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Efficacy of late First-Trimester Fetal Cardiac Screening (Four Chamber View and Ventricular Outflow Tracts) for detection of cardiac anomalies in a Low-Risk Pregnant women

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ORIGINAL ARTICLE

Efficacy of Late First-trimester Fetal Cardiac Screening (Four-chamber View and ventricular Outflow Tracts) for Detection of Cardiac Anomalies in Low-risk Pregnant Women

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Abstract

Background: **In Egypt, congenital heart defects (CHDs) are the most prevalent congenital defect and the main reason for newborn mortality.**

Aim and objectives: **To do late first-trimester screening to detect cardiac anomalies in pregnant women (12−14 weeks) (mean 13 weeks).**

Patients and methods: **This prospective research was carried out on 250 pregnant women coming to the Obstetrics and Gynecology Department at Al-Azhar University Hospitals of Assiut. The duration of the study ranged from 6 to 12 months.**

Result: **Meanwhile, highly significant differences were found in the right and left flow tract between 14 and 22 weeks ($P < 0.001$). Among the 250 fetuses involved in the research, there were three patients with CHD (1.2 %), and all of them were minor defects; two cases were detected in the first trimester.**

Conclusion: **The first-trimester heart ultrasound is meant to help doctors sort out the 'normal' pregnancies from the ones that need further examination and the help of a pediatric cardiologist. Assuring expecting mothers that their babies are healthy, conducting short-term to medium-term fofillow-ups in suspicious instances, therapy to families affected by cardiac anomalies, offering the possibility of transobstetrical oocyte preimplantation genetic screening earlier in the pregnancy, and identifying associated chromosomal disorders are all benefits of detecting CHD in the first trimester.**

Keywords: Cardiac anomalies, Fetal cardiac screening, Low-risk patient

1. Introduction

In Egypt, congenital heart defects (CHDs) account for the majority of all congenital malformations and are the primary cause of infant death. Half of all CHDs are considered 'serious,' meaning that they cause significant long-term disability or death if left untreated. In the low-risk group, about five and nine infants per thousand are affected. Although most CHDs are present by the end of the first trimester, an examination of the embryonic heart normally does not occur until weeks 18−22.[1]

Risk factors for CHDs in a fetus consist of the following: a history of CHD in the mother or family, an anomalous basic cardiac evaluation, the occurrence of indirect markers for CHD, abnormalities in chromosomes, extracardiac defects, pregnancy with identical twins, mothers with diabetes mellitus or gestational diabetes, and maternal obesity were all associated with a higher likelihood of CHD (BMI >30), teratogen exposure, and ART.[2]

If only one of the fetus's siblings is impacted, the chance of CHD rises to 2−4%; if more than one sibling is affected, the risk climbs to 10 %. A 12 % chance exists if the mother of the infant has a congenital heart abnormality.[3]

The gold standard for prenatal diagnosis of congenital abnormalities is ultrasound and fetal

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echocardiograms performed in the second and third trimesters, as well as in high-risk groups, have a sensitivity of 60–100 % in finding a major CHD.[4]

Improvements in sonographic imaging have enhanced the quality of pictures to the point that a cardiac examination may be performed during the initial stages of pregnancy. This has led to the nuchal translucency scan and first-trimester fetal heart assessment being used in both high-risk and low-risk groups.[5]

First-trimester screening has enabled the early detection of several congenital abnormalities involving CHD, as the majority of cardiac defects are already present at this stage. The relationship between dense nuchal translucency, altered ductus venosus, and tricuspid regurgitation and CHD has sparked interest in prenatal screening for cardiac abnormalities.[6]

Early CHD detection offers several benefits, involving the ability to reassure high-risk females with normal ultrasound screening results and to provide early treatment in cases of aberrant results. Due to the complexity of performing a comprehensive echocardiogram in the first trimester, a small number of first-trimester fetal heart investigations on low-risk populations have been published.[7]

2. Patients and methods

This prospective research was done on 250 patients coming to the Obstetrics and Gynecology Department at Al-Azhar University Hospitals of Assiut. The sample size was based on a study carried out by Arslan et al. (2017).[8] Fetal structural defects influence ~2–3% of pregnancies using MedCalc, Version 12.3.0.0 (Ostend, Belgium) program software. The statistical computer is based on a confidence interval of 80 % and an estimated power of 95 %. The sample needed for the study was estimated to be about 220 to compensate for dropout and loss of follow up the sample raised to 250.

