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Comparative study on ultrasonic placental grading among normotensive pregnancy and pregnancy-induced hypertension and its correlation with fetal outcome

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ABSTRACT

Background: Placenta is essential for the fetal well-being, growth, and development which can be evidenced as early as possible through ultrasound at 6 weeks of gestation. The placenta mediates the intrauterine interaction between a mother and her baby. **Aims and Objectives:** This study aims to compare the pattern of placental grading among normotensive and pre-eclampsia mothers in a tertiary care hospital. **Materials and Methods:** This hospital-based observational analytical study has been conducted in the labor ward and outpatient department of the Department of Obstetrics and Gynaecology, Bankura Sammilani Medical College and Hospital from April 2021 to September 2022. A total of 69 pre-eclampsia mothers (study group) and 69 normotensive mothers (control group) who fulfill inclusion and exclusion criteria were included in the study. Template was generated and analysis was done on Statistical Package for the Social Sciences software. **Results:** A total of 138 pregnant women with 69 pregnant normotensive and 69 pregnant preeclampsia mothers were included in the study. The mean age of the study participants was 21.3 years (standard deviation = 3.6). About 81.2% and 89.9% of the normotensive and hypertensive mothers, respectively, resided in rural areas. Cesarean/instrumental delivery was higher among the hypertensive pregnant women (42.0%) when compared to normotensive pregnant women (27.5%) and it was found to be statistically significant. Birth asphyxia was observed to be higher among the neonates in the hypertensive group (15.9%) when compared to the normotensive group (4.3%) and it was found to be statistically significant. Neonatal intensive care unit admission was more among the neonates of the mother with hypertension and it was found to be statistically significant. There was no significant difference in the birth weight of the newborn with the placental grading among the normotensive pregnant women. **Conclusion:** Ultrasonographic placental grading could be used as a screening tool for antepartum fetal surveillance in the obstetric population. Placental grading will help us to early diagnosis and to formulate line of management and timely intervention to reduce maternal and perinatal complications.

Key words: Eclampsia; Fetal outcome; Pregnancy; Ultrasound placental grading

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INTRODUCTION

The placenta being a fetal organ shows the same stress and strain, to which the fetus is exposed, thus any disease process affecting the mother and fetus has a great impact on the placenta and vice versa. Owing to the delicate and important nature of the placenta, it is sometimes referred to as the "mirror of the perinatal period which has not been sufficiently polished."[1,2]

During the course of a normal pregnancy, the placenta progressively ages and the term placenta is in the verge of a decline into morphological and functional senescence.[3] Alterations in the placenta as part of the aging phenomena are probably a part of the maturation process and goes hand in hand with the growth of the placenta. The relationship between placental morphology and its function and the fetal outcome has been the subject of study for many years. Various complications in pregnancy have been correlated with specific placental changes, among them compromised placental perfusion from uterine vasospasm almost certainly is said to be a major culprit in the genesis of increased perinatal morbidity and mortality associated with pregnancy-induced hypertension (PIH).[4,5]

PIH is defined as systolic blood pressure (BP) >140 mmHg and diastolic BP >90 mmHg. Hypertensive disorder of pregnancy affects about 5–8% of all pregnant women worldwide,[6] whereas in rural India the incidence is 10%.[7]

Women with PIH are at a greater risk of abruptio placentae, cerebrovascular events, organ failure, and disseminated intravascular coagulation, whereas their fetuses are at greater risk of intrauterine growth retardation, prematurity, and intrauterine death.[8]

The evolution of ultrasonography has been very useful in obstetrics and has found application in placental studies as it is a non-invasive procedure and is a modality of choice for the evaluation of the placenta.[9] The placenta is essential to fetal well-being, growth, and development; it can be demonstrated reliably and accurately by ultrasound and can be evidenced as early as at 6 weeks of gestation.[10]

The earlier placenta could be examined only after delivery but with serial grayscale ultrasonography it is possible to identify changes in placental anatomy earlier since the placenta also matures in a fashion similar to that of other fetal organs.[11]

The association of ultrasonically detectable placental changes with increasing gestational age was first reported by Winsberg,[12] but it was Grannum et al., who introduced a grading system based on the ultrasonographic appearance of placentas.[13] Grannum et al., classified the changes that occur in the placenta into four grades (0–III), while Hopper et al., noted that if the placenta appeared to be Grade 1 before 27 weeks, Grade 2 before 32 weeks, and Grade 3 before 34 weeks of gestation, the pregnancy would be likely to be complicated with preeclampsia.[14]

Grannum et al. introduced placental grading from 0 to 3 by noting the architecture of the basal plate, chorionic plate, and the placental substance.[13]

- Grade 0-Placenta has an easily delineated straight chorionic plate and a homogeneous texture throughout
- Grade 1-Placenta has an undulating chorionic plate and scattered echogenic areas within
- Grade 2-Small echogenic areas in the placenta along the basal layer, comma-like echogenic areas at the chorionic plate
- Grade 3-Echogenic indentations from chorionic plate to basal plate forming discrete cotyledons.

