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Electrocardiography in Chagas' heart disease

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Conventional ECG still plays an important role in the overall knowledge of Chagas' cardiopathy, because of its importance in longitudinal and epidemiological studies, its diagnostic value, and its utility in prognostic evaluation. The authors discuss these aspects, as well as the use of ECG in the acute phase and the significance of a normal ECG in Chagas' disease. Correlations were made between ECG and hemodynamic/angiographic variables among 1010 patients with positive laboratory tests for Chagas' disease: a) in the group with normal ECG there were no significant differences between symptomatic and non-symptomatic patients with regard to ejection fraction and angiographic abnormalities; b) slight abnormalities on the ECG corresponded to an intermediate level of severity of the disease, that is, between normal ECG and ECG with significant abnormalities; c) fibrosis on the ECG was not predictive of akinesia in the related area on the angiography; d) combined ECG abnormalities generally correlated with greater myocardial compromise compared to isolated abnormalities; e) under multiple regression analysis the ECG abnormalities that independently correlated with depressed ejection fraction were: premature ventricular beats, ventricular tachycardia, left bundle branch block, atrial fibrillation, complete AV block, and anterior and inferior fibrosis. Male sex, cardiac insufficiency and cardiomegaly on the thorax radiography were also significantly related.

UNITERMS: Electrocardiography. Chagasic cardiopathy. American trypanosomiasis.

INTRODUCTION

The development of non-invasive diagnostic methods with great capacity to evaluate anatomy and cardiac functions—multiplanal echodopplercardiography, scintigraphy and radioisotopic angiography– or to identify in long registers the presence of arrhythmias—dynamic electrocardiography—can create the impression that conventional electrocardiography (ECG) might be an exam of secondary importance for carriers of Chagas' disease.

Today the ECG is still of great value due to its simple attainment, practicality, low cost and its high sensitivity in detecting, quantifying and accompanying most manifestations of chagasic cardiopathy

It has great epidemiological value and is the method of choice in longitudinal populational studies in endemic areas; besides the advantages mentioned, its register does not require great qualification or training of the operator and the tracings can be arquived for later interpretation. It is known that in the natural history of Chagas' disease, the precocity and prevalence of electrocardiographic alterations are related to the survival curves. For all of these reasons it has great diagnostic value, since in most

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towns where it is endemic the medical attendance is precarious and the ECG, if available, could be the only resource in the identification of the cardiopathy, since its alterations precede the appearance of symptoms and abnormalities in the physical exam and thorax radiography. It even has prognostic value, since certain abnormalities, in themselves can indicate different evolutions.

ELECTROCARDIOGRAM IN THE ACUTE FORM

The acute phase of Chagas' disease refers to a generalized infection by *T. cruzi*, and is characterized by the finding of the parasite in the peripheral blood. It generally takes a benign course, with mortality of 5% and 10% through myocarditis or meningoencephallitis, mainly in the first years of life (75% of the obits).

The myocarditis can show variable severity, only manifesting itself as only a tachycardia disproportionate to the fever or as severe cardiac insufficiency and hypotension. The ECG was normal in 63% of the non-fatal cases and in 14% of the fatal cases of Bambui (15). It can display transitory alterations or abnormal states even without clinical evidence of carditis. The most frequent findings are non-specific and common to any myocarditis: sinus tachycardia and primary alteration of the ventricular repolarization and low QRS voltage, left ventricular overload and first degree atrioventricular block. In more severe myocarditis, more advanced atrioventricular blocks and bundle-branch block can appear. The presence of inactive areas, ST segment changes, complex ventricular arrhythmia and atrial fibrillation indicate a worse prognosis. The behavior of the ECG in the acute phase could be indicative of the late prognosis of the disease. Among patients with a normal ECG in this phases only 30% exhibit an altered ECG in the chronic phases; on the other hand, among those showing some abnormality, 60.9% show an altered ECG.

After the disappearance of the clinical manifestations in the acute phase the alterations tend to disappear; after one year 75% of the cases show a normal ECG. Some (10%-20%) alternate normal tracings and abnormal tracings with intermittent first degree atrioventricular block and alteration of the ventricular repolarization.

NORMAL ELECTROCARDIOGRAM IN CHAGAS DISEASE

A normal ECG, one of the paradigms in the characterization of the indeterminate form of Chagas' disease, shows a variable prevalence in diverse endemic regions, reflecting the pathogenesis of the disease: 91.6% in the Brazilian state of Rio Grande do Sul and 68% in the state of Goiás. It is more common in the first 20 years after the acute form, with the posterior appearance of some type of electrocardiographic alteration at a frequency of 2% to 5% per year. The study of the indeterminate form, which will be more thoroughly discussed in another chapter, has shown through the use of more sensitive diagnostic methods, either invasive or non-invasive, that most chagasic patients with normal ECG have some type of anatomical or functional alteration. Generally they are of low intensity and repercussion, which would imply a good prognosis. This was confirmed by Forichon (7), in Bambui, who, accompanying 885 young seropositive patients for 10 years, verified that in the group with normal ECG, 97.4% remained alive while only 61.3% of those who displayed some type of electrocardiographic anomaly survived. The survival of seropositives with a normal ECG was equal to that of seronegatives, and they had 9 times more chance of staying alive as those with an abnormal ECG. Carrasco (3) refers to 100% survival after 12 years for the group with normal ECG, even with slight ventriculographic alterations, against 42% of the group with abnormal ECG without cardiac insufficiency. In our experiment (8) with 109 seropositives with normal ECG submitted to hemodynamic study and left and right cineangiocardiography, we verified that 91.7% had normal left ventricular ejection fractions, but 43.1% showed abnormality on the cineangiography of the left ventricle, such as asynergy of the apical wall (26.6%), of the anterior wall (4.6%), or diffuse hypocontractability (8.3%). A smaller proportion of patients (14.3%) had contractile alteration of the right ventricle.

