



A Review Study on the Prenatal Diagnosis of Congenital Heart Disease Using Fetal Echocardiography

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ABSTRACT

Congenital heart defect (CHD) is the most common type of congenital malformation in live births with a wide and variable spectrum in each population. The prevalence of this malformation is reported to be 8 cases per 1,000 live births. The CHD is also accompanied by multiple complications, such as prematurity, low birth weight, termination of pregnancy, mortality, and morbidity. The concomitant of this defect with extra-cardiac anomalies result in the enhancement of mortality and morbidity. Due to the importance of CHD and role of genetic and environmental factors on CHD, prenatal diagnosis is an issue of fundamental importance. The prenatal diagnosis increases the survival rate and reduces complications, mortality, and morbidity. Fetal echocardiography as a non-invasive and safe method enables the pediatric cardiologists to diagnose CHD prenatally with high sensitivity and specificity. Regarding this, the present study was conducted with the aim of reviewing the literature on the prenatal diagnosis of CHD using fetal echocardiography. Based on the reviewed studies, the role of fetal echocardiography and its indications were defined. Accordingly, fetal echocardiography was suggested as a profitable method for the prenatal diagnosis of CHDs even in the low-risk pregnancies.

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Introduction

Congenital heart disease (CHD) is the most common type of congenital malformations. This defect is a kind of prenatal cardiovascular disease, which involves the structural abnormalities of the heart or great arteries. The prevalence of these malformations is about 8 cases per 1,000 live births. The prevalence rates of this anomaly in the aborted fetuses, stillbirths, and premature neonates are reported as 10-25%, 3-4%, and 2%, respectively (1-6).

Many studies have shown that CHD is six times more common than chromosomal disorders and four times more prevalent than neural tube defects (7). About 20-30% of the CHDs are so seri-

ous and life-threatening and require surgery in the first year of life (8). In addition, based on the evidence, 27 cases per 1,000 stillbirths are associated with CHD. More than 50% of the pediatric mortalities are caused by congenital diseases related to CHD (9). The most common types of developmental or structural cardiac anomalies are ventricular septal defect (VSD), atrial septal defect, and patent ductus arteriosus, respectively.

Literature review

Associated anomalies

The coincidence of CHD with extra-cardiac abnormalities increases the mortality and mor-

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idity rates. Some examples of associated abnormalities are hydrocephalus, microcephaly, holoprosencephaly, corpus callosum agenesis, spina bifida, anal atresia, diaphragmatic hernia, omphalocele, cleft palate, cleft lip, polydactyly, syndactyly, clubfoot, renal dysplasia, and pulmonary hypoplasia (11).

If CHDs are associated with extra-cardiac anomalies, fetal mortality is more common than the isolated ones. This is the same in preterm and low birth weight neonates (10). Only 10% of the CHDs are associated with obvious risk factors in pregnancy, such as extra-cardiac malformations. Most of the cardiac defects occur in the low-risk neonates without any significant congenital malformations in the pregnancy period (10).

Prenatal diagnosis

The prenatal diagnosis of cardiac abnormalities is of great importance; in this regard, earlier diagnosis results in higher benefits. The prenatal diagnosis or screening increases the survival rate, mitigates complications, and reduces mortality and morbidity (8,12). Prenatal diagnosis not only determines the cardiac abnormalities, but also distinguishes the associated anomalies. It also allows for delivery in a much more careful situation and makes pregnancy termination possible if required (12).

Prenatal diagnosis is performed in two steps. The first step is performed by an obstetrician, and the second step is implemented by a pediatric cardiologist. If there is any evidence of fetal cardiovascular disorders, the obstetrician should refer the pregnant women to a pediatric cardiologist for more examinations. Prenatal screening is possible with ultrasonography, which is performed by an obstetrician (13). A study on routine antenatal diagnostic imaging with ultrasound revealed that ultrasonography is incapable of diagnosis in more than 15,000 low-risk pregnancies.

Due to the complicated anatomy of the heart, several types of CHDs, such as VSD, are impossible to be diagnosed during the prenatal anomaly scan (14,15). Nowadays, fetal echocardiography with high-quality and high-potential anatomy imaging enables the pediatric cardiologist to recognize the CHDs with more specific items at suitable time. It also facilitates the collection of more profitable information regarding the type of cardiac abnormality, and its prognosis and management methods (9).

