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A comparative study of placental grading by ultrasonography in normal and hypertensive pregnant female in Central India

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Abstract

Background: The placenta is crucial for pregnancy. As the largest fetal organ, it has indispensable functions in the development and protection of the fetus. The role of ultrasonography in obstetric practice is immense. Placental calcification is a physiologic phenomenon associated with increasing gestational age.
Objective: The comparison of placental grading by ultrasonography in normal and hypertensive pregnant female in Central India.
Methods: The present prospective case-control study involving 200 pregnant women (100 normotensive, 100 hypertensive) of third trimester gestation. Placental grading was assessed using ultrasonography.
Results: Overall, the majority of patients in both groups had a placental grading of II. There was non-significant difference in placental grading between the two groups (p-value = 0.207). A significant association was observed between placental grading and gestational age ($p<0.001$), with all patients with grade I placental maturity having a gestational age of ≤35 weeks, while the majority of patients with grade II and III placental maturity had a gestational age of >35 weeks. A significant association between placental grading and perinatal mortality ($p=0.026$), with higher mortality rates observed in cases with grade III placental maturity (44.2%) compared to grade I (0%) and grade II (23.1%). There was a trend towards a higher proportion of positive results in cases with grade III placental maturity (39.5%) compared to grade I (20.0%) and grade II (23.1%).
Conclusion: The study concluded that a significant association was observed between placental grading and gestational age, as well as perinatal mortality, with higher mortality rates in cases with grade III placental maturity. The study suggests that placental grading may be useful in predicting fetal outcomes, particularly in hypertensive pregnancies, and highlights the importance of monitoring placental maturity in high-risk pregnancies.

Keywords: Placental grading, Hypertension, Pregnancy, Ultrasonography, Gestational age.

Introduction

Placental abnormalities with respect to location and anatomy in pregnancy include low-lying placentas, placenta previa and abnormally invasive placentas.[1] These conditions form a risk of antepartum, intrapartum and postpartum haemorrhage. In addition, they can affect placental functions and interfere with maternal or fetal well-being.[2] The etiology of these abnormalities is not well understood and their incidence is increasing, predominantly caused by the rising cesarean section rate.[1,3] Other factors that affect the incidence are prior uterine surgeries or curettage, maternal age and multiparity.[1] In addition, the incidence of a low-lying placenta and placenta previa is increased due to endometriosis, smoking, previous placenta previa and assisted reproductive technology.[3] For abnormally invasive placentas, the additional risk factor is having a placenta previa or having Asherman's syndrome.[4] Treatment options are scarce and usually result in a cesarean delivery, increasing yet again the incidence of placental abnormalities in future pregnancies. To date, adequate preventive strategies, other than preventing uterine surgery such as cesarean section and dilatation and curettage, and avoiding unnecessary assisted reproductive technologies, are not available. The placenta is part of the pregnancy from the moment that the embryo consists of a few cells until it is discharged after childbirth. As the placental formation already starts at implantation, at which point the embryo invades the endometrial wall, disorders during implantation may cause placental abnormalities in location and anatomy.[5]
The role of ultrasonography in obstetric practice is immense. Placental calcification is a physiologic phenomenon associated with increasing gestational age. Maturational changes in placenta on antenatal ultrasound have been found to correlate with functional maturity of the foetus. Grannum et al in 1979, classified all placentae into different grades according to their ultrasonographic appearance. They graded placenta from 0 (immature) to III (mature) on the basis of changes in the appearance of the chorionic plate, placental substance and basal layer. Grade 0 indicates a smooth chorionic plate and homogenous texture of the placenta; Grade I shows occasional calcification in the basal plate; Grade II has occasional calcification in placental texture; and Grade III indicates a circular appearance of calcifications up to the basal plate and divides the placenta into discrete parts.[6]

As the gestation advances, placental maturation takes place from lower to higher grades but early ripening is linked to adverse pregnancy outcomes. In 2005, McKenna et al confirmed that the detection of a grade III placenta at 36 weeks gestation, also called as Preterm Placental Calcification (PPC), helps in the identification of high risk pregnancy.[7] Various investigators later reported an association between grade III placental maturation and subsequent obstetric problems like gestational hypertension, fetal growth restriction and pregnancy complications during labour with increased risk of perinatal deaths.[6]

