Case Report

Diagnostic Errors in Echocardiography: Review of Five Interesting Pediatric Cases

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Abstract

Echocardiography is considered the primary diagnostic tool for congenital heart diseases. The pediatric echocardiography diagnostic errors, consisting of false positive or discrepant diagnoses, picked up within a 2.5-year period in our pediatric echocardiography laboratory are presented herein. In this case report, the factors contributing to the diagnostic errors are categorized as cognitive such as misidentification/misinterpretation of findings and distraction by other diagnoses; procedural or conditional such as incomplete examination of anatomy/physiology and poor imaging conditions; and finally communicational or informational such as lacking or misleading patient's history and incorrect requisition.

The quality of diagnostic pediatric echocardiography can be improved if the operator has sufficient knowledge about the normal growth and development of children, different types of congenital heart defects, and principles of ultrasound physics.

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Introduction

Echocardiography is the first line of investigation for congenital heart diseases and as such constitutes the cornerstone of a timely treatment.[1] Improvements in the resolution of the transducer and the development of color Doppler technology have firmly set echocardiography as the principal diagnostic modality in pediatric cardiology. The echocardiography laboratory (echo lab) is often the patient's last diagnostic stop before surgical or catheter intervention, which necessitates the most comprehensive anatomical and physiological description of the cardiovascular system possible and requires unprecedented detail in the echocardiographic evaluation.[2] Delayed or inaccurate diagnoses can place children with congenital heart disease at risk for adverse outcome.[1]

In this case report, five diagnostic errors, including misidentification/misinterpretation of findings as well as procedural or conditional and communicational or informational errors, are introduced.

Case reports

Case 1

A twenty-one-month-old male infant who was underdeveloped and undernourished was referred for further echocardiographic evaluation. Four weeks earlier, he had been admitted due to fever, crackles in lung auscultation, and

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increased C-reactive protein and erythrocyte sedimentation rate. Echocardiography at the time revealed a relatively large vegetation, and endocarditis treatment was, thereafter, commenced. There being no change in the vegetation size after four weeks of medical treatment, the patient was referred to our lab. He suffered from a complex congenital heart disease in that he had D transposition of great arteries, ventricular septal defect, pulmonary artery hypertension, and history of pulmonary artery banding. Precise echocardiography showed that the mass was the conal septum and not tricuspid valve vegetation as had been previously diagnosed (Figure 1).

Case 2 #

A one-month-old female newborn was referred to our hospital because of tachypnea, tachycardia, 3/6 systolic murmur, and to-and-fro murmur on the left sternal border. Echocardiography performed in the outpatient department indicated ventricular septal defect and aortic regurgitation. However, when the patient was subsequently referred to our Pediatric Eechocardiography Laboratory for further assessment of the aortic valve anatomy, precise echocardiography revealed that the regurgitation originated from an aortic left ventricular tunnel, ruling out the aortic valve pathology (Figure 2).

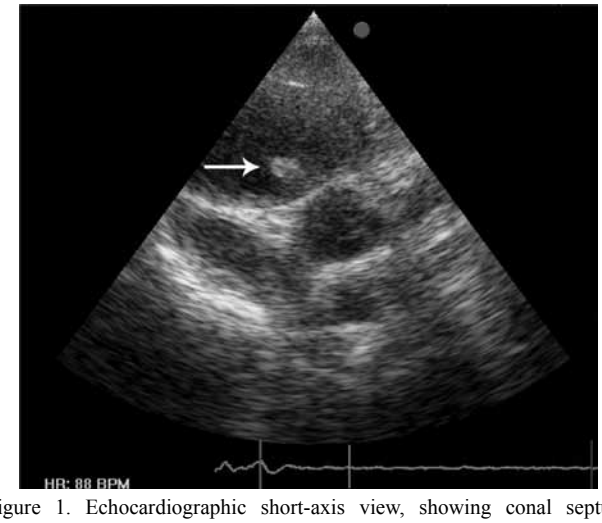

Figure 1. Echocardiographic short-axis view, showing conal septum (arrow); it had been previously mistaken as vegetation

Case 3 #

A four-year-old boy was referred to our outpatient department due to chest pain. His physical examination, electrocardiogram, and chest X-ray were normal, but a mobile elongated linear mass lesion was seen on the right atrium via echocardiography. The patient was, therefore, referred to the pediatric echo lab for further evaluation. Precise echocardiography revealed a large and crescent-shaped Thebesian valve, which is a normal variant and is called the Chiari net (Figure 3).

