Evaluation of Echocardiographic Systolic Parameters in Pre-Eclampsics and Normotensives Women

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Abstract

Objective Early detection of changes in cardiovascular echocardiographic systolic parameters and their comparison with normotensives women.

Methods This was a hospital-based prospective case-control study carried out in Department of Obstetrics and

Gynaecology in S.M.S Medical College, Jaipur, during the period from February 2013 to December 2014. In total, 100 women were enrolled in the study after applying inclusion and exclusion criteria. All women underwent two-dimensional echocardiography at rest. Cardiac systolic parameters were recorded and studied.

Results Mean LVEDV in the PIH group was 75.71 ± 4.8 versus 71.08 ± 5.6 ml in the control group, and the difference was statistically significant. Mean stroke volume was higher in the PIH group as compared to the control group, and the difference was statistically significant (59.83 ± 7.4 vs. 52.48 ± 6.4 ml/min). Mean aortic root diameter in the PIH group was 2.188 ± 1.04 cm as compared to the 1.866 ± 1.06 cm in the control group which was statistically significant. Mean left ventricular outflow tract diameter was slightly higher in the PIH group as compared to the controls although the *P* value was not significant (2.37 ± 1.06 and 1.99 ± 1.08 cm). Mean total vascular resistance was found to be higher in the PIH group

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as compared to the controls, and the difference was statistically significant (1389 ± 57.04 vs. 1286 ± 45.01 dynes/sec/cm⁻⁵).

Conclusion Systolic parameters get worsened in pre-eclampsia. Early detection of change in these parameters could help to identify high-risk women who are prone to develop cardiovascular morbidity in later life.

Keywords Echocardiography · Systolic parameters · Preeclampsia · Normotensive

Introduction

Pre-eclampsia is a multisystem disorder that occurs after 20 weeks of pregnancy. The incidence of pre-eclampsia in nulliparous women ranges from 3 to 10 % [1]. Acute pre-eclampsia is associated with significantly higher prevalence of asymptomatic abnormal global left ventricular (LV) abnormal function/geometry and myocardial injury [1]. It is also associated with significantly higher risk of subsequent heart failure, ischaemic and hypertensive heart diseases, and related mortality compared with uneventful pregnancy in later life [2, 3]. Invasive monitoring devices such as the pulmonary artery catheter have significant risks and are currently rarely used as research tools. Their use in clinical practice is limited to the intensive care setting in extremely unwell women, thus restricting their clinical applicability (Table 1).

Transthoracic echocardiography, however, is routinely used in cardiovascular system research in other areas of medicine. It is frequently considered the reference standard for cardiovascular system monitoring. It is a non-invasive, precise device and is validated in pregnancy. It is an ideal device for measuring the cardiac function in women with pre-eclampsia and, however, is currently rarely used. BP monitoring alone is insufficient to identify efficiently the risk of cardiovascular complication in these subjects. Maternal echocardiography if introduced into routine management protocol could help to identify women who are at high risk to develop complication (Table 2).

Table 1 Distribution of patients according to left ventricular end-diastolic volume (LVEDV)

LVEDV (in ml)	PIH group		Control group	
	No.	%	No.	%
65–70	14	28.00	32	64.00
70–75	6	12.00	12	24.00
75–80	4	8.00	3	6.00
80–85	20	40.00	2	4.00
>85	6	12.00	1	2.00
Total	50	100.00	50	100.00

P value 0.001

Table 2 Distribution of patients according to left ventricular end-systolic volume (LVESV)

LVESV (in ml)	PIH group		Control group	
	No.	%	No.	%
20–25	4	8.00	8	16.00
25–30	14	28.00	20	40.00
30–35	6	12.00	12	24.00
35–40	22	44.00	8	16.00
>40	4	8.00	2	4.00
Total	50	100.00	50	100.00

P value 0.06

Table 3 Distribution of patients according to stroke volume (SV)

Stroke volume (in ml)	PIH group		Control group	
	No.	%	No.	%
<40	5	10.00	10	20.00
40–50	8	16.00	18	36.00
50–60	14	28.00	5	10.00
60–70	18	36.00	5	10.00
>70	5	10.00	2	4.00
Total	50	100.00	50	100.00

P value 0.002

Methods

This hospital-based prospective type of case–control study was conducted in Department of Obstetrics and Gynaecology, S.M.S Medical College, Jaipur, from February 2013 to December 2014. In total, 100 women were recruited in the study including 50 pre-eclampsia and 50 controls. Inclusion and exclusion criteria were applied (Table 3).

