

# Clinical Diagnostic Value of Two-Dimensional and Four-Dimensional Echocardiography in Fetal Cardiac Tumor

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**ABSTRACT** Background: This paper aims to investigate the clinical diagnostic value of two-dimensional and four-dimensional echocardiography in fetal cardiac tumor. **Material and Methods:** A total of 24 pregnant women whose fetus had suspected cardiac tumor in The No.4 Hospital 1946 Jinan Shandong from February 2011 to April 2018 were selected as objects of study, including 18 cases whose fetus was pathologically diagnosed with fetal cardiac tumor (+) and 6 cases whose fetus was diagnosed with fetal cardiac tumor (-). **Results:** These patients were retrospectively analyzed. The tumor site, size, activity and fetal edema predicted using two-dimensional and four-dimensional ultrasound images were compared with pathological examination results, and the diagnostic value of the two kinds of echocardiography in fetal cardiac tumor was analyzed. The echocardiographic results revealed that there were no statistically significant differences in the four-dimensional ultrasonic diagnosis and two-dimensional ultrasonic diagnosis results compared with pathological diagnosis results ( $p > 0.05$ ). In terms of the diagnostic value, the sensitivity, specificity and diagnostic accordance rate in the clinical diagnosis of fetal cardiac tumor were 66.67%, 50.00% and 62.5%, respectively, in two-dimensional echocardiography, and 94.44%, 83.33% and 91.67%, respectively, in four-dimensional echocardiography. **Conclusions:** Echocardiography can determine the activity, shape, site, size, etc., of primary cardiac tumor. Two-dimensional and four-dimensional ultrasonic diagnosis can be used to observe the fetal cardiac tumor, thus making an early diagnosis. The sensitivity, specificity and diagnostic accordance rate of four-dimensional echocardiography in the clinical diagnosis of fetal cardiac tumor are significantly higher than those of two-dimensional echocardiography, so four-dimensional echocardiography has higher diagnostic value in fetal cardiac tumor.

**Key words:** two-dimensional ultrasound, four-dimensional ultrasound, echocardiography, fetal cardiac tumor, diagnostic value

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The incidence rate of fetal cardiac tumor (1,2), a very rare congenital cardiac space-occupying lesion, is approximately 0.14% in the world. The disease does not produce extremely special clinical symptoms in pregnant women/puerpera, and it

mainly attacks the fetus and live birth. The incidence rate of cardiac tumor in the live birth is 0.0017-0.028%. Most of primary fetal cardiac tumors are benign diseases, the most common of which is rhabdomyoma (3). The fetal cardiac

tumor can lead to arrhythmia, cardiac failure, cardiovascular obstruction, fetal edema and intrauterine fetal death, whose influences on the fetus, however, are different based on different growth sites. Therefore, the regular prenatal diagnosis for pregnant women and the development of accurate clinical scheme and therapeutic direction for fetal cardiac tumor in time have great influences on the clinical diagnosis and treatment of fetal cardiac tumor (4).

Echocardiography (5) is a kind of non-invasive, rapid and convenient technique that detects the great vessels in each valve and the specific cardiac anatomical structure and functional status using the pulsed ultrasonic wave in line with the ultrasonic distance-measuring principle, which has been usually used as a major detection method in the clinical diagnosis of heart disease currently (6). Two-dimensional ultrasound and four-dimensional ultrasound are mainly dominated in the screening of cardiac tumor in intrauterine fetus (7). The reflected signals are arranged in the form of light spots to synthesize the section image in two-dimensional echocardiography (8), and it is the most basic ultrasonic examination method at

present. Four-dimensional echocardiography (9) is an advanced ultrasonic technique that can reflect the real-time image of dynamic activity and realize the color flow imaging (10) using the Doppler effect based on two-dimensional echocardiography. This study aims to investigate the imaging features and clinical diagnostic value of two-dimensional ultrasound and four-dimensional ultrasound in the screening of fetal cardiac tumor.

