ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

A Study to Observe the Effects of Pregnancy-Induced Hypertension and Pre-eclampsia on Left Ventricular Function by Echocardiography

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ABSTRACT:

Introduction: Hypertensive disorders complicating pregnancy contribute significantly to maternal and perinatal mortality and morbidity. The spectrum of disorders includes gestational hypertension, pre-eclampsia and eclampsia which are associated with poor placentation, fetal growth restriction and long term maternal cardiovascular outcomes. Cardiac manifestations are varied and can be studied by 2D and Doppler Echocardiography.

Aims: To conduct a detailed clinical study of gestational hypertension and pre-eclampsia patients and to conduct echocardiographic assessment of their left ventricular function along with Speckle Tracking Echocardiography.

Materials and methods: The present study was an observational, prospective, cross-sectional hospital based study. This study was conducted from April 2019 to August 2020 at Institute Of Cardiovascular Sciences, R.G. Kar Medical College and Hospital, Kolkata. Total 120 pregnant patients (greater than 20 weeks of gestation) fulfilling the inclusion and exclusion criteria were included in this study.

Result: In this study, the baseline features such as age, BMI were compared between pregnancy induced hypertension (PIH) and pre-eclamptic mothers and normotensive mothers. Left ventricular ejection fraction, left ventricular end systolic volume and left ventricular end systolic values were statistically compared between the two groups. Left ventricular diastolic function was significantly impaired in PIH and Pre-eclamptic mothers.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

Conclusion: Echocardiography, including Tissue Doppler and Speckle-Tracking Echocardiography is applicable and helpful in detecting cardiac function changes (including sub-clinical left ventricular dysfunction) in women with pregnancy-induced hypertension and preeclampsia and can identify patients for early intervention to prevent heart failure, morbidity and mortality.

Keywords: Gestational hypertension, pre-eclampsia, echocardiography, left ventricular function.

Introduction:

Hypertensive disorders complicating pregnancy are common disorders contributing significantly to maternal and perinatal mortality and morbidity. This spectrum of disorder, including Gestational hypertension, Pre-eclampsia and Eclampsia are responsible for 14 % maternal deaths worldwide including India and (WHO-2015)[1]. Preeclampsia has a profound impact on multiple organ systems. Although not distinct entities, it is increasingly becoming apparent that early-onset or preterm preeclampsia is especially associated with poor placentation, foetal growth restriction, and worse long-term maternal cardiovascular outcomes than late- onset preeclampsia.[2] Cardiac manifestations in gestational hypertension and preeclampsia are varied, which can be studied by 2D & Doppler echocardiography. With the advancement in the field of strain imaging (Speckle tracking Echocardiography), we can also analyse and predict the subclinical left ventricular dysfunction in these patients which may help us to assess high-risk groups.[3, 4] Therefore this study, was conducted to evaluate the effects of gestational hypertension and preeclampsia on cardiovascular system, including chamber hypertrophy and/or dilation (left ventricle), left ventricular systolic and diastolic dysfunction. Also strain imaging to be studied in this disorder to enable early detection and subsequent prompt management, especially with respect to subclinical left ventricular dysfunction.

Materials and Methods:

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

An observational, prospective, cross-sectional hospital based study was conducted in the Institute of Cardiovascular Sciences, R.G. Kar Medical College and Hospital, Kolkata from April 2019 to August 2020 after obtaining Institutional ethic Committee approval on n =120 pregnant patients (greater than 20 weeks of gestation) both normotensive & having gestational Hypertension and/or pre- eclampsia attending the Cardiology & Gynaecology & Obstetrics Departments of R. G. Kar Medical College and Hospital.

