The application value of echocardiography in the diagnosis of congenital heart disease in neonates

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Abstract: Objective: To investigate the clinical value of echocardiography in the diagnosis of congenital heart disease (CHD) in newborns. Methods: A total of 1000 suspected cases of CHD in newborns were selected as the research subjects, and all underwent echocardiography examination and surgical/cardiac catheterization examination. The diagnostic efficacy of echocardiography in the diagnosis of CHD in newborns was analyzed using the surgical/cardiac catheterization examination results as the gold standard. Results: Among the 1000 suspected cases of CHD in newborns, 881 cases (88.10%) were not detected with CHD, 119 cases (11.90%) were detected with CHD, 2 normal newborns were misdiagnosed as having ventricular septal defect, and 6 cases were missed. The remaining results were consistent with the results of surgical/cardiac catheterization examination. Among the 1000 suspected cases of CHD in newborns, 125 cases were detected with CHD through surgical/cardiac catheterization examination. The specificity of echocardiography in the diagnosis of CHD in newborns was 99.77%, the sensitivity was 93.60%, the accuracy was 99.00%, the positive predictive value was 98.32%, and the negative predictive value was 99.09%. Conclusion: Echocardiography has a high diagnostic efficacy in the diagnosis of CHD in newborns and can reflect the condition of CHD newborns, providing better guidance for clinical diagnosis and treatment.

Keywords: Echocardiography; Newborn; Congenital Heart Disease

Introduction

Congenital heart disease (CHD) is a common cardiac malformation caused by abnormal development of the heart and blood vessels during embryonic stage. It is the leading cause of birth defects, with an incidence rate of approximately 0.8%-1.0%, accounting for 0.5%-0.8% of cardiovascular diseases in newborns. CHD is influenced by various factors such as peripheral environmental factors and genetic factors, and its incidence is gradually increasing, which affects the growth and development of newborns and even endangers their life safety. In recent years, great progress has been made in pediatric cardiac surgery technology, and most CHD patients can achieve good prognosis through surgical or interventional treatment.

This study included 1000 suspected CHD neonatal cases from June 2020 to March 2023 in our hospital as the research object, all of which underwent echocardiography examination, aiming to explore the clinical value of echocardiography in diagnosing neonatal CHD, and the specific content is reported as follows.

1. Materials and Methods

1.1 General Information

A total of 1000 newborns suspected of congenital heart disease (CHD) from June 2020 to March 2023 were randomly selected as the study subjects. All newborns underwent echocardiography and the results were analyzed. Among the 1000

newborns, the age range was 1-22 days, with a mean age of (10.25±3.14) days; the birth weight range was 2050-4160g, with a mean birth weight of (3015.12±102.39) g; there were 519 males and 481 females. All families of the newborns were informed and agreed to participate in this study, and the study was approved by the ethics committee.

1.2 Inclusion and Exclusion Criteria

Inclusion criteria: presence of symptoms such as dyspnea and cyanosis of the lips, heart murmur upon auscultation, normal liver and kidney function.

Exclusion criteria: concurrent infectious diseases, respiratory failure, other congenital diseases, difficulty in actively participating in the study.

1.3 Methods

All hospitalized infants received cardiac auscultation and routine examinations. The examination was performed using a Mindray Resona 70B color Doppler ultrasound diagnostic instrument, assisting the neonate to maintain a left lateral or supine position, and performing the examination as much as possible in its natural sleep state. The left ventricular long-axis section was obtained between the 2nd and 3rd ribs on the left edge of the neonate's sternum. Using M-mode echocardiography, the aortic valve annulus diameter, ascending aortic diameter, right atrial diameter, aortic sinus width, left ventricular internal diameter, interventricular septal thickness, left ventricular posterior wall thickness, interventricular septal motion direction, and motion amplitude were measured. The left and right atrial and ventricular upper and lower diameters, transverse diameter, interatrial septal motion direction, and blood flow spectra of the aortic valve and atrioventricular valve were measured in the four-chamber view of the cardiac apex. The continuity of the ventricular septum, right ventricular diameter, and right ventricular pressure situation were obtained in the short-axis section of the great artery, mainly for tricuspid regurgitation, pulmonary artery blood flow spectrum morphology, and pulmonary artery valve curve. The mitral valve orifice area was measured in the left ventricular short-axis view at the level of the mitral valve. At the same time, it was checked whether there was shunt in the neonatal ductus arteriosus, the specific shunt speed, location, direction, shunt volume, and pressure difference.

