



RESEARCH ARTICLE

MATERNAL CARDIOVASCULAR HEMODYNAMICS IN NORMAL AND PREECLAMPTIC PREGNANCIES USING ECHOCARDIOGRAPHY: A COLOMBIAN MULTICENTER STUDY

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ABSTRACT

Background: Preeclampsia is associated with higher prevalence of abnormal global left ventricular function. So present study was designed to compare these changes in normal and preeclamptic pregnancies using echocardiography.

Methods: In present study, 96 patients with pre-eclampsia with singleton pregnancy between 20-30 years (study group) were compared with 96 age matched healthy pregnant women (control group). They were non-invasively analysed for cardiovascular hemodynamics using echocardiography. The data was analysed using student's t- test. p value <0.05 was considered to be significant.

Results: Mean stroke volume in pre-eclampsia group was 72.4±5.1 ml v/s 67.7±5.6 ml in control group and the difference was statistically significant. Mean Cardiac output in pre-eclampsia group was 64.2±3.4 lt/min v/s 5.69±0.47 lt/min in control group which is statistically significant. Mean Systemic vascular resistance (dyne.sec cm⁻⁵) in pre-eclampsia group was 1468.22±5.7 v/s 957.7±131 in control group which is statistically significant. Mean Ejection fraction (%) in pre-eclampsia group was 68.31±5.1 v/s 66.54±4.7 in control group which is statistically significant.

Conclusions: Doppler echocardiography provides an excellent non-invasive method for evaluation of hemodynamic changes during pregnancy. Therefore if it is introduced into antenatal protocol, could help to identify subset of preeclamptic women who are at high risk to developing complications and thereby can do early intervention.

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INTRODUCTION

Pregnancy is a physiological phenomenon. It produces both anatomical and physiological changes in all the organs including reproductive organs, cardiovascular system, hemopoietic system, respiratory system and excretory system etc. It is associated with volume overload producing significant vascular and hemodynamic adaptations in cardiovascular physiology (Sonali S. Somani *et al.*, 2016) they are necessary for successful pregnancy, but they impose further load on the heart. Preeclampsia is a multisystem disorder that occurs after 20 wks. of pregnancy. Acute preeclampsia is associated with significantly higher prevalence of asymptomatic abnormal global left ventricular (LV) abnormal function/geometry and

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myocardial injury (Melchiorre *et al.*, 2011). It is also associated with significantly higher risk of subsequent heart failure, ischemic and hypertensive heart diseases and related mortality in later life (Lykke *et al.*, 2009; Mongraw-Chaffin *et al.*, 2010) Many studies of women with preeclampsia have revealed diverse hemodynamic findings such as elevated cardiac output (CO), high vascular resistance, and reduced CO and myocardial contractility (Solanki and Maitra, 2011). Impairment of LV diastolic function as well as systolic function appear very early in the course of heart disease (Kuznetsova *et al.*, 2010). Early detection and its treatment at an asymptomatic phase can help in improving the prognosis. In earlier days, gas exchange techniques were used to determine cardiac output. With development of cardiac catheterization, it was used to study right heart hemodynamics. The advent of echocardiography enabled serial noninvasive cardiovascular monitoring throughout pregnancy. Initially, investigators used M-mode but perhaps due to its limitations, results were not uniform (Vered *et al.*, 1991). Recently, Doppler echocardiography has been

used which is reproducible and non-invasive technique suitable for pregnant women (Robson *et al.*, 1989). Therefore echocardiography if introduced into the routine antenatal protocol, could help to identify women who are at high risk to develop cardiovascular complications and there by early intervention.

MATERIALS AND METHODS

Present study was carried out in the departments of obstetrics and gynecology of eight highly complex hospitals in four Colombian cities: Bogota, Medellin, Cali and Bucaramanga. It was a prospective case controlled multicentre study, conducted in 192 subjects during July 2017 to November 2017 over a period of 5 months. In present study, 96 patients with preeclampsia with singleton pregnancy between 20-30 years (study group) were compared with 96 age matched healthy pregnant women (control group). Patients who refused to participate, those suffering from cardiovascular disease, diabetes mellitus, thyroid disorder, anaemia and multiple gestation were excluded. All subjects were informed in detail about aim and procedure of study; and written consent was taken for conduct of study. Ethical approvals by the institutional ethics committees were obtained. A detailed obstetric history and thorough examination was done in all subjects. Age, height, weight were noted. Blood pressure was measured by sphygmomanometer in right arm in left lateral position after 10 minutes of rest by auscultatory method. Onset of tapping sound was taken as systolic and muffling of Korotkoff sound was taken as diastolic blood pressure. An obstetric ultrasound scan, was performed to confirm singleton pregnancy and gestational age. All subjects were subjected to echocardiography using Philips ANVISER-C model. Standard parasternal two dimensional long axis images were recorded and left ventricular diameters were measured in M mode (American Society of Echocardiography guidelines) (Sahn *et al.*, 1978). Doppler Echocardiography was used to calculate stroke volume (Van Oppen *et al.*, 1996). Simultaneously heart rate per minute was recorded. Cardiac output, Systemic vascular resistance and ejection fraction were calculated.

