fetuses with FBD were detected. In order to prevent fetal gender related bias, only female fetuses were included in the study (n:113).[3,4] Degree of discordance (DOD) was defined as the variation between BPD and FL in terms of days. DOD at the time of initial diagnosis of FBD (DOD-ID) and before delivery (DOD-BD) were calculated. Initial GA at diagnosis of discordance (GADD), GA at delivery and FBW were recorded for each fetus. Preterm delivery (PD) was defined as delivery before 259 gestational days (37 weeks) and low birth weight (LBW) was defined as FBW below 2500 g. Fetal growth restriction (FGR) was defined as EFW below 10th percentile for GA. Umbilical artery doppler was performed in cases with suspected FGR.

Study data were analyzed with Statistical Package for the Social Sciences (SPSS) program, version 15.0 (SPSS Inc, Chicago, IL, USA). Continuous variables were expressed as mean ± standard deviation (SD) and categorical variables were presented numerically and by percentage. Paired samples t-test was used to compare the difference between DOD-ID and DOD-BD. Correlation and linear regression analysis was used to determine associations between study parameters. Receiver operating characteristic (ROC) curve analyses were performed, and cut-off levels were identified for GADD and DOD-ID for PD and LBW detection. Binary logistic regression was used to calculate odds ratios. $P < 0.05$ was considered statistically significant.

Results

Mean maternal age of the study population was 25.3 ± 4.0 years (min 19- max 38). Of the 113 included fetuses with FBD, eighty three (73.4%) fetuses were delivered vaginally, while the remaining 30 fetuses (36.6%) were delivered via cesarean section. Mean FBW was 2982 ± 455 gr and 17 (15%) fetuses had LBW at delivery. Mean GA at delivery was 263 ± 11.9 days. Thirty-two (28.3%) fetuses had PD, whereas 81 (71.7%) fetuses had term delivery. Seventy seven fetuses (68.1%) had FL measurements ≥ 7 days smaller than BPD, and 36 fetuses (31.9%) had BPD measurements ≥7 days smaller than FL. PD and LBW rates were similar between groups of fetuses with small FL or BPD ($p>0.05$). Mean GADD was 140.1 ± 12.8 days (min 117- max 168). Mean DOD-ID was 10.5 ± 2.9 days (min 7- max 17). Mean DOD-BD was 12.6 ± 3.8 days (min 7- max 25). The difference between DOD-ID and DOD-BD was statistically significant ($p<0.001$).

GADD positively correlated with FBW (r:0.497, $p<0.001$) and GA at delivery (r:0.313, $p=0.001$), and negatively correlated with PD (r: -0.404, $p<0.001$). Regression analysis revealed a linear association between GADD ($p<0.001$), DOD-ID ($p<0.001$), DOD-BD ($p=0.005$) and LBW delivery, after adjustment for GA. Cut-off levels were identified for GADD (<126 days) and DOD-ID (>10 days), using ROC curves. According to these cut-off levels, odds-ratios, sensitivity and specificity percentages, positive and negative predictive values were calculated for PD and LBW detection (Table 1-2).

Table 1: Receiver operating characteristic (ROC) curve data for prediction of LBW

Parameter	Area Under Curve	Sens for LBW (%)	Spec for LBW (%)	Positive predictive value	Negative predictive value	p
GADD < 126 d	0.960	85	88	0.88	0.85	<0.001
DOD-ID > 10 d	0.826	94	64	0.94	0.63	<0.001

OR: Odds ratio, GADD: gestational age at diagnosis of discordance, DOD-ID: Degree of discordance at the time of initial diagnosis, LBW: Low birth weight, Sens: Sensitivity, Spec: Specificity

Table 2: Odds-ratios for PD and LBW

Parameter	OR for PD	OR for LBW
GADD < 126 d	**7.9** (95%CI 3.3-23.5, p<0.001)	**42.9** (95%CI 8.8-208.3, p<0.001)
DOD-ID > 10 d	**5.7** (95%CI 2.9-16.4, p<0.001)	**27.3** (95%CI 3.4-215.4, p=0.002)

OR: Odds ratio, GADD: gestational age at diagnosis of discordance, DOD-ID: Degree of discordance at the time of initial diagnosis, LBW: Low birth weight

DOD-BD positively correlated with difference between EFW prior to delivery and actual FBW (r:0.491, p<0.001). Presence of DOD-BD ≥ 14 days could predict ≥ ± 15% variation between EFW and FBW, with 86% sensitivity, 71% specificity [OR 33.3 (95%CI 5.3- 209, P<0.001)].

Discussion

Prenatal obstetric US as a method to confirm fetal viability and well-being is widely accepted by physicians throughout the world. Besides these, obstetric US is commonly used to measure fetal parts (i.e. fetal biometry) in order to detect deviations from normally accepted values for each gestational week.[1] Measurement of BPD, HC, AC and FL has become a standard approach to estimate fetal weight. In various populations, there may be some variations from the proposed "normal" values. However, the importance of discordance between BPD and FL measurements remains unclear. This study was carried out in an attempt to investigate if FBD has an effect on EFW, GA at delivery and FBW. Also, the effect of DOD-BD on prediction of actual FBW was assesed.

