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Assessment of Clinical and Echocardiographic Findings of Pregnant Women with Dyspnea

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Background: In the present study we evaluated clinical and echocardiography findings of pregnant women with dyspnea.

Material/Methods: Pregnant women with and without dyspnea and admitted to the Gynecology and Obstetrics Clinic of a tertiary hospital between December 2017 and June 2018 were enrolled in this case-control study. All patients underwent echocardiography in the third trimester (≥ 27 weeks). Pregnant women who were older than 18 years, who had dyspnea, and who were in the third trimester of their pregnancy (≥ 27 weeks) were included in the study.

Results: Left ventricle end-diastolic diameter (LVEDd) was 47.38 ± 3.68 mm in the study group and 43.70 ± 8.84 mm in the control group ($P=0.041$). On the other hand, left ventricle end-systolic diameter (LVESd) was determined to be 30.86 ± 3.90 mm in the study group and 34.45 ± 6.56 mm in the control group ($P=0.013$). Systolic pulmonary artery pressure (sPAP), calculated through tricuspid insufficiency and analyzed, was found to be 24.69 ± 9.10 mmHg in the study group and 20.39 ± 6.80 mmHg in the control group ($p=0.038$).

Conclusions: When echocardiography findings of pregnant women with dyspnea were analyzed, it was determined that their left ventricle end-diastolic diameter (LVEDd), left ventricle end-systolic diameter (LVESd), and systolic pulmonary artery pressure (sPAP), calculated through tricuspid insufficiency, were higher than those of women in the control group, although they were within normal limit range. Therefore, we recommend that women with dyspnea should see a cardiologist and undergo an echocardiogram test so that the cardiac causes of dyspnea can be clinically revealed.

MeSH Keywords: Echocardiography • Heart Diseases • Pregnancy

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Background

An increase in minute ventilation during pregnancy resulting in dyspnea has often been reported. There are many reasons for dyspnea that develops during pregnancy, including anemia, the burden from the expanding uterus load, increased pulmonary blood volume, and nasal congestion. Nearly 75% of all pregnant women have exertional dyspnea during the first 30 weeks of gestation [1–6]. However, some women have a dyspnea without any underlying factor. Certain changes occur in the cardiovascular system due to the volume load that pregnancy causes. Somani et al. determined that, with advancing trimesters, stroke volume, cardiac output, and ejection fraction all increase, but peripheral vascular resistance decreases during pregnancy [7]. In pregnancy, an increase in cardiac output results in volume increase due to an increase that occurs during secondary venous turn. On the other hand, some authors claim that the renin angiotensin aldosterone (RAS) system, activated by peripheral vasodilatation, leads to volume increase [8].

Cardiovascular diseases (CVDs) affect 6.6 million women in the USA and are major causes of morbidity and mortality in women [9]. Advances in obstetrics and cardiology have led to positive outcomes for the follow-up and treatment of many pregnant women with heart problems. Recently, significant changes have been observed in attitudes towards pregnant women with heart problems. In the beginning of the century, it used to be believed that women with cardiovascular diseases should not become pregnant. However, it is now acknowledged that, due to medical advances, women with cardiac diseases can maintain their pregnancy with close monitoring [10]. However, despite positive developments, physiological changes in pregnancy impose a heavy burden on women with cardiac diseases. Cardiac diseases are still important causes of maternal morbidity and mortality. Therefore, pregnant women with cardiac diseases should be followed by a team, which requires collaboration of a cardiologist and a gynecologist. This collaboration should begin before the patient becomes pregnant so that she can be informed of probable risk factors and optimum pregnancy conditions. Moreover, during delivery and early postpartum periods, an anesthesiologist should be included into the team to determine proper anaesthesia administration and follow-up treatment. In short, for women with cardiac diseases, a close, multi-disciplinary team approach should be adopted in order to have optimum outcomes for both mother and the child. In pregnant women who had no prior cardiac problem, certain complaints, such as dyspnea, chest pain, and tachycardia, should be taken into consideration for a better diagnosis of any cardiac diseases. Since the incidence of rheumatic heart disease is relatively high in our Turkey, diagnosis of cardiac diseases during pregnancy is of utmost importance. Due to innovations in cardiovascular surgery, recovery ratios and life quality of patients with congenital heart diseases have improved greatly. Therefore, women

