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Original Research Article

The value of colour doppler assessment of the uteroplacental circulation in predicting intrauterine growth restriction

Vimla Dhakar*, Sabiha Naz

Department of Obstetrics and Gynecology, GMCH, Udaipur, Rajasthan, India

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***Correspondence:**

Dr. Vimla Dhakar,

E-mail: vimladhakar1950@gmail.com

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ABSTRACT

Background: Intrauterine growth restriction is a complication that arises due to decrease in uteroplacental blood flow during pregnancy. This decrease is associated with a pathological condition of spiral arteries thought to arise during placentation in first trimester of pregnancy. Thus, it might be possible to predict the development of these conditions by assessing uteroplacental blood flow in pregnancy with colour Doppler. The aim of the study was to assess the findings of Doppler data in predicting IUGR and finding the best predictors of IUGR in uterine and umbilical artery Doppler.

Methods: In this prospective study, total of 100 women with high risk pregnancy attending Department of Obstetrics and Gynecology at Geetanjali Medical College and Hospital, Udaipur were subjected to uterine and umbilical artery Doppler Study. Women with high risk pregnancy between 26-32 weeks of gestation were studied with colour Doppler. This study was carried over a period of 1 year from 2015-2016.

Results: Out of total 100 patients, 8 were found to have IUGR. Out of different parameters, Notch is the best indicator with high sensitivity and highest positive predictive value (PPV) of 50% followed by combination of parameter as it had the highest sensitivity of 62.5% for uterine artery Doppler. S/D Ratio is the best indicator with high sensitivity and highest positive predictive value (PPV) of 25% and 40% respectively followed by RI with highest sensitivity of 42.86% for umbilical artery Doppler.

Conclusions: Value of Doppler assessment of uteroplacental circulation in predicting IUGR and is very useful in improving pregnancy outcome.

Keywords: IUGR, Notch, Resistance index, S/D ratio, Uterine artery Doppler, Umbilical artery Doppler

INTRODUCTION

The development of a good utero-placental circulation is essential for achievement of a normal pregnancy. Prevention of low birth weight (LBW) is a public health priority in India where, the condition is largely attributed to IUGR. A foetus affected by IUGR forms a subset of cases of small for gestational age (SGA) infants.¹

Foetus requires several nutrition for normal growth and all this nutrition are transported to foetus from the mother

through placenta. Any persistence decrease in the availability of these substances will limit the ability of the foetal growth potential.² The majority of conditions affecting foetal growth are placental in origin and the most common placental condition is alteration in the uteroplacental and fetoplacental circulation.³

Since there are several methods to identify, clinically the most common method of detecting IUGR is the serial measurement of fundal height and abdominal growth. Symphysio-fundal height normally increases by 1cm per

week between 14-32 weeks. A lag in fundal height of 4 weeks is suggestive of moderate IUGR while lag of 6 weeks suggest severe IUGR. But this method may be inaccurate in the presence of maternal obesity, leiomyomata and polyhydramnios.⁴ Thus, commonly used parameter includes biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length and various morphometric ratios. Foetal weight and AC are most accurate parameters for diagnosis of IUGR.⁵ Women identified with high risk of IUGR in antenatal period should be further screened with colour Doppler.⁶

METHODS

In this prospective study, total of 100 women with high risk pregnancy attending Department of Obstetrics and Gynecology at Geetanjali Medical College and Hospital, Udaipur were subjected to uterine and umbilical artery Doppler study. Women with high risk pregnancy between 26-32 weeks of gestation were studied with colour Doppler. This study was carried over a period of 1 year from 2015-2016. Patients with congenital anomaly of foetus or multiple gestations were excluded from the study.

The indices used for the study were

1. S/D ratio = $\frac{[\text{Peak systolic velocity (A)}]}{[\text{End diastolic velocity (B)}]}$
2. Resistance index (RI) = $\frac{\text{Peak systolic velocity} - \text{End diastolic velocity}}{\text{Peak systolic velocity}}$
3. Notch = End diastolic velocity

These patients were followed up till delivery, and details of pregnancy events, labor and delivery, and neonatal outcome were noted. The abnormal pregnancy outcomes considered were PIH and IUGR. Abnormal perinatal outcomes considered were intrauterine death, five minutes APGAR score, Neonatal intensive care unit (NICU) admission, and birth weight.