Patients with gestational age < 20 weeks, having pre-existing medical disorders such as systemic hypertension, diabetes mellitus, pre existing heart disease, and chronic renal or hepatic disease and connective tissue disorders, addiction to smoking or alcohol, with moderate to severe anaemia, in eclampsia or in labour, twin pregnancy or other specific obstetrical complications, and not willing to give consent or having poor echo window were excluded from the study. Samples were taken till the desired size is reached i.e., 120 patients, out of which 60 patients were of Pregnancy induced 64 hypertension and /or Pre-eclampsia and 60 normotensive patients of similar gestational period as a control group.

Parameters Studied:

Clinical History (Pregnancy confirmation by Last Menstrual Period-LMP, Urine or blood for Beta-HCG, Gestational age confirmation by LMP & 1st Trimester USG) General Survey including Pulse, blood pressure & cardiovascular & respiratory system examination Urine for Proteinuria estimation by(Dipstick test for Protein or 24 hours quantitative protein estimation or Urine –ACR) ECG ,Echocardiography (2D, M-Mode, Color Doppler)

Study tools:

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

Instruments for clinical examination, ECG & Echocardiography machine “Philips-Epic 7” with 2D & Doppler (CW, PW & TDI) as well as Speckle-Tracking Echo/ Strain Imaging facility. Computer and statistical software for data analysis, 65 Questionnaire, clinical & investigation proforma, Informed consent.

Study techniques:

Clinical assessment of the cardiovascular system was done. Transthoracic echocardiogram was performed by single echo cardiographer using a Philips Epic7 system (Philips Medical Systems, Andover, MA, USA) and an S5-1 1.5/3.6 MHz transducer, after attaining mother’s consent on full explanation of the procedure and study, in presence of a female attendant. Current guidelines of the American Society 67 of Echocardiography were used to obtain Left ventricular (LV) measurements. Modified biplane Simpson’s method was used to calculate LV volumes and LVEF. LV stroke volume was calculated as the product of left ventricular (LV) outflow area and LV outflow tract VTI (velocity time integral) which was assessed by means of pulsed-wave Doppler positioned at the LV outflow tract.

LVEF was analysed to be normal or reduced to mild, moderate, and severe according to the Table: 1 (ASE Cut-offs of EF for Females)

