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Original Research Article

The Importance of Venous Doppler for Evaluation of Intrauterine Growth Restriction

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Abstract

Aim: The aim of this study was to determine the role of venous Doppler Ultrasonography for the prediction of adverse perinatal outcome in "intrauterine growth restricted fetus", providing the obstetrician with additional information about the time frame and significance of the IUGR to help determine the optimal time of delivery.

Patients and Methods: Ninty females with IUGR affected pregnancies, gestational age between 28 and 38 weeks of gestation were enrolled in the study. All patients in the study were subjected to Doppler examination of the umbilical vein (UV), Ductus venosus (DV) and umbilical artery (UA).

Results: Abnormal UA Doppler was found in 60 patients. Abnormal DV Doppler was found in 27 patients. Abnormal UV Doppler was found in 20 patients. All parameters studied were strongly related to perinatal mortality, however, none had 100% sensitivity, the pulsatility index in DV and UV pulsations were the best single indices to use in the prediction of perinatal mortality.

Conclusion: Venous Doppler is superior to arterial Doppler in predicting poor perinatal outcome.

Introduction

Intrauterine growth restriction is defined as the rate of fetal growth that is below the normal, in respect of the growth potential of a specific fetus as per the age, race of the specific fetus. [1,2]

After prematurity, IUGR is second commonest cause of perinatal morbidity and mortality. As there is no treatment of this condition, So it becomes crucial to diagnose this condition at the correct gestational age, to optimise timing of delivery and perinatal outcome associated with it. [3]

Placenta based IUGR is basically a vascular disorder. Doppler velocimetry allows measurement of hemodynamic flow of major fetal vessels, comparing the flow indices and pattern of normal and IUGR cases. [4]

Among all the factors, IUGR that results from placental pathologies has worse prognosis and associated with significant perinatal morbidity and mortality. So by doing doppler USG in pregnancies complicated by IUGR, we can see the severity of fetal blood redistribution that shows the degree of fetal adaptation and gives an idea about how long we can continue the pregnancy safely. As IUGR complicates, there is sequential pattern of doppler changes that suggest the sequential pattern of disease progression. The deterioration in venous doppler occurs after the arterial doppler deterioration. Deteriorating venous doppler suggest major changes in fetal circulation as a result of hypoxia and acidemia in fetus. These venous doppler changes reflects the preferential blood flow to the brain and myocardium. [5]

Examination of venous doppler waveform was first reported in early 1980. Clinical utilization of this technique began in 1990 and has since emerged as a primary means of assessing fetal condition with cardiac manifestations caused by placental disorders. [6]

Doppler examination of fetal venous system allows functional assessment of cardiovascular system, which is beyond the capability of arterial doppler alone. Worsening arterial doppler correlates with worsening fetal status but only addition of venous doppler velocimetry allows comprehensive understanding of cardiovascular adaptation by fetus due to progression of disease and defines a subgroup of fetus at high risk of still birth, neonatal and perinatal mortility and morbidity. Thereafter, addition of venous doppler sharpens the detection of acidemia and contributes to prevent permanent compromise in severe IUGR fetuses. [7]

Patients and methods:

After approval of our ethics committee, this prospective study was conducted in the Obstetrics and gynecology department of SMS Medical College and attached hospitals, Jaipur from January 2020 to December 2020 among ninty pregnant women 20–35 years of age who have singleton pregnancies affected with IUGR at third trimester of their pregnancies between 28 and 38 weeks of gestation. A sample size was calculated based on the sensitivity of umbilical artery and vein Doppler in prediction of perinatal outcome in IUGR. Assuming a =0.05 and power=0.80, the total sample size was 90 pregnant women. Patients with IUGR due to fetal anomalies diagnosed by ultrasound were excluded from the study. After obtaining an informed written consent from all participants they were subjected to full assessment via full history taking including personal, medical, family, menstrual and obstetric history, general and obstetric examination, routine laboratory investigations including CBC, blood grouping, kidney and liver function tests and fasting and 2 h postprandial blood sugar. Ultrasonography examination was done for assessment of fetal position, presentation and biometric indices including biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), and femur length (FL), expected fetal weight (EFW), amount of liquor and site and grade of placenta. Intrauterine growth restriction defined as fetal weight <10th centile for the gestation. Doppler examination of umbilical artery, ductus venosus and umbilical vein was done. Absent or reversed UA end diastolic flow and pulsatile flow in the umbilical vein were examined for their efficacy to predict critical outcomes (stillbirth, neonatal death, APGAR score <5). All patients were followed till their delivery and neonatal assessment was carried out (1 min Apgar score, birth weight). The number of death cases (neonatal death and stillbirths) was recorded. All patients were managed according to local protocol and guidelines.

