Doppler waveform patterns of the umbilical artery — screening test for high risk pregnancies

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Abstract

Doppler assessment of umbilical artery waveforms using the peak systolic to end diastolic (S/D) ratio was used to determine if complications associated with impaired trophoblastic invasion of placental bed (i.e. pregnancy induced hypertension and intrauterine growth retardation) could be predicted. Values for S/D ratio of at least 4, 3.5 and 3 at 22–26, 30–32 and ≥37 weeks gestation, respectively, were found to be better predictors of such complications. Pregnancy-induced hypertension could be predicted in 63% and growth retardation in 60% cases at 22–26 weeks of gestation.

Keywords: Doppler; Umbilical artery waveforms; High risk pregnancy; Pregnancy induced hypertension; Growth retardation.

Introduction

Normal fetal growth and development depend on adequate perfusion of the intervillous space. It has long been recognised that impaired perfusion is associated with pregnancy induced hypertension (PIH) [3] and intrauterine growth retardation (IUGR) [12]. Hypertension or clinically evident fetal growth retardation are late signs in a disease process. Most methods for predicting these conditions are of value in the late second and early third trimesters.

Analysis of Doppler ultrasound waveform is currently accepted as a means of studying blood flow patterns of uteroplacental and fetoplacental circulations. Systolic-to-diastolic ratios (S/D ratio) of the umbilical artery waveforms have been used to assess downstream placental vascular resistance. Decreased end-diastolic velocities reflect increased peripheral vascular resistance [17] which in the placental bed may be due to restricted trophoblastic erosion of the maternal spiral arteries.

This study explores the hypothesis that measurement of umbilical artery blood velocity waveform patterns between 22 and 26 weeks might predict those pregnancies destined to become complicated by PIH and/or IUGR.

Materials and Methods

Consecutive 73 gravids with singleton pregnancies attending the antenatal clinic, who were willing to participate, were recruited for the study at 22–26 weeks of pregnancy. Doppler waveform patterns of the umbilical artery were studied at the time of
recruitment and repeated once between 30 and 32 weeks and again after 37 weeks.

A continuous wave Doppler duplex system with a 3.5 MHz transducer was used to calculate the peak systolic to end diastolic ratio. An average of 4 such readings was taken. A value of 3 was taken as the cut off, as it was seen most often that ratio ≥3 were associated with antenatal and perinatal problems [8,9,13,16].

A woman was considered to have PIH, according to the recommendations of the American College of Obstetricians and Gynecologists [5]. Gestational age assessment of infant at birth by modified Dubowitz method [7] and antenatal clinical assessment was used to classify the woman in IUGR group. Mann-Whitney U-test was applied to find out the significance of difference between the two averages and χ²-test were used where applicable.

Results

Doppler waveform patterns of the umbilical artery in 73 pregnancies revealed 4 patients with absent end-diastolic flow. Of the 69 gravidas with the presence of end-diastolic flow, 41 developed complications during the course of pregnancy viz: PIH (10), PIH with IUGR (20) and IUGR alone (11) and were grouped as high risk pregnancies.

Among these, 7 had repeat PIH, 1 was hypertensive, 5 had IUGR in previous pregnancies and 10 were poor obstetric performers. Of the high risk groups, 3 (7.3%) were aged less than 20 years and 4 were over 30 years; 14 were primigravidae. Age and parity distributions were comparable to the composition of normal group.

The average S/D ratios obtained at 3 different gestational periods in high risk pregnancies was found to be significantly higher than the normal group (Table 1). Receiver operator curve analysis suggested that S/D ratios of 4, 3.5 and 3 were better suited cut off values in predicting PIH and IUGR at 22–26 weeks, 30–32 weeks and 37–40 weeks, respectively, and their predictive efficacy is shown in Table 2.

Taking a cut off of 3 at any gestational age, this study predicted PIH at 22–26 weeks in all of the 30 cases who developed it. The first clinical record of hypertension was made by 30–32 weeks in 18 (60%) and later in the rest. With the cut off of 4, PIH could be predicted, at 22–26 weeks in 63% cases.

Of the 31 patients suspected to have IUGR, 27 had small for gestational age infants and 35 (93%) had high S/D ratio (≥3) at the initial Doppler study. With 4 as cut off, development of IUGR could be predicted in 70% of pregnancies. In contrast, the first sonologic or clinical evidence of IUGR was made at a later

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<th>Table 1. S/D ratio at different gestational ages.</th>
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<td>Normal (n=28)</td>
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<td>Hypertension (n=10)</td>
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<td>Hypertension with growth retardation (n=20)</td>
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<td>Intrauterine growth retardation (n=11)</td>
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Values ± mean ± 1 standard deviation
Mano-Whitney U-test: *P < 0.05; **P < 0.01; ***P < 0.001

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<th>Table 2. Predictive efficacy of S/D ratio cut offs at different gestational periods.</th>
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<td>S/D ratio</td>
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<td>Gestation (weeks)</td>
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<td>Sensitivity</td>
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<td>Specificity</td>
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<td>Positive Predictive value</td>
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period of gestation, i.e. 30–32 weeks in only 6 of 27 (22%) patients ($x^2 P < 0.001$).

**Discussion**

A considerable number of tests have been introduced to predict the future occurrence of hypertension. These include the roll over test and the infusion of vasoactive drugs. The former has a false positive rate of 16–46% and the latter is an invasive procedure with 10% false positive and false negative rates [6]. Other clinical [15], biochemical [18] and ultrasound imaging techniques [14] are of predictive value only in late second and early third trimesters. Assessment of uteroplacental blood flow has been done by methods which were either invasive or used radioisotopes [11]. Thus only ultrasound techniques are suitable for consideration as a screening tool in pregnancy.

This study of 41 high risk pregnancies has shown that analysis of umbilical artery flow patterns at 22–26 weeks gestation does appear to be of value in predicting the risk of pregnancy induced hypertension and intrauterine growth retardation.

Most authors have correlated the diagnostic efficacy in the prediction of perinatal outcome. Fleischer et al. [9] have predicted IUGR with a sensitivity of 87%, specificity of 81% and positive predictive value of 67%. Berkowitz et al. [2] also predicted IUGR at 32 weeks with a sensitivity of 55%, specificity of 92% and positive predictive value of 73%. However, the present study showed a sensitivity of 85%, specificity of 12% and positive predictive value of 88.5% with the cut off value of 3 at term; it could also predict IUGR by 22–26 weeks with sensitivity of 60%, specificity of 25% and positive predictive value of 72%, with 4 as the cut off value.

Campbell et al. [4] studied blood flow patterns of the arcuate artery prior to 22 weeks of gestation and reported that 64% of patients with high resistance flow developed PIH. As is seen from the present study, PIH can also be predicted by studying the umbilical artery S/D ratios as early as 22–26 weeks with a sensitivity of 59.3%, specificity of 25% and positive predictive value of 69.9% taking 4 as a cut off at this gestational age.

High S/D ratios of the umbilical artery waveform predicted, 6–8 weeks in advance, hypertension and IUGR in those who were destined to develop these complications.

Arduini [1] Berkowitz [2] and Gaziano [10] also found S/D ratio of the umbilical artery to be the first abnormal parameter in IUGR. Hence, the measurement of umbilical blood flow appears promising as a screening tool to indicate those pregnancies at risk of developing PIH or IUGR. It is felt that a Doppler study of the umbilical arteries between 22 and 26 weeks could be combined with routine ultrasound scan which would be more effective in identifying fetal morphology.

**Reference**


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