Hypertensive disorder for pregnancy effect about 5.0% - 8.0% of all pregnant women worldwide. Pregnancy-induced hypertension (PIH) varies widely among underdeveloped nations; in Zimbabwe, it is around 7.0%, whereas in Columbia, it is approximately 0.81%.[8] 10.0% is the incidence in India's rural areas. Pregnancy-related hypertension substantially raises the risk of maternal and perinatal morbidity and death.[9] The relationship between placental morphology function and Fetal outcome has been the subject of study for many years. Placental is an important Fetal organ which is intermediate link between fetus and the mother. Owing to the delicate and important nature of the placenta, it is sometimes referred to as the "mirror of perinatal period with has not been sufficiently polished".[10]

Pregnancy-related hypertensive disorders are frequent, and they significantly increase maternal and fetal morbidity and death along with bleeding and infection. According to several research, hypertension accounts for 2.6% to 7.6% of maternal fatalities.[11] Preterm delivery, low birth weight, placental abruption, caesarean delivery, liver insufficiency, subcapsular liver hematoma, cerebral edema, renal failure, thrombocytopenia, and intravascular coagulation are all common outcomes in preeclampsia-complicated pregnancies.[12] Placental anomalies have been linked to pregnancy-related hypertension diseases' consequences.[13] As a result, there is a lot of curiosity in the hypertensive woman's placenta. Ultrasound study being a routine part of antenatal care is a relatively easier and convenient way to predict development of any adverse outcome in third trimester of pregnancy. This led us to conduct this study in this institute where all low-risk and high-risk pregnant women in Central India, Bhipal city come for delivery. The aim of the present study was to assess placental grading in normal and high-risk pregnancy and its correlation with adverse foetal outcomes.

Martial and Method

The present prospective case control study was conducted in department of anatomy in LNCT UNIVERSITY BHOPAL for the period of 1.5 year from August 2020-February 2022 in Lucknow. A minimum of 200 patients were chosen, with 100 pregnant women with hypertension serving as the case group and the other 100 as the control group. All singleton pregnant women with hypertensive disorders presenting in labour in third trimester with blood pressure more than 140/90 mmHg were enrolled in this study. Pregnant women with Multifetal gestation, Epilepsy, Bone disorder of any multivitamin intake, Renal diseases, Liver disease, Thyroid disease or any endocrinal disease, Haemorrhagic disorder and Diabetes mellitus were excluded from the study. A detailed clinical history including age, sex, occupation, socio – economic status and any associated risk factors contributing for the illness was elicited from the case and controls.

Patients were having to meet American College of Obstetricians & Gynecology (ACOG) criteria for diagnosing hypertensive disorders pregnancy (Diastolic Blood Pressure >= 90 mmHg or Systolic Blood Pressure >= 140 mmHg or both). Hypertensive Disorders of Pregnancy (HDP) could be divided into 4 subgroups according to ACOG:

1. **Preeclampsia (PE)-Eclampsia (EC)**

PE is defined as blood pressure ≥140/90 and proteinuria ≥+1, measured at least twice 4-6 h apart after gestational weak 20. Eclampsia was defined as the onset of convulsion in woman with EP that could not be attributed to other cases.

2. **Chronic hypertension**

Chronic (preexisting) hypertension was defined as hypertension (systolic blood pressure ≥140mmHg or diastolic blood pressure ≥90 mmHg or both) that present before 20 weeks gestational or prior to pregnancy.

3. **Chronic hypertension with Supremeimposed preeclampsia**

When preeclampsia develops in women with chronic (preexisting) hypertension, the classification of disease was chronic (preexisting) hypertension superimposed preeclampsia.

4. **Gestational hypertension**

GH was defined as development of hypertension (i.e., systolic BP ≥140 mmHg and diastolic BP ≥90 mmHg) for the first time after mid pregnancy (after 20 weeks) gestation without proteinuria or other features of preeclampsia; this terminology replaces the term "pregnancy included hypertension. All women who fit into the inclusion criteria would be informed about the study protocol and their written & informed consent would be taken. Detail history of these women with include age, religion, literacy, occupation, residence socioeconomic status would be noted. Obstetrics history, past history, any history of previous pregnancy affected by hypertension disorder of pregnancy (HDP), family history, pre-existing medical conditions, gestational age, education, socioeconomic status, smoking status. Equal number of healthy pregnant women would be taken under control group.