Curiously, when we divide this group up into asymptomatic individuals (74 cases) and those who showed symptoms (35 cases), we could verify, in the comparison of clinical and hemodynamic-cineangiographic variables, that the symptomatic subgroup, in spite of a greater average age, showed more cases of normal left ventricle (71.4%) on the cineangiography and a greater number of normal left ventricle ejection fractions (97.1%) than the subgroup of asymptomatic individuals (89,2%). However, though curious, these numbers were not statistically significant

Table 1
Characteristics of the population with Chagas' disease and submitted to left ventricle cineangioventriculography

	Asymptomatic	Symptomatic	Total	p
No.	74	35	109	
Men	44 (59.5%)	19 (54.3%)	63 (57.8%)	ns
Age	37.9 ± 9.1	42.3 ± 8.3	39.8 ± 9.1	p<0.05
Normal LV	37 (50%)	25 (71.4%)	62 (57%)	ns
LVEF Normal	66 (89.2%)	34 (97.1%)	100 (91.7%)	ns
LVEF Depressed	8 (12.2%)	1 (2.9%)	9 (8.3%)	ns
Apical asynergy	22 (29.7%)	7 (20.0%)	29 (26.6%)	ns
Anterior asynergy	4 (5.4%)	1 (2.9%)	5 (4.6%)	ns

Normal LV=normal left ventricle; LVEF Normal=normal left ventricular ejection fraction; LVEF Depressed=depressed left ventricle ejection fraction; ns=No statistical significance.

(Tab. 1). Of the 35 symptomatic patients with normal ECG, 7 suffered cerebral or systematic embolia, 5 of them with normal left ventricle, all with normal ejection fractions of the left ventricle, and without mural thrombus detected by the cineangioventriculography or the echocardiogram.

In an analysis of 1010 chagasic patients submitted to cineangioventriculography or the same type of clinical and hemodynamic-cineangiocardiographic evaluation, we observed that patients with normal ECG, when compared to patients with ECG abnormalities such as ventricular extrasystoles, right bundle branch block , block of the anterosuperior division of the left bundle branch and isolated atrial extrasystoles, had a significantly younger average age, fewer cases of depressed ejection fraction of the left ventricle and less abnormal cineangioventriculography of the left ventricle (Tab. 2).

A normal ECG in chagasic patients, symptomatic or not, even coinciding with anatomical or functional alterations detected by other preliminary methods, indicates a favorable prognosis with less myocardial dysfunction, evaluated by the ejection fraction of the left ventricle and more normal left ventricle on the cineangioventriculography, than in patients with isolated ECG alterations, even those most frequently found in Chagas' disease.

Table 2
Isolated findings on the electrocardiogram of 1010 chagasic patients

	No. of cases	Age	Depressed LVEF	Abnormal LV
Normal	109	39.3 ± 9.1	8.3%	43%
VE	40	47.5 ± 9.9***	50%***	20%***
RBB	39	46.1 ± 13***	23.1%*	30.8%**
LAHB	18	45.3 ± 9.8*	33.3%**	27.8%*
ASF	5	58.5 ± 12***	60%**	20% ns

* =p<0.05; ** =p<0.01; *** =p<0.001 (statistical analysis—each isolated alteration versus normal electrocardiogram).
Normal= normal electrocardiogram; VE=ventricular extrasystoles; RBB=Right branch block; LAHB=Left anterior hemiblock; ASF=anteroseptal fibrosis; ns=no statistical significance.

ELECTROCARDIOGRAM IN THE CHRONIC PHASE

The attendance and observation of populations in endemic areas with systematic registry of ECG in regular intervals over years and even decades (6,12) allows analysis of the time of appearance and types of alterations found, correlating them with serological exams for chagasic infection. This brought us important knowledge about the natural electrocardiographic history of Chagas' disease, which we summarize as follows:

a) The prevalence of ECG alterations in seropositives can be as much as 4 times more frequent than seronegatives in the same region. This reaches 9.6 times more frequent between the ages of 25 and 44, with reduction of this disproportion after the fifth decade. In older persons (over 64), and in youths up to 14 years old, there is no difference between seropositives and seronegatives (Castro Alves, Bahia (14).

b) In national electrocardiographic inquiry (11), the prevalence of electrocardiographic alterations was 37.4% in seropositives against 22.6% in seronegatives, this being variable according to the region studied: 8.4% in Rio Grande do Sul and up to 32% in Goiás. This behavior reflects regional differences in the pathogenesis of the disease, which is known to be more severe in the states of Goiás, Minas Gerais, Bahia, São Paulo and Paraná, and less in the Southern states and the Amazon region.

