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Effect of Preeclampsia on Left Ventricular Diastolic Function

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Abstract

Background: Preeclampsia is a significant cause of maternal cardiovascular morbidity and mortality. An increase in PVR (peripheral vascular resistance) and Left Ventricular (LV) mass can predict negative maternal and fetal outcomes. Additionally, LV systolic tissue doppler parameters were found to be decreased in preeclampsia indicating impaired myocardial contractility. As diastolic function is known to precede systolic dysfunction in preeclamptic women may indicate early cardiovascular (CV) dysfunction and prompt early intervention.

Aim of Study: This study investigates the diastolic function in preeclamptic patients.

Patients and Methods: This study was conducted at Misr University Hospital from 1-4-2015 to 31-12-2015. Sixty pregnant women were allocated intotwo groups: group I [n=30] includin preeclamptic women and group II [n=30] including normotensive pregnant women. Maternal echocardiography was conducted to measure the diastolic (E /A and E/Em) and systolic LV function (EF and Tei index).

Results: There were no statistically significant differences between both groups in all parameters of systolic function (EF, mitral C-to-O time, LVE time, Tei index, stroke volume and cardiac output) (p>0.05), nor conventional mean E/A ratio, whereas the mean E/Em ratio was (5.58±2.60 and 4.31±1.04) in preeclamptic and normotensive women respectively, which was statistically significant (p<0.05). Nevertheless, there were no significant differences between both groups at 6-month follow-up.

Conclusion: There was no significant difference between normotensive and mild preeclamptic women regarding systolic functions. However, mild preeclamptic patients had impaired diastolic functions. This may suggest that assessing diastolic functions in early pregnancy may be of significance in predicting preeclampsia.

Key Words: *Preeclampsia – Cardiac function – Diastolic function.*

Introduction

WOMEN undergo physiological changes during pregnancy such as increased plasma volume, heart rate, and cardiac output by 40-50%, in addition to reduction in peripheral vascular resistance **[1-3]**. However, preeclampsia (defined as recent onset of hypertension and proteinuria or end-organ dysfunction ± proteinuria in women >20 weeks pregnancy) is known to associate with lower cardiac output due to reduced intravascular volume and elevated Systemic Vascular Resistance (SVR) (caused by the increased arteriolar vasospasm), which may lead to pressure overload and induce important changes in LV function **[4]**. LV diastolic dysfunction is, therefore, assumed to occur before systolic dysfunction **[5]**.

Aim of the work: We sought to investigate the impact of preeclampsia on diastolic function.

Patients and Methods

Patient selection and methodology: This is a cross-sectional prospective study. Sixty healthy women with single fetus- pregnancies ≥27 weeks gestation (estimated by LMP and establishedby ultrasound in the first trimester) who were normotensive or preeclamptic were recruited, with their consent, from the outpatient Obstetrics clinic of Misr University Hospital in the period from 1-4-2015 to 31-12-2015.

Exclusion criteria included: Smokers, women with history of chronic illness (as hypertension, diabetes mellitus, heart failure, renal disease and SLE) or receiving medications(as antihypertensive drugs, digoxin and cortisone), women with undetermined gestational age, Rh incompatibility, premature rupture of membrane & polyhydramnios and whose fetuses have known chromosomal abnormalities or genetic syndromes.

According to the diagnosis criteria of mild preeclampsia (which included elevated blood pressure (140/90-160/11 0mmHg with 2 readings was at least 6hrs apart, proteinuria trace 0 to +1, with or without lower limb edema).

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Patients were allocated into 2 groups: Group 1: Preeclamptic group (n=30) and Group 2: Normotensive control group (n=30).

Full history was obtained including age, menstrual and past history. Thorough clinical examination was performed recording height, weight, BMI, HR and ABP. Mean arterial pressure was calculated abdominal examination was conducted.

