

Assessment of Maternal Cardiovascular Function Using Echocardiography in Hypertensive Diseases of Pregnancy

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Abstract

Introduction: Hypertensive disease of pregnancy (HDP) is also known as maternal hypertensive disorder is a group of diseases such as preeclampsia gestational hypertension and chronic hypertension. A study was undertaken to evaluate the cardiovascular hemodynamic alterations in hypertensive disorders of pregnancy on echocardiography and assess its impact on maternal outcome.

Methods: A total of 100 pregnant patients presenting in our hospital with hypertension in 3rd trimester were selected for the study matching the inclusion and the exclusion criteria. A detailed history of each case was recorded and a detailed examination was performed. Echocardiography was done to note structural changes noted in the heart along with severity of disease.

Results: Out of Total 100 cases, 39 were gestational hypertension, 48 had pre eclampsia, 4 had eclampsia and 9 had chronic hypertension. Stroke volume was found to be significantly higher in eclampsia group. Also the diastolic dysfunction (29%) was associated with severity of disease and 10 women had pulmonary hypertension in pre eclampsia and eclampsia group. There was significant change in LVID(S) and LVID (D) showing changes of left eccentric ventricular hypertrophy in preeclampsia group and concentric left ventricular hypertrophy in chronic hypertensive group. An important finding in our study was the structural parameters such as LVID D, LVID S, IVS and LWPW D were on higher side of normal or raised in HDP and the values were statistically significant in pre-eclampsia and eclampsia groups as compared with the normal reference values .

Conclusions: The study concluded that cardiac structure and function using echocardiography are

altered in HDP. The severity of adverse changes seen in HDP is seen more in pre eclampsia and is proportional to the severity of the pre eclampsia. The cardiac functions which help in determination of impending dysfunction are the: LV end-diastolic volume, LV end-systolic volume, ejection fraction, stroke volume, left atrial diameter and pulmonary hypertension. Out of these diastolic dysfunction and increased peripheral vascular resistance correlate with disease severity.

Keywords: Echocardiography; 2 D echo; Preeclampsia; Gestational hypertension; Cardiovascular; Hypertension.

Introduction

Hypertensive disease of pregnancy (HDP) is also known as maternal hypertensive disorder is a group of diseases such as preeclampsia gestational hypertension and chronic hypertension. The current trend is a rising incidence of HDP due to various associated risk factors.

Physiological changes and maternal adaptations in pregnant women are exaggerated in HDP and can precipitate cardiovascular complications.

In Hypertensive disorders of pregnancy there is increased chances of myocardial injury and global left ventricular hypertrophy and dysfunction as compared to uneventful pregnancies. Cross sectional studies have revealed diverse hemodynamic findings such as: In early phase cardiac output is high with low peripheral resistance, but as the

disease progresses this changes to low cardiac output with high peripheral resistance. There is reduced central venous pressure and pulmonary wedge pressure along with generalized vasospasm. Cardiac arrhythmia, failure of left ventricle and pulmonary edema can occur.

Various studies have documented impairment of LV diastolic function as well as systolic function that appear very early in course of heart disease. Detection of any abnormality in ventricular function at asymptomatic phase can be of use in improving prognosis and outcome.

The severity of pre eclampsia has been shown to have an association with the magnitude of future cardiovascular risk as woman who developed severe pre eclampsia have greater risk of future cardiovascular disease (CVD) as compared to women with milder forms of disease.

Hence this study was undertaken to evaluate the cardiovascular hemodynamic alterations in hypertensive disorders of pregnancy on echocardiography and assess its impact on maternal and foetal outcome.

Material and Methods

Study Area

Department of Obstetrics and Gynecology in a tertiary care hospital, Bharati hospital at Bharati Vidyapeeth University, Pune.

Study Population

All patients attending the Gynecology OPD with symptoms suggestive of adnexal mass were taken for the study.

Study Design

A Prospective, observational, Clinical study.

Sample Size Calculation

A total of 100 pregnant patients presenting in our hospital with hypertensive disorder of pregnancy were selected for the study after taking informed consent.

Study Duration

Sept 2017 - Aug 2019

Inclusion Criteria

All women with HDP between 28 to 36 weeks of pregnancy.

Exclusion Criteria

1. Patients with known heart disease.

2. Patients with any pre-existing medical disorder like overt diabetes mellitus, renal disease and connective tissue disorder.

Methodology

Detailed history was taken and they were classified in 4 groups of hypertensive disorders of pregnancy.

Group 1: Gestational hypertension

Group 2: Pre-Eclampsia

Group 3: Eclampsia

Group 4: Chronic Hypertension.

All the four groups were referred for echocardiography. Demographic laboratory and echocardiographic data were reviewed. Systolic and diastolic blood pressure was taken from the brachial artery in the sitting position and then they were sent for echocardiography. Findings were recorded.

