

Correlation of ductus venosus flow with fetal outcome

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Abstract

Introduction: Ductus venosus is the most important among venous circulation in monitoring of fetal conditions that may affect forward cardiac function. The ductus venosus doppler indices plays crucial role in assessment of IUGR, chromosomal anomalies, hydrops fetalis, supra-ventricular tachycardia, complicated twins and congenital heart diseases.

Aims: To find an association between Ductus Venosus waveforms with fetal outcome

Objectives: The objective of this study is to evaluate ductus venosus waveforms in 1st, 2nd and 3rd trimesters of gestation, to identify cases with abnormal ductus venosus flow and to follow up on cases of abnormal flow to find a correlation with fetal outcome.

Methodology: A prospective study was conducted on 100 antenatal ladies over a period of 2 years where ductus venosus waveforms were evaluated in all 3 trimesters for any abnormality. A-wave pattern was specifically noted in all subjects for any reversal or absence, as it is very sensitive and specific for predicting fetal outcome.

Results: Of all the cases in this study showing a-wave abnormality, 76% of them showed adverse fetal outcomes like intrauterine growth retardation, chromosomal defects, Non- cardiac and cardiac anomalies, and even intrauterine death.

Conclusion: In an otherwise normal fetus with increased nuchal translucency, regular assessment of ductus venosus blood flow, with special attention to the a-wave on Doppler evaluation, could significantly improve the predictive ability for an underlying abnormality.

Keywords: Ductus venosus, Doppler, fetal outcome, a-wave, increased nuchal thickness

Introduction

Antepartum fetal monitoring from first trimester of pregnancy till the birth is the corner stone of preventive obstetric management. It is aimed at reducing adverse obstetric outcome like maternal and perinatal mortality and morbidity.

Doppler sonography in ANC work up emerged as unique noninvasive tool for evaluation of physiological hemodynamic fetoplacental blood flow information. It readily detects abnormal vascular resistance and is the gold standard modality for the same. It helps in

detection and of IUGR fetus and aids in deciding the time of termination of pregnancy. Doppler indices change if the fetus is compromised.^{1,2}

The first vessel to show the change in fetal doppler pattern in IUGR or other fetal condition is umbilical artery followed by middle cerebral artery and then other peripheral arteries.

Ductus venosus is the most important among venous circulation in monitoring of fetal conditions that may affect forward cardiac function. The ductus venosus doppler indices plays crucial role in assessment of IUGR, chromosomal anomalies, hydrops fetalis, supra-ventricular tachycardia, complicated twins and congenital heart diseases.

The ductus venosus is the main vessel which regulates the distribution of oxygenated blood from umbilical vein to heart and brain. It is a short vessel with relatively fixed position and has the highest forward velocities in the venous system.³ It shows antegrade forward flow throughout the cardiac cycle. Therefore the ductus waveform is the reflection of pressure-volume changes in heart.⁴

Aims & Objectives

The aim of the study is to find a correlation between ductus venosus flow and fetal outcome.

The objective of this study is to evaluate ductus venosus waveforms in 1st, 2nd and 3rd trimesters of gestation, to identify cases with abnormal ductus venosus flow and to follow up on cases of abnormal flow to find a correlation with fetal outcome.

Materials & Methods

Type of study: Prospective study.

Period of study: October 2018 to September 2020.

Institute Ethics Committee approval was obtained and written informed consent was obtained from the patients before the start of study.

Sample size- 100 cases were studied and followed up.

Plan of the study

- This was a prospective study to study Ductus Venosus waveform and to evaluate correlation with fetal outcome in 1st, 2nd and 3rd trimesters.
- The data was obtained from the antenatal cases coming for their routine ultrasounds examinations to the obstetric unit of the mother and child care hospital of MGM at Kalamboli, Navi Mumbai. ANC was done during their visits in the 1st trimester for the NT scan, the 2nd trimester for the targeted anomaly scan and the 3rd trimester for the doppler study.
- All the patients were scanned strictly adhering to PCPNDT Act.
- Gestational age was calculated on the basis of date of last menstrual period and confirmed by fetal crown-rump length.
- Scan was performed trans-abdominally with 3-5 MHz curvilinear transducer probe. The ductus venosus was sampled at the isthmus near its origin from umbilical vein in right mid-sagittal/cross-sectional abdominal plane.

Inclusion Criteria

- All the singleton pregnancies coming for the routine ANC scans to the department of Radiodiagnosis in all the trimesters of gestation.
- ANC ladies who are willing for the study.
- All the ANC ladies who are willing for the follow till the birth.

Exclusion Criteria

- Multifetal pregnancy.
- The ANC ladies who are not willing for study.
- The ANC ladies who are not willing for the follow up.

Statistical Analysis: Data was analysed using appropriate statistical tests.

Results

100 patients in this study, ageing from 21-34 years, 25% of them with gestational age between 26-30 weeks. 66% of them were multigravida with 13% giving a past history of previous failed pregnancies. During the early scans 16% of the subjects had nuchal thickness above 3.5mm of which 4% showed chromosomal abnormality on karyotyping. 2 cases of Down's syndrome and 1 case each of Turner's syndrome and Trisomy 13 were confirmed. The follow up scans show normal fetometry in 91% subjects, with growth restriction noted in the remaining 9% cases. Majority of them turned out to be normal fetuses (76%) without any major postnatal abnormalities. However 9% showed intrauterine growth retardation late in the pregnancy and another 5% showing non cardiac defects which were detected post-natally. Among non-cardiac defects anencephaly was reported in 2 fetuses. Other 3 outcomes were 1 case each of diaphragmatic hernia, Arnold-Chiari malformation and renal agenesis. 3 cases of IUD were noted during this study. 1 was a fetus with IUGR and poor intraplacental development.

