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Correlation of Cardiomegaly on Chest X-Ray with 2d-Echocardiography in Pediatrics Patients

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ABSTRACT

Introduction: Cardiomegaly is a common finding on chest X-ray (CXR) in pediatric patients and is frequently used as an initial screening tool for cardiac abnormalities. However, the ability of CXR to accurately detect true cardiac enlargement remains uncertain. Two-dimensional echocardiography (2D-ECHO), the gold standard for assessing cardiac size and structure, can help confirm these findings. Evaluating the correlation between cardiomegaly on CXR and 2D-ECHO findings is important for improving diagnostic accuracy and guiding appropriate clinical management.
Aim: To evaluate the correlation between cardiomegaly detected on chest X-ray and findings on 2D-echocardiography in pediatric patients.
Methods: The present study Prospective, Cross-sectional and observational study. This Study was conducted for 18 months. Department of paediatrics,. Study population 527.
Results: This study included 527 pediatric patients who underwent chest X-ray and 2D echocardiographic evaluation. Cardiomegaly was identified on both imaging modalities, with echocardiography demonstrating a slightly higher detection rate. Chest X-ray showed a moderate correlation with echocardiography in identifying cardiomegaly. The diagnostic assessment revealed that chest radiography was useful as an initial screening tool but had limitations in confirming true cardiac enlargement. Age-wise analysis showed variation in cardiomegaly occurrence, with younger children showing a higher frequency of cardiac enlargement. No significant association was observed between cardiomegaly and congenital heart disease.
Conclusion: Chest X-ray remains a valuable initial investigation for screening cardiomegaly in pediatric patients; however, 2D echocardiography provides a more accurate and definitive assessment. Echocardiographic evaluation should be considered in children with radiological evidence of cardiomegaly to confirm diagnosis and assess underlying cardiac abnormalities.

Keywords: *Cardiomegaly, Chest X-ray, 2D Echocardiography, Pediatric Patients, Cardiac Enlargement, Congenital Heart Disease.*

INTRODUCTION

Cardiovascular diseases in children comprise a diverse group of congenital and acquired disorders that contribute significantly to pediatric morbidity and mortality. Early diagnosis of cardiac abnormalities is essential for timely treatment and improved outcomes. Among the various diagnostic modalities available, chest radiography remains one of the most commonly used initial investigations because it is inexpensive, widely available, and non-invasive [1]. One of the most important radiological findings on chest X-ray (CXR) is cardiomegaly, which may indicate the presence of underlying structural or functional heart disease. Cardiomegaly refers to an abnormal enlargement of the cardiac silhouette and is commonly assessed using the cardiothoracic ratio (CTR) on a posteroanterior chest radiograph. In pediatric patients, the