Statistical Analysis

Continuous variables was summarized as mean and standard deviation while nominal/ categorical variables as proportion. Parametric tests like unpaired T-test and one-way ANOVA was used for continuous variable whereas $\chi 2$ test and fisher-exact test was used for nominal/categorical variables. P-value < 0.05 was taken as significant.

Results:

Mean age of the studied patients was 25.82± 3.32 years.56.7% women were nulliparous. The mean Gestational age at presentation was 35.6±2.3 week. 53.3% women had hypertensive disease of pregnancy, 2.2% had GDM, 4.4% had hypothyroidism, Anemia was found in 6.7% patients, heart disease in 2.2% and in the remaining 31% patients no underlying risk factor found. Majority of cases in this study, presented after 32 weeks of period of gestation as late onset IUGR and only 5.6% patients presented before 32 weeks of period of gestation as early onset IUGR incidence of IUGR is slightly higher in male fetus (57%). Among 90 IUGR fetuses,70 survived, 8 were still born and 12 died in postnatal period. 54.4% patients delivered by cesarean section.

Table 1: Distribution of subjects according to umbilical artery Doppler

Umbilical Artery	Number (n)	Percentage (%)
Normal	30	33.34
High PI	27	30.0
Absence EDF	16	17.77
Reversal EDF	17	18.89
Total	90	100.0

The above table shows distribution of subjects according to umbilical artery Doppler findings. 30 (33.34%) out of 90 cases had normal flow in umbilical artery. While the rest of them had had increased PI value.16 cases(17.77%) had absent end diastolic flow in umbilical artery and 17 cases (18.89%) had reversed end diatolic flow in umbilical artery.

Table 2: Distribution of subjects according to Ductus Venosus Doppler

Ductus venosus	Number (n)	Percentage (%)
Normal Pulsatility index	63	70
High Pulsatility index	8	8.88
Absent a wave	09	10
Reversed a wave	10	11.12
Total	90	100.0

Majority of cases in our study had normal DV Doppler (70%). Among abnormal Doppler 8 (8.88%) patients had increased Pulsatility index in Ductus venosus, 9 (10%)had absent a wave and 10(11.12%) had reversed a wave in Ductus Venosus.

Table 3: Distribution of subjects according to umbilical vein Doppler

Umbilical Vein	Number (n)	Percentage (%)
Normal	70	77.78
Monophasic	02	2.22
Biphasic	02	2.22
Triphasic	16	17.78
Total	90	100.0

The above table show distribution of study subjects according to umbilical vein Doppler findings. UV continous pulsation (which was considered as normal) was

present in 70 cases, monophasic pulsation was found in 2 cases (2.22%) and biphasic pulsation was also found in 2 cases (2.22%) and remaining 16 case (17.78%) had triphasic pulsation in UV. Monophasic, biphasic and triphasic pulsations was considered abnormal and associated with adverse perinatal outcome. All cases with reversed EDF in UA were found to had abnormal UV Doppler while in majority of patients with absent EDF and all patients with only increased Pulsatility index in umbilical artery, UV Doppler were normal.

Table 4: Comparison of perinatal outcome in between abnormal arterial and venous Doppler group

Perinatal outcome	Umbilical Arterry Doppler abnormality	Percentage	Ductus Venous Doppler abnormality	Percentage	Umbilical vein Doppler abnormality	Percentage
No adverse effect	04	12%	0	0%	0	0%
Still born	00	0%	08	29.6%	08	40%
Neonatal death	02	2%	08	29.6%	08	40%
NICU admission	11	33.33%	19	70.3%	12	60%
APGAR score <5 at 1 min after birth	02	6%	17	62.96%	16	80%

P value: <0.05 (significant) chi-square value-12.09. df-4

The above table shows that out of 90 patients,60 patients had Doppler abnormality among them 33 patients had only arterial Doppler abnormality and 27 cases had additional DV Doppler abnormality and 20 cases had abnormal UV Doppler. In abnormal arterial Doppler group only 4 patients had no adverse perinatal outcome, 2 case had neonatal death and no still birth was noted in isolated arterial Doppler abnormality. whereas in abnormal ductus venous Doppler group 100% patients had adverse perinatal outcome, 8 were still birth (29.6%) and 8 (29.6%) were postnatal deaths. The rate of NICU admission and APGAR score <5 at 1 minute after birth was significantly higher in abnormal venous Doppler group.

Table 5: Sensitivity, specificity, positive predictive value and negative predictive value of Doppler in relation to perinatal mortality in fetus with growth restriction.