Standard two dimensional doppler echocardiography was performed position using a 3.5 MHz transducer in the left decubitus as per current practice. LV wall thickness and LV end diastolic diameter (LVEDD) and LV end systolic diameter (LVESD) were measured from parasternal long and short axis views with M-mode recording under two dimensional guidance.

Statistical Analysis

The quantitative data was represented as their mean \pm SD. Categorical and nominal data was expressed in percentage. All analysis was carried out by using SPSS software version 21.

Results

Out of Total 100 cases, 39 were gestational hypertension, 48 had pre eclampsia, 4 had eclampsia and 9 had chronic hypertension.

Systolic BP in Group 1 (Gestational HTN), Group 2 (Pre Eclampsia), Group 3 (Eclampsia) and Group 4 (Chronic HTN) is 136.7 ± 7.4 mmHg, 153.7 ± 10.8 mmHg, 160.0 ± 16.3 mmHg and 141.1 ± 9.3 mmHg respectively showing significantly higher BP in pre eclampsia and eclampsia group.

Diastolic BP in Group 1 (Gestational HTN), Group 2 (Pre Eclampsia), Group 3 (Eclampsia) and Group 4 (Chronic HTN) is 84.8 ± 5.5 mmHg, 98.2 ± 6.8 mmHg, 102.5 ± 5.0 mmHg and 85.6 ± 7.3 mmHg respectively showing significantly higher BP in pre eclampsia and eclampsia group (Table 1).

These findings were in comparison with the definitions of Pre Eclampsia and Eclampsia.

Table 1: Inter-group distribution of means of various 2D Echo parameters.

Parameters	Group 1 (Gestational HTN)(n=39)		Group 2 (Pre Eclampsia) (n=48)		Group 3 (Eclampsia) (n=4)		Group 4 (Chronic HTN)(n=9)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Aortic root (mm)	23.79	3.47	23.98	3.77	27.25	2.22	23.22	2.44
Left atrial diameter (mm)	21.92	2.67	26.87	3.01	26.25	1.50	25.67	4.89
LVID D (mm)	38.92	5.26	41.35	4.84	48.75	4.86	38.33	6.76
LVID S (mm)	23.05	4.96	24.23	4.22	30.00	2.16	21.22	5.93
Stroke volume	66.41	19.37	76.14	18.67	101.21	24.81	69.13	19.71
LVPW D (mm)	8.51	0.99	9.29	0.92	10.00	1.41	8.78	0.83
IVS S (mm)	9.10	0.79	9.94	0.98	10.50	1.29	9.22	0.44
RVSP	25.09	6.09	29.90	4.70	31.20	3.99	22.74	4.09
Ejection fraction (%)	58.00	0.00	57.00	0.00	55.00	0.00	60.00	0.00

Table 2: Inter-group statistical comparison of means of various 2D Echo parameters.

	Group 1 v Group 2	Group 1 v Group 3	Group 1 v Group 4	Group 2 v Group 3	Group 2 v Group 4	Group 3 v Group 4
Aortic root (mm)	0.999 ^{NS}	0.408 ^{NS}	0.999 ^{NS}	0.474 ^{NS}	0.999 ^{NS}	0.586 ^{NS}
Left atrial diameter (mm)	0.001 ^{***}	0.055 ^{NS}	0.006 ^{**}	0.999 ^{NS}	0.999 ^{NS}	0.999 ^{NS}
LVID D (mm)	0.187 ^{NS}	0.003 ^{**}	0.999 ^{NS}	0.047 [*]	0.509 ^{NS}	0.006 ^{**}
LVID S (mm)	0.999 ^{NS}	0.027 [*]	0.999 ^{NS}	0.110 ^{NS}	0.223 ^{NS}	0.007 ^{**}
Stroke volume	0.154 ^{NS}	0.006 ^{**}	0.999 ^{NS}	0.091 ^{NS}	0.999 ^{NS}	0.049 [*]
LVPW D (mm)	0.003 ^{**}	0.028 [*]	0.999 ^{NS}	0.981 ^{NS}	0.999 ^{NS}	0.366 ^{NS}
IVS S (mm)	0.001 ^{***}	0.025 [*]	0.999 ^{NS}	0.999 ^{NS}	0.269 ^{NS}	0.140 ^{NS}
RVSP	0.001 ^{***}	0.176 ^{NS}	0.999 ^{NS}	0.999 ^{NS}	0.002 ^{**}	0.043 [*]
Ejection fraction (%)	0.999 ^{NS}	0.999 ^{NS}	0.999 ^{NS}	0.999 ^{NS}	0.999 ^{NS}	0.999 ^{NS}

Aortic root value is slightly higher as compared to normotensive patients ie. 20+/- 3mm vs 23+/-3.7 mm (Table 1).