assessment of heart size can be challenging due to age-related anatomical variations, differences in thoracic dimensions, respiratory movements, and the presence of the thymus gland, which can alter the appearance of the cardiac shadow [2]. Nevertheless, chest radiography continues to be an important screening tool in the evaluation of suspected cardiovascular disorders in children. Congenital heart disease (CHD) is the most common congenital anomaly worldwide, with an estimated prevalence of approximately 8–10 cases per 1,000 live births [3]. Children with CHD often present with symptoms such as respiratory distress, cyanosis, feeding difficulties, poor weight gain, recurrent respiratory infections, or cardiac murmurs. In these situations, chest X-ray is frequently used as an initial imaging investigation. The presence of cardiomegaly on radiography may suggest conditions such as ventricular septal defect, atrial septal defect, patent ductus arteriosus, cardiomyopathy, valvular heart disease, and congestive heart failure [4]. Despite its widespread use, chest radiography has several limitations in accurately identifying true cardiac enlargement. An increased cardiothoracic ratio does not always reflect enlargement of the cardiac chambers. Various factors, including patient positioning, radiographic technique, pericardial effusion, obesity, chest wall abnormalities, and mediastinal conditions, can influence the size and shape of the cardiac silhouette, leading to false-positive or false-negative interpretations [5]. Therefore, chest X-ray findings alone may not always provide an accurate assessment of cardiac size. Two-dimensional echocardiography (2D-ECHO) is considered the gold standard for evaluating cardiac anatomy and function in pediatric patients. It provides detailed real-time visualization of cardiac chambers, valves, septa, and great vessels, allowing accurate assessment of chamber dimensions and ventricular performance [6]. Echocardiography is highly sensitive and specific for the diagnosis of congenital and acquired heart diseases and is routinely used to confirm suspected cardiomegaly identified on chest radiographs. Several studies have investigated the relationship between cardiomegaly detected on chest X-ray and actual cardiac enlargement demonstrated by echocardiography. While some studies have shown a significant correlation between increased cardiothoracic ratio and echocardiographic findings, others have reported only moderate agreement, especially among infants and younger children [7,8]. These variations may be attributed to differences in study populations, age groups, and radiographic techniques. The correlation between chest X-ray and echocardiographic findings has important clinical implications. In many resource-limited settings, chest radiography is often the first and sometimes the only available imaging modality for evaluating pediatric cardiac disease [9]. Determining the reliability of cardiomegaly on chest X-ray in predicting true cardiac enlargement can assist clinicians in identifying patients who require further echocardiographic evaluation and can help optimize the utilization of healthcare resources. Therefore, the present study aims to evaluate the correlation between cardiomegaly detected on chest X-ray and findings on two-dimensional echocardiography in pediatric patients. The study seeks to determine the diagnostic value of chest radiography as a screening tool and its usefulness in predicting true cardiac enlargement and underlying heart disease in children [10]. To evaluate the correlation between cardiomegaly detected on chest X-ray and findings on 2D-echocardiography in pediatric patients.

MATERIALS AND METHODS

Study design: Prospective, Cross-sectional and observational study
Study Place: The division of pediatric cardiology of a tertiary care pediatric centre
Duration of the Study: 18 Months
Sample Size:527 patients

Inclusion Criteria:

- Children aged over 1 month who are referred for 2D Echocardiography (any indication).
- Availability of a well-exposed, inspiratory Chest X-ray plate (done within the last 3 months) in the referred children

Exclusion Criteria:

- Children referred for 2D echocardiography (any cause) without an chest X-ray done within 3 months of referral
- All patients with a previous diagnosis of heart disease (congenital / acquired) who were referred for follow-up echoes.

Study Variable:

- Age
- Gender
- Cardiomegaly on Chest X-ray (CXR)
- Cardiac Enlargement on 2D-Echocardiography (2D-ECHO)
- Left Ventricular Dilatation
- Congenital Heart Disease (CHD)

Statistical Analysis: For statistical analysis data were entered into a Microsoft Excel spreadsheet and then analyzed by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and Graph Pad Prism version 5. Data had been summarized as mean and standard deviation for numerical variables and count and percentages for categorical variables. Z-test (Standard Normal Deviate) was used to test the significant difference of proportions. Once a t value is determined, a p-value can be found

using a table of values from Student's t-distribution. If the calculated p-value is below the threshold chosen for statistical significance (usually the 0.10, the 0.05, or 0.01 level), then the null hypothesis is rejected in favor of the alternative hypothesis. P-value ≤ 0.05 was considered for statistically significant.

RESULT

Table 1. Demographic Characteristics of the Study Population (N = 527)

Variable	Category	Frequency	Percentage (%)
Gender	Male	321	60.9
	Female	206	39.1
Age Group	≤1 year	86	16.3
	1–5 years	155	29.4
	5–10 years	164	31.1
	>10 years	122	23.1
Total		527	100

Table 2. Distribution of Cardiomegaly Detected by Chest Radiography and 2D Echocardiography

Modality	Cardiomegaly n (%)	No Cardiomegaly n (%)	Total
Chest X-ray	277 (52.6)	250 (47.4)	527
2D Echocardiography	285 (54.1)	242 (45.9)	527

