

DOPPLER STUDY IN HIGH-RISK PREGNANCIES IN THIRD TRIMESTER OF PREGNANCIES FOR PREDICTION OF ADVERSE PERINATAL OUTCOME

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ABSTRACT

BACKGROUND

Our study aimed to evaluate the Doppler value in third trimester of pregnancy where the features at risk is suspected. The patient with abnormal findings are identified and intervened for timely confinement. After delivery, the neonates were also taken care and the outcome were analysed.

MATERIALS AND METHODS

Study conducted from June 2015 to October 2016 in Add Annex Healthcare Centre and Hi-Tech Medical College, Bhubaneswar. The case referred from the SCB Medical College, Cuttack, and Hi-Tech Medical College. Around 50 randomly selected cases beyond 28 wks. of pregnancy with foetus risk were studied.

RESULTS

The study shows that the abnormal perinatal outcomes are more with abnormal findings in different arteries (Umbilical Artery-UA, Middle Cerebral Artery-MCA, Maternal Uterine Artery-MUA), i.e. 10 out of 19. But, in cases with normal fetoplacental perfusion, the perinatal outcome is much better, i.e. 4 out of 14.

CONCLUSION

Doppler study by an expert hand offers a tremendous potential in identification of fetoplacental perfusion defect and then timely inversion of pregnancies with "foetus at risk" and decreases the neonatal deaths and maternal morbidity.

KEYWORDS

Umbilical Artery (UA), Middle Cerebral Artery (MCA), Maternal Uterine Arteries (MUA), CPR= Cranioplacental Ratio, Pregnancy-Induced Hypertension (PIH), Intrauterine Growth Retardation (IUGR).

HOW TO CITE THIS ARTICLE: Upadhyay U, Dash B, Kanungo S, et al. Doppler study in high-risk pregnancies in third trimester of pregnancies for prediction of adverse perinatal outcome. J. Evid. Based Med. Healthc. 2017; 4(34), 2051-2055. DOI: 10.18410/jebmh/2017/398

BACKGROUND

Doppler study has emerged as an important noninvasive technique during past decade in every medical discipline to study the blood flow in different disease where alteration of the haemodynamic are anticipated. In the field of obstetrics, there has been an increase in use of Doppler sonography for routine antenatal surveillance, especially in high-risk cases. The quantitative and qualitative analysis of uteroplacental flow and foetal circulation can predict placental and foetal dysfunction well before the clinical manifestation of obstetric complication.

Hyperintense disorders of pregnancy complication approximately 12 to 22% of all pregnancies and are directly responsible for 17.6% maternal death and significant perinatal morbidity.^{1,2} A significant number of hypertensive pregnant woman have perinatal morbidity, prematurity and foetal growth retardation. Intrauterine growth restriction is defined as pathological decrease in the rate of total growth. It is complex multisystem syndrome with overall incidence of 2.8% in developed countries.³ Foetal demise, birth asphyxia, maximum aspiration, neonatal hypoglycaemia and hypothermia along with long-term neurological morbidities are significant associated with IUGR.⁴ The severity of this foetal outcome can be correlated to the degree of abnormal flow velocities in certain material and foetal vessels.⁵ Combining arterial and venous Doppler study along with biophysical profile scoring provides the most accurate assessment of foetal status and best predicts the longitudinal progression. The Doppler study thought to be the earlier and more precise predictor of foetal jeopardy as compared to BPP and NST.

Financial or Other, Competing Interest: None.
Submission 10-02-2017, Peer Review 17-02-2017,
Acceptance 02-03-2017, Published 26-04-2017.
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DOI: 10.18410/jebmh/2017/398



In the present study, it is limited to late pregnancies (third trimester) complicated by hypertensive disorders of pregnancy and IUGR as both of them have common pathophysiology of compromised uteroplacental circulation. In the countries like India with perinatal mortality rate as high as 49/1000 livebirths and Orissa state in higher side MR among the major states (55.6/1000 livebirths) (2013) and with background fact that the neonatal death accounts for 72.5% of IMR, the present study hopefully contribute significantly in appropriate management of high-risk population and "foetuses at risk."

Aim and Objective of Study

The purpose of the study is to evaluate the diagnostic efficacy of Doppler sonography of foetal MCA, umbilical artery and maternal uterine artery for prediction of adverse outcome of high-risk pregnancies in third trimester.

