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ASSESSMENT OF SUBCLINICAL LEFT VENTRICULAR SYSTOLIC DYSFUNCTION IN GESTATIONAL DIABETES BY USING SPECKLE TRACKING ECHOCARDIOGRAPHY

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ABSTRACT

Background: Gestational diabetes mellitus (GDM), affecting around 15% of pregnancies worldwide, is associated with increased maternal and fetal risks, including subclinical cardiac dysfunction. Traditional echocardiography may not detect early myocardial abnormalities, while speckle tracking echocardiography (STE) offers enhanced sensitivity by evaluating global longitudinal strain (GLS), a marker of early left ventricular (LV) systolic impairment. **Aim:** This study aimed to assess the subclinical impact of GDM on maternal LV systolic function using STE. **Methods:** A prospective, cross-sectional study was conducted at Baghdad Teaching Hospital between September 2023 and May 2024. A total of 105 pregnant women were enrolled: 45 with GDM and 60 healthy controls. Participants underwent clinical and comprehensive echocardiographic evaluation, including STE. Data were analyzed using descriptive and inferential statistical methods. Ethical approval was obtained, and informed consent was secured from all participants. **Results:** Women with GDM exhibited significant alterations in cardiac structure and function compared to controls. The GDM group showed increased interventricular septal thickness (9.52 mm vs. 8.14 mm, $p = 0.0001$), left ventricular posterior wall thickness (9.64 mm vs. 8.43 mm, $p = 0.0001$), higher relative wall thickness (0.44 vs. 0.37, $p = 0.0001$), elevated left ventricular mass index (79.91 g/m² vs. 67.24 g/m², $p = 0.001$), and reduced GLS (-15.68 vs. -18.87, $p = 0.0001$). **Conclusion:** GDM is associated with subclinical LV systolic dysfunction and structural cardiac remodeling detectable by STE. Early cardiac assessment in GDM patients may facilitate timely intervention and improve maternal cardiovascular outcomes.

KEYWORDS: Subclinical, Left, Ventricular, Systolic, Dysfunction, Gestational Diabetes, Speckle, Echocardiography.

INTRODUCTION

Gestational diabetes mellitus poses a significant health risk during pregnancy, affecting roughly 15% of pregnancies globally. While the primary focus of managing gestational diabetes mellitus revolves around controlling maternal and fetal blood sugar levels, emerging evidence suggests potential cardiac implications associated with this condition. One such implication is the development of subclinical left ventricular systolic dysfunction, characterized by impaired myocardial contractility without overt symptoms.[1,2] Unlike traditional echocardiography, speckle tracking echocardiography has emerged as a sensitive tool for detecting subtle myocardial deformation abnormalities.[3] There is an evidence for the effectiveness of two-dimensional speckle-tracking echocardiography in identifying subclinical left ventricular systolic dysfunction in gestational diabetes mellitus.[4] Thus, this study aimed at identifying the subclinical impact of gestational diabetes on maternal ventricular systolic function by speckle tracking echocardiography**.**

METHOD

This prospective, cross-sectional study was conducted at Baghdad Teaching Hospital with the support of the Baghdad College of Medicine. The study period extended from September 1, 2023, to May 31, 2024. Ethical approval was obtained from both the Baghdad Medical College and Baghdad Teaching Hospital. All

participants were informed about the study details, and written informed consent was obtained before enrollment. The study population consisted of 105 pregnant women, including 45 diagnosed with gestational diabetes mellitus (GDM) according to the NICE criteria and 60 healthy pregnant women who served as controls. Participants were aged between 18 and 45 years and had singleton pregnancies. Control subjects were demographically matched to the GDM group. Exclusion criteria included pre-existing diabetes mellitus (type 1 or type 2), cardiovascular disease, hypertension, other systemic illnesses, multiple pregnancies, pregnancies resulting from in vitro fertilization, incomplete echocardiographic data, and refusal to participate. Each participant underwent a detailed medical history review and physical examination, followed by comprehensive transthoracic echocardiography. Conventional echocardiographic parameters included.

1. **LV End-Diastolic Diameter (LVEDd)** and **LV End-Systolic Diameter (LVESd)** using M-mode in parasternal long-axis view.
2. **Interventricular Septum (IVS)** and **Posterior Wall Thickness (PWT)** measured at end-diastole.
3. **LV Mass (LVM)** calculated using the Devereux formula.
4. **Relative Wall Thickness (RWT)** calculated as 2 × (PWT / LVEDd).
5. **LV Ejection Fraction (LVEF)** via biplane Simpson method.
6. **Stroke Volume Index (SVI)** and **LV Mass Index (LVMI)** indexed to body surface area.

Speckle-tracking echocardiography (STE) was performed to assess **Global Longitudinal Strain (GLS)** from apical 4-chamber, 2-chamber, and long-axis views using high-resolution machines. The average GLS was calculated for each subject. Data were analyzed using descriptive statistics. Means and standard deviations were calculated for continuous variables, while frequencies and percentages were used for categorical variables. Group comparisons were made using independent sample t-tests, with a significance level set at $p < 0.05$.

