Value of the Radiological Study of the Thorax for Diagnosing Left Ventricular Dysfunction in Chagas' Disease

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Objective *- To determine the value of the radiological study of the thorax for diagnosing left ventricular dilation and left ventricular systolic dysfunction in patients with Chagas' disease.*

Methods *- A cross-sectional study of 166 consecutive patients with Chagas' disease and no other associated diseases. The patients underwent cardiac assessment with chest radiography and Doppler echocardiography. Sensitivity, specificity, and positive and negative predictive values of chest radiography were calculated to detect left ventricular dysfunction and the accuracy of the cardiothoracic ratio in the diagnosis of left ventricular dysfunction with the area below the ROC curve. The cardiothoracic ratio was correlated with the left ventricular ejection fraction and the left ventricular diastolic diameter.*

Results *- The abnormal chest radiogram had a sensitivity of 50%, specificity of 80.5%, and positive and negative predictive values of 51.2% and 79.8%, respectively, in the diagnosis of left ventricular dysfunction. The cardiothoracic ratio showed a weak correlation with left ventricular ejection fraction (r=-0.23) and left ventricular diastolic diameter (r=0.30). The area calculated under the ROC curve was 0.734.*

Conclusion *- The radiological study of the thorax is not an accurate indicator of left ventricular dysfunction; its use as a screening method to initially approach the patient with Chagas' disease should be reevaluated.*

Key words: chest radiography, left ventricular dysfunction, Chagas' disease

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Chagas' disease currently affects 20 million individuals in Latin America [1]. In Brazil, approximately 5 million chagasic patients exist [1,2]. Chagas' disease has a wide variety of clinical presentations, ranging from completely asymptomatic individuals, who represent the great majority of the patients, to others with severe, sometimes fatal, cardiac alterations. Of the indicators of a poor prognosis, left ventricular dysfunction stands out as the major predictor of morbidity and mortality [3-7].

The radiological study of the thorax is a routine investigative method to initially assess patients with Chagas' disease, aiming at detecting cardiac impairment and at characterizing the clinical form of the disease.[8] In other cardiac diseases, however, conventional radiography of the thorax is known not to allow an accurate assessment of the degree of ventricular dysfunction [9,10].

We determined the value of the radiological study of the thorax in the diagnosis of left ventricular dilation and left ventricular systolic dysfunction on Doppler echocardiography of patients with Chagas' disease. The prevalence of echocardiographic and electrocardiographic alterations predictive of a worse prognosis in patients with a normal and enlarged cardiac silhouette was also determined.

Methods

To determine the value of chest radiography for detecting left ventricular dilation and left ventricular systolic dysfunction in patients with Chagas' disease, we carried out a cross-sectional study on 166 consecutive patients with Chagas' disease, whose ages ranged from 21 to 70 years. The patients were selected from the Referral Outpatient Care Unit for Chagas' Disease of the Hospital das Clínicas of the Universidade Federal de Minas Gerais and in the "Orestes Diniz" Training and Referral Center for Infectious and Parasitic Diseases according to inclusion and exclusion criteria from January 1998 to July 1999.

Individuals with positive serology for *Trypanossoma cruzi* according to 2 different techniques or more, including indirect immunofluorescence, indirect hemagglutination, and ELISA were considered chagasic.

