

Diagnostic Value of Chest Radiography in Pediatric Cardiovascular Diseases: A Retrospective Study in Tabriz, Northwest of Iran

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Abstract

Introduction

Chest X-ray is usually the first radiography performed for a newborn. This test is easily accessible and yet a basic screening method. Different results have been reported in various studies regarding the diagnostic value of chest X-ray in cardiovascular disease in children.

Materials and Methods

The study was carried out retrospectively using the medical files of 100 patients under 10 years of age who were referred to Tabriz Children's Hospital, Tabriz-Iran, during 2013-2014. The data obtained were analyzed with SPSS-17. The mean difference test was used to compare the quantitative variables.

Results

Fifty-two patients (52%) were male. Their mean age was 4.54 ± 1.22 (0-108) months, and the patients' mean weight was 4.38 ± 0.34 (1.25-27) kg. Cardiovascular examination and radiology report were negative in 70% and 57% of the patients, respectively, while cardiologic assessments revealed cardiovascular problems in 70% of the cases. The diagnostic accuracy, sensitivity, and specificity, and the positive and negative predictive value of chest X-ray in this study were 61%, 80%, 53%, 86%, and 42%, respectively. In addition, gender, age, weight, the presence or absence of clinical signs, and the type of cardiovascular disease had no effect on the diagnostic accuracy of chest X-ray.

Conclusion

According to the results, chest radiography cannot be referred to as a test to confirm or rule-out cardiovascular disease in children. Therefore, when a cardiovascular disease is suspected in physical examination, echocardiography can be recommended without a need for chest X-ray.

Key Words: Cardiovascular, Chest X-ray, Children, Value.

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Introduction

New imaging systems have provided novel areas for accurate detection of congenital cardiovascular disease in children. Magnetic resonance imaging (MRI) and Computerised tomography (CT) scan are now more preferred than the invasive methods such as cardiovascular angiography, however, chest X-ray is the most applied radiography test (1-4).

According to literature, congenital heart disease (CHD) account for 3 to 12 cases in 1,000 live births. Most studies using color-Doppler echocardiography have reported higher incidence, which means that this method had facilitated the detection of asymptomatic lesions (5, 6).

Chest X-ray is usually the first radiography performed for a newborn. This test is easily accessible and yet a basic screening method. Digital radiography has improved this method. However, it should be noted that observation of certain issues is of great importance in its performance and interpretation. The quality of radiography is also important for differentiating minor cases, and the significance of resolution needed for radiography is comparable with those of mammography (7).

Although digital radiography has eliminated the problem of underexposed and overexposed radiographies, observing the following issues are still necessary: radiation of beam during a sufficient inhalation which is confirmed by the shadow of right hemi-diaphragm under the posterior eighth rib; and no rotation of the child and symmetry of the ends of ribs and the inner ends of clavicles as possible. Over-lordosis and over-kyphosis can also affect the appearance of heart lines and should be avoided. There is also controversy regarding the number of radiographies and the way they are performed, however, it seems that anterior, lateral, and two oblique views are sufficient (8).

Interpretation and assessment of heart and lungs is more difficult in immature newborns or infants than in children. In fact, they have no cooperation and their respiratory rates are higher. Moreover, respiratory assist devices such as respirators, as well as venous and arterial lines and feeding tubes, may also disturb appropriate positioning of the patient and prevent the effective and proper radiation. For a precise interpretation of chest X-ray in newborn suspected to cardiovascular disease, some points should be particularly noticed; they include pulmonary vessels, aerated regions, pulmonary parenchyma, esophagus, aorta and pulmonary vessels trunk, bones, and the position of organs (9).

Different results have been reported in various studies regarding the diagnostic value of chest X-ray in cardiovascular disease in children (9-16). Given the insufficient research in Iran and the importance of timely diagnosis of congenital heart diseases, and since the findings in previous studies are hardly consistent, the present study aimed at evaluating the diagnostic value of this method in children with cardiovascular disease.

Materials and Methods

The study was carried out retrospectively using the medical files of 100 patients under 10 years of age who were admitted to Tabriz Children's Hospital, Tabriz- Iran, during 2013-2014. The patients suspected to cardiovascular disease by a physician through physical examination underwent chest X-ray, and then were examined by a children cardiologist in terms of cardiovascular disease. All patients' information including age, gender, weight, chief complaint, the radiologist comment, and the final diagnosis were extracted from the patients' files.

To make the final diagnosis, all patients underwent necessary assessments ordered by the children cardiologist, including ECG, echocardiography, and if necessary, CT angiography and MRI. The obtained data were analyzed with SPSS-17 software.

The statistical analyses were performed through descriptive methods (frequency, percent, mean, standard deviation), and Chi-square and Kappa tests were used to compare the qualitative variable. The mean difference test was used to compare the

quantitative variables. P-values less than 0.05 were considered significant.

Results

Fifty-two patients (52%) were male. Their mean age was 4.54 ± 1.22 (0-108) months, and their mean weight was 4.38 ± 0.34 (1.25-27) kg. Cardiovascular examination and radiology report were negative in 70% and 57% of the patients, respectively, while cardiologic assessments revealed cardiovascular problems in 70% of the cases (Table.1).