RESULTS

A study was conducted on 105 pregnant women from Baghdad Teaching Hospital to investigate the subclinical impact of gestational diabetes mellitus (GDM) on maternal left ventricular function using speckle tracking echocardiography. The participants were divided into two groups: 45 patients with gestational diabetes (42.9%) and 60 patients without gestational diabetes (57.1%), serving as the control group. **Table 1** compares demographic and clinical characteristics between pregnant women with and without gestational diabetes, along with the corresponding p-values indicating statistical significance. There was no significant difference in age between women with gestational diabetes (mean 31.36 years, SD 4.9) and those without gestational diabetes (mean 28.34 years, SD 6.8; p = 0.067). Additionally, women with gestational diabetes had higher mean weight (85.36 kg, SD 12.98) and BMI (33.57 kg/m^2, SD 5.56) compared to those without gestational diabetes (weight: mean 76.86 kg, SD 11.55; BMI: mean 29.81 kg/m^2, SD 3.96). Height did not show a significant difference between the two groups (p = 0.529).

Table 1: The association of the demographic and clinical characteristics between pregnant women with the gestational diabetes.

Variables	Gestational Diabetic pregnancy		Non-Gestational Diabetic Pregnancy		P value
	Mean	Standard deviation	Mean	Standard deviation	
Age (years)	31.36	4.9	28.34	6.8	0.067
Gestational Weeks	34.5	2.7	36.5	1.7	**0.002**
Weight (Kg)	85.36	12.98	76.86	11.55	**0.01**
Height (m)	1.59	0.054	1.60	0.048	0.529
BMI (Kg/M^2)	33.57 5.56		29.81 3.96		**0.003**

Table 2 compares cardiovascular and metabolic parameters between pregnant women with and without gestational diabetes, along with the corresponding P-values indicating statistical significance. Systolic blood pressure (SBP) was significantly higher in women with gestational diabetes (mean 119.20 mmHg, SD 8.50) compared to those without gestational diabetes (mean 112.86 mmHg, SD 8.68; p = 0.007). However, diastolic blood pressure (DBP) did not show a significant difference between the two groups (p = 0.168). Heart rate (HR) also did not significantly differ between women with gestational diabetes (mean 94.76 bpm, SD 7.61) and those without gestational diabetes (mean 94.17 bpm, SD 7.20; p = 0.762). Fasting blood glucose (FBG) level was significantly higher in women with gestational diabetes (FBG: mean 134.88 mg/dl, SD 30.57; FPG: mean 7.48 mmol/l, SD 1.69) compared to those without gestational diabetes (FBG: mean 84.06 mg/dl, SD 5.96; FPG: mean 4.66 mmol/l, SD 0.33; p = 0.0001 for both).

Table 2: The association of the cardiovascular and metabolic parameters between pregnant women with the gestational diabetes.

Variables	Gestational Diabetic pregnancy		Non-Gestational Diabetic Pregnancy		P value
	Mean	Standard deviation	Mean	Standard deviation	
SBP (mmHg)	119.20	8.50	112.86	8.68	**0.007**
DBP (mmHg)	70.40	7.89	67.57	7.60	0.168
HR (bpm)	94.76	7.61	94.17	7.20	0.762
FBG (mg)	134.88	30.57	84.06	5.96	**0.0001**

Table 3 presents echocardiographic parameters comparing left ventricular structure and function between pregnant women with and without gestational diabetes, along with the corresponding p-values indicating statistical significance. Interventricular septum thickness (IVS) and left ventricular posterior wall thickness (LVPW) were both significantly higher in women with gestational diabetes compared to those without gestational diabetes (IVS: mean 9.52 mm, SD 0.957 vs. mean 8.14 mm, SD 1.192; p = 0.0001) (LVPW: mean 9.64 mm, SD 1.215 vs. mean 8.43 mm, SD 0.957; p = 0.0001). Left ventricular end-diastolic diameter (LVEDd) and end-systolic diameter (LVESd) did not show significant differences between the two groups (LVEDd: p = 0.159) (LVESd: p = 0.297). Relative wall thickness (RWT) was significantly higher in women with gestational diabetes (mean 0.44, SD 0.061) compared to impaired myocardial function. those without gestational diabetes (mean 0.37, SD 0.056; p = 0.0001). Left ventricular mass index (LVMI) was significantly higher in women with gestational diabetes (mean 79.91 g/m^2, SD 15.92) compared to those without gestational diabetes (mean 67.24 g/m^2, SD 10.11; p = 0.001). While the left ventricular ejection fraction (LVEF) was found to be no significantly difference in women with gestational diabetes (mean 63.54%, SD 3.14) compared to those without gestational diabetes (mean 64.65%, SD 3.41; p = 0.199). Stroke volume index (SVI) did not show a significant difference between the two groups (p = 0.584). Left ventricular global longitudinal strain (LV-GLS) was significantly less negative in women with gestational diabetes (mean -14.88, SD 5.45) compared to those without gestational diabetes (mean -18.87, SD 1.95; p = 0.0001), indicating

Table 3: The association of the echocardiographic parameters comparing left ventricular structure and function between pregnant women with the gestational diabetes.

