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Original Article

Evaluation and Comparison of Electrocardiographic and Echocardiographic Findings in Pregnant Women: A Prospective Study

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Abstract

Background: Physiological changes during pregnancy occur in all organs, including the cardiovascular system. Since these changes may mimic the symptoms associated with diseases, awareness of them is very important to manage the condition. The present study was conducted with the aim of investigating and comparing Trans Thoracic Echocardiography (TTE) and ECG findings in pregnant women <35 and ≥35 years old.

Methods: The present descriptive-cross-sectional study was conducted in a comparative manner on 200 pregnant women referring to Imam Ali Clinic and Hajar Shahrekord Hospital. The data of the study was collected using a researcher-made checklist including demographic information and information related to pregnancy, TTE and ECG findings. SPSS version 24 software was used for data analysis.

Results: TTE and ECG indices have been evaluated in both groups. Based on the results, it was shown that the average indices of QRS axis, LAD, AO, LVDD, PAP, RVDD, IVSD and PW were lower in the <35 group of patients compared to the ≥35 group. The difference in the average indices between the two groups was statistically significant ($p<0.05$). On the other hand, it was shown that the average indices of LVEF, LVSD, and TAPSE in patients of the ≥35 group were significantly lower compared to the <35 group of patients ($p<0.05$).

Conclusion: With the increase in the gestational age of women, the rate of changes in heart parameters increases, which indicates that age as a risk factor can affect the function of the heart.

Keywords: Echocardiography, Electrocardiography, Pregnancy

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Introduction

Pregnancy is a completely unique and distinct period that is accompanied by complex hormonal and physiological changes in women. These changes are aimed at adapting women's bodies to pregnancy and helping the fetus grow (1,2). Changes during pregnancy affect many organs and systems of the body, including body water homeostasis, cardiovascular system, respiratory system, digestive system, urinary system and many others. In many situations, these changes cause the appearance of a series of symptoms that can be seen in some diseases (3). Awareness of these symptoms and changes can be important for doctors in order to use appropriate strategies for managing patients (4).

During pregnancy, there are important changes in cardiovascular function that are necessary for the proper development of pregnancy. In addition, Cardiovascular Disease (CVD) may be exacerbated following the adaptations that occur during pregnancy (5-7). These changes can create important therapeutic challenges in the management of cardiac patients during pregnancy. Mainly, the number of pregnant women who are at risk of cardiovascular complications is increasing, so it is necessary to identify the risk factors that are predictors of cardiac outcomes for optimal screening of pregnant patients (8,9).

Trans Thoracic Echocardiography (TTE) has become one of the most important clinical tools. TTE provides the possibility of immediate diagnosis of pericardial effusion and cardiac tamponade, evaluation of the contractile and volumetric state of the heart, and diagnosis of right ventricular enlargement due to pulmonary embolism (10). TTE creates tomographic images of structures and blood flow. Two-dimensional TTE images provide detailed anatomical data in the form of a single image sheet, but a complete evaluation of the cardiac cavities and valves requires several image sheets (11).

Electrocardiogram (ECG) records the electrical activity of the heart muscle from the surface of the body. ECG provides information about heart rate, rhythm and conduction within the heart. Also, ECG findings can show enlargement of the cavity of the heart, myocardial disease, ischemia, pericardial disease, specific electrolyte imbalance and some drug poisoning (12). In previous studies, it has been shown that the use of TTE and ECG findings can provide valuable information on the heart condition of pregnant women. However, few studies have been presented on the evaluation of these data based on the age of pregnant women (13).

TTE and ECG changes in pregnancy according to age has not been done in ages less than and more than 35 years, the present study was done in order to make this comparison.

Materials and Methods

Study population

Pregnant women in the second and third trimesters of pregnancy who visited Imam Ali Clinic and Hajer Shahrekord Hospital in 2021 for routine pregnancy examinations were included in the study. This study was approved by the ethics committee of Shahrekord University of Medical Sciences (IR.SKUMS.MED.REC.1401.060). Informed consent was obtained from each patient before participation in the study.

Inclusion and exclusion criteria

Inclusion criteria included patients' willingness to participate in the study, complete clinical data, and no prior history of CVD. Any patients who did not meet the inclusion criteria were excluded from the study.

Procedure

After the necessary coordination with the Vice-Chancellor of Research and Technology and obtaining the necessary permits, the present descriptive-cross-sectional study was conducted. In this comparative study, 200 pregnant women in the second and third trimesters who visited Imam Ali Clinic and Hajar Hospital in Shahrekord city for regular check-ups were studied. The study population included two groups of pregnant women namely; under 35 years old and above/equal to 35 years old who were in their second and third trimesters of pregnancy. People were included in the study based on the entry and exit criteria.

