Evaluation of Doppler Indices and Fetal Outcome in Normal and Pre-eclampsia Patients

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Abstract

Background: Preeclampsia (PE) is one of the major risk factors in maternal mortality. The impairment in placental perfusion due to vascular abnormalities leads to clinical manifestationsand isevident by Doppler ultrasound. Doppler velocimetry is a rapid, non-invasive and efficient diagnostic test to detect fetal jeopardy. Objective of the study is to observe thefetal outcome in Preeclampsia cases by using Doppler ultrasound study after 30 weeks of gestation and comparing these with normal controls.

Materials and methods: This case control study was conducted in the Department of Obstetrics and Gynecology, Khulna Medical College Hospital between 1st September 2019 and 28th February 2020. Thirty-three pregnant women after 30 weeks of gestational age who were clinically diagnosed as preeclampsia were selected as cases (Group I) and equal number (33) of age, parity and gestational age group matched apparently healthy normotensive pregnant women were selected as control (Group II) for the study. Then each patient was subjected to color Doppler study and ultrasound examination. All clinical and socio-demographic information were collected in a pre-designed separate case record form.Data were analyzed by using Statistical Package for Social Science (SPSS) version 22.0.

Results: There was no remarkable difference in Doppler study findings of uterine artery between both groups Regarding umbilical artery, both mean RI (0.73±0.25 vs 0.62±0.11) and mean PI (1.18±0.35 vs 0.82±0.15) was significantly different in two groups with lesser perfusion in preeclampsia group. Regarding middle cerebral artery, mean RI(0.76±0.20 vs 0.86±0.32) and mean PI (1.32±0.29 vs 1.48±0.29) was significantly different in two groups with lesser perfusion in preeclampsia group. Regarding fetal outcome, fetal birth weight, (1.76±0.44 kg vs 2.67±0.63 kg), APGAR score at 1 min,(5.24±1.25 vs 5.85±0.83) and APGAR score at 5 min (8±1.50vs 8.82±0.58) was statistically different between both groups with more frequency of adverse outcome in preeclampsia group. There was no significant difference in NICU admission and perinatal death.

Conclusion: This study observed high incidence of low birth weight and low APGAR score with abnormal Doppler in preeclampsia group. So, Color Doppler study can be used as an adjunct in pre-eclampsia with adverse fetal outcome.

Key words: Doppler study; Pre-eclampsia; Pregnancy.

Introduction

Preeclampsia (PE) is the main risk factor in maternal mortality across the world, affecting 5% to 8% of pregnant women. The impairment in placental perfusion due to vascular abnormalities leads to adverse fetal outcome and is detectable by Doppler ultrasound.[1] Doppler velocimetry is a rapid, non-invasive test that gives important information about hemodynamic situation of the fetus and is an efficient diagnostic test of fetal jeopardywhich helps in timely intervention and management of high-risk pregnancy for better perinatal outcome.[2]

The underlying pathology in preeclampsia is defective placentation and extensive vasoconstriction resulting in endothelial damage. This exerts influence on multiple organs in mother and has a remarkable impact on the fetus. The main objective of antepartum fetal surveillance in a high-risk pregnancy in preeclampsia is to detect compromised fetus to allow timely delivery.

The principle of Doppler ultrasound was described in 1842 by Johann Christian Doppler.[3] Identification of the pregnancies at risk for preventable perinatal morbidity and mortality is a primary goal of the obstetric care. The development