On Doppler evaluation

- 18% of the subjects show abnormally raised pulsatility index (>1.3) and 22% of them showing raised resistivity index (>0.8) in ductus venosus.
- A-waveform abnormality was observed in 17% of cases as absent or reversal of a-wave. (Figure 1)

- The rest 83% of the cases in the study showed normal a-waveform pattern.
- Follow up scans showed 4 of the 17 abnormal a-wave had normal fetal outcome (Figure 2). The other 13 cases (76%) showed adverse fetal outcomes like intrauterine growth retardation (5), chromosomal defects (3), Non-cardiac (2) and cardiac (2) anomalies, and intrauterine death (1).

Discussion

Ductus venosus is a crucial shunt to supply the oxygenated blood and nutrients from the maternal circulation to the fetal circulation. It has a trumpet shape⁽³⁾, where the narrowest portion, the isthmus measurement, closer to the umbilical vein, increases from 0.5 mm at mid-gestation to no more than 2 mm during the rest of the gestation, the outlet width increases from 1.25 to 3 mm and the length of the ductus venosus from 5 to 17 mm.⁵⁻⁷

This blood flow across the ductus venosus reaches a high velocity that increases with gestational age, from 29 cm/s in the first trimester to 65 cm/s at 18 weeks and up to 75 cm/s at term.^{5,6,7,8,9,10,12}

In the combined data from seven studies, abnormal ductal blood flow was observed in 5.2% of euploid fetuses and 70.8%, 89.3%, 81.8% and 76.9% of fetuses with trisomies 21, 18 and 13 and Turner syndrome, respectively.^{15,17,18,19}

In growth restricted fetuses there is an increased cardiac after load due to high placental resistance and a peripheral fetal arterial vasoconstriction.¹⁴ In the presence of fetal hypoxemia and acidemia the myocardium has a reduced compliance.¹¹ The combination of an increased cardiac after load and a myocardial dysfunction leads to an increased end-diastolic ventricular pressure resulting in an abnormal

blood flow at the ductus venosus, with higher pulsatility, mainly due to a reduction of the a-wave velocity and in the most severe cases an absent or reversed a- wave.^{11, 14}

In severe growth restricted fetuses before 32 weeks, there is an increased umbilicalartery pulsatility index, a middle cerebral artery pulsatility index, and reduced amniotic fluid index for four or five weeks before delivery. These parameters show changes about two weeks before delivery, but the ductus venosus Doppler and short term variation of the heart rate only become abnormal a few days before delivery and can be used to time the delivery.^{14,22} A more recent study has also shown that the ductus venosus is a good predictor of neonatal outcome in growth restricted fetuses before 33 weeks.²⁰

A-wave reflects the changes during atrial contraction. It indirectly reflects the preload and after-load status in the fetus. The a-wave pattern carries the sensitivity of 87.3% and specificity of 82.7%. It is having the highest positive predictive value of 95% among all the doppler indices. It also shows the least negative predictive value of 68.5%. Thus, a-wave pattern is the most vital index for predicting a fetal condition.^{13, 21}

A first-trimester screening study reported that the association with abnormal flow in the ductus venosus noted in the cases resulting in fetal death being 22.2% compared to 5.9% in the normal outcome group.¹⁶

Conclusion

USG Doppler study is a very powerful tool in assessing the fetal wellbeing and predicting any abnormal outcomes, if regularly done and followed up with in all trimesters. In an otherwise normal fetus with increased nuchal translucency, assessment of ductus venosus blood flow, with special attention to the A-wave in Doppler study,

could significantly improve the predictive ability for an underlying abnormality. It also plays a significant role in predicting fetal outcome in cases of growth retardation.

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Legend Figure

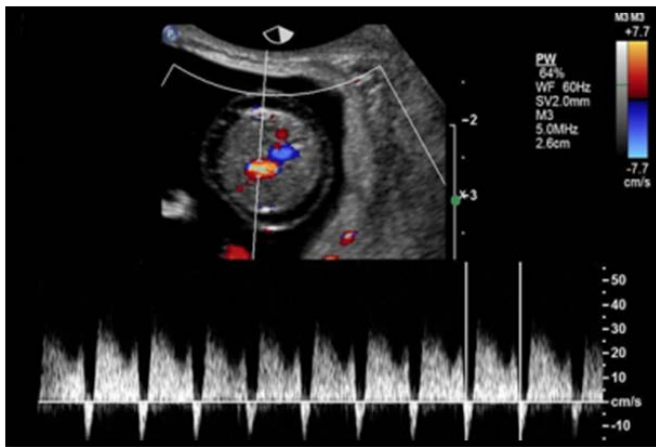


Figure 1: A 34 year old primi gravid with increased nuchal thickness and absent nasal bone. Doppler findings included a reversed A-wave in the ductus venosus waveform.

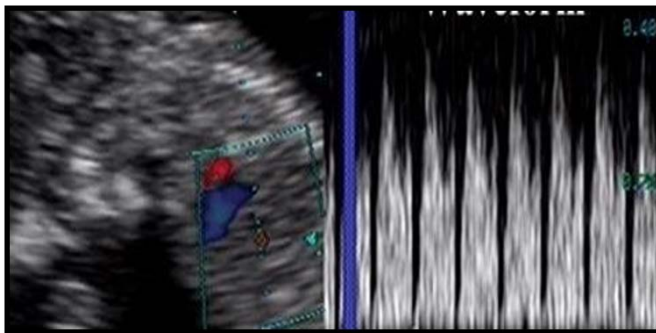


Figure 2: A 31 year old Multi-gravida presented at gestational age of 26 weeks. Doppler evaluation showed an absent A-waveform on ductus venosus Doppler.