Doppler findings	Sensitivity	Specificity	PPV	NPV
Umbilical artery	50%	49%	12%	93%
Ductus venosus	80%	84%	59.25%	93.65%
Umbilical vein	80%	94%	80%	94%

The above table shows that pulsations in UV followed by waveform abnormalities in Ductus Venousus was the most sensitive Doppler parameter for identifying fetuses at risk of Perinatal mortality and that the most specific parameter with highest positive predictive values regarding adverse perinatal outcome were abnormal venous Doppler values.

Discussion

Intrauterine growth restriction is a major obstetric problem and is associated with high perinatal Morbidity and mortality. Fetal growth restriction is most commonly due to abnormal vascular development of the placenta. Defective trophoblastic invasion and failure of physiological transformation of uterine vessels results in progressive occlusive vasculopathy in the

maternal and fetal vascular compartment of placenta. Abnormal vascular tone, as well as obliterative loss of fetal vellous vessel, raises UA Doppler resistance. Fetal cardiovascular compromise progresses from arterial to venous flow.

Fetal venous Doppler studies represent valuable diagnostic test that can influence the management of IUGR fetuses as it helps in identification of the fetuses at risk for perinatal complications and helps in prediction of neonatal complications. Kaponis et al (2011) [6] reported that alterations of venous flow volume waveforms precede fetal heart rate decelerations and therefore offer warning signs to act before a fetal life threatening situation occur.

In the present study the ductus venousus and umbilical vein Doppler abnormalities were significantly related to poor perinatal outcome when compared with abnormal umbilical artery Doppler. On statistical analysis, significant association was found between perinatal outcome and doppler finding (p value < 0.05) [8]

Dr. Sandhya Rai et al (2018)1conduct a study of comparative evaluation of arterial and venous Doppler in predicting perinatal outcome in fetuses with IUGR. They found that out of 50 cases, 28 cases had Doppler abnormality among which 23 arterial abnormality and five had additional venous abnormality. In abnormal arterial Doppler group only 4 had no adverse outcome, 4(17%) cases had neonatal deaths, 9(39%) had intrauterine deaths In abnormal Venous Doppler group all (100%) had adverse effects. 3(60%) had neonatal deaths,1 was stillborn,1 was intrauterine death The only statistically significant relation between Doppler indices and outcome was the association between abnormal DV Doppler and fetal death (p <0.05).

Among all the studied Doppler, DV and UV were strongly related to perinatal mortality, however none had 100% sensitivity. Ductus Venosus and umbilical vein were most sensitive parameter for detection of perinatal mortality with higher positive predictive value than umbilical artery Doppler. (p value <0.05)

N. Giuliano et al (2014) 3 observed that MCA was found to be a better predictor for fetal outcome in IUGR when compared with Umbilical artery in terms of sensitivity and predictive value. Instead ductus Venosus was considered as the strongest Doppler predictor of perinatal mortality.

Our data were also comparable with study done by N.M. Abdel Maboud et al (2014) 8 and O.M. Turan et al(2011) [9]. They found DV and UV Doppler was most sensitive and specific with highest PPV to predict perinatal mortality as compared to umbilical artery Doppler.

Morris et al (2011) [10] investigated the accuracy of fetal UA Doppler to predict the risk of compromise of fetal/neonatalwell being in a high-risk population by a systematic review, con-cluding that in a high risk population, fetal UA Doppler is a moderately useful test with which to predict mortality and riskof compromise. In the present study, raised UA-PI constituted 66% of the UA abnormality while the extreme end of the spectrum represented by AEDF and REDF constituted 35.5% this stratification of abnormalities leads to the UA being reported as insignificantly related to poor perinatal outcome.

Similar results were also obtained by Nicola Fratelli et al, (2020) [11] They did a retrospective cohort study including 132 early onset fetal growth restricted pregnancies to assess the association between ductus venosus Doppler and adverse outcome in early onset growth restriction. They observed that newborn with neonatal morbidity or death had abnormal DV Doppler.

Ana Elisa Rodrigues Baiao et al (2020) [12] studied antenatal predictors of adverse perinatal outcomes in a population of preterm fetuses with early placental insufficiency diagnosed by doppler

abnormalities. fetal weight and absent /reversed ductus venosus a wave were the main predictors of survival in the regression model.

