A STUDY ON ROLE OF DOPPLER ULTRASOUND IN NORMAL AND HIGH-RISK PREGNANCIES WITH PERINATAL OUTCOME

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ABSTRACT

OBJECTIVES

To evaluate the diagnostic value of various waveform of Doppler ultrasound of three vessels (uterine artery, middle cerebral artery and umbilical artery) in high-risk pregnancies in compare to normal pregnancy related to perinatal outcome.

MATERIALS AND METHODS

200 singleton pregnancies beyond 28 weeks of gestation were studied out of which 100 were normal and 100 were high-risk pregnancies with PIH and clinical suspicion of IUGR. Doppler examination was done after recording history, clinical ex and USG.

RESULTS

The PI, RI and S/D of Umbilical artery and Uterine artery were significantly higher in study group as compared to control group and the PI, RI and S/D of middle cerebral artery were significantly lower in study group as compared to control group. 70% of foetuses in study group had at least one adverse outcome in study group in contrast to only 10% of control group had adverse outcome. Doppler study of UA and UmbA together had a better sensitivity than individual vessel. The MCA/UmbA PI ratio of study group showed more foetuses to redistribute their cardiac output than the abnormal MCA PI or UmbA PI. The cerebroumbilical ratio provided a better predictor of high-risk pregnancies and adverse perinatal outcome than either MCA or UmbA.

CONCLUSION

Hence, we conclude that Doppler studies of multiple vessels in the foetoplacental circulation can help in the monitoring of compromised foetus and can help in predicting neonatal morbidity. This may be helpful in determining the optimal time of delivery in complicated pregnancies.

ABBREVIATIONS

UA-Uterine artery, UmbA-Umbilical artery, MCA-Middle cerebral artery, RI-Resistive index, PI-Pulsatility index, S/D-Systolic/Diastolic ratio, IUGR-Intrauterine growth restriction, IUFD-Intrauterine fetal demise, LSCS-Lower segment caesarean section, SVD-Spontaneous vaginal delivery, PIH- Pregnancy-induced hypertension.

KEYWORDS

Doppler Ultrasound, PIH, IUGR, RI, PI, S/D Ratio.

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INTRODUCTION: Labour is one of the most important episode in the life of women. Labour is the process through which a pregnancy ends and a baby is born. The birth of a child is one of the most rewarding and memorable experiences a person can have. At the same time, the labour process can be difficult and painful. The development of good uteroplacental circulation is required for the achievement of normal pregnancy. The normal growth of foetus during intrauterine life, its ability to withstand stress of labour and delivery and its healthy development during neonatal period depend to a greater extent upon the integrity of the foetoplacental circulation.

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Intrauterine Growth Restriction (IUGR) is a term used to describe the condition of a foetus whose size or growth is subnormal. The most common definition of intrauterine growth restriction is that "A foetus is growth restricted if its weight is less than tenth percentile of its gestational age."[(1)] The incidence of IUGR where the mother is healthy and well-nourished is estimated to be 3-5%. In a population of women with hypertension or previous growth restricted foetus, the incidence increases to 15-20% or higher.[(2)] The incidence of IUGR varies from region to region and even in same region it varies in different subpopulation. In INDIA according to recent UNICEF survey, the incidence of IUGR is 25-30%.[(3)] Growth restricted foetuses have 8-10% increase in perinatal mortality and 50-75% morbidity compared to appropriate size foetuses.[(4)] Accurate antenatal diagnosis of IUGR by ultrasound can reduce the complication and improve the outcome. After the introduction of real time ultrasound, the small foetuses could be identified.