The exclusion criteria were as follows: 1) impossibility or no availability to perform the examinations; 2) systemic arterial hypertension, operationally defined as blood pressure ≥ 160/95 mmHg, or use of hypotensive drugs; 3) history compatible with coronary heart disease, according to clinical evaluation; 4) previous episode suggestive of acute rheumatic disease; 5) diabetes mellitus or reduced tolerance to glucose, according to the definition of the National Diabetes Data Group; 6) thyroid dysfunction manifested as abnormal levels of thyroid stimulating hormone (TSH) and free thyroxin (T_4F); 7) renal failure, defined as an increase in the serum levels of creatinine (> 1.2 mg/dL for females and > 1.5 mg/dL for males) and urea (> 36 mg/dL for females and > 42 mg/dL for males); 8) chronic obstructive pulmonary disease, according to the presence of suggestive history, physical examination, electrocardiogram, and radiological alterations; 9) electrolytic and fluid disorders (serum levels of sodium > 145 mg/dL and serum levels of potassium > 5.5 mg/dL); 10) significant anemia defined as hemoglobin < 10 g/dL; 11) alcoholism, defined as a mean week consumption above 420 g of ethanol (daily mean > 60g of ethanol); 12) any other acute or chronic significant systemic disease; 13) pregnancy defined by the laboratory finding of plasma levels of chorionic gonadotropin > 5 mUImL; and 14) presence of atrial fibrillation or implanted pacemaker.

All individuals selected underwent complementary investigations, which comprised chest radiography in posteroanterior and lateral views and Doppler echocardiography. The examinations proposed were performed with the written informed consent of all patients taking part in the study, which was approved by the Committee on Ethics in Research of the Federal University of Minas Gerais (UFMG). The well being and rights of all patients studied were considered.

Chest radiography was performed according to the conventional technique at the Radiological Unit of the Hospital das Clínicas of the UFMG and analyzed by one observer who ignored the echocardiographic findings. The cardiac silhouette and the cardiothoracic ratio were assessed. The cardiothoracic ratio was obtained by the relation between the transverse diameter of the heart and the transverse diameter of the thorax at the level of the right diaphragmatic cupula. The transverse diameter of the heart was calculated by adding the greatest segment obtained in the cardiac area to the right of the central axis (T_1) and the greatest segment obtained in the cardiac area to the left of the central axis (T_2) (fig. 1).

The echocardiographic parameters were obtained by an experienced echocardiographer, who ignored the findings of the chest radiography, and used HDI 5000 equipment. The measurements of the M mode and of the contractility of the regional wall were performed according to the recommendations of the American Society of Echocardiography [11]. The ejection fraction was obtained with the Simpson method (fig. 2), and the score of motility of the left ventricular wall was obtained by using the model of 16 segments.

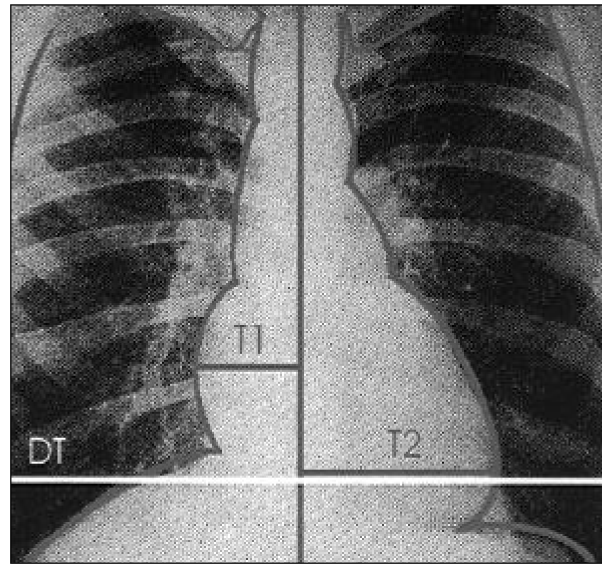

Fig. 1 – Conventional chest radiography. The cardiothoracic ratio was obtained dividing the transverse diameter of the heart by the transverse diameter of the thorax at the level of the right diaphragmatic cupula. The transverse diameter of the heart was calculated by adding the greatest segment obtained in the cardiac area to the right of the central axis (T_1) and the greatest segment obtained in the cardiac area to the left of the central axis (T_2).

Left ventricular dysfunction was defined by the presence of left ventricular dilation (left ventricular diastolic diameter > 55 mm) or depressed ejection fraction (ejection fraction < 0.50), or both, obtained on Doppler echocardiography.

