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ASSOCIATION BETWEEN ECHOCARDIOGRAPHIC PARAMETERS OF RIGHT VENTRICULAR FUNCTION AND VENTRICULAR-ARTERIAL COUPLING IN PATIENTS WITH HEART FAILURE, THEIR SIGNS AND SYMPTOMS

Suzana Santos Ryu
http://lattes.cnpq.br/0964705742202246

Carolina Hamilton Miranda
Filipe Ozório

Hélder Jorge de Andrade Gomes
http://lattes.cnpq.br/6289212874382992

Abstract: Introduction: Heart failure (HF), the final common pathway of heart disease, has an increasing prevalence in the Brazilian population, as a result of factors such as the ageing of the population, greater presence of cardiovascular risk factors and therapeutic advances that reduce mortality, and whose high morbidity significantly affects patients' quality of life, also causing high socio-economic costs. Early diagnosis of decompensation in patients with HF is a challenge in order to take measures to avoid hospital admissions and other unfavorable clinical events. Echocardiographic parameters of right ventricular function and ventriculo-arterial coupling may be associated with signs and symptoms of this clinical decompensation. **Objectives:** The aim of the study is to evaluate the association between echocardiographic parameters of right ventricular function and ventriculo--arterial coupling with the presence of signs and symptoms of left and right heart failure in outpatients. **Materials and Methods:** This is a quantitative and qualitative study, with data collected at the Jundiaí Medical School outpatient clinic, from the medical records, clinical history and physical examination of heart failure patients with reduced ejection fraction (LVEF < 50%). Data will be collected from the echocardiograms performed. An analysis of the echocardiographic parameters obtained and possible relationship with the presence of signs and symptoms of HF will be carried out. **Results:** Due to this non-significant amount of echocardiographic parameters of ventricle-arterial coupling, analysis was changed to the verification of right ventricle function and its association with signs / symptoms of heart failure. The mean age of the patients was 62.4± 12.2 years, 62% male, with a left ventricular ejection fraction (LVEF) of 38.8± 8.5%. According to the sample collected, no relationship could be found between right ventricular dysfunction and the signs/symptoms of heart failure. The presence of right ventricular dysfunction was only statistically significantly associated with a worse LVEF. **Conclusion:** The presence of right ventricular dysfunction on echocardiography was not associated with a greater number of signs and symptoms of heart failure. Patients with right ventricular dysfunction had a worse left ventricular ejection fraction.

Keywords: Echocardiographic parameters, right ventricular dysfunction, heart failure, signs and symptoms.

INTRODUCTION

Despite the substantial reduction in age--adjusted cardiovascular mortality rates in recent decades, cardiovascular disease remains the most common cause of death in Brazil and worldwide (1,2). The final common cause of heart disease, heart failure (HF) is an out-of-control global pandemic with an increasing prevalence as a result of an ageing population, a greater presence of cardiovascular risk factors and therapeutic advances that reduce mortality (2). In addition to the high mortality rate, which can reach 9% per year (3), at least a third of patients hospitalized for HF can be readmitted to hospital within the first 6 months, with a direct impact on their quality of life (4,5).

Heart failure is a complex clinical syndrome, the result of a structural and/or functional abnormality of the heart, characterized by typical symptoms such as dyspnea, orthopnea, paroxysmal nocturnal dyspnea, lower limb edema or fatigue, and accompanied by signs on physical examination such as lung crackles, the presence of a third heart sound, jugular turgor or hepatojugular reflux (6,7).

Among the complementary methods, echocardiography is essential in the routine of these patients. It is used as a diagnostic and prognostic tool, and offers parameters that contribute to investigating the etiology and

classification of heart failure (8). Segmental alterations in contractility suggest an ischemic etiology, especially if they are associated with inactive electrical areas on the electrocardiogram. Heart valve dysfunction, associated with morphological changes, points to valve etiology. The presence of a digitiform apical aneurysm, changes in inferior or inferolateral contractility and right ventricular dysfunction are frequent findings in Chagas cardiopathy. Echocardiography also makes it possible to classify HF according to the left ventricular ejection fraction (LVEF). In its most recent classification, it is divided into preserved LVEF (≥50%), reduced LVEF (≤40%) and slightly reduced LVEF (41 to 49%) (3,9).