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of Doppler ultrasound evaluation of utero-placental and fetoplacental circulation is one of the most important achievements of modern obstetrics. Doppler velocimetry is a rapid and non-invasive test that provides important information about hemodynamic situation of the fetus and is an efficient diagnostic test of fetaljeopardy that helps in management of high-risk pregnancy.[4] The first application of Doppler velocimetry in obstetrics was reported by Fitzgerald, Drumm, McCallum et al.[5] Since beginning, it has beenshown that insufficient uterine, placental and fetal circulations result in worse pregnancy outcomes and those abnormalities can be detected by the use of Doppler ultrasonography.[6] In the past decades, Color Doppler ultrasound has been used for fetal surveillance.[7] Doppler studies are noninvasive and help in detecting the degree of placental insufficiency and also to detect aggravation of the situation, thereby decision to intervene can be taken once the need arises.[8] The results of Umbilical Artery (UmA) Doppler are reflection of the placental status, whereas the results obtained from a Middle Cerebral Artery (MCA) indicates the state of fetal circulation.[9] Doppler ultrasound is used in high-risk pregnancies, particularly the cases complicated by fetal growth retardation, preeclampsia, or other maternal medical conditions.[10]

In normal pregnancy the 3 indices Systolic Diastolic ratio (S/D), Pulsatility Index (PI) and Resistive Index (RI) decreases with advancing gestation in umbilical artery but in IUGR first there is decline diastolic flow in umbilical artery due to increase in the resistance that occurs in small arteries and arterioles of the tertiary villi. This raises the S/D ratio, PI and RI of umbilical artery. As the placental insufficiency worsens, the diastolic flow decreases, then becomes absent, and later reverses. Fetal MCA is a low resistance circulation throughout pregnancy and accounts for 7% cardiac output of the fetus. The MCA seems to react earlier and sensitively to hypoxia and ischemia.[11] But abnormal MCA Doppler alone showed limited predictive accuracy for compromise of fetal and neonatal well-being.[12] This study was conducted to find out fetal outcomes in Preeclampsia cases by using Doppler ultrasound study after 30 weeks of gestation and comparing these with normal pregnancy. This study may help the clinician to specify the spectrum of use of color Doppler study in preeclampsia patients.

Materials and methods

This case control study was carried out in the Department of Obstetrics & Gynecology, Khulna Medical College Hospital, Khulna between 1st September 2019 and 28th February 2020. Ethical clearance for the study was obtainedfrom the institutional review board, Khulna Medical College. A total of 66 pregnant women between 18 and 35 years of age attending outdoor antenatal clinic were enrolled in this study. Among them, 33 pregnant women with clinical diagnosis of preeclampsia were considered as case and group I, and rest 33 apparently healthy normotensive pregnant women were considered as control and group II.Pregnancy with chronic hypertension, Pregnancy Induced Hypertension (PIH) without proteinuria, Diabetes Mellitus (DM) Gestational Diabetes Mellitus (GDM) multiple pregnancy, maternal history of taking antithyroid drug, previous history of any thyroid disorder, thyroid surgery, chronic renal disease, chronic liver disease were excluded from this study. Purposive sampling was done according to the availability of the participants who had voluntarily joined this study. The purpose and procedure of study was discussed with the participants and informed written consent was taken. An interviewer administered questionnaire was used for data collection. Detailed socio-demographic data, obstetric history, menstrual history (LMP) to calculate gestational age, family history and medical history were recorded. Then physical examination, anthropometric measurements (Height, weight) were taken and obstetric examination were performed and recorded.After 10 minutes of rest, BP was measured following standard procedure for systolic (SBP) and diastolic (DBP). The subjects with blood pressure ≥ 140/90 mm of Hg on two occasions were evaluated for presence of urinary protein by Dipstick method to establish the diagnosis of preeclampsia. When proteinuria found > 1+ in collected urine sample, then the diagnosis of preeclampsia was established and they were selected as cases (Group I).[13] The subjects who were found normotensive were selected as control

(Group II). Then each patient was subjected to color Doppler study and ultrasound examination. All information were collected in a pre-designed separate case record form. All data were analyzed using the software SPSSversion 22.0.

Pulsatility Index (PI), it is consistently used to evaluatethe resistance in a pulsatile vascular system.

