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Role of Chest Radiograph in Diagnosis of Acyanotic Congenital Heart Disease

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ABSTRACT

Introduction: Early diagnosis of acyanotic congenital heart disease could lead to early referral and treatment before the onset of irreversible sequelae. Despite the development of modern imaging methods, conventional chest radiographs remain an important component of diagnostic process in pediatric cardiology. The aim of this study is to determine the accuracy of the results of chest X-ray examination with echocardiography results in patients with suspected acyanotic congenital heart disease at H. Adam Malik General Hospital Medan in 2019-2020.

Method: This study was a retrospective cross-sectional analytical observational study with a diagnostic test design to compare the sensitivity and specificity of conventional chest radiography compared with echocardiography of patients with suspected acyanotic CHD with shunts. The sample population was all children <18 years with suspicion of cyanotic CHD who came for treatment at H. Adam Malik Hospital Medan in the period January 2019 - December 2020. The study used data from medical records at H. Adam Malik Hospital Medan. The collected data is then analysed for diagnostic tests.

Results: This study had a sample of 64 people with the highest proportion of samples being women, the average age was 67.9±54.1 months, and the results of echocardiography of the ductus arteriosus were persistent. The results of the diagnostic test showed a sensitivity of 78% and specificity of 80%, 95% PPV value and 40% NPV value, LR+ 3.8 and LR- 0.2.

Conclusion: Chest X-ray is adequate as a diagnostic tool in acyanotic congenital heart disease with left-to-right shunt. Clinical suspicion accompanied by chest X-ray results suggesting acyanotic congenital heart disease should be further assessed.

Keywords

Chest X-ray, Echocardiography, Acyanotic Congenital Heart Disease, Diagnostic

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INTRODUCTION

Acyanotic congenital heart disease (ACHD) is defined as the anatomical relationship between the pulmonary and systemic circulation. The oxygenated systemic blood flow on the left side of the heart moves to the partially deoxygenated pulmonary blood flow the right side of the heart. In general, cyanotic congental heart disease is more common than cyanotic congenital heart disease.[1]

In 2017, the global incidence of CHD was 17.9 / 1000 children worldwide, with 19.1 / 1000 for men and 16.6 / 1000 for women. In Asia, this figure is more minor, namely 15.4 / 1000.[2] There is no national-scale study to assess the incidence of CHD in Indonesia. Research Ismail et al. at the national referral hospital in Yogyakarta reported an incidence of CHD of 13.4/1000 children.[3] Recent advances in surgical diagnosis and treatment over the past 40 years have led to dramatic increases in survival for children with severe heart defects.[2]

Early diagnosis of superficial lesions can lead to early referral and treatment before the onset of irreversible sequelae. Early diagnosis of congenital heart disease has also been shown to reduce the burden of patient care costs, which is crucial for poor and developing countries. In some developing countries, access to treatment for more severe conditions remains unavailable.[3]

Radiological imaging can provide structural and functional information about the cardiovascular system, help plan management, evaluate intervention outcomes and predict long-term outcomes. Currently, various imaging modalities have been used to detect and follow up congenital cardiovascular disorders.[4]

Even with the development of modern imaging methods, chest X-ray remains an essential component of the diagnostic process in pediatric cardiology.[4] In neonates suspected of having heart disease, chest X-ray is one of the imaging modalities performed to exclude lung disease and to evaluate pulmonary vasculature, lung and cardiomegaly. Chest X-ray was one of the first tests performed on newborns admitted to the intensive care unit to rule out lung disease as well as cardiac evaluation.[5] However, data regarding the accuracy of chest X-rays for the diagnosis of acyanotic congenital heart disease are limited. The aim of this study is to determine the accuracy of the results of chest X-ray examination with echocardiography results in patients with suspected acyanotic congenital heart disease.

METHOD

This study was a retrospective cross-sectional analytical observational study with a diagnostic test design to compare the sensitivity and specificity of conventional chest radiography compared with echocardiography of patients with suspected acyanotic CHD with left-to-right shunt. The sample population was all children <18 years with suspicion of cyanotic CHD who came for treatment at H. Adam Malik Hospital Medan in the period of January 2019 - December 2020. The study used data from medical records at H. Adam Malik Hospital Medan. The chest X-rays was interpreted by radiologists working at H. Adam Malik Hospital with at least ten years of experience. Echocardiography was performed by cardiologists specialized in pediatric. Patients with more than one congenital heart defect confirmed by echocardiography, patients with the presence of severe infectious disease or malignancy that accompanies cardiac abnormalities, and patients with anatomical abnormalities that can cause chest deformity were excluded. The minimum sample size required for analysis was 51. The collected data is then analyzed for diagnostic tests using statistical analysis software. Samples with missing data was excluded.

