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Original Article

Electrocardiographic and echocardiographic profile of patients with heart failure

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Abstract: Describing and analyzing the electrocardiographic and echocardiographic profile of patients with heart failure (HF). Methods: Documentary, retrospective, quantitative and descriptive research; data collected at the Hospital das Clinicas of Uberlandia with patients diagnosed with HF. Results: 81 patients participated in this study, with the average age of 66.75 years, 4 to 6 years of formal education and family income of approximately two minimum wages. A diagnosis time of 5 to 6 years and Left Ventricular Ejection Fraction (LVEF) of 40.88±11.97% were observed. In the clinical profile, the presence of comorbidities was evident, such as systemic arterial hypertension, arterial disease and cardiac arrhythmias (82.72%, 30.86% and 35.80% respectively). Conclusion: Cardio Vascular Diseases (CVD) directly impacts the lives of thousands of people, presenting an important public expenditure, not to mention the scarcity of diagnostic research, which can contribute to future research and guideline development.

Keywords: Heart failure, electrocardiography, echocardiography, clinical profile

Introduction

Cardiovascular diseases (CVD) are a group of diseases that affect the heart and/or blood vessels, including coronary heart disease, cerebrovascular disease, arterial disease, rheumatic heart disease, congenital heart disease, deep venous thrombosis and pulmonary embolism [1, 2]. CVD is the leading cause of death in the world, while in Brazil it represents the third leading cause of hospitalization in the public health system (SUS). The most frequent pathology of these hospitalizations is due to Heart Failure (HF) [3, 4]. HF is a pathology where the heart muscle does not oxygenate and nurture the tissues properly. The etiology can be different among individuals, providing indirect or direct consequences in cardiac function and cardiorespiratory system as a whole [5].

Such heart disease is considered a clinical challenge in the public health and cardiology areas because it is an endemic problem in progression, besides the fact that most cardiovascular diseases culminate in HF as a pathological final pathway [6, 7].

A screening electrocardiogram (ECG) and ecocardiogram are reasonable in patients with symptoms suggestive of HF. International guidelines state that both of screening are the most useful test in the diagnosis of HF structural abnormality, systolic dysfunction, diastolic dysfunction, or a combination of these abnormalities needs to be documented in patients who present with resting or/and exertional symptoms to establish a definitive diagnosis of HF [8].

Moreover, studies show that ECG and ecocardiogram retains an extremely powerful role in the assessment of patients with dilated cardiomyopathy, which can provide diagnostic red flags useful to orient the following phases of the diagnostic work-up, prognostic stratification criteria and information that can direct appropri-

ate decision making in HF. ECG and ecocardigram still may suggest an acute tachyarrhythmia or bradyarrhythmia as the cause of heart failure. It may also aid in the diagnosis of acute myocardial ischemia or infarction as the cause of heart failure, or it may suggest the likelihood of a prior myocardial infarction or the presence of coronary artery disease as the cause of HF [8, 9].

In Brazil, few studies have shown ECG and ecocadiogram details. Brazilian researchers follow international guidelines, especially with regard to the echocardiographic profile of HF patients with, which presents the thicknesses of cardiac layers and specific structural anatomical alterations in this heart disease [9]. In this sense, this study evaluated the electrocardiographic and echocardiographic profile of patients with HF, and described the sociodemographic and clinical profile of those patients.

Materials and methods

Type of study

This is a documental research, retrospective, quantitative and descriptive approach.

Study site and data collection procedures

The study was conducted in the outpatient clinic of the Hospital de Clínicas de Uberlândia (HCU) with patients with medical diagnosis of HF. Initially, the hospital statistics section (HSS) provided the number of patients with confirmed HF diagnosis and require outpatient HCU care. The statistical sector used the international codes specific for HF disease in order to include patients in the study, which are: ICD 10 - I50 for Heart failure; ICD 10 - I50.0 for Congestive heart failure; ICD 10 - I50.1 for Left ventricular failure, and ICD 10 - I50.9 for Unspecified heart failure.

After the medical records were collected the researchers extracted the data through documentary review using a validated instrument 10. Data were collected between January and July 2019.

