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Pregnancy and left ventricular remodeling: Echocardiography parameter.

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Abstract

Background: Profound maternal hemodynamic changes occur in order to satisfy the demands of a growing foetus. Early in pregnancy, peripheral vascular resistance (PVR) lowers, generating a considerable rise in cardiac output. Many parameters are employed for measuring the LV systolic function with different echocardiographic modalities including: M-Mode echocardiography, two-dimensional echocardiography, three-dimensional echocardiography, tissue doppler imaging. Objective: To determine the effects of first pregnancy on the LV systolic and diastolic function using Echocardiography. Subjects and Methods: This is a cross sectional study, conducted at Baghdad medical city in the time period from August 2020 to January 2021. Patients and controls were recruited among individuals attending the Obstetrics and Gynecology department and examined in the department of echocardiography and catheterization of the same hospital. A total of 80 women were enrolled in this study, and they were categorized into two groups: A set of 40 non pregnant women with mean age (24 ±3 year) served as controls. 40 pregnant women with normal singleton pregnancy (30-40 weeks of gestation) with mean age (23±2.6 year) served as study group. Results: the studied groups showed no significant difference in height and age with a significant increase in body weight in the study group over the control. Pregnant female group had mean BMI and BSA significantly higher than control group. Pregnant female group had a significant increase in Left ventricular internal dimensions during diastole(LVIDd) over controls, the Interventricular septal thickness (IVS) was significantly higher in pregnant female than controls. In pregnant women the A wave velocity didn't have a significant difference compared to the control group, while E wave velocity and E/A ratio was significantly lower in pregnant women than controls, LA area was significantly higher in pregnant women over controls. Conclusions: Echocardiography is very useful to determine the effects of first pregnancy on the LV systolic and diastolic function.

Keywords
left ventricular function, pregnancy, and echocardiography.

Profound maternal hemodynamic changes occur in order to meet the demands of a growing fetus. Early in pregnancy, peripheral vascular resistance (PVR) drops, inducing a substantial increase in cardiac output. [1]

During the whole period of pregnancy cardiac output increases to about 30 – 60% above baseline. Most of this increase is at the beginning of the first trimester and continues to rise to reach its peak level at the end of the second trimester, then in the third trimester there is debate weather cardiac output increases, decreases or plateaus [2,3].

Coronary blood flow must increase in order to cope with the rise in cardiac output [4]. The increased capacitance of the maternal circulation that results from the reduction in systemic vascular resistance and the increase in global arterial compliance leads to an increase in the vascular compliance early in pregnancy to the level that threatens the maintenance of blood pressure despite the high cardiac output. [5].

A complete echocardiographic evaluation of the LV includes: assessment of LV dimensions, LV shape, wall thickness, cavity size, LV mass, LV systolic function (global & regional function), LV diastolic function, outflow tract (LVOT) morphology, LV contractile function, and finally inspection of LV for masses or thrombus [6]. Many parameters are used for evaluating the LV systolic function with different echocardiographic modalities including M-Mode echocardiography, two-dimensional echocardiography, three-dimensional echocardiography, tissue doppler imaging. The most commonly used parameter is ejection fraction. Most of the previous studies uses the left ventricular ejection fraction (LVEF) for evaluation of left ventricular systolic function during pregnancy and hence they reported a conflicting results because the LVEF is load dependent parameter and as a result it is not a true measure of myocardial contractility additionally, LVEF only measures the whole ejection performance of the LV, so it is insensitive to subtle changes in the myocardial contractile state. [6,7].

Echocardiography is the most common modality of imaging technique used in pregnancy, with some limitations, including observer variability in interpretation and poor image quality in some women [8]. There is controversy regarding the diastolic function when assessed from the transmitral flow velocities, as this method is known to be dependent on preload and blood pressure, rather than differences in intrinsic left ventricular (LV) compliance [9]. Early diastolic velocity (E) has shown wide variation and has been reported to rise [10], fall [11], or remain unchanged [12].