The cardiac silhouette was classified as normal or enlarged based on the subjective analysis of the cardiac area observed on chest radiography in posteroanterior and lateral views. Chest radiography with a cardiothoracic ratio greater than 0.50 or an enlarged cardiac silhouette, or both, was considered abnormal.

The quantitative variables were described by the mean and standard deviation or the median and interquartile range; the qualitative variables were described by frequency. The correlation between them was obtained with the Spearman correlation coefficient. The patients with a significant discordance between the chest radiographic findings and those on Doppler echocardiography were identified and their cases were carefully reviewed. The normality test for quantitative variables (Ryan – Anderson) and the Bartlett test for homogeneity of variance were performed. In all tests, $p<0.05$ was used for rejecting the null hypothesis.

The sensitivity, specificity, and positive and negative predictive values of the abnormal chest radiography on the diagnosis of left ventricular dysfunction were calculated. The performance of the different values of the cardiothoracic ratio on the detection of left ventricular dysfunction in patients with Chagas' disease was assessed with the ROC (receiver-operator-characteristic) curve. The area below the

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curve varies from zero to 1 and measures the accuracy of a diagnostic test. Considering 0.5 as the cut point established in the literature [12,13], the sensitivity, specificity, and positive and negative predictive values of the cardiothoracic ratio on the diagnosis of left ventricular dysfunction were calculated.

The patients were divided into 2 groups according to the finding of normal or enlarged cardiac silhouette. In each group, the characteristics of the indices obtained on Doppler echocardiography (left ventricular diastolic diameter, ejection fraction, regional contractility, presence of aneurysm, and left ventricular diastolic function) and on electrocardiography (duration of the QRS complex, heart rate, presence of ventricular extrasystoles, and intraventricular blocks) were assessed. The cardiac silhouette was confronted with the cardiothoracic ratio. The comparisons were performed with ANOVA, the Kruskal-Wallis test or the Pearson chi-square test, depending on the type and distribution of the variable studied.

Results

The study comprised 166 patients with Chagas' disease, 55% of whom were males, and their ages ranged from 21 to 70 (mean = 42.6) years. Forty-eight (29%) patients had left ventricular dysfunction.

The abnormal chest radiogram had a sensitivity of 50%, specificity of 80.5%, and positive and negative predictive values of 51.2% and 79.8%, respectively, in diagnosing left ventricular dysfunction.

The cardiothoracic ratio correlated weakly with the ejection fraction (r = -0,23; 95% CI = -0.37 to -0.08; p<0.05) and with the left ventricular diastolic diameter (r = 0.30; 95% CI = 0.15 to 0.43; p<0.05) (fig. 3). The cardiothoracic ratio greater than 0.5 showed sensitivity of 41.7%, specificity of 88.1%, and positive and negative predictive values of 58.9% and 78.7%, respectively, in detecting left ventricular dysfunction. The area calculated under the ROC curve was 0.734±0.04 (fig. 4).

Table I - General, echocardiographic, electrocardiographic, and radiological characteristics of chagasic patients with normal and enlarged cardiac silhouette

	Normal silhouette	Enlarged silhouette	P
Absolute number	119	47	
Age (years)#	41.9 ± 9.0	45.9 ± 10.6	0.02
Males	57	50	0.54
LVd (mm)*	50 (29-74)	55 (46-77)	<0.01
LVd > 55 mm	19	49	<0.01
EF (%)*	62 (26-69)	57 (23-72)	<0.01
EF < .50	11	43	<0.01
LVD	20	51	<0.01
Aneurysm	18	28	0.27
Score *	1.00 (1-2.61)	1.31 (1-2.81)	<0.01
Diastolic dysfunction	8	33	<0.01
HR #	64.1 ± 11.7	62.5 ± 10.7	0.74
QRS (ms)#	0.095 ± 0.024	0.119 ± 0.030	<0.01
VES	7	19	0.01
RBBB	19	55	<0.01
CTR*	0.44 (0.34-0.49)	0.52 (0.42-0.52)	<0.01

Data in percentages, except # mean ± SD, and * median (minimum and maximum). LVd- left ventricular diastolic diameter; EF- ejection fraction; LVD- left ventricular dysfunction; aneurysm = aneurysm of the left ventricular apex; score = score of the motility of the left ventricular wall; HR- heart rate; QRS- duration of the QRS complex; VES- ventricular extrasystoles; RBBB- right bundle-branch block; CTR = cardiothoracic ratio.