MATERIALS AND METHODS

Study was conducted from June 2014 to October 2015 in the Add Annex Healthcare Centre, Hi-tech Medical College, Bhubaneswar, in cases referred mostly from S.C.B. Medical College and Hospital, Cuttack, and Khetrabasi Sevasadan, Cuttack, and Hi-Tech Medical College Hospital.

50 high-risk singleton pregnancies beyond 28 week of gestation selected randomly were included in the study. Gestational age determinations were mostly based on menstrual history and few were by foetal biometry by USG. Most of these women were taking iron, calcium and protein and other adjuvant therapies. Some of the patients were also taking antihypertensive drugs.

These women were undergone Doppler study of maternal uterine artery, foetal umbilical artery and foetal middle cerebral artery by 3.5 to 5 MHz curvilinear probe. Most of these women were diagnosed as hypertensive disorder of pregnancy, preeclampsia and IUGR.

The multigravidas, pregnancies with previously diagnosed congenital anomalies, pregnancies with known Rh isoimmunisation and foetal anaemia, pregnancies with diabetes, cardiac disease, renal disease and systemic vascular disease were excluded.

Doppler values were considered abnormal when S/D ratio, RI, PI of foetal umbilical artery and maternal uterine artery were >2 SD and that of foetal MCA is <5th percentile.

Abnormal Findings in Doppler Study⁶

Uterine Artery-

1. Difference of S/D ratio between two sides of uterine arteries should not exceed 1 (normal range 0.9 to 0.3).
2. Persistence of early diastolic notch beyond 24 weeks.
3. S/D ratio should not be >3 between 27 to 40 weeks of pregnancy.
4. PI value in third trimester = 1.32.
First trimester = 2.6.
5. RI should not exceed 0.6 (Normal - 0.58).

Umbilical Artery

1. Absence or reversal of diastolic flow.
2. S/D ratio >3.
3. RI value >0.66.
4. PI value >1.32 in third trimester.

MCA

1. PSV value >95 (normal - 60.13 to 9.23).
2. PI value >1.45 (normal - 1.29 to 1.45).
3. S/D ratio >3 (normal - 2.8 to 3).
4. RI value >0.85 (normal - 0.75 to 0.85).

C.P.R. (Cranioplacental Ratio)

1. PI (MCA)/PI (umbilical artery) should not <1.
2. S/D (MCA)/S/D (umbilical artery) should not <1.

Ductus Venosus

1. Reversal of a wave.
2. VVS/VAS >5 (normal - 2.8 to 4.2).

RESULTS

EDN	PIH Present	PIH Absent	Total
Early diastolic notch - present	8	2	10
Early diastolic notch - absent	19	21	40
Total	27	23	50

Table 1. PIH and Early Diastolic Notch (EDN) in Either Uterine Artery in High-Risk Group

Positive predictive value of EDN in PIH=80%, specificity of EDN in PIH=21/23=91.304%.

Category	Uterine Artery S/D	Umbilical Artery S/D	Present Study %	Rajan 1993
1.	Normal	Normal	71.42%	57.15%
2.	Abnormal	Normal	14.285%	18.37%
3.	Normal	Abnormal	7.142%	14.28%
4.	Abnormal	Abnormal	7.142%	10.10%
5.		AE DF	7.407%	6.12%
6.		RE DF	7.407%	

Table 2. Blood Flow Velocity Abnormality in PIH (Irrespective of IUGR)

	Abnormal Perinatal Outcome	Normal Perinatal Outcome	Total
Abnormal UA Doppler	10	9	19
Normal UA Doppler	4	10	14
	14	19	33

Table 3. Abnormal Umbilical Artery Doppler and Adverse Perinatal Outcome in All IUGR>

Sensitivity of the test=42.85%	10/14
Specificity of the test=52.63%	10/19
Positive predictive value 52.63%	10/19
Negative predictive value 74.28%	10/19

Category	Uterine Artery S/D	Umbilical Artery S/D	Perinatal Mortality Rate %	Low AP Gr. %	IUGR %	Normal Term Birth %	Perinatal Mortality Rate %	Low AP %	IUGR Preference %	Normal Term Birth %
1.	Normal	Normal	Nil	11.11	5.55	83.33	Nil	4.21	16.89	78.95
2.	Abnormal	Normal	7.14	7.14	28.57	57.14	Nil	13.35	19.98	66.67
3.	Normal	Abnormal	Nil	Nil	66.66	33.33	Nil	Nil	40	60
4.	Abnormal	Abnormal	33.33	Nil	66.66	Nil	33.33	Nil	66.67	Nil