c) The prevalence of abnormal ECG is 4.3 times greater in seropositive men than in seronegative men, while seropositive women are only 2.6 times as likely to have abnormal ECG as seronegative women.

d) Dias (5), analyzing the casework of Bambui, verified that ECG alterations like incomplete right branch block, block of the anterosuperior division of the left bundle branch, flattened T waves, and first degree atrioventricular block, showed up earlier, between 10 and 20 years old in the acute phase and often preceded the manifestation of the disease, and its detection by physical examination and thorax radiography.

e) Right bundle branch block and ventricular extrasystoles occurred later and other abnormalities like inactive areas, complex arrhythmias and total atrioventricular block occurred in even later periods.

This kind of evolution could be explained by the fact that the initial lesions, transitory or specific, correspond with an active inflammatory process, nevertheless focal,

Table 3
The electrocardiogram in chronic chagasic cardiopathy. Prevalence of the most common abnormalities

	Maguire et al.*	Dias-Kloetzel**	Celmo Porto***	Garzon-Lorga****
VE	7.5%	17.5%	28%	40.3%
RBB	13.3%	24.8%	31.5%	33.3%
LAHB	2.9%	-	-	32.7%
LBB	0%	0.8%	2.3%	3.1%
ST-T	9%	4.9%	9.2%	26.7%
LVQRS	-	7.6%	2.6%	7%
AVB 1st	1.2%	-	3%	3%
AVB 2nd	0.3%	-	2%	3%
AVB 3rd	0%	2.6%	4%	5.6%
VT	0%	-	0.3%	8.2%
AF	0%	1.8%	2.3%	2.5%
ASF	-	-	2.5%	10.3%
IEA	3.5%	2,8%	0%	25.1%

VE=ventricular extrasystoles; RBB=right branch block; LAHB=left anterior hemiblock; LBB=left branch block; ST-T=alterations of the ST-T segment; LVQRS=low voltage of the QRS; AVB 1st =first degree AV block; VT=ventricular tachycardia; AF=atrial fibrillation; ASF=anteroseptal fibrosis; IEA=presence of inactive electrical area.
* = Non-selected samples, 346 cases, city of Castro Alves, Bahia, Brazil.
** = Non-selected samples, 387 cases, Bambui, Minas Gerais
*** = Selected samples from doctor offices, 503 cases, Triângulo Mineiro
**** = Selected from diagnostic center, 1010 cases, São José do Rio Preto, SP

	N ECG	SA ECG	AB ECG
No. of cases	109	118	392
Men	63 (57.8%) ns	62 (52.5%) ns	236 (60.2%)
Age	39.8 ± 9.1***	45.1 ± 11.1 ns	44.1 ± 11
SYMP	35 (32.1%)***	95 (80.5%) ns	344 (87.7%)
LV normal	62 (56.9%)*	50 (42.4%)***	78 (19.9%)
LVEF normal	100 (91.7%)**	90 (76.3%)*	249 (63.5%)
Apical asynergy	29 (26.6%) ns	39 (33.1%)**	224 (57.1%)

N ECG=normal ECG; SA ECG=slight or initial ECG alterations; AB ECG=Abnormal ECG with normal RX and without cardiac insufficiency; SYMP=symptomatic; LV=left ventricle; LVEF= left ventricle ejection fraction.
* = $p<0.05$ / ** = $p<0.01$ / *** = $p<0.001$

while the more severe and later alterations correspond with permanent lesions through the formation of fibrosis and scarring.

However, studies in endemic areas show that electrocardiographic alterations are more frequent in seropositive men than women, that there is a period of 10 to 20 years after infection with a low prevalence of abnormalities, and that their appearance is normally gradual, around 2.6% per year in persons with initially normal ECG. The frequent occurrence of conduction defects, especially right bundle branch block with or without block of the anterosuperior division of the left bundle branch, is characteristic in endemic areas. Ventricular extrasystoles are more common than atrial ones and we also notice that wave alterations are more prevalent in young seropositive patients when compared with seronegative people of the same age. Curiously, the incidence of sinus arrhythmia among young seropositives was significantly less than that of seronegatives, possibly through damage to the automatic cardiac system. Some of the more frequent electrocardiographic alterations of Chagas' disease have a well-defined anatomical substrate. Anatomopathological studies done by Andrade, Oliveira, Prata, and Mott, show predilection of the disease for the conduction system, as observed by areas of degeneration and fibrosis mainly in the right half of the His bundle, the right branch, the left anterosuperior fascicle and less in the posterior-inferior fascicle. This fairly random distribution explains the high prevalence of right bundle branch block, its frequent association with block of the anterosuperior division of the left bundle branch and the uncommon presence of block of the posterior-inferior division of the bundle branch and left branch block, except when more extensive lesions lead to total atrioventricular blocks of the trifascicular type.