But, it could not determine, which of these foetuses were at increased risk due to uteroplacental insufficiency and therefore needed special surveillance. Small for foetuses were therefore monitored by nonstress test for foetal heart rate and biophysical profile. Unfortunately, neither of these test is particularly sensitive for predicting poor perinatal outcome in IUGR pregnancies. With the introduction of Doppler ultrasound examination, it become possible to asses uteroplacental blood flow, foetoplacental blood flow and to asses foetal blood circulation.(5) The uteroplacental and foetoplacental circulation give information of the placental resistance whereas evaluating the foetal circulation by Doppler ultrasound could non-invasively asses foetal response to hypoxia. This has become possible to identify those small for foetuses that of perinatal morbidity and mortality due to impaired uteroplacental and foetoplacental circulation.(6)

AIMS AND OBJECTIVES:

- To compare the waveform pattern in Doppler ultrasound of triple vessels (uterine artery, middle cerebral artery and umbilical artery) in normal and high-risk pregnancies.
- To evaluate the diagnostic value of various abnormal waveform of Doppler ultrasound of triple vessels waveforms in high-risk pregnancies.
- To compare the perinatal outcome of high-risk pregnancies with normal and abnormal triple vessel waveform.

MATERIAL AND METHODS: An interventional prospective study conducted in the Department of Obstetrics and Gynaecology, Silchar Medical College, Silchar, Assam, from 1st May, 2015, to 30th April, 2016. The study group (A) consist of 100 cases of high-risk pregnancies after fulfilling inclusion and exclusion criteria. Control group (B) consist of 100 cases of normal pregnancies without any risk factors. The inclusion criteria includes clinical suspicion of IUGR (based on fundal height discrepancy and poor maternal weight gain), well-documented date (reliable menstrual history with and early clinical examination or dating by USG in early weeks), PIH, singleton pregnancies, gestational age ranging from 28-38 weeks. The exclusion criteria are patient with congenital anomaly of the foetus, multiple gestation, chronic hypertension and renal and cardiac disease.

Waveforms were obtained for umbilical, uterine and middle cerebral artery of both study and control group and various indices were calculated viz. Pulsatility Index (PI), difference between peak systolic and diastolic flow over the mean flow velocities. Resistance Index (RI), difference between peak systolic and diastolic flow over systolic flow and S/D ratio done. The Doppler indices of study group and control group is then compared. Flow velocimetry waveform of uterine artery, umbilical and middle cerebral artery were obtained for all 200 cases and were analysed. Doppler USG done every 4th weekly in normal cases and every weekly in high-risk cases with abnormal Doppler indices, however, only the result of last Doppler USG were used for analysis of perinatal outcome. Detailed delivery and neonatal followup information was gathered in all cases.

RESULTS AND OBSERVATION:

Age Group (in years)	Study Group			Total Number	
	Primi Gravida	2nd Gravida	3rd Gravida or More	(n)	(%)
<20	10	4	0	14	14.00
20-25	28	17	5	50	50.00
26-30	2	25	3	30	30.00
>30	2	1	3	6	6.00
Total	**42**	**47**	**11**	**100**	**100.00**

Table 1: Age and Gravida Distribution of Study Group

Here Doppler examination was done in 100 cases with high-risk pregnancies. Out of them, 42 cases were primi, 47 are 2nd and 11 are 3rd gravida. Table - 4.5 also show 14 cases <20, 50 cases between 20-25 and 30 are 26-30 and only 6 cases are >30 years.

Age Group	Control Group			Total Number	
	Primi Gravida	2nd Gravida	3rd Gravida	(n)	(%)
<20	10	4	0	14	14.00
20-25	20	25	5	50	50.00
26-30	10	15	5	30	30.00
>30	2	3	1	6	6.00
Total	**42**	**47**	**11**	**100**	**100.00**

Table 2: Age and Gravida Distribution of Control Group

Here, Doppler examination was done in 100 cases without any antenatal complication. Out of them, 42 cases were primi, 47 are 2nd and 11 are 3rd gravida. Table - 4.2 also show 14 cases <20, 50 between 20-25 and 30 are 26-30 and only 6 cases are >30 years. In this study of 200 antenatal mothers, the gestational age at the time of Doppler examination ranges between 28-38 weeks. In this group of 200 cases, uterine artery indices shows significant increased pulsatility index, resistance index and S/D ratio in high-risk group in comparison to control group (p value <0.001) whereas in umbilical artery Doppler indices also shows a significant increase in high-risk group in comparison to control group. In middle cerebral artery, Doppler indices shows a significant decrease in high-risk group than control group of pulsatility index, resistance index and S/D ratio with a p value of <0.001.

