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CROSS-SECTIONAL STUDY TO EVALUATE VARIOUS CARDIOVASCULAR MANIFESTATIONS IN PREGNANT WOMEN WITH PREECLAMPSIA USING 2D ECHOCARDIOGRAM

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Abstract

Preeclampsia is one of the most frequent complications found in pregnancy. Preeclampsia was initially thought to cause poor long-term cardiovascular outcomes, but recent studies have shown its effect to be more early and severe.

Aims: To reduce the morbidity and mortality for all patients with hypertension in pregnancy through any cardiovascular problem that is directly caused by hypertension in pregnancy

Methods: it is a cross-sectional and observational study of pregnant women with preeclampsia in the reproductive age group (15–44 years) diagnosed with preeclampsia in the antenatal ward/HDU/MICU at Niloufer hospital were evaluated with 2d echo on diagnosis and a follow up 2d echo after delivery was done and changes in 2d echo were noted, patients with prior changes in 2d echo have been excluded from the study. About 113 preeclamptic patients were studied and further classified as non-severe and severe preeclampsia, and their results were compared.

Results: This study shows significant cardiovascular dynamics changes in subjects with preeclampsia (both severe and non-severe) which can be studied by 2 D echo. Non-severe preeclampsia was associated with more normal birth weight. This was found statistically significant in our study. IUD and early neonatal death were more associated with severe preeclampsia when compared to non-severe preeclampsia, which was found statistically significant.

Conclusions: Early identification of preeclamptic patients at higher risk of developing cardiovascular complications later in life by undergoing timely echocardiography.

Keywords: echocardiography, preeclampsia, cardiovascular dynamics, morbidity, mortality, hypertension, cardiovascular problem, Tricuspid regurgitation, Left atrium.

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1. Introduction

Hypertension in pregnancy can cause multisystem disorder, which includes end-organ damage like cardiovascular, renal and ocular complications. Preeclampsia is defined as the onset of hypertension(blood pressure more than 140/90)after 20 weeks of period of gestation with new onset proteinuria (>300mg/24-hour urinary proteinuria) or onset of hypertension after 20 weeks period of gestation with significant end-organ damage with or without proteinuria. The incidence of preeclampsia is reported to be 8-10 % among pregnant women in India. Overall 10–15 % of direct maternal deaths are associated with preeclampsia and eclampsia. Preeclampsia can cause various cardiac manifestations, including asymptomatic global left ventricular abnormal function, myocardial injury [1], and global hypokinesia of the left ventricle that can cause increased morbidities and mortality in preeclamptic women. The 2 D echocardiography can detect cardiac problems in asymptomatic women that can help in early treatment and follow up hence preventing any fur-

ther maternal morbidities due to cardiovascular manifestations. Hence, a Cross-sectional study of preeclampsia in pregnant women and their cardiovascular implications that can be detected with 2D echo is being conducted.

2D Echocardiography and its implications are two-dimensional (2D) ultrasound is the most commonly used modality in echocardiography. The two dimensions are width (x-axis) and depth (y-axis). The ultrasound transducer used for 2D echocardiography is a passed array transducer; the ultrasound field created with it is sector-shaped and created using sequential activation of piezoelectric crystals. This activation goes from right to left and then from left to right, repeating rapidly. To create an image sector of 90-degree width and 15 cm depth, approximately 200 ultrasound lines are required, and this takes about 40 milliseconds (ms) to generate. Identifying diastolic dysfunction using 2D echocardiography. To measure left ventricular ejection fraction using bi-plane Simpson's method measuring both systole and diastole of the left ventricle in 4 and 2 chamber view [2–4].

Mitral valve inflow: E wave next, performing an accurate PW of MV inflow and obtain your peak E wave velocity, determining average E/e' measurement, correctly done PW technique included are Apical 4 chamber, Pulsed-wave Doppler, Sample volume between mitral valve leaflet tips, Low wall-filter, E wave: early diastole (after T –wave on ECG) and MV inflow diastology echo.