Only female fetuses were evaluated in our study, as a number of previous publications suggested that male fetuses had significantly larger head circumference (HC) and biparietal diameter (BPD) measurements compared to female fetuses.[5] These fetal sex-related differences were established by as early as 16 weeks of gestation and tended to increase with advancing GA.[5] In light of these data, to prevent gender related bias, we elected to include only female fetuses.

Prenatal US scans are performed approximately once every four weeks at our institution. In this study, mean GADD was nearly 140 days (i.e. 20 gestational weeks), meaning that chances of diagnosing FBD is high in 18-23 weeks' scan, which also provides an invaluable opportunity to detect major fetal anomalies. Early GADD was associated with an increased risk of LBW, and PD (Table 1). As prenatal US intervals were non-homogenous in our study population, the exact time of FBD occurrence could not be identified. DOD-ID more than 10 days also increased the risk of LBW and PD.

We intended to assess the effects of FBD on low-risk pregnancies. However, it should be remembered that FBD may represent a sign for chromosomal anomalies (especially Down syndrome). In a previous study, the sensitivity of BPD-to-FL ratio and actual FL-to-expected FL ratio as a screening technique for Down syndrome was 66.7 and 100 percent, with a specificity of 93.4 and 89.2 percent, respectively.[6] The authors suggested that these sonographic parameters may be a useful method in screening for Down syndrome.[6] However, there is currently lack of adequate evidence to support Down syndrome screening based solely on US measurements. As our study included only fetuses with low-risk for aneuploidy, we could not provide information on the value of FBD presence on Down syndrome screening.

Decrease in BPD or FL may also be evident in fetal growth restriction (FGR).[7] However, it is well established that the major determinant of FGR is retardation in AC growth. In our study population, however, FBD was caused by mainly by BPD-FL discordance, and AC measurements were mostly within normal limits for GA. Umbilical artery doppler scans were also normal in all fetuses with suspected risk of FGR. Hence, we believe that most of the LBW infants in our study were due to preterm delivery rather than FGR.

Birth weight estimations with US at term pregnancies are generally no more accurate than predictions that are based solely on quantitative assessment of maternal and pregnancy-specific characteristics.[8] In a previous study, Hadlock 1 and 2 formula gave the closest approximation of birth weight in a Turkish population.[9] Hadlock 1 formula is used for EFW calculation in our institution. In previous studies, actual FBW was found to be mostly within ±10-15% limits of EFW. However, we have found that discordance between BPD and FL causes a larger variation between EFW and FBW, especially when DOD-BD is ≥14 days. We also noted that DOD tended to increase with advancing gestation, which could cause further miscalculation of EFW.

In conclusion, this study suggests that FBD - especially when diagnosed early in pregnancy - is associated with increased PD and LBW rates. Clinicians should also be aware of the effect of FBD on EFW, as miscalculations may lead to unnecessary interventions.

Fetal Bipariyetal Çap ve Femur Uzunluğu Arasındaki Diskordansin Klinik Önemi

AMAÇ: Bipariyetal çap (BPD) ve femur uzunluğu (FL) arasındaki fetal biyometrik diskordans (FBD) ile tahmini fetal ağırlık (EFW), fetal doğum ağırlığı (FBW) ve doğum sırasındaki gestasyonel yaş (GA) arasındaki ilişkinin araştırılmasıdır.

GEREÇ VE YÖNTEMLER: Kurumumuzda 1 Ocak 2009 ile 1 Ocak 2010 arasında takipleri yapılan 1496 tekiz gebenin kayıtları retrospektif olarak incelendi. FBD, BPD-FL arasındaki en az 7 gün fark bulunması olarak tanımlandı. Doğuma kadar FBD devam eden fetüsler belirlendi. Diskordans derecesi (DOD), BPD-FL arasındaki farkın gün cinsinden değeri olarak tanımlandı. FBD'nin ilk tespit edildiği (DOD-ID) ve hemen doğum öncesi (DOD-BD) diskordans dereceleri, diskordansın tespit edildiği gestasyonel yaş (GADD), doğum haftası, EFW ve fetal doğum ağırlığı (FBW) her fetüs için belirlendi. Çalışma parametreleri arasındaki ilişkinin değerlendirilmesinde korelasyon ve lineer regresyon analizi kullanıldı.

BULGULAR: GADD, fetal doğum ağırlığı (r:0,497, p<0,001) ve doğum haftası (r:0,313, p=0,001) ile pozitif, preterm doğum (PD) (r: -0,404, p<0,001) ile negatif korele idi. Doğum öncesi diskordans derecesi, EFW ile gerçek doğum ağırlığı arasındaki fark ile pozitif korele olarak bulundu (r:0,491, p<0,001).

SONUÇ: Özellikle erken gebelikte tespit edilen fetal biyometrik diskordans, preterm doğum ve düşük doğum ağırlığı ile ilişkilidir. Ayrıca, doğum öncesindeki diskordans derecesi arttıkça fetal doğum ağırlığının hesaplanmasındaki hata oranı artmaktadır.

Anahtar Kelimeler: Fetal biyometri, Bipariyetal çap, Femur uzunluğu, Tahmini fetal ağırlık, Düşük doğum ağırlığı, Preterm doğum

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