In view of the above, the present study was undertaken to compare the ultrasound placental grading in pregnancy complicated with hypertension and normotensive pregnancy and its correlation with fetal outcome.

Aims and objectives

This study aims to compare the pattern of placental grading among normotensive and pre-eclampsia mothers and to determine the correlation between placental grading and fetal outcome among normotensive pregnancy and pre-eclampsia mothers in a tertiary care hospital.

MATERIALS AND METHODS

Study design

This is a hospital-based observational analytical study. This study was conducted in the labor ward and outpatient department (OPD) of the Department of Obstetrics and Gynaecology, Bankura Sammilani Medical College and Hospital within a time frame of about 18 months (April 2021-September 2022) after acceptance of the synopsis.

This study was conducted among pre-eclampsia mothers (study group) and normotensive mothers (control group) those who fulfill inclusion and exclusion criteria, during their third-trimester attending the OPD or labor ward at the Department of Obstetrics and Gynecology, BSMCH.

Study population

The final sample size was 138 (69 in each group). The study group comprises patients with PIH with a period of gestation ≥ 28 weeks and BP ≥140/90 mmHg. The other group consists of normotensive. Patients matched with age and parity. All patients were subjected to routine

antenatal examination, detailed history with general physical and obstetrics examination was done.

Inclusion criteria

Patients with PIH with a period of gestation ≥28 weeks and BP ≥140/90 mmHg and normotensive patients with pregnancy consented for the study were included in the study.

Exclusion criteria

Exclusion criteria were all chronic hypertension patients and patients with end-organ damage.

Tools used for data collection

All patients were subjected to routine antenatal examination, detailed history with general physical and obstetrics examination was done using pre-designed study pro forma. The perinatal outcome was assessed by birth weight, mode of delivery, fetal maturity, perinatal morbidity and mortality, and presence of fetal distress.

Data collection and processing

Ultrasonic examinations were performed twice by the on-duty radiologist, once between 28 and 34 weeks and another after 34 weeks till term. Apart from routine parameters routine placental grading was performed according to the classification proposed by Grannum et al., and associates.[13]

Statistical analysis

Data were analyzed using Statistical Package for the Social Sciences V21 for Windows. Categorical variables are expressed as frequency and percentages. Continuous variables are presented as mean (standard deviation) or median (interquartile range). The Chi-square test or Fishers exact test was used to determine the association for the categorical variables with the feto-maternal outcomes. Independent samples t-test or one-way ANOVA was used to determine the association for continuous variables. Chi-square trend analysis was used to determine the association between the placental grading and perinatal outcomes. P<0.05 was considered statistically significant.

Ethical clearance

The study was conducted only after obtaining written approval from the Institutional Ethics Committee of Bankura Sammilani Medical College and Hospital. (BSMC/Aca/199, Date: 19.01.2019). Written informed consent will be taken from every study patient or their logical representative.

RESULTS

A total of 138 pregnant women with 69 pregnant normotensive and 69 pregnant pre-eclampsia mothers were included in the study. The mean age of the study participants was 21.3 years (standard deviation=3.6). About 81.2% and 89.9% of the normotensive and hypertensive mothers, respectively, resided in rural areas. The study shows that the mean period of gestation at the time of delivery among the normotensive and hypertensive groups was 38.9 and 38.4 weeks, respectively.

The study shows that Grade 3 placenta at early gestational age (28–34 weeks) was more among those with hypertension (34.8%) when compared to normotensive pregnant women (2.9%) and it was found to be statistically significant (P<0.001).

The study shows that Grade 3 placental at late gestational age (≥34 weeks) was more among those with hypertension (63.8%) when compared to normotensive pregnant women (24.6%) and it was found to be statistically significant (P<0.001). It is also noteworthy to mention that the placental maturation of Grade 3 from grade to was achieved among 31.0% of normotensives compared to 44.4% of hypertensives, indicating a faster rate of maturation among the hypertensives and it was found to be statistically significant (McNemar test).

