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Original Research Article

Fetal ductus venosus Doppler as a predictor of pregnancy outcome

Medhat S. Hewidy, Ahmed M. Hagras, Mohamed M. Elnamoury, Heba M. Hendy*

Department of Obstetrics and Gynecology, Faculty of Medicine, Tanta University, Tanta, Egypt

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***Correspondence:**
Dr. Heba M. Hendy,
E-mail: hebahendy68@gmail.com

ABSTRACT

Background: The ductus venosus (DV) transports oxygenated blood to the developing heart and brain by avoiding the hepatic circulation. Due to the anatomical location of the DV, measurement of DV blood flow velocity waveforms indirectly disclose the cardiac functions and health of the foetus, which represents the pressure gradient between the umbilical vein and right atrium. The aim of this study was to evaluate the value of ductus venosus pulstality index of veins in early pregnancy in prediction of adverse pregnancy outcomes.
Methods: 50 pregnant women with a single viable foetus between 13 and 24 weeks participated in this prospective cross-sectional study from 2021 to 2022 at Tanta University Hospital.
Results: PI in normal group ranged from 0.80-1.20 with mean value 0.90±0.130 and in abnormal group ranged from 0.46-0.50 with mean value 0.522±0.069. S/a ration in normal group ranged from 1.74-3.18 with mean value 2.30±0.40 and in abnormal group ranged from 1.50-2.05 with mean value 1.833±0.212. There was statistically significant difference between outcomes of pregnancy with ultrasound findings ($p<0.05$).
Conclusions: Numerous foetal disorders that might result in cardiovascular deterioration and other aberrant outcomes in newborns can be managed clinically and predicted perinatally using the DV Doppler examination.

Keywords: Doppler, Ductus venosus, Fetus, Outcomes, Pregnancy

INTRODUCTION

The ductus venosus (DV) transports oxygenated blood to the developing heart and brain by avoiding the hepatic circulation. The measurement of the blood flow velocity waveforms of the DV indirectly reflects the fetus's heart health and function, and the anatomical position of the DV reflects the pressure gradient between the right atrium and the umbilical vein.[1]

The foetal cardiovascular system relies on the ductus venousus to transfer the cardiac output as needed. Only in a few nations is the first-trimester screening a requirement for prenatal treatment, despite its critical role in identifying foetal chromosomal and anatomical defects. DV blood flow measurement is an optional component of first-trimester screening.[2] Doppler ultrasound has developed into a useful tool for evaluating the circulation of the foetus and placenta, forecasting unfavourable pregnancy outcomes, and minimising the need for emergency procedures, hospital admissions, and stays for both the mother and the child, particularly in situations where there is a possibility of intrauterine growth restriction (IUGR). Also, in timing delivery of severely growth-restricted fetuses by promoting the use of ductus venosus (DV) Doppler study. Doppler ultrasound study for fetal circulations would be a useful addition to the obstetrician catalog of tests for antenatal fetal well-being and timely intervention that might be effective in reducing mortality and major morbidity in high-risk pregnancy.[3]

Predicting chromosomal abnormalities, major congenital heart defects (CHD), and adverse pregnancy outcomes like miscarriage, stillbirth, small for gestational age, low birth weight, foetal growth restriction, and major congenital heart defect are all improved by incorporating abnormal DV blood flow patterns (reversed/absent a-wave or

increased pulsatility index for veins) to the first-trimester screening.[4]

The aim of this study was to evaluate the value of ductus venosus pulstality index of veins in early pregnancy in prediction of adverse pregnancy outcomes.

METHODS

50 pregnant women with a single viable foetus between 13 and 24 weeks participated in this prospective cross-sectional study from 2021 to 2022 at Tanta University Hospital.

Inclusion criteria

Uncomplicated, singleton pregnancy belonging to gestational age between 13-24 weeks were included for the study from 2021-2022.

Exclusion criteria

Multiple pregnancies, morbid obesity, congenital anomalies, structural anomalies of uterus and cervix, cases refusing study and cases refusing follow up.

All patients in this study were subjected to the following:

History taking

Personal (age, length of marriage, unique habits), menstrual (last menstrual period (LMP), regularity of cycle, length of cycle, and amount of flow of last menstrual period (LMP), obstetric (number of C-sections, abortion, placenta previa in previous pregnancy, history of ectopic pregnancy, medical disorder with pregnancy, and the number of children still alive), current history of any medical or obstetric problems, past history of postpartum sep.

Clinical examination: general and obstetric examination.

Ultrasound study

Fetal biometric measurements and congenital deformity detection, ductus Venosus Doppler was measured at 13-24 week with serial follow up and follow up of the cases was done at delivery to confirm the outcome. Follow up of cases with abnormal ductus venosus Doppler.

