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Left ventricular dysfunction in preeclamptic patients

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Abstract
Pregnancy is the physiological change which causes dramatic and reversible changes in a women cardiovascular system and hemodynamic variables which require necessary adaptations in order to develop fetus normally. When this adaptation fails, the consequences like preeclampsia and other hypertensive disorder results which affects the fetus growth and delivery. Preeclampsia is one of the most common and potentially life threatening complications of pregnancy. It is a multiorgan syndrome that affects 8% to 10% of pregnancy and its the leading cause for maternal mortality and morbidity and it is the leading cause of preterm delivery. It is a unique condition of placental pathogenesis with acute onset of predominantly cardiovascular changes and dysfunction attributable to generalized vascular endothelial activation and vaso-spasm resulting in hypertension and multi-organ syndrome.
Aim and Objectives of the Study: To study the cardiac function in preeclamptic patients by transthoracic echocardiography and compare these features with normal pregnant patients, belonging to third trimester.
Materials and Methods: This study was conducted in Govt Institute of Obstetrics and Gynecology Hospital Egmore over a period of 1 year. This study has assigned and categorized into two groups.
Results: This study shows that there are significant structural and functional changes in the cardiovascular hemodynamics in patients with preeclampsia. It appears that BP monitoring alone is insufficient to effectively identify the risk of cardiovascular complications in these women. Maternal echocardiography, if introduced into the routine management protocol, could help to identify women who are at high risk of developing complications.
Conclusion: Women with established preeclampsia are characterised by a higher resistance in the entire arterial system. The altered arterial properties persisted after six months and were also elevated three years postpartum in women with previous preeclamptic pregnancy. These changes indicate that preeclampsia induces persistent cardiovascular disturbances.

Keywords: Preeclampsia, left ventricular dysfunction

Introduction
Pregnancy is the physiological change which causes dramatic and reversible changes in a women cardiovascular system and hemodynamic variables which require necessary adaptations in order to develop fetus normally. When this adaptation fails, the consequences like preeclampsia and other hypertensive disorder results which affects the fetus growth and delivery Pregnancy is adapted by increase in blood volume and plasma volume which leads to increase in cardiac output (CO) affected by remodeling of heart similar to that observed in athletes with increase in chamber dimensions and LV wall thickness and mass. Normal pregnancy also results in decrease in systemic vascular resistance and decline in blood pressure.
Preeclampsia is one of the most common and potentially life threatening complications of pregnancy. It is a multiorgan syndrome that affects 8% to 10% of pregnancy and its the leading cause for maternal mortality and morbidity and it is the leading cause of preterm delivery. It is a unique condition of placental pathogenesis with acute onset of predominantly cardiovascular changes and dysfunction attributable to generalized vascular endothelial activation and vaso-spasm resulting in hypertension and multi-organ syndrome.
Various cross sectional studies on pre eclamptic women showed diverse hemodynamic changes that includes reduced CO due to reduced myocardial contractility and in some cases, elevated CO and high vascular resistance in early pregnancy, which is much exaggerted during latent stage of pregnancy.
Various societies provide different criteria for the diagnosis of preeclampsia. Common to all diagnostic criteria is that preeclampsia is a syndrome characterized by new-onset hypertension (140 mm Hg systolic blood pressure [SBP] or 90 mm Hg diastolic blood pressure [DBP]) on two occasions at least 4 hours apart arising after 20 weeks of gestation with proteinuria 300 mg per 24 hour urine collection with >1 organ system involvement and complete resolution within

12 weeks postpartum. Although not distinct entities, it is increasingly becoming apparent that early-onset preeclampsia is especially associated with poor placentation, fetal growth restriction, and worse long-term maternal cardiovascular outcomes than late-onset preeclampsia, whose pathogenesis is more related to predisposing cardiovascular or metabolic risks for endothelial dysfunction. Furthermore, because the pathogenesis of preeclampsia has not been fully elucidated, the search for predictive markers and a preventative strategy remains an unfulfilled goal. Hence, clinical management is mainly symptomatic and directed to prevent maternal morbidity and mortality.

Advancement in technology in the field of medicine like transthoracic echocardiography is the reference standard investigation for cardiovascular system diagnosis, monitoring and research purposes. It is a valid, precise and reproducible measurement device in research studies providing information not only about cardiac output, which the perioperative literature is currently focusing on, but also on other measurements of systolic function, and diastolic, structural and functional information of heart.

Aim and Objectives of the Study

To study the cardiac function in preeclamptic patients by transthoracic echocardiography and compare these features with normal pregnant patients, belonging to third trimester.

Cardiac function in healthy pregnancy

Cardiovascular system changes that occur during pregnancy can be broadly divided into the four categories:

1. The effects of circulating hormones
2. Mechanical pressure due to the enlarging uteroplacental fetal unit
3. Increasing metabolic demands of the uteroplacental fetal unit
4. The presence of the uteroplacental circulation. Manycardiac murmurs, mitral regurgitation and tricuspid regurgitation and small pericardial effusions have been reported in pregnancy and are asymptomatic.