Uterine artery doppler

For uterine artery investigation, the patients were scanned in a semi recumbent position with a slight lateral tilt. This minimizes the risk of developing supine hypotension syndrome due to inferior caval compression. The patient's abdomen was exposed from the xiphisternum to the groin hairline. The uterine artery was located by the trans abdominal approach by placing the transducer longitudinally in the lower lateral quadrant of the abdomen with a slight medial angulation according to the method of Bhide et al.⁷ Color Doppler imaging was then used to identify the uterine artery as it is seen crossing the external iliac artery.⁷ The wall filter was kept at a low value (50-60 Hz) and the angle of insonation set below 20°C. Then, pulsed wave Doppler with a gate size of 2

mm was placed over it at about 1 cm below the crossover point to generate the wave pattern.⁷

Both uterine arteries were insonated, the right before the left. After recording six consecutive spectral waveforms of similar size and shape, measurements were made on three consecutive uniform waveforms. The RI, S/D ratio, Notch and combined parameters were measured from the waveforms and the mean value from the three measurements was obtained for each parameter.

Umbilical artery Doppler

A free loop of umbilical cord was then located with B-mode ultrasonography for simplicity and consistency of measurements.^{7,8} The umbilical artery was identified using color Doppler interrogation.⁷ Pulsed Doppler with a gate size of 2 mm was applied. Spectral peak average intensities were set below 100 m/wcm² in this study.⁹ Doppler velocities were recorded in the absence of fetal movement or uterine contraction.⁹ The RI, S/D ratio and combined parameters were measured from three consecutive uniform umbilical arterial waveforms and the mean for each parameter documented.

Statistical analysis

Statistical analysis was done using screening tests such as sensitivity, specificity and predictive values.

RESULTS

In this study, total of 100 study subjects were studied. Majority of them were of age 21-25 (55%) with 1 and II Gravida (74%). Placental position was central in majority (55%). Regarding pregnancy outcomes majority had normal outcome (86%) and 14% had some complications. Out of these 14% complications, 5% were of pre-eclampsia, 8% of PIH and IUGR and 3% were of IUD, abruption and delivery before 34 weeks. Majority had undergone normal delivery (58%) and 42% had LSCS, out of which 12% were elective LSCS Table 1.

Table 2 shows that, out of total 100 patients, 8 were found to have IUGR. It was observed that when both uterine and umbilical Doppler was abnormal, 100% of patients developed IUGR. When both were normal, only 2.56% developed IUGR. With abnormal uterine and normal umbilical Doppler, 25% developed IUGR and with abnormal umbilical and normal uterine Doppler 12.5% developed IUGR.

Table 3 reveals that Notch is the best indicator with high sensitivity and highest positive predictive value (PPV) of 50%. Also, combination of parameter is considered as good indicator as it had highest sensitivity of 62.5% and PPV of 35.71%. It has also been observed that in uterine artery Doppler when there was notch 50% of patients developed IUGR.

Table 1: Maternal characteristics.

Variables	Number of patients
Age	
<20	11
21-25	55
26-30	33
>30	01
Gravida	
1	36
2	38
3	19
4	05
>5	02
Placental position	
Left	22
Right	23
Central	55
Pregnancy events	
Normal	86
Pre-eclampsia	05
PIH	08
IUGR	08
IUD	03
Abruption	03
Delivery before < 34 weeks	03
Mode of delivery	
Vaginal	58
Emergency LSCS	30
Elective LSCS	12
Total	100

Table 2: Combination of uterine and umbilical Doppler values and IUGR.