Transabdominal ultrasound

It was performed by Samsung Medison H60, Korea and 50/60 HZ trans-abdominal probe. Routine ultrasound examination including the placental site and af measure the CRL, Measure the biparietal diameter, femur length, and abdomen circumference to validate dating in instances during the first trimester and in cases during the second trimester. To prevent contamination from surrounding veins, the pulse wave of the doppler sample volume must be modest (0.5-1.0 mm) and located in the area of yellowish aliasing. Less than 30 degrees must be the insonation angle. Low frequency (50-70 Hz) filtering is used to conceal the a-wave. To ensure that the waveforms are spread out and allow for a better evaluation of the wave, speed must be high (2-3 cm/second).

Ethical consideration

The Tanta University Faculty of Medicine's ethics committee gave the study the thumbs up. The following provisions are sufficient to protect participants' privacy and the data's confidentiality.

Statistical analysis of the data

Utilizing the IBM SPSS software package, version 24.0, data were input into the computer (95) Number and percentage were used to describe qualitative data. The Chi-square test was used to compare differences in categorical variables between several groups. Mean and standard deviation were used to describe quantitative data that were normally distributed.

RESULTS

This study was conducted on 50 pregnant women with single viable fetus between 13-24 weeks at department of obstetrics and gynecology at Tanta University Hospital.

Table 1: Demographic data of the study group.

	Number	Percent
Age group		
<25	14	28.0
25-30	21	42.0
>30	15	30.0
Range	20.0-34.0	
Mean±SD	27.8±4.19	
Duration of marriage		
<2 years	13	26.0
3-5	29	58.0
>5	8	16.0
Range	1.0-6.0	
Mean±SD	3.62±1.67	

Table 1 shows demographic data of the studied group. Age from 25-30 was higher with 21 (42%) and ranged from 20-34 with mean value 27.8±4.19 and duration of marriage from 3-5 was higher with 29 (58%) and ranged from 1-6 with mean value 3.62±1.67.

Table 2 shows distribution of the studied groups regarding the outcome of pregnancy. Normal valid cases were 43 (86%), while abnormal cases were 7 (14%) included congenital heart defects 2 (4%), congenital malformation 1 (2%), low birth weight 3 (6%), and stillbirth 2 (4%).

Table 2: Distribution of the studied groups regarding the outcome of pregnancy.

Valid	Frequency	Percent
Normal	43	86.0
Abnormal	7	14.0
Congenital heart defects	2	4.0
Congenital malformation (trisomy 21)	1	2.0
Low birth weight	3	6.0
Stillbirth	1	2.0
Total	50	100.0

Table 3: Comparison between outcome of pregnancy with basic demographic and maternal data.

	Normal n=43	Abnormal n=7	t-test, p value
Age			
Range	20.00-34.00	20.00-31.00	1.375 0.247
Mean	28.14	26.14	
SD	4.16	4.30	
Duration of marriage			
Range	1.00-6.00	1.00-5.00	1.818 0.184
Mean	3.74	2.86	
SD	1.60	1.68	
G.A.			
Range	13.00-24.00	13.00-20.00	1.540 0.221
Mean	18.53	16.71	
SD	3.69	2.87	

t-test = student t-test; p was significant if <0.05; NS = not significant

Table 4: Comparison between outcome of pregnancy with ultrasound findings.

	Normal n=43	Abnormal n=7	t-test p value
PI			
Range	0.80-1.2	0.46-0.50	42.21 0.0001*
Mean	0.900	0.522	
SD	0.130	0.069	
S/a ratio			
Range	1.74-3.18	1.50-2.05	12.354 0.001*
Mean	2.30	1.833	
SD	0.40	0.212	

t-test = student t-test; p was significant if <0.05; * = significant

Table 3 shows that age in normal group ranged from 20-34 with mean value 28.14±4.16 and in abnormal group ranged from 20-31 with mean value 26.14±4.30. Duration of marriage in normal group ranged from 1-6 with mean value 3.74±1.60 and in abnormal group ranged from 1-5 with mean value 2.86±1.68. GA in normal group ranged from 13-24 with mean value 18.53±3.69 and in abnormal group ranged from 13-20 with mean value 16.71±2.87. There was no statistically significant difference between outcome of pregnancy with basic demographic and maternal data (p>0.05). There was no statistically significant difference between outcome of pregnancy with basic demographic and maternal data (p>0.05).

Table 4 shows that PI in normal group ranged from 0.80-1.20 with mean value 0.90±0.130 and in abnormal group ranged from 0.46-0.50 with mean value 0.522±0.069. S/a ration in normal group ranged from 1.74-3.18 with mean value 2.30±0.40 and in abnormal group ranged from 1.50-2.05 with mean value 1.833±0.212. There was statistically significant difference between outcome of pregnancy with ultrasound findings (p<0.05).

Table 5: Comparison between outcomes of pregnancy with pregnancy outcome.