PW tissue Doppler imaging: measuring PW TDI diastolic function in 4 chamber view, measuring tissue Doppler of the mitral valve on both septal and basal region are Average E/e'(abnormal cut-off value>l4), Septal e' velocity (cm/sec) (<7cm/s), Lateral e'velocity (cm/sec) (<l0cm/s). The average value of E/e' is calculated using the average value of both the septal and lateral TDI velocities.

Tricuspid regurgitation, Left atrium size measured in end-systole in both 4 and 2 chamber views, a cut off of >34ml/m^2 is used for measurement.

If a patient has 3 or more abnormal parameters, the patient has diastolic dysfunction. Therefore, we aim to calculate the percentage of women developing various cardiac changes as per the 2 D echocardiography.

The aim of the research was to reduce morbidity and mortality for all patients with hypertension in pregnancy through any cardiovascular problem that is directly caused by hypertension in pregnancy.

2. Materials and methods

It is a cross-sectional and observational study of all pregnant ladies with preeclampsia for a period of 8 months in the Department of Paediatrics in Niloufer.

The period from February 2022 to September 2022 (IEC number-IEC/OMC/2022/M.No.(01)/ Aced-01 dated 25/01/2022).

Inclusion criteria: 15–44 years aged pregnant women in the reproductive age group, primiparous or multiparous.

Exclusion criteria: Pre-existing cardiac disease, gestational diabetes/overt diabetes, pre-existing renal disease and prior known case of hypertension.

Sample size

According to the National Health Portal of India, the incidence of preeclampsia is reported to be 8–10 % among pregnant women. Considering the 95 % level of confidence interval(Z=1.96) with 5 % precision (d=0.05) the minimum required sample size is

$N=(Z\ a/2)^2\ X\ p\ (1-p)/d^2$

$N=(1.96)^2\ X(0.08)\ X(1-0.08)/(0.05)^2$

=113.09 =113 (approx.)

Therefore, the minimum required sample for the study is 113.

Methodology: All pregnant ladies visiting our hospital are checked for blood pressure. Suppose a patient is found to have preeclampsia. In that case, they are advised for routine investigations, and any other co-morbidities are excluded. They are followed up for gestational age at delivery and 2D echo for any cardiovascular manifestations. The diastolic dysfunction and ejection fraction are calculated as per the cardiologist.

Statistical analysis plan:

All the qualitative parameters like parity, past obstetric history of preeclampsia, family history, per abdomen signs of IUGR, and PPCM are presented with frequencies and percentages.

To find the association between qualitative factors and preeclampsia, we have used the Chi-Square test to measure of association. A p-value less than 0.05 was considered significant. Data was entered in MS Excel and analyzed by using SPSS 19.0v.

3. Results

All patients who were diagnosed with preeclampsia in the antenatal ward/HDU/MICU at niloufer hospital were evaluated with 2d echo on diagnosis, and a follow-up with 2d echo after delivery was done, and changes in 2d echo were noted; patients with prior changes in 2d echo have been excluded from the study. About 113 preeclamptic patients were studied and further classified as non-severe and severe preeclampsia, and their results were compared.

The percentage of cases in the age group of fewer than 20 years was 13.2 %, between 21–29 years was 74.4 %, and above 30 years was 12.4 %. Parity primiparous 51.2 %, multiparous 48.8 %. Preeclampsia was first detected among 14 % of patients before 28 weeks, 44.6 % between 28–34 weeks, and 41.3 % after 34 weeks. Among all the multigravidas, past obstetric history of preeclampsia was present in 18.64 %. Among all cases of preeclampsia, 48.8 % had a family history of hypertension. Among all cases, 54.5 % developed severe preeclampsia, and 45.5 % had non-severe preeclampsia (**Table 1**).