1.4 Observation indicators

Using surgical/cardiac catheterization results as the gold standard, the diagnostic efficacy of echocardiography for newborns with CHD was analyzed. The main indicators include specificity, sensitivity, accuracy, positive predictive value, and negative predictive value. Specificity = true negative cases (/true negative cases + false positive cases) × 100%, sensitivity = true positive cases (/true positive cases + false negative cases) × 100%, accuracy = (true positive cases + true negative cases) / total cases × 100%, positive predictive value = true positive cases / (true positive cases + false positive cases) × 100%, and negative predictive value = true negative cases (/true negative cases + false negative cases).

1.5 Statistical methods

SPSS 21.0 statistical software was used to analyze the data. Count data was expressed as n/%, and the chi-square test was used. Measurement data was expressed as mean ± standard deviation (s), and the t-test was used. A P value < 0.05 indicated a statistically significant difference.

2. Results

2.1 Analysis of Detection of CHD in Newborns using Echocardiography

Among 1000 suspected cases of CHD in newborns undergoing echocardiography, 881 cases (88.10%) were not detected with CHD, while 119 cases (11.90%) were detected with CHD. Among them, 43 cases (36.13%) were simple patent foramen ovale, 25 cases (21.01%) were patent ductus arteriosus, including 2 cases with associated ventricular septal defect and 3 cases with associated atrial septal defect, 27 cases (22.69%) were ventricular septal defect, including 3 cases with associated patent ductus arteriosus and 4 cases with associated membranous subaortic stenosis, 16 cases (13.45%) were atrial septal defect, including 2 cases with associated patent ductus arteriosus and 2 cases with associated pulmonary vein drainage anomaly, 2 cases (1.68%) were endocardial cushion defect, including 1 complete type, 3 cases (2.52%) were Tetralogy of Fallot, 2 cases (1.68%) were pulmonary artery stenosis, and 1 case (0.84%) was complete transposition of great arteries. Two normal newborns were misdiagnosed as ventricular septal defect, and 6 cases were missed. The remaining results were consistent with the results of surgical/cardiac catheterization examination.

2.2 Analysis of Diagnostic Performance of Echocardiography in CHD Newborns

Among 1000 suspected cases of CHD in newborns undergoing surgical/cardiac catheterization examination, 125 cases had CHD. The specificity of echocardiography in diagnosing CHD in newborns was 99.77% (873/875), the sensitivity was 93.60% (117/125), the accuracy was 99.00% (990/1000), the positive predictive value was 98.32% (117/119), and the negative predictive value was 99.09% (873/881). See Table 1.

Table 1 Diagnostic Results of Echocardiography in CHD Newborns (n)

Surgery/Cardiac Catheter Diagnosis	Echocardiogram		total
	Positive	negative	
positive	117	8	125
negative	2	873	875
total	119	881	1000

3. Discussion

Congenital heart disease (CHD) in newborns is the leading cause of fatal birth defects in infants, and can significantly impair their overall health. In severe cases, symptoms such as cyanosis (blue discoloration of the skin), fainting, and breathing difficulties can occur, putting the newborn's life at risk. Data shows that over 50% of CHD patients die within the first year of life.

Clinical screening methods for newborn CHD include cardiac auscultation, electrocardiogram (ECG), and ultrasound examination. The most common clinical presentation of CHD in newborns is a heart murmur, but murmurs in neonates are often atypical and require multiple auscultations for preliminary screening, followed by further examination.

ECG mainly reflects changes in blood flow dynamics and conduction pathways. ECG changes in CHD depend on the type of malformation, and can roughly reflect changes in blood flow dynamics and the location of the defect. It can be used as a preliminary screening method.

Echocardiography is a type of ultrasound examination that can form a reflected echo on the organ in the body through the relevant physical properties of ultrasound, to explore the large blood vessels and heart in the body, and obtain relevant

parameters and images. Echocardiography is a radiation-free and safe auxiliary examination method, and its physical properties ensure that it will not have any adverse effects on mothers or newborns. A value analysis of the screening equipment for high-risk newborn CHD conducted by Liu Chunyan using cardiac ultrasound technology showed that timely application of cardiac ultrasound technology equipment is necessary for high-risk newborns, in order to quickly screen for CHD and adopt appropriate treatment measures according to the severity of the condition and symptoms, to improve the quality of life of affected infants, and establish a good foundation for subsequent treatment.

Through exploring the value of multiplane echocardiography in the early diagnosis of congenital heart disease (CHD) and analyzing the factors that lead to missed diagnosis and misdiagnosis, Wu Yi-yi et al. found that age over 35, excessive body weight, oligohydramnios, and abdominal wall scars are all factors that contribute to the missed diagnosis and misdiagnosis of CHD using multiplane echocardiography. Furthermore, multiplane echocardiography has high value in the early diagnosis of fetal CHD and is an important means of prenatal assessment of fetal cardiac abnormalities.

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