



Role of Ductus Venosus Doppler in Evaluation of Intra Utrine Fetal Growth Restriction

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Abstract

Background: For the purpose of assessing the fetus in conditions of intrauterine growth restriction (IUGR) and heart abnormalities, Doppler measures of DV have become crucial. In fetal growth restriction (FGR), the connection between fetus size and development and fetus Doppler indices is complicated, but generally speaking, Doppler degradation is linked to actual fetal size as opposed to rate of growth. **Objective:** in the present study, we establish the importance of the Duct Venous Doppler in situations of intrauterine FGR for the prognosis of a poor perinatal outcome. **Patients and methods:** This research was done in MUST hospital fetal medicine unit from December 2018 till the completion of the number of cases suggested by sample size (60 patients). **Results:** Regarding Ductus venosus, findings were Normal 35 (58.3%), High PI 8 (13.3%), Absence a-wave 9 (15.0%) and Reversal a-waves 8 (13.3%). Abnormal DV findings had highest sensitivity, NPV and Youden's index. Abnormal DV a-wave had highest specificity and PPV (97.3% and 94.1% respectively) in predicting perinatal mortality. **Conclusion:** We found that Ductus venosus Doppler performs better in forecasting poor perinatal outcome than artery Doppler. We also came to the conclusion that placental vascular impairment in IUGR babies may be efficiently classified into risk groups using multi-vessel Doppler ultrasound. These testing methods each seem to represent fetal deterioration separately, therefore their combined usage is likely to be complementary.

KeyWords: Duct venosus Doppler, perinatal, fetal growth restriction.

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Introduction:

The vitelline veins, cardinal veins, and right and left umbilical veins are three bilaterally symmetrical pairs of veins from which the venous system develops. A portion of the umbilical veins, the ductus venosus (DV), forms a canal in the liver as the liver enlarges and presses on the remnant left umbilical vein. Blood may travel via this tiny, trumpet-shaped vein from the umbilical vein to the left part of the inferior vena cava (IVC), which is close to the heart's opening. Blood travels into the left part of the IVC from the DV, the left and medial hepatic veins, and is then directed vertically into the foramen ovale.¹

Abnormal DV waveforms between 10 and 13 weeks have shown relationship with chromosomal defect, cardiac anomalies and poor gestational prognosis.² For the purpose of assessing the fetus in conditions

of IUGR and heart abnormalities, Doppler measures

of DV have become crucial. The diagnosis of fetuses at risk of acidemia and perinatal mortality has also been done using the study of DV. Also linked to twin to twin transfusion syndrome and fetal anemia is an aberrant DV blood flow velocity waveform. Current research on the A-wave of DV has also shown how crucial it is to use DV during the first trimester of gestation to test for fetus chromosomal disorders.³

A pathologic slowing down of fetal development is referred to as FGR. The most frequent source of late-onset prenatal growth limitation is uteroplacental dysfunction, which results from insufficient nutrition and oxygen delivery to maintain the baby's normal aerobic development. Fetal infections, structural defects, and chromosomal abnormalities should all be thoroughly ruled out in cases with symmetrical IUGR.



Endovascular trophoblastic invasion causes uteroplacental vascular maladaptation, which results in higher vascular resistance and less blood flow to

the placenta in the choriodecidual compartment.⁴ The middle cerebral artery, umbilical artery, and dorsal vaginal artery are the fetal arteries that are most often investigated.⁵

While the relationship between fetus development and size and fetus Doppler indices in FGR is complex, in general, Doppler deterioration is related to actual fetal size instead of development velocity.⁶

With nonexistent or modest placental anomalies, late-onset FGR is more prevalent but less extreme; umbilical artery Doppler may be typical, but in response to hypoxemia, fetuses may have reduced middle cerebral artery (MCA) impedance.⁷

Patients and methods:

It was a prospective clinical research carried out in MUST hospital fetal medicine unit from December 2018 till the completion of the number of cases suggested by sample size (60 patients).