Ventricular arrhythmias, so frequently found, could have their genesis: a) in lesions located in the His-Purkinje (intraventricular) region, creating focal points of ectopic activity or re-entry mechanisms; b) from automatic imbalance with greater sensitivity to circulating catecholamines; c) in areas of tissue lesion through inflammatory process; d) adjacent to areas of fibrosis and aneurysmatic formations, mainly in apical regions of both ventricles and posterior and inferolateral walls of the left ventricle.

DIAGNOSTIC IMPORTANCE

Conventional ECG is sensitive in the detection of chronic cardiopathy and ECG alterations almost always precede the appearance of signs and symptoms. In our experience, ECG alterations have always preceded the appearance of abnormalities on thorax radiography. This occurs due to the preference of the disease for the conduction system and excitoconduction system, producing lesions that manifest themselves early on the

ECG, and that can be the only evidence of cardiopathy until contractile dysfunctions and their clinical repercussions appear.

Chagas' disease can cause any type of ECG alteration, but classically we recognize right bundle branch block, associate with block of the anterosuperior division of the left bundle branch and ventricular extrasystoles as typical ECG tracings.

In the literature, the prevalence varies with the population studied. In Table 3 we see, in the first two columns, casework in endemic rural areas with non-selected samples; the last two columns refer to samples from doctor's offices and urban diagnostic centers in areas of high incidence of the disease.

The percentage values vary with the type of selection, but right bundle branch block, block of the anterosuperior division of the left bundle branch, ventricular extrasystoles and alterations in the T wave are the most frequent findings. Right bundle branch block is the most characteristic alteration, since it is highly prevalent, fairly specific and of great positive predictive value; it is rare in a seronegative person under 50 (5.5%), while it occurs in up to 53% of the seropositive population (Maguire [5]). Incomplete right bundle branch block, block of the anterosuperior division of the left bundle branch and block of the posteroinferior division of the left bundle branch, occur in isolation in seropositives as much as seronegatives, but their association is highly specific.

Table 5
Analyses of the "fibrosis type abnormalities" tests on the ECG in order to detect alterations of the segmental contraction of the left ventricle through cineangiography

ECG	Segmental alteration	Sens.%	Spec.%	+PV%	−PV%	OR
Anterior	Apical	19	89	66	49	1.8
Septal	Apical	16	90	63	49	1.6
Anteroseptal	Apical	12	92	65	48	1.7
Inferior	Inferior	11	95	8	96	2.2
Anterior	Anterior	17	85	12	89	1.1
Lateral	Lateral	4	95	2	98	0.8
Posterior	Dorsal	0	100	0	97	0

ECG=electrocardiographic alteration suggestive of fibrosis; Sens.= sensitivity; Spec.=specificity; +PV=positive prognostic value; −PV=negative prognostic value; OR= odds ratio.

Other fairly characteristic alterations before the seventh decade are second degree atrioventricular block (Mobitz type (7)), and total atrioventricular block, which are uncommon in seronegatives. Left branch block, frequently seen in dilated cardiomyopathy, is rare in Chagas; disease, having an average prevalence 28 times smaller than that of right bundle branch block. Isolated ventricular extrasystoles are frequently found but are non-specific, not differentiating seropositives from seronegatives, occurring as much in healthy persons as in diverse cardiopathies. Its presence in seropositives has great predictive value for repetitive ventricular arrhythmias: 82% of chagasic patients with ventricular extrasystoles on the conventional ECG had pairs or volleys of extrasystoles on the Holter against 21% in non-chagasic individuals (12). In endemic areas the register of 24 hour dynamic electrocardiogram shows that the average number of ventricular extrasystoles is 137 times higher in seropositives than in seronegatives, and pairs and volleys are more frequent as well.

Ischemic type alterations occurs in 10% of our patients and can be confused with ischemic cardiopathy. Isolated and discrete alterations like first degree atrioventricular block, low QRS voltage, rare ventricular extrasystoles, incomplete right branch block and localized flattening of the T wave could be the first and only sign of Chagas' disease. The authors (8), in order to verify the importance of this abnormality, selected a group of

Table 6
Electrocardiographic and clinical variables versus the presence of apical lesion of the left ventricle—simple and multiple regression analyses

Variable	Dependent correlation	Independent correlation
VE	p<0.0001	p<0.0001
Ischemia	p<0.0001	p<0.0001
VT	p<0.0001	ns
RBB	p<0.0001	ns
LAHB	p<0.0001	ns
LBB	p<0.005	ns
Anterior ECG	p<0.0001	ns
Septal ECG	p<0.001	ns
Inferior ECG	p<0.01	ns
Lateral ECG	p<0.002	ns
Age	p<0.01	ns
Syncope	p<0.001	p<0.04

VE= ventricular extrasystoles; VT=ventricular tachycardias; RBB= right branch block; LAHB=left anterior hemiblock; LBB=left branch block; ECG= electrocardiographic alteration suggestive of fibrosis; Ischemia=ischemic type ST-T alteration.