Variables	Gestational Diabetic pregnancy		Non-Gestational Diabetic Pregnancy		P value
	Mean	Standard deviation	Mean	Standard deviation	
IVS (mm)	9.52	0.957	8.14	1.192	**0.0001**
LVPW (mm)	9.64	1.215	8.43	0.957	**0.0001**
LVEDd (mm)	47.52	4.175	45.94	4.249	0.159
LVESd(mm)	32.20	3.524	33.17	3.527	0.297
RWT	0.44	0.061	0.37	0.056	**0.0001**
LVMI (g/m^2)	79.91	15.92	67.24	10.11	**0.001**
LVEF (%)	63.548	3.1490	64.657	3.4123	0.199
SVI (ml/m^2)	36.42	6.90	37.46	7.37	0.584
LV-GLS	-15.68	2.45	-18.87	1.95	**0.0001**

DISCUSSION

This study explored the subclinical cardiac effects of gestational diabetes mellitus (GDM) using conventional echocardiography and speckle-tracking echocardiography (STE). The findings revealed significant structural and functional cardiac alterations in women with GDM compared to healthy pregnant controls. Women with GDM had significantly higher body weight and BMI, aligning with previous studies that link increased maternal weight to a higher risk of GDM. In our cohort, the mean weight and BMI were notably elevated in the GDM group (85.36 kg, BMI 33.57 kg/m²) compared to controls (76.86 kg, BMI 29.81 kg/m²). These findings are consistent with Zhang et al. (2022), who found significantly higher weight in GDM pregnancies across trimesters[5], and Mirabelli et al. (2023), who reported a higher preconception BMI among women with GDM.[6] Elevated fasting blood glucose (FBG) levels in the GDM group further confirmed the metabolic dysregulation inherent to the condition, with a

significant mean FBG difference compared to controls. This is consistent with findings from Xu et al. (2018), who linked elevated FBG with altered glucose metabolism in GDM.[7] Echocardiographically, GDM was associated with marked changes in myocardial structure. Interventricular septal (IVS) and posterior wall thickness (PWT) were significantly higher in the GDM group, indicative of early concentric hypertrophy. These results mirror findings from Li et al. (2022), who highlighted similar myocardial thickening in GDM pregnancies[8], and Hassan et al. (2022), who demonstrated increased IVS in GDM cases.[9] However, despite increased wall thickness, LV end-diastolic and end-systolic diameters remained statistically similar between groups. This suggests that although myocardial hypertrophy occurs, it does not yet manifest in chamber dilation, a finding supported by Nar et al. (2014).[10] Relative wall thickness (RWT) and left ventricular mass index (LVMI) were also significantly elevated in the GDM group. Increased RWT suggests concentric remodeling, likely driven by chronic hemodynamic stress and insulin resistance, consistent with the findings of Buddeberg et al. (2020).[11] Elevated LVMI reflects increased myocardial mass, a known predictor of adverse cardiovascular outcomes. Zhang et al. (2021) similarly reported significantly increased LVMI in GDM pregnancies.[12] Left ventricular ejection fraction (LVEF), although slightly reduced in the GDM group, remained within normal limits and was not statistically significant. This highlights the limitation of traditional echocardiography in detecting early systolic dysfunction. Appiah et al. (2016) also reported preserved LVEF in GDM patients, despite underlying structural abnormalities.[13] Importantly, global longitudinal strain (GLS), assessed by STE, was significantly reduced in GDM pregnancies, indicating subclinical systolic dysfunction. The mean GLS was −15.68 in the GDM group compared to −18.87 in controls. Less negative GLS values signify impaired myocardial deformation, which may precede overt dysfunction. These findings are in line with Li et al. (2022), who noted that 2D-STE could detect subclinical LV dysfunction not seen with conventional echocardiography.[8] Meera et al. (2017) similarly reported significantly lower GLS in GDM pregnancies, reinforcing the diagnostic utility of STE.[14] Overall, our findings emphasize that GDM is associated with early myocardial remodeling and dysfunction, even in the absence of symptoms. This highlights the value of STE in detecting subtle myocardial changes and suggests the importance of early cardiovascular surveillance in GDM to prevent long-term complications.

CONCLUSION

Pregnant women with gestational diabetes mellitus (GDM) exhibit early signs of subclinical left ventricular systolic dysfunction, primarily indicated by impaired global longitudinal strain (LV-GLS). Structural cardiac changes, including increased interventricular septum (IVS) and posterior wall thickness (LVPW), as well as elevated left ventricular mass index (LVMI), suggest significant cardiac remodeling. These findings underscore the importance of early cardiovascular monitoring in GDM patients. Speckle tracking echocardiography proves valuable in detecting myocardial dysfunction not evident through conventional measures like ejection fraction, enabling timely intervention to reduce long-term cardiovascular risks.

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