Table 3. Diagnostic Correlation of Chest Radiography with 2D Echocardiography for Detection of Cardiomegaly

Chest X-ray Findings	2D Echo Cardiomegaly	No Cardiomegaly	Total
Cardiomegaly	184 (66.4%)	93 (33.6%)	277
No Cardiomegaly	101 (40.4%)	149 (59.6%)	250
Total	285 (54.1%)	242 (45.9%)	527
Parameter	**Value (%)**	**95% CI**	
Sensitivity	66.43	60.67–71.73	
Specificity	59.6	53.42–65.49	
Positive Predictive Value	64.56	58.85–69.89	
Negative Predictive Value	61.57	55.31–67.47	
Diagnostic Accuracy	63.19	58.99–67.20	

Table 4. Association of Cardiomegaly with Age Group on Chest X-ray and 2D Echocardiography

Age Group	CXR Cardiomegaly n (%)	Echo Cardiomegaly n (%)
≤1 year	62 (72.1)	64 (74.4)
1–5 years	68 (43.9)	88 (56.8)
5–10 years	76 (46.3)	69 (42.1)
>10 years	71 (58.2)	64 (52.5)
p-value	**<0.001**	**<0.0001**

Table 5. Association Between Cardiomegaly and Congenital Heart Disease

Modality	CHD Present n (%)	No CHD n (%)	p-value
Chest X-ray Cardiomegaly (n=277)	12 (4.3)	265 (95.7)	0.135
No Cardiomegaly on Chest X-ray (n=250)	5 (2.0)	245 (98.0)	
2D Echo Cardiomegaly (n=285)	11 (3.9)	274 (96.1)	0.371
No Cardiomegaly on 2D Echo (n=242)	6 (2.5)	236 (97.5)	

Table 6. Major Clinical Indications for 2D Echocardiography (N = 527)

Indication	Frequency	Percentage (%)
Cardiomegaly on Chest X-ray	128	24.3
Not Available (NA)	126	23.9
On Chemotherapy	85	16.1
To Rule Out Cardiac Involvement	70	13.3
Pre-Chemotherapy Workup	29	5.5
Completed Chemotherapy	20	3.8
Accidentally Detected Murmur	18	3.4
Others*	51	9.7

Figure 1: Diagnostic Correlation of Chest Radiography with 2D Echocardiography for Detection of Cardiomegaly