In addition to ventricular function, other parameters such as the size of the heart chambers, the presence of pulmonary hypertension or secondary mitral insufficiency are also recognized predictors of adverse prognosis. On the other hand, parameters for assessing the right heart chambers, such as TAPSE (tricuspid *annular plane systolic excursion*), is a way of estimating right ventricular (RV) systolic function, and together with the estimation of pulmonary artery systolic pressure (PASP), are also related to a worse prognosis (8,10).

Precisely these last two parameters (TAPSE and PSAP) allow us to non-invasively and simply evaluate data on right ventricle-arterial coupling: TAPSE is the component of ventricular function and PSAP is the reference data for its afterload. Ventricular-arterial coupling allows us to determine how well the right ventricle's contractility adapts to afterload. Ideal coupling occurs when there is maximum transfer of potential energy from one elastic chamber (the ventricle) to another (the arterial system) (11), but in the case of patients with heart failure, this relationship does not seem to hold (12,13,14). Recent studies link the right ventricle-arterial coupling measured by echocardiography (TAPSE/PSAP ratio) as an independent marker for assessing the severity of the disease and predicting outcomes in pulmonary hypertension, as well as significant correlations between TAPSE/PASP and invasive hemodynamic variables (14).

The TAPSE/PASP ratio is inversely correlated with functional class, but the role of echocardiographic parameters of right ventricular function and ventricular-arterial coupling and their relationship with the presence of signs and symptoms of decompensated left or right heart failure in outpatients is not entirely clear.

OBJECTIVES

To assess whether right ventricle-arterial coupling values by echocardiography (TAPSE/PSAP) are associated with the presence of more signs (jugular stasis, hepatojugular reflux, third heart sound, lower limb edema, pulmonary crackles) and symptoms (dyspnea, orthopnea, paroxysmal nocturnal dyspnea, functional class, fatigue/asthenia) of heart failure in patients followed up in the cardiology outpatient clinic.

METHOD

TYPE OF STUDY

This is a quantitative and qualitative study. Data will be collected from the medical records, clinical history and physical examination of patients with heart failure seen at the cardiology outpatient clinic of the Jundiaí Medical School. The echocardiogram reports of these patients will be used and an analysis of the echocardiographic parameters with the signs and symptoms of HF will be produced in order to observe any relationship

STATISTICAL ANALYSIS

They were collected during the service:

- Sociodemographic characteristics such as age and gender.

- Presence of heart failure symptoms, pre-existing diseases and cardiovascular risk factors.
- Physical examination (signs and symptoms of right and left HF).
- General laboratory results (basic blood count, biochemistry and coagulation).
- Echocardiographic parameters of left and right ventricular function, as well as the TAPSE and PSAP values for calculating non-invasive right ventricle-arterial coupling.

The data was collected using a questionnaire developed for the Rosa dos Ventos Study, which is a national registry of HFpEF of which our outpatient clinic is part as a participating center, whose work aims to understand the regional characteristics of patients with HFpEF in Brazil, and which has been approved by the Research Ethics Committee of the Jundiaí Medical School (opinion number 5.444.580, CAAE 25756919.9.2040.5412, appendix 4 of this report). The questionnaire consists of a registration form in which epidemiological, social and economic data is collected, as well as data on the participant's clinical history of heart failure, which is attached to this project.

ETHICAL ASPECTS

The data is being collected after authorization from the institution and approval of the research by the Research Ethics Committee of the Jundiaí Medical School, available in appendix 4 (consolidated opinion number 5.444.580, CAAE 25756919.9.2040.5412). We will use the Free and Informed Consent Form (FICF) of the Rosa dos Ventos Study, available in Appendix 5, a study with no proposed intervention, which poses no major risk to the patients involved, where we undertake to preserve the privacy of the patients whose data will be collected from medical records and databases of the Outpatient Clinic, and we also agree that this information will be used solely and exclusively anonymously for the execution of this project.

Thus, because it is an observational, analytical or descriptive retrospective study, which will only use information from medical records, institutional information systems and/or other sources of data and clinical information available at the institution without the use of biological material; because all the data will be handled and analyzed anonymously, without nominal identification of the research participants; because the results of the study will be presented in aggregate form, not allowing the individual identification of the participants, and because it is a non-interventional study (without clinical interventions) and without changes/influences in the routine/treatment of the research participant, and consequently without adding risks or harm to their well-being.