Table 4. Perinatal Outcome in PIH

"Dandolo Gramellini et al"	MCA %	UA %	MCA/UA %
Sensitivity	24	64	68
Specificity	100	90.7	98.4
PPV	100	72.7	94.4
NPV	77.3	86.7	88
"BN Lakhakar et al"			
Sensitivity	41.6	50	47.2
Specificity	90.9	59	86.3
PPV	88.2	66.6	85
NPV	48.2	45.4	50
"Present Study"			
Sensitivity	50	53.84	54.54
Specificity	89.47	65	57.89
PPV	75	50	42.85
NPV	73.9	68.42	68.75

Table 5. PI in Prediction of Adverse Perinatal Outcome Comparison with Other Studies

DISCUSSION

All the randomly selected subjects in our study group 30% of the subjects has PIH (preeclampsia/eclampsia 8% and gestational hypertension 22%), IUGR=46% had both IUGR and PIH.

The sensitivity of specificity of uterine artery S/D for predicting maternal and foetal morbidity in our study is high as 72.72% and 90.47%, respectively. In other studies in 1993 by Rajan et al showed similar values 81% and 90% respectively;⁷ however, Rai Lavanya et al in 2010 advocated that high S/D ratio alone does not precisely as curtain material and foetal risk rather abnormal divergence of S/D ratios between two uterine arteries is a more important parameter.⁸ In ratio >1 only constitute 7.69%. In subjects where both side S/D ratio and the difference of S/D ratios are abnormal, the abnormal perinatal outcome is 100%. The presence of end-diastolic notch beyond 24 weeks show PPV 80% for PIH, the specificity for association is as high as 91.30%. The values are comparable with other studies Rajan et al PPV=87%.

Abnormal Doppler flow pattern in umbilical arterial circulation is evidenced only after at least 50% or placental vascularity is affected. The abnormality in waveform should be considered as on index on foetal acidosis for ahead of hypoxaemia and hypoxia.⁹⁻¹² In our study, the sensitivity of abnormal waveform in umbilical artery is 71.428% with PPV and specificity is 52.631%, which are comparable with studies done by Arduini et al in 1992.¹³ The S/D ratio sensitivity is low in study of B.N Lathar et al.¹⁴ But, sensitivity of RI in his study (50%) show similar value.

Our statistical analysis have showed that of all umbilical arteries waveform parameter, PI has high sensitivity of 53.896% than other two (S/D ratio and RI) in predicting

perinatal outcome. However, S/D ratio has a high specificity of 81.48% with high PPV 80%. Umbilical artery RI had also a high specificity of 45.4% for S/D ratios in his series. However, he had similar sensitivities for umbilical artery PI.

Increasing pathology of the foetal perfusion can lead to a complete Absence of End-Diastolic Phase (AEDF). Further deterioration leads to retrograde blood flow, i.e. Reversal of End-Diastolic Flow (REDF). Further deterioration leads to retrograde bold flow, i.e. Reversal of End-Diastolic Flow (REDF).¹⁵ Both are ominous and carry a markedly increasing risk of neurovascular handicaps and long-term sequelae apart from mortality. In our study group, we had 2 cases of AEDF and 4 cases of REDF. The average gestational age was 36 weeks for both groups, but these cases were not turned for further checkup. But, from the feedback, two were stillborn and other undergone LSCS, two were normal and other two were hospitalised to NICU. No reports of neonatal death.

Regarding AEDF and REDF in umbilical artery, which indicates a serious perinatal outcome in our study, we had 2 cases of AEDF and 4 cases of REDF, out of which 50% had preterm and one in each group are stillbirth. After LSCS of other babies, 2 are living out of 3. All the living babies were associated with IUGR.

The Doppler velocimetry in MCA shows a large number of variability. Low resistance flow in MCA is due to brain sparing effect. Disappearance of brain sparing effect denotes cerebral oedema and is an ominous sign. This is usually associated with abnormal A-wave in ductus venous. Hence, whenever one gets high PI in MCA, the ductus venouses should be examined. However, the study of ductus venous was not included in our study. Cerebroplacental ratio (C-P ratio) is normally >1; if it is <1, then it indicate foetal hypoxia. The MCA, PSV, S/D ratio, PI and RI had high specificity in our study, i.e. 92%, 92%, 89.4% and 88%, respectively. The PPV of MCA S/D ratio and PI were also very high (77.77% and 75%). These values are comparable to the high specificity and PPV of the study by Lakhkar et al and Dandolo Gramellini et al.¹⁶ Similarly, the sensitivity, specificity and PPV and NPV of CP ratio greater in predicting adverse foetal outcome in our study were 58.33%, 56.52%, 41.176% and 72.22%, which show lesser value than the values get by the study done by Rajan et al.⁷

On the whole, PIH and IUGR had 51.85% and 60% of normal neonatal outcome with higher LSCS rate of 81.48% and 71.428%. However, the incidence of LSCS in abnormal Doppler finding is high.