The study shows that the cesarean/instrumental delivery was higher among the hypertensive pregnant women (42.0%) when compared to normotensive pregnant women (27.5%) and it was found to be statistically significant (P=0.048).

The present study shows that more than 3/4th of the neonates were delivered at term in both the groups. However, pre-term delivery was significantly higher among the pregnant women with hypertension when compared to the normotensive pregnant women (15.9% vs. 5.8%; P=0.044) (Table 1).

The study shows that there was no significant difference in the birth weight of the neonates between the two groups (P=0.865).

Study shows that the birth asphyxia was observed to be higher among the neonates in the hypertensive group (15.9%) when compared to the normotensive group (4.3%) and it was found to be statistically significant (P=0.024).

Study shows that oligohydramnios was found to be higher among the pregnant women with hypertension when compared to normotensive pregnant women but it was not found to be statistically significant (P=0.459).

Study shows that Apgar score <7 at 5 min was observed more among the neonates born to hypertensive mothers and it was found to be statistically significant (P=0.038).

Neonatal intensive care unit (NICU) admission was more among the neonates of the mother with hypertension and it was found to be statistically significant (P=0.014).

There were two stillbirths and three neonatal deaths and all five deaths were accounted by the hypertensive mothers (Table 2).

Trend analysis shows birth asphyxia, oligohydramnios, and Apgar score <7 at 5 min were higher among the pregnant women with a higher grade of placental grading both among the hypertensive group and normotensive group but it was not found to be statistically significant.

Study shows that there was no significant difference in the birth weight of the newborn with the placental grading among the normotensive pregnant women. However, among the hypertensive pregnant women, the mean birth weight was significantly lower among those with grade 3 placental grading when compared to Grade 2 placental grading (P=0.008).

Table 1: Maternal parameters

No.	Parameters	Normotensive	Preeclampsia	P-value
1.	Age of mothers (Years)			
	Mean	20.9	21.8	0.113
	SD	2.9	4.08	
2.	Residence			
	Urban	13 (18.8)	07 (10.1)	0.147
	Rural	56 (81.2)	62 (89.9)	
3.	Gestational age (weeks) at time of delivery			
	Mean	38.9	38.4	0.144
	SD	1.7	1.9	
4.	Early placental grading (28–34 weeks)			
	Grade 1	25 (36.2)	0	<0.001
	Grade 2	42 (60.9)	45 (65.2)	
	Grade 3	02 (2.9)	24 (34.8)	
5	Late placental grading (≥34 weeks)			
	Grade 1	02 (.9)	0	<0.001
	Grade 2	50 (72.5)	25 (36.2)	
	Grade 3	17 (24.6)	44 (63.8)	
6.	Mode of delivery			
	Vaginal delivery	50 (72,5)	40 (58.0)	0.044
	LUCS/Instrumental delivery	19 (27.5)	29 (42.0)	
7.	Fetal maturity at birth			
	Term	59 (85.5)	52 (75.4)	0.835
	Pre-term	04 (5.8)	11 (15.9)	
	Post-dated	06 (8.7)	06 (8.7)	

SD: Standard deviation

Table 2: Fetal parameters

No.	Parameters	Normotensive	Pereclampsia	P-value
1.	Birth weight (kg)			
	Mean	2.59	2.60	0.862
	SD	0.4	0.5	
2.	Birth asphyxia			
	Yes	08 (11.6)	11 (15.9)	0.024
	No	61 (88.4)	58 (84.1)	
3.	Oligohydramnios			
	Yes	08 (11.6)	11 (15.9)	0.459
	No	61 (88.4)	58 (84.1)	
4.	Apgar score at 5 min (n=136)*			
	<7	08 (11.6)	17 (25.4)	0.038
	7 or more	61 (88.4)	50 (74.6)	
5.	SNCU admission			
	Yes	08 (11.6)	19 (28.4)	0.014
	No	61 (88.4)	48 (71.6)	
6.	Fetal outcome			
	Live and healthy baby	69 (100)	64 (92.8)	0.023
	Stillborn baby	0	05 (7.2)	

*Missing–stillborn, SNCU: Special newborn care unit

It shows that the special newborn care unit (SNCU) admission was more among the pregnant women with higher grade of placental grading among the hypertensive group and it was found to be statistically significant on trend analysis (P=0.033) (Table 3).