To ensure confidentiality, the questionnaires will only be identified by a numerical code according to the order of the interviews. Even if personal information were to be leaked, there would be no way of identifying the participants' personal information. As for the benefits, the patient will have no direct benefit, however, given the structured care and the results of the research, it will be possible to better prevent cardiovascular events and the clinical management of heart failure patients, which can have a significant impact on patients' quality of life.

SCHEDULE

Stage identification	Start (dd/mm/yyyy)	End (dd/mm/yyyy)
Bibliographic survey	15/01/2023	15/01/2024
Preparation of the Research Project and submission to the CEP	15/01/2023	23/08/2023
Data collection	14/08/2023	14/03/2024
Results Analysis	15/11/2023	15/04/2024
Data Tabulation and Statistical Analysis	15/11/2023	15/04/2024
Discussion of Results	15/07/2024	15/07/2024
Finalizing Research for Publication	15/08/2024	15/08/2024

RESULTS

Data is still being collected and analyzed at the Jundiaí Medical School outpatient clinic. From August 2023 to December 2023, a total of 50 viable data collections for the study were carried out with inclusion criteria of the study at the Jundiaí Medical School outpatient clinic. Of these 50 patients, the mean ejection fraction was 38.8± 8.5%.

DESCRIPTIVE RESULTS

1) Sex

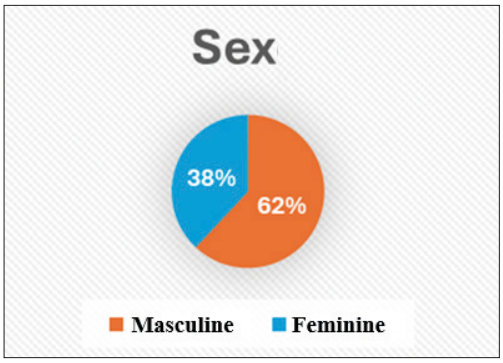

Figure 1: The average age of the patients was 62.4± 12.2 years, with the majority being male (62%):

2) Functional Class

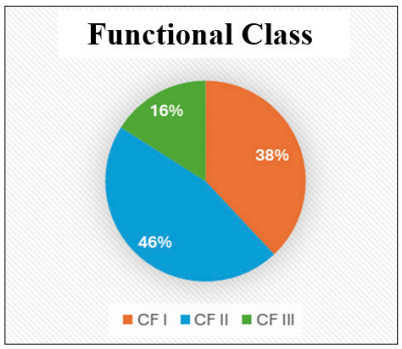

Figure 2: The functional class was represented by the percentages of: I of 38%, CF II of 46% and CF III of 16%.

3) Etiology

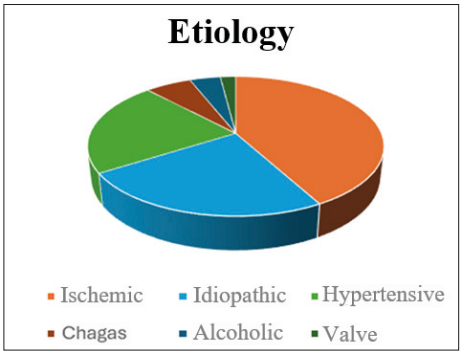

Figure 3: The main etiologies were mostly ischemic with 42%, followed by idiopathic with 24%, hypertensive with 22%, Chagas with 6%, alcoholic with 4% and valvular with 2%.

4) Symptoms

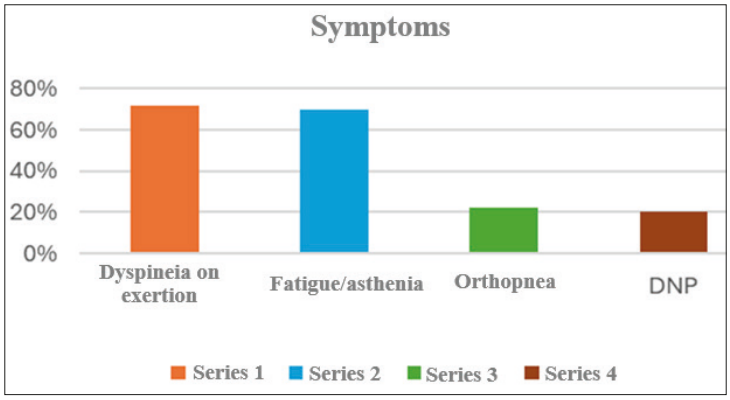

Figure 4: The symptoms are represented by dyspnea on exertion (72%), orthopnea (22%), DNP (20%) and fatigue/asthenia (70%).