The inclusion criteria were: all pregnancies of 12–14 weeks and twins' pregnancy of 12–14 weeks with a mean of 13 weeks.

The exclusion criteria were: high-risk pregnancies and high-risk pregnancies for the evaluation of the embryonic heart at tertiary centers.

Pregnancies at increased risk of CHD include those with the following: maternal factors identified at booking (a family history of congenital heart disease, maternal diabetes, and exposure to teratogens in early pregnancy) and fetal high-risk factors (ultrasound detection of an extracardiac fetal anomaly, fetal arrhythmias, especially complete heart block, and increased nuchal translucency during the initial pregnancy using Voluson E6 US, GE HealthCare, USA).

2.1. Methods

All patients were subjected to: women were measured for weight and height to determine their BMI (kg/m^2) after obtaining informed permission (informed written consent) from each patient.

Ethical considerations: Research Ethics Committee permission was sought for the protocol; informed consent was gained from the patients before recruitment. Data were kept anonymous, and participants were allowed to withdraw from the research at any time without repercussions to their care.

2.2. Statistical analysis

SPSS (version 25) for Windows was used for coding, processing, and analyzing the gathered data. Means, SDs, medians, ranges, and percentages are all part of the descriptive statistics that were computed. Independent t tests were conducted to compare means of regularly distributed data for continuous variables, while Mann–Whitney U tests were used to examine median differences of the data that were not normally distributed, and the c^2 test was used for categorical data. Independent groups utilized the t-test and the Wilcoxon test. The significance level is set at a P value of less than 0.05.

3. Results

Table 1.

Table 1. Demographic characteristics in the studied females.

Parameters	Studied women ($N = 250$)
Age (years)	
Mean ± SD	29.32 ± 6.59
Median	28.0
Range	19.0–45.0
Weight (kg)	
Mean ± SD	81.77 ± 8.90
Median	82.0
Range	56.0–102
Height (cm)	
Mean ± SD	161.78 ± 4.99
Median	160.0
Range	146.0–175.0
BMI (kg/m^2)	
Mean ± SD	31.22 ± 4.27
Median	31.63
Range	19.99–39.84

Table 2 shows the demographic characteristics among the studied women. The age of the studied women was extended from 19 to 45 years with a mean ± SD of 29.32 ± 6.59 years and a median of 28 years. The mean weight and height were 81.77 ± 8.90 kg and 161.78 ± 4.99 cm, respectively. The mean BMI was 31.22 ± 4.27 kg/m^2.

The studied women were assessed by echocardiography. The appropriate screening was determined to be when the four chambers, the aortic valve, and the point of origin and crossing of the major arteries were clearly visible. The four-chamber view at 14 weeks revealed that 96.8 % were intact, one case had cardiomegaly, and one case had pericardial effusion. Right and left outflow tract at 14 weeks was unsatisfactory for visualization of the cardiac structures in 242 (96.8 %) out of 250 cases (Table 3).

Following an insufficient echocardiography scan (242 participants), an additional echocardiography examination at 22 weeks was done. The four-chamber view revealed that 98.8 % were intact, one case had cardiomegaly with dilated right atrium, one case had ventricular septal defect, and one case had pericardial effusion. Right and left outflow tract at 22 weeks revealed that 245 (98 %) out of 250 cases were intact, two cases free mobile with one of them not seen, edema around the chest and the lung was noticed in one case while pulmonary dilatation was seen in one case (Table 4).

Table 5 shows that the four-chamber view revealed no statistically significant distinctions during 14–22 weeks ($P > 0.05$). Meanwhile, highly significant differences were found in the right and left flow tract from 14 to 22 weeks ($P < 0.001$; Figs. 1 and 2).

Table 2. Distribution of the studied women regarding echocardiography findings at 14 weeks.