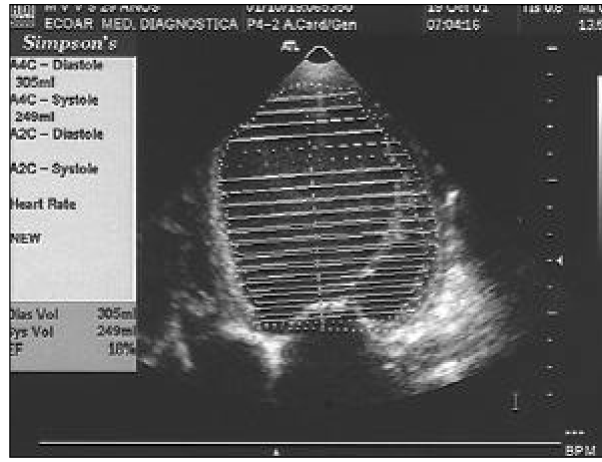

Fig. 2 – The ejection fraction was obtained with the Simpson's method.

The comparisons between the echocardiographic and electrocardiographic parameters of patients with normal and enlarged cardiac silhouette are shown in table I. The patients with Chagas' disease and an enlarged silhouette were significantly older than those with normal silhouette. The presence of left ventricular dysfunction was significantly more frequent in patients with an enlarged cardiac silhouette, and a similar pattern was observed for the presence of diastolic dysfunction and alterations in the segmentary contractility. A significant increase in the duration of the QRS complex was evident in patients with an enlarged cardiac area. The occurrence of ventricular extrasystoles and complete right bundle-branch block was significantly greater in the group of patients with an enlarged cardiac silhouette. On Doppler echocardiography, no significant difference was found between the 2 groups in regard to the presence of left ventricular aneurysms.

Discussion

The value of measuring cardiac size based on radiological film has decreased as compared with that based on Doppler echocardiography, which provides a more precise analysis of the diameter of the cardiac chambers and of the left ventricular function, and also other important functional data, such as evaluation of the diastolic function and segmentary contractility. Although cardiac size may be determined by chest radiography, many cardiac and extracardiac factors influence this measure, such as the examination technique, the patient's biotype, the patient's physiological status, thoracic alterations (scoliosis, pectus excavatum), the size of the lungs, the breathing phase, the cardiac cycle phase, and heart rate at the time of examination [12,13]. Therefore, chest radiography may only provide a raw and sub-