5) Physical examination (signs)

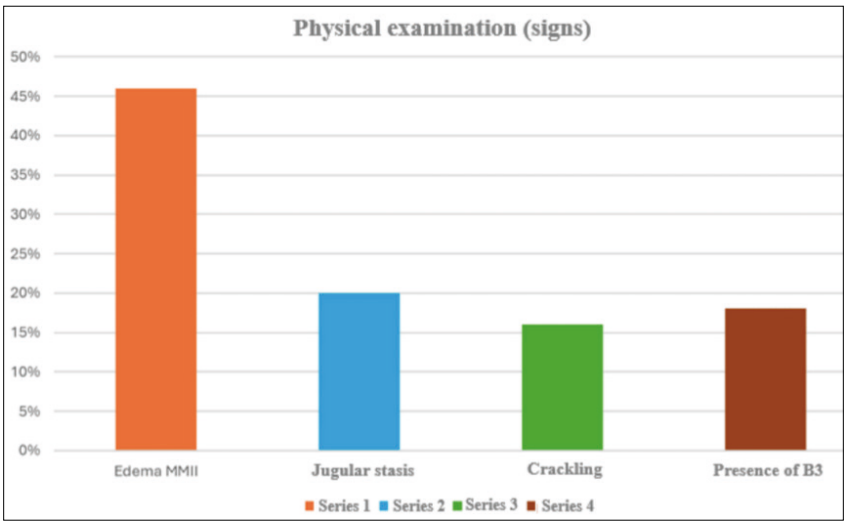

Figure 5: The signs are represented by edema of the lower limbs (LL) with 46%, jugular stasis 20%, crackles 16%, presence of B3 18%.

Independent Samples T-Test

	t	df	p	Mean Difference	SE Difference
Sex	1.455	16	0.165	0.351	0.241
Age	1.000	16	0.332	6.208	6.206
Dyspnea	0.204	16	0.841	0.039	0.191
CF	0.286	16	0.778	0.091	0.318
Orthopnea	0.323	16	0.751	0.052	0.161
DPN	1.054	16	0.307	0.195	0.185
Asthenia	0.204	16	0.841	0.039	0.191
Edema of the lower limbs	1.054	16	0.307	0.260	0.241
Jugular	0.260	16	0.798	0.065	3.536
Crepit	-0.204	16	0.841	-0.039	0.191
B3	-0.323	16	0.751	-0.078	0.241
FEVE	2.501	16	0.024	8.844	3.536

Note. **Student's-test.**

Table 1: The results shown in the table indicate that the only variable with a $p<0.05$ (0.024) is significantly associated with right ventricular dysfunction.

Group Descriptive

	Group	N	Mean	SD	SE	Coefficient of variation
Sex	0	7	0.714	0.488	0.184	0.683
	1	11	0.364	0.505	0.152	1.387
Age	0	7	65.571	7.115	2.689	0.109
	1	11	59.364	15.273	4.605	0.257
Dyspnea	0	7	0.857	0.378	0.143	0.441
	1	11	0.818	0.405	0.122	0.494
CF	0	7	2.000	0.577	0.218	0.289
	1	11	1.909	0.701	0.211	0.367
Orthopnea	0	7	0.143	0.378	0.143	2.646

	1	11	0.091	0.302	0.091	3.317
DPN	0	7	0.286	0.488	0.184	1.708
	1	11	0.091	0.302	0.091	3.317
Asthenia	0	7	0.857	0.378	0.143	0.441
	1	11	0.818	0.405	0.122	0.494
EdemaMMII	0	7	0.714	0.488	0.184	0.683
	1	11	0.455	0.522	0.157	1.149
Jugular	0	7	0.429	0.535	0.202	1.247
	1	11	0.364	0.505	0.152	1.387
Crepit	0	7	0.143	0.378	0.143	2.646
	1	11	0.182	0.405	0.122	2.225
B3	0	7	0.286	0.488	0.184	1.708
	1	11	0.364	0.505	0.152	1.387
FEVE	0	7	45.571	10.097	3.816	0.222
	1	11	36.727	4.941	1.490	0.135
Symptoms	0	7	2.143	1.215	0.459	0.567
	1	11	1.818	1.079	0.325	0.593
Signs	0	7	1.000	0.816	0.309	0.816
	1	11	1.364	1.502	0.453	1.101
Signs/symptoms	0	7	3.143	1.864	0.705	0.593
	1	11	3.182	2.272	0.685	0.714

