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Assessment of Cardiac Effect of Preeclampsia. Right Ventricular Function Analysis Using Speckle Tracking Echocardiography

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Abstract. Introduction, Preeclampsia is a hypertensive disorder of pregnancy that has significant implications for cardiac function, particularly on the right ventricle (RV). Research has shown that speckle tracking echocardiography (STE) is a valuable tool in evaluating subtle RV dysfunction that might not be detected by traditional methods. Method: Pregnant ladies with preeclampsia (n= 50) compare to normotensive pregnant women (n= 50) regarded as control. Echocardiography done for them by speckle tracking to evaluate function of right ventricle. Result: There was significant difference in right ventricular function, in right ventricular longitudinal strain from normotensive pregnant women by speckle tracking echo cardio graph (-16.1±2.05 vs -17.3±1.9). Conclusion: Hypertensive disease of pregnancy including preeclampsia affect the myocardial performance, this can be diagnosed by decrease in global longitudinal strain of right ventricle by speckle tracking echocardiography.

Highlights:

1. Preeclampsia affects right ventricular function, detectable via speckle tracking echocardiography.
2. Compared 50 preeclamptic and 50 normotensive pregnant women using echocardiography.
3. Reduced right ventricular longitudinal strain in preeclampsia (-16.1±2.05 vs -17.3±1.9).

Keywords: preeclampsia, speckle tracking echocardiography, right ventricle, global longitudinal strain

Introduction

Preeclampsia is a hypertensive disorder of pregnancy that has significant implications for cardiac function, particularly on the right ventricle (RV). Research has shown that speckle tracking echocardiography (STE) is a valuable tool in evaluating subtle RV dysfunction that might not be detected by traditional methods [1][2].

It is believed that preeclampsia (PE) results from placental hypoxia caused by poor placental perfusion. Maternal hypertension, with or without proteinuria (as it may be

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associated with and at least one end-organ malfunction) are characteristics of PE. PE affects 5% to 7% of pregnant women overall [3].

Maternal mortality rates are at an all-time high across the world and are set to increase in subsequent years. Cardiovascular disease is the leading cause of death during pregnancy and postpartum [4].

Pregnancy's high metabolic demands necessitate certain physiological and anatomical adjustments. Nearly every organ system is impacted by these alterations, including the cardiovascular system [5].

One of the main causes of pregnancy-related morbidity and mortality is hypertensive disorders of pregnancy (HDP). The effects of these diseases are extensive and go much beyond conception and the first few months after giving birth.

Preeclampsia is often near term and often manifests after 20 weeks of pregnancy. It can manifest with or without severe symptoms and is characterized by new-onset hypertension, typically accompanied by proteinuria. From prenatal hypertension to the onset of severe symptoms and, ultimately, the more severe forms of the disease, like eclampsia and HELLP syndrome, this condition covers a wide range of hypertensive diseases in pregnancy [6].

The best imaging method for detecting, categorizing, and monitoring cardiovascular issues during pregnancy is echocardiography. Echocardiography is a frequently used technique for serial monitoring during pregnancy and the postpartum phase in pregnant women with cardiovascular disease [7].

Pregnant women are evaluated using transthoracic echocardiography, which is safe and known to have no adverse effects on the growing fetus. However, because the heart is positioned more horizontally during pregnancy, acoustic windows—which are necessary for imaging quality—may not be optimal [8].

Due to the intricate RV geometry and load dependence of the RV functional parameters, traditional echocardiographic indicators such as RV fractional area change (FAC) and tricuspid annular plane systolic excursion (TAPSE) have limited prognostic power in many individuals. Most of these limitations have been overcome by RV longitudinal strain, which quantifies regional myocardial deformation and is angle-independent, less load-dependent, and highly reproducible [9].

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RV longitudinal strain, which has excellent predictive value and amazing consistency in patients with a variety of CV diseases, forms the basis of RV mechanics evaluation [10].

RV function may be impacted by preeclampsia. To ascertain the clinical significance of the noted strain changes, longer-term monitoring with a bigger sample is required [11]. Significant functional alterations, including greater RV diameter, elevated pulmonary pressure, and reduced RV longitudinal strain, were observed by a few writers. However, other research showed that pregnant women with hypertension problems and normotensive controls did not differ in RV structure and function [12].

Furthermore, the majority of research has been on anatomical and functional changes that take place in the left side of the heart. The right side of the heart's myocardial anatomy and function in PE are not well documented.

In this study, the aim is to evaluate the performance of the myocardium of the right ventricle in preeclamptic women.

Methods

Patients

This case control research comprised 100 women between 2023 and 2024, 50 of them had preeclampsia and the other 50 of them were pregnant with normotensive. Obstetrics and gynecology outpatient clinics referred the patients. The AL-Hussain Teaching Hospital in Karbala Governorate served as the study's site. Each participant gave their verbal consent.

Inclusion Criteria:

Pregnant women with preeclampsia (n=50)

Control women with normal pregnancy (n=50)

All pregnancies were pass the 20 weeks of gestation.

Exclusion criteria:

Diabetes mellitus

Cardiac diseases

Pulmonary diseases

Chronic hypertensions

Before 20 weeks of gestation

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Multiple pregnancies

Method

Full history has been taken from all participant in the study about age, parity, gestational age, history of medical diseases or cardiac diseases, and obstetrical history.