Variables

Clinical and demographic variables were collected, such as age, formal education, income, diagnostic time of HF, comorbidities, etiology of HF and habits of life. ECG variables collected were: Left ventricular ejection fraction (LEVE%), aorta diameter (mm), Left Atrium Diameter (mm), Diastolic Diameter of the Left Ventricle (mm), Systolic Diameter of the Left Ventricle (mm), Intra-ventricular Septum Diameter (mm), Left Ventricle Posterior Wall (mm), Electrocardiogram Rhythm, Left Branch Block, Atrioventricular block and final rhythm of ECG. ECG variables collected through Conventional ECG was performed in Ecafix electrocardiograph model ECG6 and analyzed according to the classic electrocardiographic diagnostic criteria. The ECG was performed by an echocardiographer accredited by the Brazilian Society of Cardiology in a GE-branded ultrasound equipment model Logic500.

Inclusion criteria

(1) >18 years old. (2) Patients with clinical criteria of HF reported in medical records, such as: dyspnea, fatigue, orthopnea, paroxysmal nocturnal dyspnea, lower limbs edema, high levels of BPN or NT-pro-BNP. (3) Patients with diagnosed HF already confirmed in medical records. (4) Require semiannual outpatient clinic follow-up. (5) Medical records with no gaps.

Exclusion criteria

(1) Hospitalization of at least 30 days. (2) Cardiovascular procedures programed in 3 mounths ahead. (3) Patients undergone cardiovascular procedures 3 mounths before screening. (4) Other kind of comorbities able to change ECG and ecocardiogram results.

Ethical aspects

This study was evaluated and approved by the Ethics and Research Committee with Human Beings of the institution, obtaining Brazilian approval number 1,864,889.

Sample size and statistical data analysis

The determination of the sample size considered a coefficient of aprioristic determination R2 = 0.13, in a linear regression model with 4 predictors, having a significance level or of type I error of $\alpha = 0.05$ and type II error of $\beta = 0.1$, resulting, therefore, in a prioristic statistical power of 90%. Using the Power Analysis and Sample Size (PASS) application, version 13, entering the above values, a minimum sample

Table 1. Quantitative variables on the socioeconomic profile of patients with Heart Failure, attended at the Cardiology Outpatient Clinic "Amelio Marques" at Hospital das Clínicas of Uberlandia, 2019

Variables	Average ± SD	Median ± IQ	[CI]	*p*-value
Age (years)	66.75±10.84		64.36-69.15	0.309
Formal education (years)		4±6	4-5	**<0.001**
Family Income (R$)		1640.0±1125.0	1640.0-1640.0	**<0.001**
Per Capta Income (R$)		820,0±92,0	820-820	**<0.001**

p-values in bold indicate that the data do not follow normal distribution (symmetric); therefore, the median was adopted to represent them; IQ: interquartile amplitude; SD: standard deviation; IC: Confidence Interval.

Table 2. Quantitative variables about the clinical and echocardiographic profile of patients with Heart Failure attended at the Cardiology Outpatient Clinic "Amelio Marques" at Hospital das Clínicas of Uberlandia, 2019

Variables	Average ± SD	Median ± IQ	[CI]	*p*-value
Diagnostic Time (years)		5±6	3-6	**<0.001**
LVEF (%)	40.88±11.97		38.23-43.52	0.297
Aorta Diameter (mm)	33.81±3.19		33.11-34.52	**0.193**
Left Atrium Diameter (mm)	43.12±5.41		41.93-44.32	0.824
Diastolic Diameter of the Left Ventricle (mm)		57±16	53-62	**0.012**
Systolic Diameter of the Left Ventricle (mm)		45±18	40-49	**0.039**
Intra-ventricular Septum Diameter (mm)		9±2	9-10	**<0.001**
Left Ventricle Posterior Wall (mm)		9±2	9-9	**<0.001**

p-values in bold indicate that the data do not follow normal distribution (symmetric), so adopted the median to represent them; IQ: interquartile amplitude; SD: standard deviation; IC: Confidence Interval; LVEF: Left ventricular ejection fraction.

size of n = 81 subjects. Data were typed in double input in the Excel software® and imported into environment R: A Language and Environment for Statistical Computing® where statistical analysis was performed, obtaining measures of central trend, proportion, normality tests and confidence interval.