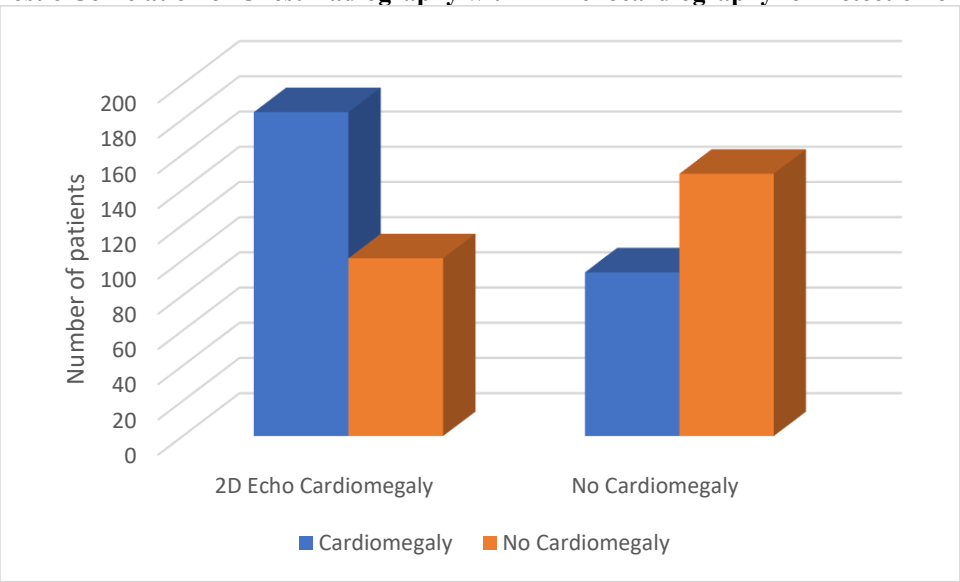
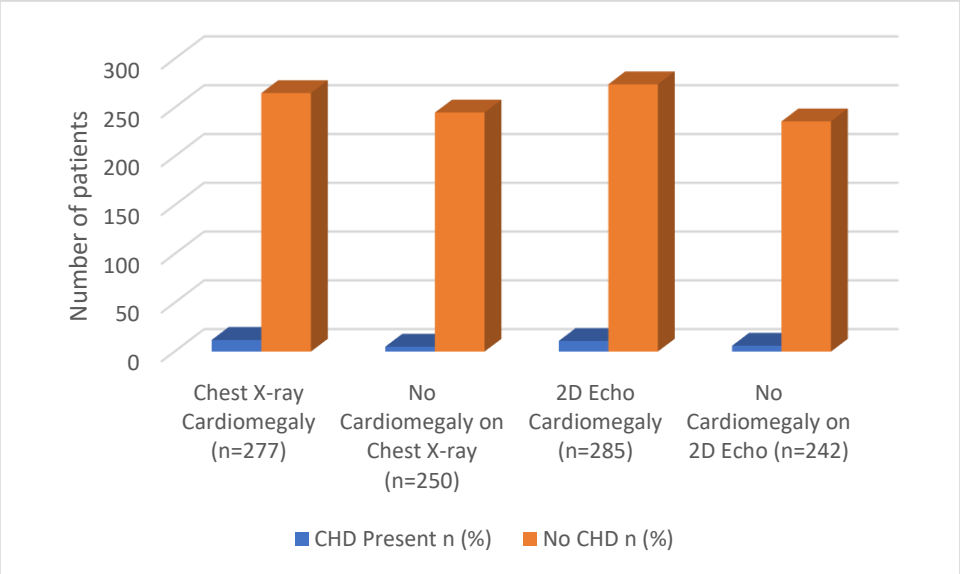


Figure 2:Association Between Cardiomegaly and Congenital Heart Disease



On the basis of Table 1, Baseline Demographic Characteristics of the Study Population; In the present study, a total of 527 pediatric patients were evaluated. The gender distribution showed that 321 (60.9%) were males and 206 (39.1%) were females, indicating a male predominance in the study population. Regarding age distribution, the majority of patients

belonged to the 5–10 years age group (164, 31.1%), followed by 1–5 years (155, 29.4%), >10 years (122, 23.1%), and ≤1 year (86, 16.3%). Thus, children between 1–10 years constituted the major proportion of the study participants.
In Table 2: Distribution of Cardiomegaly Detected by Chest X-ray and 2D Echocardiography; Among the 527 pediatric patients, cardiomegaly was detected in 277 (52.6%) patients on chest X-ray, whereas 250 (47.4%) patients did not show cardiomegaly on radiography. On 2D echocardiography, cardiomegaly was observed in 285 (54.1%) patients, while 242 (45.9%) patients had no cardiomegaly. The detection rate of cardiomegaly was slightly higher on 2D echocardiography compared to chest X-ray, suggesting better identification of cardiac enlargement by echocardiographic assessment.