with major cardiac anomalies can become pregnant if they undergo a proper treatment procedure. Pulmonary hypertension (PH) is a severe progressive disease, characterized by an increased pulmonary vascular resistance that may eventually leads to right heart failure and death. Data received from national and international registry institutions illustrate that PH cases are increasing worldwide. PH is also associated with an increase in pulmonary artery pressure (PAP), due to various cardio-pulmonary diseases. In invasive measurements, if mean pulmonary artery pressure (mPAP) at rest is 14 ± 3 mmHg, it is considered to be normal. However, if $mPAP \geq 25$ mmHg, PH is identified [11]. In this context, this study evaluated cardiac pathologies of pregnant women who were determined to have dyspnea in the third trimester. We performed clinical examinations and echocardiography.

Material and Methods

Pregnant women with and without dyspnea were admitted to the Gynecology and Obstetrics Clinic of a tertiary hospital between December 2017 and June 2018 and were enrolled in this case-control study. A total of 62 pregnant women were included in the study. All patients underwent an echocardiography in the third trimester (≥ 27 weeks). The study sample consisted of pregnant women admitted to the hospital for dyspnea. A group of controls was randomly selected from among pregnant women who visited the hospital for routine pregnancy follow-ups. In both groups, echocardiography was performed for this study only in order to determine if there was cardiac dysfunction in the group with dyspnea.

Pregnant women older than 18 years who had dyspnea and who were in the third trimester of their pregnancy (≥ 27 weeks) were included in the study. However, patients with chronic systemic diseases, diabetes mellitus (DM), previously-diagnosed cardiac diseases, acute or chronic anemia, pulmonary embolism, chronic obstructive respiratory disease, asthma, or interstitial lung diseases were excluded from the study. Pregnant women's demographical features – weight, height, gestational week, hematocrit (HTC), hemoglobin (HB), platelet (PLT), total protein, glucose, aspartate transaminase (AST), alanine transaminase (ALT) levels, urinary protein amount, and preeclampsia or eclampsia – were recorded. We used echocardiography to evaluate left ventricle end-diastolic diameter (LVEDd), left ventricle end-systolic diameter (LVESd), left ventricular ejection fraction (LVEF%), left interventricular septum thickness (IVSd), left ventricle posterior wall thickness (LVPWD), aortic root diameter, right atrium diameter, right ventricle diameter (RVD), left atrium diameter, mitral E wave velocity (m/sn), mitral A wave velocity (m/sn), mitral insufficiency, tricuspid insufficiency, and systolic pulmonary artery pressure (sPAP), calculated through tricuspid insufficiency. Clinical and

Table 1. A comparison of demographical parameters of pregnant women with dyspnea and women in the control group.

	Women with dyspnea mean $\pm$ SD (min–max)		Women in the control group mean $\pm$ SD (min–max)		P
Age (year)	27.97 $\pm$ 6.57	(18.00–41.00)	30.06 $\pm$ 6.47	(19.00–42.00)	0.211
BMI (kg/m ²)	28.59 $\pm$ 2.56	(23.00–37.00)	29.03 $\pm$ 2.40	(23.00–34.00)	0.484
Glucose (mg/dL)	82.49 $\pm$ 16.42	(67.00–107.00)	78.39 $\pm$ 9.60	(67.00–102.00)	0.229
Urea (mg/dl)	13.88 $\pm$ 3.07	(8.00–20.00)	13.55 $\pm$ 4.04	(8.00–26.76)	0.722
Creatine (mg/dl)	0.58 $\pm$ 0.70	(0.49–0.70)	0.56 $\pm$ 0.06	(0.50–0.70)	0.170
Total protein (mg)	7.30 $\pm$ 0.67	(6.00–8.00)	7.60 $\pm$ 0.52	(7.00–8.00)	0.279
ALT (u/L)	12.66 $\pm$ 4.72	(5.00–23.00)	11.00 $\pm$ 4.43	(5.00–23.00)	0.160
AST (u/L)	10.55 $\pm$ 2.44	(7.00–15.00)	9.39 $\pm$ 2.77	(5.00–15.00)	0.088
WBC (10 e3/uL)	10.21 $\pm$ 2.32	(5.00–13.98)	10.79 $\pm$ 2.38	(6.80–13.98)	0.339
HTC (%)	37.34 $\pm$ 4.15	(30.00–48.01)	36.72 $\pm$ 3.82	(31.60–43.54)	0.543
HGB (g/dl)	12.18 $\pm$ 1.04	(10.00–14.78)	12.00 $\pm$ 1.15	(8.62–14.09)	0.508
PLT(K/uL)	231.62 $\pm$ 37.42	(150.00–343.00)	235.20 $\pm$ 64.26	(142.00–351.40)	0.793
Gestational week	34.56 $\pm$ 2.14	(28.50–38.30)	33.45 $\pm$ 2.65	(28.40–38.10)	0.075