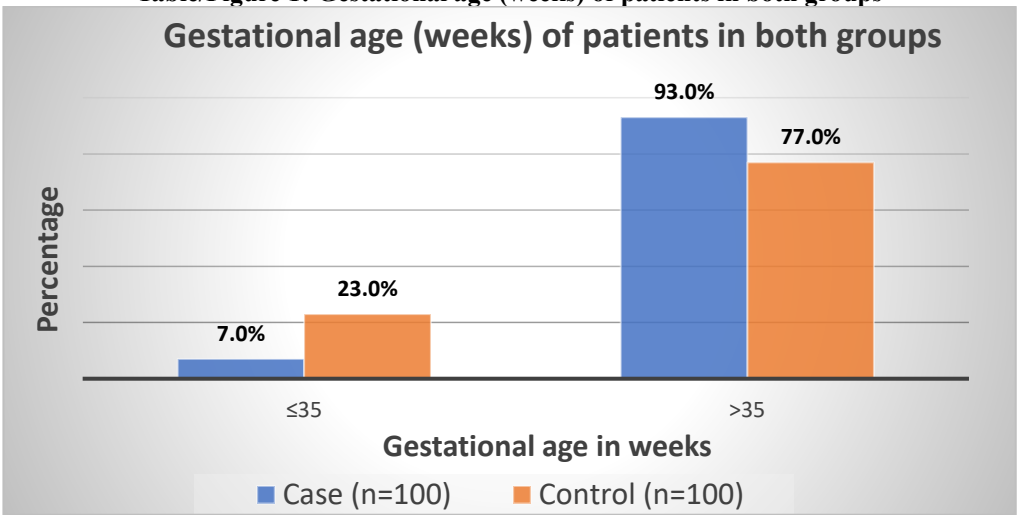
After a written informed consent form was obtained, a detailed history of the presenting symptoms and their onset was recorded. Detail histories of all the women was obtained (like demographic, age of patient, age of menarche, previous menstrual history) and radiological finding was noted on patient proforma. Each participant underwent ultrasonographic

examination to estimate the gestational age, routine haemogram and other biochemical investigation was carried out as and when required. Both the control and study groups had their placental grades recorded using ultrasound technology, and the research's results were examined in terms of placental grading, fetal distress, birth asphyxia, delivery method, fetal maturity, and prenatal morbidity.
Ultrasonographic assessment is performed on a GE LOGIQ PRO5, using a high frequency 7-12MHz linear electronic array transducer. All ultrasounds were performed by a single radiologist to avoid inter-observer variation. Patient in supine position, Jelly was applied over the abdomen and examination was carried out. The placenta's morphology was examined in the following headings in order to scan it for placental grading: Chorionic plate, echo-texture of placental substance and basal layer. Microsoft Excel was used in creating the database and producing graphs, while the data was analysed using the statistical Package for the Social Science (SPSS) version 23.0 for Windows. Mean and standard deviation (±SD) was used to describe quantitative data meeting normal distribution. Both control and research groups had their ultrasonic placental grading recorded. The outcome was examined in relation to baby's birth weight, fetal maturity, prenatal morbidity and mortality, and placental grading. Result was compared using a chi square test of significance. The student "t" test was used to determine whether there was a statistical difference between two groups and the parameters measures.

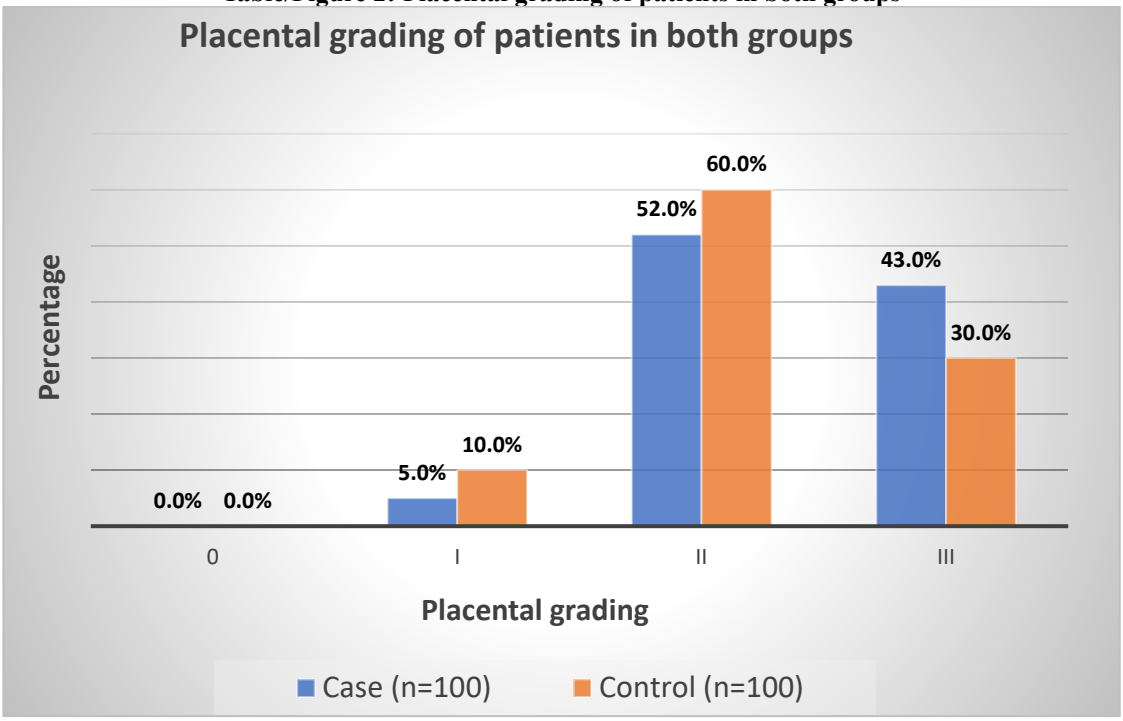
Result:

In the case group, only 7% had gestational age ≤35 weeks, while in the control group, 23% had gestational age ≤35 weeks. Most patients in both groups had gestational age more than 35 weeks. The mean age of the case group was 25.10±4.3 years, which was similar to the control group (24.71±4.2 years), with a p-value of 0.517. Additionally, there were no significant differences in body mass index (BMI) (24.2±1.0 kg/m2 vs 24.10±1.1 kg/m2, p=0.501) between the case and control groups, respectively [**Table/Figure 1**]
Placental grading I was observed in 5% of the case group and 10% of control group. The majority of patients in both groups had a placental grading of II, with 52% in case group and 60% in control group. Placental grading III was observed in 43% of the case group and 30% of control group. Overall, the majority of patients in both groups had a placental grading of II. There was non-significant difference in placental grading between the two groups (p-value = 0.207) [**Table/Figure 2**].
Present study found no significant association between placental grading and sociodemographic factors such as age, BMI, religion, education, occupation, and socioeconomic status (p>0.05). However, a significant association was observed between placental grading and gestational age (p<0.001), with all patients with grade I placental maturity having a gestational age of ≤35 weeks, while the majority of patients with grade II and III placental maturity had a gestational age of >35 weeks [**Table/Figure 3**]. Our study found a significant association between placental grading and perinatal mortality (p=0.026), with higher mortality rates observed in cases with grade III placental maturity (44.2%) compared to grade I (0%) and grade II (23.1%). However, no significant associations were observed between placental grading and other fetal outcomes, including sex, mean birth weight, birth asphyxia, and perinatal morbidity (p>0.05) [**Table/Figure 4**].
There was no significant association between placental grading and urine routine microscopy results (p=0.193), although there was a trend towards a higher proportion of positive results in cases with grade III placental maturity (39.5%) compared to grade I (20.0%) and grade II (23.1%) [**Table/Figure 5**].

Table/Figure 1: Gestational age (weeks) of patients in both groups



Table/Figure 2: Placental grading of patients in both groups



Table/Figure 3: Comparison placental grading with sociodemographic data in hypertensive cases

Socio demographic		Placental grading			p-value
		I (n=5)	II (n=52)	III (n=43)	
Age group in year	20-25	4 (80.0%)	37 (71.2%)	34 (79.1%)	0.861
	26-30	1 (20.0%)	11 (21.2%)	5 (11.6%)	
	31-35	0	3 (5.8%)	2 (4.7%)	
	>35	0	1 (1.9%)	2 (4.7%)	
Mean age in year		23.8±4.1	24.9±4.2	25.2±4.5	0.764
Mean BMI (kg/m2)		23.6±2.0	24.1±1.1	24.4±0.6	0.172
Religion	Hindu	5 (100.0%)	48 (92.3%)	33 (76.7%)	0.061
	Muslim	0	4 (7.7%)	10 (23.3%)	
Education	Primary	2 (40.0%)	7 (13.5%)	5 (11.6%)	0.503
	Intermediate	2 (40.0%)	30 (57.7%)	25 (58.1%)	
	Graduate	0	9 (17.3%)	10 (23.3%)	
	Illiterate	1 (10.0%)	6 (11.5%)	3 (7.0%)	
Occupation	Employe	2 (40.0%)	13 (25.0%)	10 (23.3%)	0.187
	Housewife	3 (60.0%)	29 (55.8%)	15 (34.9%)	
	Farmer	0	4 (7.7%)	6 (14.0%)	
	Other	0	6 (11.5%)	12 (27.9%)	
Socioeconomic status	Upper	1 (20.0%)	5 (9.6%)	1 (2.3%)	0.329
	Upper middle	1 (20.0%)	3 (5.8%)	7 (16.3%)	
	Upper lower	0	10 (19.2%)	7 (16.3%)	
	Lower middle	0	16 (30.8%)	12 (27.9%)	
	Lower	3 (60.0%)	18 (34.6%)	16 (37.2%)	
Gestational age (Weeks)	≤35	5 (100.0%)	2 (3.8%)	0	<0.001
	>35	0	50 (96.2%)	43 (100%)	