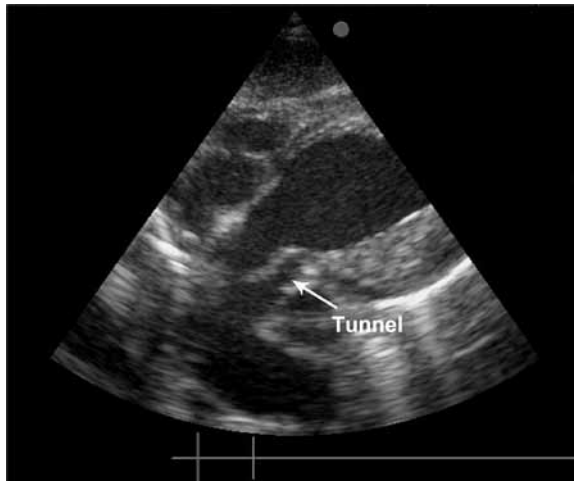

Figure 2. Subcostal coronal view, showing aortic left ventricular tunnel (arrow). In the previous echocardiographic evaluation, it had been ignored

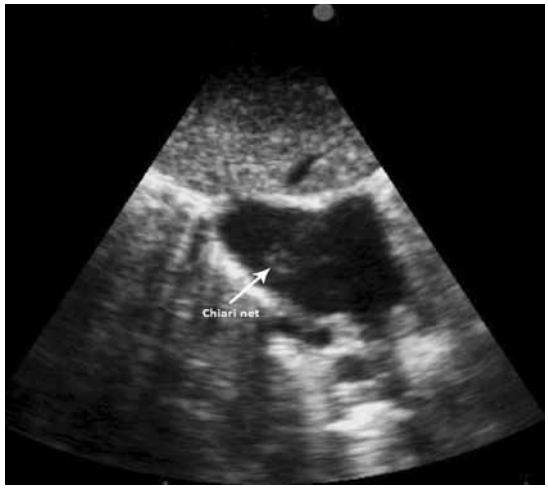

Figure 3. Subcostal sagittal view from the right atrium, showing the Chiari net (arrow). It had been previously mistaken as an abnormal mass

Case 4 #

A four-month-old female infant was referred to our outpatient department with a history of respiratory infection and cardiomegaly on her chest X-ray; physical examination was otherwise normal. Echocardiography showed an extra cardiac mass in the short-axis view, requiring in-depth echocardiographic evaluation in our pediatric echo lab, where precise echocardiography revealed that, far from being a real mass, the shadow was indeed the thymus gland (Figure 4).

Case 5 #

An eleven-day-old female newborn was referred to our hospital with a diagnosis of heart failure. At the time of admission, she was extremely poorly with tachycardia and tachypnea. On physical examination, the second heart sound was loud and 3/6 cardiac systolic murmur was heard. The chest

X-ray revealed severe cardiomegaly. Initial echocardiography failed to detect any anatomic lesion; and a reduced cardiac function prompted the diagnosis of cardiomyopathy, for which medical treatment was immediately commenced. The following day, precise echocardiography was conducted in our pediatric echo lab and showed the dilatation of the brachiocephalic arteries and diastolic run-off in the thoracic descending aorta without any defects such as patent ductus arteriosus or aorto-pulmonary window. In addition, there was no aortic valvular regurgitation. These findings were highly suggestive of cranial arteriovenous fistula, and subsequent diagnostic procedures confirmed this diagnosis (Figure 5).

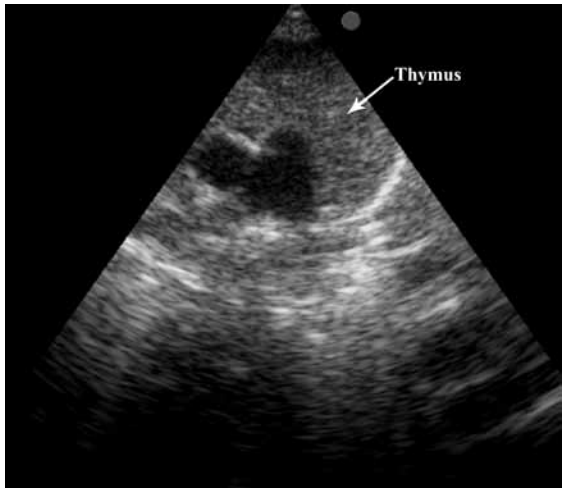

Figure 4. Parasternal short-axis view from the main pulmonary artery and its bifurcation, showing an anterior extra cardiac tissue (arrow), which is the thymus gland. It is not abnormal during infancy