Parameters	Studied women ($N = 250$) [n (%)]
Four-chamber view at 14 weeks	
Cardiomegaly	1 (0.4)
Freely mobile flow tract	1 (0.4)
Intact	242 (96.8)
Not seen	5 (2.0)
Pericardial effusion	1 (0.4)
Right outflow tract at 14 weeks	
Intact	49 (19.6)
Freely mobile flow tract	1 (0.4)
Not seen	200 (80.0)
Left outflow tract at 14 weeks	
Intact	17 (6.8)
Freely mobile flow tract	1 (0.4)
Not seen	232 (92.8)

Table 3. Distribution of the studied women regarding echocardiography findings at 22 weeks.

Parameters	Studied women ($N = 250$) [n (%)]
Four-chamber view at 22 weeks	
Cardiomegaly, dilated right atrium	1 (0.4)
Intact	247 (98.8)
Pericardial effusion	1 (0.4)
Ventricular septal defect	1 (0.4)
Right outflow tract at 22 weeks	
Not seen	1 (0.4)
Edema around the chest and lung	1 (0.4)
Freely mobile flow tract	2 (0.8)
Intact	245 (98.0)
Tricuspid regurgitation	1 (0.4)
Left outflow tract at 22 weeks	
Not seen	1 (0.4)
Edema around the chest and lung	1 (0.4)
Freely mobile flow tract	3 (1.2)
Intact	244 (97.6)
Pulmonary dilatation	1 (0.4)

Among the 250 fetuses involved in the research, there were three participants with CHD (1.2 %), and all of them had minor defects. Two cases were detected in the first trimester (Table 6).

Among the 250 fetuses involved in the research, there were eight (3.2 %) participants with ventricular septal defect, one (0.4 %) with atrial septal defect, one (0.4 %) with Tetralogy of Fallot, one (0.4 %) with aortic stenosis, one (0.4 %) with pulmonary stenosis, and one (0.4 %) with transposition of the great arteries.

4. Discussion

Fetal echocardiography is not a standard aspect of prenatal screening as it is a time-consuming process that requires trained investigators. Therefore, obstetric ultrasonography does not reliably detect heart problems. Only pregnant women who are at high risk should consider having a fetal echocardiogram. All obstetric scans performed in the second and third trimesters must now evaluate the four-chamber view of the heart and cardiac outflow pathways, as recommended by medical societies. Prenatal detection of a heart defect may aid in the proper treatment of the infant after it arrives at the tertiary care facility. The significance of this study will differ depending on the standard of newborn care in the population.[9]

The main results of this study were as follows:

Demographic features of the women examined: the examined women's ages varied from 19 to 45 years, with a mean ± SD of 29.32 ± 6.59 years. The average weight and height were 81.77 ± 8.90 kg and

Table 4. Comparison of echocardiography findings at 14 and 22 weeks.

Parameters	At 14 weeks [*n* (%)]	At 22 weeks [*n* (%)]	*P* value
Four-chamber view			
Cardiomegaly, dilated right atrium	1 (0.4)	1 (0.4)	0.217
Intact	242 (96.8)	247 (98.8)	
Pericardial effusion	1 (0.4)	1 (0.4)	
Freely mobile flow tract	1 (0.4)	0	
Not seen	5 (2.0)	0	
Ventricular septal defect	0	1 (0.4)	
Right outflow tract			
Not seen	200 (80.0)	1 (0.4)	
Edema around the chest and lung	0	1 (0.4)	
Freely mobile flow tract	1 (0.4)	2 (0.8)	<0.001
Intact	49 (19.6)	245 (98.0)	
Tricuspid regurgitation	0	1 (0.4)	
Left outflow tract			
Not seen	232 (92.8)	1 (0.4)	
Edema around the chest and lung	0	1 (0.4)	
Freely mobile flow tract	1 (0.4)	3 (1.2)	<0.001
Intact	17 (6.8)	244 (97.6)	
Pulmonary dilatation	0	1 (0.4)	

P value less than or equal to 0.05 is considered statistically significant, P value less than or equal to 0.01 is considered high statistically significant. Comparison between groups done by Mann–Whitney *U* test.

Table 5. Cases of congenital heart disease.

