

DOPPLER ASSESSMENT IN PREGNANCY-INDUCED HYPERTENSION AND USEFULNESS OF DOPPLER IN PREDICTING FOETAL OUTCOME

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ABSTRACT

BACKGROUND

Normal foetal growth and development depends on adequate perfusion of the intervillous space through the maternal spiral arterioles. Reduced perfusion is associated with asymmetrical retardation of the foetal growth and foetal hypoxia, which is the major cause of perinatal mortality.

The aim of the study is to evaluate the blood flow velocity pattern in uteroplacental and fetoplacental circulations using Doppler ultrasound in PIH cases in our population.

MATERIALS AND METHODS

The present study comprises of 50 antenatal cases that have been referred from the Department of Obstetrics and Gynaecology (CKM Hospital, Warangal) and (GMH Hospital, Hanamkonda). These cases were evaluated in Department of Radiology and Imaging, MGM Hospital with colour Doppler Toshiba machine using 3.5 MHz curvilinear transducer. The period of study was one year.

RESULTS

In our study, we have taken 50 clinically-suspected PIH cases along with equal number of controls. The highest number of cases in our study is between 21-25 years followed by below 20 years of age. In the study group, 32 (64%) cases show abnormal Doppler and the remaining 18 cases showed normal Doppler. In the control group of same gestational age who does not show any complication, 6 cases (12%) showed abnormal Doppler findings.

CONCLUSION

We conclude that the Doppler velocimetry is primary tool for fetomaternal surveillance in hypertensive pregnancies, because changes in umbilical and uterine circulation strongly correlate with pregnancy outcome. We strongly recommend the use of colour Doppler examination in all cases of PIH.

KEYWORDS

Colour Doppler, Pregnancy, Systolic/Diastolic Ratio, Pulsatility Index and Resistance Index of Umbilical Artery and MCA.

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BACKGROUND

Pregnancy-induced hypertension remains the major cause of maternal and perinatal morbidity and mortality. The principal problem in PIH is poor placental perfusion attributable to the abnormal implantation or underlying maternal vascular diseases. Reduced placental perfusion on PIH is thought to be result from failure of trophoblast to invade maternal spiral arteries in the first half of pregnancy leading to development IUGR.

IUGR is defined as small for gestation age as those fetuses whose birth weight falls below the 10th percentile for gestational age. This is the most commonly used and widely accepted definition. There are basically two types of growth disorders of foetus.

- Symmetrical growth disorder commonly known as small for gestation age. These are caused by genetic, infection, unknown ailments. The foetus is proportionally small throughout the pregnancy.
- Asymmetric growth disorder or IUGR- It is caused by malnutrition, placental insufficiency resulting from maternal complication like PIH is the main cause of IUGR.

Assessment of foetal wellbeing in high-risk pregnancies like PIH is done by variety of methods, which includes NST, biophysical profile and daily foetal kick count. All of which may not carry a high degree of sensitivity and specificity.

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The positive predictive value for assessment of foetal wellbeing by these tests may not be to the optimum level desirable. Colour Doppler flow velocitometry, which is recent advance in ultrasound technology has revolutionised at the diagnosis of abnormal blood flow in the fetoplacental bed and early identification of these abnormal patterns are useful in determining the optimal time for delivering and to reduce the perinatal mortality. One more advantage of colour Doppler flow velocitometry is the early diagnosis of IUGR, which can reduce foetal morbidity and mortality. Hence, role of Doppler examination has become indispensable in screening, diagnosis and management of PIH cases.

This is non-invasive technique to study the uteroplacental foetal circulation and it is simple, safe and reproducible.

In the present study, we examined the flow velocity waveforms in uteroplacental (uterine artery) and fetoplacental (umbilical artery and middle cerebral artery) circulations in both normal pregnancy and in situation of suspected placental insufficiency such as PIH/subsequently resulting in IUGR, to derive ratio, physiological information about placental flow resistance and assess the diagnostic potential of this measurement.

Aims and Objectives

To evaluate the blood flow velocity pattern in uteroplacental and fetoplacental circulations using Doppler ultrasound in PIH cases in our population.