Left atrial diameter is significantly higher in groups 2,3 and 4 compared to Group 1 (P-value<0.05 for all).

LVID D is significantly higher in group 3 compared to groups 1, 2 and 4 (P-value<0.05 for all).

LVID S is significantly higher in group 3 compared to groups 1 and 4 (P-value<0.05 for all).

Stroke volume is significantly higher in group 3 compared to groups 1 and 4 (P-value<0.05 for all).

LVPW D is significantly higher in groups 2 and 3 compared to group 1 (P-value<0.05 for all) (Table 2)..

IVS S is significantly higher in groups 2 and 3 compared to group 1 (P-value<0.05 for all). Out of 100 subjects: 29 had diastolic dysfunction but Distribution of diastolic dysfunction did not differ significantly across four groups of hypertensive disorders in pregnancy. Diastolic dysfunction was

more common in the eclampsia group and the severe pre-eclampsia group. The findings were not statistically significant (Table 2).

Pulmonary hypertension was found in 10 patients. It was found to be more common in patients with eclampsia. The findings were not statistically significant.

Discussion

Echocardiography is extensively used in cardiology for diagnosis and management of hypertensive disorders, but its use in pregnancy is under-rated and under-evaluated.

Our objective was to assess the efficacy of echocardiography in pregnancies complicated by hypertensive disease of pregnancy by noting down the structural and functional changes in maternal heart during the course of hypertensive disease of pregnancy.

HDP is associated with a plethora of changes in the 2D ECHO parameters which include the

structural changes regarding size of left ventricular wall, left atrial diameter, posterior wall thickness, inter-ventricular septal thickness, aortic root which can be quantified numerically and functional abnormalities such as change in stroke volume and cardiac output, right ventricular systolic pressure, diastolic dysfunction, pulmonary hypertension and the ejection fraction abnormalities.

The structural remodeling of the heart occurs during HDP and is carried out even after the postpartum period and has got serious implications on the maternal heart functions leading to the heart diseases like left ventricular hypertrophy, chronic hypertension, cardiac failure and postpartum or delayed cardiomyopathy in future.

In the current study, we discuss the comparison between the four groups of hypertensive disease of pregnancy: gestational hypertension, pre eclampsia, eclampsia and chronic hypertension in pregnancy on the basis of 2 D echo parameters obtained.

We evaluated 100 pregnancies with HDP where in 39 women were diagnosed to have gestational hypertension, 48 women had pre-eclampsia, 4 had eclampsia and 9 were with chronic hypertension with superimposed pre-eclampsia (Table 1).

The mean systolic and diastolic blood pressure was significantly higher in the Pre-Eclampsia and Eclampsia group (Table 1) suggesting the values to be directly proportional to the severity of the HDP.

An important finding in our study was the structural parameters such as LVID D, LVID S, IVS and LWPW D were on higher side of normal or raised in HDP (Table 1) and the values were statistically significant in pre-eclampsia and eclampsia groups as compared with the normal reference values.

Another significant finding was of pulmonary hypertension which was observed in 10 patients. These patients were referred to the cardiologist and were under close supervision and observation. The incidence of pulmonary hypertension was 2% in the gestational hypertension group, 14% in pre eclampsia and almost 50% in eclampsia.

Diastolic dysfunction was observed in 29 patients. It was graded as grade 1 and grade 2 with respect to the severity of the dysfunction. It was more common in pre-eclampsia (17.9%) and eclampsia (39.6%) groups. Diastolic dysfunction is an important diagnostic and prognostic indicator of the cardiac wellbeing and there have been studies which mention diastolic dysfunction to occur earlier than the systolic dysfunction and ejection fraction abnormalities.^{1,2}

Right ventricular systolic pressure was significantly higher in pre eclampsia and eclampsia group.

The results of our study were compared with the results of the studies done in past to assess the significance of your findings of the cardiovascular changes in pre eclampsia. Since the current use of 2 D echo is very limited in assessing pregnant women there was meager data in the literature. But few studies which were undertaken to determine the structural and functional changes in maternal heart during pregnancy were reviewed and the results were compared to our findings.

A study by Julie Gainer et. al. was done in 2004 in 87 pregnant women who had chronic hypertension.³ The most common findings included concentric left ventricular hypertrophy, dilatation of the left atrium, impaired relaxation of the mitral valve, or a combination of these findings. The findings were similar to echocardiography finding in chronic hypertensive population and hence conclusion was taken out that no significant adverse changes are noted during pregnancy in these women. In our study women who had HDP superimposed on chronic hypertension had similar findings. Also the newly developed hypertensives of pregnancy having pre eclampsia were showing similar structural changes in 2 D echo such as left atrial dilatation, left ventricular hypertrophy and impaired relaxation during diastole. Our study was far superior than by Julie Gainer et. al. in that we compared the 2D ECHO findings in all four categories of HDP rather than chronic hypertension.