## DATA AND METHODS

### Clinical Data

A total of 24 pregnant women whose fetus had suspected cardiac tumor in The No.4 Hospital 1946 Jinan Shandong from February 2011 to April 2018 were selected as objects of study, including 18 cases with fetal cardiac tumor and 6 cases without fetal cardiac tumor according to pathological diagnosis. The pregnant women enrolled were aged 23-38 years old with an average age of  $(27.5 \pm 3.6)$  years old. The gestational week was 24-39 weeks with an average of  $(30.5 \pm 5.6)$  weeks (Table 1).

Table 1. Clinical data of 24 pregnant women whose fetus has suspected cardiac tumor [n (%)]

Item		[n (%)]
Age (years old)	$\leq 27$	11 (45.83)
	$> 27$	13 (54.17)
Weight (kg)	$\leq 55$	8 (33.33)
	$> 55$	16 (66.67)
Smoking	Yes	17 (70.83)
	No	7 (29.17)
History of exposure to radiation	No	24 (100)
	Yes	0 (0.00)
Fetal chromosomal abnormality	Yes	1 (4.17)
	No	23 (95.83)
Blood glucose	$\leq 6.1$ mmol/L	19 (79.17)
	$> 6.1$ mmol/L	5 (20.83)
Blood type	A	5 (20.83)
	B	6 (25.00)
	AB	7 (29.17)
	O	6 (25.00)

Inclusion criteria: pregnant women treated in the Obstetrics Department in The No.4 Hospital 1946 Jinan Shandong (the international diagnostic criteria for fetal cardiac tumor were used), and pregnant women without pregnancy complications. Exclusion criteria: pregnant women with hypertension, hepatitis B virus, gallstone, AIDS, blood diseases, intrauterine malposition, head-pelvic asymmetry or stenosis of pelvis space. The objects of study and their families signed the informed consent, and this study was approved by the Ethics Committee of The No.4 Hospital 1946 Jinan Shandong.

### Main Instruments and Detection Methods

The Mindray black-and-white ultrasonic apparatus DP-7 (Shenzhen Mindray Bio-Medical Electronics Co., Ltd.) was used (probe frequency: 3-8 MHz, convex array probe volume: 2D & 4D). Philips color Doppler ultrasonic apparatus (Royal Philips) was used for echocardiography (cardiac probe: S5-1, frequency: 2-6 MHz). The fetal ultrasonic cardiogram was diagnosed and analyzed according to the standardized operation procedure published by the International Society of Echocardiography. The site of cardiac tumor was recorded, whether there were space-occupying lesions in atrioventricular cavity and ventricular wall was observed, and the size, number and activity of cardiac tumor and whether there was fetal edema were detected. 3 live births should be reviewed via echocardiography again, and the consent should be obtained from pregnant women and their families before the autopsy and pathological examination for the aborted fetus. All operations were performed by two professional imaging physicians.

### Echocardiographic Features of Fetal Cardiac Tumor

The lesions were mostly located in the left atrium, followed by the right atrium. They were in a circular or quasi-circular shape with clear edge and no capsule. There were no obvious blood flow signals inside the lesions mingled with heterogeneous and loose echo. Most lesions had pedicles with a great range of motion, partially leading to the hemodynamic changes.

### FETAL Four-dimensional Echocardiography

Case 1: : The left and right chambers of the heart were symmetrical in the four-chamber view, the oval foramen was about 6.8 mm, and there were valves. In the left ventricular cavity, there were

homogeneous moderate-strong echoes (21\*19 mm and 33\*22 mm) attached on the interventricular septum and a few blood flow signals. The mitral and tricuspid end diastolic velocities were normal, and there were a few reflux signals detected in the tricuspid valve. The initial parts of aorta and pulmonary artery showed an intersecting shape. The width of aorta was 4.3 mm and the forward blood flow velocity was 102 cm/s. The width of pulmonary artery was 8.2 mm and the forward blood flow velocity was 58 cm/s. Multiple-section scanning was performed for the interatrial septum and interventricular septum, but the possibility of interatrial and ventricular septal defects still could not be eliminated.