Among the 100 control group, 80 cases were delivered Spontaneous Vaginal Delivery, 16 cases had emergency LSCS and 4 forceps delivery were done. The mean birth weight of these babies was 3.23±0.24. In no case, birth weight <10th percentile was found. 5 min APGAR score <7 in only 1 cases and 3 baby admitted in NICU. No perinatal mortality was found in normal cases. Only 1 baby dies due to pressure asphyxia by mother.

Among 100 high-risk cases, 50 cases were delivered Spontaneous Vaginal Delivery, 40 cases had emergency

LSCS and 10 forceps delivery were done. The mean birth weight of these babies was 2.14±0.46 and 5 mins. APGAR score <7 is found in 20 cases and 30 baby were admitted in NICU. IUFD occurs in 10 cases of high-risk pregnancy and perinatal mortality was found in 14 cases. This implied poor perinatal outcome in high-risk cases in the presence of abnormal Doppler indices and hence the presence of foetal anoxia.[7] Absent or reverse End-Diastolic Flow seen in 25 cases. All these cases has adverse outcome. There were 10 IUFD in which 6 cases had absent End-Diastolic Flow and 4 cases had reverse End-Diastolic Flow. Mortality in cases of absent and reverse were 80% and 30% respectfully. Among 100 high-risk cases 70% of the foetus had evidence of redistribution of blood to brain as evidence from reduced ratio of pulsatility index of middle cerebral artery and umbilical artery of which 62 cases had adverse outcome.

MCA/Umbilical Artery Pulsatility Index	Number (n)	Adverse Outcome	
		(n)	(%)
<1.08	70	62	88.57
Normal	30	8	26.67
Total	**100**	**70**	**70.00**

Table 3: Ratio to Determine Foetal Blood Flow Redistribution in Study Group (Ratio of PI of MCA to PI of UmbA)

Doppler finding was most abnormal in the group with concomitant PIH and IUGR (15 cases). All the 15 cases have DN in the UA, UmbA S/D >3 and abnormal C/U PI. Also, the perinatal outcome is worst in the group with low APGAR, LBW babies in all 15 cases and all 15 cases admitted in NICU, out of which 2 deaths. In PIH group, Doppler findings were abnormal in 16 cases and low APGAR in 2. LBW in 8 and 4 admitted in NICU out of which 2 neonatal deaths occurs.

High Risk	Number (n)	DN	UmbA A S/D >3	Abn C/Umb PI	Apgar <7	LBW	NICU	Neonatal Death
PIH	22	16	12	19	2	8	4	2
IUGR	20	14	13	17	4	16	4	0
PIH + IUGR	15	15	15	15	8	15	15	2
PIH + BOH	7	7	6	7	2	0	2	0
IUGR + DM	4	4	4	4	0	0	0	0
PIH + IUGR +BOH	2	2	2	2	2	2	1	0
IUGR + BOH	2	2	1	0	0	0	0	0
IUGR + Anaemia	4	4	2	4	2	4	2	0
BOH	20	0	0	2	0	6	0	0
RH - Ve	4	0	0	0	0	2	2	0

Table 4: Doppler Finding in Different Categories of High-Risk Cases

Following table depict sensitivity, specificity, PPV, NPV of the individual vessels studied in predicting neonatal morbidity. Here all emergency LSCS, IUD, NICU admission and APGAR <7 were taken as positive cases.