chagasic patients with these initial alterations and compared it with a group with normal ECG and a group with greater ECG alterations, but with radiography that indicated a normal cardiac area and no cardiac insufficiency (Tab. 4). The variables analyzed were sex, age, depressed ejection fraction of the left ventricle, abnormal left ventricle cineangioventriculography and the presence of apical asynergy. The "slightly altered ECG" group positioned itself in intermediate severity between the normal ECG group and the obviously abnormal ECG group as far as prevalence of depressed ejection fraction of the left ventricle and abnormal left ventricle cineangioventriculography: 26.7% had depressed ejection fraction versus 7.6% in the normal ECG group (p<0.01) and 36.5% in the abnormal ECG group (p<0.05).The left ventricle cineangioventriculography was abnormal in 57.6% versus 46.1% in the normal ECG group (p<0.05) and 80.01% in the abnormal ECG group (p<0.001). The patients with slightly altered ECG showed, in relation to the normal ECG group, a higher average age (p<0.001) and a greater prevalence of symptomatic patients (p<0.001), though the incidence of apical lesion was not significant. In relation to the group with abnormal ECG, there was no difference as to average age and the presence of symptoms, though they had fewer apical lesions, 36.1% versus 57.1% (p<0.01). These data coincide with clinical experience that shows that patients with slight ECG

alterations are at risk of developing more accentuated alterations and greater progression of the disease, and their cases should be carefully accompanied.

Contractile alterations of the apical wall of the left ventricle, or "apical lesion", are anatomical peculiarities of Chagas' disease and their electrocardiographic correspondence has been searched for. Anterior, septal and anteroseptal fibrosis have already been proposed as electrocardiographic manifestations. Correlations done by the authors show that these alterations generally have good specificity, though very low sensitivity and positive predictive value (+PV) (Tab. 5). In statistical studies of uni- and multivariate analysis, considering all the ECG alterations and with apical lesion as a dependent variable (Tab. 6), it was observed that most electrocardiographic alterations relate to apical lesions, though only ventricular extrasystoles, the ischemic pattern of the ST segment and left branch block relate with it independently.

In ischemic cardiopathy there is a good correlation between the inactive areas or "fibrosis" of certain walls and the correspondent alteration of the segmental contraction or the left ventricle on the cineangioventriculography. In our experience, such correspondence does not occur in Chagas' disease: Table 5 shows that the anterior, inferior, posterior and lateral fibrosises have low positive predictive value (+PV) for corresponding asynergic areas on the

cineangioventriculography. The sum of the sensitivity and specificity percentages is close to 100%, indicating an aleatory relationship between ECG alteration and localized contractile dysfunction of the left ventricle.

PROGNOSTIC IMPORTANCE

A given ECG alteration should not be considered in isolation in the prognostic evaluation of a chagasic patient, but rather together with the clinical chart and anatomical and functional data obtained through other complementary exams. However, certain alterations can, nevertheless, be prognostically important because of their inherent severity, for example, a ventricular tachycardia, or when it represents aggression of specific conduction tissues, such as atrioventricular blocks or branch blocks.

As it has been previously discussed (7,8,12), it is known that a normal ECG indicates a significantly greater survival rate and that certain isolated abnormalities of little importance can correspond to greater myocardial compromise. Other isolated alterations, but mainly in association, can indicate greater aggression by the disease and a worse prognosis.

Longitudinal studies (4,5,15,17), some performed decades ago (5,15), indicate to us which electrocardiographic alterations are related to greater mortality, but we should remember that today the use of more effective drugs in the treatment of arrhythmias and cardiac insufficiency have modified the survival curves.

Porto (10) and Dias and Kloitzel (6), Laranja (10), and Brasil (2) and their collaborators, in these longitudinal studies, compared the electrocardiographic findings of living patients with the findings of the group of dead patients and agreed that multifocal ventricular extrasystole, total atrioventricular block, left branch block, atrial fibrillation and fibrosis indicated greater risk of death.

Porto (5) and Dias (6), comment that certain alterations like right bundle branch block and monomorphic ventricular extrasystoles, when isolated, had good prognosis, however, when associate with themselves, with other bundle blocks (hemiblock of the anterosuperior division of the right bundle branch), or different types of fibrosis, there was less survival.

THE NUMBER OF ALTERATIONS PER TRACING

Porto (15), verified an average number of 1.5 alterations per tracing, an average that, in a group with fatal evolution, was 1.8, and non-fatal, 1.4. He suggested that in a tracing with one alteration, the prognosis was good, two was worse, and in cases with three or more abnormalities per tracing the prognosis was bleak.

Dias (6) found an average of 1.75, observing that the fatal group had an average of 2 alterations per tracing.

In our material of 901 chagasic patients with electrocardiographic alterations, together with clinical and radiological evaluations, and left ventricle ejection fractions measured by cineangioventriculography, we verified an average of 3.06 ± 0.9 alterations per tracing. In cases where the left ventricle ejection fraction was normal, the average was 2.5 ± 0.9 versus 3.53 ± 1.0 in cases with depressed ejection fractions (p<0.001). The average number per tracing was also significantly larger (p<0.001) in the group with cardiomegaly on their thorax radiography (3.52 ± 0.9) than in the group with normal thorax radiography (2.62 ± 0.85). This suggests that tracings combining a greater number of alterations correspond with a lower ejection fraction and greater cardiomegaly on the thorax radiography, indicating a worse prognosis.