Inclusion Criteria

- Singleton pregnancy
- Gestational age >34 weeks
- Pre-eclamptic women

Exclusion Criteria

- Gestational age <34 weeks
- Heart disease
- Medical problems
 - Severe anaemia
 - Twin pregnancy
 - Alcohol and tobacco use

- Chronic hypertension
- Angina pectoris
- Previous myocardial infarction
- Heart failure
- Chronic obstructive pulmonary disease
- Diabetes mellitus

Normotensive healthy, non-smoking pregnant women with normal foetal growth matched for maternal age and gestation were recruited as controls from routine antenatal clinic (Table 4).

All subjects were studied by standard two-dimensional and Doppler transthoracic echocardiography at rest. Patients were studied in left lateral decubitus position, and data were acquired at end expiration from standard parasternal/apical views using scanner (Table 5).

M-mode studied was performed at the level of aorta, left atrium and left ventricle at a midposition between the tips of the mitral valve and papillary muscles. Pulsed Doppler flow across the mitral valve was recorded to obtain the LV diastolic filling pattern (Table 6).

Systolic parameters studied were:

- Left ventricular end-diastolic volume (LVEDV)
- Left ventricular end-systolic volume (LVESV)
- Stroke volume (SV)

Table 4 Distribution of patients according to cardiac output (CO)

Cardiac output (in L/min)	PIH group		Control group	
	No.	%	No.	%
4.5–5	5	10.00	8	16.00
5.1–5.5	20	40.00	22	44.00
5.6–6	22	44.00	10	20.00
6.1–6.5	2	4.00	2	4.00
6.6–7	1	2.00	4	8.00
7.1–7.5	0	0.00	4	8.00
Total	50	100.00	50	100.00

P value 0.05

Table 5 Distribution of patients according to aortic root diameter (ARD)

Aortic root diameter (in cm)	PIH group		Control group	
	No.	%	No.	%
1–1.5	5	10.00	8	16.00
1.5–2	11	22.00	30	60.00
2–2.5	28	56.00	8	16.00
>2.5	6	12.00	4	8.00
Total	50	100.00	50	100.00

P value 0.002

Table 6 Distribution of patients according to left ventricular outflow tract (LVOT)

Left ventricular outflow tract (in cm)	PIH group		Control group	
	No.	%	No.	%
<1	1	2.00	2	4.00
1–1.5	5	10.00	12	24.00
1.5–2	18	36.00	24	48.00
2–2.5	22	44.00	10	20.00
>2.5	4	8.00	2	4.00
Total	50	100.00	50	100.00

P value 0.06

- Cardiac output (CO)
- Aortic root diameter (ARD)
- Left ventricular outflow tract (LVOT)

Results

Mean LVEDV was higher in the PIH group as compared to the control group. Mean LVEDV in the PIH group was 75.71 ± 4.8 versus 71.08 ± 5.6 ml in the control group, and the difference was statistically significant. In the PIH group, maximum number of patients, i.e. 22 (44 %), had LVESV between 35 and 40 ml, 14 (28 %) between 25 and 30 ml, 4 (8 %) between 20 and 25 ml and other 4 (8 %) patients >40 ml. In the control group, majority, i.e. 20 (40 %), of the patients had LVESV between 25 and 30 ml and 12 (24 %) of the patients had LVESV between 30 and 35 ml (Table 7).

The mean was higher in the PIH group as compared to the control group, and the difference was statistically significant (33.75 ± 4.2 vs. 30.1 ± 3.7 ml). Mean stroke volume was higher in the PIH group as compared to the control group, and the difference was statistically significant. Forty-four percentage of the patients in the PIH group

Table 7 Distribution of patients according to total vascular resistance (TVR)

Total vascular resistance (in dynes/sec/ cm ⁻⁵)	PIH group		Control group	
	No.	%	No.	%
<1200	0	0.00	10	20.00
1200–1300	10	20.00	26	52.00
1300–1400	26	52.00	12	24.00
1400–1500	12	24.00	1	2.00
>1500	4	8.00	1	2.00
Total	50	100.00	50	100.00

P value 0.001

had CO between 5.6 and 6 L/min, whereas only 20 % patients in the control group had CO in this range, indicating a statistically significant difference.

Mean ARD in the PIH group was 2.188 ± 1.04 cm as compared to the 1.866 ± 1.06 cm in the control group which was statistically significant.

Mean LVOT diameter was slightly higher in the PIH group as compared to the controls although the P value was not significant (2.37 ± 1.06 and 1.99 ± 1.08 cm).

Discussion

Solanki et al. [4] and Ghossein Doha et al. [5] studied the same parameter in pre-eclampsics and normotensives and found a significant difference in LVEDV between the two groups (108.23 ± 27.95 vs. 107.73 ± 5.66 ml, 100 ± 16 vs. 94 ± 7 ml).