Index	TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	DA
UA DN	60	16	4	16	78.94	83.33	93.75	55.55	80
UARI	60	15	15	10	84.71	50	80	60	75
UmbA PI	55	20	10	15	78.57	66.66	84.61	57.14	75
UmbA S/D	39	14	16	31	55.71	46.66	70.79	31.11	53
MCA PI	54	27	3	16	77.14	90	94.73	62.79	81
MCA/UmbA PI	62	22	8	8	88.88	73.33	88.88	73.33	84

Table 5: Showing Comparison of Doppler Indices and Adverse Perinatal Outcome

Statistical analysis shows MCA/UmbA PI has the highest sensitivity (88.88%) in predicting perinatal outcome. MCA PI has the highest specificity (90%). Mean birth weight in study group is 2.14 kg, but in control is 3.23 kg. APGAR score at 5 mins. is lower in study group than control. In high-risk majority of patient had LSCS (40) where in control had SVD. High-risk cases had high admission to NICU compared to control.[8]

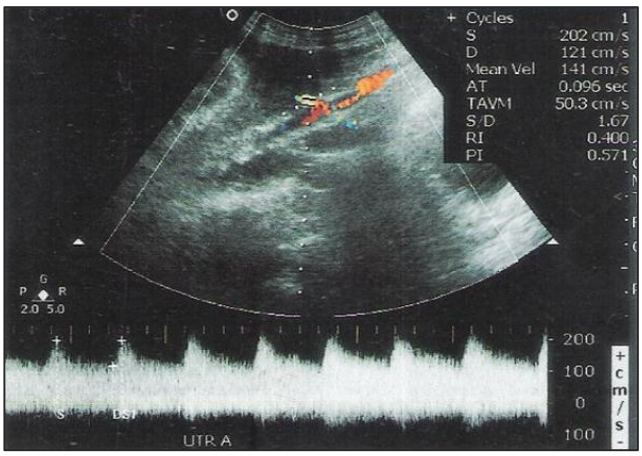

Fig. 1: Uterine Artery Showing Normal Waveform and Velocity

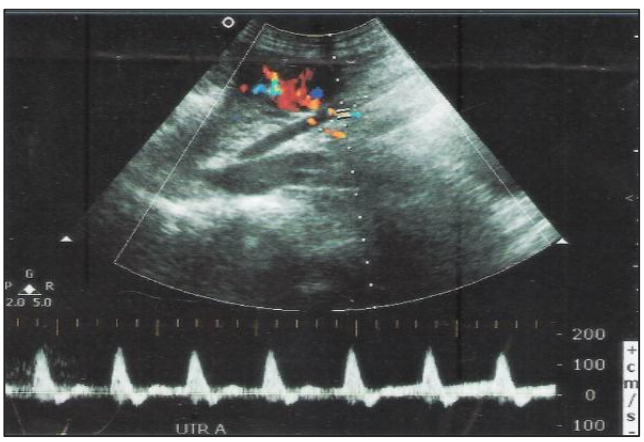

Fig. 2: Uterine Artery Doppler Showing Early Diastolic Notch with S/D Ratio and Elevated PI and RI