Resistive Index (RI) is a calculated flow parameter in ultrasound, derived from the maximum, minimumand mean Doppler frequency shifts during a defined cardiac cycle.

Results

In this study total number of pregnant women was 66 and they were equally divided into two groups, preeclampsia pregnancy group and normal pregnancy group. In this study 36.4% respondents having age between 18 to 22 years in both group, 39.4% of preeclampsia pregnancy group and 30.3% of normal pregnancy group having age between 23 to 27 years. Besides 24.2% of preeclampsia pregnancy group and 33.3% of normal pregnancy group having age between 28 to 32 years. Mean age of mother was 24.39±4.13 years of SD in preeclampsia pregnancy group whereas mean age of mother was 24.6±4.61years of SD in normal pregnancy group. No statistical difference has been found between both groups (p>0.05).

In this study 84.8% were house wife and 15.2% were service holder among preeclampsia pregnancy group whereas 81.8% were housewife and 18.2% were service holder among normal pregnancy group. No significant difference has been found between both groups with occupation.

In this study 48.5% respondents of preeclampsia pregnancy group were primigravida and 39.4% respondents of normal pregnancy group were primigravida. Primigravida was more common in preeclampsia patient and significant difference has been found between both groups.

Table I Comparison of general characteristics between study groups (n=66)

Characteristics	Preeclampsia pregnancy Mean±SD	Normal pregnancy Mean±SD	p value
Maternal age	24.39±4.13	24.6±4.61	*0.758
Gestational weeks	33.67±2.48	36.91±2.35	*<0.01
Systolic blood pressure	148.48±28.62	110.61±7.04	*<0.01
Diastolic blood pressure	107.58±15.81	67.68±4.15	*<0.01

*p value was determined by independent sample t test.

Table I shows mean age of mother was 24.39±4.13 years of SD, mean gestational week was 33.67±2.48, mean systolic blood pressure was 148.48±28.62 and mean diastolic blood pressure was 107.58±15.81 in preeclampsia pregnancy group besides mean age of mother was 24.6±4.61 years of SD, mean gestational week was 36.91±2.35, mean systolic blood pressure was 110.61±7.04 and mean diastolic blood pressure was 67.68±4.15 in normal pregnancy group. Highly significant difference has been found between both groups with gestational weeks and blood pressure.

Table II Distribution of the respondents according to fetal outcome (n=66)

Fetal outcome	Preeclampsia pregnancy Mean±SD	Normal pregnancy Mean±SD	p value
Birth weight (kg)	1.76±0.44	2.67±0.63	*<0.01
APGAR score at 1 min	5.24±1.25	5.85±0.83	*0.02
APGAR score at 5 min	8±1.50	8.82±0.58	*<0.01

*p value was determined by independent sample t test.

Table II shows mean of fetal birth weight was 1.76±0.44 kg, APGAR score at 1 min was 5.24±1.25 and APGAR score at 5 min was 8±1.50 in preeclampsia pregnancy group besides mean of fetal birth weight was 2.67±0.63 kg, APGAR score at 1 min was 5.85±0.83 and APGAR score at 5 min was 8.82±0.58 in normal pregnancy group. There was highly significant difference between both groups

Table III Distribution of the respondents according to NICU admission (n=66)

NICU admission	Preeclampsia pregnancy Frequency (%)	Normal pregnancy Frequency (%)	p value
Yes	14 (42.4)	4 (12.1)	
No	19 (57.6)	29 (87.9)	>0.05
Total	33(100)	33(100)	

*p value was determined by chi square test.

Table III shows 42.4% baby of preeclampsia pregnancy group and only 12.1% baby of normal pregnancy group had to admit in NICU.No significant deference was found in both groups.

Table IV Distribution of the respondents according to Perinatal death (n=66)

Perinatal death	Preeclampsia pregnancy Frequency (%)	Normal pregnancy Frequency (%)	p value
Yes	7 (21.2)	2 (6.1)	
No	26 (78.8)	31 (93.9)	0.074
Total	33 (100)	33 (100)	

*p value was determined by chi square test.