Table/Figure 4: Comparison placental grading with fetal outcome in hypertensive cases

Fetal outcome		Placental grading			p-value
		I (n=5)	II (n=52)	III (n=43)	
Sex	Male	3 (60.0%)	31 (59.6%)	18 (41.9%)	0.211
	Female	2 (40.0%)	21 (40.4%)	25 (58.1%)	
Mean weight (kg)		2.5±0.2	2.5±0.21	2.6±0.25	0.485
Birth asphyxia	Yes	2 (40.0%)	5 (9.6%)	8 (18.6%)	0.131
	No	3 (60.0%)	47 (90.4%)	35 (81.4%)	
Perinatal morbidity	Yes	2 (40.0%)	12 (23.1%)	13 (30.2%)	0.588
	No	3 (60.0%)	40 (76.9%)	30 (69.8%)	
Perinatal mortality	Yes	0	12 (23.1%)	19 (44.2%)	**0.026**
	No	5 (100.0%)	40 (76.9%)	24 (55.8%)	

Table/Figure 5: Comparison placental grading with urine routine microscopy in hypertensive cases

Urine routine microscopy	Placental grading			p-value
	I (n=5)	II (n=52)	III (n=43)	
Positive	1 (20.0%)	12 (23.1%)	17 (39.5%)	0.193
Negative	4 (80.0%)	40 (76.9%)	26 (60.5%)	

Discussion

Our study noted that the mean age for the case group was 25.10±4.3 and for control group was 24.71±4.2, with non-significant difference between groups. In a similar study **Nazir S et al**[14] reported that mean + S.D of maternal age was 27.7+4.3years with minimum and maximum maternal age were 20 and 40 years respectively. In a study **Chhatwal J et al**[15] reported mean age of cases: 27.60±4.37 years.

Our study noted that there was anthropometric variable (height, weight and BMI) comparable in the both groups (p-value > 0.05). In this study there were significant differences higher pulse rate, SBP, DBP and RR in the case with respect to control groups (p-value < 0.001).

In the case group, only 7% had gestational age ≤35 weeks, while in the control group, 23% had gestational age ≤35 weeks. Most patients in both groups had a gestational age of more than 35 weeks. Significant difference in gestational age between the case and control groups (p-value = 0.001). **Nazir S et al**[14] reported that the mean + S.D gestational age was 34.9+2.3 weeks with minimum and maximum were 27 and 39 in weeks respectively. In a comparative study **Zhang LY et al**[16] reported that gestation age at delivery (37.38±2.10 weeks) in case group and ((39.48±2.44 weeks) in control group (p<0.05).

In this study we noted that the fetal weight 2.5±0.2kg in case group was significantly lower than fetal weight 2.7±0.3kg in control group (p<0.05). Although there was no statistically significant difference between case and control groups terms of the number of birth asphyxia, neonatal morbidity, and neonatal death (p>0.05). In a comparative study **Zhang LY et al**[16] found that in cases with placenta premature aging, baby birth weights (2802.00±502.99g) were considerably lower in control group (3324.35±411.34g, p<0.01). In another study **Begum F et al**[17] reported that among the delivered babies 89% had birth weight of 2.5 to 3.9 kg, 8% had low-birth weight & 3% had weight of 4 kg or more.