RESULTS

This study had a sample of 64 pediatric patients with suspicion of acyanotic CHD who went to the H. Adam Malik General Hospital Medan during 2019-2020 who had met the criteria. Table 1 presents the demographic characteristics of the research subjects. The dominant female sex subjects were 41 people (64.1%). The age of the patients in this study was an average of 67.9 ± 54.1 months, with the youngest patient being four months old and the oldest patient being 206 months (17 years).

Table 1. Sample Characteristic

Characteristic	n	%
Gender		
Male	23	35,9
Female	41	64,1
Characteristic	Mean	Standard Deviation
Age (month)	67,9	54,1
Body mass index	14,3	2,8

Table 2 presenting data from echocardiography of research subjects. The results showed that PDA constituted the most significant proportion, amounting to 22 people (34.3%), followed by VSD and ASD, each with 16 people (25%). There were ten subjects (15.6%) with normal echocardiography results.

Table 2. Echocardiography Result

Echocardiography	n	%
ASD	16	25,0
VSD	16	25,0
PDA	22	34,4
Normal	10	15,6
Total	64	100,0

Based on Table 3, it can be seen that the results of the chest X-ray diagnostic test compared with echocardiography in patients with acyanotic CHD at H. Adam Malik Hospital, Medan, had a sensitivity of 78% and specificity of 80%, 95% PPV value and 40% NPV value, and LR+ 3, 8 and LR- 0.2.

Table 3. Diagnostic Test Result

		Echocardiography		
		Abnormal	Normal	Total
Chest X-ray	Abnormal	42	2	44
	Normal	12	8	20
	Total	54	10	64
Sensitivity		78%		
Specificity		80%		
PPV		95%		
NPV		40%		
LR+		3,8		
LR-		0,2		

DISCUSSION

Congenital heart disease (CHD) is an abnormality in the heart's structure or the function of the heart's circulation that is brought from birth. Congenital heart disease that is not recognized early in infants and children carries a severe risk of avoidable death, morbidity and disability. The main advantage of early recognition and diagnosis of congenital heart disease is the earlier assessment of the clinical condition. This problem requires modalities that are widely available, easy to use, affordable and reliable.

In this study, most of the research samples were women, as many as 41 people (64.1%). Globally, the prevalence of congenital heart disease is higher in boys.[2] However, if we look only at acyanotic congenital heart disease, the global prevalence of women is slightly higher.[2] There has been no national-scale study on the prevalence of congenital heart disease, especially the acyanotic type. Research on the description of congenital heart disease in the neonatal intensive care unit of Prof. Dr. R. D. Kandou Manado Hospital for the 2013-2017 period reported a greater prevalence of male.[6] Research on the profile of congenital heart disease in pediatric inpatient installations, RSUP Dr. M. Djamil Padang in the period January 2013 – December 2015 also reported a greater prevalence of men.[7] Research at Dr. RSUP. Soetomo Surabaya reported a more significant proportion of men with acyanotic congenital heart disease in the study period January to December 2016.[8] Recently, there has been increasing interest in sex studies in patients with congenital heart disease, especially in terms of prevalence, clinical manifestations, management and prognosis. It has been shown that there is a relationship between sex and prognosis, with males having a better prognosis. The mechanism of this sex-induced difference is still not elucidated. However, in general, the data on sex found as in the studies cited by this study show different results.[9] The difference in the results of this gender prevalence is very likely to be influenced by the population where the study is located and how aware the population is to check themselves, where it is possible that patients with mild symptoms do not go to the hospital.

The average age of the sample in this study was 67.9 months, with the youngest being four months old and the oldest being 206 months (17 years). Globally there is no mention of the age distribution of patients with congenital heart disease.[2] One study focused on the global prevalence of congenital heart disease in

school-aged children (4-18 years) without including data on the age distribution of the sample.[4] Research at Dr. RSUP. M. Djamil Padang reported that the highest proportion of sample age was > 1 year.[7] Research at Dr. RSUP. Soetomo Surabaya reported the highest proportion of patients with acyanotic congenital heart disease < 5 years.[8] Despite the different age samples, various studies on congenital heart disease limited the sample in the age range of children (< 18 years) due to efforts to improve diagnostic and treatment capabilities. Early age at diagnosis is very likely to be influenced by the severity of congenital heart disease, public awareness to check themselves and their children, and the availability of congenital heart disease screening services in the area. Early diagnosis can prevent preventable morbidity and mortality in patients.