1. To also compare these patterns with that of normal patients.
2. To detect the presence of IUGR by Doppler in PIH.
3. To analyse the significance of different Doppler parameters taken in predicting IUGR in PIH.
4. To compare the results of our study with similar studies available in present literature.

MATERIALS AND METHODS

The present study comprises of 50 antenatal cases that have been referred from the Department of Obstetrics and Gynaecology (CKM Hospital, Warangal) and (GMH Hospital, Hanamkonda). These cases were evaluated in Department of Radiology and Imaging, MGM Hospital with colour Doppler Toshiba machine using 3.5 MHz curvilinear transducer. The period of study was one year. Ethical committee approval was taken to conduct the study. Written informed consent was obtained from patients who participated in this study.

Inclusion Criteria

1. Women with pregnancy complicated by PIH.
2. Singleton pregnancy.
3. Pregnant women with 28 to 36 weeks gestation.

Exclusion Criteria

1. Women with twin gestation.
2. Pregnant women with other risk factors like anaemia, heart disease and DM.
3. Congenital abnormalities.

Type of Intervention- (50 cases) study group of pregnancy complicated by PIH taken into the study and complicated with an equal number of women with normal pregnancy without complication (control group).

In the present study, we have assessed the flow velocity waveforms of both uterine arteries, umbilical artery and foetal middle cerebral artery. The parameters taken into consideration to study are systolic/diastolic ratio, pulsatility index and resistance index.

Method of Examination

1. Patients were subjected to ultrasonographic examination. Synthetic ultragel was applied liberally to get a good acoustic contact. The machine used was Toshiba machine with 3.5 MHz curvilinear probe.
2. Gestational age was determined with BPD, HC, FL, AC, placental grading done. Foetal weight and amniotic fluid index were calculated.
3. Doppler studies done on uterine artery, umbilical artery and MCA by B-mode real-time scanner cases were followed till the time of delivery and birth weight of baby, perinatal outcome was noted.

1. Identification of Uterine Artery

In Doppler ultrasonography, the main branch of the uterine artery is easily located at the cervicocorporal junction. Doppler velocitometry measurements are usually performed near this location. Where a crossover between the larger iliac vessels and uterine artery can be easily visualised in real-time colour images.

2. Identification of Umbilical Artery

The umbilical artery was identified within amniotic fluid by the appearance of parallel line echoes, which displays pulsatility activity; pulsed Doppler was used to get Doppler signals after the vessel. Then, S/D, PI and RI calculated.

3. Identification of Middle Cerebral Artery

Visual axial plane at the level of brain stem shows the circle of Willis, which is clearly visualised especially with colour Doppler, then the three branches on side (anterior, middle, posterior cerebral branches) seen. The Doppler is placed over the middle cerebral and pulse wave Doppler is scanned.

RESULTS

Number of cases	50
Number of controls	50
Total	100

Table 1. Number of Clinical PIH Cases Vs. Number of Controls

Age (Years)	Cases	Percentage	Control	Percentage
Less than 20	9	18%	6	12%
21-25	37	74%	34	68%
26-30	4	8%	10	20%
Total	50	100%	50	100%

Table 2. Age Distribution of Cases

The highest number of cases in our study is between 21-25 years.

Study Groups	Number of Cases	Percentage
Number of cases with abnormal Doppler	32/50	64%
Number of cases with normal Doppler	18/50	36%
Total	50	100%

Table 3. Percentage of Doppler Positive in Cases

Parameters	Uterine Artery	Percentage	Umbilical Artery	Percentage	MCA	Percentage
S/D	31/50	62%	29/50	58%	10/50	20%
RI	26/50	52%	28/50	56%	9/50	18%
PI	28/50	56%	30/50	60%	13/50	26%

Table 5. Percentage of Abnormal Doppler Findings in Individual Arteries in Cases

S/D Ratio	Number of Cases	Percentage
<2.6	19	38%
>2.6	31	62%
Total	50	100%

Table 6. Uterine Artery- S/D Ratio

Parameters	Number of Cases	Percentage
Uterine artery normal PI	22	44%
Uterine artery abnormal PI	28	56%
Total	50	100%

Table 7. Uterine Artery- Pulsatility Index

Parameters	Number of Cases	Percentage
<0.68	23	46%
>0.68	27	54%
Total	50	100%

Table 8. Uterine Artery- Resistance Index

Parameters	Number of Cases	Percentage
Number of cases with notch	28	56%
Number of cases without notch	22	44%
Total	50	100%

Table 9. Uterine Artery- Diastolic Notch

The above table shows number of cases with notch more than without notch.