BRANCH BLOCKS

Maguire et al. (12) and Dias et al. (6) observed that isolated right bundle branch block occurred as much in the fatal group as in the non-fatal group, being compatible with long life. When associated with other alterations, principally ventricular extrasystoles and fibrosis, it was three times more common in the fatal group. When observed in young patients, there was a greater risk of progression of the disease, and cardiac insufficiency and total atrioventricular block, necessitating more frequent clinical attention. The association with ventricular extrasystoles was related to a greater incidence of sudden death.

In our casework (Tab. 7), of the cases with isolated right bundle branch block, 77% had normal ejection fractions of the left ventricle; however, when it was associate with some other alteration, it was normal in only 45.2 % (p<0.001). If the association was with ventricular extrasystoles, the number of normal ejection fractions was even less (36%).

| | Isolated alterations | | Combined alterations | | p |
	No.	DEF%	No.	DEF%	
VE	40	50	407	61.2	p<0.05
RBB	39	23.1	336	54.8	p<0.001
LAHB	18	33.3	330	58.5	ns
LBB	11	81.8	31	90.3	ns
"Fibrosis"	33	42.4	228	69.7	p<0.01
RBB + LAHB	49	24.5	217	59	p<0.05

No. = number of patients; DEF%= % of cases with depressed ejection fraction in the group; VE= ventricular extrasystoles; RBB=right branch block; "Fibrosis"=inactive areas; p=significance of comparison between the prevalence of depressed ejection fraction in the groups with isolated ECG alterations versus the groups with combined alterations; ns=no statistical significance.

Association with block of the anterosuperior division of the left bundle branch did not correspond with the worse prognosis and 75.5% of those cases had normal left ventricle ejection fractions. Isolated block of the anterosuperior division of the left bundle branch corresponded to 66.7% normal left ventricles; if associate with other alterations, then 41.5% (not significant).

In chagasic patients with left branch block (31 cases), the left ventricle ejection fraction was only normal in 9.7%, confirming a poor prognosis.

VENTRICULAR ARRHYTHMIAS

Ventricular extrasystole is found more often in the ECG of chagasic patients; it occurs in 40% of our patients, in 4% being the only alteration, and it occurs in 54.5% of the casework of Santana (17). While some authors suggest that isolated ventricular extrasystoles do not imply a worse prognosis, others point out that its presence on the tracing already indicates the high prevalence of complex, repetitive forms and of ventricular tachycardia on 24 hour continuous registers.

We have observed that 50% of our patients with isolated ventricular extrasystoles on conventional ECG had depressed ejection fractions of the left ventricle, and in cases where ventricular extrasystoles combined with other alterations then the incidence rose to 67.2% (p<0.05). If the combination was with some kind of fibrosis, then it was worse: 84.4% had depressed ejection fractions. Barretto (1) found ventricular extrasystoles in 14% of the patients with normal ejection fraction and in 65% when the ejection fraction was less than 44%, with similar ventricular tachycardia behavior on the Holter exam. Santana et al. (17) observed that in cases with Own type 4B ventricular extrasystoles, patients had a 48% chance of survival in 7 years, but that if there was associate cardiomegaly the chances of survival were only 29.5%.

Conventional ECG cannot recognize the transitory character of a ventricular arrhythmia, nor can it allow evaluation of its frequency or severity; nevertheless, when present, these arrhthmias are indicators of severity. If associated with clinical data, other electrocardiographic alterations or functional indicators of greater myocardial compromise, the prognosis is significantly worse. Rassi et al. (16) verified mortality of nearly 100% in 5 years in patients with sustained ventricular tachycardia; Lorga et al. (9) accompanied the cases of 40 chagasic patients with sustained ventricular tachycardia over 13 years, certifying

that in the group with normal ejection fraction there were no obits, while of the patients with very depressed ejection fraction only 20% survived.

ATRIOVENTRICULAR BLOCKS

Since the time when Carlos Chagas called attention to the frequency and importance of "slow pulse", great progress has been made in the diagnosis and treatment of bradyarrhythmias.

Dysfunctions of the sinus node are better identified through electrophysiologic study than with conventional ECG, but they rarely manifest themselves clinically, and need to be identified in symptomatic patients and in candidates for the use of bradycardial drugs.

Atrioventricular blocks, as has already been seen, are relatively frequent; however, besides the degree of the block, its location should also be identified: whether it is in the atrioventricular node or in the His-Purkinje (intraventricular) system, since these display diverse evolutions and prognosises. Blocks of the His-Purkinje are usually symptomatic, appearing suddenly, with lower frequency, and don't respond to vagal exercise or vagal inhibition and have a worse prognosis than nodal blocks. Rassi et al. (16), studying atrioventricular blocks in chagasic patients through electrocardiogram of the His bundle (EHB), verified that first and second degree type I atrioventricular block without associate branch block, and total atrioventricular block with narrow QRS generally are located in the atrioventricular node. First degree atrioventricular blocks, total atrioventricular blocks with wide QRS and second degree type II atrioventricular blocks most commonly correspond to lesions in the His-Purkinje system. In cases of second degree type I atrioventricular block with wide QRS the most frequent location is in the atrioventricular node (70%), and it is rare that it evolves to total atrioventricular block (20% of the cases). The atropine test is useful in helping its localization.