Table IV shows 21.2% baby of preeclampsia pregnancy group and 6.1% baby of normal pregnancy group had perinatal death. No significant difference has been found between both groups.

Table V Doppler Ultrasoundfindings by uterine artery of mother in the study groups (n=66)

Doppler US finding	Preeclampsia pregnancy Mean±SD	Normal pregnancy Mean±SD	p value
Right artery RI	0.74±0.22	0.79±0.22	*0.775
Right artery PI	1.16±0.42	1.14±0.41	*0.840
Left artery RI	0.79±0.19	0.77±0.19	*0.585
Left artery PI	1.42±0.82	1.36±0.68	*0.750

*p value was determined by independent sample t test.

Table V shows doppler US findings of uterine artery of mother. Mean RI of right uterine artery was 0.74±0.22 and PI was 1.16±0.42 besides mean RI of left uterine artery was 0.79±0.19 and PI was 1.42±0.82 in preeclampsia pregnancy group. Mean RI of right uterine artery was 0.79±0.22 and PI was 1.14±0.41 besides mean RI of left uterine artery was 0.77±0.19 and PI was 1.36±0.68 in normal pregnancy group. No statistically significant difference has been found between the groups.

Table VI Doppler Ultrasound findings by Umbilical artery of fetus in the study groups (n=66)

Doppler US finding	Preeclampsia pregnancy Mean±SD	pregnancy Normal Mean±SD	p value
UmARI	0.73±0.25	0.62±0.11	*0.03
UmA PI	1.18±0.35	0.82±0.15	*<0.01

*p value was determined by independent sample t test.

Table VI shows Mean RI of umbilical artery of fetus was 0.73±0.25and PI was 1.18±0.35 in preeclampsia pregnancy group besides mean RI of umbilical artery was 0.62±0.11 and PI was 0.82±0.15 in normal pregnancy group. Highly significant difference was found between the groups.

Table VII Classification of Doppler Ultrasound findings by middle cerebral artery of fetus in the study groups (n=66)

Doppler US finding	Preeclampsia pregnancy Mean±SD	Normal pregnancy Mean±SD	p value
RI	0.76±0.20	0.86±0.32	*0.148
PI	1.32±0.29	1.48±0.29	*0.039

*p value was determined by independent sample t test.

Table VII shows mean middle cerebral artery of fetus RI was 0.76±0.20 and PI was 1.32±0.29 in preeclampsia pregnancy group and mean middle cerebral artery RI was 0.86±0.32 and PI was 1.48±0.29. Highly significant difference was found with middle cerebral artery PI between two groups.

Discussion

In this study total number of pregnant women was 66 and they were equally divided into two groups, preeclampsia pregnancy group and normal pregnancy group. In this study 36.4% respondents having age between 18 to 22 years in both group, 39.4% of preeclampsia pregnancy group and 30.3% of normal pregnancy group having age between 23 to 27 years. Besides 24.2% of preeclampsia pregnancy group and 33.3% of normal pregnancy group having age between 28 to 32 years. Mean age of mother was 24.39±4.13 years of SD in preeclampsia pregnancy group whereas mean age of mother was 24.6±4.61years of SD in normal pregnancy group. No statistical difference has been found between both groups ($p>0.05$).

In this study 84.8% were house wife and 15.2% were service holder among preeclampsia pregnancy group whereas 81.8% were housewife and 18.2% were service holder among normal pregnancy group. No significant difference has been found between both groups with occupation.