Parameters	Number of Cases	Percentage
Number of cases with unilateral notch	20	40%
Number of cases with bilateral notch	8	16%
Number of cases without notch	22	44%
Total	50	100%

Table 10. Uterine Artery- Incidence of Diastolic Notch

In our study, we found number of cases showing bilateral and unilateral notches forming 56% of total number of cases.

Parameters	Number of Cases	Percentage
Number of cases with abnormal Doppler study	6/50	12%
Number of cases with normal Doppler	44/50	88%

Table 4. Percentage of Doppler Study in Controls

Doppler positivity in our study group 64%, control group 12%.

Parameters	Number of Cases	Percentage
Number of cases with positive uterine artery Doppler	31	62%
Number of cases with negative uterine artery Doppler	19	38%
Total	50	100%

Table 11. Uterine Artery- Sensitivity Percentage

S/D	Number of Cases	Percentage
<2	-	-
2-3	21	42%
3-4	8	16%
>4	21	42%

Table 12. Umbilical Artery- S/D Ratio

Parameters	Number of Cases	Percentage
Normal umbilical artery PI	20	40%
Abnormal umbilical artery PI	30	60%
Total	50	100%

Table 13. Umbilical Artery- Pulsatility Index

Parameters	Number of Cases	Percentage
<0.6	21	42%
>0.6	29	58%
Total	50	100%

Table 14. Umbilical Artery- Resistance Index

Parameters	Number of Cases	Percentage
Umbilical artery positive Doppler	30/50	60%
Umbilical artery negative Doppler	20/50	40%
Total	50	100%

Table 15. Umbilical Artery- Sensitivity Percentage

Parameters	Number of Cases	Percentage
Number of cases positive Doppler	13/50	26%
Number of cases negative Doppler	37/50	74%
Total	50	100%

Table 16. Middle Cerebral Artery- Sensitivity Percentage

Parameters	Rhee and Detti	Katherine W Fong	Present Study
PI of umbilical artery	63%	44.7%	60%
PI of MCA	53%	72.4%	28%

Table 17. PI of MCA vs. Umbilical artery

Parameters	Abnormal Doppler Cases (32/50)	Percentage	Normal Doppler Cases (18/50)	Percentage
Live birth	25/32	78.12%	18/18	100%
Term birth	11/32	34.37%	15/18	83.3%
Preterm	14/32	43.75%	3/18	16.6%
LBW	25/32	78.12%	5/18	27.77%
Stillbirth	5/32	15.87%	-	-
IUD	2/32	6.25%	-	-

Table 18. Foetal Outcome

DISCUSSION

In our study, we have taken 50 clinically-suspected PIH cases along with equal number of controls. The highest number of cases in our study is between 21-25 years followed by below 20 years of age. In the study group, 32 (64%) cases show abnormal Doppler and the remaining 18 cases showed normal Doppler. In the control group of same gestational age who does not show any complication, 6 cases (12%) showed abnormal Doppler findings.

Uterine Artery:

Systolic to Diastolic Ratio (S/D Ratio)- The normal value is 2.6 value increased in cases of PIH. In our study, about two third of cases shows elevated S/D ratio.

Pulsatility Index- The normal PI of uterine artery is 1. It is increased in cases of PIH. In our study, PI of uterine artery is increased in more than 50% of cases.