Fetal assessment by trans-abdominal and pelvic ultrasound were conducted to confirm fetal life, number of fetuses, gestational age, amniotic fluid index and to localize the placenta.

Maternal assessment was performed by a single examiner using a 3.5MHz transducer (Accuson, Siemens Healthcare GmbH, Germany).

The subjects were studied in left lateral decubitus position and conventional 2D echocardiography and tissue doppler echocardiography were done to assess the following:

- Systolic function was assessed by: Myocardial Performance Index (Tei index), stroke volume (product of LVOT area and VTI of the pulsed doppler subaortic waveform recorded in the five-chamber-view). Cardiac output is the product of HR and S V.
- Diastolic function was assessed by: 1- Doppler trans-mitral flow to measure the peak velocity of early (E), late (A) atrial filling and E/A ratio. 2-Tissue Doppler image recordings at the lateral mitral annulusto measure the peak velocity of early (Em), late (Am) diastolic filling, peak systolic velocity (Sm) and (E/Em) ratio.

Six months post delivery follow-up was done by conventional and tissue doppler echocardiography to assess LV diastolic function by calculating the E/A ratio and E/ Em ratio.

Statistical analysis:

Independent student's *t*-test and Mann-Whitney's U-test were used. Pearson's correlation coefficient was calculated to estimate association between numerical variables.

Results

Baseline demographics:

The mean age was 26.93±5.35 years (range: 18-42 years), and the mean gestational age was 33.64±3.74 weeks (range: 27-39 weeks). There was a non-significant difference between both groups regarding age and gestational age (Table 1).

Baseline haemodynamic parameters:

In preeclamptic women: The mean systolic blood pressure was 145.3±11.8mmHg (range: 140-160mmHg, mean diastolic blood pressure was 95.5±6.4mmHg (range: 90-105mmHg) and mean arterial blood pressure was 107.75±18.08mmHg (range: 93.33-166.67mmHg) (Table 2).

Table (1): Difference between study and control groups concerning baseline characteristics.

	Group I (Preeclamptic) [n=30]	Group II (Normotensive) [n=30]	*p*	Sig.
	Range Mean ± SD	Range Mean ± SD		
Age (Years)	21-42 (28.4±4.76)	18-37 (25.45±5.61)	>0.05*	NS
Gestational age (Weeks)	28-37 (33.4±3.8)	27-39 (33.85±3.76)	>0.05*	NS

Table (2): Blood pressure among preeclamptic and normotensive groups.

	Group I (Preeclamptic) [n=30]		Group II (Normotensive) [n=30]		*p*	Sig.
	Range	Mean ± SD	Range	Mean ± SD		
- Systolic Blood Pressure (mmHg)	140-160	145.3±11.8	90-130	109.3±10.5	<0.05	S
- Diastolic Blood Pressure (mmHg)	90-105	95.5±6.4	60-80	71.8±7.1	<0.05	S
- Mean Arterial Blood Pressure (mmHg)	93.33-166.67	107.75±18.08	70-95	82.25±7.04	<0.05	S

In normotensive women: The mean systolic blood pressure was 109.3±10.5mmHg (range: 90-130mmHg), the mean diastolic blood pressure was 71.8±7.1mmHg (range: 60-80mmHg) and the mean arterial blood pressure was 82.25±7.04mmHg (range: 70-95mmHg) (Table 2).

Baseline systolic function parameters: There were no statistically significant differences between both groups in all parameters of systolic function (Ejection fraction, mitral C-to-O time, LVE time and Tei index) (p>0.05), stroke volume or cardiac output (p>0.05) (Table 3).

Table (3): Difference between study and control groups concerning systolic function parameters.

