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The Effect of Pregnancy-Induced Hypertension on Uteroplacental Vasculature Hemodynamic Changes and Pregnancy Outcome

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Among the various complications of pregnancy, pregnancy-induced hypertension is found to be the most common which may affect maternal and fetal outcome. Pregnancy induced hypertension can cause growth retardation of fetus.
Aim and Objective: This study aims to assess hemodynamic variations in uteroplacental circulation in pregnancy-induced hypertension and its effect on fetal outcome.
Materials and Methods: The study was carried out at tertiary care hospital of nawab shah for the period of 06 months at Department of Radiology in association with Department of Gyne and Obs. Total 106 participants were selected for the study and all females were pregnant with 1st or 2nd trimester gestational record and medical history was taken from all participants and co-morbidities was also evaluated. Blood pressure was checked from all participants from their right arm in lying position and Ultrasound test was repeated as per requirement through color Doppler ultrasound machine and Data was analyzed by using statistical software SPSS. 24.00 version.

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Results: After collection of research data from all participants, the entire data was assembled for the analysis. Participants were divided into various age groups as 26 were in 18-21yeras, 34 in 22-25years, 21 in 26-29years and only 07 were from 34-37years. 26 participants were belongs to 1st trimester, 34 among 2nd trimester and 21 in third trimester. PI was also noted with three different readings 32 in Umbilical artery, 21 in middle cerebral artery and 37 in uterine artery. RI was also noted among different arteries 41 in umbilical, 36 in middle cerebral and 39 in uterine arteries. S/D was also noted, 33 in umbilical artery, 49 in middle cerebral artery and 30 in uterine arteries.
Conclusion: Pregnancy-induced hypertension causes hemodynamic variations in uteroplacental vasculature which may be responsible for causing impaired fetal growth in some cases.

Keywords: Pregnancy-induced hypertension; uteroplacental circulation; fetal growth.

1. INTRODUCTION

Gestational period is an important and interesting physiological experience for every female. It can be worsen, if complication arise during pregnancy there is higher chance of maternal morbidity and mortality. The major complication observed during pregnancy is gestational induced hypertension and anemia and if these complications cannot be treated on time, they can develop numerous adverse effects. Hypertension during pregnancy is considered as most common complication observed among the females and if it is not managed properly on time then it may cause severe complication during labor and after delivery and leads to severe neonatal outcomes [1]. Pregnancy induced hypertension or PIH can be defined as "The persistence increase in the blood pressure up to 140/90mm of Hg among the pregnant females or gradually enhance in the systolic pressure up to 30mm of Hg and enhance in diastolic pressure up to 15mm of Hg or more" [2]. Gestational hypertension may lead to severity of complication like as growth retardation placental insufficiency and rupture of the placenta. Ultrasound of abdomen can help to detect the complication shows the abnormal findings and helps to detect the changes, Whereas, Color Doppler ultrasound images helps to sort out the defects among the fetus as fluctuation in blood pressure can leads to abnormal growth of fetus. Ultrasound after 12 weeks of pregnancy helps to detect the insufficiency of placenta and fetus growth. Color Doppler studies can be used for the detection of utero-placental vascular changes non-invasively and it is used to calculate the age of gestational sac and effects of placental insufficiency due to pregnancy induced hypertension.

2. MATERIALS AND METHODS

The study was carried out at tertiary care hospital of Nawab Shah for the period of 06 months at Department of Radiology and Department of Obstrietics and gynaecology. Total 106 participants were selected for the study and a record based study with pregnant females in the first and 2nd trimester of pregnancy were taken and medical history was taken from all participants and co-morbidities was also evaluated. Blood pressure was checked from all participants from their right arm in lying position and Ultrasound test was repeated as per requirement through color Doppler ultrasound machine and Data was analyzed by using statistical software SPSS. 24.00 version.

3. RESULTS

After collection of research data from all participants, the entire data was assembled for the analysis. Participants were divided into various age groups as described in Table 1.

Table 1. Age wise distribution of study subjects

Age group	Frequency	Percentage (%)
18-21	26	24.52%
22-25	34	32.07%
26-29	21	19.81%
30-33	18	16.98%
34-37	07	6.60%

Table 2. Trimester wise group of study subjects

Trimester wise group	Frequency	Percentage (%)
1st Trimester	26	24.52%
2nd Trimester	34	32.07%
3rd Trimester	21	19.81%

Table 3. Doppler Indices among various arteries

Doppler indices	Umblical artery	Middle cerebral artery	Uterine artery
PI	32(30.18%)	21(19.81%)	37(34.90%)
RI	41(38.67%)	36(33.96%)	39(36.79%)
S/D	33(29.24%)	49(46.22%)	30(28.30%)

Table 4. Fetal Growth of study subjects

Fetal characteristics	Frequency	Percentage
Small Growth of gestation	27	25.47%
Large Growth of gestation	79	74.52%

Table 5. Abnormal doppler indices among various arteries

Abnormal doppler indices	Frequency	Percentage
Umblical artery	27	25.47%
Middle cerebral artery	23	21.69%
Uterine artery	56	52.83%