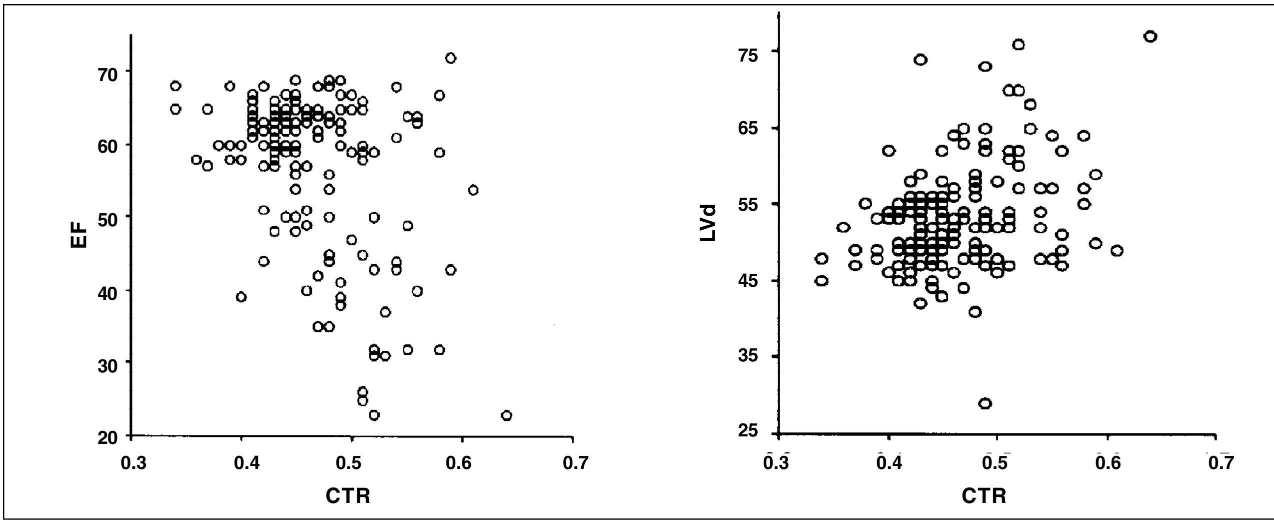

Fig. 3 – Correlation between the cardiothoracic ratio, the ejection fraction, and the left ventricular diastolic diameter.

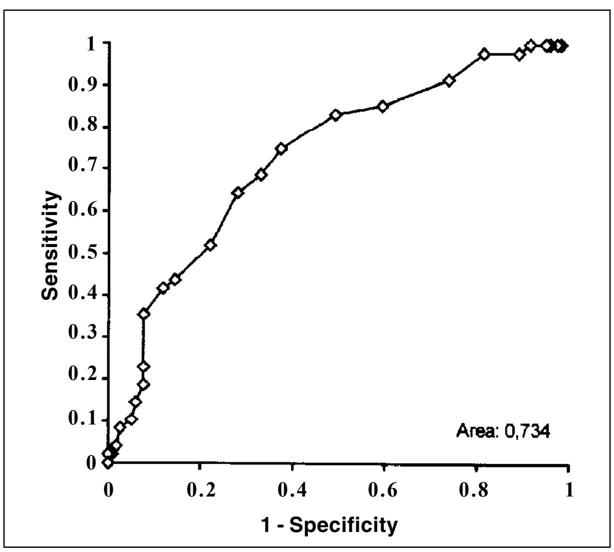

Fig. 4 – Performance of the cardiothoracic ratio in the diagnosis of left ventricular dysfunction in chagasic patients. Area under the ROC curve = 0.734.

jective estimation of the cardiac size through the classification of the cardiac silhouette as normal or enlarged. More objective numerical parameters provided by noninvasive examinations, such as Doppler echocardiography, are required for an accurate estimation of the diameter of the cardiac chambers.

In this study, in accordance with the results obtained in patients with heart failure [9,10], chest radiography alone was not an accurate indicator of the degree of left ventricular dysfunction in patients with Chagas' disease, although a weak and significant correlation has been observed between the cardiothoracic ratio and the left ventricular diastolic diameter ($r = 0.30$; $p<0.05$) and between the cardiothoracic ratio and the ejection fraction ($r = -0.23$; $p<0.05$). These values are different from those of a previous study [14], in which a clear correlation between the radiological and echocardiographic measurements in patients with Chagas' disease was observed. In that study [14], a small sample of 22 patients was divided into 2 different groups according to the cardiac size obtained on radiological imaging. Samples representing extreme values of cardiothoracic ratio and cardiac diameter were compared; patients with cardiothoracic ratio near the maximum limit, which is considered normal in the literature [12,13], were not assessed. In addition, the authors [14] considered a cardiothoracic ratio of 0.5 as abnormal, contrary to the maximum limit value adopted for the cardiothoracic ratio in our study [12,13].