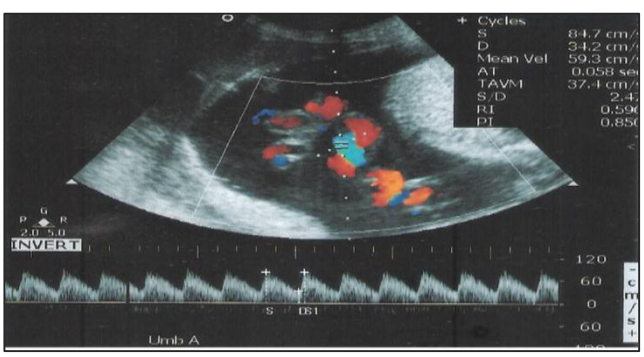

Fig. 3: Umbilical Artery Showing Normal Waveform and Velocity

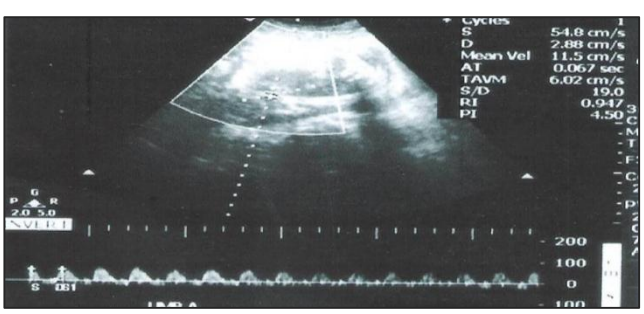

Fig. 4: Umbilical Artery Showing Absent End-Diastolic Flow

Fig. 5: Middle Cerebral Artery Showing Normal Waveform and Velocity

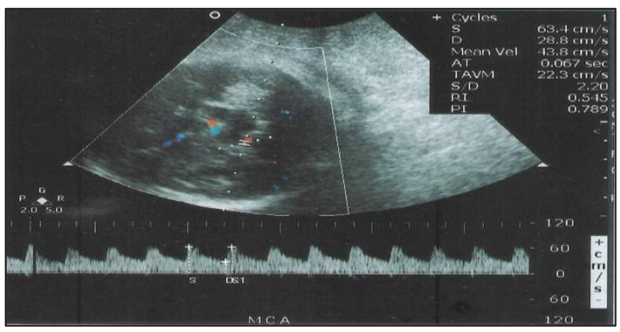

Fig. 6: Middle Cerebral Artery Showing Increased Diastolic Flow with Reduced PI Values

DISCUSSION: In this study, all patient underwent Doppler in 3rd trimester with 70% between 31-35 weeks' pregnancy monitored when foetus would have begun develop sufficient lung maturity to survive outside. Majority of the patient in the study group had PIH and IUGR. PIH is more common in primigravida due to first time exposure to chorionic villi. In present study, PI, RI and S/D of UmbA shows significantly higher value in study group as compared to control ($p < 0.001$) indicating increased peripheral resistance and consequently decreased diastolic flow leading to foetal compromise in high-risk group. Sharma Urmila et al 2010[9] showed that in their study there is significant difference of PI, RI and S/D between study and control group. PI, RI and S/D of MCA in high-risk pregnancy were significantly lower than control group indicating increased diastolic flow and cerebral vasodilatation in high-risk group.

In the present study, persistent early diastolic notch beyond 28 weeks gestation showed a sensitivity of 83.33%. This is slightly lower than study done by Farrell et al[10] who showed sensitivity of UA as 88% for adverse perinatal outcome. This maybe because of the included women was with bilateral notch in Farrell study whereas in present study present of diastolic notch either left or right nor both were included. However, the analysis done by Colemann et al[11] for reliability of early diastolic notch of uterine artery as predictor for uteroplacental insufficiency reveals a sensitivity of 76% The sensitivity of RI was 84.71% in our study in comparison to that of Benson and Doubliet[12] is 67% and Colemann et al (2000) is 83%. This discrepancy maybe contributed to different cut off level of RI varying between 0.5-0.62. Best screening test is measuring placental site UA RI.

If the placenta is situated in the midline, the highest RI is the best predictor. When both Doppler parameters were taken into account, the sensitivity of UA Doppler for predicting perinatal outcome was 83%. This is in agreement to the study by Zimmermann et al[13] who found a combination of several Doppler parameters to be superior than single parameter. In the present study, the UmbA PI had a sensitivity of 78.57%. According to D Grammelini et al,[14] the sensitivity of PI in the UmbA in predicting perinatal outcome was 64%. UmbA was the main artery used for monitoring high-risk pregnancies. This is because UmbA represent foetoplacental system and primarily reflect placental resistance. In present study as there is highest no. of PIH cases probably this can be attributed for difference in the studies. Another study by K.W. Fong et al[15] showed the sensitivity of PI in the UmbA as 58.3%. Absence or reversal of EDF seen in 25% in our study group as compared with that of 37% in the study by Benson and Doubliet. The PI of MCA decrease in 57% of foetuses. In the present study, foetal MCA had a sensitivity of 77.14%. In Arduini D, Rizzo G[16] study, the sensitivity of MCA in predicting perinatal outcome was 68%. Obviously, the present study cannot be compared with the above study in view of different in considering the intracranial artery as it is clearly established that PI varies in relation to intracranial artery considered.