Ghossein Doha et al. [5] studied systolic parameters in 40 pre-eclampsic women and 40 normotensive women and concluded that the mean LVEDV was higher in pre-eclampsic group, i.e. (100 ± 16 vs. 94 ± 7 ml), highlighting the importance of this variable in early detection of cardiovascular morbidity.

Although the results of our study were similar to all the above studies, there was a difference in the values of mean LVEDV (75.71 vs. 100 ml). It could be because of the difference in the body surface area of the patients. Indian women have smaller habitus as compared to Western women. They concluded that pre-eclampsia is characterised by a significant increase in left ventricular end-systolic volume.

A study carried out by Solanki et al. [4] assessed LVESV in pre-eclampsics and normotensives by two-dimensional echocardiography. Mean LVESV was found to be higher in the PIH group as compared to the controls (36.04 ± 13.32 vs. 27.2 ± 3.5 ml).

Our results were comparable with the study done by Dennis et al. [6] who studied left ventricular systolic and diastolic function and structure using transthoracic echocardiography in women with 40 untreated pre-eclampsia and 40 normotensive women and found a higher mean LVESV in the pre-eclampsia group. Dennis et al.'s study [6] observed the haemodynamics in women with 40 untreated pre-eclampsia and 40 matched healthy pregnant controls by using transthoracic echocardiography, and they calculated a increased stroke volume in untreated pre-eclampsic group, i.e. (58.9 ± 12.8 vs. 56.9 ± 7.2 ml).

Solanki et al. [4] did a similar study to evaluate various systolic parameters in pre-eclampsics and normotensive women, and they found a statistically significant difference in mean SV between two groups studied. Stroke volume in

women with pre-eclampsia and normotensives was 73.3 ± 14.19 versus 70.8 ± 3.22 ml, respectively.

Our results were also comparable to the study done by Dennis et al. [6] who studied systolic parameters in pre-eclampsics and healthy pregnant women. In total, 40 pre-eclampsic and 40 healthy pregnant women underwent Doppler echocardiography and observed for cardiac output which was found to be higher in the PIH group as compared to the controls (4789 ± 14 vs. 4109 ± 59 ml/min). They stated that cardiac output is increased in women with untreated pre-eclampsia due to an increase in stroke volume.

Solanki et al. [4] assessed cardiac output in 40 patients. Cardiac output in pre-eclampsics was 6600.85 ± 4.56 ml/min as compared to 5600.1 ± 1.77 ml/min which was significantly higher. Our results were comparable to the study done by Solanki et al. [4] in which they assessed the echocardiographic changes in pre-eclampsic women. Women with pre-eclampsia had higher aortic root diameter as compared to normotensive control (2.48 vs. 2.02 cm).

Naidoo et al. [7] also reported a higher mean ARD in pre-eclampsics as compared to the controls (24 vs. 23 mm). They studied haemodynamics in 36 pre-eclampsics and 41 normotensive women using tissue Doppler imaging studies. Yuan et al. [8] studied the impact of pre-eclampsia on left ventricular outflow tract in 40 normal and 23 pre-eclampsic pregnancies by two-dimensional transthoracic echocardiography, and LVOT diameter calculated was found to be higher in the PIH group.

Solanki et al. [4] did a study in which they assessed various systolic and diastolic parameters and observed that mean TVR in the PIH group was 1396.85 ± 156.2 dynes/sec/cm⁻⁵ as compared to the 1204.5 ± 71.18 dynes/sec/cm⁻⁵. They suggested that women with pre-eclampsia had a uniform pattern of high total vascular resistance and high cardiac output. High TVR in pre-eclampsia suggests elevated after load which is linked with reduced emptying of left ventricle.

Karen et al. [1] also found TVR to be higher in the PIH group as compared to the controls mainly due to vasoconstriction.

Dennis et al. [6] in his study found a significant difference in mean TVR in pre-eclampsics and controls. Mean TVR was 2015.7 ± 624.7 and 1612.5 ± 315.4 dynes/sec/cm⁻⁵ in the PIH group and normotensives, respectively.

Conclusion

Pre-eclampsia is a multisystem disease with acute onset of cardiovascular manifestations. The cardiovascular system undergoes a host of changes which ultimately lead to

classic high cardiac output—high systemic vascular resistance state. Since there are structural and functional changes in the cardiovascular dynamics in subjects with pre-eclampsia, maternal echocardiography if introduced in the routine management protocol could help to identify women who are at high risk to develop complications.

Compliance with Ethical Standards

Conflict of interest Neha Jain, Asha Verma and Lata Rajoria declared that they have no conflict of interest.

Ethical standards Studies with human subjects include the following statement: all procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5).

Informed consent Informed consent was obtained from all patients included in the study.

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