Conventional chest radiography and electrocardiography are the initial investigation techniques used in a patient with Chagas' disease to assess cardiac impairment and to characterize the clinical form of the disease [15]. Absence of alterations on chest radiography is required to characterize the chronic undetermined form of Chagas' disease [8], even knowing that, if assessed on more refined methods, these patients may have significant cardiac alterations [16]. However, in our study, chest radiography had a low sensitivity (50%) for detecting left ventricular dilation and left ventricular systolic dysfunction, in addition to a negative predictive value lower than 80%, having, therefore, limited value as a screening test. The overall performance of the cardiothoracic ratio was also limited, with an area under the ROC curve of 0.734.

The presence of cardiac enlargement on radiography is a reliable indicator of left ventricular dysfunction as follows: a cardiothoracic ratio greater than 0.5 has a specificity of 88.1% and a positive predictive value of 58.9%. In addition, an enlarged cardiac silhouette is associated with electrocardiographic and echocardiographic markers of cardiac impairment, such as the presence of right bundle-branch block and ventricular extrasystoles, although it does not relate to other significant abnormalities, such as the presence of ventricular aneurysm. Therefore, although inadequate for screening left ventricular dysfunction, chest radiological study plays an important role in the clinical assessment of patients with Chagas' disease and defined heart disease. In addition to providing elements about the pulmonary circulation in patients with heart failure, a significantly enlarged cardiac silhouette is an indicator of the severity of the disease and of a worse prognosis [5].

Left ventricular dysfunction is the major prognostic factor in Chagas' disease [3-7]. Identification of the group of individuals with left ventricular dysfunction among the numerous populations of patients with Chagas' disease is a challenge in clinical practice. These individuals are candidates for preventive treatment with angiotensin-converting enzyme inhibitors, which can delay the appearance of symptoms and reduce mortality in the presence of left ventricular dysfunction [17]. Although the beneficial effects of these drugs on the survival of patients with Chagas' heart disease have not been formally tested, their beneficial clinical and hemodynamic effects on patients with Chagas' heart disease are evident [18,19]. In addition, these drugs are indicated in all patients with left ventricular dysfunction, symptomatic or not, independent of its etiology [20].

The electrocardiogram is particularly useful for identifying the low-risk population, because a normal examination is associated with an excellent prognosis in the midterm [21-23]. The additional value of chest radiography in the initial assessment of patients with Chagas' disease and a normal electrocardiogram is questionable, because the examination has little sensitivity for detecting left ventricular dysfunction, the major indicator of risk in Chagas' disease. Currently, even echocardiography, although able to show abnormalities in segmentary contractility [24] or more subtle alterations on Doppler tissue imaging [25], seems to have its routine use questionable in this population with an excellent prognosis. On the other hand, because individuals with typical electrocardiographic alterations may have either depressed or within the normal range left ventricular systolic function, additional examinations are indicated to identify the presence of left ventricular dysfunction. Considering the insufficient diagnostic performance of chest radiography, echocardiography appears to be one method of choice for the subsequent evaluation of cardiac impairment in patients with abnormal electrocardiographic findings, allowing the stratification of patients into high- and low-risk groups and the selection of candidates for therapy with angiotensin-converting enzyme inhibitors [23]. However, some limitations of echocardiography should be considered, especially the difficulty in performing the examination in rural areas where the disease is endemic, the existence of patients without an adequate window for the examination, and the need for an experienced examiner. Measurement of the type B natriuretic peptide is an important marker of left ventricular dysfunction in nonchagasic patients [26], and it may also be a useful tool in the initial evaluation of patients with Chagas' disease. Data obtained in our study indicate that the method has an excellent diagnostic performance in detecting left ventricular dysfunction in chagasic patients [27]. Because of the high prevalence of Chagas' disease among us, cost-benefit studies could quantify the medical, social, and economic impact of the application of different approaches in the initial evaluation of these patients.

In conclusion, although specific, chest radiography has little sensitivity in diagnosing left ventricular systolic dysfunction; its use as a screening method in the initial approach to patients with Chagas' disease should be reevaluated.

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