In this study 48.5% respondents of preeclampsia pregnancy group were primigravida and 39.4% respondents of normal pregnancy group were primigravida. Primigravida was more common in preeclampsia patient and significant difference has been found between both groups. A previous study observed Primigravida constituted 62% of total PE cases they observed preeclampsia was high in primigravid patient.[14]

In this study mean gestational week was 33.67±2.48, mean systolic blood pressure was 148.48±28.62 and mean diastolic blood pressure was 107.58±15.81 in preeclampsia pregnancy group whereas mean gestational week was 36.91±2.35, mean systolic blood pressure was 110.61±7.04 and mean diastolic blood pressure was 67.68±4.15 in normal pregnancy group. High significant difference has been found between both groups with gestational weeks and blood pressure.In this study mean of fetal birth weight was 1.76±0.44 kg, APGAR score at 1 min was 5.24±1.25 and APGAR score at 5 min was 8±1.50in preeclampsia pregnancy group whereas mean of fetal birth weight was 2.67±0.63 kg, APGAR score at 1 min was 5.85±0.83 and APGAR score at 5 min was 8.82±0.58 in normal pregnancy group. High significant difference has been found between the groups.A previous study observed fetal Birth weight, APGAR score is low in preeclampsia pregnancy compared with control group.[4]

In this study 42.4% baby of preeclampsia pregnancy group and only 12.1% baby of normal pregnancy group had to admit in NICU. Total 21.2% baby of preeclampsia pregnancy group and 6.1% baby of normal pregnancy group had perinatal death. A similar type of previous study found 12.19% of cases of perinatal mortality.[15]

In this study Mean RI of right uterine artery of mother was 0.74±0.22 and PI was 1.16±0.42 whereas mean RI of left uterine artery of motherwas 0.79±0.19 and PI was 1.42±0.82 in preeclampsia pregnancy group. Mean RI of right uterine artery of mother was 0.79±0.22 and PI was 1.14±0.41 whereas mean RI of left uterine artery of mother was 0.77±0.19 and PI was 1.36±0.68 in normal pregnancy group. No statistically significant difference has been found between both groups. Mean RI of umbilical artery of fetus was 0.73±0.25and PI was 1.18±0.35 in preeclampsia pregnancy group whereas mean RI of umbilical artery of fetus was 0.62±0.11 and PI was 0.82±0.15 in normal pregnancy group. Highly significant difference has been found between both groups. Mean middle cerebral artery(fetus) RI was 0.76±0.20 and PI was 1.32±0.29 in preeclampsia pregnancy group whereas mean middle cerebral artery(fetus) RI was 0.86±0.32 and PI was 1.48±0.29 in normal pregnancy group. Highly significant difference has been found with middle cerebral artery PI between both groups. A previous study observed that RI and PI parameters of the uterine artery showed a close gap between the study groups and therefore they were not associated to PE (P values > 0.05). The umbilical RI and PI were 0.59 and 0.91 for the cases group and 0.51 and 0.78 for the control group, respectively. There was a positive association between individual values.[16]

Limitations

The present study was conducted within a short period of time. The study population was selected from one selected hospital, so that the results of the study may not be reflect the exact picture of the country. Small sample size with purposive sampling was also a limitation of the present study.

Conclusion

This study observed increase frequency of low birth weight, low Apgar score among patients with preeclampsia. Abnormal Doppler findings were statistically prevalent in preeclamptic pregnant women. So, Color Doppler can be recommended as marker to predict preeclampsia with adverse fetal outcome. It may also help to determine the optimal time for delivery.

Recommendations

Further longitudinal studies with larger sample size with multicentre approach and long duration are needed to establish the actual spectrum of color Doppler study in preeclampsia patients.

This will strengthen the outcome of this study result.

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Contribution of authors

MP-Conception, acquisition of data, drafting & final approval.

NH-Data analysis, interpretation of data, critical revision & final approval.

NH-Interpretation of data, critical revision & final approval.

ES-Acquisition of data, drafting & final approval.

MFU-Acquisition of data, drafting & final approval.

MAK-Data analysis, drafting & final approval.

AKP-Design, critical revision & final approval.

Disclosure

All the authors declared no conflict of interest.

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