The Inclusion criteria were women who are pregnant and are in the age range of 28 to 35 with singleton viable fetus examined between 27 to 37 weeks attended to outpatient clinics with IUGR determine by AC less than 5% and fetus weight below 10% for gestation age and There pregnant are diabetic, hypertensive, cardiac and preeclampsia.

The Exclusion criteria were Multi fetal pregnancy, Chromosomal abnormalities and Age lower 28 years old or greater 35 years old.

Methods:

The complete clinical history was gathered, and the accurate last menstrual period (LMP) was verified. The patient was lying flat when the ultrasound was done. Utilizing synthetic ultrasonic gel, good acoustic coupling was achieved. A 3.5 MHz convex probe was used in obstetric ultrasonography on a Mindray ultrasound system. The following parameters were gathered from each subject. Biparietal diameter (BPD), abdominal circumference (AC), head circumference (HC), femur length (FL), amniotic fluid index (AFI), anticipated weight of the fetus, and placental position are the parameters to consider. DV, middle cerebral artery, and umbilical artery Doppler examination

characteristics, including as waveforms and measures, were also noted.

Ductus venosus examination

Umbilical artery examination

Statistical methods

The collected data were coded, tabulated, and statistically analyzed using the Statistical Package for Social Sciences, IBM Corp., Chicago, USA, 2013. Descriptive statistics were done on quantitative normally distributed data as lowest and maximum of the range, mean± SD (standard deviation), while it was performed on qualitative normally distributed data as number and percentage.

Inferential investigations for quantitative information employed the Shapiro-Wilk test for testing normality and the independent t-test in cases of two independently groups with data distributed normally. Chi square tests for proportional differences and Fisher’s Exact tests for variables with tiny anticipated numbers were used in inferential analysis for independent factors in qualitative data. If the P value is < 0.050, the level of significance was considered to be significant.

Results:

Table (1) Demographic features among the investigated cases

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Variables	Mean±SD	Range	
Age (years)	32.3±2.2	28.0–35.0	
Body mass index (kg/m ²)	28.2±1.8	23.8–31.8	
Gestational age (week)	34.0±1.6	31.0–37.0	
	N	%	
Parity	Primiparous	21	35.0
	Multiparous	39	65.0
Maternal pathology	Pregnancy induced hypertension	17	28.3
	Preeclampsia	16	26.7
	Idiopathic	19	31.7
	Chronic hypertension	6	10.0
	Diabetes mellitus	2	3.3

Total=60.

Among the studied cases Mean ±SD of age was 32.3±2.2 years with range 28.0–35.0, Mean±SD of **Body mass indexkg/m2** was 28.2±1.8 with range 23.8–31.8 while Mean±SD of **Gestational age** was 34.0±1.6 weeks with range 31.0–37.0. Concerning parity, **Primiparous** was in 15 (25.0%) of cases and **Multiparous** was in 45 (75.0%). Regarding **Maternal pathology** were **Pregnancy induced hypertension** 17 (28.3%), Preeclampsia 16 (26.7%), Idiopathic 19 (31.7%), Chronic hypertension 6 (10.0%) and **Diabetes mellitus** 2 (3.3%).

Table (2): Ductus venosus findings among the investigated cases



Findings	N	%
Normal	35	58.3
High PI	8	13.3
Absence a-wave	9	15.0
Reversal a-waves	8	13.3

Total=60.

Regarding DV, findings were **Normal** 35 (58.3%), **High PI** 8 (13.3%), **Absence a-wave** 9 (15.0%) and **Reversal a-waves** 8 (13.3%).