Aim of the study

To determine the effects of pregnancy on the LV systolic and diastolic function using Echocardiography.

Subjects and Methods

This is a cross sectional study, conducted at Baghdad teaching hospital in the time period from August 2020 to January 2021. Patients and controls were selected from those attending the Obstetrics and Gynecology department and examined in the department of echocardiography and catheterization of the same hospital.

A total of 80 women were enrolled in this study, and they were classified into two groups: A group of 40 non pregnant women with mean age (24 ±3 year) served as controls. 40 pregnant women with normal singleton pregnancy (30-40 weeks of gestation) with mean age (23±2.6 year) served as study group.

The Inclusion criteria for pregnant women in this study were.

" First Singleton uncomplicated pregnancy (Primi),

"Age 20-35 years old,

" During the third trimester (30-40 week),

BP < 140/90 mmHg measured in the left lateral decubitus position,

"Normal fetal parameters and amniotic fluid index (confirmed by

ultrasound in the same hospital).

However, exclusion criteria included.

" All complications of pregnancy (congenital fetal abnormalities, placenta previa, accreta etc), Essential hypertension, Ischemic heart diseases, Diabetes mellitus DM, Valvular heart disease, Anemia, Dyslipidemia, Thyroid dysfunction, Smoking.

" Each subject signed an informed consent to participate in this study.

" Each subject was submitted to a detailed medical and gynecological.

history.

"Blood pressure for all women was measured after 15 minutes of rest in the sitting position for non-pregnant women, while for pregnant women it was measured in the left lateral decubitus position to eliminate the effect of the gravid uterus on the inferior vena cava. For both groups, an adult size mercury sphygmomanometer and stethoscope were used to measure the blood pressure.

Anthropometric measurements

Weight and height measurements were recorded for all patients in hospital using SECCA Device, while they were with light clothes and not wearing shoes. Body mass index (BMI) was calculated according to the formula:

BMI= weight (KG)/ Height (m2) [13].

Body surface area BSA was calculated according to [14] , who suggested that BSA is equal to the square root of product of the weight in kg times the height in cm divided by 3600:

The "normal" BSA is generally taken to be 1.7 m^2.

Echocardiography

Echocardiography was performed for all patients using (Vivid E9; GE Healthcare, Horten, Norway). Equipped with 2.5 MHz S5-1 transducer All patients were examined in the left lateral decubitus position, to bring the heart forward to the chest wall and lateral to the sternum, as recommended by the American society of echocardiography with dimmed light room [15].

Conventional Echocardiography:

Parasternal long axis view PLAX: is obtained by placing the transducer adjacent to the sternum in the left third or fourth intercostal space with the marker indicating to about 10 o'clock. Reference ranges from the American Society of echocardiography's guidelines for chamber quantification. [15]. **Tissue Doppler imaging:** in the apical 4 chambers view, TDI was used to acquire the mitral annular velocities. To calculate Ejection Fraction, the following formula was used:

LVEF= ((LVEDV-LVESV)/LVEDV) *100% [16]

Statistical analysis

In this cross-sectional study, Statistical analysis was performed using the statistical package SPSS for windows (version 23, SPSS Inc., Chicago, IL, USA). Data were shown as mean ± SD. continuous variables were compared using independent sample t tests. A P value < 0.05 was adopted to indicate statistical significance.

Results

The General characteristics of the study groups:

Table (1) shows baseline characteristics of 80 women aged (20 – 35) year; 40 women were nulliparous with mean age (24±3) years served as **controls** and 40 women were pregnant in the **third trimester** (30-38 weeks of gestation) mean age (23±2.6) years,

Table 1: Distribution of baseline characters between groups.

Groups Parameters	Age (years)	Weight (Kg)	Height (meters)	BMI (Kg/m^2)	BSA (m^2)
Control group	24 ±3	65.1±6.61	160.56±4.93	25.2±2.08	1.7±0.15
Study group	23±2.6	80.8±10.38	161.93±6.64	30.7±2.49	1.9±0.15
P- value	0.22 (NS)	**0.001***	0.37(NS)	**0.001***	**0.001***

Data are presented as mean± standard deviation.

