OBSTETRICS

The association between fetal Doppler and admission to neonatal unit at term

Asma A. Khalil, MD, MRCOG; José Morales-Rosello, MD; Malaz Elsadigg; Naila Khan; Aris Papageorghiou, MD, MRCOG; Amar Bhide, MD, MRCOG; Basky Thilaganathan, PhD, MRCOG

OBJECTIVE: Fetal cerebroplacental ratio is emerging as a better proxy than birthweight for placental insufficiency and as a marker of fetal compromise at term. The extent to which these fetal Doppler changes are related to neonatal outcomes has not been systematically assessed. The main aim of this study was to evaluate the association between estimated fetal weight percentile, cerebroplacental ratio recorded at 34^{+0}—35^{+6} weeks' gestation, and neonatal unit admission at term.

STUDY DESIGN: This was a retrospective cohort study in a tertiary referral center over an 11 year period from 2002 to 2012. The umbilical artery pulsatility index (PI), middle cerebral artery PI, and cerebroplacental ratio were recorded at 34^{+0}—35^{+6} weeks. Weight values were converted into percentiles and Doppler parameters into multiples of the median (MoM), adjusting for gestational age. Logistic regression analysis was performed to identify, and adjust for, potential confounders.

RESULTS: We identified 2518 pregnancies in which a scan was performed at 34^{+0}—35^{+6} weeks and delivery occurred at or beyond 37 weeks. In the 2485 pregnancies included in the analysis, the umbilical artery PI MoM was significantly higher, and the middle cerebral artery PI and cerebroplacental ratio MoM significantly lower in the babies requiring neonatal unit admission ($P < .05$). However, the estimated fetal weight percentile was not significantly different between those who required neonatal unit admission and those who did not ($P = .087$). According to multivariate logistic regression, cerebroplacental ratio MoM (odds ratio, 0.39; 95% confidence interval, 0.19—0.79; $P = .008$) and gestational age at delivery (odds ratio, 0.70; 95% confidence interval, 0.61—0.80; $P < .001$) were significantly associated with the risk of neonatal unit admission, whereas maternal age and birthweight percentile were not ($P = .183$ and $P = .460$, respectively). Irrespective of birthweight or estimated fetal weight percentile, the fetal cerebroplacental ratio appears to be a better predictor of the need for neonatal unit admission ($P < .001$).

CONCLUSION: Lower cerebroplacental ratio and gestational age at delivery, but not fetal size, were independently associated with the need for admission to the neonatal unit at term in a high-risk patient group. The extent to which fetal hemodynamic assessment could be used to predict perinatal morbidity and optimize the timing of delivery merits further investigation.

Key words: birthweight, cerebroplacental ratio, Doppler, neonatal unit admission, small for gestational age

Cite this article as: Khalil AA, Morales-Rosello J, Elsadigg M, et al. The association between fetal Doppler and admission to neonatal unit at term. Am J Obstet Gynecol 2014;212:xx-xx.

Small for gestational age (SGA), defined as birthweight (BW) less than the 10th percentile for gestation, is commonly used as a proxy to identify fetuses at risk of adverse outcomes secondary to fetal growth restriction.[1,2] However, the majority of SGA babies are not pathologically growth restricted and do not demonstrate signs of placental insufficiency. The clinical definition of SGA is further confused by the finding that a proportion of average for gestational age (AGA) infants also fail to meet their growth potential or, more correctly, suffer from occult placental insufficiency.[3,4]

We and others have recently reported that fetal Doppler assessment immediately prior to delivery at term might be of value in detecting AGA pregnancies that are at increased risk of adverse outcome from fetal hypoxemia secondary to placental insufficiency and failure to reach growth potential.[4,5] Fetal Doppler indices assessed just prior to delivery appear to be a better marker than BW or BW percentile for adverse pregnancy outcomes, such as the need for operative delivery for fetal compromise in an average risk group for fetal growth restriction (FGR).[4,5] However, national guidance in the United Kingdom and the United States does not recommend the use of fetal Doppler as a screening tool for placental insufficiency, except when the fetus is already known to be SGA.[1,2] The antenatal diagnosis of FGR using fetal biometry alone has recently been challenged, and the use of fetal Doppler assessment has been proposed as a potentially better marker.[4,6,7]

It is now increasingly routine in many hospitals and individual practices to undertake a 34-36 week ultrasound scan for fetal assessment. There is a paucity of data to support such routine assessment, but nevertheless its proponents are convinced of its utility. The main aim of this study was to investigate the association between fetal Doppler and

From the Fetal Medicine Unit, St George's Hospital, St George's University of London, London, England, UK.

Received June 15, 2014; revised Aug. 23, 2014; accepted Oct. 7, 2014.

The authors report no conflict of interest.

Corresponding author: Asma Khalil, MD, MRCOG. asmakhalil79@googlemail.com

0002-9378/$36.00

http://dx.doi.org/10.1016/j.ajog.2014.10.013

ultrasound parameters at the 34-36 week growth scan and the need for neonatal unit admission at term.