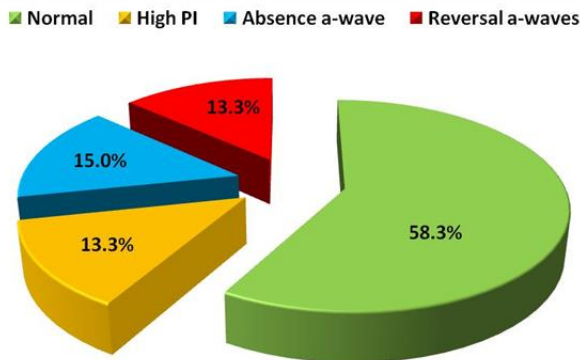


Figure (1): Ductus venosus findings among the investigated cases.

Table (3): Neonatal outcomes among the investigated cases

Outcomes	N	%
Still birth	1	1.7
Neonatal mortality	22	36.7
Perinatal mortality	23	38.3
PH <7.2	29	48.3
NICU admission	45	75.0

Total=60

Neonatal outcomes were **Still birth** 1 (1.7%), **Neonatal mortality** 22 (36.7%), **Perinatal mortality** 23 (38.3%), **PH<7.2** 29 (48.3%) and **NICU admission** 45 (75.0%).

Table (4): Doppler results' diagnostic traits for predicting neonatal death

features	UA abnormal	UA EDF abnormal	MCA abnormal	DV abnormal	DV a-wave abnormal
Sensitivity	54.5%	31.8%	59.1%	86.4%	68.2%
Specificity	65.8%	81.6%	81.6%	84.2%	94.7%
DA	61.7%	63.3%	73.3%	85.0%	82.0%
YI	20.3%	13.4%	40.7%	70.6%	62.9%
PPV	48.0%	50.0%	65.0%	76.0%	88.2%
NPV	71.4%	67.4%	77.5%	91.4%	83.7%
LR+	1.59	1.73	3.21	5.47	12.95
LR-	0.69	0.84	0.50	0.16	0.34
LR	2.31	2.07	6.40	33.78	38.57
Kappa	0.198	0.145	0.415	0.686	0.661

DA: Diagnostic acuity Youden's index, or Positive Predictive Value (PPV), Negative Predictive Value (NPV), and LR: Diagnostic odd ratio, LR+: Positive likelihood ratio, LR-: Negative likelihood ratio

Abnormal DV findings had highest sensitivity, **NPV and Youden's index** (86.4%, 70.6% and

91.4% respectively), while **abnormal DV a-wave** had highest **specificity and PPV** (94.7% and 88.2% respectively) in predicting **neonatal mortality**

Table (5): Comparison according to neonatal mortality

Variables	Present (N=22)	Absent (N=38)	P-value	
Age (years)	32.2±2.3	32.3±2.1	0.880	
Body mass index (kg/m ²)	28.3±1.9	28.1±1.8	0.658	
Gestational age (week)	32.7±1.1	34.7±1.3	<0.001*	
Parity			#0.465	
	Primiparous	9 (40.9%)	12 (31.6%)	
	Multiparous	13 (59.1%)	26 (68.4%)	
Maternal pathology			\$0.149	
	induced hypertension during pregnancy	3 (13.6%)	14 (36.8%)	
	Preeclampsia	6 (27.3%)	10 (26.3%)	
	Idiopathic	8 (36.4%)	11 (28.9%)	
	Chronic hypertension	3 (13.6%)	3 (7.9%)	
	Diabetes mellitus	2 (9.1%)	0 (0.0%)	
Umbilical artery findings			\$0.482	
	Normal	10 (45.5%)	25 (65.8%)	
	High PI	5 (22.7%)	6 (15.8%)	
	Absence EDF	4 (18.2%)	4 (10.5%)	
	Reversal EDF	3 (13.6%)	3 (7.9%)	
Middle cerebral artery findings			#0.001*	
	Abnormal	13 (59.1%)	7 (18.4%)	
	Normal	9 (40.9%)	31 (81.6%)	
DV findings			§<0.001*	
	Normal	3 (13.6%)	32 (84.2%)	
	High PI	4 (18.2%)	4 (10.5%)	
	Absence a-wave	7 (31.8%)	2 (5.3%)	
	Reversal a-waves	8 (36.4%)	0 (0.0%)	

^Independent t-test. #Chi square test. \$Fisher's Exact test. *Significant

Gestational age (week) was significantly lower in cases of neonatal mortality 32.7±1.1 than in non-neonatal mortality 34.7±1.3 (p<0.001). **Middle cerebral artery abnormality** was significantly more frequent in cases of neonatal mortality 13 (59.1%) than in non-neonatal mortality 7 (18.4%) (p=0.001). **DV normality** was significantly less frequent in cases of neonatal mortality 3 (13.6%) than in non-neonatal mortality 32 (84.2%) (p=0.001).