Many Studies have been designed and tried to attempt to answer the two fundamental questions. What are the normal cardiovascular system changes that occur in pregnancy and the other what is their longitudinal relationship to the developing fetus and gestation.

Non-invasive assessments of cardiac output during pregnancy using transthoracic (Doppler) echocardiography have been studied previously. Transthoracic echocardiography is a preferred technique due to its relative ease of use, high quality and range of data. and its safety profile and accuracy (Augoustides, Hosalkar *et al.* 2005; Ferguson, Paech *et al.* 2006) [12, 13] Doppler echocardiography has been found to be an acceptable measurement of cardiac output in pregnancy (Easter ling, Carlson *et al.* 1990) [7].

Increase in normal cardiac output in healthy term pregnant women is approximately 5 l/min to 8 l/min with the peak of cardiac output being achieved at 28 to 30 weeks

Few studies report a decrease in cardiac output from second trimester (Atkins, Watt *et al.* 1981; Chestnut 2004) [15]. There is general statement that cardiac output increases during early pregnancy, however the precise mechanism is controversial. Increase in cardiac output in second trimester compared with first and third trimester, mainly due to an increase in heart rate which increases shortly after conception. This is thought to be mediated by the corpus luteum and is related to increasing levels of estrogens or vasodilatory peptides and factors such as calcitonin-gene-related peptide and nitric oxide. They also observed changes in blood pressure, blood volume and systemic vascular resistance. Some studies also have reported a reduction in both systolic and diastolic function near term. Systolic function, as measured by the septal Doppler indices of the septal s' velocity was significantly reduced to 6.7 cm/s compared with early pregnancy values. From the observations, normal pregnancy at term is associated with a mild impairment of systolic and diastolic function (Mone, Sanders *et al.* 1996) [11].

Despite an increase in cardiac output during pregnancy, blood pressure is not increased. This is due to a reduction in systemic vascular resistance during pregnancy. This reduction is attributable to blood flow through the low resistance region of the uterine inter villous space acting in a similar to shunt. There is also receptor down regulation of the and adrenoceptors, in pregnancy and that prostacyclin release mediates the increase in regional blood flow. There is a debate about the effects of the sympathetic nervous system and the parasympathetic nervous system in pregnancy (Hughes, Levinson *et al.* 2002), however most studies investigating the sympathetic nervous system reports the increase in heart rate.

Methodology

This study was conducted in Govt Institute of Obstetrics and Gynecology Hospital Egmore over a period of 1 year. This study has assigned and categorized into two groups.

Group I

Normotensive pregnant patients - 40 cases, between age group of 18 to 32 years.

Inclusion Criteria

Pregnant women with normal blood pressure.
Pregnant women in gestational age 28 to 40 weeks as calculated by LMP and dating scan.
No previous h/o preeclampsia or essential hypertension
Not on treatment for any medical or surgical illness

Exclusion Criteria

Previous history of hypertension
Recurrent gestational hypertension/PIH
Patients with medical disorders of pregnancy

Group 2

Pregnant preeclamptic patients 40 cases, between age group of 18 to 32 years.

Inclusion Criteria

Pregnant patients with systolic BP >/=140mm Hg and diastolic BP>/=90mm Hg that develops after 20 weeks of gestation confirmed by repeated examination of at least 6 hours apart with proteinuria of trace to 2+ or spot PCR >0.3
Pregnant women in gestational age 28 to 40 weeks as calculated by LMP and dating scan.
No previous H/O essential hypertension
No other medical disorders complicating this pregnancy

Exclusion Criteria

Previous history of hypertension
Recurrent gestational hypertension/PIH
Patients with medical disorders of pregnancy

Results

Table 1:

S. No	Parameters	Normal		Pre eclamptic		P value	
1	Age distribution	24.60	± 3.44	24.92 ± 4.44		0.15	NS
2	Weight distribution	67.52	± 13.53	63.5	± 12.15	0.49	NS
3	Height distribution	152.85 ± 8.22		150.02 ± 8.76		0.46	NS
4	BMI rate	28.93	± 5.5	28.57 ± 6.97		0.07 (S)	
5	Gestational age	39.12	± 1.11	36.5	± 2.16	0.001	(HS)
6	Spot Protein /Creatinine	0.18 ± 0.07		0.52	± 0.09	0.122	NS
	Ratio						
7	Nature of Delivery						
	LSCS	15(37.5%)		23(57.4%)		0.058	NS
	NVD	25(62.5%)		17(42.5%)			
8	Baby birth weight	3.02 ± 0.27		2.72	± 0.34	0.036	(S)
9	Blood pressure difference in						
	the groups						
	Systolic	109.3	±7.90	150.03 ± 4.59		0.001	(HS)
	Diastolic	66.45	± 6.91	92.75 ± 4.52		0.035	(S)
10	Systolic function – IVSs	1.20 ± 0.037		1.02	± 0.017	0.01	(S)
11	Systolic function – IVSd	0.94 ± 0.040		0.88	± 0.009	0.01	(S)
12	Ventricular function-	1.33± 0.036		1.16	± 0.024	0.022	(S)
	LVPWs						
13	Ventricular function -	0.99± 0.022		0.85	± 0.017	0.831	NS
	LVPWd						
14	Percentage of Ejection	73.87	± 1.11	64.95	± 1.12	0.484	NS
	Fraction value						
15	Percentage of Fractional	32.65	± 0.544	64.95	± 0.634	0.396	NS
	Shortening value						
16	E - wave velocity	83.6 ± 2.38		78.67	± 3.06	0.042	(S)
17	A - wave velocity	60.97	± 2.59	72.54	± 3.33	0.007	(S)
18	E wave /A wave Ratio	1.43 ± 0.056		1.15 ± 0.068		0.027	(S)
19	IVRT value	83.55	± 2.27	97.35	± 3.99	0.001 (HS)	
20	AO (Aortic root diameter)	2.903	±	2.925	± 0.0264	0.668	NS
	Value	0.0256					
21	LA (Left Atrium diameter)	3.11 ± 0.030		3.13 ± 0.029		0.749	NS
	Value						