Table/Figure 6: Compare the Placental grade in present study with other studies

		Grade-0	Grade-I	Grade-II	Grade-III
Mishra N et al[18] (2006)		0.0%	15.0%	58.0%	27.0%
Sunanda KM et al[19] (2014)		33.0%	24.0%	22.0%	17.8%
Vidyarthi A et al[20] (2017)		0.0%	8.0%	61.0%	31.0%
Nazir S et al[14] (2017)		0.0%	18.0%	56.0%	26.0%
Begum F et al[17] (2020)		6.5%	25.0%	35.5%	33.5%
Naik Aet al[21] (2021)		0.0%	0.0%	21.0%	79.0%
Gupta N et al[22] (2022)	Case	0.0%	7.5%	30.0%	62.5%
	Control	0.0%	12.8%	50.0%	37.5%
Present study	Case	0.0%	5.0%	52.0%	43.0%
	Control	0.0%	10.0%	60.0%	30.0%

The majority of patients in both groups had a placental grading of II, with 52% in case group and 60% in control group. Placental grading III was observed in 43% of the case group and 30% of control group. Non-significant difference in placental grading between two groups (p-value = 0.207). In a similar study **Naik A et al**[21] reported that when compared to the previous research, it was discovered that the placental grades of 39% and 61% of the control group's women and 21% and 79% of the study group's women, respectively, were statistically not significant (p>0.05).[18,19] According to **Saliha et al**[23] the impact hypertension on development procedure of placenta is identified by ultrasonography. 100 pregnant women were included. 50 normotensive and 50 hypertensive ladies were analysed by ultrasonography at three periods. Initially between 29- 32 weeks growth, second between 33-35 weeks and third following 36 weeks till 40 weeks development were included. The result, G II and G III placenta was 27 of 50 (54%) and 2 of 50 (4%) at third trimester.

Our study found no significant association between placental grading and sociodemographic factors such as age, BMI, religion, education, occupation, and socioeconomic status (p>0.05). However, a significant association was observed between placental grading and gestational age (p<0.001), with all patients with grade I placental maturity having a gestational age of ≤35 weeks, while the majority of patients with grade II and III placental maturity had a gestational age of >35 weeks. **Proud J & Grant AM**[24]**, Kasegaonkar MS et al**[25] and **Begum F et al**[26] studies also demonstrated that the childbirth would probably become complex with FGR and preeclampsia if the placenta emerged to be grade-III before 34 weeks gestation. This large difference signifies the association of accelerated placental maturity and utero-placental ischemia which contributes to the etiopathogenesis of these conditions.

Present study found a significant association between placental grading and perinatal mortality (p=0.026), with higher mortality rates observed in cases with grade III placental maturity (44.2%) compared to grade I (0%) and grade II (23.1%). In a similar study **Kour G et al**[27] reported that with respect to perinatal outcomes, women who underwent LSCS for fetal distress and women who had babies with preterm birth and LBW were more likely to have grade III placenta on antenatal ultrasound (21.6%,15.9% and 19.2% respectively) when compared to Grade I/II placenta (6.9%,4.8% and3.4% respectively). **Mirza FG et al**[28] also found correlation between early placental calcification and LBW and poor perinatal outcome. A randomised controlled trial has also suggested that a grade III placenta is associated with low birthweight, problems during labour, poor condition at birth and perinatal death.[24]

Present study found no significant association between placental grading and urine routine microscopy results (p=0.193), although there was a trend towards a higher proportion of positive results in cases with grade III placental maturity (39.5%) compared to grade I (20.0%) and grade II (23.1%).

Thus, ultrasound reviewing arrangement of placenta light of its development. This essentially influences the degree of calcifications. Placental insufficiency brought on by long-term hypertension is linked to placental grade III maturity. This may lead intrauterine growth restriction (IUGR), fetal distress, abnormal fetal growth, and hyaline membrane disease. Birth weight depends on the mother's body size and growth of placenta.[29] In hypertensive pregnancy, the preterm placental calcifications have adverse effects on uteroplacental blood flow, fetal growth and fetal death.

Limitations of the study:

1. Our study was single center with small sample size, which may not be representative of the larger population.
2. The study did not monitor the long-term survival of neonates after discharge from the Special Newborn Care Unit (SNCU).

Conclusion

The study concluded that placental grading by ultrasonography showed no significant difference between hypertensive and normal pregnant females, with the majority of patients in both groups having a placental grading of II. However, a significant association was observed between placental grading and gestational age, as well as perinatal mortality, with higher mortality rates in cases with grade III placental maturity. The study suggests that placental grading may be useful in predicting fetal outcomes, particularly in hypertensive pregnancies, and highlights the importance of monitoring placental maturity in high-risk pregnancies.

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