VALUE OF ECG AND CHEST X-RAY IN COMPARISON WITH ECHO IN DIAGNOSIS OF CONGENITAL HEART DISEASE

By

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ABSTRACT

Background: *Echocardiography is the gold standard in diagnosis of congenital heart diseases in pediatric.*

Aim: *To detect value of echocardiography in diagnosis of congenital heart diseases in pediatrics and to evaluate any possible correlation between echocardiographic finding and in comparison, to chest x-ray and electrocardiogram (ECG) findings.*

Patients and Methods: *This is a retrospective study between 1st March 2020 and 28th February 2021 and prospective study between 1st March 2021 and 30th November 2021, this study of cases of congenital heart diseases will undertake in the inpatient and outpatient Al-Azhar Assuit hospital, pediatric cardiology unit. the study included eighty patients; their ages vary from (1 day to 18 years old) with a mean age of 10 (±3.5) months.*

Results: *value of echo more specific and sensitive than CXR and ECG in the diagnosis of congenital heart diseases.*

Conclusion: *So using echocardiography as gold standard in diagnosis of C.H.D is mandatory.*

Keywords: *Congenital heart diseases; electrocardiogram; Chest X ray; Electrocardiography.*

INTRODUCTION

Congenital heart diseases (CHDs) refer to structural or functional heart diseases, which are present at birth. Some of these lesions may be discovered later. **Alsharqi, 2018** Assessment for CHDs must involve a variety of modalities that can be used in a complementary fashion and that together are sensitive, accurate, reproducible, and cost effective, whilst minimizing harm **(Bhattacharya, 2019)**.

Echocardiography detects the reflection of transmitted soundwaves by cardiac tissue and blood; several techniques that use this principle are available to assess the cardiovascular system. **(Brandes et al., 2020)** Transthoracic echocardiography is especially useful in neonates and children whose small thoracic diameter provides an optimal acoustic window. Its wide availability, the limited need for sedation, and the possibility for bedside imaging make echocardiography the preferred imaging tool in the diagnosis and follow-up of patients with CHD **(Cai, Q., et al., 2020)**.

Furthermore, the assessment of myocardial velocities for the evaluation of myocardial function was made possible by the introduction of tissue Doppler imaging. 3D echocardiography allows the comprehensive evaluation of ventricular volumes and function. However, the use of echocardiography is hampered by operator dependency, a small field of view, the inability to penetrate air and bones, and variable acoustic windows, especially in obese patients and postoperatively.

Therefore; The aim of this study is to detect value of echocardiography in diagnosis of congenital heart diseases in pediatrics and to evaluate any possible correlation between echocardiographic, chest x-ray and electrocardiogram (ECG) findings.

Ethical Considerations:

This study was carried out after being approved by the local Ethics Committee of the Faculty of medicine Al-Azhar University, Assuit, Egypt. Consent will be taken from the patients before including them in the study. Aim of the study and possible risks will be explained to patients. Privacy of collected data will be assured.

No conflict of interest regarding the study or publication.

Inclusion criteria:

Age was from day 1 to 18 years old.

Any patient with symptoms suggestive of C, H, D. e.g. cyanosis. dyspnea. palpitation. recurrent chest infection.

Exclusion criteria:

Other chronic disorders including; anemia, renal, hepatic and pulmonary diseases. Children with a history of other heart diseases as Rheumatic heart disease, heart failure, cardiomyopathy, pericardial effusion.

Study Design:

This was a retrospective study that was done between 1st March 2020 and 28th February 2021 and prospective study between 1st March 2021 and 30th November 2021, congenital heart diseases were conducted in the inpatient and outpatient of Al-Azhar Assuit hospital pediatric cardiology unit.

The study included eighty patients (Female 35 and male 45) their ages vary from (1 day to 18 years old) with a mean age of 10 (±3.5) months, with manifestation suggestive of C.H.D.