Out of the 57 cases of total atrioventricular block that we studied hemodynamically, 66.6% had depressed left ventricle ejection fraction. This parameter seems to be important in the prognostic analysis, since the follow-up of total atrioventricular blocks treated with pacemakers showed that, in spite of the relief of low output symptoms, it did not significantly increase survival when the contractile system was severely compromised.

INACTIVE AREAS

The presence of "fibrosis" in the ECG has always been considered a sign of severity and its association with ventricular arrhythmias and branch blocks would indicate a greater myocardial lesion and less survival.

In our cases work we found "fibrosis" in 228 cases (22.5%), occurring as the only electrocardiographic alteration in 33 cases (6.3%). When they were an isolated manifestation, fibrosises corresponded to a depressed left ventricle ejection fraction in 42.4%; when associate with other electrocardiographic alterations there were 69.7% with depressed ejection fraction (p<0.001) (Tab.7).

ECG ALTERATIONS VERSUS LEFT VENTRICLE EJECTION FRACTION: SIMPLE AND MULTIPLE REGRESSION ANALYSIS

The combination of electrocardiographic alterations is quite frequent in the tracings of chagasic patients and is considered an aggravating factor in the prognosis. In order to verify the behavior of these variables with regard to left ventricle ejection fraction obtained with linear cineventriculography, the authors (9) did a uni-and multivariate analysis, verifying (Tab.8) that almost all abnormalities with the exception of the alteration of the ventricular repolarization and low QRS voltage, related independently with depressed left ventricle ejection fraction. Nevertheless, multivariate analysis showed that the electrocardiographic variables that related independently with lower left ventricle ejection fraction were only ventricular extrasystoles, ventricular tachycardia, left branch block, atrial fibrillation, total atrioventricular block and anterior and inferior inactive areas. Right bundle branch block, block of the anterosuperior division of the left bundle branch and septal and anterior fibrosis were not considered significantly related to depressed left ventricle ejection fraction.

When we added the clinical variables such as age, sex, symptoms of cardiac insufficiency and cardiomegaly on the thorax radiography to the electrocardiographic alterations, we verified that the same electrocardiographic parameters continued to be significantly related, but with a slight alteration in the probability rate. We noticed that, of the clinical variations, only age did not independently

Table 8
Correlation between ECG alterations, clinical variations and linear values of the ejection fraction of the left ventricle – simple and multiple regression analyses

Variable	Prevalence	Dependent Correlation p<	Independent Correlation p<
VE	407	0.0001	0.0001
Anterior "fibrosis"	153	0.0001	0.026
VT	83	0.001	0.011
Inferior "fibrosis"	52	0.0001	0.001
LBB	31	0.0001	0.0001
AF	25	0.0001	0.017
RBB	336	0.05	ns
LAHB	330	0.0001	ns
Lateral "fibrosis"	48	0.0001	ns
Septal "fibrosis"	131	0.0001	ns
Male	624	0.0001	0.001
Age	1010	0.03	ns
Cardiomegaly	271	0.0001	0.0001
CI	404	0.0001	0.001

Observation: The other ECG alterations did not show any statistical correlation. Fibrosis= inactive area; VE= ventricular extrasystoles; VT=ventricular tachycardias; RBB=right branch block; LAHB=left anterior hemiblock; LBB=left branch block; AF=atrial fibrillation; CI=cardiac insufficiency; cardiomegaly=increased cardiothoracic index on X-ray; ns=no statistical significance.

relate to the left ventricle ejection fraction. Male sex, cardiac insufficiency and cardiomegaly related to a lower left ventricle ejection fraction.

CONCLUSIONS

Conventional ECG still has an important place among preliminary methods for the study of Chagas' disease.

Because of its low cost, easy use and interpretation, it has epidemiological value in endemic areas without access to more sensitive exams.

Its diagnostic importance comes from knowledge about the greater prevalence of certain alterations. Right bundle branch block associate with block of the anterosuperior juncture of the left bundle branch and/or ventricular extrasystoles in young people or adults up to the fifth decade, for example, can be highly suggestive of the disease.

The development of diagnostic methods that allow evaluation of the anatomy and cardiac functions and that quantify the intensity of arrhythmias has considerably increased our knowledge of this cardiopathy. The correlation of these findings with certain ECG alterations has made this simple method very valuable in the prognostic evaluation of Chagas' disease.

More information can be extracted from ECG through this methodology, rendering it more useful and indeed indispensable in the diagnosis, observation and follow-up of chagasic cardiopathic patients.