DISCUSSION

This was an observational analytical study conducted in the Department of Obstetrics and Gynaecology in Bankura Sammilani Medical College and Hospital for 1½ years (April 2021–September 2022). The aim of this study was to compare the ultrasonographic placental grading in hypertensive and normotensive patients along with its fetal outcome so that it could be used as an appropriate screening tool for antepartum fetal surveillance in the obstetric population. This close surveillance of the fetus in utero will help the obstetrician plan timely intervention. Detection of early placental maturation could alert the obstetrician to monitor for the development of preeclampsia-associated maternal and neonatal complications.

Table 3: Stratified association: Association of placental grading with fetal outcome

Placental grading	Birth asphyxia		P-value trend
	Yes	No	
Normotensive (n=69)			
Grade 1	0	2 (100)	0.098
Grade 2	1 (2.0)	49 (98.0)	
Grade 3	2 (11.8)	15 (88.2)	
Preeclampsia (n=69)			
Grade 2	3 (12.0)	22 (88.0)	0.503
Grade 3	8 (18.2)	36 (81.8)	
	Oligohydramnios		P-value trend
	Yes	No	
Normotensive (n=69)			
Grade 1	0	2 (100.0)	0.324
Grade 2	5 (10.0)	45 (90.0)	
Grade 3	3 (17.6)	14 (82.4)	
Preeclampsia (n=69)			
Grade 2	2 (8.0)	23 (92.0)	0.177
Grade 3	9 (20.5)	35 (79.5)	
	Apgar score at 5 min		P-value trend
	<7	>7	
Normotensive (n=69)			
Grade 1	1 (50.0)	1 (50.0)	0.077
Grade 2	2 (4.0)	48 (96.0)	
Grade 3	5 (29.4)	12 (70.6)	
Preeclampsia (n=69)			
Grade 2	3 (12.5)	21 (87.5)	0.073
Grade 3	14 (32.6)	29 (67.4)	
	Birth weight in kg		P-value (One-way ANOVA)
	Mean	SD	
Normotensive (n=69)			
Grade 1	2.3	0.7	0.129
Grade 2	2.7	0.4	
Grade 3	2.4	0.4	
Preeclampsia (n=69)			
Grade 2	2.8	0.4	0.008
Grade 3	2.5	0.5	
	SNCU admission		P-value trend
	Yes	No	
Normotensive (n=69)			
Grade 1	1 (50)	1 (50.0)	0.077
Grade 2	2 (4.0)	48 (96.0)	
Grade 3	5 (29.4)	12 (70.6)	
Preeclampsia (n=69)			
Grade 2	3 (12.5)	21 (87.5)	0.033
Grade 3	16 (37.2)	27 (62.8)	

SNCU: Special newborn care unit

In our study, there was accelerated placental maturation in the hypertensive mothers, whereas an almost normal pattern of placental maturation was seen in the normotensive group. It was observed that in the normotensive patients, Grade III placenta was seen after 34 weeks of gestation, whereas Grade I and Grade II were seen between 28 and 34 weeks of gestation. In the hypertensive group, Grade II and III placenta was seen between 28 and 34 weeks. This observation was consistent with the findings in the study done by Grannum et al.[13] suggested that early placental maturation can be associated with maternal hypertension and these findings were further substantiated by a study conducted by Valenzuela et al.[15]

In our study, analysis of placental grade distribution among hypertensive and normotensive patients between 28 and 34 weeks revealed that in the hypertensive group 0%, 65.2%, and 34.8% of women had placental Grades I, II, and III, respectively, as against 36.2%, 60.9%, and 2.9% of the normotensive group women.

At the period of gestation >34 weeks, Grade III placenta was seen predominantly in the hypertensive group. In the hypertensive group, 0%, 36.2%, and 63.8% of women had placental Grades I, II, and III, respectively, as against 2.9%, 72.5%, and 24.6% of the normotensive group.

Petrucha and Platt in their study found that the mean gestational age at which the placenta matures to Grade I is 31.11 weeks, Grade II is 36.36 weeks, and Grade III is 38.04 weeks. An early progression to Grade III is concerning and is associated with placental insufficiency associated with hypertension.[3]

In a study done by Vidyarth A et al., a total of 200 patients were included in the study. Hundred of pregnant patients with pre-eclampsia were in the study group and 100 normotensive pregnant patients were in the control group. In the study group, 3%, 54%, and 43% of women had placental Grades I, II, and III, respectively, as against 8%, 61%, and 31% of the control group women, respectively. However, at 37 weeks of gestational age Grade III placental changes were 76.7% in the study group and 90.3% in the control group.[16]

In a study done by Sersam LW, scans were performed at 36 weeks of gestation in 591 low-risk pregnant women to correlate placental maturity and pregnancy outcome. It was found that the prevalence of Grade 3 placenta at 36 weeks of gestation was 3.9% and it was associated with the development of pre-eclampsia later in pregnancy.[17]

In the present study, the prevalence of pre-term delivery <37 weeks of gestational age was 15.9% in the hypertensive group which was significantly higher than the 5.8% in the normotensive group. P<0.05.