Cases no.	Age	Parity	Four-chamber view at 22 weeks	Right outflow tracts at 22 weeks	Left outflow tract at 22 weeks	Weight	Height	BMI
18	30	para2	Ventricular septal defect	Edema around the chest and lung	Edema around the chest and lung	69	167	24.74
25	20	primi	Pericardial eff	Intact	Intact	87	170	30.10
42	33	para3	Cardiomegaly, dilated rt atrium	Tricuspid regurgitation	Pulmonary dilatation	76	158	30.44

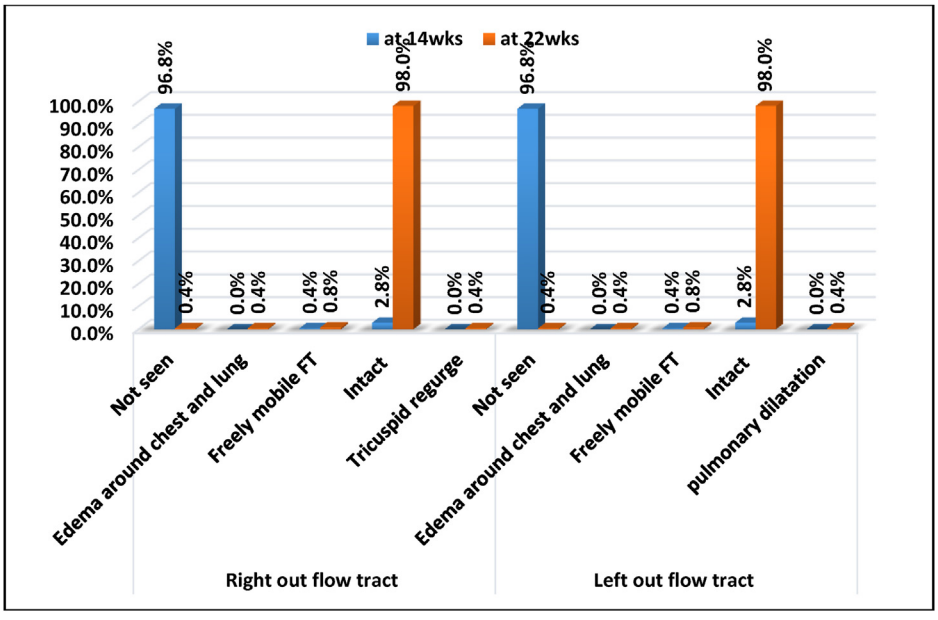

Fig. 1. Comparison of echocardiography findings at 14 and 22 weeks.

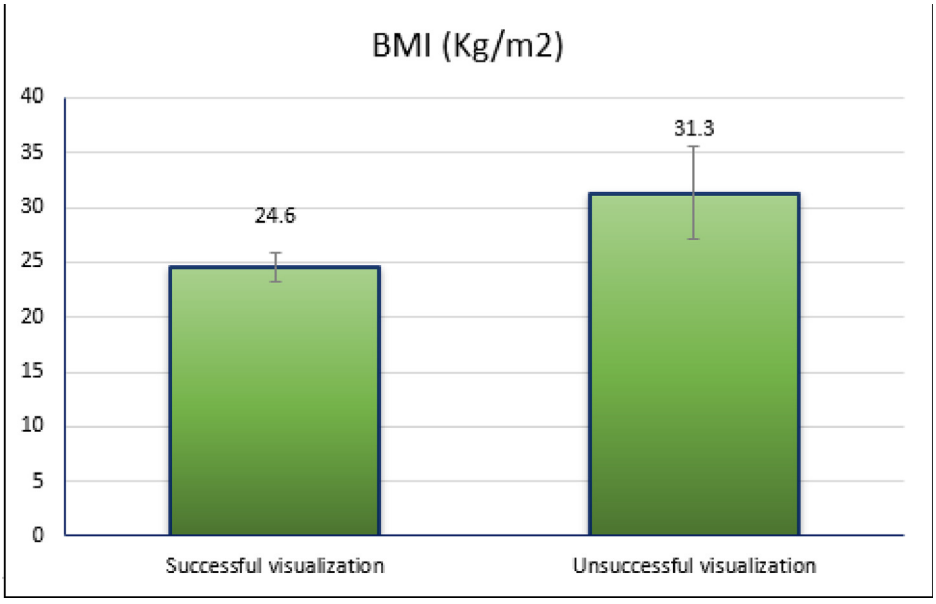

Fig. 2. Relation between BMI and visualization by echocardiography.

161.78 ± 4.99 cm, respectively. The average BMI was 31.22 ± 4.27 kg/m^2.