*A P value less than or equal to 0.05 was considered as statistically significant NS= non-Significant

As illustrated in table 1 the studied groups showed no significant difference in height and age with a significant increase in body weight in the study group over the control with P value equal to

(0.001). Pregnant female group had mean BMI (30.7±2.49 kg/m2) and BSA (1.9±0.15m2) which was significantly higher than control group who had BMI (25.266±2.08 kg/m2) and BSA (1.70±0.10 m2) with P value of 0.001.

Table 2: Comparison of Heart rate & Blood pressure findings between the pregnant and control group

Groups Parameters	Heart rate Beat\min	SBP (mmHg)	DBP (mmHg)
Control group	75.9 ± 7.23	120.3 ± 9.09	70.0 ± 9.91
Study group	95.9 ±11.24	106.8±18.59	64.1 ± 7.08
P- value	**0.001***	**0.001***	**0.011***

Data are presented as mean± standard deviation.

*A P value less than or equal to 0.05 was considered as statistically significant

SBP = systolic blood pressure, DBP = diastolic blood pressure

The table above shows that there is significant increase in heart rate in the pregnant females with (p value of 0.001), while the systolic blood pressure (SBP) and the diastolic blood pressure (DBP) decreased in pregnant females in comparison to the control non-pregnant females with (p value 0.001 and 0.011) respectively.

The left ventricular dimensions and systolic function assessment with 2D and M mode echocardiography is shown in **table 3** which demonstrated that pregnant female group had a significant increase in Left ventricular internal dimensions during diastole(LVIDd) with mean (46.45±2.66 mm) over controls who had a mean of (41.01±2.40 mm) and (***P value* of 0.002**), the Interventricular septal thickness **(**IVS) was significantly higher in pregnant female than controls with mean (9.011±0.80 mm) and (P-value of **0.001)**. There is no significant difference in the ejection fraction (p value equal to 0.214)

Table 3: Assessment of LV dimensions and systolic function in the studied Groups using 2D& M-mode Echo.

Groups Parameters	LVIDd (mm)	(IVS) (mm)	EF %
Control group	41.01±2.40	7.870±0.69	**65.83 ± 3.68**
Study group	46.45±2.66	9.011±0.80	**64.70 ±3.50**
P- value	**0.002***	**0.001***	**0.214 (NS)**

Data are presented as mean± standard deviation.

*A P value less than or equal to 0.05 was considered as statistically significant

- LVIDd = Left ventricular internal dimension during diastole.
- IVS = Interventricular septal thickness. NS= non-Significant

EF = ejection fraction

Pulsed wave Doppler assessment of the mitral inflow parameters and Left Atrium area(LA) are expressed in **Table 4.** In pregnant women the A wave velocity didn't have a significant difference compared to the control group, while E wave velocity and E/A ratio was significantly lower in pregnant women than controls with (P value of 0.001 and 0.003 respectively), LA area was significantly higher in pregnant women (mean 15.11±2.31 cm²) over controls (14.21±1.65 cm²) with (P value of 0.001).

Table 4: Assessment of diastolic function using mitral inflow parameters.

Groups Parameters	E velocity (cm/sec)	A velocity (cm/sec)	E/A ratio	LA area (cm²)
Control group	86.97±14.89	60.05±15.67	1.49±0.33	14.21±1.65
Study group	82.45±20.98	67.94±18.12	1.25±0.35	15.11±2.31
P- value	**0.001***	0.43	**0.003***	**0.001***

Data are presented as mean± standard deviation.

*A P value less than or equal to 0.05 was considered as statistically significant
NS= non-Significant
E velocity = peak velocity blood flow from left ventricular relaxation in early diastole
A velocity = peak velocity flow in late diastole caused by atrial contraction
LA area = Left Atrium area

The lateral, septal and average é velocities were recorded using Tissue Doppler(TDI) and the results are shown in **table 5.** There was no significant difference in lateral, septal, average é velocity and E/é lateral ratio between pregnant women and controls (***P value >0.05***).