Pre-term delivery at <37 weeks was significantly more in the hypertensive group (28%) than the normotensive group 15%. (P<0.005). However, Grade III changes in <37 weeks and >37 weeks of gestation between the study (23.3%) and control group (9.7%) were not statistically significant. (P>0.005).[16]

It was more common among the pregnant women with hypertension when compared to normotensive pregnant women but it was not found to be statistically significant (P=0.459). Oligohydramnios was also seen more among the pregnant women with a higher grade of placental grading both among the hypertensive group and normotensive group but it was not found to be statistically significant on trend analysis in our study.

In a retrospective study conducted by Rabinovich A et al., among 81 mothers, 4.8% of all the pre-term pre-eclamptic patients had oligohydramnios.[18]

In our study, there was no significant difference in the birth weight of the newborns with the placental grading among the normotensive pregnant women. However, among the hypertensive pregnant women, the mean birth weight was significantly lower among those with Grade 3 (2.5 kg) placental grading when compared to Grade 2 (2.8 kg) placental grading. This correlates with the study done by Proud and Adrian (1987).[19]

In the present study, birth asphyxia was higher among the neonates in the hypertensive group (15.9%) when compared to the normotensive group (4.3%) and it was found to be statistically significant (P=0.024). Birth asphyxia was higher among the pregnant women with a higher grade of placental grading both among the hypertensive group (18.2% in Grade III placenta vs. 12% in Grade II) and normotensive group (11.8% in Grade III placenta vs. 2% in Grade II) but it was not found to be statistically significant on trend analysis.

Birth asphyxia was observed in all placental grades in the study group in the study conducted by Vidyarth A et al., and it was more in the study/hypertensive group (8%) compared to the control group (4%). Birth asphyxia was more with Grade III placenta in the study group (9.3%) compared to the control group (3.2%) which was not statistically significant P>0.05.[16]

In our study, the hypertensive group (n=67, 28.4%%) had more number of SNCU admissions as compared to the normotensive group (n=69, 11.6%). The SNCU admission was more among the pregnant women with a higher grade of

placental grading among the hypertensive group and it was found to be statistically significant on trend analysis. Gowda SH et al., in their study, found that earlier placental maturation was associated with a higher incidence of NICU admissions.[20]

There were two stillbirths and three neonatal deaths and all the five deaths were accounted by the hypertensive mothers, athough there was no significant association with respect to the placental grading in our study.

In a retrospective study conducted by Das et al., and associates in a teaching institute from North- eastern India, evaluated the prevalence and risk factors of intrauterine fetal death (IUFD) in pregnant women and found hypertensive disorder of pregnancy as the second-most common cause of IUFD (14.5%).[21]

Similar findings were noted by Dasgupta et al., in their study on perinatal mortality.[22] Chen et al., reported that Grade 3 placenta between 28 and 32 weeks of gestation was associated with a higher incidence of neonatal death.[23]

Limitations of the study

In the current study, the size of the sample is rather small to declare a generalized recommendation, further multicentric study with adequate follow-up may improve the sensitivity and specificity. The final outcome of the neonate after discharge from SNCU could not be monitored. Thus their longtime survival could not be assessed.

CONCLUSION

The placenta is the mirror image of the fetal outcome. Examination of the placenta by ultrasonography, there is definite evidence of changes in placental morphology and grading in pregnancy-induced hypertensive mothers. There is accelerated placental grading in pre-eclampsia mothers and is associated with adverse perinatal outcome.

Ultrasonographic placental grading could be used as a screening tool for antepartum fetal surveillance in the obstetric population. Detection of early and accelerated placental maturation could alert the obstetrician for the development of pre-eclampsia-associated maternal and perinatal complications. Placental grading will help us to early diagnosis and to formulate line of management and timely intervention to reduce maternal and perinatal complications.

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ETHICAL APPROVAL

The study was approved by the institutional ethics committee.

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PG, **PM**- Involved in the diagnosis and management of the cases; **SCB**, **KKP**- Did the literature search; **KKP**, **KPM**- Help in writing manuscript.

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