Resistance Index- The upper limit of normal value is 0.68. RI value is increased in PIH cases. In our study, more than 50% of cases show increased RI values (as comparable to study done by Zimmerman P, 1997).¹

Significance of Diastolic Notch- It is defined as decrease in maximum flow velocity below the maximum diastolic velocity occurring just after systolic wave. In non-pregnant state, the uterine artery is a high resistance vessel, showing low diastolic flow and early notching is the normal feature. During the 2nd trimester, the trophoblast invades the myometrium converting the high resistance flow pattern into that of the low resistance pattern characterised by increased in diastolic flow and disappearance of notch. Persistence of notch after 26 weeks of gestation is indicator of PIH. Persistence of notch indicates unaltered vasospasm. Disappearance of notch will happen first in the uterine artery, which is directly under the placenta.

In our study, the number of cases with diastolic notch more than the cases without notch. The number of cases showing unilateral and bilateral notch forms 56% of total number of cases.

It is essential to study both uterine arteries because of variation in placentation. In cases of laterally located placenta, the placental side uterine artery is the main supplier and has a low resistance as compared to the opposite uterine

artery. Examination of both arteries is an indispensable element of Doppler examination to assess placental performance and risk to the foetus.²

In our study, we found abnormal uterine artery Doppler in more than 62% of cases.

Umbilical Artery:

Systolic to Diastolic Ratio (S/D Ratio)- More than 3 after 30 weeks are abnormal.³ In our study, the maximum number of cases 29/50 (58%) show abnormal S/D ratio.

Pulsatility Index- The normal range is 0.4-1.0 (Harrington K 1995).⁴ It is increased in cases of PIH. In our study, the PI values is increased in 30/50 (60%) cases as comparable with study done by John Vogt.

Resistance Index- The normal value of RI in umbilical artery is 0.6. It is evaluated in cases of PIH. In our study, 29/50 (58%) of cases show abnormal resistance index.

In our study, sensitivity of S/D, PI, RI is 58%, 60% and 56%, respectively. In our study, we found abnormal PI ratio in more sensitive among other parameters comparable with other study.^{4,5}

Absent or reversal of end-diastolic velocity-

In our study, we found 9/50 (18%) of cases reversal or absent EDV, of these 2 cases show reversal of EDV, 2 cases died before 30 weeks of gestation (IUD), absent diastolic flow seen in 7 cases of which 5 cases died stillbirth, 2 cases (preterm) admitted in NICU with severe respiratory distress.

In other similar studies, patients with absent end-diastolic velocity and reverse end-diastolic velocity, perinatal mortality was 50%.⁶

In the study of 83 fetuses with absent or reversal of EDV, perinatal mortality was 19%. The perinatal mortality rate in AEDV is 8.9%, in REDV is 35.7%.⁷

VHM Karsdarp et al (1994)⁸ in their study of high-risk pregnancies (PIH, IUGR), the overall perinatal mortality was 28%, perinatal death was 41% in AEDV and 75% in REDV.

Our study shows AEDV/REDV is more sensitive in predicting adverse foetal outcome comparable with study done by CJ Bhatt, J Arora, MS Shah (2003), Kurkinen Ratty (1997) and Karsadarp (1994).