Case 2: Fetal four-dimensional echocardiography: The left and right chambers of the heart were symmetrical in the four-chamber view, the oval foramen was about 4.3 mm, and there were valves. At the right of the top of right atrium, there were heterogeneous high echoes (8\*7 mm), and the location was relatively fixed. The mitral and tricuspid end diastolic velocities were normal, and there were a few reflux signals detected in the tricuspid valve. The initial parts of aorta and pulmonary artery showed an intersecting shape. The width of aorta was 4.3 mm and the forward blood flow velocity was 81 cm/s. The width of pulmonary artery was 5.6 mm and the forward blood flow velocity was 50 cm/s. Multiple-section scanning was performed for the interatrial septum and interventricular septum, but the possibility of interatrial and ventricular septal defects still could not be eliminated.

### STATISTICAL METHODS

SPSS 17.0 [Yiyun (Shanghai) Information Technology Co., Ltd.] software system was used for statistical analysis of data. Enumeration data were presented as percentage [n (%)], and chi-square test was used for the pairwise comparison of difference.  $p < 0.05$  suggested that the difference was statistically significant.

### RESULTS

#### Echocardiographic Results of 18 Patients Pathologically Diagnosed with Fetal Cardiac Tumor (+)

In this study, the site, size and activity of cardiac tumor and whether there was fetal edema in patients with fetal cardiac tumor (+) detected via two-dimensional and four-dimensional echocardiography are shown in Table 2.

Table 2. Analysis of diagnostic results of two-dimensional echocardiography and four-dimensional echocardiography [n (%)]

Group		Two-dimensional echocardiography (n=12)	Four-dimensiona l echocardiography (n=17)	Pathological diagnosis (n=18)	χ <sup>2</sup>	p
Site	Left ventricle	4 (33.33)	6 (35.29)	6 (33.33)	0.019	0.991
	Right ventricle	2 (16.67)	4 (23.53)	4 (22.22)	0.213	0.899
	Left ventricle of interventricular septum	4 (33.33)	4 (23.53)	4 (22.22)	0.524	0.770
	Right ventricle of interventricular septum	2 (16.67)	3 (17.65)	4 (22.22)	0.182	0.913
	≤23 mm*16 mm	10 (83.33)	15 (88.24)	15 (83.33)	0.206	0.902
Size	>5 mm*4 mm	2 (16.67)	2 (11.76)	3 (16.67)	0.206	0.902
	High	8 (66.67)	13 (76.47)	14 (77.78)	0.524	0.770
Activity	Low	4 (33.33)	4 (23.53)	4 (22.22)	0.524	0.770
	No	1 (8.33)	1 (5.88)	1 (5.56)	0.104	0.949
Fetal edema	Yes	11 (91.67)	16 (94.12)	17 (94.44)	0.104	0.949

Echocardiographic Analysis

Example 1: Conditions of pregnant women: number of fetus: 1, fetal position: head presentation, maturity: stage I, fetal heart rate: 144 beats/min, fetal movement: yes, abdominal diameter: 91 mm, spine: no obvious abnormalities, biparietal diameter: 84 mm, femur: 64 mm, magenblase: shown, kidney: double kidneys shown, bladder: shown, upper lip skin: no obvious continuous interruption, placental position: anterior wall, depth of amniotic fluid: 61 mm, and umbilical blood flow S/D: 2.7.

The echocardiographic results indicate the abnormality in the fetal cardiac development and solid space-occupying in the left ventricle (Figure 1).

Figure 1: Fetal four-dimensional echocardiography is performed using Philips color Doppler ultrasonic apparatus.