Resumo

O ECG convencional ainda desempenha papel importante no conhecimento da cardiopatia chagásica, pela sua importância nos estudos longitudionais e epidemiológicos, pelo seu valor diagnóstico e utilidade na avaliação prognóstica. Estes aspectos são revistos e discutidos neste artigo, assim como o ECG na fase aguda e o significado do ECG normal na Doença de Chagas. Numa casuística de 1.010 soropositivos foram feitas correlações entre as alterações do ECG e parâmetros hemodinâmicos e cineangiográficos: a) a presença ou não de sintomas nos indivíduos com ECG normal não correspondeu a diferenças nas prevalências de alterações na cineangioventriculografia ou de fração de ejeção de ventrículo esquerdo deprimida; b) um "ECG pouco alterado" corresponde a uma gravidade intermediária entre o ECG normal e o ECG com alterações mais importantes quanto à fração de ejeção e alterações na cineangioventriculografia de ventrículo esquerdo; c) áreas inativadas no ECG não tiveram valor preditivo para detectar assinergias em paredes correspondentes na cineangioventriculografia; d) as alterações combinadas do ECG geralmente correspondem a maior comprometimento miocárdico que as isoladas; e) as alterações eletrocardiográficas que se relacionaram independentemente com a fração de ejeção deprimida em análises de regressão múltipla foram: extrassístoles ventriculares, taquicardia ventricular, bloqueio do ramo esquerdo, fibrilação atrial, bloqueio atrioventricular total e áreas inativadas anterior e inferior. O sexo masculino, a insuficiência cardíaca e a cardiomegalia ao radiografia do tórax também se relacionaram significativamente.

REFERENCES

1. BARRETO, A.C.P.; BELLOTTI, G.; DEPERON, S.D. et al. - O valor do eletrocardiograma na avaliação da função miocárdica de portadores de Doença de Chagas. **Arq Bras Cardiol 52**:69-73, 1989.

2. BRASIL, A. - Cardiopatia chagásica crônica. In: Cançado, J.R. **Doença de Chagas**. Belo Horizonte, 1968. p. 481-500.

3. CARRASCO, H.A.; BARBOSA, J.S.; INGLESSIS, G.; FUENMAYOR, A. & MOLINA, C. - Left ventricular cineangiography in Chagas' disease: detection of early myocardial damage. **Am Heart J 104**: 595-602, 1982.

4. CARRASCO, H.A.; GUERREIRO, L.; PARADA, H.; MOLINA, C.; VEGAS, E. & CHUECOS, R. - Ventricular arrhythmias and left ventricular myocardial function in chronic chagasic patients. **Int J Cardiol 28**:35-41, 1990.

5. DIAS, J.C.P. - História natural. In: Cançado, J.R.; Chuster, M. Cardiopatia chagásica. Belo Horizonte: **Fundação Carlos Chagas**, 1985. p. 99-113.

6. DIAS, J.C.P. & KLOETZEL, K. - The prognostic value of the electrocardiographic features of chronic Chagas' disease. **Rev Inst Med Trop S Paulo 10**:158-62, 1968.

7. FORICHON, S. - **Contribuition aux estimations de morbidité et mortalité dans la maladie de Chagas**. 1974 [Tese - Toulouse, França, Univ. Paul Sabatier].

8. GARZON, S.A.C.; LORGA, A.M.; JACOB, J.L.B. et al. - O ECG normal em indivíduos soropositivos para Doença de Chagas: qual o seu significado ? (Abstr). **Arq Bras Cardiol 61**: 130, 1993.

9. GARZON, S.A.C.; LORGA, A.M.; NICOLAU, J.C. et al. - Correlações entre alterações eletrocardiográficas e a fração de ejeção do VE em chagásicos crônicos considerando anormalidades isoladas por análise de regressão múltipla (Abstr). **Arq Bras Cardiol 61**:130, 1993.

10. GUIMARÃES, A.C. - Aspectos eletrocardiográficos da cardiopatia crônica. In: Cançado, J.R.; Chuster, M. Cardiopatia chagásica. Belo Horizonte, **Fundação Carlos Chagas** 1985. p. 141-47.

11. MACEDO, V. - Inquérito eletrocardiográfico nacional para Doença de Chagas (Abstr). **Rev Soc Bras Med Trop 26**:12-13, 1993.

12. MAGUIRE, J.H.; HOFF, R.; SHERLOCK, I. et al. - Cardiac morbidity and mortality due to Chagas' disease: prospective electrocardiographic study of a Brazilian community. **Circulation 75**:1140-1145, 1987.

13. MAGUIRE, J.H.; MOTT, K.E.; LEHMAN, J.S. et al. - Relationship of electrocardiographic abnormalities and seropositivy to *T. cruzi* within a rural community in northeast Brazil. **Am Heart J 105**:287-94, 1983.

14. MOTA, E.A.; GUIMARÃES, A.C.; SANTANA, O.O.; SHERLOCK, I.; HOFF, R. & WELLER, T.H. - A nine-year prospective study of Chagas' disease in a defined rural population in NE Brazil. **Am J Trop Med Hyg 42**:429-40, 1990.

15. PORTO, C. - O eletrocardiograma no prognóstico e evolução da Doença de Chagas. **Arq Bras Cardiol 17**:313-46, 1964.

16. RASSI, A.; LORGA, A.M. & RASSI, S. - Abordagem diagnóstica e terapêutica das arritmias na cardiopatia chagásica crônica. In: Germiniani, H. **Diagnóstico e terapêutica das arritmias cardíacas**. 3 ed. Rio de Janeiro, Editora Guanabara, 1990. p. 225-44.

17. SANTANA, O. - **Arritmias ventriculares e evolução clínica na forma crônica da Doença de Chagas**. Salvador, Bahia, 1987 [Dissertação de mestrado - Universidade Federal da Bahia].