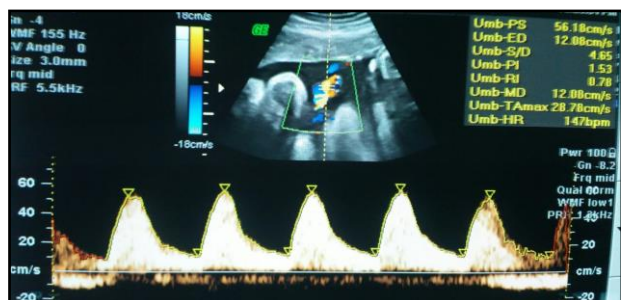


Figure 1. Decreased Diastolic Flow in Umbilical Artery

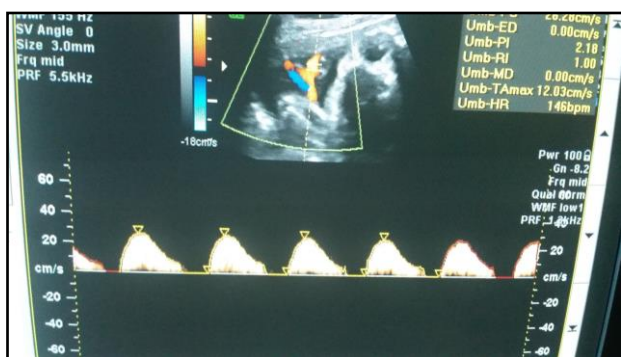


Figure 2. Absent Diastolic Flow in Umbilical Artery

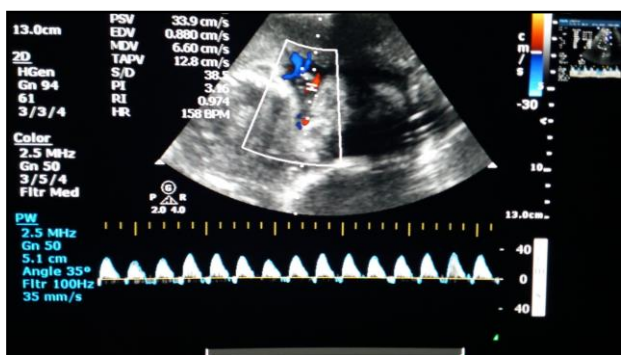


Figure 3. Reverse Diastolic Flow in Umbilical Artery

FOETAL MCA- In normal foetus, there is little diastolic flow in MCA. The normal PI value of MCA in 28 weeks of gestation is 1.6 ± 0.4 and at 40 weeks 1.2 ± 0.4 . Normal RI value is 0.8-1 and S/D ratio is greater than 4. In IUGR, there is increased diastolic flow, a pattern believed to reflect brain sparing phenomenon described in experimental model of foetal hypoxia. In our study, we found abnormal MCA Doppler in 26% of cases. According to Katherine W Fong,⁹ the criteria for cerebral redistribution are as follows-

1. Ratio of PI of umbilical artery/MCA >0.72 .
2. Ratio of RI of umbilical artery/MCA >1 .
3. Ratio of RI of MCA/umbilical artery <1 .

In our study, 26% of cases showed abnormal PI, suggesting PI value of MCA is more sensitive than other parameters as compared to study done by Katherine W. Fong.⁹

In our study, PI value of umbilical artery is more sensitive than PI value of MCA comparable to the study by Rhee and Detti (1998).¹⁰

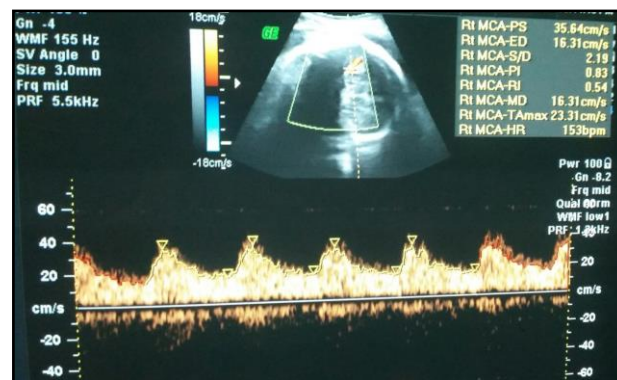


Figure 4. Brain Sparing Phenomenon in Middle Cerebral Artery

CONCLUSION

The introduction of Doppler technology has provided the first opportunity for repetitive non-invasive haemodynamic monitoring in human pregnancy. There is ample evidence that Doppler indices from the uteroplacental and foetoplacental circulation can reliably predict adverse perinatal outcome in obstetric patient population with a high prevalence of complications such as foetal growth retardation.

In our study, uterine artery sensitivity is 62% followed by umbilical artery 60% and middle cerebral artery 26% in predicting the foetal outcome.

Thus, we conclude that the Doppler velocimetry is primary tool for fetomaternal surveillance in hypertensive pregnancies, because changes in umbilical and uterine circulation strongly correlate with pregnancy outcome. We strongly recommend the use of colour Doppler examination in all cases of PIH.

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