Table 1

Demographic distribution in the present study

Age (years)	No. of subjects	Percentage
<=20	16	13.2 %
21–29	90	74.4 %
30&above	15	12.4 %
Total	121	
Parity		
Primi	62	51.2 %
G2	33	27.3 %
G3 & above	26	21.5 %
Time of preeclampsia detection		
<=28 weeks	17	14.0 %
28–34 weeks	54	44.6 %
More than 34 weeks	50	41.3 %
Past obstetric history of preeclampsia		
Present	11	9.1 %
Absent	48	39.7 %
Family history		
Present	59	48.8 %
Absent	62	51.2 %
Preeclampsia		
Severe	66	54.5 %
Non-severe	55	45.5 %
PPCM		
Present	5	4.1 %
Absent	116	95.9 %

Among all the cases of preeclampsia in our study, 4.1 % developed PPCM, but the development of PPCM was not statistically significant in both the severe and non-severe preeclampsia groups.

In our study, 15 patients developed left ventricular systolic dysfunction, out of which 14 people were from the severe preeclampsia group and 1 from the non-severe preeclampsia group. As-

sociation was found statistically significant for developing left ventricular systolic dysfunction among patients who developed severe preeclampsia.

In our study, 21 patients developed gr 1 diastolic dysfunction, 7 patients developed gr 2 diastolic dysfunction, and 1 patient developed gr 3 diastolic dysfunction. Among 21 patients with gr 1 diastolic dysfunction, 17 patients had severe preeclampsia,4 had non-severe preeclampsia; out of 7 patients with gr 2 diastolic dysfunction, 6 had severe preeclampsia, and 1 had non-severe preeclampsia, 1 patient who had gr 3 diastolic dysfunction had severe preeclampsia. In addition, a statistical correlation was found between severe preeclampsia and the development of left ventricular diastolic dysfunction (**Table 2**).

Table 2
Cardiac disorders in the present study

Peripartum cardiomyopathy (PPCM)	Preeclampsia		Total
	Severe	**Non-severe**	
Present	4 (6.06 %)	1 (1.82 %)	5
Absent	62 (93.94 %)	54 (98.18 %)	116
Total	66	55	121
P-value (Chi-Square Test)	0.243		
Left ventricular systolic dysfunction			
Present	14 (11.5 %)	1 (1.82 %)	15
Absent	52 (42.9 %)	54 (44.6 %)	106
Total	66	55	121
P-value (Chi-Square Test)	0.001		
Left Ventricular Diastolic dysfunction			
Absent	42 (63.64 %)	50 (90.21 %)	92
Grade 1	17 (25.76 %)	4 (7.27 %)	21
Grade 2	6 (9.09 %)	1 (1.82 %)	7
Grade 3	1 (1.52 %)	0	1
Total	66	55	121
P-value	0.006		

In our study, left ventricular hypertrophy was present in 18 patients among 121, among which 15 patients had severe preeclampsia, and 3 patients had non-severe preeclampsia; a statistical correlation was found between the development of LVH and severe preeclampsia.

In our study, right heart dysfunction was found in 3 patients, 2 of the patients had severe preeclampsia, and 1 had non-severe preeclampsia. However, no statistical correlation was found between severe and non-severe preeclampsia (**Table 3**).

Table 3
LVH and RHD in the present study

LVH	No. of Subjects	Percentage
Present	18	14.9 %
Absent	103	85.1 %
Total	121	
Right Heart Dysfunction		
Present	3	2.5 %
Absent	118	97.5 %

In our study, baby weights of patients with preeclampsia were noted, 53 of the cases had normal birthweight, 37 of them had low birth weights,18 of them had very low birth weights, 13 of them had extremely low birth weights, out of 13 extremely low birth weights, 11 babies mother had

severe preeclampsia and 2 non-severe preeclampsia, among 18 patients with very low birth weights 14 babies mother had severe preeclampsia and 4 with non-severe preeclampsia, out of 37 low birth weights, 27 babies mother had severe preeclampsia, and 10 had non-severe preeclampsia. Severe preeclampsia was associated with extremely low birth weight (11 vs 2, 14 vs 4). Non-severe preeclampsia was associated with more normal birth weight. This was found statistically significant in our study. In our study, 36 patients had a vaginal delivery, 80 had less, and 5 had hysterotomy; among 36 patients with vaginal deliveries, 17 had severe preeclampsia, and 19 had non-severe preeclampsia; among 80 patients with less than 44 had severe preeclampsia, and 36 had non-severe preeclampsia, among 5 who had hysterotomy, all had severe preeclampsia.

