

# CONTRIBUTION OF RADIOLOGICAL FINDINGS IN EVALUATING CARDIAC INVOLVEMENT IN HIV POSITIVE PATIENTS

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**Abstract:** *The paper presents a study of radiologic modifications associated with heart involvement in HIV positive patients. Its main goal is to assess the value of X-ray investigations as a tool to diagnose heart pathology typical for this group of patients. The main characteristics of the subjects included in the study were age below 18 and horizontally acquired HIV infection. Our results validate the screening test value of the radiologic method for diagnosing pulmonary hypertension and left ventricle hypertrophy and the necessity of an additional echocardiographic examination for a positive diagnosis. The method also proves to be reliable in diagnosing cardiomegaly.*

**Key words:** *chest X-ray, heart pathology, HIV.*

## 1. Introduction

The X-ray examination of the heart is considered to be a compulsory stage in the evaluation of any cardiac patient. It offers important morphological data regarding the global size of the organ and its cavities, the major vessels, the pericardium and also regarding the pulmonary circulation and the hemodynamic impact of heart failure.

The main radiological techniques are the radioscopy and the radiography using different views; the CT scan is used to assess the pericardium and heart tumors and not so much the morphology of the heart. The angiography is usually performed when a surgical treatment is

anticipated, which is unlikely in the HIV infected child and teenager.

The chest X-ray examination of an HIV patient is very simple and affordable procedure but the information it provides is limited compared to echocardiography which is very valuable for a proper assessment of any morphological alterations and also compared to the electrocardiography, the golden standard when it comes to heart rhythm and conduction disorders. The chest X-ray offers important information regarding the pulmonary parenchyma, often affected in HIV patients, which in return has an important impact on heart function.

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## 2. Objectives

The study assumes that the most common morphological findings typical for heart condition in an HIV infected patient, such as heart hypertrophy, partial or global dilation of its chambers or modifications secondary to pulmonary hypertension can be readily detected by Rx examinations [15].

The goal of the study is to assess the effectiveness of the x-ray examinations in determining the extent of the heart involvement in young HIV positive patients, also its sensitivity and specificity compared to echocardiography. The study also aims to analyze the prevalence of pathological heart Rx findings in such patients.

## 3. Material and Methods

We went for a prospective cohort longitudinal study. It took place between January 2002 and January 2009. The cases included HIV infected children and teenagers monitored by Mures Regional Center for HIV Infection Monitoring and Treatment.

The inclusion criteria were HIV infection, age below 18 and horizontal transmission.

The lot was comprised of 146 patients. All of them underwent yearly chest X-ray examinations using 2 views – posteroanterior and left lateral. Patients suffering from respiratory infections required supplementary radiological investigations. Lung and heart diseased patients were examined more frequently. The two annual Rx exposures combined amount to 0.4 mSv (micro Silvert), way below the threshold accepted as safe in our country – 5-20 mSv.

In order to get images of the right ventricle we used the left anterior oblique view. On selected patients we used the

right anterior oblique view to visualize the pulmonary artery. Occasionally radioscopy was used instead of the oblique radiological views.

On posteroanterior radiographies we identified the right inferior arch corresponding to the right atrium, the right superior arch corresponding to the superior vena cava, and the left inferior, middle and upper arch corresponding to the left ventricle, pulmonary artery and aortic button respectively. An increased heart size prompted us to calculate the cardiothoracic index. However, having many children with abnormally low weights made the index less relevant therefore we didn't place much emphasis on it.

We evaluated the pulmonary circulation and the pulmonary parenchyma aspect considering that a chronic pulmonary condition could lead to hypoxia and pulmonary hypertension through restrictive dysfunction. A pulmonary alteration was considered chronic if it persisted for at least 3 months on consecutive radiological examinations.

The lateral views were used to assess right ventricle enlargement (narrowed retrosternal space) and left ventricle enlargement (narrowed prevertebral space).

All the data was stored using Microsoft Office Excel 2003 and analyzed using nonparametric quantification.