Blood pressure measurements done for the patients by using mercury sphygmomanometer and stethoscope.

Echocardiography: Using GE Vivid E9 equipment, a single examiner conducted all echocardiographic examinations.

Position the patient in the left lateral decubitus position to enhance imaging quality.

Apply the ultrasound gel to the chest for better acoustic coupling.

Using the appropriate probe. Patient is connecting to ECG.

Access the Speckle Tracking Echocardiography (STE) , select the apical four-chamber view where the right ventricle is prominently visualized. Manually or semi-automatically trace the endocardial border of the RV free wall and septum, the system will automatically track myocardial speckles along the RV walls. The system calculates longitudinal strain for the RV free wall and septal segments.

Statistical Analysis:

Data were entered and analyzed using Microsoft 360 and SPSS (Version 26). Descriptive statistics included frequencies and percentages for categorical variables and means with standard deviations for continuous variables. Data normality was assessed with the Shapiro-Wilk test. Statistical analyses included Chi-square tests for assessing association among categorical variables. while, independent t-test was used to assess the presence of difference in the means of continuous variables between cases and controls. A p-value ≤ 0.05 was utilized to determine the degree of significance.

Result and Discussion

History and examination of studied groups:

The study involved 100 participants, 50 of them were pre-eclamptic pregnant women and the rest 50 were control, both of two groups are of same age groups.

Parity.

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pregnant women were categorized based on their parity, as detailed in Table (1). Nulliparous women comprised 14% of the case group and 16% of the control group. Women with 1-3 accounted for 32% of cases and 16% of controls. Finally, women with 4 or more para constituted 11% of cases and 12% of controls with no significant association as P= 0.07.

Table (1): Parity distribution of cases and controls

		Group		Total	P
		Cases(n=50)	Controls(n=50)		
Parity	Nulliparous	7(14%)	16(32%)	23(23%)	0.07
	1-3	32(64%)	22(44%)	54(54%)	
	4+	11(22%)	12(24%)	23(23%)	

Systolic and diastolic blood pressure.:

Individuals in the case group exhibited significantly higher mean systolic (140.9 mmHg vs. 114.2 mmHg) and diastolic (91.9 mmHg vs. 75.2 mmHg) blood pressures compared to the control group (P-value = 0.0001), as shown in table (2)

Table (2): comparison of systolic, and diastolic blood pressure between cases and controls (preeclamptic and normotensive pregnant women)

Measurements	Cases (n=50) Mean±SD	Controls(n=50) Mean±SD	P
Systolic BP	140.9±6.1	114.2±6.1	0.0001
Diastolic BP	91.9±4.7	75.2±5.05	0.0001

RV Strain by speckle tracking echocardiography

Cases in our study showed statistical difference in global longitudinal strain of right ventricle as mean (-16.1±2.05 vs -17.3±1.9) as compare to control normotensive pregnancy (p value= 0.004). As seen in table (3).

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Table (3): Difference of right ventricular longitudinal strain between two groups.

Measurements	Cases (n=50) Mean±SD	Controls(n=50) Mean±SD	P
global longitudinal strain of right ventricle	-16.1±2.05	-17.3±1.9	0.004

Discussion

Pregnant ladies involved in our study were divided into two groups: one was the control normotensive pregnant group, and the other consisted of pregnant women with preeclampsia. As mentioned by Tanner et al. [16], women are diagnosed with preeclampsia after 20 weeks of gestation if they experience proteinuria and a systolic blood pressure (SBP) of 140 mmHg or a diastolic blood pressure (DBP) of 90 mmHg. Another finding by Bülez et al. [5] states that proteinuria and two measurements of increased BP taken at least four hours apart after the 20th week of pregnancy are used to diagnose preeclampsia. Karrar et al. [10] found that preeclampsia, with or without severe symptoms, is characterized by new-onset hypertension, typically accompanied by proteinuria, and is usually diagnosed from 20 weeks of gestation until term. This finding aligns with our selection of cases that showed significant differences from controls in their systolic and diastolic blood pressure.Our study revealed significant differences in right ventricular strain (RVS) between cases and controls. RVS decreased in preeclamptic patients, which agrees with the study by Hassan et al. [8], who stated that in patients with preeclampsia, speckle tracking echocardiography (STE) is effective and applicable for evaluating cardiac function. It reveals substantial changes in RV measures, and its use helps to reduce additional morbidity and mortality in these patients. There was also a decrease in both left ventricular global longitudinal strain (LV-GLS) and right ventricular global longitudinal strain (RV-GLS) in preeclamptic women compared to normotensive pregnancies, as stated by Paudel et al. [12]. The decrease in RV longitudinal strain may be caused by increased pulmonary resistance in preeclampsia, which results from decreased LV compliance and elevated LV diastolic filling pressures. The elevated mean pressure of the pulmonary artery in preeclampsia and gestational hypertension partially supports this [3].Endothelial dysfunction in preeclampsia causes vasoconstriction and increased pulmonary vascular resistance, so the RV must work against increased

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afterload to maintain efficient contraction, affecting the longitudinal fibers of the RV. About 40% of preeclamptic women had LV interstitial edema identified by cardiac magnetic resonance imaging, as reported by Joubert et al. [9]. Similar alterations in the RV may be the cause of the worsening of RV strain in women with preeclampsia and gestational hypertension, according to a plausible theory.

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