For the purpose of detailed analysis, the group of pregnant women under 35 years of age were divided into two groups of 50 in the second and third trimesters, and the equal/over 35 years of age were

also divided in the same way.

Also, the groups were matched in terms of Body Mass Index (BMI) and number of pregnancies. The age of 35 years was selected based on previous studies. Pregnant women older than 35 years are considered to be at higher risk than before, because the incidence of CVD in pregnant women increases leading to maternal and fetal complications. Therefore, in this study, age 35 years was considered as a group division factor for patients (14,15). After obtaining the consent form from the participants in the study, TTE and ECG were performed and the required data were collected and analyzed based on the checklist made by the researcher.

Statistical analysis

After collecting the data, the items that were inconsistent with the inclusion criteria were excluded from the study and the other data were entered into the SPSS version 24. After analysis, data were expressed as mean±SD and n (%). Appropriate parametric tests for quantitative and qualitative variables, including Independent t-test, One-way analysis of variance, Pearson's correlation test, and Chi-square were used for data analysis. Univariate and Multivariate logistic regression models were used to examine the relationship and effect of independent variables on the dependent variable. $p<0.05$ was considered as a significant level.

Results

Description information of patients

Table 1 shows the demographic data of the patients. The average age in the <35 years group was 28.63±4.63 years, while in the other group it was 37.87±3.14 years (p=0.001). In terms of BMI, gravidity, abortion, gestational age and trimester variables, no significant relationship was observed between the two groups (p>0.05). In terms of occupation, the majority of patients in both groups were housekeeper, while employee and self-employment were other cases (p=0.036). In terms of education, in the <35 years group, they mostly had a high school graduate degree, while in the other group, they were mostly undergraduate (p=0.001).

Evaluation of echocardiography and ECG finding in two groups

TTE and ECG indices have been evaluated in both groups. Based on the results, it was shown that the average indices of QRS axis, Left Atrial Dimension (LAD), Ascending Aorta (AO), Left Ventricular

Table1. Description information of patients

Variables		Age(years) <35	Age(years) ≥35	p-value
Age (year)		28.63±4.63	37.87±3.14	0.001
BMI (kg/m^2)		28.03±4.48	27.69±3.38	0.569
Gravid (n)		1.72±0.87	2.01±1.03	0.445
Abortion (n)		0.01±0.10	0.06±0.39	0.196
Gestational age (week)		28.63±6.28	27.27±5.58	0.128
Job n(%)	Housekeeper	70(77.80%)	81(90%)	0.036
	Employee	18(20%)	9(10%)	
	Self-employment	2(2.2%)	0(0%)	
Education n(%)	High school	18(20%)	39(43.3%)	0.001
	Diploma	38(42.2%)	35(38.9%)	
	University	34(37.8%)	16(17.8%)	
Trimester n(%)	Two	43(47.8%)	53(58.9%)	0.089
	Three	47(52.2%)	37(41.1%)	

Table 2. TTE and ECG finding in two groups

Variables	Normal range	Age		p-value
		<35 years	≥35 years	
Heart rate	60-100 Beats/minute	89.87±12.00	88.96±12.61	0.620
QT interval *millisecond (ms)*	<460 *ms*	392.07±20.14	390.13±46.36	0.717
QT dispersion	40-50 *ms*	32.22±12.96	38.06±39.14	0.180
PR interval	120-200 *ms*	134.00±21.08	135.44±22.69	0.659
QRS axis	(-30) and (+90) degree	67.33±18.10	72.66±15.99	0.038
LVEF	50-70	56.61±2.34	54.77±2.23	0.001
LAD	18-39 *mm*	31.78±3.14	32.88±3.12	0.020
AO	26-36 *mm*	25.30±3.36	26.56±3.65	0.017
LVSD	25-39 *mm*	30.91±3.07	31.15±3.96	0.644
LVDD	42-58 *mm*	41.51±3.42	44.83±3.85	0.001
TAPSE	24-35 *mm*	22.07±2.52	20.30±1.57	0.001
PAP	<30 *mmHg*	28.04±3.43	31.62±3.57	0.001
RVD	19-35 *mm*	27.95±3.25	29.81±3.36	0.001
IVSD	6-9 *mm*	7.73±0.88	8.10±0.86	0.005
PW	6-9 *mm*	7.65±0.86	8.17±0.90	0.001

LVEF: Left Ventricular Ejection Fraction, LAD: Left Atrial Dimension, AO: Ascending Aorta, LVSD: Left Ventricular Systolic Dimension, LVDD: Left Ventricular Diastolic Dimension, TAPSE: Tricuspid Annular Plane Systolic Excursion, PAP: Pulmonary Arterial Pressure, IVSD: Interventricular Septal Diastolic Diameter, RVD: Right Ventricular Dimension, PW: Posterior Wall.