In our study, 96 patients had babies alive, out of which 45 had severe preeclampsia, 54 were non-severe preeclampsia, 15 were early neonatal death, out of which 13 had severe preeclampsia, and 2 had non-severe preeclampsia, 10 IUD out of which 8 had severe preeclampsia, and 2 had non-severe preeclampsia. IUD and early neonatal death were found to be more associated with severe preeclampsia when compared to non-severe preeclampsia, which was found statistically significant (**Table 4**).

Table 4

Fetal outcome in the present study

Baby Weight	**Preeclampsia**		**Total**
	Severe	**Non-severe**	
ELBW	11	2	13
VLBW	14	4	18
LBW	27	10	37
Normal	14	39	53
Total	66	55	121
P Value	<0.001		
(Chi-Square Test)			
Mode of delivery			
Vaginal delivery	17	19	36
LSCS	44	36	80
Hysterotomy	5	0	5
Total	66	55	121
P-value	0.084		
Baby outcome			
Alive	45	51	96
Early neonatal death	13	2	15
IUD	8	2	10
Total	66	55	121
P-value	0.004		
(Chi-Square Test)			

4. Discussion

Preeclampsia causes increased vascular resistance, which causes hypertension to occur, which causes hypoperfusion of the tissues. Hypertension that occurs causes left ventricular structural changes, which causes the clinical manifestation. In normal pregnancy, due to reduced vascular resistance and an increase in blood volume, there is an increase in preload and reduced af-

terload. Hence there is increased emptying during systole, but in preeclampsia, elevated afterload occurs due to increased vascular resistance. This causes structural changes in the left ventricle [5].

In a study by Nuzhat zaman et al. [6], there was a statistical difference in systolic BP, diastolic BP, mean arterial pressure and, total vascular resistance and was significantly higher statistically among patients with preeclampsia than the control group. In contrast, left ventricular end-systolic volume, left ventricular end-diastolic volume, stroke volume, cardiac output, and ejection fraction were not found to have any statistical significance. Subclinical left ventricular dysfunction was found to be more in patients with preeclampsia. Valensese et al. and Poppas et al. [7] found significantly higher total vascular resistance, which is a cause for increased afterload, causing significant left ventricular hypertrophy and diastolic dysfunction

In our study, the percentage of cases in the age group of fewer than 20 years was 13.2 %, between 21–29 years was 74.4 %, and above 30 years was 12.4 %.

Parity primiparous 51.2 % and multiparous 48.8 %/preeclampsia was first detected among 14 % of patients before 28 weeks, 44.6 % between 28-34 weeks, and 41.3 % after 34 weeks. Among all the multigravidas, past obstetric history of preeclampsia was present in 18.64 %. Among all cases of preeclampsia, 48.8 % had a family history of hypertension. Among all cases, 54.5 % developed severe preeclampsia, and 45.5 % had a non-severe preeclampsia group.

In our study, left ventricular hypertrophy was present in 18 patients among 121, among which 15 patients had severe preeclampsia, and 3 patients had non-severe preeclampsia; a statistical correlation was found between the development of LVH and severe preeclampsia. In our study, we found preeclamptic patients having lower cardiac output as compared to the control. LV dysfunction, either overt or subclinical, is seen as associated with preeclampsia [8–11]. Severe LV dysfunction in the form of peripartum cardiomyopathy is more common in preeclamptics [12].