4. DISCUSSION

In our study, we have tried to assess hemodynamic changes in pregnancy-induced hypertension non-invasively by color Doppler and its effect on pregnancy outcome. The study's main findings were decrease in mean values of Doppler indices in normal pregnancy and pregnancy-induced hypertension, that is, decreased impedance to blood flow. However, less decrease was found pregnancy-induced hypertension for same gestational period as compared to normal pregnancy suggesting more impedance to blood flow and more chances of uteroplacental insufficiency in pregnancy-induced hypertension. Out of all three arteries, that is, umbilical, uterine, and fetal middle cerebral artery, changes in umbilical blood flow are seen to be most significant in uteroplacental insufficiency in pregnancy-induced hypertension. All 3 Doppler indices, that is, RI, PI, and S/D were showing a decreasing trend as pregnancy advances which may be due to decreased vascular impedance and increased blood supply in uteroplacental circulation. Similar results had been found in the previous studies [3]. It is supported by the fact that a normal uteroplacental circulation during pregnancy is essential for fetal growth as it is main channel of providing nutrients and oxygen to fetus from mother. Throughout the pregnancy, there is uterine wall hyperplasia and hypertrophy and arterioles elongate and coil. At the base of placenta, there is thinning of endometrium with invasion of trophoblast. The trophoblastic invasion leads to stripping off the muscular elastic coat of spiral arteries by the twentieth postmenstrual week. This decreases the opposition to blood flow progressing from radials artery into the intervillous space. The pressure decreases from about 70-80 mm Hg in the former to 10 mmHg [4]. Furthermore, there is production of some vasodilatory peptides locally in decidua and myometrium that promote maternal uterine blood flow. As a result of these mentioned physiological changes in uteroplacental vasculature, the blood flow in gravid uterus increases by 14 times as compared to that in non-gravid uterus after 28 weeks of pregnancy. The diastolic phase of the uterine artery Doppler waveform is thus transformed during normal pregnancy from one of low peak flow velocity to high peak flow velocity by the second trimester [5]. Blood flow through the umbilicus increases as the mother's gestational age grows and pressure gradient driving the blood from the descending aorta through the placenta and back to inferior vena cava. The continuous intervillous circulation may be associated with change in pressure gradient

caused by the expansion of intervillous space and modification in blood gases and metabolite concentrations [4]. As pregnancy advances, there is increasing end-diastolic flow velocity with lesser changes in S [4]. This change does not occur in gestational hypertension, thereby showing all high values of Doppler indices for that gestational age. According to our study in gestational hypertensives, all three Doppler indices showed a decreasing trend in as in normal pregnancy, but the individual values are showing less decrease for that gestational age in normal and usual pregnancy. Systolic / Diastolic ratio of more than 3 in umbilical artery was considered as an abnormal value after 30 weeks of gestation & it was concluded that placental vascular resistance between 31-34 weeks of gestation was higher in lower weight group as compared to normal weight for gestational age as also revealed by our study [6]. In our study, it is found that in normal pregnancy, the umbilical arterial blood flow increases with advancing gestation. This happens due to increasing number of functioning vascular channels in this blood vessel. As a result, end-diastolic component which is absent in early pregnancy is found to increase after 20 weeks of gestation [7]. Uterine artery Doppler studies are found to be increased and persistence of diastolic notching beyond 26 weeks of gestation was considered as abnormal and predisposing to high risk for the development of pregnancy-induced hypertension and intrauterine fetal growth retardation [8]. In our study, this has been found but hemodynamic changes in umbilical artery as seen by Doppler are found to be more significant than uterine artery blood flow changes. It is concluded in our study that increased values of Doppler indices of uterine artery are associated with 40°/C of high-risk pregnancies and 80°/of them are associated with small for age gestation. Uterine artery blood flow with increased resistance was found in 40% pregnancies with preeclampsia and about 20% of those have developed intrauterine growth restriction [9]. Results are quite consistent with our studies. Thus, our study has shown that different fetomaternal vasculature Doppler indices can assess foregoing complications in pregnancy outcome and fetal growth. As pregnancy advances, gradually the uterine artery diameter enlarges, peak systolic velocity and volume flow rates increase and a progressive fall in impedance of blood flow occurs [10] which is also corroborating our findings. There is a relationship between vasodilatation in middle cerebral artery and fetal hypoxemia that exist only in mild to moderate hypoxemia; with more severe degree of hypoxemia and academia, the value of PI reaches a nadir which has been suggested to represent the maximum vessel dilatation [11]. In our study PI value of middle cerebral artery was found to be decreased with advancing gestational age in normal pregnancy and in gestational hypertension (usually the values were below 2S.D). This may be explained by the fact that the middle cerebral artery of the fetus has a low resistance circulation throughout pregnancy. All doppler indices showed a decreasing pattern due to decrease in resistance in middle cerebral artery as fetus responds to hypoxemia by increase in cardiac output to myocardium and brain at the expense of viscera. This adaptation of fetus to the effect of hypoxia is called brain sparing effect [12]. Our study found that Doppler measurements of multiple vessels in the fetoplacental circulation can help in the monitoring of compromised fetus. A significant difference was found in between the between the three vessels' Doppler indices (Umbilical, Uterine & Middle cerebral artery) in the study and the control group which is in agreement with other study [13]. In our study umbilical artery doppler indices were found to be more significant whereas in another study MCA doppler indices were found to be more significant [14].

5. CONCLUSION

Pregnancy-induced hypertension can cause hemodynamic changes in uteroplacental circulation which may cause impaired fetal growth. Doppler velocimetry is very helpful in detecting and monitoring such complicated pregnancies which may lead to intrauterine growth retardation and timely recognition of such impending complications may help clinician to take preventive and corrective measures in time to have a better fetal outcome.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline Patient’s consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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