Results

A total of 81 patients of identical final pathology (HF), but with distinct etiology (ischemic, hypertensive, chagasic, valvar and idiopathic diseases), as well as associated comorbidities (smoking, alcoholism, sedentariness) participated of this study.

The average age of the participants was 66.75±10.84 years, formal education with a median of 4±6 years, family income of approximately two minimum wages (R$1,640.00± 1,125.00), with a per capita income of R$820.0±92.0 (**Table 1**).

A diagnostic time of 5±6 years was observed, with LVEF of 40.88±11.97%. Other values related to cardiac structural diameters, evaluated by echocardiogram can be observed in the table below, as well as their intervals of confidence and distribution according to *p*-value (**Table 2**).

The majority of the patients had non-sinus electrocardiogram rhythm (n=80; 98.77%) in relation to electrical conduction in electrocardiographic reports, as well as the prevalence of left branch block (90.12%) (**Table 3**).

The presence of systemic arterial hypertension, coronary heart disease and cardiac arrhythmias were the most prevalent comorbidities, with 82.72%, 30.86% and 35.80% of cases, respectively. Pacemakers were used as surgical procedure in 57 patients (70.37%) for the treatment of HF, as well as chagasic (53.10%) and ischemic etiologies (30.86%) (**Table 4**).

Discussion

HF is classified, according to current national guidelines, in Heart Failure with preserved ejection fraction (HFpEF) with LVEF ≥ 50%; and Heart Failure with reduced ejection fraction (HFrEF) with LVEF<50% [3-11].

Table 3. Variables on the electro and echocardiographic profiles of patients with Heart Failure treated at the Cardiology Outpatient Clinic "Amelio Marques" at the Hospital das Clínicas of Uberlandia, 2019

Variable	n	%	[CI]
Electrocardiogram Rhythm			
Sinus	1	1.23	0.03-6.69
Not sinus	80	98.77	93.31-99.97
Left Branch Block	73	90.12	81.46-95.64
Right Branch Block	10	12.34	6.08-21.53
Atrioventricular block	10	12.34	6.08-21.53
Rhythm			
Regular	64	79.01	68.54-87.27
Irregular	17	20.99	12.73-31.46
Ascending Aorta Diameter			
Normal	67	82.72	72.70-90.22
Discreet increase	15	16.05	8.83-25.88
Moderate increase	1	1.23	0.03-6.69
Pulmonary Artery Diameter			
Normal	78	96.30	89.56-99.23
Discreet increase	2	2.47	0.30-8.64
Moderate increase	1	1.23	0.03-6.69
Right Atrium Diameter			
Normal	64	79.01	68.54-87.27
Discreet increase	10	12.34	6.08-21.53
Moderate increase	1	1.23	0.03-6.69
Significant increase	6	7.42	2.77-15.43
Left Atrium Diameter			
Normal	24	29.62	19.99-40.81
Discreet increase	23	28.40	18.93-39.50
Moderate increase	13	16.05	8.83-25.88
Significant increase	21	25.93	16.82-36.86
Right Ventricle Diameter			
Normal	67	82.72	72.70-90.22
Discreet increase	7	8.64	3.55-17.00
Moderate increase	4	4.94	1.36-12.16
Significant increase	3	3.70	0.77-10.44
Left Ventricle Diameter			
Normal	34	41.97	31.09-53.46
Discreet increase	16	19.75	11.73-30.09
Moderate increase	13	16.05	8.83-25.88
Significant increase	18	22.23	13.73-32.83
Right Ventricular Function			
Preserved	62	76.54	65.82-85.25
Reduced	19	23.46	14.75-34.18
Left Ventricular Function			
Preserved	14	17.28	9.78-27.30
Reduced	67	82.72	72.70-90.22
Mitral anatomical/functional alteration	75	92.59	84.57-97.23
Anatomical/functional lung alteration	47	58.03	50.17-64.98

According to the literature, the average for the diagnosis of HF is approximately 7 years [10]. This value slightly greater than the present study (4±6 years). The average LVEF found is less than 50%, so most patients have HFrEF.