	Group I (Preeclamptic) [n=30]		Group II (Normotensive) [n=30]		p	Sig.
	Range	Mean ± SD	Range	Mean ± SD		
Mitral C-to-O Time* (sec)	0.28-0.42	0.32±0.04	0.22-0.42	0.31±0.03	>0.05	NS
LVE Time (sec)**	0.21-0.33	0.26±0.03	0.17-0.34	0.25±0.04	>0.05	NS
Tei Index	0.03-0.71	0.25±0.2	0.04-0.55	0.26±0.15	>0.05	NS
Ejection Fraction (%)	0.57-0.75	0.64±0.05	0.53-0.76	0.64-0.07	>0.05	NS
LVOT# Diameter (cm)	1.65-3.25	2.04±0.37	1.68-2.24	1.93±0.14	>0.05	NS
LVOT Area (cm^2)	2.14-8.3	3.36±1.4	2.22-3.94	2.93±0.44	>0.05	NS
TVI^ of LVOT (cm/sec)	8.14-27.64	18.18±4.71	10.39-34.2	19.02±5.73	>0.05	NS
Stroke Volume (SV) (ml/sec)	32.49-98.91	57.83±17.97	27.33-95.64	56.15±19.84	>0.05	NS
Heart Rate (bpm)	78-104	89.05±8.05	78-105	90.4±9.3	>0.05	NS
Cardiac Output (ml/min)	2956.91-8205.05	5214.61±1548.8	2787.45-7460.18	4949.09±1403.59	>0.05	NS

*Mitral C-to-O Time: Mitral Closure to Opening time. #LVOT :Left Ventricular Outflow Tract.
**LVE time : Left ventricular Ejection Time. ^TVI : Tissue Velocity Integral.

Baseline Diastolic function Doppler parameters:

There were no significant differences between both groups concerning Doppler parameters of diastolic function (E, A and E/A ratio). The mean E/A ratio was 1.25±0.2 and 1.45±0.49 in preeclamptic and normotensive women, respectively was statistically insignificant (p>0.05) (Table 4) and (Fig. 1).

Table (4): Difference between study and control groups concerning diastolic function parameters.

	Group I (Preeclamptic) [n=30]		Group II (Normotensive) [n=30]		p	Sig.
	Range	Mean ± SD	Range	Mean ± SD		
E (m/sec)	20-98	80.3±16.79	53-112	81.1±18.03	>0.05	NS
A (m/sec)	24-100	56.05±16.85	30-104	59.35±17.5	>0.05	NS
E/A Ratio	0.83-1.62	1.19±0.2	1.02-3.14	1.48±0.49	<0.05	S

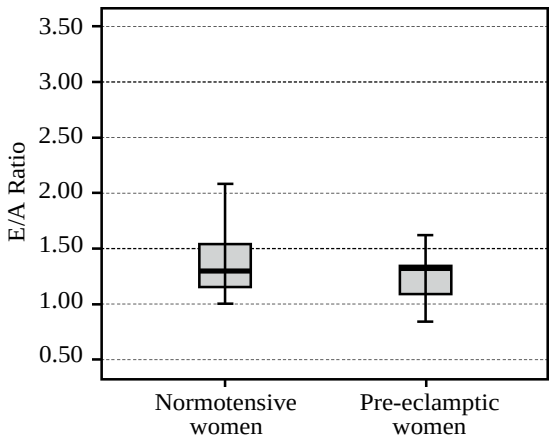

Fig. (1): Box-plot chart showing difference between study and control groups concerning diastolic function parameters.

Baseline diastolic function tissue doppler parameters:

There were no significant differences between both groups in tissue Doppler image recordings as Sm, Em or Am. However, there was significant difference between both groups as regards E/Em ratio (5.58±2.60 in preeclamptic and 4.31±1.04 in normotensive women) (p<0.05) (Fig. 2).

Six month post-partum follow-up of Diastolic function:

There were no significant differences between both groups concerning Doppler parameters of diastolic function (E/A ratio 1.19±0.3 vs. 1.39±0.51 respectively, p>0.05), nor in tissue Doppler image recordings (E/Em ratio 4.87±1.94 vs. 4.58±1.46

respectively, $p>0.05$). Both groups were normotensive.