Statistical analysis

The data was expressed as Mean \pm S.D and was analysed using student's t- test P-value <0.05 was considered to be significant.

RESULTS AND DISCUSSION

Pregnancy is a condition of primary peripheral arterial vasodilation, associated with hyperdynamic circulation with high CO and low SVR (Schrier, 1989). Preeclampsia is a disease unique to pregnancy that contributes substantially to maternal and fetal morbidity and mortality, and is associated with increased vascular resistance and hypertension (Easterling *et al.*, 1990). Hypertension produces structural changes in the left ventricle usually accompanied by functional alterations and in majority of cases, these alterations precede clinical manifestations (Escudero *et al.*, 1988) In normal pregnancy, an increased preload and a decreased afterload favor an improved emptying of the left ventricle during systole and a reduction of the end-systolic pressure (Valensise *et al.*, 2001). In preeclamptic women, the elevated afterload is linked with a reduced emptying of the left ventricle and elevated end-systolic pressure.

Table 1. Comparison of mean age, mean height and mean weight of control and study groups (n =50)

	Control group (n=25)	Study group (n=25)	p value
Mean age (years \pm SD)	24.5 \pm 4.18	25.91 \pm 3.24	>0.05
Mean height (cm \pm SD)	154.34 \pm 2.78	149.08 \pm 4.55	>0.05
Mean weight Kg \pm SD)	55.4 \pm 3.04	60.34 \pm 4.54	<0.05

p value: <0.05 – significant; Mean age and height in control and study groups were comparable. Mean weight was more in study group which was statistically significant.

Table 2. Comparison of heart rate and blood pressure between study and control group (n=50) (Mean \pm SD)

Parameter	Control Group (n=25)	Study Group (n=25)	p value
Heart rate (Beats/min)	97.6 \pm 4.1	106 \pm 8.05	<0.05
Systolic blood pressure (mmHg)	107.32 \pm 6.9	114 \pm 8.4	<0.05
Diastolic blood pressure (mmHg)	71.5 \pm 5.1	82 \pm 7.2	<0.05

Hemodynamic parameters are more in study group than control group and is statistically significant.

Table 3. Comparison of echocardiographic parameters between study and control group (n=50) (Mean \pm SD)

Parameter	Control group (n=25)	Study group (n=25)	p value
Stroke volume (ml)	67.7 \pm 5.6	72.4 \pm 5.1	<0.05
Cardiac output (lt/min)	5.69 \pm 0.47	64.2 \pm 3.4	<0.05
Systemic vascular resistance (dyne.sec cm ⁻⁵)	957.7 \pm 131	1468.22 \pm 5.7	<0.05
Ejection fraction (%)	66.54 \pm 4.7	68.31 \pm 5.1	<0.05

Rizwana Solanki *et al* found a statistically significant difference in mean SV between pre eclamptics and normotensive women groups studied (Solanki and Maitra, 2011). Results of present study were also comparable to study done by Dennis *et al.* (2012) They observed cardiac output was higher in PIH group as compared to the controls. They stated that cardiac output is increased in women with untreated pre eclampsia due to an increase in stroke volume. Solanki *et al* found cardiac output was significantly higher in pre eclamptic patients⁵our results were comparable to their. In present study, systemic vascular resistance was more in pre eclamptic patients. This is in accordance with study of Solanki *et al.* (2011).

Conclusion

Doppler echocardiography provides an excellent non-invasive method for the evaluation and serial analysis of hemodynamic changes during pregnancy. They help in distinguishing abnormal changes from maternal physiologic changes. Preeclampsia still contributes to a majority of preventable maternal mortality and morbidity. Therefore echocardiography if introduced into the antenatal protocol, could help to identify subset of preeclamptic women who are at high risk to develop cardiovascular complications and there by can do early intervention.

Limitation: Present work had not a monitoring and control for those women who developed preeclampsia during the first weeks postpartum, given that it was not possible to do an effective echocardiographic monitoring due to logistical difficulties because the patients lived in dispersed areas of the

cities and their postpartum controls were carried out in other health centers. This would have been valuable to compare the data on stroke volume, ejection fraction, cardiac output and systemic vascular resistance in cases of preeclampsia without pregnancy, which changes the total maternal plasma volume and therefore modifies these hemodynamic variables in contrast to preeclamptic pregnant women.

Future: Further studies can be made by 3D echocardiography which is based on direct volumetric quantification, which is independent of geometric assumption of Left Ventricle.

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