Table 5: Comparison of TDI measurements of mitral annular velocity among groups.

Groups Parameters	é(lateral) velocity (cm/sec)	é(septal) velocity (cm/sec)	É (average) Velocity (cm/sec)	E/é lateral
Control group	16.89±3.53	13.98±2.4	15.45±0.93	6.23±0.77
Study group	16.39±1.66	12.70±2.8	14.63±1.51	6.30±0.85
P- value	0.87 (NS)	0.70(NS)	0.77(NS)	0.91(NS)

Data are presented as mean± standard deviation
NS= non-Significant
é(lateral) velocity= Early diastolic mitral annular velocity measured at the lateral annulus.
é (septal) velocity= Early diastolic mitral annular velocity measured at the interventricular-septal annulus. **É (average) Velocity=** mean value of é (lateral) and é (septal) velocities.

Discussion

Major cardiovascular adaptive mechanisms take place during pregnancy, the
most remarkable changes include increased cardiac output and blood volume expansion associated with a decline in the systemic vascular resistance and blood pressure leading to left ventricular remodeling [6,17]. In the current study, we find significant increase in the body weight of pregnant women along with BMI & BSA, the increased weight gain during pregnancy is considered among the risk factors for maternal and fetal complications, including the risk of future cardiovascular diseases [18] Similar results were found by [19] [20].

Regarding cardiovascular changes in the healthy pregnancy in comparison with control non-pregnant women the heart rate shows significant rise in pregnant women within physiological range this comes in agreement with previous studies : [21] [22] , whereas the systolic & diastolic blood pressure decreases also within physiological range [23] [24] which mention that despite the Sympathetic hyperactivity and increased plasma volume, most normal pregnancies are associated with normal or decreased blood pressure.

LV structure analysis by conventional echocardiography in this study revealed that LVIDd and Interventricular septal thickness had a significant increase during normal pregnancy and body builder [6,25] which goes in agreement with Studying the LV diastolic function in normal pregnancy in the current study Shows that the velocity of the mitral E wave and the E/A ratio decreasedwhereas LA area significantly increased, and this finding considered as anindirect predictor of increased RA filling the cause might be attributed to theincreased preload to the heart associated with the increased total blood volumeand this goes in agreement with Kawamatsu and his colleagues as theyconclude that normal pregnancy is associated with lightly decreased diastolicfunction that might be caused by the geometric changes related to theventricular dilatation and it is not an indication of deterioration in myocardial function. [26]. Moran et al. & Tasar et al. reach to the same conclusion and they mention in their studies that the cause of increase of left atrial volume during pregnancy is the increase in the venous return to the left atrium that ultimately leads to expansion of dimension of the left atrium. [27], [28]. It is noteworthy to mention that Tissue Doppler (TDI) is a load independent measure and might be reliable to be used during pregnancy which is characterized by higher load on the LV, the TDI results in this study shows no significant change in the mitral annular velocities which indicate normal LA pressure in pregnant women and this goes in agreement with Selma and colleagues [29,30]

Regarding the LV systolic function, Numerous studies have been evaluated it during pregnancy but they have reported conflicting results, most of these studies had used global ejection phase indices like fractional shortening (LVEF) for this purpose. Although LVEF has been the most commonly used modality for measuring LV systolic function in clinical practice, it has its own limitations: it is load-dependent and is therefore not reliable for measuring myocardial contractility in pregnancy in addition LVEF only measures the overall ejection performance of the LV so it is not sensitive to subtle changes in myocardial contractile function and is also indifferent to regional or segmental disparities in LV contractility. [30] .

Conclusions

1. Echocardiography is very useful to determine the effects of first pregnancy on the LV systolic and diastolic function. 2. Ejection fraction is a load dependent parameter and proved to be insensitive to changes in the myocardial contractile state during pregnancy.

The authors declared no conflict of interest.

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