All patients were subjected to the following:

- Detailed history included; age, sex, time at onset of complaint, any history of cardiac manifestation.
- Clinical examination was done for all cases and included: General examination: conscious level, appearance, vital signs: (Heart rate, respiratory rate, temperature, blood pressure measurements in 4 limbs).
- Anthropometric measures. Cardiac examination; included: Inspection: apex beat, pericardial bulge, pulsation. Palpation: apex beat.
- palpable thrill and Auscultation: heart sounds and murmurs. Chest examination: Sign of respiratory distress, breath sound, air entry, adventitious sounds.

Full Abdominal examination.

Neurological examination.

Regional examination.

Laboratory Evaluations including:

Complete blood count, kidney function test and serum electrolyte.

Chest x-ray: Postero-anterior & lateral views.

Electrocardiogram (ECG) analysis: for detection of cardiac situs, cardiac size.

Pulse oximetery,

Echocardiogram:

For Definite detection of cardiac site and visceropathies situs. Accurate measurements of chamber diameters and wall thickness with referral of these measurements to the standard for age, Detection of anatomical abnormalities within the heart or proximal parts of great vessels, Estimation of pulmonary pressure, Evaluation of the pericardium and Detection of the thymus gland and its size.

Statistical Analysis: Data were analyzed using Statistical Program for Social Science (SPSS) version 18.0. Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

RESULTS

Table (1): Demographic data findings:

	Patients	
Age (months) Mean ±SD	10 ±3.5 months	
Sex		
Male	45	56.3%
Female	35	43.7%

Table (2): Chest x-ray findings

	N	%
C/T ratio		
<60	31	38.75%
>60	49	61.25%
Enlarged cardiac chamber		
Rt. Atrium	41	51.25%
Lt. Atrium	19	23.75%
Rt. Ventricle	47	58.75%
Lt. Ventricle	21	26.25%
Thymus shadow	47	58.75%
Pulmonary Vasculature		
Pulmonary congestion	57	71.25%
Pulmonary oligemia	6	7.50%
Radiological evidence of pulmonary disease	41	51.25%

As shown in **table (2)** shows that the most radiological findings are increased C/T ratio increased up to 61.25, enlarged Rt. Ventricle & pulmonary congestion in 71.25% of cases.

Table (3): Echocardiographic examination findings

	N	%
Echocardiogram exanimations		
Dilated Rt. Atrium	38	47.50%
Dilated Lt. Atrium	27	33.75%
Dilated Rt. Ventricle	29	36.25%
Dilated Lt. Ventricle	11	13.75%
Hypertrophied Rt. Ventricle	7	8.75%
Dilated and Hypertrophied Rt. Ventricle	22	27.50%
Hypertrophied Lt. Ventricle	10	12.50%
Dilated and Hypertrophied Lt. Ventricle	3	3.75%
Increase Pulmonary disease	22	27.50%

RT=Right LT=Left N=Number %=Percent

As shown in **table (3)**; Echocardiogram exanimations classified into 9 parts, Dilated Rt. Atrium included 38 (47.50%), Dilated Lt. Atrium included 27 (33.75%), Dilated Rt. Ventricle included 29 (36.25%), Dilated Lt. Ventricle included 11 (13.75%), Hypertrophied Rt. Ventricle included 7 (8.75%), Dilated and Hypertrophied Rt. Ventricle included 22 (27.50%), Hypertrophied Lt. Ventricle included 10 (12.50%), Dilated and Hypertrophied Lt. Ventricle included 3 (3.75%), and Increase Pulmonary disease included 22 (27.50%),

Table (4): Sensitivity and specificity of chest X-ray and ECG in comparison with ECHO results of enlarged right atrium

	Enlarged right atrium		Sensitivity	specificity	PPV	NPV	Accuracy	
	Positive	Negative						
Right atrium (CXR)								
Positive	22	28	68.75	41.67	44	66.7	52.5	.552
Negative	10	20						
Right atrium (ECG)								
Positive	13	8	40.63	83.33	61.9	67.8	66.3	.620
Negative	19	40						

CXR=Chest x ray; ECG=Electrocardiogram; ECHO=Echocardiogram; PPV=Positive predictive value; NPV=Negative predictive value

As shown in **table (4)**; The sensitivity in right atrium enlargement was 41.67% for chest x ray and 83.33 % for ECG, the specificity was 68.75%, 40.63% for chest x ray and ECG respectively, the accuracy 63.54% for chest x ray and 68.9% for ECG.