Systolic Dimension (LVSD), Left Ventricular Diastolic Dimension (LVDD), Pulmonary Arterial Pressure (PAP), Right Ventricular Dimension (RVD), Interventricular Septal Diastolic Diameter (IVSD) and Posterior Wall (PW) were lower in the <35 years group of patients compared to the ≥35 years group. The difference in the average indices between the two groups was statistically significant ($p<0.05$). On the other hand, it was shown that the average indices of Left Ventricular Ejection Fraction (LVEF), and Tricuspid Annular Plane Systolic Excursion (TAPSE) in patients of the ≥35 group were significantly lower compared to the <35 group of patients ($p<0.05$) (Table 2).

Evaluation of TTE and ECG finding based on the pregnancy trimester in two groups

Based on the results, the average LAD in second trimester patients was significantly lower (0.025) compared to the third trimester. Also, heart rate, QT interval, PR interval, AO, LVSD, LVDD, TAPSE, PAP, RVD, IVSD and PW indices were also lower in second trimester patients compared to third trimester, but there was no significant relationship between them ($p>0.05$). On the other hand, QT dispersion, QRS axis and LVEF indices were lower in third trimester patients compared to second trimester patients, but no statistically significant relationship was observed ($p>0.05$) (Table 3).

Table 3. TTE and ECG finding in based on pregnancy trimester

Variables	Normal range	Trimester		p-value
		Second	Third	
Heart rate	60-100 Beats/minute	89.09±12.01	89.79±12.65	0.703

Contd. table 3.

QT interval	<460 *ms*	388.34±41.39	394.26±27.60	0.268
QT dispersion	40-50 *ms*	36.52±37.88	33.57±13.93	0.500
PR interval	120-200 *ms*	134.27±21.75	135.23±22.08	0.768
QRS axis	(-30) and (+90) degree	71.45±17.34	68.33±17.06	0.226
LVEF	50-70	55.83±2.36	55.52±2.57	0.421
LAD	18-39 *mm*	31.84±3.17	32.90±3.02	0.025
AO	26-36 *mm*	25.83±3.62	26.04±3.50	0.688
LVSD	25-39 *mm*	30.68±3.35	31.42±3.71	0.162
LVDD	42-58 *mm*	43.03 ± 4.03	43.28±3.98	0.723
TAPSE	24-35 *mm*	21.09±2.10	21.29±2.47	0.549
PAP	<30 *mmHg*	30.02±4.03	29.61±3.81	0.495
RVD	19-35 *mm*	28.65±3.29	29.14±3.57	0.344
IVSD	6-9 *mm*	7.73±0.93	8.10±0.83	0.403
PW	6-9 *mm*	7.90±0.96	7.92±0.87	0.782

LVEF: Left Ventricular Ejection Fraction, LAD: Left Atrial Dimension, AO: Ascending Aorta, LVSD: Left Ventricular Systolic Dimension, LVDD: Left Ventricular Diastolic Dimension, TAPSE: Tricuspid Annular Plane Systolic Excursion, PAP: Pulmonary Arterial Pressure, IVSD: Interventricular Septal Diastolic Diameter, RVD: Right Ventricular Dimension, PW: Posterior Wall.

Univariate and multivariate logistic regression analysis

In table 4, logistic analysis of single and multivariable regression has been performed. Based on the results, it was found that none of the TTE and ECG parameters were related to the second and third trimesters of pregnancy in patients (p>0.05) (Table 4).

Table 4. Univariate and multivariate (Heart rate, QT interval, QT dispersion, QRS axis, LVEF, LAD, AO, IVSD, LVSD, LVDD, RVD, TAPSE, PAP, PW, PR interval) logistic regression

Parameters	Univariate logistic regression		Multivariate logistic regression	
	OR(95% CI)	p-value	OR(95% CI)	p-value
Heart rate	0.98(0.98,1.00)	0.66	1.00(0.97,1.02)	0.93
QT interval	1.00(0.99,1.01)	0.27	1.00(0.99,1.02)	0.28
QT dispersion	0.99(0.98,1.01)	0.53	0.99(0.98,1.01)	0.93
QRS axis	0.99(0.97,1.00)	0.14	0.98(0.96,1.00)	0.15
LVEF	0.94(0.96,1.07)	0.39	0.90(0.78,1.05)	0.20
LAD	1.10(1.00,1.21)	0.04	1.08(0.96,1.22)	0.15
AO	1.00(0.92,1.09)	0.84	0.99(0.90,1.09)	0.89
IVSD	1.15(0.82,1.61)	0.39	1.25(0.76,2.05)	0.37
LVSD	1.06(0.97,1.15)	0.16	1.05(0.95,1.16)	0.33

Contd. table 4.