The average body mass index of the sample in this study was 14.3. Research on the relationship between congenital heart disease and nutritional status in children aged 1-6 years at Prof. RSUP. Dr. R. D. Kandou Manado, in 2009-2013, stated that there was a significant relationship between poor nutritional status and congenital heart disease.[10] Research on anthropometric features of congenital heart disease at Dr. RSUP. M. Djamil Padang, in 2010-2013 stated that the majority of patients with acyanotic congenital heart disease had good nutritional status. Research at RSUP Dr. Soetomo Surabaya reported that most people with acyanotic congenital heart disease are malnourished.[8] Many factors can affect the nutritional status of children with congenital heart disease, such as genetic mutations, disease severity, and family sociodemographic conditions.[11]

Based on echocardiography results, the most acyanotic congenital heart disease in this study sample was PDA as many as 22 people (34.4%) followed by ASD and VSD with 16 people each (25%). This proportion differs from the results reported by other studies. Globally, the most significant proportion of cyanotic congenital heart disease is VSD, followed by ASD and PDA.[2] Research at Dr. RSUP. M. Djamil Padang reported the highest proportion of DSA followed by DSV.[7] While research at Prof. RSUP. Dr. R. D. Kandou Manado reported that the highest proportion of congenital heart disease was DSV, followed by PDA and ASD.[6] Research results at Dr. RSUP. Soetomo Surabaya reported DSA as the type of acyanotic heart disease with the highest proportion.[8] These different results can be caused by conditions in each area. Cyanotic congenital heart disease is generally not detected until complications occur; therefore, the level of diagnosis of cyanotic congenital heart disease is also influenced by public awareness to examine children with suspected congenital heart disease. There has been no national scale research conducted to describe the state of cyanotic congenital heart disease in Indonesia.

The results of the chest X-ray diagnostic test were compared with echocardiography in patients with acyanotic CHD at H. Adam Malik Hospital, Medan, having a sensitivity of 78% and specificity of 80%, 95% PPV value and 40% NPV value, and LR+ 3.8 and LR- 0,2. The sensitivity of 78% can be interpreted that the chest X-ray can identify 78% of cyanotic congenital heart disease. Specificity of 80% can be interpreted that the chest X-ray can identify 80% of patients without acyanotic congenital heart disease. The PPV value of 95% can be interpreted that patients with suspected acyanotic congenital heart disease have a 95% probability of suffering from acyanotic congenital heart disease. The NPV value of 40% can be interpreted that patients with chest X-ray results do not suspect acyanotic congenital heart disease have a 40% probability of not suffering from acyanotic congenital heart disease. The LR+ 3.8 value can be interpreted that patients with acyanotic congenital heart disease are 3.8 times more likely to have a chest X-ray that suggests acyanotic congenital heart disease. The value of LR-0.2 can be interpreted that patients with acyanotic congenital heart disease are 0.2 times more likely to have a normal chest X-ray. How practical and acceptable baseline values are from diagnostic test results depends on the clinical context of use and the availability of the tools used. In general, examinations with sensitivity and specificity above 50% are considered good.[10] Chest X-ray is a widely available examination, and the results are independent of the operator. Chest X-ray is also essential to rule out pathological processes in the lungs. Pulmonary vascularity assessment can help differentiate the type of CHD.[12]

At the time of the implementation of this study, there were no national or international studies that discussed the specific role of diagnosis in acyanotic congenital heart disease. One study reported that the mean

accuracy of distinguishing a normal chest X-ray from CHD, in general, was 78%. When the specific lesions are compared, the reader has the most difficulty distinguishing ASD from VSD and PDA.[13] With low accuracy, the value of the chest X-ray as a diagnostic tool for specific cardiac lesions is reduced. Based on the results of this study, chest X-ray is reliable enough to be a diagnostic modality for acyanotic congenital heart disease. The limitation of this study that this study was done retrospectively in a centre, so the sample was limited. Chest X-ray is a widely available, affordable and operator-independent examination. Radiologists should shift the emphasis from the diagnosis of specific lesions to a more descriptive approach. The results of the chest X-ray that point to cyanotic congenital heart disease can be a guide for clinicians in areas where echocardiography is not available to refer or follow up patients with suspected congenital heart disease.

CONCLUSION

This study indicates that chest X-ray can be relied upon as a diagnostic tool in acyanotic congenital heart disease. Therefore, clinical suspicion accompanied by chest X-ray results suggesting acyanotic congenital heart disease should be followed up with more sensitive and specific diagnostic modalities.

DECLARATIONS

Ethics approval and consent to participate. Permission for this study was obtained from the Ethics Committee of Universitas Sumatera Utara and H. Adam Malik General Hospital..

CONSENT FOR PUBLICATION

The Authors agree to publication in Journal of Society Medicine.

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COMPETING INTERESTS

None.

AUTHORS' CONTRIBUTIONS

MHRS collects the data and writes the initial manuscript. ERD provided contribution and revision regarding the data analysis and imaging aspect of the discussion. RH provided contribution and revision regarding the data analysis and clinical aspect of the discussion. All authors read and approved the final manuscript.

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