## 4. Results

On an X-ray image left ventricular hypertrophy presents as an increase in the length and convexity of the lower inferior arch in the posteroanterior view and narrowing of the prevertebral space or even touching the spine on the lateral view. Using the left anterior oblique view the heart shadow can appear as overlapping the spine [3], [4], [16]. A cardiothoracic index over 55% could mean the same thing

but lacking an echography it's hard to tell whether it's caused by hypertrophy or chamber dilation [3]. A large number of patients (in excess of 35%) presented delayed growth leading to an obvious discrepancy between heart and chest development and high cardiothoracic index. It is for that reason that the index was not used to assess the existence and degree of left ventricle hypertrophy.

A global cardiomegaly leads to cavity enlargement and posterior movement of the heart, creating a false left ventricular hypertrophy appearance on left lateral views and differential diagnosis difficulties.

Throughout the study, 43.83% of the patients presented an enlarged left inferior arch and 8.21% narrowing of the retrocardiac space, both suggestive of left ventricular hypertrophy. The difference in percentages is due to the late posterior migration of the heart during the development of the left ventricular hypertrophy [3].

Table 1

*Accuracy of radiological diagnosis of left ventricular hypertrophy*

Left ventricular hypertrophy	%
Sensitivity	73,33%
Specificity	72,41%
Positive predictive value	40,74%
Negative predictive value	91,30%

Comparing radiological findings with echography we found a decent sensitivity (73.33%) and specificity (72.41%), but a very low predictive value (40.74%) as a result of the large number of left ventricular hypertrophy false positives (n=32). The negative predictive value is very high (91.30%), meaning that normal radiological findings make the left ventricular hypertrophy quite unlikely.

The pulmonary hypertension has several radiological landmarks: hilar vessel dilation, right pulmonary artery diameter over 20 mm, well defined hilar vessel design abruptly merging into a poorly defined vascular design on the periphery, hilar vessel pulsatility on radioscopy, pulmonary fields hyper transparency, straightening of the left middle arch then the development of a convex left middle arch [3], [4], [16]. The evolution of the pulmonary hypertension towards right heart failure leads to enlargement of the right atrium appearing as an increase of the right inferior arch on the posteroanterior view, followed by right ventricle enlargement appearing as a double contour or narrowing of the retrosternal space in the lateral view. The pulmonary arteries trunk can be well seen on a right anterior oblique view, seldom used in practice though [3], [4], [16]. Although numerous, none of the radiological signs described above offers confidence that we're dealing with a pulmonary hypertension case.

The X-ray examination of the pulmonary parenchyma is crucial in identifying a pulmonary disease capable of inducing pulmonary hypertension through hypoxia.

36.98% of the cases (n=55) had an abnormally large left middle arch. The high percentage includes patients with pulmonary hypertension of various causes: global heart failure, chronic pulmonary heart disease due to pulmonary disease or even what appears to be primary pulmonary hypertension associated with the HIV infection.

Only a minority of the children (n=12) presented a right pulmonary artery diameter over 20 mm. The measurement was sometimes difficult in view of hilar pathology.

Regarding pulmonary circulation we noticed increased vascular pedicles (n=13), dilated (n=11) or pulsatile (n=10) hilar vessels, poor peripheral vascular design

and hyper-transparent lung in 6 patients. Globally we noted radiological signs of an altered pulmonary circulation in 8.90% of the children (n=13). The percentage is low compared to echography which shows pulmonary hypertension in 27 of the patients (23.08%), due to late modifications of the pulmonary circulation during the natural course of the pulmonary hypertension syndrome.

An indirect but useful marker of pulmonary hypertension was atrial hypertrophy – diagnosed on posteroanterior views where it shows as an enlarged right inferior arch, and right ventricular hypertrophy seen on lateral views as narrowing of the retrosternal space [1], [3]; only one patient had double contour of the right inferior arch.

11 patients (7.53%) presented right ventricular hypertrophy in isolation, without cardiomegaly. All patients displaying radiological signs of pulmonary hypertension also had right ventricular hypertrophy.