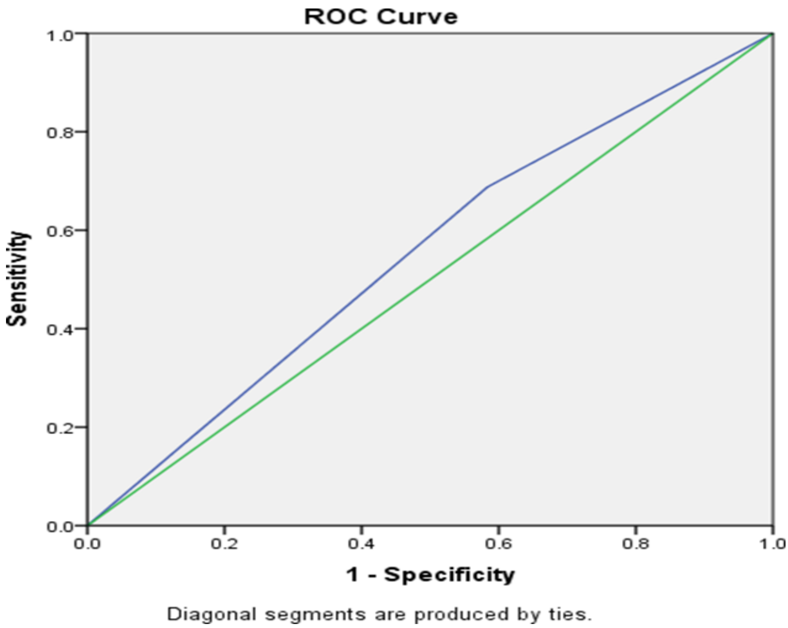


Table (5): Sensitivity and specificity of chest X-ray and ECG in comparison with ECHO results of enlarged left atrium

	Enlarged leftatrium		Sensitivity	specificity	PPV	NPV	Accuracy	AUC
	Positive	Negative						
Left atrium (CXR)								
Positive	12	10	40	80	54.5	69	65	.600
Negative	18	40						
Left atrium (ECG)								
Positive	8	7	26.67	86	53.3	66.2	63.8	.563
Negative	22	43						

CXR=Chest x ray ECG=Electrocardiogram ECHO=Echocardiogram
PPV=Positive predictive value NPV=Negative predictive value

As shown in **table (5)**; The sensitivity in left atrium enlargement was 79.17% for chest x ray and 85.42% for ECG, the specificity was 37.50%, 25.0% for chest x ray and ECG respectively, the accuracy 61.34% for chest x ray and 59.41% for ECG.

Table (6): Sensitivity and specificity of chest X-ray and ECG in comparision with ECHO results of enlarged right ventricle

	Enlarged right ventricle		Sensitivity	specificity	PPV	NPV	Accuracy	AUC
	Positive	Negative						
Right ventricle (CXR)								
Positive	24	20	57.14	47.37	54.5	50	52.5	.523
Negative	18	18						
Right ventricle (ECG)								
Positive	13	9	30.95	75.32	59.1	50	52.5	.536
Negative	29	29						

CXR=Chest x ray ECG=Electrocardiography ECHO=Echocardiogram
PPV=Positive predictive value NPV=Negative predictive value

As shown in **table (6)**; The sensitivity in right ventricle enlargement was 47.37% for chest x ray and 85.4% for ECG, the specificity was 57.14%, 30.95% for chest x ray and ECG respectively, the accuracy 55.2% for chest x ray and 57.3% for ECG.