From above we infer that, Age, Weight and Height, spot protein/Creatinine ratio, Nature of delivery Ventricular function LV PWd, Percentage of Ejection, were statistically not significant with respect to Normal and Pre-eclamptic women.

Discussion

The cardiovascular system undergoes significant changes in preeclamptic patients compared to normal healthy women.

In this study we have assessed the role of echocardiography and found it to be a useful technique for evaluation of maternal cardiac function in preeclamptic women. Rizwana *et al*. (2011) [16] found that preeclampsia in women is characterized by high CO and a high vascular resistance state. This study confirms earlier studies 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.

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 through knowledge on maternal cardiac function during normal pregnancy is a prerequisite for identification of cardiac pathology in others. This is highly relevant since heart disease is one of the leading cause of non-obstetric mortality during pregnancy. In this thesis we studied the effects of hemodynamic changes during normal pregnancy on LV function by use of echocardiography and also hemodynamic changes and subclinical LV dysfunction in many preeclamptic patients.

The parameters BMI rate, Gestational Age, Systolic, Diastolic, Systolic Function IVSs, Systolic function-IVSd, Ventricular function LVPWs, E wave velocity, A wave velocity, E wave/A wave Velocity, E wave/A wave Ratio and IVRT value were statistically significant with respect to Normal and Pre eclamptic women.

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 cardiovascular risk priory and 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.

Gilson *et al*. (1997) [4] found no change in EF% and FS%, but the current study shows non-significant increase in circumferential fiber shortening, which is due to increase in myocardial contractility.

In normal pregnancy there was an increase in preload as a result of increased blood volume, causing an increased E velocity and a low A velocity, but that was changed to high E-wave velocity and high A-wave velocity. The high E-wave velocity in preeclamptic women were observed suggests that transmitral pressure gradient during early passive filling is greater and reflects changes in passive myocardial compliance in the hypertrophic ventricle. The higher peak A-wave velocity in preeclamptic women suggests the more crucial role of the atrial systole in filling the hypertrophied ventricle in these patients.

Butters *et al* reported that 67% of babies weighed less than the 10th percentile at birth after the mothers were treated for chronic

hypertension.

In our study also we found the above changes, and also that preeclampsia in an earlier stage may lead to premature delivery and there is a higher rate of low birth weight. One limitation of this study is that it was not possible to follow up subjects in the postpartum period.

This study shows that there are significant structural and functional changes in the cardiovascular hemodynamics in patients with preeclampsia. It appears that BP monitoring alone is insufficient to effectively identify the risk of cardiovascular complications in these women. Maternal echocardiography, if introduced into the routine management protocol, could help to identify women who are at high risk of developing complications.

Conclusion

1. During normal pregnancy, profound alterations in LV function occur. Increases in circulating blood volume are reflected by increased CO and cardiac dimensions. LV contractility is significantly reduced, whereas filling pressures (e/e') are unchanged. These findings suggest that pregnancy represents a larger load on the cardiovascular system than previously assumed. Reference values obtained are relevant in order to identify cardiovascular dysfunction in pregnant women with heart disease.
2. During normal pregnancy there is an increase in cardiac output, and decrease in blood pressure and peripheral arterial resistance whereas central aortic properties are less altered. The increased ventriculoarterial coupling index ($E_aI/E_{LV}I$) during normal pregnancy indicates a decrease in LV function not fully compensated for by vascular adaptation.
3. Blood pressure measured repeatedly by two different noninvasive devices during pregnancy and postpartum showed a statistically significant drop in mid-pregnancy, followed by a progressive increase until term. The lack of the mid-trimester drop in blood pressure might play a predictive role for a subsequent development of early-onset preeclampsia.
4. Women with established preeclampsia are characterised by a higher resistance in the entire arterial system. The altered arterial properties persisted after six months and were also elevated three years postpartum in women with previous preeclamptic pregnancy. These changes indicate that preeclampsia induces persistent cardiovascular disturbances.

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