So, it is important that the artery be identified precisely and with certainty. The following study compares the result of present study with other studies. The redistribution calculated from the ratio of PI MCA and PI UmbA showed 70% of foetuses to redistribute their cardiac output than either UmbA PI (65%) or MCA (57%) alone. The sensitivity of MCA PI/UmbA PI in our study is 88.88% in predicting perinatal outcome. These result is slightly higher than D. Gramellini et al (1992) study (68%) and BN Lakhkar 47.20%,[17] probably this may be attributed to small sample size. The redistribution calculated from the ratio of PI MCA and PI UmbA showed 70% of foetuses to redistribute their cardiac output than either UmbA PI (65%) or MCA (57%) alone. The sensitivity of MCA PI/UmbA PI in our study is 88.88% in predicting perinatal outcome. These result is slightly higher than D Gramellini et al (1992) study (68%), probably this may be attributed to small sample size 70% of high-risk foetuses had at least one adverse outcome. Remaining 30% foetuses had favourable outcome. There were 10 IUD. Of the 10 IUD, 6 had absent and 4 had REDF.

The mortality in case of reverse and absent EDF are 80% and 30% respectively indicating grave prognosis. Among high-risk patient, 30 neonates are admitted to NICU and 20 had 5 mins. APGAR score <7 and 40 had emergency LSCS due to foetal distress. These result are slightly higher than study done by D Gramellini et al. This can be contributed to different in perinatal mortality and morbidity rates from western standard to Indian standard. By using Doppler USG result for analysis, the MCA/UmbA PI ratio had a higher sensitivity for predicting adverse perinatal outcome than the MCA and UmbA PI. Our finding agrees with the result of the study done by Gramellini et al that have shown MCA/UmbA PI Doppler ratio to be more useful than UmbA PI and MCA PI in predicting adverse perinatal outcome.

Comparison between different studies would be meaningful if uniform of standardised criteria were used. In present study, most women in the control group had vaginal delivery (80) while in high-risk group majority of patient had LSCS (40) indicating high incidence of operative delivery in high-risk group based on abnormal Doppler finding. Mean birth weight and APGAR score were lower in study group as compared to control group and difference was highly significant. In present study, there were higher incidence of admission to NICU (30) in study group as compared to control.[3] UmbA and MCA Doppler indices those were abnormal admitted in NICU compared to babies were not admitted. This explain poor perinatal outcome in presence of abnormal indices with foetal anoxia. 4 neonatal deaths in study group while one of neonatal death in control group indicate poor perinatal outcome in high-risk group associated with abnormal Doppler waveform. 70% of high-risk foetuses had at least one adverse outcome. Total 10 IUD where 6 had AEDF and 4 had REDF. Mortality in case of reverse and absent EDF are 80% and 30% respectively indicating grave prognosis. Using Doppler USG result for analysis - MCA/UmbA PI ratio had higher sensitivity for predicting adverse perinatal outcome than the MCA and UmbA PI individually.

CONCLUSION: Higher incidence of LSCS, low birth weight, increased admission to NICU and low APGAR score at 5 mins. was with abnormal Doppler indices. Umbilical, placental and cerebral vascular beds are directly involved in the haemodynamic adjustment of foetal growth restriction. Assessment of both uteroplacental circulation and foetoplacental circulation together is more sensitive to predict perinatal outcome than assessment of each alone. In suspected IUGR, cerebro-umbilical ratio (MCA PI/UmbA PI) is a better predictor of adverse perinatal outcome than an abnormal MCA PI or UmbA PI as compared to other study.[17] Diastolic flow absent/reversal in UmbA is ominous sign. It carries a grave sign in prognosis and high mortality. Thus, triple vessel Doppler study is very useful in predicting high-risk pregnancies with adverse perinatal outcome when the Doppler velocimetry is abnormal by which we can reduce perinatal mortality. So, it should be available in all hospital both Govt. and private sector to achieve the goal in India.

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