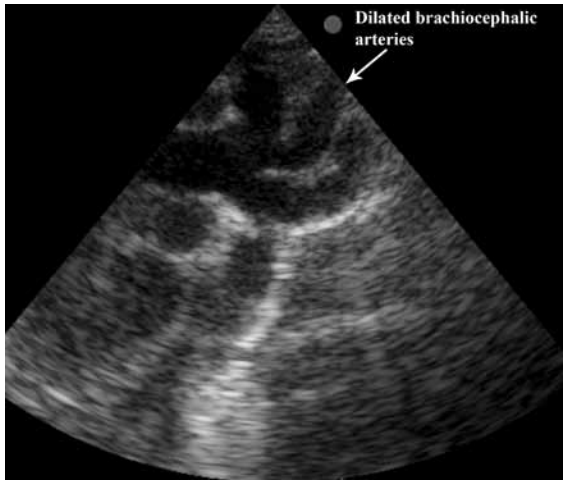

Figure 5. Suprasternal long-axis view, showing dilated brachiocephalic arteries (arrow). This finding had been missed in the previous echocardiographic examination

Discussion

Diagnostic errors are defined as diagnoses that are unintentionally delayed, wrong, or missed as judged from the eventual appreciation of the existing data or of more definitive information. Diagnostic errors are categorized as false negative, false positive, and discrepant. A false negative diagnosis is an error that omits a finding or states that a finding is normal (or absent) when an abnormality is present or when the reader fails to include a significant diagnostic possibility; e.g., patent ductus arteriosus is ruled out or omitted when a patent ductus arteriosus is present. A false positive diagnosis is an error that reports an abnormality when there is no abnormality or when the reader overemphasizes the significance of a finding; e.g., an atrial septal defect is diagnosed when no atrial septal defect is present. And finally, when the actual diagnosis is different from the diagnosis made; e.g., a diagnosis of double-inlet left ventricle is made when the actual diagnosis is tricuspid atresia; it is called a discrepant diagnosis.[1]

Contributors to diagnostic errors in pediatric echocardiography are classified as 1) administrative or data-entry related (incorrect name assigned to imaging data, scheduling error, and incorrect data entry), 2) procedural or conditional (failure to confirm the patient's identity or diagnosis, incomplete examination of anatomy or physiology, poor imaging environment, and failure to improve imaging conditions when possible), 3) communicational or informational (lacking or misleading patient's history, no access to prior studies, failure to report critical findings in a timely fashion to referring physician, and incorrect requisition), 4) cognitive (insufficient knowledge base, inadequate technical skills, faulty data synthesis), 5) technical (technical factors, modality limitation, and poor acoustic windows equipment malfunction), and finally 6) patient- or disease-related (rare or complex anatomy and misleading anatomy or physiology).[1]

In this case report, the factors contributing to diagnostic errors are categorized as cognitive (misidentification/ interpretation of finding and distraction by other diagnoses), procedural or conditional (incomplete examination of anatomy/physiology and poor imaging conditions), and communicational or informational (lacking or misleading patient's history and incorrect requisition). The diagnoses introduced in this case report are all either false positive or discrepant.

Some studies have revealed a high incidence of diagnostic errors in the pediatric echocardiograms performed in community-based adult laboratories, despite a preponderance of patients with simple diagnoses or no heart disease.[3] Diagnostic errors are more common and of increased severity in infants less than 1 month of age but extended throughout all age groups. The major and life-threatening errors reported thus far in the existing literature show a tendency to rise with increasing diagnostic complexity and there are unacceptably high error rates in pediatric echocardiographic diagnoses by non-pediatric cardiologists throughout all age groups.[4]

Echocardiography plays a pivotal role in the diagnosis and follow-up of patients with congenital heart diseases.[5] Echocardiography of congenital and acquired pediatric heart diseases is an operator-dependent imaging technique and thus requires a high level of technical and interpretive skills to maximize its diagnostic accuracy.[6]

Conclusion

Enhancement in the quality of diagnostic pediatric echocardiography requires that the operator possess sufficient knowledge regarding the normal growth and development of children, different types of congenital heart defects, and principles of ultrasound physics. The fact that diagnostic accuracy hinges on the image quality means that the operator should exercise enough patience in order to be able to adjust the resolution and augment the signal-to-noise ratio of the instrument. Furthermore, every diagnostic pediatric echocardiography conducted by a technician should be supervised by a pediatric cardiologist. It is also advisable that pediatric echocardiography be performed in a comfortable and suitable environment and that frightened infants and toddlers be sedated properly.

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