Table (6): Diagnostic characteristics of Doppler findings in predicting perinatal mortality.

Characteristics	UA abnormal	UA EDF abnormal	MCA abnormal	DV abnormal	DV a-wave abnormal
Sensitivity	56.5%	30.4%	60.9%	87.0%	69.6%
Specificity	67.6%	81.1%	83.8%	86.5%	97.3%
DA	63.3%	61.7%	75.0%	86.7%	86.7%
YI	24.1%	11.5%	44.7%	73.4%	66.9%
PPV	52.0%	50.0%	70.0%	80.0%	94.1%
NPV	71.4%	65.2%	77.5%	91.4%	83.7%
LR+	1.74	1.61	3.75	6.43	25.74
LR-	0.64	0.86	0.47	0.15	0.31
LR	2.71	1.88	8.04	42.67	82.39
Kappa	0.237	0.124	0.458	0.723	0.703

Abnormal DV findings had highest **sensitivity, NPV and Youden's index** (87.0%, 73.4% and 91.4% respectively), while abnormal DV a-wave had highest **specificity and PPV** (97.3% and 94.1% respectively) in predicting **perinatal mortality**.



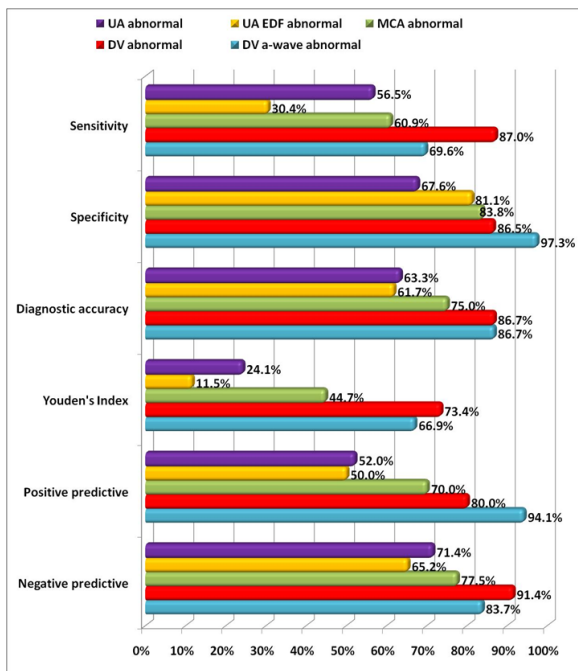


Figure (2): Doppler results' diagnostic features for predicting perinatal death

Discussion:

Defects in the venous system Doppler waveforms are sensitive instruments for assessing fetus health, particularly before 32 weeks' pregnancy, and they may aid in optimizing our choices for when to deliver babies that are at risk. Compared to the umbilical artery velocity pattern, it is a faster predictor of hemodynamic function.⁸

With the aim of identifying the chronology of advancement of venous Doppler anomalies from the start of placental failure in IUGR to the moment of birth, the study's primary interest was the prediction of perinatal prognosis. No discernible change in GA at the time of termination in instances with IUGR was seen in this investigation. The choice to deliver the baby is heavily influenced by the fetus' gestational age. Bashat et al.⁹ revealed that the most important factor affecting the overall survival of FGR till 26 weeks and complete surviving till 29 weeks gestation age. In the current investigation, one case was discontinued before 28 weeks due to unsatisfactory Doppler values that resulted in a poor perinatal outcome and an early infant mortality.