Table 1: Left Ventricular Ejection Analysis

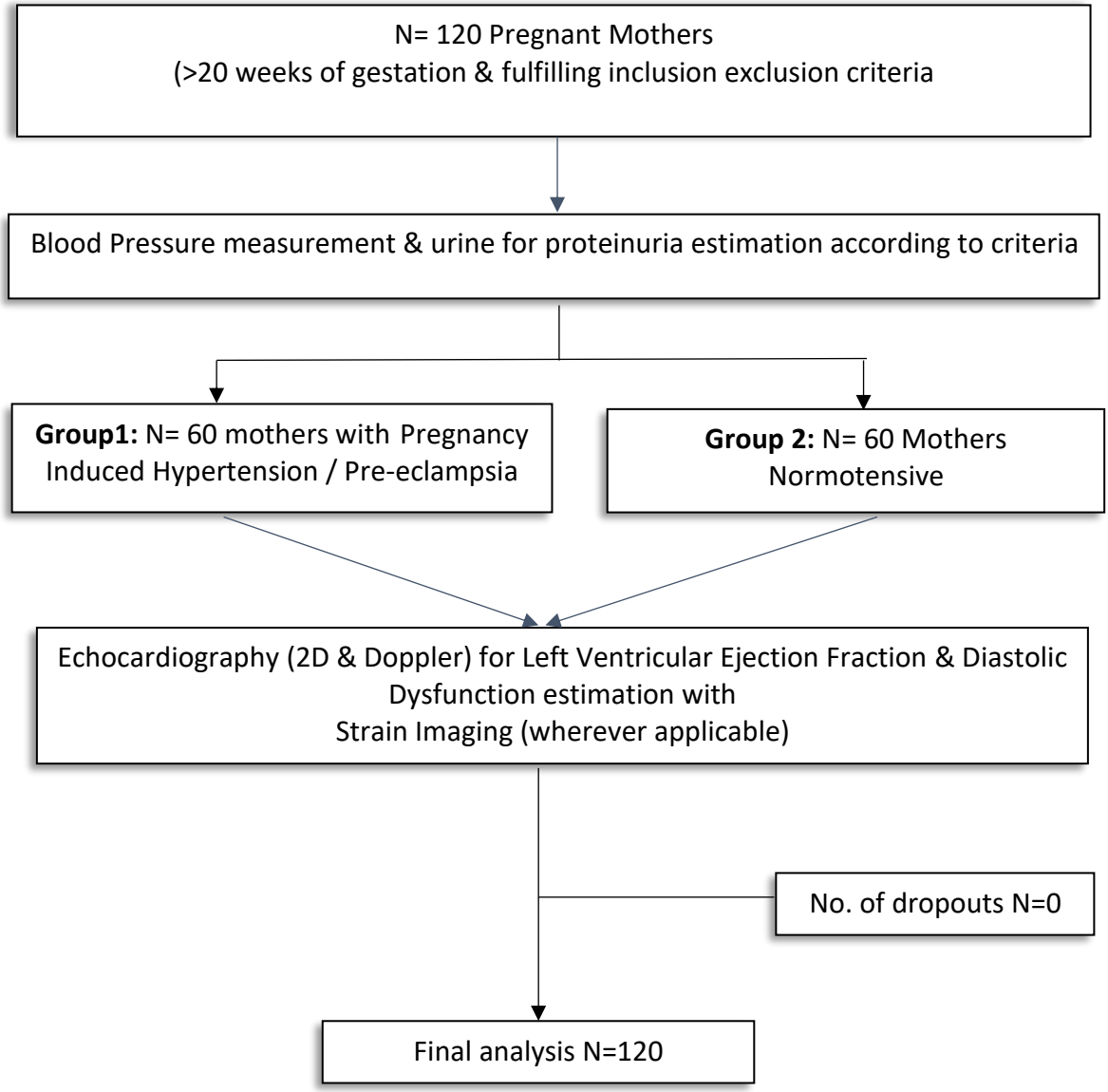
Normal EF	Mildly Reduced EF	Moderately Reduced EF	Severely Reduced EF
54-74%	41-53 %	30-40 %	< 30 %

To assess diastolic parameters apical four chamber view were used along with Pulse wave and tissue Doppler imaging. To obtain Global longitudinal strain (GLS) three apical views were acquired at a frame rate of 40–80 MHz for three consecutive cardiac cycles and was stored

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

digitally as raw data which then underwent post-processing analysis. QLAB 9 cardiac motion quantification (CMQ); Philips Medical Systems software was used for post processing analysis. The flow of the study is depicted in Figure 1.

Figure: 1 Flow chart of the study technique



Data analysis:

Data will be analysed by standard statistical method by applying SPSS-19. Categorical data were expressed as frequencies and percentages. Comparison of categorical variables was performed by chi-square test. Continuous variables were expressed as means and standard

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

deviations and analysis was done using two tailed t-test for equality of means. A p value of <0.05 was considered as statistically significant. Sensitivity and specificity were calculated using standard formulas.

Results:

All the recruited study participants (n=120) were analysed at the end of the study with zero incidence of dropouts. The various parameters assess were depicted in the Table 2 below. In this study, the baseline features such as the age of the patient, BMI were compared between PIH and Pre-eclamptic mothers (cases) and normotensive mothers (control) and found they had statistically insignificant difference (Table 2).