In the comparison of mean $\pm$ SD (min–max) values presented in the table, the *t* test was used. For the comparison of % values, descriptive statistics method was used. For categorical variables, the chi-square test (χ^2) was used. * *p*<0.05 was regarded as statistically meaningful.

echocardiography findings of the pregnant women with dyspnea were compared to those of women in the control group.

Statistical analysis

For data analysis, the SPSS 20.0 package program was used. Mean and standard deviation values were calculated for the collected data. For examining normal distribution data, Kolmogorov-Smirnov test was used. For non-normal distribution data, we used the Mann-Whitney U test, which is a non-parametric test. For normally distributed parametric values, The *t* test was used. While comparing % values of the data, descriptive statistics method was employed. For categorical variables, the chi-square test (χ^2) was used. * *p*<0.05 was regarded as statistically meaningful.

Ethical statement

This research was conducted after an ethics committee report was obtained from the Department of Medicine, University of Harran, and written approval forms were collected from participants.

Findings

A total of 62 pregnant women were included in the study. Of these, 29 (46.7%) were in The dyspnea group and 33 (53.2%)

were in the control group. The average age of the pregnant women in the study group was 27.97 $\pm$ 6.57(18-41) and it was 30.06 $\pm$ 6.47 (19–42) in the control group (*P*=0.211). The average body mass index (BMI) was 28.59 $\pm$ 2.56 (23-37) in the study group and 29.03 $\pm$ 2.40 (23-34) in the control 106 group (*P*=0.484) (Table 1). Mean gestational week was 34.56 $\pm$ 2.14 (28-38) weeks in the study group and 33.45 $\pm$ 2.65 (28–38) week in the control group (*P*=0.075). The average hemoglobin level was 12.18 $\pm$ 1.04 (10-14) g/dl in the study group and 12.00 $\pm$ 1.15 (8.62–14.09) g/dl in the control group (*P*=0.508). Other biochemical parameters, such as glucose, ALT, AST, and total protein, were analyzed and found have no statistically significant association between groups (*P*=0.229, *P*=0.160, *P*=0.088, and *P*=0.279, respectively) (Table 2). Echocardiography showed that left ventricle end-diastolic diameter (LVEDd) was 47.38 $\pm$ 3.68 (41-56) mm in the study group and 43.70 $\pm$ 8.84 (24–57) mm in the control group (*P*=0.041). However, whereas left ventricle end-systolic diameter (LVESd) was 30.86 $\pm$ 3.90 (24-40) mm in the study group, it was 34.45 $\pm$ 6.56 (25–49) mm in the control group (*P*=0.013). When left ventricular ejection fraction (LVEF%) was analyzed, it was observed that it was 64.38 $\pm$ 64.36 (60–68) in the study group and 64.36 $\pm$ 2.78 (60–69) in the control group (*p*=0.982). Similarly, when left interventricular septum thickness (IVSd) was examined, it was 9.48 $\pm$ 2.37 (6–18) mm in the study group and 9.39 $\pm$ 1.75 (5–15) mm in the control group (*p*=0.866). Likewise, left ventricle posterior wall

Table 2. A comparison of echocardiography findings of pregnant women with dyspnea and women in the control group.