In the study of Fernández et al.,[10] a total of 663 females were involved. The mean age of the mother was 34 ± 4.78 years and the mean BMI was 24.16 ± 4 kg/m^2.

The present study showed that as regards obstetric characteristics among the studied women. Regarding parity, para 2 was the most frequent (31.2 %) followed by para1 that reported in 25.2 % women then para3 in 24.8 % women. Ten percent of studied women were primi. The mean ± SD gestational age at first examination was 13.95 ± 0.23 weeks with most of them (94.4 %) were at 14th pregnancy week while 5.6 % was at 13th week.

However, Orlandi et al.[11] demonstrated that the gestational age was 12.5 weeks. Gestational age at the examination was 11+ weeks in 645 (16 %) pregnancies, 12+ weeks in 1813 (45 %), and 13+ weeks in 1572 (39 %).

Regardless of the fetal karyotype, recent observations of an enlarged nuchal translucency or an altered ductus venosus blood flow at 10–14 weeks of pregnancy have been linked to a significant risk for CHD. This risk rises exponentially with nuchal translucency 8 thickness. The idea of early fetal echocardiography has to be considered in light of the rising demand for prenatal diagnosis of congenital abnormalities.[12]

Table 6. Distribution of comorbidity.

Parameters	Studied women ($N = 250$) [n (%)]
Ventricular septal defect	8 (3.2)
Atrial septal defect	1 (0.4)
Tetralogy of Fallot	1 (0.4)
Aortic stenosis	1 (0.4)
Pulmonary stenosis	1 (0.4)
Transposition of the great arteries	1 (0.4)

The current study showed that the studied women were assessed by echocardiography. When the four chambers, the aortic valves and the point of origin and crossing of the major arteries could be seen clearly, screening was deemed adequate. The four-chamber view at 14 weeks revealed that 96.8 % were intact, one case had cardiomegaly, and one case had pericardial effusion. Right and left outflow tract at 14 weeks was unsatisfactory for visualization of cardiac structures in 242 (96.8 %) out of 250 cases. The mean ± SD gestational age at second examination was 21.6 ± 0.53 weeks with most of them (62.4 %) were at 22nd pregnancy week, 35.6 % women at 21st pregnancy week, while 5 % was at 20th weeks. The axis ranged from 28 to 64 with a mean of 33.72 ± 5.84.

Following an insufficient echocardiography scan (242 patients), an additional echocardiography examination at 22 weeks was done. The four-chamber view revealed that 98.8 % were intact, one case had cardiomegaly with dilated right atrium, one case had ventricular septal defect, and one case had pericardial effusion. Right and left outflow tract at 22 weeks revealed that 245 (98 %) out of 250 cases were intact, two cases free mobile with one of them not seen, edema around the chest and the lung was noticed in one case, while pulmonary dilatation was seen in one

case. The four-chamber view showed no significant variances among 14–22 weeks ($P > 0.05$). Meanwhile, high significant differences were found in the right and the left flow tract between the period from 14 to 22 weeks ($P < 0.001$). Three (1.2 %) of the 250 neonates who participated in the study were diagnosed with CHD, and all of them were minor defects; two cases were detected in the first trimester.

Also, Iliescu et al.[13] assessed 5472 unselected patients with a prevalence of 0.54 % ($n = 30$) for cardiac defects. The authors reported that 8.7 % of fetuses who had elevated nuchal translucency had significant cardiac anomalies, which is nearly 10 times higher than the prevalence of major CHD among fetuses with normal nuchal translucency, which was 0.98 %.[14] The prevalence of cardiac defects was 9.8 % in pregnancies with higher nuchal translucency (^{3}2.5 mm) in contrast to 0.3 % in fetuses with normal nuchal translucency (<2.5 mm).

In the study of Ye and Cheng,[15] in 171 single pregnancies, including 104 with thickened nuchal translucency, a more detailed fetal echocardiography was performed. The crown–rump length ranged from 65 to 90 mm, with a mean of 76.32 ± 7.27 mm.

Our results showed that the mean BMI in women in whom echocardiographic visualization was successful was 24.60 ± 1.34 kg/m^2, while the mean BMI in women in whom echocardiographic visualization was unsuccessful was 31.30 ± 4.23 kg/m2. Women whose echocardiography examinations were unsatisfactory had a substantially higher BMI than those whose examinations were successful ($P = 0.010$).