Table 2: Comparison of the various parameters assessed in the two study group

Variables	GROUP: 1 (n=60)	GROUP : 2 (n=60)	P value
Age (years)	24.92 ± 4.44	24.60 ± 3.44	0.15
BMI	24.6 ± 3.17	23.9 ± 4.14	0.49
LVEDV (ml)	105.23 ± 19.74	103.64 ± 11.46	0.62
LVESV (ml)	34.67 ± 10.12	29.27 ± 7.25	0.17
LVEF (%)	55.83 ± 2.74	57.38 ± 2.33	0.45
Septal e'(cm/s)	9.97 ± 1.75	11.29±1.43	**0.01**
Lateral e' (cm/s)	11.93 ± 2.41	13.75±2.09	**0.01**
E/A wave ratio	1.15 ± 0.068	1.43 ± 0.056	**0.027**
E/e' ratio	8.16 ± 2.17	6.79 ± 1.29	**< 0.001**
IVRT (mili sec)	95.91 ± 8.73	82.47 ± 6.7	**0.03**
DT (mili sec)	190.27 ± 36.73	124 ± 17.67	**0.02**
Normal Diastolic function	36 (60%)	58 (96.67%)	**0.01**

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

Grade I Diastolic Dysfunction	19 (31.67%)	2 (3.33%)	**<0.001**
Grade II Diastolic Dysfunction	5 (8.33%)	0 (0%)	**<0.001**
GLS (%)	-15.63 ± 1.69	-20.86 ± 1.52	**<0.001**
Circumferential Strain (%)	-16.93 ± 1.11	-21.76 ± 1.25	**<0.001**

BMI: Body Mass Index, LVDEV: Left Ventricular End-Diastolic Volume, LVESV: Left Ventricular End-Systolic Volume, LVEF: left ventricular ejection fraction, IVRT: Isovolumic relaxation time of left ventricle, DT: Deceleration Time, GLS: Global Longitudinal Strain

The Left ventricular Diastolic function were assessed for both the groups with respect to Septal and Lateral e', E/A ratio, E/e' ratio, Isovolumic relaxation time (IVRT) and Deceleration time (DT). Left ventricular Diastolic function was significantly impaired in PIH and Pre-eclamptic mothers, than in normotensive mothers, which was statistically significant (p value <0.05 in all the charts). The Speckle-Tracking Echocardiographic analysis (Strain Imaging) revealed statistically significant impairment of Left Ventricular Global Longitudinal strain (GLS) and Circumferential Strain in PIH and Pre-eclamptic mothers, even in presence of Normal LVEF (Chart 10 and 11). GLS and Circumferential strain values were in normal range in normotensive mothers (p-values <0.001).

Discussion:

The cardiovascular system undergoes significant changes in Pregnancy induced hypertension and pre-eclamptic patients compared to normal healthy women. Pregnancy represents a unique physiological condition in which heart undergoes morphological, hemodynamic, and functional adaptation with significant transient changes in cardiac loading conditions and work requirements. A thorough knowledge on maternal cardiac function during normal pregnancy is a prerequisite for identification of cardiac pathology in others. This is highly

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

relevant since heart disease is one of the leading causes of non-obstetric mortality during pregnancy.

Rizwana et al. (2011)[5] found that preeclampsia in women is characterized by high CO and a high vascular resistance state. Their study concluded that there were physiological changes in LV structure and function during normal pregnancy but that exaggerated physiological changes were seen in pregnant women with preeclampsia in third trimester Thus pregnancy is now considered a stress test to the maternal cardiovascular system. This study shows that women planning to become pregnant should be thoroughly screened for clinical and biochemical and Echocardiography to assess cardiovascular risk on priority basis. Also, women presenting with clinical features of preeclampsia in pregnancy should be thoroughly investigated, and echocardiography should be done in all women, monitored periodically and treated according to recommendations, in order to prevent them from cardiovascular complications including acute left ventricular failure/ pulmonary oedema and/or Eclampsia.

In this study, the effects of hemodynamic changes during normal pregnancy on LV function was studied by use of echocardiography and hemodynamic changes and subclinical LV dysfunction in many PIH and pre-eclamptic patients. In this study we have assessed the role of echocardiography for left ventricular systolic and diastolic function and strain imaging and found it to be a useful technique for evaluation of maternal left ventricular function in pre-eclamptic women.