	Women with dyspnea mean $\pm$ SD (min–max)		Women in the control group mean $\pm$ SD (min–max)		P
LVEDd (mm)	47.38 $\pm$ 3.68	(41.00–56.00)	43.70 $\pm$ 8.84	(24.00–57.00)	0.041*
LVESd (mm)	30.86 $\pm$ 3.90	(24.00–40.00)	34.45 $\pm$ 6.56	(25.00–49.00)	0.013*
LVEF (%)	64.38 $\pm$ 64.36	(60.00–68.00)	64.36 $\pm$ 2.78	(60.00–69.00)	0.982
IVSd (mm)	9.48 $\pm$ 2.37	(6.00–18.00)	9.39 $\pm$ 1.75	(5.00–15.00)	0.866
LVPWd (mm)	7.86 $\pm$ 2.74	(0.80–12.00)	8.79 $\pm$ 1.49	(6.00–15.00)	0.096
Aortic root diameter (mm)	27.29 $\pm$ 2.65	(1.00–35.00)	27.09 $\pm$ 4.16	(20.00–36.00)	0.827
Left atrium diameter (mm)	34.41 $\pm$ 2.80	(30.00–39.00)	35.09 $\pm$ 4.39	(24.00–41.00)	0.479
RVD (mm)	33.48 $\pm$ 4.17	(27.00–44.00)	31.79 $\pm$ 3.88	(27.00–44.00)	0.103
Right atrium diameter (mm)	32.48 $\pm$ 3.86	(23.00–38.00)	31.82 $\pm$ 3.84	(25.00–42.00)	0.500
mitral E wave velocity (m/sn)	0.77 $\pm$ 0.21	(0.50–1.10)	0.77 $\pm$ 0.17	(0.50–1.20)	0.876
mitral A wave velocity (m/sn)	0.63 $\pm$ 0.016	(0.40–1.10)	0.65 $\pm$ 0.18	(0.40–1.10)	0.748
sPAP (mmHg)	24.69 $\pm$ 9.10	(8.00–35.00)	20.39 $\pm$ 6.80	(10.00–30.00)	0.038

LVEDd – left ventricle end-diastolic diameter; LVESd – left ventricle end-systolic diameter; LVEF – left ventricular ejection fraction; IVSd – left interventricular septum thickness; LVPWd – left ventricle posterior wall thickness; RVD – right ventricle diameter; sPAP – systolic pulmonary artery pressure. In the comparison of mean $\pm$ SD (min–max) values presented in the table, the *t* test was used. For the comparison of % values, descriptive statistics method was used. For categorical variables, the chi-square test (χ^2) was used. * $p < 0.05$ was regarded as statistically meaningful.

thickness (LVPWd) was found to be 7.86 $\pm$ 2.74 (0.8–12) mm in the study group while it was 8.79 $\pm$ 1.49 (6–15) mm in the control group ($p = 0.096$). When aortic root diameter was evaluated, it was 27.29 $\pm$ 2.65 (21–35) mm in the study group and 27.09 $\pm$ 4.16 (20–36) mm in the control group ($p = 0.827$). Left atrium diameter was 34.41 $\pm$ 2.80 (30–39) mm in the study group and 35.09 $\pm$ 4.39 (24–41) mm in the control group ($p = 0.429$). Similarly, right ventricle diameter (RVD) was 33.48 $\pm$ 4.17 (27–44) in the study group and 31.79 $\pm$ 3.88 (27–44) in the control group ($p = 0.103$). Right atrium diameter was 32.48 $\pm$ 3.86 (23–38) mm in the study group and 31.82 $\pm$ 3.84 (25–42) in the control group ($p = 0.500$). When mitral E wave velocity (m/sn) was examined, it was 0.77 $\pm$ 0.21 (0.50–1.10) (m/sn) in the study group and 0.77 $\pm$ 0.17 (0.50–1.20) (m/sn) in the control group ($p = 0.876$). Mitral A wave velocity (m/sn) was 0.63 $\pm$ 0.016 (0.40–1.10) (m/sn) in the study group and 0.65 $\pm$ 0.18 (0.40–1.10) (m/sn) in the control group ($p = 0.748$). Lastly, when systolic pulmonary artery pressure (sPAP), calculated through tricuspid insufficiency, was evaluated, it was 24,69 $\pm$ 9,10 (8–35) mmHg in the study group and 20,39 $\pm$ 6,80 (10–30) mmHg in the control group ($p = 0.038$).