Doppler values	IUGR	Total patients
Both normal	2 (2.56%)	78 (100%)
Normal uterine and abnormal umbilical Doppler	1 (12.5%)	8 (100%)
Normal umbilical and abnormal uterine Doppler	3 (25%)	12 (100%)
Both abnormal	2 (100%)	2 (100%)
Total	8 (8%)	100 (100%)

Table 3: Uterine artery Doppler parameters in predicting IUGR.

Indices	Sensitivity	Specificity	PPV	NPV
S/D ratio	37.5%	93.48%	33.30%	94.5%
RI	25%	94.56%	28.57%	93.55%
Notch	50%	95.65%	50%	95.65%
Combined	62.5%	90.22%	35.71%	96.51%

Table 4 reveals that S/D Ratio is the best indicator with high sensitivity and highest positive predictive value (PPV) of 25% and 40% respectively. Also, RI is considered as very good indicator as it had highest

sensitivity of 42.86% and PPV of 37.5%. It has also been observed that in umbilical artery Doppler when there was abnormal S/D ratio 40% of patients developed IUGR and with abnormal RI 37.5% developed IUGR.

Table 4: Umbilical artery Doppler parameters in predicting IUGR.

Indices	Sensitivity	Specificity	PPV	NPV
S/D ratio	25%	96.59%	40%	93.41%
RI	42.86%	94.62%	37.5%	95.65%
Combined	37.5%	92.39%	30%	94.4%

In our study 2 patients had abruption placenta and intra uterine foetal death. Both of them had abnormal indices in uterine artery Doppler. Out of 2 patients, 1 patient had bilateral notch in uterine artery and abnormal indices in both uterine and umbilical arteries and intra uterine foetal death at 35 weeks of gestation (IUGR). Another foetal death at 33 weeks of gestation with birth weight of 1.8 kg had abnormal S/D ratio in uterine artery and unilateral notch.

There was 1 more patient of abruption placenta who had bilateral notch and abnormal S/D ratio, who delivered a live baby at 34 weeks of gestation with birth weight of 1.8 kg.

There was 1 patient with absent end Diastolic flow in umbilical artery and bilateral notch in uterine artery that had intra uterine death at 32 weeks of gestation with IUGR birth of 1.1 kg which was delivered by induction.

DISCUSSION

This prospective study includes women from both rural and urban sectors and a predictive value of various Doppler indices has been evaluated. Prevalence of IUGR was 8%, which was similar to that quoted by North et al, (6.6%).¹⁰

Eight patients with IUGR, which was predicted by abnormal uterine artery Doppler in 5 cases with sensitivity of 37.5%, 25% and 50% for S/D ratio, RI and Notch respectively which is similar to findings of Irion et al, North et al, and Bower et al.¹⁰⁻¹² the sensitivity was 93.48%, 94.56% and 95.65% for S/D ratio, RI and Notch respectively. The Positive predictive value (PPV) of Notch was 50%, which was highest. Hence Notch was found to be best predictor as compared to other indices.

Out of 10 patients with abnormal umbilical artery Doppler, 3 had IUGR births with a sensitivity of 25% and 42.86% for S/D ratio and RI. It was similar to findings of Antsaklis et al, and Beattie et al, sensitivity of absent end Diastolic flow was 100%.^{13,14}

2 patients found to have both artery Doppler to be abnormal and both developed IUGR with 100% sensitivity and specificity.

Findings of our study regarding parameters is similar to Velauthar et al, did meta-analysis (18 studies of 55,974 women) and found that the sensitivities of abnormal uterine artery Doppler for predicting fetal growth restriction were 26.4% and 15.4%, respectively, and specificities were 93.4% and 93.3%, respectively.¹⁵ The positive predictive value of notch was 50%, which is the highest. Here again notch was the best predictor than any other indices.

Romero et al, studied 43 women, and among them, 52% had abnormal umbilical Doppler.¹⁶ They found that abnormal umbilical Doppler is associated with lower birth weight, lower APGAR score, and significant neonatal morbidity. Sensitivity of absent end diastolic flow was 100%.

These all results shows that abnormal Doppler values is associated with intrauterine growth restrictions which leads to poor pregnancy outcomes.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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