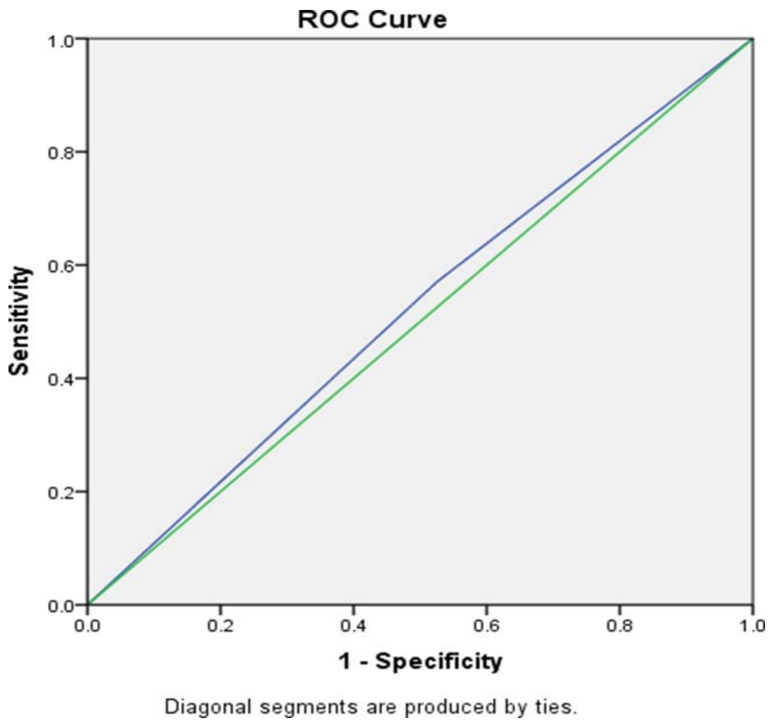
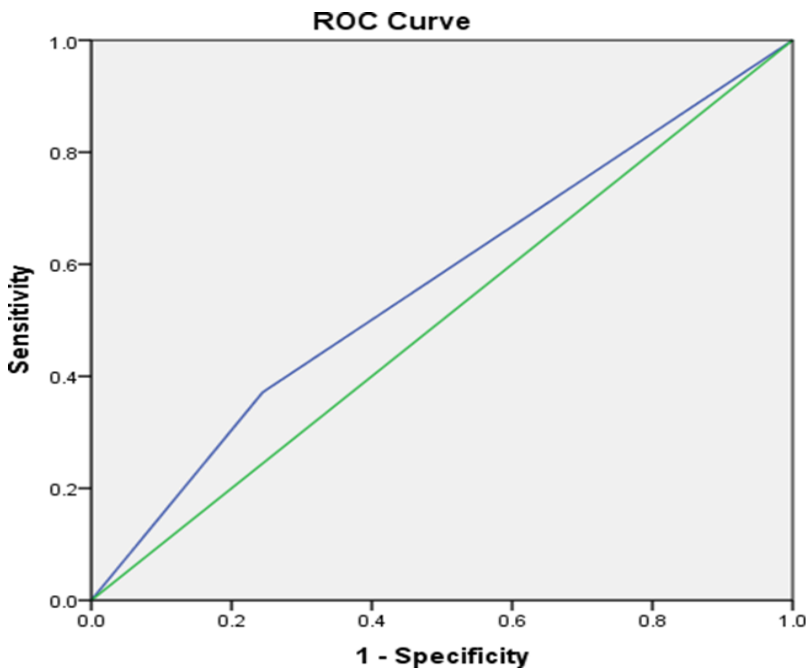


Table (7): Sensitivity and specificity of chest X-ray and ECG in comparision with ECHO results of enlarged left ventricle

	Enlarged left ventricle		Sensitivity	specificity	PPV	NPV	Accuracy	AUC
	Positive	Negative						
left ventricle (CXR)								
Positive	13	11	37.14	75.56	54.2	60.7	58.8	.563
Negative	22	34						
left ventricle (ECG)								
Positive	19	17	54.29	62.2	52.8	63.6	58.75	.583
Negative	16	28						

ECHO=Echocardiogram CXR=Chest x ray ECG=Electrocardiography PPV=Positive predictive value NPV=Negative predictive value

As shown in **table (7)**; The sensitivity in left ventricle enlargement was 75.56% for chest x ray and 62.22% for ECG, the specificity was 37.14%, 54.29% for chest x ray and ECG respectively, the accuracy 58.6% for chest x ray and 60.5% for ECG.