	Pregnancy Out come				χ^2, p value
	Normal (n=43)		Abnormal (n=7)		
	No.	%	No.	%	
Regularity of the cycle					
Non regular	2	4.7	1	14.3	0.991
Regular	41	95.3	6	85.7	0.370 NS
Placenta previa in previous pregnancy					
No	32	74.4	6	85.7	0.421
Yes	11	25.6	1	14.3	0.458 NS
History of ectopic					
No	40	93.0	7	100.0	0.520
Yes	3	7.0	0	0.0	0.630 NS
Present history of obstetric problems					
No	28	65.0	4	57.1	0.166
Yes	15	34.9	3	42.9	0.495 NS
Past history of obstetric problems					
No	34	79.1	5	71.4	0.205
Yes	9	20.9	2	28.6	0.487 NS
Contraceptive history					
No	31	72.1	4	57.1	0.641
Yes	12	27.9	3	42.9	0.348 NS
Family history					
No	34	79.1	5	71.4	0.205
Yes	9	20.9	2	28.6	0.487 NS

χ^2 = Chi square test; p was significant if <0.05; NS = not significant

Table 5 shows that non regular cycle cases in normal group were 2 (4.7%) and regular cycle cases were 41 (95.3%), while in abnormal group were 1 (14.3%) and 6 (85.7%) respectively. Cases without placenta previa in normal group were 32 (74.4%) and cases with placenta previa were 11 (25.6%) while in abnormal group were 6 (85.7%) and 1 (14.3%) respectively. There was no statistically significant difference between outcome of pregnancy with pregnancy outcome (p>0.05).

The sensitivity was 92% and 87%, specificity was 88% and 82% and accuracy was 90% and 85% respectively of

both PI and S/a ratio in predict pregnant outcome with p value 0.0001 and 0.002 respectively.

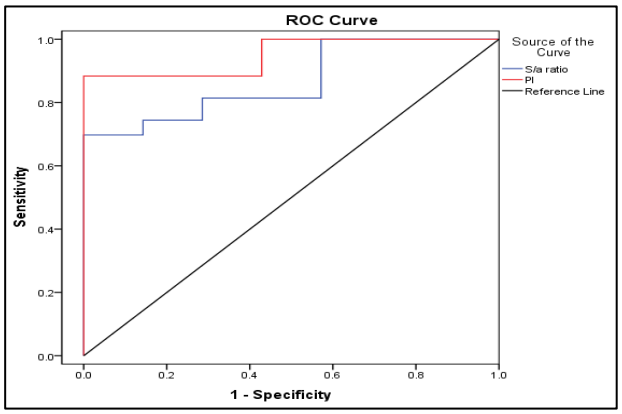

Figure 1: ROC curve to detect the sensitivity, specificity and accuracy of PI and S/a ratio in predict bad outcome of pregnancy.

The sensitivity was 92% and 87%, specificity was 88% and 82% and accuracy was 90% and 85% respectively of both PI and S/a ratio in predict pregnant outcome with P value 0.0001 and 0.002 respectively.

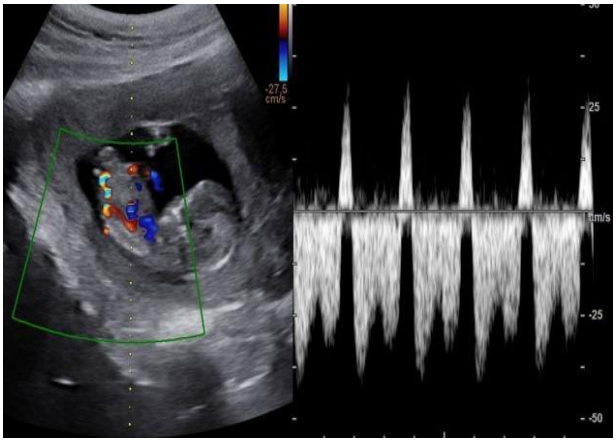

Figure 2: Reverse A wave.

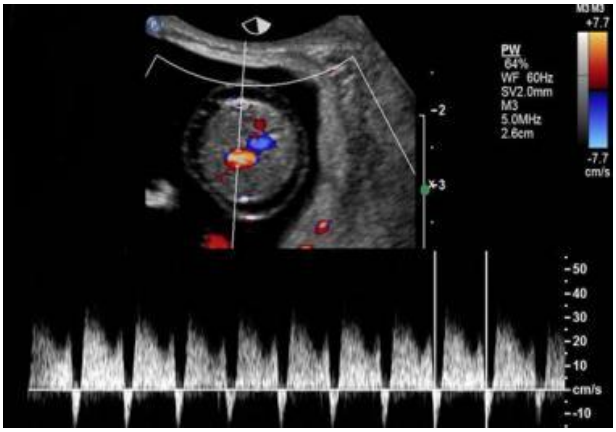

Figure 3: Abnormal A-wave with a strong predictor of still birth.