Fetal echocardiography defines identified factors, which increase the risk of fetal congenital cardiac disorders. It also facilitates pregnancy termination if needed. If the pregnancy continues, it

enables appropriate workup with more coordination. The prenatal diagnosis of CHD based on fetal echocardiography has been used in many countries, mostly the western ones. There are many studies investigating the prevalence and types of CHD. Studies have shown the prenatal diagnosis of complex CHD or in the cases associated with stillbirth or abortion. They have also presented the prenatal CHDs spectrum and represented its differences with postnatal findings (16-21).

Fetal echocardiography indications

There are several factors increasing the possibility of CHD development in a fetus. Fetal echocardiography, like other methods, has its own indications. They can be categorized under three groups of maternal, fetal, and familial indications.

Fetal indications

Fetal indications are more significant. The main reason for the referral of the pregnant women to assess the condition of the fetal heart is the suspicion of structural abnormalities using midwife ultrasonography, which usually leads to diagnosis in 40-50% of the referral cases. Other fetal risk factors are rhythm abnormalities, associated extra-cardiac abnormalities, known or suspected chromosomal abnormalities, increased nuchal translucency, cord or placenta abnormalities, monozygotic twins, hydrops fetalis, and intrauterine growth restriction.

Maternal indications

The second category is maternal indications, involving the following risk factors:

- Metabolic diseases, such as diabetes mellitus, gestational diabetes, and phenylketonuria.
- Connective tissue diseases, such as lupus, Sjogren's syndrome.
- Infectious diseases, such as rubella, Coxsackie, and adenovirus.
- Use of assisted reproductive technology.
- Medication exposure.
- Age of > 35 years.

Familial indications

The familial indications include the structural disorder of the parents' heart, history of cardiovascular disease in previous children, history of CHD in a second- or third-degree family, and parental consanguinity (22).

Discussion

There are different studies reporting the prevalence of CHD. According to the American Heart Association guideline, CHD has a prevalence rate of 6-12 cases per 1,000 live births, while others

have reported this rate as about 15 cases per 1,000 (22, 23). The majority of the diagnosed cardiac abnormalities are generally observed in 16-19 weeks of gestation, which is considered as the best time for referral (24). Most of the pregnant women are referred by an obstetrician due to the observation of ultrasonographic abnormalities (17). Positive family history has been mentioned as the next frequent referral reason. Hydrops fetalis and aneuploidy are considered at the bottom of the referral reason list (21).

Based on the majority of the studies, VSD is the most common type of CHD. However, CHD has a greatly different spectrum due to different factors, such as environment and genetics. Atrio-ventricular septal defects, endocardial cushion defects, single ventricle defects, and hypoplastic left heart syndrome are also indicated as the most common CHDs (8,23,25,26). The identification of the most common type of CHD in each region is a matter of paramount importance because it may lead to better conceptualization regarding its etiology, management, prognosis, and the associated planning and coordination.

Accordingly, the prevalence of the anomalies associated with CHD has been reported to vary in different regions. The different types of anomalies mentioned in various studies include genitourinary, central nervous system disorders, and musculoskeletal disorders (17,22,23). The CHDs associated with extra-cardiac anomalies have been significantly observed in the preterm neonates with low birth weight. Fetal echocardiography is reported to have a notable efficacy in the prenatal screening of CHD conducted with the aim of diagnosing the cardiac anomalies. Studies have shown that screening program using fetal echocardiography improves the prenatal diagnosis of CHD, compared to the data available before screening (8).

A complete agreement were reported between the prenatal and postnatal findings indicating the high sensitivity and specificity of fetal echocardiography (23). There is significant difference in CHD diagnosis between the high- and low-risk pregnancies (26). Nearly 50% of the neonates with CHD do not have a definite risk factor (9). Most of the retrieved studies have suggested fetal echocardiography as a certain part of the prenatal screening performed in the second trimester. Accordingly, they recommended to implement this procedure for all pregnant women regardless of the presence of the risk factors (22-24).

Conclusion

Based on the findings of the reviewed articles, fetal echocardiography is beneficial for the pre-

natal diagnosis of CHD with high sensitivity and specificity, even in the low-risk pregnancies. Given the importance of the issue and the role of genetic and environmental factors, this test can be helpful if used as an integral part of the prenatal screening.

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Conflict of Interest

The authors declare no conflict of interest.

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