LVDD	1.08(0.93,1.08)	0.84	1.00(0.91,1.10)	0.86
RVD	1.03(0.95,1.13)	0.41	1.02(0.91,1.14)	0.68
TAPSE	1.04(0.91,1.18)	0.51	1.07(0.91,1.26)	0.39
PAP	0.97(0.90,1.04)	0.45	0.93(0.84,1.03)	0.20
PW	1.02(0.74,1.41)	0.86	0.89(0.54,1.47)	0.65
PR interval	1.00(0.99,1.01)	0.63	1.00(0.98,1.01)	0.62
Constant			0.060	0.65

LVEF: Left Ventricular Ejection Fraction, LAD: Left Atrial Dimension, AO: Ascending Aorta, LVSD: Left Ventricular Systolic Dimension, LVDD: Left Ventricular Diastolic Dimension, TAPSE: Tricuspid Annular Plane Systolic Excursion, PAP: Pulmonary Arterial Pressure, IVSD: Interventricular Septal Diastolic Diameter, RVD: Right Ventricular Dimension, PW: Posterior Wall.

Discussion

The results showed that there was significant difference in heart rate, QT interval, QT dispersion, PR interval, and QRS axis variation between the two groups and in the second and third trimesters of pregnancy. However, the QRS period was significantly longer in the ≥35 years group than in the <35 years group. It was also found that heart rate, QT interval, PR interval, and QRS axis indices were within normal ranges in both groups, while QT dispersion was less than normal in both groups.

In line with these results, the study by Aslan *et al* showed that although there was no significant difference in QT interval, QT dispersion, PR interval, and P wave between groups; these values were higher in the advanced pregnancy group. Also, repolarization parameters increase in advanced pregnancies even if they remain within the normal range, which should be investigated to determine whether this is a pathological condition or not. Also, in this study, it was shown that the risk of cardiac arrhythmia increased with the age of pregnant mothers, and it was found that the BMI of pregnant women was also higher as their age increased (16). In another study, Omidi *et al* showed that the average difference of ECG indices (QT interval, QT dispersion, PR interval, P wave and QRS axis) in pregnant women older than and younger than 30 years was not significant. Also, the average QT dispersion was 2% higher in women over 30 years old. These results indicate the effect of age on cardiovascular function, especially during pregnancy (17). Zamani *et al* showed that the QT interval was longer in pregnant women compared to normal women, however, in both groups, the QT interval was within the normal range (18). Also, in the study of Madras *et al*, it was found that the QRS axis was reduced throughout pregnancy (19). In the present study, despite the increase in QRS axis in pregnant women in the ≥35 group, the QRS axis did not change. Also, there was no change in the QRS axis of the second and third trimesters.

The mean of LVEF in the ≥35 years group was significantly lower than the <35 years group (but both of them were in normal range). The mean of LAD and PAP in the ≥35 years group was significantly higher than the <35 years group. The amount of TAPSE was significantly lower in the ≥35 years group than in the <35 years group. The mean LAD index in both groups was within the normal range, while the mean PAP in the <35 years group was within the normal range and in the other group was above the normal range. On the other hand, the mean TAPSE in both groups was below the normal range.

The amount of LAD, AO, RVD, TAPSE and PW in the third trimester patients were higher than in the second trimester patients, while the mean LVEF was lower (p>0.05). The mean LAD, RVD, PW, and LVEF indices in the two groups were within normal limits, while the mean TAPSE in both groups was below normal.

Sonaglioni *et al* showed that, unlike TAPSE, the mean LVEF was higher in the group ≥35 years than in the group <35 years. These results were not consistent with the present study. The lack of alignment can be due to the number of patients studied as well as its

design (20). In the present study, it was found that the average LVEF was higher in the second trimester than the third, while in a similar study, it was found that the average LVEF was higher in the third trimester (21). Also, unlike the present study, which did not observe a significant relationship between two-dimensional echocardiographic parameters and pregnancy trimester, in the study of Cong *et al*, it was found that there is a relationship between them (22).

Conclusion

In general, the results of the present study showed that with the increase in the maternal age of pregnant women, some ECG and echocardiographic findings are changed that should be considered in interpretation of pregnant ECG and echocardiography.

Ethical approval

All the procedures performed in the studies involving human participants were in accordance with the ethical standards of the local ethics committee of Shahrekord university of medical science (IR.SKUMS.MED.REC.1401.060), as well as the 1964 Helsinki declaration.

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Conflict of Interest

There was no conflict of interest in this manuscript.

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