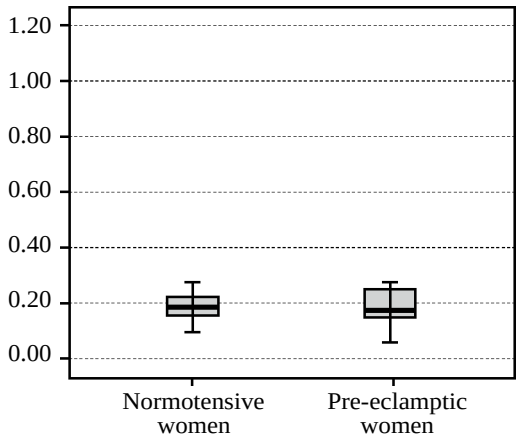

Fig. (2): Box-plot chart showing difference between study and control groups concerning E/Em Ratio.

Table (5): Six Months post-partum Follow-up.

	Group 1	Group 2	*p*-value
E/A	1.19±0.3	1.39±0.51	$p>0.05$ (NS)
E/Em	4.87±1.94	4.58±1.46	$p>0.05$ (NS)

Discussion

We sought to assess the effect of preeclampsia on the diastolic function among third-trimester-pregnant women and a comparable group in parity, maternal and gestational age. We found that there were no significant differences between normotensive and mild preeclamptic women regarding systolic function but there was a statistically significant difference between them regarding E/A and E/Em ratio.

There was no significant statistically difference between both groups concerning the systolic function by trans-thoracic echocardiography as measured by ejection fraction and Tei index, likely due to the mild degree of preeclampsia among the study cohort.

There was no statistically significant difference in stroke volume or cardiac output in mild preeclamptic and normotensive women in this study, unlike severe preeclampsia which causes decreased intravascular volume, increased arteriolar vasospasm and reduced stroke volume **[6,7]**.

Regarding diastolic functions, preeclamptic women had a statistically significantly lower E/A ratio, by conventional Doppler, compared to normotensive pregnant women and significant difference between both groups as regards E/Em ratio.

The changes in diastolic parameters of LV diastolic functions were found to be reversible at 6-month post-partum, with no statistically significant difference between both groups by conventional Doppler E/A ratio or tissue Doppler E/Em ratio. This result was different from Soma-Pillay et al., who found persistent diastolic dysfunction one year post-partum in a cohort who had early-onset preeclampsia requiring termination of pregnancy prior to 34 weeks, denoting severe preeclampsia which is out of the scope of the present study.

This study supports the hypothesis that changes in left ventricular diastolic functions may occur early in mild preeclampsia before hemodynamic disturbances (as changes in SV and SVR) which may occur late in severe preeclampsia **[8,9]**. Echocardiographic screening for diastolic dysfunction may be helpful in predicting high-risk pregnancies **[11]**.

Conclusion:

This study revealed a significant impairment in the diastolic function of preeclamptic ≥27 weeks pregnant women compared to normotensive ones. However, it showed no significant difference as regards the systolic functions. This may suggest the significance of E/Em ratio to assess maternal cardiac functions and their prognosis in patients with mild preeclampsia.

Recommendation: We recommend bigger prospective studies to test sensitivity and specificity of diastolic dysfunction as a predictor of preeclampsia.

Conflicts of interest: The Authors had No Conflict of Interest.

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تقييم الوظائف الانبساطية لقلب الأمهات الحوامل اللائى يعانين من مقدمات الارتعاج البسيط

إن الإصابة بمقدمات الإرتعاج يعتبر خلل فى عدة أجهزة فى الجسم وتعرف بوجود ارتفاع فى ضغط الدم ووجود بروتين فى البول بعد ٢٠ أسبوع من الحمل. ويؤثر هذا على من ٥٪–٨٪ من الحوامل وهذه المقد مات بالإرتعاج يمكن أن تسبب الوفاة للأم أو الجنين وكذلك حديثى الولادة.