Table 3 showed Correlation Between Cardiomegaly on Chest X-ray and 2D Echocardiography that The correlation between chest X-ray and 2D echocardiography showed that among the 277 patients diagnosed with cardiomegaly on chest X-ray, 184 (66.4%) were confirmed to have cardiomegaly on 2D echocardiography, while 93 (33.6%) did not show cardiomegaly on echocardiography. Among the 250 patients without cardiomegaly on chest X-ray, 101 (40.4%) were found to have cardiomegaly on 2D echocardiography, whereas 149 (59.6%) had no cardiomegaly.The diagnostic evaluation of chest X-ray using 2D echocardiography as the reference standard showed a sensitivity of 66.43% (95% CI: 60.67–71.73) and specificity of 59.60% (95% CI: 53.42–65.49). The positive predictive value was 64.56%, negative predictive value was 61.57%, and overall diagnostic accuracy of chest X-ray for detection of cardiomegaly was 63.19% (95% CI: 58.99–67.20).
On basis of Table 4, Age-wise Distribution of Cardiomegaly on Chest X-ray and 2D Echocardiography; The occurrence of cardiomegaly varied significantly across different age groups. On chest X-ray, the highest proportion of cardiomegaly was observed in children aged ≤1 year (62, 72.1%), followed by children aged >10 years (71, 58.2%), 5–10 years (76, 46.3%), and 1–5 years (68, 43.9%).On 2D echocardiography, cardiomegaly was also highest among children aged ≤1 year (64, 74.4%), followed by 1–5 years (88, 56.8%), >10 years (64, 52.5%), and 5–10 years (69, 42.1%). The association between age group and cardiomegaly was statistically significant for both chest X-ray ($p < 0.001$) and 2D echocardiography ($p < 0.0001$), indicating that age significantly influenced the presence of cardiomegaly.

Table 5 showed Association of Cardiomegaly with Congenital Heart Disease ,The association between cardiomegaly and congenital heart disease (CHD) was assessed. Among patients with cardiomegaly on chest X-ray, 12 (4.3%) had congenital heart disease, while 265 (95.7%) did not have CHD. Among those without cardiomegaly on chest X-ray, 5 (2.0%) had CHD and 245 (98.0%) did not have CHD. This association was not statistically significant ($p = 0.135$).Similarly, among patients with cardiomegaly detected on 2D echocardiography, 11 (3.9%) had CHD, whereas 274 (96.1%) did not have CHD. Among patients without cardiomegaly on echocardiography, 6 (2.5%) had CHD and 236 (97.5%) did not have CHD. The association between echocardiographic cardiomegaly and CHD was also statistically insignificant ($p = 0.371$).

Table 6 showed that Clinical Indications for Performing 2D Echocardiography, The most common indication for performing 2D echocardiography was cardiomegaly detected on chest X-ray (128, 24.3%), followed by patients who were on chemotherapy (85, 16.1%) and evaluation for cardiac involvement (70, 13.3%). Other indications included pre-chemotherapy workup (29, 5.5%), completed chemotherapy follow-up (20, 3.8%), and incidentally detected murmurs (18, 3.4%). A proportion of cases (126, 23.9%) had no specific indication recorded. Overall, chest X-ray findings of cardiomegaly represented the major reason for referral for echocardiographic evaluation in the pediatric population.

DISCUSSION

In the present study, 527 pediatric patients were evaluated to determine the correlation of cardiomegaly detected on chest X-ray (CXR) with 2D echocardiography. Cardiomegaly was detected in 52.6% (277/527) patients on chest X-ray and in 54.1% (285/527) patients on 2D echocardiography. The slightly higher detection rate by echocardiography indicates that echocardiography may identify cardiac enlargement more accurately due to its ability to directly assess cardiac chambers, ventricular dimensions, and cardiac function. Similar findings were reported by Satou et al., who evaluated pediatric patients undergoing both chest radiography and echocardiography and concluded that chest X-ray has limitations in accurately predicting true cardiac enlargement when compared with echocardiography.[11]

In the present study, the correlation between CXR and echocardiography showed that among patients with cardiomegaly on chest X-ray, 66.4% (184/277) were confirmed to have cardiomegaly on 2D echocardiography, whereas 33.6% (93/277) were not confirmed. Among patients without cardiomegaly on CXR, 40.4% (101/250) showed cardiomegaly on echocardiography. The overall diagnostic accuracy of chest X-ray was 63.19%, with sensitivity of 66.43%, specificity of 59.60%, positive predictive value of 64.56%, and negative predictive value of 61.57%. These findings suggest that although chest X-ray is a useful screening tool, it cannot completely replace echocardiography for confirmation of cardiomegaly. Satou et al. reported a sensitivity of 58.8% and specificity of 92.3% for chest radiography in detecting cardiac enlargement in children, emphasizing that CXR may have reduced sensitivity despite good specificity.