Orlandi et al.[11] corroborated our findings, reporting that a high BMI and a relatively early gestational age were the primary variables hindering an effective imaging of heart structures. Those whose TA and TV assessments were both unsatisfactory had a substantially higher BMI than those whose examinations were successful, 30.2 versus 24.5 kg/m^2 ($P < 0.001$). The mean length of the crown to the base of the tail was 65 mm in successful cases and 58 mm in unsuccessful cases.

4.1. Conclusion

The first trimester heart ultrasound is meant to help doctors sort out the 'normal' pregnancies from the ones that need further examination and the help of a pediatric cardiologist. Assuring expecting mothers that their babies are healthy, conducting short-term to medium-term follow-ups in suspicious instances, therapy families affected by cardiac anomalies, offering the possibility of transobstetrical oocyte preimplantation genetic screening earlier in the pregnancy, and identifying associated chromosomal disorders are all benefits of detecting CHD in the first trimester.

Conflicts of interest

Authors declare that there is no conflict of interest and no financial interest to declare in relation to the content of this article.

References

1. Pace ND, Oster ME, Forestieri NE, Enright D, Knight J, Meyer RE. Sociodemographic factors and survival of infants with congenital heart defects. *Pediatrics*. 2018;142:3.
2. Suwansumrit C, Jittham W. Parental risk factors associated with congenital heart disease in a Thai population: multivariable analysis. *Asian Biomed*. 2021;15:267–276.
3. Ison HE, Griffin EL, Parrott A, et al. Genetic counseling for congenital heart disease – practice resource of the National Society of Genetic Counselors. *J Genet Counsel*. 2022;31:9–33.
4. Poojari VG, Reddy A, Vasudeva A. Feasibility and accuracy of fetal echocardiography at routine 11 to 13 weeks 6 days ultrasound performed on unselected obstetric population in a tertiary maternity centre with high patient turnover. *Int J Reprod Contracept Obstetr Gynecol*. 2018;7:159–164.
5. Wang S, Celebi ME, Zhang YD, et al. Advances in data preprocessing for biomedical data fusion: an overview of the methods, challenges, and prospects. *Inf Fusion*. 2021;76:376–421.
6. Helle E, Priest JR. Maternal obesity and diabetes mellitus as risk factors for congenital heart disease in the offspring. *J Am Heart Assoc*. 2020;9:e011541.
7. Wagner R, Tse WH, Gosemann JH, Lacher M, Keijzer R. Prenatal maternal biomarkers for the early diagnosis of congenital malformations: a review. *Pediatr Res*. 2019;86:560–566.
8. Arslan H, Güven Y, Karataş E, Doğanay E. Effect of the simultaneous working length control during root canal preparation on postoperative pain. *J Endod*. 2017;43(9):1422–1427.
9. Şen C, Yayla M. Fetal heart examination. *Fetal Heart*. 2019;31:26.
10. Fernández SG, Ramirez JA, Chouza MT, Alonso BR, Coto ÁP. Early fetal ultrasound screening for major congenital heart defects without Doppler. *Eur J Obstet Gynecol Reprod Biol*. 2019;233:93–97.
11. Orlandi E, Rossi C, Perino A, Musicò G, Orlandi F. Simplified first-trimester fetal cardiac screening (four chamber view and ventricular outflow tracts) in a low-risk population. *Prenat Diagn*. 2014;34:558–563.
12. Bonnet D. Impacts of prenatal diagnosis of congenital heart diseases on outcomes. *Transl Pediatr*. 2021;10:2241.
13. Iliescu D, Tudorache S, Comanescu A, et al. Improved detection rate of structural abnormalities in the first trimester using an extended examination protocol. *Ultrasound Obstet Gynecol*. 2013;42:300–309.
14. Becker R, Wegner RD. Detailed screening for fetal anomalies and cardiac defects at the 11–13-week scan. *Ultrasound Obstet Gynecol*. 2006;27:613–618.
15. Ye B, Cheng W. VP17. 10: the diagnostic efficiency of the more detailed fetal echocardiography in 13 to 14 weeks' gestational age and molecular diagnostic analysis. *Ultrasound Obstet Gynecol*. 2020;56:126–127.