DISCUSSION

In this study, we prospectively evaluated the diagnostic performance to detect cardiac enlargement to children attended to Al-Azhar Assiut hospital pediatric cardiology unit. ECHO showed that the percentage of cases with true chamber enlargement and /or hypertrophy among cases diagnosed as having C/T ratio of ≥60 % in the chest radiograph was 49 cases (61,25%) in spite of fallacies mentioned regarding the use of C/T ratio in this age group like horizontal position of the heart ,difficulty in obtaining mid inspiratory film in this age group and the frequent presence of thymus **Brandes et al.,** proved that C/T to be of value in determining cardiac dilation and/ or hypertrophy this is in agreement with Doherty et al.,6 who stated that cardiothoracic ratio are useful in detection of cardiomegaly in cases of left ventricular enlargement but are not sensitive to right ventricular enlargement.

In our study, Regarding the general accuracy results; CXR was better than ECG as predictor of positive and negative cases of left atrium and left ventricular enlargement when compared with ECHO. ECG was better than CXR as predictor of positive and negative cases of right atrium enlargement.

In children this assumption rarely holds true, and the various levels of inspiration leads to variable image quality **Enriquez et al.,**.

Our findings demonstrated a relatively low sensitivity (48.8%) and positive predictive value (54.5%). These results are consistent with previous studies in which the accuracy of CXR in predicting heart detects in children referred for murmurs were evaluated using an overall ‘’positive” or “negative” CXR diagnosis **Fields et al.,** evaluated 95 consecutive outpatients children to determine the usefulness of heart size on CXR in predicting cardiac enlargement in children, CXR and echocardiography performed for all cases.

In agreement of our results the sensitivity with a (41.67%) of the CXR to identify cardiomegaly was predictive and negative (68.75%), specificity (66.7%) of positive predictive value and negative (44.0%) value. **Bhattacharya et al.,** investigated the diagnostic value of the CXR in the evaluation of whether asymptomatic children with a cardiac murmur had a heart disease as defined by echocardiograph.

Li et al., reviewed CXR from 281 patients (<12 years) by five pediatric radiologists from three institutions, concluded that CXR alone is not diagnostic for specific cardiac lesions, with a low accuracy of only 71%.

Mahmoud et al., stated that the value of routine CXR and ECG helped to rule out significant lesions in only 28% of patients and diagnose definite heart disease in only 20% of patients. Regarding pulmonary vascularity, our results showed that (35.3%) of normal pulmonary vasculature in CXR had increased pulmonary pressure in ECHO and (34.5%) of congestion in x-ray had increased pulmonary pressure in echocardiogram. **Meinel et al.,** reported that pediatric CXR exhibits good accuracy and reproducibility to identify significantly abnormal pulmonary vascularity in children with congenital heart disease. However, the sensitivity to detect decreased pulmonary vascularity pattern is low. **Mutlu et al.,** concluded that the vast maiority ECG and CXR examination did not help in the diagnosis and in those cases where it was thought helpful it was often misleading.

CONCLUSIONS

The value of echo is more specific and sensitive than CXR and ECG in the diagnosis of congenital heart diseases. using echocardiography as gold standard. Regarding pulmonary vascularity, no significant difference in comparison between pulmonary vasculature of chest-x ray and increased estimated pulmonary pressure in the echocardiogram

RECOMMENDATION

Using echocardiogram is mandatory for diagnosis of any suspected case of C.H.D.

LIMITATIONS OF THE STUDY

- Wide range of age group of studied patients
- Difficulties in x-ray exposure in young infants
- Small numbers of studied patients

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