As stated by Andrea Dall Asta (2021) [13] and Tomoki Suekane (2021) [14], DV was found to be the most valuable Parameter, for the antenatal prediction of fetal acidemia in the management of IUGR fetuses which was in accordance with the present study. [15]

Conclusion:

Doppler examination of fetal venous system allows functional assessment of cardiovascular system, which is beyond the capability of arterial doppler alone. Worsening arterial doppler correlates with worsening fetal status but only addition of venous doppler velocimetry allows comprehensive understanding of cardiovascular adaptation by fetus due to progression of disease and defines a subgroup of fetus at high risk of still birth, neonatal and perinatal mortility and morbidity. Thereafter, addition of venous doppler sharpens the detection of acidemia and contributes to prevent permanent compromise in severe IUGR fetuses.

References:

1. Dr. Sandhya Rao, Dr. Ayesha, Dr. K. Pavan Kumar. Comparative Evaluation of Arterial and Venous Doppler in Predicting Perinatal Outcome In Fetus With IUGR. Journal of Dental and Medical Sciences.2018;17(11):12-21.
2. Deepak Sharma, Sweta Shastri, Pradeep Sharma. Intrauterine Growth Restriction: Antenatal and Postnatal Aspects. Clin Med Insights Pediate. 2016; 10:67-83.
3. N. Giuliano, M. L. Annunziata, S. Tagliaferri, F. G. Esposito, O. C. M. Imperato, M. Campanile, M. G. Signorini, A. Di Lieto, IUGR Management: New Perspectives, Journal of Pregnancy, 2014; Article ID 620976, 8 pages.
4. O. M. Turan, S. Turan, S. Gungor, C. Berg, D. Moyano, U. Gembruch, K. H. Nicolaids C. R. Harman. Progression of Doppler abnormalities in intrauterine growth restriction. Ultrasound in Obstetrics and Gynecology. July, 2008; 32(2):160-167.
5. Baschat AA, Cosmi E, Bilardoo CM, Wolf H, Berg C, Rigano S et al. Predictors of neonatal outcome in early onset placental dysfunction. Obstet Gynecol. 2007; 109:253-261.
6. A. Kaponis, T. Harada, G. Makrydimas et al. The importance of Venous Doppler velocimetry for evaluation of intrauterine growth restriction. Journal of ultrasound in medicine, 2011; 30(4):529-545.
7. Seravalli V, Miller JL, Block-Abraham D, Baschat AA. Ductus venosus Doppler in the assessment of fetal cardiovascular health: an updated practical approach. Acta Obstet Gynecol Scand. 2016 Jun;95(6):635-44.
8. Noha Mohamed Abdel Maboud, Hytham Haroon Elsaid. Role of venous doppler evaluation of intrauterine growth retardation. The Egyptian Journal of radiology and nuclear medicine. 2015;46(1).
9. O. M. Turan, S. Turan, C. Begr, U. Gemburch, K.H. Nicolaides, C.R. Harman and A.A. Baschat. Duration of persistent abnormal ductus venosus flow and its impact on perinatal outcome in fetal growth restriction. Ultrasound obstet Gynecol. 2011; 38:295-302.
10. R. K. Morris, G. Malin, S. C. Robson, J. Kleijnen, J. Zamora, K. S. Khan. Fetal umbilical artery Doppler to predict compromise of fetal/neonatal wellbeing in a high-risk population: systematic review and bivariate meta-analysis. Ultrasound in Obstetrics & Gynecology. 2011;37(2):135-142.
11. Nicola Fratelli, Serena Amighetti, Amar Bhide, Anna Fichera, Asma Khalil, Aris T Papageorghiou, Federico

Prefumo, Basky Thilaga Nathan. Ductus venosus Doppler waveform pattern in fetuses with early growth restriction. Acta Obstet Gynecol Scand. 2020 May; 99(5):608-614.
12. Ana Elisa Rodrigues Baião, Paulo Roberto Nassar de Carvalho, Maria Elisabeth Lopes Moreira, Renato Augusto Moreira de Sá, Saint Clair Gomes Junior. Predictors of perinatal outcome in early-onset fetal growth restriction: A study from an emerging economy country. Prenat Diagn. 2020 Feb;40(3): 373379
13. Dall Asta A, Minopoli M., Ghi, T., Frusca T. Monitoring, Delivery and Outcome in Early Onset Fetal Growth Restriction. Reprod. Med. 2021; 2:85-94.
14. Suekane, T., Tachibana, D., Kurihara, Y. et al. Time interval analysis of ductus venosus and cardiac cycles in relation with umbilical artery pH at birth in fetal growth restriction. BMC Pregnancy Childbirth. 2021; 21: 671.
15. Chakdoufi S., Moumen A., & Guerboub A. Dyslipidemia and Diabetic Retinopathy in Moroccans Type 2 Diabetics Patients: A Cross-Sectional Study. Journal of Medical Research and Health Sciences, 2023; 6(3): 2471–2479.