The left and right chambers of the heart are symmetrical in the four-chamber view, the oval foramen is about 6.8 mm, and there are valves. In the left ventricular cavity, there are homogeneous moderate-strong echoes (21\*19 mm and 33\*22 mm) attached on the interventricular septum and a few blood flow signals. The mitral and tricuspid end diastolic velocities are normal, and there are a few reflux signals detected in the tricuspid valve. The initial parts of aorta and pulmonary artery

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show an intersecting shape. The width of aorta is 4.3 mm and the forward blood flow velocity is 102 cm/s. The width of pulmonary artery is 8.2 mm and the forward blood flow velocity is 58 cm/s. Multiple-section scanning has been performed for the interatrial septum and interventricular septum, but the possibility of interatrial and ventricular septal defects still cannot be eliminated. The echocardiographic results indicate the abnormality in the fetal cardiac development and solid space-occupying in the left ventricle.

Example 2: Conditions of pregnant women: number of fetus: 1, fetal position: head presentation, maturity: stage I, fetal heart rate: 141 beats/min, fetal movement: yes, abdominal diameter: 68 mm, biparietal diameter: 70 mm, femur: 47 mm, magenblase: shown, kidney: double kidneys shown, spine: no obvious abnormalities, bladder: shown, upper lip skin: no obvious continuous interruption, placental position: posterior wall, depth of amniotic fluid: 50 mm.

The echocardiographic results indicate the space-occupying in the right atrium, and myxoma is suspected (Figure 2).

Figure 2: Fetal four-dimensional echocardiography is performed using Philips color Doppler ultrasonic apparatus.



The left and right chambers of the heart are symmetrical in the four-chamber view, the oval

foramen is about 4.3 mm, and there are valves. At the right of the top of right atrium, there are heterogeneous high echoes (8\*7 mm), and the location is relatively fixed. The mitral and tricuspid end diastolic velocities are normal, and there are a few reflux signals detected in the tricuspid valve. The initial parts of aorta and pulmonary artery show an intersecting shape. The width of aorta is 4.3 mm and the forward blood flow velocity is 81 cm/s. The width of pulmonary artery is 5.6 mm and the forward blood flow velocity is 50 cm/s. Multiple-section scanning has been performed for the interatrial septum and interventricular septum, but the possibility of interatrial and ventricular septal defects still cannot be eliminated. The echocardiographic results indicate the space-occupying in the right atrium, and myxoma is suspected.

Comparison of Clinical Diagnostic Value in Fetal Cardiac Tumor Between the Two Kinds of Echocardiography

The sensitivity, specificity and diagnostic accordance rate in the clinical diagnosis of fetal cardiac tumor were 66.67%, 50.00% and 62.5%, respectively, in two-dimensional echocardiography, and 94.44%, 83.33% and 91.67%, respectively, in four-dimensional echocardiography. It can be seen that the sensitivity, specificity and diagnostic accordance rate of four-dimensional echocardiography in the clinical diagnosis of fetal cardiac tumor were higher than those of two-dimensional echocardiography. There were statistically significant differences in the sensitivity and diagnostic accordance rate, except specificity, between the two kinds of echocardiography ( $p<0.05$ ) (Table 3-5).

Table 3. Clinical diagnostic results of two-dimensional echocardiography for fetal cardiac tumor

Group	Pathological diagnosis		Total
	(+)	(-)	
Tumor (+) in two-dimensional echocardiography	12	3	15
Tumor (-) in two-dimensional echocardiography	6	3	9
Total	18	6	24

**Table 4. Clinical diagnostic results of four-dimensional echocardiography for fetal cardiac tumor**

Group	Pathological diagnosis		Total
	(+)	(-)	
Tumor (+) in four-dimensional echocardiography	17	1	18
Tumor (-) in four-dimensional echocardiography	1	5	6
Total	18	6	24

**Table 5. Comparison of clinical diagnostic value in fetal cardiac tumor between the two kinds of echocardiography**

Factor	Two-dimensional echocardiography	Four-dimensional echocardiography	$\chi^2$	<i>p</i>
Sensitivity	66.67%(12/18)	94.44%(17/18)	4.433	0.035
Specificity	50.00%(3/6)	83.33%(5/6)	1.500	0.221
Diagnostic accordance rate	62.5%(15/24)	91.67%(22/24)	5.779	0.016