The present findings are also comparable with the study by Tomar et al., who evaluated pediatric cardiomegaly using chest X-ray and echocardiography and observed that chest radiography may overestimate cardiac size because of technical factors such as projection, lung pathology, and patient positioning. They emphasized echocardiography as the preferred modality for assessing true structural and functional cardiac enlargement.[12]

The age-wise analysis in the current study demonstrated a significant association between age group and cardiomegaly. Cardiomegaly on chest X-ray was highest among children aged ≤1 year (72.1%), followed by children >10 years (58.2%). Similarly, echocardiographic cardiomegaly was highest in children aged ≤1 year (74.4%). The significant association ($p < 0.001$ for CXR and $p < 0.0001$ for echocardiography) suggests that younger children may have a higher incidence of detectable cardiomegaly due to congenital heart disease, volume overload states, or increased referral for cardiac evaluation. Similar pediatric observations have been reported where cardiomegaly on radiographs was more frequently associated with younger age groups requiring cardiac evaluation.[13]

In the present study, congenital heart disease was detected in only 3.2% (17/527) of patients. Among children with cardiomegaly on chest X-ray, 4.3% (12/277) had congenital heart disease, whereas 2.0% (5/250) of children without cardiomegaly had CHD. However, this association was not statistically significant ($p = 0.135$). Similarly, cardiomegaly detected on 2D echocardiography was not significantly associated with CHD (3.9% vs 2.5%, $p = 0.371$). This indicates that cardiomegaly in pediatric patients may occur due to causes other than congenital structural abnormalities, including anemia, chemotherapy-related cardiac effects, inflammatory conditions, and physiological variations.

The relationship between anemia and cardiomegaly was also assessed in the study. No statistically significant association was observed between cardiomegaly and anemia. Similar results were reported by Amelia et al., who studied children with anemia using chest radiography and echocardiography and found no significant correlation between anemia and cardiomegaly.[14]

The major indication for performing 2D echocardiography in the current study was cardiomegaly detected on chest X-ray (24.3%), followed by patients on chemotherapy (16.1%) and evaluation for possible cardiac involvement (13.3%). This highlights that chest radiography continues to play an important role as an initial screening investigation in pediatric patients, with echocardiography being used as a confirmatory diagnostic modality.

Previous studies have also questioned the reliability of cardiothoracic ratio on chest radiography as a sole indicator of cardiac enlargement. A comparative study demonstrated that radiological cardiac measurements may correlate poorly with echocardiographic cardiac dimensions, particularly in children without established heart disease.[15] Similarly, systematic review evidence suggests that cardiothoracic ratio on chest radiography has variable sensitivity and specificity for predicting left ventricular enlargement, supporting the role of echocardiography as the definitive assessment tool.[16]

CONCLUSION

The current study shows that although chest radiography is a helpful first screening technique for suspected cardiomegaly in children, a number of technical and physiological issues restrict its ability to properly identify real heart enlargement. As a result, chest X-rays should be viewed more as screening than as a conclusive diagnosis tool, and echocardiography should be used to further assess suspicious instances. Increased cardiothoracic ratios on chest X-rays, suspected or confirmed heart abnormalities, incidental murmurs, systemic illnesses, and related congenital anomalies were among the many causes for echocardiography in infants. The incidence of cardiomegaly varied according to age, with younger children exhibiting a stronger propensity for heart enlargement. This highlights the significance of interpreting radiography results in an age-appropriate manner. All things considered, 2D echocardiography continues to be a crucial diagnostic technique for the verification and final assessment of pediatric cardiomegaly, especially when cardiomegaly is detected on chest radiography.

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