CONCLUSION

This prospective study conducted to determine and evaluate the diagnostic efficacy of Doppler study of foetal middle cerebral artery, umbilical artery and maternal uterine arteries for prediction of perinatal outcome in high-risk pregnancies (i.e. PIH, IUGR in the present context) in 50 randomly selected cases beyond 25 weeks of gestation. These cases undergone Doppler study of maternal uterine arteries, foetal middle cerebral arteries and foetal umbilical arteries along a routine obstetric scan and were subsequently intervened if required to improve the prenatal outcome.

Out of high-risk cases 30% (n=15) had PIH 46% (n=23) had IUGR and 24% (n=12) had both.

1. Majority of our parents were nulliparous, i.e. 66% (2=23) and were below 30 years of age (78%, n=38).
2. Principal mode of delivery was LSCS (74%, n=38), the principal indication being foetal distress (45.91%, n=17).
3. 96% (n=48) of the babies are born alive out of which, 4% (n=2) succumbed in NICU. The overall survival rates beyond 1 week were 92%.
4. Though majority of the babies born were termed (74%, n=37) only 29% (n=12) had birth weight of 25 kg and 16% (n=8) were VLBW babies. The average birth weight was 2.216 kg.
5. 8% (n=4) of the babies had mild-to-moderate depression at 5 minutes of birth (i.e., Apgar score <7) and overall 14% (n=7) required NICU care for various region.
6. Analysing the Doppler parameters of the patients, we draw the following inferences.

Uterine Artery

7. Uterine artery S/D ratio have high sensitivity (72.72%) and specificity (90.47%) in predicting adverse perinatal outcome.
8. If both S/D ratios are >3, then irrespective of the difference, there is a drastic increase in perinatal outcome (100% in other group in our studies).
9. In patients of PIH, presence of early diastolic notch has a high specificity (91.304%) among the high-risk population. But, for prediction of adverse perinatal outcome, the presence of EDN had a specificity of 79.310%.
10. Neonatal morbidity and mortality is highest in PIH patients having abnormal S/D ratios in both uterine and umbilical arteries.

Umbilical Arteries

11. Umbilical S/D ratio has high specificity (81.48%) and PPV (80%) in predicting adverse perinatal outcome in high-risk group.

12. For umbilical artery, PI has a high sensitivity (58.84%) for predicting adverse perinatal outcome in high-risk group.

13. Abnormal umbilical Doppler is highly sensitive (71.428%) in predicting perinatal outcome in IUGR cases, though specificity and PPV is 52.631%.

Middle Cerebral Artery

14. All MCA indices (PSV, PI, S/D ratio and RI) have very high specificities for predicting adverse perinatal outcome in order of preferences.

15. MCA S/D ratio and MCA PI have high positive predictive values for adverse perinatal outcome (77.77% and 75%, respectively). Though MCA-PSV and PI are more accurate than S/D and RI, but in our study, PI and S/D are taken to include the brain sparing effect and independent of angle correction.

16. In our study, C-P ratio has moderate sensitivity and specificity of 58.33% and 56.52%, respectively, for adverse perinatal outcome combining all the Doppler parameters has a high sensitivity (76.19%) for adverse perinatal outcome.

Thus, Doppler study by an expert hand offers a tremendous potential in the identification of fetoplacental perfusion defects and then timely intervention of pregnancies with "foetus at risk". Furthermore, it ensures the confidence in treating obstetrician in the era of legal liabilities to bring time for the foetal maturity before plan of any obstetric intervention.

More number of multicentric trials are needed to arrive at a conclusion to universalise a suitable index to identify, specify or predict a particular adverse outcome in a "foetuses at risk." Our work my aid in the process.

Lastly, ongoing Doppler trials in recent future may extrapolate the author's dream of an era of predictive and preventive obstetrics rather than therapeutic obstetrics or antenatal paediatrics.

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