In our study, right heart dysfunction was found in 3 patients, 2 had severe preeclampsia, and 1 had non-severe preeclampsia. No statistical correlation was found between severe and non-severe preeclampsia. In our study, baby weights of patients with preeclampsia were noted, 53 of the cases had normal birthweight, 37 of them had low birth weights, 18 of them had very low birth weights, 13 of them had extremely low birth weights, out of 13 extremely low birth weights, 11 babies mother had severe preeclampsia and 2 non-severe preeclampsia, among 18 patients with very low birth weights 14 babies mother had severe preeclampsia and 4 with non-severe preeclampsia, out of 37 low birth weights, 27 babies mother had severe preeclampsia, and 10 had non-severe preeclampsia. Severe preeclampsia was associated with extremely low birth weight (11 vs 2, 14 vs 4). Non-severe preeclampsia was associated with more normal birth weight. This was found statistically significant in our study.

In our study, 36 patients had a vaginal delivery, 80 had lscs, and 5 had hysterotomy; among 36 patients with vaginal deliveries, 17 had severe preeclampsia, and 19 had non-severe preeclampsia; among 80 patients with lSCS, 44 had severe preeclampsia, and 36 had non-severe preeclampsia, among 5 who had hysterotomy all had severe preeclampsia. In our study, 96 patients had babies alive, out of which 45 had severe preeclampsia, 54 were non-severe preeclampsia, 15 were early neonatal death, out of which 13 had severe preeclampsia, and 2 had non-severe preeclampsia, 10 IUD out of which 8 had severe preeclampsia, and 2 had non-severe preeclampsia. IUD and early neonatal death were more associated with severe preeclampsia when compared to non-severe preeclampsia, which was found statistically significant. Our study is comparable with other studies [13–16].

Valensise et al. [7] found that cardiac output, left ventricle mass and total vascular resistance in the preeclamptic group were higher than that of the normotensive group. B. Vasapollo [17] and Bosio et al. [18] reported that the preclinical phase of preeclampsia is characterized by low total vascular resistance and high cardiac output. Established preeclampsia is characterized by high TVR and low cardiac output. Poppas et al. [19] suggest that TVR should be considered the predominant parameter to characterize the systemic arterial load, i.e. vascular after load. Valensise et al. [20] found that women with early mild gestational hypertension who have high total vascular resistance (TVR > 1340 dyne, s/cm^5) and concentric geometry of the left ventricle have a higher risk of developing maternal and fetal complications.

Study limitations: One limitation of this study is that it was not possible to follow up with subjects in the postpartum period to examine whether the altered cardiovascular hemodynamic state reverts to normal after pregnancy. Also, the sample size was small as subjects had to be taken to a heart care facility for the echocardiography assessment.

Prospects for further research: There are, however, clinical trials underway to determine the optimal management of diastolic dysfunction, which may yield valuable guidance in the future, with the appropriate limitations applied to this particular population who may be contemplating further pregnancies. Currently, brain natriuretic peptide (BNP), which is widely used in the assessment of systolic dysfunction, does not have a well-established role in diastolic dysfunction. Further literature review specific to BNP is needed to evaluate this.

5. Conclusion

Among all the cases of preeclampsia in our study, 4.1 % developed **Peripartum cardiomyopathy**. In our study, a total of 15 patients developed left ventricular systolic dysfunction, and the association was found statistically significant for developing left ventricular systolic dysfunction among patients who developed severe preeclampsia.

A statistical correlation was found between the development of severe preeclampsia and the development of left ventricular diastolic dysfunction. IUD and early neonatal death were found to be more associated with severe preeclampsia when compared to non-severe preeclampsia, which was found statistically significant.

Preeclampsia is one of the leading causes of maternal mortality and morbidity, as well as fetal mortality and morbidity. This study shows that there are significant cardiovascular dynamics changes in subjects with preeclampsia (both severe and non-severe) which can be studied by 2 D echo. Hence, this study concludes the early identification of preeclamptic patients who are at higher risk of developing cardiovascular complications later in life by undergoing timely echocardiography.

Conflict of interest

The authors declare that there is no conflict of interest in relation to this paper, as well as the published research results, including the financial aspects of conducting the research, obtaining and using its results, as well as any non-financial personal relationships.

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