In the present study, Left ventricular Ejection Fraction (LVEF %), Left ventricular end systolic volume (LVESV) and Left ventricular end diastolic volume (LVEDV) values were statistically compared between the two groups, and were found to be of statistically insignificant difference). This is in confirmation to study by Clemenssen et al.[6] and Rafik HR et al.[7] where they also, could not find any difference in these parameters, with respect to the two groups.

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

However, subclinical Left ventricular systolic dysfunction may be present, in presence of LVEF in normal range which may be later confirmed by Strain Imaging.

The Left ventricular Diastolic function were assessed for both the groups with respect to Septal and Lateral e', E/A ratio, E/e' ratio, Isovolumic relaxation time (IVRT) and Deceleration time (DT), Left ventricular Diastolic function was significantly impaired in PIH and Pre-eclamptic mothers, than in normotensive mothers, which was statistically significant (p value <0.05 in all the charts). In this study, Diastolic Dysfunction was found in 40 % of the PIH and pre-eclamptic mothers (Grade I in 31.67% and Grade II in 8.33%) and in only 3.33% of normotensive mothers. This agrees to studies done by Sumathy et al. [8] and Bokslag et al.[9] where they have found Left ventricular Diastolic Dysfunction in 30 to 50 % of pre-eclamptic cases respectively.

In this study, left ventricular Ejection Fraction (LVEF %), Left ventricular end systolic volume (LVESV) and Left ventricular end diastolic volume (LVEDV) values were statistically compared between the two groups, and were found to be of statistically insignificant difference. This is in confirmation to study by Nageh et al.[10] and Roberto M et al.[11] where they also could not find any difference in these parameters, with respect to the two groups. However, subclinical Left ventricular systolic dysfunction may be present, in presence of LVEF in normal range which may be later confirmed by strain Imaging. This agrees to studies done by Sahul et al.[12] and Zaman et al.[5] This shows Gestational Hypertension and Pre-eclamptic mothers have subclinical left ventricular dysfunction in presence of normal LVEF, which may progress to systolic dysfunction if preventive measures including tight blood pressure control and assessment of other risk factors are not taken pre-emptively. This emphasises the significant role of Echocardiography, especially strain imaging which even if technically demanding and

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

time consuming, helps to curtail morbidity and mortality in these subsets of Obstetric patients.

The Speckle-Tracking Echocardiographic analysis (Strain Imaging), revealed statistically significant impairment of Left Ventricular Global Longitudinal strain (GLS) and Circumferential Strain in PIH and pre-eclamptic mothers, even in presence of normal LVEF. GLS and Circumferential strain values were in normal range in normotensive mothers (p values <0.001).

This shows Gestational Hypertension and pre-eclamptic mothers have subclinical left ventricular dysfunction in presence of normal LVEF, which may progress to systolic dysfunction if preventive measures including tight blood pressure control and assessment of other risk factors are not taken pre-emptively. This emphasises the significant role of Echocardiography, especially strain imaging which even if technically demanding and time consuming, helps to curtail morbidity and mortality in these subsets of obstetric patients.

Conclusion:

Echocardiography, including Tissue Doppler and Speckle-Tracking Echocardiography are applicable and helpful in detecting cardiac function changes (including sub-clinical left ventricular dysfunction) in women with pregnancy-induced hypertension and preeclampsia and can identify patients for early intervention to prevent heart failure, morbidity, and mortality.

Limitations of the study:

The study was conducted in a small cohort of population as part of dissertation and therefore opens the opportunity for larger sample size based study to establish these findings. The follow-up period only during that of hospital stay, long term follow-up regarding the prognosis

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

could not be assessed. Due to inadequate logistic supports in Labour room, Gynaecology HDU and Eclampsia room, Echocardiography with strain-imaging could not be performed in the mothers admitted to these wards and had to be left out in this study.

Conflict of interest: None

Funding: None

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ISSN: 0975-3583,0976-2833 VOL15, ISSUE 9, 2024

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