Table 1: Demographic information and the prevalence of clinical findings, radiology report, and positive cardiology diagnosis in the studied patients

| Variables | Frequency (%) | |
|----------------------------------|---------------|-----------------|
| Gender | Male | 48 (48%) |
| | Female | 52 (52%) |
| Cardiovascular clinical findings | + | 30 (30%) |
| | - | 70 (70%) |
| Radiology report | + | 43 (43%) |
| | - | 57 (57%) |
| Cardiology diagnosis | + | 70(70%) |
| | - | 30 (30%) |
| Age (months) | Mean \pm SD | 4.54 ± 1.22 |
| | Range | 0-108 |
| Weight (kg) | Mean \pm SD | 4.38 ± 0.34 |
| | Range | 1.25-27 |

Table.2 shows that the radiology report was consistent with cardiology diagnosis (kappa=0.26). The diagnostic accuracy, sensitivity, and specificity, and the positive and negative predictive values of chest X-ray in this study were 61%, 80%, 53%,

86%, and 42%, respectively. In addition, gender, age, weight, the presence or absence of clinical signs, and the type of cardiovascular disease had no effect on the diagnostic accuracy of chest X-ray (Table.3).

Table 2: The consistency of radiology report with final diagnosis in the studied patients

| Variable | Cardiology diagnosis | | Kappa | P-value | |
|------------------|----------------------|------------|------------|---------|-------|
| | - | + | | | |
| Radiology report | + | 6 (14%) | 37 (86%) | 0.26 | 0.002 |
| | - | 24 (42.1%) | 33 (57.9%) | | |

Table 3: The effect of demographic factors, clinical findings, and the type of cardiovascular disease on the diagnostic accuracy of chest X-ray in the studied patients

| Variables | Accuracy | | P-value | |
|----------------------------------|--------------------------------|-------------|-------------|---------|
| | + | - | | |
| Gender | Female | 29 (60.4%) | 19 (39.6%) | 1.00* |
| | Male | 32 (61.5%) | 20 (38.5%) | |
| Age (months) | | 5.72 ± 1.91 | 2.70 ± 0.88 | 0.16** |
| Weight (kg) | | 4.73 ± 0.50 | 3.83 ± 0.41 | 0.16** |
| Cardiovascular clinical findings | - | 39 (55.7%) | 31 (44.3%) | 0.12* |
| | + | 22 (77.3%) | 8 (26.7%) | |
| | Reduced pulmonary blood flow | 3 (60.0%) | 2 (40.0%) | |
| | Increased pulmonary blood flow | 29 (50.9%) | 28 (49.1%) | |
| Cardiovascular disease | Left heart obstructive lesions | 5 (100.0%) | 0 (0.0%) | 0.05*** |
| | Other conditions | 19 (59.4%) | 13 (40.6%) | |
| | Pulmonary artery hypertension | 13 (68.4%) | 2 (31.6%) | |
| | Normal | 24 (80.0%) | 6 (20.0%) | |

* Chi-square; ** Independent samples test; *** Chi-square (by Mont Carlo method)

Discussion

Chest X-ray is usually the first radiography performed for a newborn. Although new imaging systems have provided novel areas for detection of cardiovascular disease in children, chest X-ray is the most utilized radiography test. Mixed results have been reported in various studies regarding the diagnostic value of chest X-ray in cardiovascular disease in children.

Cardiovascular disease is usually suspected when three main criteria are noticed in an antero-posterior chest X-ray:

1. Heart image size to chest diameter;
2. Pulmonary vessels appearance;
3. Heart image.

According to Smevik, chest radiography should not be used for a definitive diagnosis of cardiovascular disease and congenital malformation; however differences in the signs should not be ignored (9).

In this study, the radiology report were consistent with cardiology diagnosis in 26% of the cases, therefore, like the study of Smevik, the diagnosis of cardiovascular disease cannot be confirmed or ruled out based on chest radiography.

Laya *et al.* (10) reported the accuracy of chest X-ray in the diagnosis of congenital heart disease as 71%, which is low and

similar to that of the present study (nearly 61%). According to the result of Higgins (11), echocardiography and magnetic resonance imaging (MRI) have a significant impact on the diagnosis of cardiovascular disease, which is also evident in the present study. In the study by Danford *et al.* (12), chest X-ray increased the power of diagnosis in patients with medium and large ventricular septal defects. However, the type of cardiovascular disease had no effect on the accuracy of chest radiography in the present study.

In the study by Birkebeak *et al.* (13), the number and the age range of patients were similar to our study. The sensitivity of the test was low, and its specificity was high in both studies, however, in contrast to the former study, the positive value of the test was higher than the negative predictive value in this study. Similar to Laya and Birkebeak, Temmerman *et al.* (14) did not recommend the chest X-ray for confirmation or ruling out the cardiovascular disease. In the present study, patients' age, gender, and weight, as well as the presence or absence of cardiovascular specific signs, and the type of cardiovascular disease had no significant effect on the diagnostic accuracy of chest radiography.

Conclusion

Results showed that the chest radiography cannot be referred to as a test to confirm or rule out cardiovascular disease in children. Therefore, when a cardiovascular disease is suspected in physical examination, echocardiography can be recommended without requiring chest X-ray. In addition, if there is a suspected heart disease in chest radiography, it should be confirmed or ruled out through echocardiography, and if necessary, through CT angiography, MRI, or invasive angiography. As a final remark, given the results obtained, more extended studies with large sample size are suggested.

Conflict of interests: None.

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