Table 2

*Accuracy of radiological diagnosis of pulmonary hypertension.*

Pulmonary hypertension	%
Sensitivity	70,58%
Specificity	81,00%
Positive predictive value	66,66%
Negative predictive value	89,01%

The radiological diagnosis of pulmonary hypertension syndrome obtained by measuring the left middle arch has a relatively low sensibility and specificity compared to echography (70.58% and 81% respectively). The positive predictive value of an identified lesion is small (66.66%). The negative predictive value is quite good though (89.01%).

Only 10 patients, representing 6.84%, presented pulmonary parenchyma

alterations lasting over 3 months, possibly causing the pulmonary hypertension syndrome. The most common were tuberculosis sequelae, fibrotic sequelae following pleuropulmonary staphylococcal infection and in one case fibrotic lesions of uncertain origin.

Diagnosing heart failure in children with HIV by X-ray had several particularities. The study was based on 3 criteria: the size of the cardiac shadow, the heart configuration and the state of the pulmonary and systemic circulation.

The most important radiological sign is the size of the heart, best assessed by cardiothoracic index which is normally below 0.5 [3], [4]. However for reasons already discussed we considered the index of little relevance in our particular context. For a threshold of 0.6 we obtained statistically significant data that fits the echographic findings.

The usual radiological signs denoting increased venous and capillary pressure in the lungs are often less meaningful in patients with HIV due to the specific lung pathology leading to modified hilar and interstitial design. The classical signs of systemic venous hypertension such as superior vena cava dilatation or azygos vein dilatation were not identified among our cases [3], [4], [16].

We were left with two radiological criteria to determine heart failure: heart dilation and alveolar stasis alterations.

By using the criteria above we found global heart enlargement in 25 patients, representing 17.12% of the lot. Radiological modifications associated with pulmonary vascular stasis were found only in 2.05% of the cases, being transitory, determined by infections aggravating the heart failure symptoms and having little value as a useful diagnostic tool.

The sensitivity (81.81%), specificity (94.35%), positive predictive value (72%) and negative predictive value (96.69%) of

the radiological findings used to assess the global enlargement of the heart show a good correlation with the echography.

The X-ray diagnostic of exudative pericarditis was simple except for patients with a very low amount of liquid where echography was needed. We diagnosed 4 cases of exudative pericarditis (2.75%), all having a classical aspect [3], [4], [16]. The small number of patients doesn't warrant any kind of statistical analysis. We had no cases of constrictive pericarditis or pericardial calcifications.

## 5. Discussions

The rich semiology imposes the X-ray examination as very useful in investigating the cardiovascular apparatus. For HIV patients the method is limited for 2 reasons. The first one is that radiological investigations offer good morphological data but very little functional ones. The second is represented by the associated pulmonary pathology making objective interpretation of data more difficult [10].

On the other hand X-ray examinations are cheap and have long become routine for any cardiologic evaluation of the HIV positive patient. The method is noninvasive but the irradiation exposure should be kept in check.

Numerous studies confirm the necessity of a radiological exam in monitoring heart involvement for all HIV infected patients, considering that yearly chest X-ray examinations are optimal [5], [12]. The radiological examinations are useful in showing that we have a pathological state of the cardiovascular apparatus but are not the best tools when it comes to identifying the exact nature of the underlying condition. For differential diagnosis the echocardiography is better equipped to provide answers [7], [9], [13].

The statistical analysis of the data was focused on 3 pathological entities: left

ventricle hypertrophy, pulmonary hypertension syndrome and heart failure.

The left ventricle hypertrophy is the most common heart alteration seen in HIV positive patients [6], [17]. Judging by echocardiography it is present in 25-36% of HIV infected children [2], [12], [14]. Its prevalence when diagnosed by radiology is 43.83% among our cases, which is similar to our previous data where we found it in 34.04% on a smaller group of patients [9].