Materials and Methods

This was a retrospective cohort study in a single tertiary referral center over an 11 year period from 2002 to 2012. Cases were identified by searching the ViewPoint database (ViewPoint 5.6.8.428; ViewPoint Bildverarbeitung GmbH, Weßling, Germany) in the Fetal Medicine Unit, St George's Hospital. The inclusion criteria were singleton morphologically normal fetuses born at term that had previously had an ultrasound scan at 34^{+0}–35^{+6} weeks' gestation for a variety of indications such as suspected poor/excessive fetal growth, reduced fetal movements, history of SGA or large for gestational age baby, high midtrimester uterine artery Doppler indices, and gestational diabetes. Therefore, these pregnancies were at risk of fetal growth disorders.

Pregnancies complicated by fetal abnormality, aneuploidy, or antepartum stillbirth were excluded from the analysis. Gestational age (GA) was calculated from the crown-rump length measurement at 11-13 weeks, and only 1 examination (the last in the 34^{+0}–35^{+6} week window) per fetus was included in the analysis.[8] Routine fetal biometry was performed according to a standard protocol and the estimated fetal weight (EFW) calculated using Hadlock's formula.[9] Data on pregnancy outcomes were collected from hospital obstetric and neonatal records.

The umbilical artery (UA) and middle cerebral artery (MCA) Doppler were recorded using color Doppler, and the pulsatility index (PI) calculated according to a standard protocol.[10,11] The cerebroplacental ratio (CPR) was calculated as the simple ratio of the MCA PI to the UA PI.[12] All Doppler indices were converted into multiples of the median (MoM) correcting for GA using reference ranges, and BW values were converted into percentiles.[4,13,14]

The study cohort was divided into 4 groups according to a combination of a BW cutoff of the 10th percentile and an optimal CPR cutoff of 0.6765 MoM[4] to assess the difference between the SGA model, which relies on fetal biometry, and the placental insufficiency model, which relies on fetal hemodynamic assessment. This was derived from our previous work in which, to define the threshold for the failure to achieve growth potential, we calculated the fifth centile of the CPR in the group least likely to present with failure to achieve growth potential (those with BW greater than the 90th percentile). This value corresponded to 0.6765.[4]

Data on admission to the neonatal unit were ascertained from the maternity and neonatal records. The indications for admission to the neonatal unit were respiratory complications (defined as respiratory distress syndrome and transient tachypnea of the newborn, use of continuous positive airway pressure, endotracheal intubation), hypoglycemia, sepsis, need for phototherapy, post-resuscitation observation, seizures, and hypothermia.

Statistical analysis

Categorical data were presented as number (percentage) and were compared using the Fisher exact test or the χ^2 test. Continuous data were presented as median (interquartile range [IQR]). The D'Agostino and Pearson Omnibus test was used to assess the normality of the data. Nonparametric analysis using the Mann-Whitney *U* test was then used to compare continuous data between the study groups. A logistic regression analysis was performed to identify, and adjust for, potential confounders. Both unadjusted and adjusted odds ratios (ORs) were calculated. The analysis was performed using the statistical software packages SPSS 18.0 (SPSS Inc, Chicago, IL), Stata 11 (release 11.2; College Station, TX), and GraphPad Prism 5.0 for Windows (InStat; GraphPad Software Inc, San Diego, CA).

Results

We identified 2518 pregnancies with fetal Doppler assessment at 34^{+0}–35^{+6} weeks, in which the delivery occurred at or beyond 37 weeks' gestation. We excluded 33 pregnancies (1.3%) because they had aneuploidy, major structural abnormalities, stillbirth, or missing outcome data, leaving 2485 pregnancies included in the analysis. The maternal characteristics, ultrasound, and birth indices in the groups requiring and not requiring admission to the neonatal unit are shown in Table 1. The prevalence of SGA, defined as BW less than the 10th percentile and the fifth percentile, was 25.8% and 14.0%, respectively.

The overall neonatal admission rate in the study cohort was 6.7%. This fell with advancing gestation from 16.8% to 8.7%, 4.2% and 4.2% at 37, 38, 39, and longer than 40 weeks, respectively. The most common indications for admission to the neonatal unit were respiratory complications and post-resuscitation observation. There were 2 early neonatal deaths and 1 late neonatal death.

The scatter plot of CPR MoM values against BW percentiles showed a significant linear relationship (Figure 1: CPR MoM = (0.0019 × BW percentile) + 0.9705, $R^2 = 0.049$). At the ultrasound assessment, UA PI MoM was significantly higher and MCA PI and CPR MoM were significantly lower in the neonates requiring neonatal unit admission ($P < .05$, Table 1, Figure 2), but the EFW percentile was not significantly different between the 2 study groups ($P = .087$).

The results of the regression analysis are shown in Tables 2 and 3. According to a multivariate logistic regression, CPR MoM, GA at delivery, maternal ethnicity, and male gender were significantly associated with the risk of neonatal unit admission ($P < .05$), whereas maternal age and BW percentile were not ($P = .183$ and $P = .460$, respectively). When divided into 4 groups according to a combination of a BW cutoff of the 10th percentile and an optimal CPR cutoff of 0.6765 MoM, the rates of neonatal unit admission were significantly different ($P < .001$, Figure 3).

The incidence of admission to the neonatal unit in the AGA neonates with low CPR (9.8%) was almost double that in the group of AGA with normal CPR (5.5%). However, the difference in the admission rates between the groups of AGA with low CPR and AGA with

FLA 5.2.0 DTD ■ YMOB10069_proof ■ 2 December 2014 ■ 6:17 pm ■ ce