Similar findings were noted in study done in Korea^{4,5,6} during 2008-2012 year. Eccentric LVH was noted in pre eclampsia group as compared to concentric LVH in chronic hypertension group.

In 2016 systematic review by James Castleman et al performed systematic review of 36 studies which had 745 gestational hypertensive women and 836 pre eclamptic women. 2 D echo performed during these studies showed that left ventricular wall thickness of ≥ 1.0 cm and exaggerated reduction in E/A were differentiating features from normal pregnancy.⁷ Conclusion was that the changes of HDP can be picked up earlier using echocardiography.

In 2018 at Hopkins hospital a study was conducted by Vaught AJ et. al. The conclusion of this study was similar to our study that women with Pre eclampsia have higher RVSP, higher rates of abnormal diastolic function, increased left-sided chamber remodeling, and higher rates of pulmonary hypertension and edema, when

compared with healthy pregnant women.⁸

Conclusion

The study concluded that cardiac structure and function using echocardiography are altered in HDPs. The severity of adverse changes seen in HDP is seen more in pre eclampsia and is proportional to the severity of the pre eclampsia. For women with pre eclampsia, diastolic dysfunction and increased peripheral vascular resistance correlate with disease severity. Recognition of impairment in cardiac function is important in the contemporary management of HDP and pre eclampsia to improve pregnancy outcomes and long term cardiovascular health.

HDPs affect maternal structure and function of heart. But currently echocardiography is not routinely performed in pregnant patients having HDPs. It is safe and non invasive technique to identify and stratify patients.

This study clarifies that echocardiography can be used as adjunct to clinical parameters of diagnosing preeclampsia. Presence of any indicator of adverse outcome such as diastolic dysfunction, left ventricular remodeling, pulmonary hypertension observed during the course of pregnancy can forewarn severity of underlying disease. Hence close surveillance of patient along with echocardiography would allow an early diagnosis of severe forms of HDPs and guide in a timely intervention improving long term cardiovascular health of women

References

1. Ganau A, Devereux RB, Roman MJ, de Simone G, Pickering TG, Saba PS, Vargiu P, Simongini I, Laragh JH. Patterns of left ventricular hypertrophy and geometric remodeling in essential hypertension. *J Am Coll Cardiol.*1992;19:1550-1558
2. Katz R, Karliner JS, Resnik R. Effects of a natural volume overload state (pregnancy) on left ventricular performance in normal human subjects. *Circulation.* 1978;58(3 Pt1):434-441
3. Gainer, Julie et. al. Maternal echocardiogram findings in pregnant patients with chronic hypertension, *American Journal of Obstetrics & Gynecology*, Volume 191, Issue 6, S40
4. Lang RM, Bierig M, Devereux RB, Flachskampf FA, Foster E, Pellikka PA, PicardMH, RomanMJ, SewardJ, ShanewiseJS, SolomonSD, SpencerKTSutton MS, Stewart WJ, Chamber Quantification Writing Group. American Society of Echocardiography's Guidelines and Standards Committee. European Association of Echocardiography Recommendations for chamber quantification: a report from the American Society of Echocardiography's Guidelines and Standards Committee and the Chamber Quantification Writing Group, developed in conjunction with the European Association of Echocardiography, a branch of the European Society of Cardiology. *J Am Soc Echocardiogr.*2005;18:1440-1463.
5. Mi-Jeong Kim, JonggooSeo, Kyoung-Im Cho, Se-Jung Yoon, Jung-Hyun Choi, Mi-Seung Shin, Echocardiographic assessment of structural and haemodynamic changes in hypertension related pregnancy, *J Cardiovasc Ultrasound.* 2016 Mar; 24(1): 28-34. Published online 2016 Mar 24. doi: 10.4250/jcu.2016.24.1.28PMCID:PMC4828411
6. Easterling TR, Benedetti TJ, Schmucker BC, Millard SP. Maternal hemodynamics in normal and preeclamptic pregnancies: A longitudinal study. *Obstet Gynecol.* 1990;76:1061-9.
7. Castleman, J. S., Ganapathy, R., Taki, F., Lip, G. Y. H., Steeds, R. P., & Kotecha, D. (2016). Echocardiographic Structure and Function in Hypertensive Disorders of Pregnancy: A Systematic Review. *Circulation: Cardiovascular Imaging*, 9 (9), [e004888]. <https://doi.org/10.1161/Circimaging.116.004888>
8. Vaught AJ, Kovell LC, Szymanski LM, Mayer SA, Seifert SM, Vaidya D, MurphyJD, ArganiC, O' KellyA, YorkS, OuyangP, MukherjeeM, ZakariaS. Acute Cardiac Effects of Severe Preeclampsia. *J Am Coll Cardiol.* 2018 Jul 3;72(1):1-11. doi:10.1016/j.jacc.2018.04.0.