Our statistical findings suggest that the X-ray leads to over diagnosing this lesion and cannot be recommended as a reliable tool for a positive diagnosis. Among the main reasons we offer the particular morphological features of the thoracic cage in children but also the false positives generated by heart dilation and right ventricle hypertrophy secondary to pulmonary hypertension [3]. Moreover an incipient left ventricular hypertrophy cannot be diagnosed radiologically. However some studies have used the cardiothoracic index to diagnose cardiomegaly, considering it to be pathological above 0.5 [17]; other authors prefer a more subjective approach for reasons that we previously described, and we have adopted the same position. The good negative predictive value of the radiological examination warrants it as an excellent screening tool. Its low sensitivity and specificity impose the echocardiography as a compulsory investigation and many authors drop X-ray examinations for left ventricular hypertrophy altogether [5], [7], [12].

The X-ray findings in cases of pulmonary hypertension are very rich and different authors use various criteria to diagnose it. Kim and collaborators see a diameter of over 16 mm for the descending branch of the right pulmonary artery as pathological; also a left pulmonary artery diameter over 18 mm combined with poor peripheral design and enlargement of the

right cavities[11]; Friese and collaborators use a different number for the descending right pulmonary artery diameter – 20 mm [8]. Our criteria are the ones used by Edwards: enlargement of the left middle arch, the descending branch of the right pulmonary artery over 20 mm, enlargement of the right ventricle on lateral views; additionally we took into account the pulmonary parenchyma modifications [3]. By using these criteria we found the syndrome in 36.98% of our patients, similar to data found in medical literature. Sharon and collaborators found a prevalence of 17.23% on a sample of 23 children, and Mast and collaborators found it 46.66% of their cases [12]. Again the low positive predictive value (66.66%) suggests that echocardiography is necessary. However the chest X-ray remains very useful because if it is normal chances are that the patient has no pulmonary hypertension, in view of the examination's high negative predictive value (89.01%).

Table 3

*Accuracy of radiological diagnosis of cardiomegaly*

Cardiomegaly	%
Sensitivity	81,81%
Specificity	94,35%
Positive predictive value	72,00%
Negative predictive value	96,69%

Even though the X-ray examination has both good sensitivity and specificity in identifying cardiomegaly, and also has good positive and negative predictive values, it is not used to diagnose heart failure except for late stages. The main tools used to this end are the rich clinical signs and the echography, whereas the X-ray has just a secondary role, being unable to provide information about the functional parameters of the heart [5], [7], [13], [18].

The radiologic criteria used to diagnose heart failure were global heart dilatation combined with pulmonary alveolar and venous stasis. These modifications have such a rich semiology that no author deems necessary to use objective criteria except the cardiothoracic index and maybe the alveolar edema [3]. Among our patients the pulmonary stasis modifications had a low prevalence, being of little use to the positive diagnosis. The global heart enlargement has a prevalence (17.12%) that comes very close to the ones found in literature – see Mast and collaborators (17.77%).

Using X-ray imaging to diagnose pericardial collections can be very useful. The literature points to a rate of 11% a year pericardial effusions in HIV patients [14], most of which remaining undiagnosed as shown by both necroptic and clinical studies proving conclusively that at least 200-300 ml of pericardial liquid are needed to be noticed on the X-ray image [3], [16]. Since we found only 4 cases of pericarditis we couldn't conduct any statistical analysis on this topic.

Last but not least the radiologic examination of the lung is useful for any cardiological evaluation since various pulmonary pathologies have an impact on heart functions [15]. Chronic pulmonary heart disease is a reality for HIV patients with repeated pulmonary infections reaching the adult age [10].

## 6. Conclusions

1. The radiologic examination of the heart in children with HIV is difficult given the particular morphological features associated with delayed growth and the sequelae resulting from lung infections.
2. The low sensitivity, specificity and positive predictive value compared to the echocardiography render the X-ray examination ineffective in establishing

a positive diagnosis of left ventricular hypertrophy.

3. Compared to the echocardiography the radiologic method has a weaker sensitivity, specificity and positive predictive value for pulmonary hypertension, making it useful only as a preliminary investigation but insufficient to use in isolation. Echocardiographic confirmation is required.
4. The high negative predictive values make the X-ray examination useful as a screening tool for diagnosing left ventricular hypertrophy and pulmonary hypertension in children with established HIV infection.
5. The global enlargement of the heart as diagnosed by radiology has good sensitivity, specificity, positive and negative predictive value in comparison with echocardiography.

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