Average LVEF values presented in the literature are varied, since they are closely linked to peculiar characteristics of the study population, level of health care addressed, in addition to the etiology itself. Some recent studies point to LVEF average values in 50%, with high standard deviation [12-16]. In contrast, other studies show LVEF values lower than 40% [17-20].

When analyzing the echocardiographic profile, the dilation values of the Proximal Ascending Aorta were divergent with the findings in the literature. Literature correlating proximal ascending aorta dilation with HF is scarce [21, 22]. Hypotheses indicate an association of clinical and echocardiographic findings (ascending aorta dilation) with advanced age and presence of comorbidities such as diabetes mellitus (DM) and atherosclerotic inflammatory processes.

Although there is a lack of articles in literature, when we relate to dilation in cardiac patients, we see that most have a risk for coarctation, aneurysm and dissection of the non-ascending thoracic vessel, with no more recurrent associations of HF. Therefore, we can relate only the results of the study with the comorbidities associated with patients and we observed a relationship with the cause of alteration of the vascular endothelium.

In the left ventricular evaluation, both systolic and diastolic diameters do not corroborate with the

Anatomical/functional alteration Tricuspid	74	91.36	84.76-95.12
Pericardium			
Normal	73	90.12	81.46-95.64
Pericardial effusion	8	9.88	4.36-18.54
Total	81	100	

CI: Confidence Interval.

Table 4. Variables about the clinical profile of patients with Heart Failure attended at the Cardiology Outpatient Clinic "Amelio Marques" at Hospital das Clinicas of Uberlandia, 2019

Variable	n	%	[CI]
Comorbidities			
Systemic Arterial Hypertension	67	82.72	72.70-90.22
Diabetes Mellitus	13	16.05	8.83-25.88
Dyslipidemia	15	18.52	10.75-28.70
Coronary Artery Disease	25	30.86	21.07-42.11
Angina	6	7.41	2.77-15.43
Obesity	8	9.88	4.36-18.54
Arrhythmias	29	35.80	25.45-47.23
Stroke	1	6.17	2.03-13.82
Atrial fibrillation	14	17.28	9.78-27.30
Other	31	38.27	27.68-49.74
Etiology			
Ischemic heart disease	25	30.86	21.07-42.11
Hypertensive heart disease	7	8.64	3.55-17.00
Chagas heart disease	43	53.10	41.67-64.27
Valvar Heart disease	3	3.70	0.77-10.44
Idiopathic heart disease	3	3.70	0.77-10.44
Habits of Life			
Smoker	10	12.34	6.08-21.53
Ex-smoker	23	28.40	18.93-39.50
Etilist	1	9.88	4.36-18.54
Ex-Etilist	18	22.22	13.73-32.83
Physical Activity	5	6.17	1.36-12.16
Physical Rehabilitation	1	1.23	0.03-6.69

CI: Confidence Interval.

literature, and were above the published values [23], indicating greater ventricular dysfunction in the patients in this study.

In patients with HFrEF (most patients in this study), tension strength concomitant to cardiac muscle kinesis leads to concentric increase in ventricular mass, which, over time, impairs LV dilation, justifying increases in diameters of both left atrium and ventricle.

The findings about the posterior wall of the Left Ventricle (LV) of this study are compatible with the data in the literature [24]. However, when analyzing the IQ (±2 mm) in the present study, values above physiological were found, probably as a consequence of HF dysfunction and ventricle thickening, also accompanied by systolic and diastolic LV diameters above physiological, as mentioned above.

The variable "left ventricular function", which is reduced in a large portion of the population studied, is closely related to previously discussed echocardiogram parameters, such as reduced LVEF, changes in the left ventricular diameter and ventricular hypertrophy. Anatomical and physiological changes in valve apparatus are prevalent in the research, where studies show that these changes can aggravate HF prognosis, besides drastically increasing cardiovascular risk [25, 26]. Moreover, several surgical procedures could be considered for the treatment of valve dysfunction; however, a considerable portion of the population with HF is inoperable or with high surgical risk, due to their pathological situation (mainly HF with addition of mitral regurgitation and severe systolic dysfunction) [27-30].