إن تقييم الوظائف الانبساطية للبطين الايسر لقلب الأمهات الحوامل اللائى يعانين من مقدمات الارتعاج البسيط تساعدنا فى علاج الاصابة بمقدمات الارتعاج بناءا على الفروق فى ديناميكية الدم ووظائف القلب.

إن الهدف من هذه الدراسة هو معرفة الوظائف الانبساطية للبطين الايسر لقلب الأمهات الحوامل اللائى يعانين من مقدمات الارتعاج البسيط.

طرق الدراسة : إن هذه الدراسة اشتملت على ٦٠ سيدة حامل من المترددات على العيادة الخارجية بمستشفى جامعة مصر للعلوم والتكنولوجيا وتم تقسيمهن إلى مجموعتين:

– المجموعة الأولى : اشتملت على ٣٠ سيدة حامل ويكون عمر الحمل أكثر من ٢٧ أسبوع وهن مصابات بمقدمات الإرتعاج من الدرجة البسيطة.

– المجموعة الثانية : اشتملت على ٣٠ سيدة حامل ويكون عمر الحمل أكثر من ٢٧ أسبوع جاءت للعيادة الخارجية لمتابعة الحمل بشرط ضغط الدم طبيعى.

كل المشتركات فى الدراسة تعرضن لقياس نتاج القلب بالدوبلر:

الوظيفة الانبساطية للقلب تم تعيينها بواسطة استخدام الدوبلر لقياس الدم المدفوع خلال الصمام الميترالى فى وضع مفتوح كلياً أثناء الانبساط ليقيس أقصى سرعة. أيضاً باستخدام E/A ويتم حساب النسبة A والمتأخر E لامتلاء الأذين المبكر الدوبلر النسيجى فى القياس تم عن طريق استخدام عينة على الجزء الجانبى من E حلقة الصمام الميترالى وقياس قمة سرعة حركة الامتلاء الانبساطى المبكر بين قمة E/E والمتأخر وقمة سرعة الانقباض بالدوبلر الأنسجة وحساب النسبة والدوبلر الأنسجة من E سرعة حركة الامتلاء الانبساطى المبكر بالدوبلر العادى E الجزء الجانبى لحلقة الصمام الميترالى وكسر طرد البطين Tei الوظيفة الانقباضية للقلب تم تعيينها بواسطة مؤشر E الايسر.

نتائج الدراسة : سجلت النتائج فى جداول وتم تحليلها إحصائياً وقد أوضحت الدراسة ما يلى : هناك إنخفاض فى الوظيفة الإنبساطية للقلب فى السيدات الحوامل المصابة بمقدمات الإرتعاج من خلال قياس النسبة بين أقصى سرعة لامتلاء الأذين المبكر يتم حسابها. فقد إنخفضت هذه النسبة فى السيدات E/A والنسبة A والمتأخر E عنها فى السيدات ٢±١ المصابة بمقدمات الإرتعاج فكان متوسط قياسها هو ١٩، ٤٩±١، الحوامل ذوات الضغط الطبيعى فكان متوسط قياسها هو ٤٨ كذلك قياس النسبة بين قمة سرعة حركة الامتلاء الانبساطى المبكر بالدوبلر العادى والدوبلر الأنسجة. قد أثبتت أن هناك خلل وإنخفاض فى الوظيفة الإنبساطية للقلب فى السيدات الحوامل المصابة بمقد مات الإرتعاج. وهذا الخلل لا يوجد فى السيدات الحوامل ذوات الضغط الطبيعى حيث أن متوسط قياسها فى السيدات ٢ وفى السيدات ذوات الضغط ٦±٥ الحوامل المصابة بمقدمات الإرتعاج هو ٥٨، ٤±٤. الطبيعى هو ٣١.