Discussion

In pregnancy there is an increase in left ventricular end-diastolic pressure (lvedp) and systolic pulmonary artery pressure when compared to the pre-pregnancy period [12]. It is well known that an increase in pulmonary artery pressure leads to dyspnea. The volume increase in left ventricular end-diastolic pressure, which stems from volume increase, results in pulmonary congestion and dyspnea. There are individual differences in volume increase during pregnancy. Those who have a higher level of volume increase may have a clear increase in left ventricular end-diastolic pressure (lvedp) and systolic pulmonary artery pressure. Similarly, we found that, when compared to those without dyspnea, pregnant women with dyspnea have an increased left ventricular end-diastolic pressure and higher systolic pulmonary artery pressure. This increased left ventricular end-diastolic pressure and systolic pulmonary artery pressure that stem from volume increase can lead to dyspnea during pregnancy. A strength of our study is that anemia, one of the major causes of dyspnea, was compared between groups, showing no difference.

By influencing the cardiovascular system, physiological changes that happen during pregnancy can cause problems such as dyspnea. During pregnancy, blood volume increases range from

30% to 50%. Moreover, some hemodynamic changes may occur, including an increase in cardiac output and pulse rate and decrease in systemic vascular resistance and blood pressure. Therefore, hemoglobin levels of pregnant women with dyspnea should be monitored. In addition, since even mild anemia can cause dyspnea in women during normal pregnancy, patients should undergo a quick and efficient treatment procedure. Regarding hemoglobin levels, our study could not find any statistically meaningful difference between the study and control groups ($P=0.508$).

Similarly, when other biochemical parameters such as glucose, ALT, AST, and total protein amount were analyzed, no statistically significant difference was determined between the groups (P values were $P=0.229$, $P=0.160$, $P=0.088$, and $P=0.279$, respectively). In pregnancy cases, perinatal and maternal mortality and morbidity depend on the type of existent cardiac disease, patient cardiac function, and other pregnancy complications.

Even if they have a heart problem, many women of reproductive age want to become pregnant [13]. However, it was reported that pregnant women with cardiac diseases have an increased risk for negative maternal and fetal outcomes [14]. For example, they might have increased intracranial hemorrhage, respiratory distress syndrome, and other risk factors stemming from gestational age. Moreover, babies born to women with cardiac diseases might have intrauterine growth restriction, prematurity, and extended length of stay in the intensive care unit [15]. Lima et al. reported that pregnant women with cardiac diseases have less placenta and lower fetal weight [16]. Likewise, Powe et al. found that pregnancy causes stress on the cardiovascular system.

In addition, there are some other risk factors that lead to cardiovascular diseases. For instance, preeclampsia affects 8% of all pregnancies and therefore it is regarded as an abnormal placenta. It is thought that since spiral arteries cannot perform remodelling during placenta growth, they lead to hypoperfusion and hypoxia. This in turn triggers a systemic inflammatory response, and results in endothelial dysfunction and vasoconstriction [17]. A study by Wu et al. was suggested that preeclampsia is associated with pathophysiological changes that increase short- and long-term cardiovascular risks [18]. Since heartbeat

volume reaches peak levels at the 28th and 34th gestational weeks, pre- and after-load of the heart increases. In pregnant women with mitral stenosis, this leads to heart failure and maternal mortality. Therefore, in the third trimester, women with dyspnea should be carefully examined for cardiac pathologies.

Many studies have found that pulmonary hypertension causes right ventricle dysfunction along with right atrium and ventricle expansion [19]. However, in the present study we found that right atrium diameter, no statistically significant difference was not significantly different between groups ($p=0.500$). But when left ventricle end-diastolic diameter (LVEDd) and left ventricle end-systolic diameter (LVESd) were examined, a statistically meaningful difference was observed ($P=0.041$, and $P=0.013$, respectively). Similarly, when systolic pulmonary artery pressure (sPAP), calculated through tricuspid insufficiency, was evaluated, a statistically meaningful difference was detected between the groups ($p=0.038$).

Limitations

The present study has some limitations. It was a single-center study, and multi-center studies with higher numbers of participants are needed.

Strength

A strength of this study is that the data analyzed were obtained from a tertiary hospital, which has a strong network and database.

Conclusions

When echocardiography findings of pregnant women with dyspnea were analyzed, we found that their left ventricle end-diastolic diameter (LVEDd), left ventricle end-systolic diameter (LVESd), and systolic pulmonary artery pressure (sPAP), calculated through tricuspid insufficiency, were higher than those of women in the control group, although they were still within normal limits. Therefore, we recommend that women with dyspnea should see a cardiologist and undergo echocardiography to reveal any cardiac-related causes of dyspnea.

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