The DV-PI was typical in all patients, showing positive a-waves in 35 patients (58.3%), elevated PI in 8, missing a-waves in 9, and reverse a-waves in 8 patients (13.3%). the sensitivity of high DV PI and abnormal DV a-wave is (87.0%), (69.6%) respectively. the specificity of high DV PI

and abnormal DV a-wave is (86,5%),(97,3%) respectively.

Abnormal DV findings had highest sensitivity, NPV and Youden's index (65.5%, 46.2% and 71.4% respectively), while abnormal DV a-wave had highest specificity and PPV (87.1% and 76.5% respectively) in predicting PH <7.2.

The MCA PI was typical in 40 patients and abnormal in 20 patients. the sensitivity of abnormal MCA PI is (60.9%) and the specificity is (83.8%).

The PIV in the DV is the best single index to utilize in the perinatal death prediction since it is simple to compute. All indicators tested were substantially connected to perinatal mortality, although none showed 100% sensitivity. With a greater PPV values than UA-PI, pulsations in a-wave anomalies in the DV are the most sensitive criteria for prenatal death identification. As compared to abnormal UA Doppler in the current investigation, DV Doppler anomalies were strongly associated with poor outcome parameter and perinatal death (p <0.001).

Hofstaetter et al. 10 utilized the same multi-vessel Doppler US to monitor 154 FGR, and among the vessels examined, HV and DV-PIV were the most helpful indices in predicting perinatal outcome, along with UV pulsations. DV-PI had a higher sensitivity for perinatal mortality identification than HV-PI, which was 76% sensitive. The blood velocity waveforms in the HV were marginally more effective in predicting result than those in the DV, and the venous characteristics investigated were strongly correlated with perinatal outcomes, which was consistent with the findings in the current research.

Rt. HV was investigated by Hecher et al.¹¹ before 32 weeks, when the Rt. HV exhibited substantial variations between the affected and non-compromised babies. This may be due to the fact that the sooner growth impairment manifests, the more acute the condition is and, therefore, the more extreme the venous circulation anomalies are. Hofstaetter et al.¹⁰ revealed that although the fetal left ventricle in highly damaged fetuses often had to operate against a smaller after load than the right ventricle owing to brain sparing in chronic hypoxia, a compromised fetal condition was reflected more effectively in the HV than in the DV. The HV was a more accurate predictor of approaching death than the DV, based on the study's author. HV-RF exhibited a greater sensitivity (79%) than A/R DV a-wave (63%) in our

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research, and a strong substantial variation was seen in the HV-PI ($p + 0.048$), with superior specificity of the Rt. HV-PI than DV-PI in forecasting perinatal death. this was consistent with Hofstaetter et al.¹²

Hung et al.¹³ revealed that for forecasting neonates with growth restrictions with acidemia, combining the PI of the UA and DV offers the highest level of accuracy when compared to single vessel evaluation.

Bashat et al.¹⁴, revealed that Doppler and biophysical indicators are endpoints that reflect various fetus compromise processes in IUGR, and as such, they may actually work better together than alone. Good results are obtained when biophysical profile scoring is used to a cohort of IUGR fetuses that has been preselected by Doppler testing. The fact that Doppler and biophysical degradation may happen apart from one another is a significant component in explaining these findings. Bashat et al.¹⁴ revealed that Doppler and BPP findings seem to be independent, even when DV Doppler Ultrasound is taken into consideration. This offers compelling evidence that the prenatal modalities of BPP and Doppler testing are complimentary.

Conclusion:

We observed that when it comes to forecasting a bad perinatal outcome, ductus venosus Doppler is better than artery Doppler. We also came to the conclusion that placental vascular impairment in IUGR babies may be efficiently classified into risk groups using multi-vessel Doppler ultrasound. These testing methods each seem to represent fetal deterioration separately, therefore their combined usage is likely to be complementary.

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