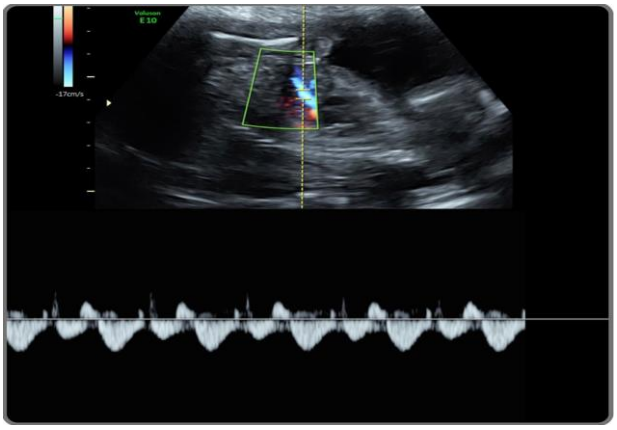

Figure 4: Obvious reversal A-wave in 23 week pregnancy.

DISCUSSION

Particularly in light of aberrant arterial Doppler waveforms, a thorough evaluation of the fetus's cardiac and circulatory health is required, has been made possible by venous Doppler flow measurements.[5] This study, which involved 50 pregnant women with a single viable foetus at 13 to 24 weeks of the first trimester, was carried out at Tanta University Hospital's department of obstetrics and gynecology.

Normal valid cases were 43 (86%), while abnormal cases were 7 (14%) included congenital heart defects 2 (4%), congenital malformation 1 (2%), low birth weight 3 (6%), and stillbirth 1 (2%).

On comparing the normal and abnormal outcome groups, it was found that the demographic, basic clinical data and clinical history data was matched in the two studied groups.

The ultrasound findings showed that a significant decrease in PI and S/A ratio in abnormal group less than the normal group, the cut off value of PI and S/A ratio was less than 0.55 and less than 1.90, respectively. The sensitivity, specificity and accuracy of both PI and S/A ratio was 92.0, 88.0 and 90.0% for PI and 87.0%, 82.0% and 85.0% for S/A ratio. A number of studies using cordocentesis during the past ten years have found a connection between abnormal DV Doppler and foetal acidity. Cordocentesis has not, however, been incorporated into conventional care in the management of these cases due to the higher risks of complications in these already wounded foetuses.[6] Rizzo et al created an area under the ROC curve with 72% sensitivity and 60% specificity for the prediction of hypoxemia using the DV ratio of the S/atrial systole (A) 0.66.[7] According to the results of the current investigation, acidosis at delivery may be detected with 100% sensitivity, 57% specificity, and 80% accuracy using a DV RI cut-off of 0.29. Additionally, persons with DV RI >0.29 had a risk of neonatal acidosis that was more than three times higher than those with level 0.29. In a study by Allam et al, the

MCA S/D ratio served as the Doppler parameter for the prediction of acidosis during delivery, with a cut-off value of 4.37 and 87.5% sensitivity, 64% specificity, and 77% accuracy.[8] Hypoxia was 12 times more likely to develop in cases with MCA S/D 4.37 compared to those with level >4.37. The majority of the foetuses had aberrant MCA PIs, according to Bahlmann et al; however, in six cases, the MCA PI increased with a tendency to normalise before delivery or foetal demise.[9] The MCA PI of three additional children gradually reduced until delivery, but the MCA PI of one foetus scarcely altered.

The DV Doppler acts as a measure of cardiovascular deterioration in response to FGR in cases of early-onset FGR, when the DV typically becomes abnormal after an increase in the PI in the UA. An irregular DV waveform (the lack or reversal of the A-wave, as seen in Figure 4) appears to be the most effective single predictor of the likelihood of foetal mortality in early-onset FGR. This waveform has the potential to predict foetal acidaemia and stillbirth.[10] The link between the foetal biophysical profile score's related anomalies and reduced foetal heart rate variability on the cardiotocogram emphasises the aberrant DV's predictive efficacy even more. When placental insufficiency affects a pregnancy, an abnormal DV Doppler provides a moderate level of accuracy for predicting compromised foetal and neonatal health as well as perinatal death, according to a 2010 comprehensive evaluation of the relevant literature.[11] The usual indicators of prenatal outcomes, GA and foetal weight, were the best predictors of morbidity and mortality. Ultrasound and Doppler variables were not included in the model at any of the GAs in our series due to the substantial relative influence of these factors on the prediction of the composite bad outcome. The abnormal DV Doppler for mortality prediction was an exception. This result was in line with some earlier investigations.[12]

CONCLUSION

Numerous foetal disorders that might result in cardiovascular deterioration and other aberrant outcomes in newborns can be managed clinically and predicted perinatally using the DV Doppler examination.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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