## DISCUSSION

The fetal cardiac tumor (11) is mostly rhabdomyoma, and it can be complicated with tuberous sclerosis. Fibroma, teratoma, hemangioma and myxoma are less common. Although the fetal cardiac tumor is generally benign, different tumor sites and sizes have different influences on the fetus. In most cases, there are no obvious clinical manifestations in the fetal cardiac tumor, and it is manifested as progressive fetal edema (12), significant hemodynamic changes and severe cardiac dysfunction when specific symptoms are produced. The fetal cardiac tumor (13) generally leads to the fetal blood flow obstruction, arrhythmia, pericardial effusion, fetal edema, and even intrauterine fetal death in severe cases. Observing and detecting the physical conditions of pregnant women can determine the site and size of fetal cardiac tumor and whether severe complications occur simultaneously more accurately, which is extremely important for the fetal echocardiography for pregnant women. In the clinical application currently, fetal echocardiography is the most important screening technique. Due to the particularity in the fetal period, CT (14,15) and MRI (16) with extremely high diagnostic efficiency are seldom used in the fetal ultrasound screening due to adverse radiation impacts on pregnant women and fetuses. In this study, the echocardiographic features and clinical diagnostic value of two-dimensional echocardiography and four-dimensional echocardiography in the fetal cardiac tumor were investigated.

In this study, the fetal cardiac tumor was examined via two-dimensional and four-dimensional fetal echocardiography to reflect the site, size and activity of cardiac tumor and whether there was fetal edema in patients with fetal cardiac tumor (+). Results revealed that there were certain differences in two-dimensional and four-dimensional fetal echocardiography compared with pathological diagnosis, but no statistically significant differences were found ( $p>0.05$ ), indicating that two-dimensional and four-dimensional echocardiography can be applied in the detection of fetal cardiac tumor. Echocardiographic results demonstrated that four-dimensional echocardiography can display the site, size and activity of cardiac tumor clearly and accurately in patients with fetal cardiac tumor (+), which is rapid and non-invasive. The above results are similar to research conclusions of Xue et al (17): They detected the patients with suspected fetal cardiac tumor using black-and-white B ultrasound (18) (two-dimensional ultrasound) and color Doppler (four-dimensional ultrasound) and compared the findings with clinical pathological diagnosis results, and it was found that two-dimensional and four-dimensional echocardiography has a high diagnostic accuracy rate for patients with fetal cardiac tumor, which well confirm the research results in this paper. Finally, the diagnostic value was compared between two-dimensional echocardiography and four-dimensional echocardiography, and results showed that the sensitivity, specificity and diagnostic accordance rate of four-dimensional echocardiography in the clinical diagnosis of fetal

cardiac tumor were higher than those of two-dimensional echocardiography. There were statistically significant differences in the sensitivity and diagnostic accordance rate, except specificity, between the two kinds of echocardiography ( $p < 0.05$ ). At present, a large number of studies (19-21) have proved that four-dimensional echocardiography has great clinical application value in the diagnosis of fetal cardiac tumor and judgment of fetal malformation, its diagnostic sensitivity and accordance rate are significantly improved compared with traditional two-dimensional echocardiography, and it can also reflect the intrauterine fetal conditions more clearly and stereoscopically than traditional black-and-white two-dimensional echocardiography.

In this experiment, the number of objects of study selected was smaller due to the small number of patients with fetal cardiac tumor in our hospital, so there may be certain contingency in the results.

Objects of study will be followed up for survey for a longer time, and the experiment will be constantly improved in the future, so as to obtain the optimal experimental results.

In conclusion, two-dimensional and four-dimensional echocardiography can be used in the observation of fetal cardiac tumor to make an early diagnosis. The sensitivity, specificity and diagnostic accordance rate of four-dimensional echocardiography in the clinical diagnosis of fetal cardiac tumor are significantly higher than those of two-dimensional echocardiography. It is inevitable to widely apply four-dimensional echocardiography in clinic to reflect the intrauterine fetal cardiac tumor more clearly and accurately, which has important clinical value in providing accurate information for clinicians and improving the quality of newborns.

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