Few alterations were observed during pericardium evaluation, a fact that can be inferred considering that the attendance was in an outpatient clinic, and that severe cases, like pericardial effusion or cardiac tamponade, were attended in emergency services [9].

Electrocardiographic changes in HF patients are common in most cases and electrocardiogram along with echocardiogram will assist in the diagnosis of the disease. It is reported that these exams do not have great specificity, although almost all patients present a non-sinus rhythm. The signs and symptoms that affect HF are not specific to this pathology and may be present even in cardiopulmonary dis-

eases. Despite being a pathology with shared symptoms, research demonstrates that there are still manifestations that can reliably diagnose heart failure in the patient, guiding complementary conduct and tests for confirmation [3, 9, 31, 32].

HF is a predisposing factor for the onset of multi-systemic and associated comorbidities such as anemia, renal failure, atrial fibrillation, depression, anxiety and chronic obstructive pulmonary disease [33, 34]. Hypertension is considered both a comorbidity causing HF and a multisystemic disease that can be derived from HF and is the most correlated with it [35-40].

Patients diagnosed with these diseases associated with HF will have aggravated prognosis. This can be explained by renal and cardiac interrelationship, defined by Cardiorenal Syndrome [33, 34].

Another fact of paramount importance is the identification of the etiology of the disease, since it makes it possible to plan an appropriate treatment, promoting a positive prognosis. Patient information can be obtained through previous history, physical examination, ECG, and laboratory analyses [4, 41, 42].

In this study, chagasic heart disease was the most prevalent etiology. The disease in question comes from infection by *Trypanossoma cruzi* and in the long run brings cardiac impairments, which can lead to involvement of the sinus node, atrioventricular node and His bundle, resulting in HF. Studies indicate at least 35% of Chagasic patients present direct complications of cardiac impairment [43].

Lifestyle should also be considered as a predisposing factor for cardiovascular diseases. Inadequate habits such as sedentarism, alcohol consumption, smoking, inadequate eating are the major obstacles found in the Brazilian population that are related to the increase in cardiovascular diseases. Such habits are considered modifiable factors and should be highly emphasized to patients, in order to improve life quality [38, 40, 44, 45].

It should be emphasized that HF brings several physiological and psychological modifications, and routine changes in patients' lives. Support to patients is provided by cardiac rehabilitation programs, which aim to promote better physical, social and mental conditions. However, only a small number of patients from this study joined a cardiac rehabilitation program, which is fundamental, in conjunction with drug treatment, to promote better life quality and prognosis [45].

Conclusion

HF is responsible for numerous deaths worldwide, and in Brazil they are the third leading cause of hospitalization in SUS, besides having an important impact on life quality of those affected by it. Therefore, when tracking the disease, it is necessary to consider related comorbidities such as SAH (systemic arterial hypertension) and diabetes mellitus; etiological questions, especially Chagasic patients (closely linked to HF); social/biological factors; level of education, and income, among others. It is important to understand that the level of instruction and knowledge about these pathologies directly interfere in the promptness to demand for health care, thus worsening the clinical and pathophysiological condition, directly implying in greater number of HFrEF.

Brazilian studies detailing the electrocardiographic and echocardiographic profile of HF patients are pioneer. It is essential to associate cardiac anatomorphological findings and alterations with the therapeutic care plan of these patients, since each type of alteration leads to a distinct clinical manifestation. The results of this study, which have high internal validity and potential external value, demonstrated that it is possible to trace specific conducts and outpatient clinical management for HF patients, thus, these individuals have positive prognosis, especially by maintaining life quality and controlling disease signs and symptoms.

The study has some limitations: the document review of the medical records contained some gaps, limiting the explanation of additional clinical data. Furthermore, the retrospective methodology is not capable of explaining and predicting the facts.

In short, our expectation is that future research can be carried out with more robust methodologies in order to make clinical inferences about the relationship between electrocardiographic

and echocardiographic variables in the outcomes of patients with heart failure.

Disclosure of conflict of interest

None.

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