Table 2: The results show that in the Group column, 0 is the sample group that does not have right ventricular dysfunction and 1 is the group that does. N is the number of the sample with right ventricular dysfunction in the report, with 18 of the 50 reports analyzed, of which only 7 were women and 11 were men with RV dysfunction, representing a mean of 0.714 and 0.364 and a standard deviation (SD) of 0.488 and 0.505, respectively.

INFERENTIAL RESULTS

Five patients without LVEF values were excluded. Only 9 patients had a PSAP value and 4 had a TAPSE value, even though the physician's order specified that the values were required

We changed the analysis to RV (right ventricle) function and its association with signs/symptoms:

DISCUSSION

According to the analysis of the data collected at the Jundiaí Medical School outpatient clinic, the descriptive data of the 50 patients included with heart failure had a mean age of 62.4± 12.2 years, 62% were male and had an LVEF measurement of 38.8± 8.5%. The functional class resulted in those classified as I comprising 38% of this sample, II 46%, and III 16%, showing that the majority of patients already have some symptom related to heart failure feeling well at rest, but with a limitation in moderate activities causing tiredness or shortness of breath, correlating with the majority of symptoms presented by these patients which are dyspnea on exertion (72%) and fatigue/asthenia (70%) followed by orthopnea (22%) and paroxysmal nocturnal dyspnea (20%).

With regard to signs on examination, the majority had edema in the lower limbs (46%), followed by jugular stasis (20%), the presence of B3 (18%) and crepitus (16%). The predominant etiology of heart failure in this sample was ischemic (42%), in second place hypertensive (22%), followed by Chagas disease (6%) and valvular heart disease (2%).

According to the inferential analysis, 5 patients were excluded because they did not have ejection fraction values on the echocardiogram report, only 9 had a PSAP value and 4 had a TAPSE value, even though the medical order specified the request for these values, so there was a loss of data which led to the

limitation of the analysis and, consequently, of the study. Due to this non-significant amount of data for the study of the relationship between the echocardiographic parameters of PSAP and TAPSE, the analysis was changed to the verification of right ventricular function and its association with signs and symptoms of heart failure, since the right ventricle is an important predictor of the progression of an insult that increases afterload, alter preload or decrease contractility, such as ischemia, cardiomyopathies or arrhythmias. In this study, ischemia[15] is the main cause of heart failure, so since it can cause right ventricular dysfunction, it could be inferred that it is related to the increase in signs and symptoms of HF.

The sample collected was not yet sufficient to make a reliable association. There were numerous difficulties encountered during the research. Access to reports with TAPSE and PSAP values, which would be the main parameters analyzed in this study, are not part of the cardiology outpatient routine. For this reason, the patients included in the study were asked to redo the echocardiogram with a doctor's order so that the values for these parameters could be included in the report. It took months of trying to arrange dates and times for them to go for the test, but due to the lack of direct involvement with the research and the patients' lack of understanding of the importance of the research, many didn't show up on the scheduled date, accepted unknown calls, which made it impossible to contact some patients, or those who did go for the test didn't send in the report.

Therefore, the obstacles to the research having a satisfactory result ranged from technical issues, because TAPSE and PSAP are not values commonly measured by the operator, to logistical/human issues, in which the patients were not more involved in the research to the point of collaborating with the generation of data

The association between worse right ventricle-arterial coupling and the presence of a greater number of signs and symptoms of heart failure in outpatients could be a significant piece of data that could lead to the future possibility of a new tool capable of helping to identify patients with decompensated heart failure at an early stage and acting before these patients reach a negative outcome. However, according to the sample collected, no relationship could be found between right ventricular dysfunction and the signs/symptoms of heart failure. This is despite clinical evidence to the contrary, since patients with this dysfunction progress to symptoms/signs such as dyspnea, jugular stasis, lower limb edema, among others.

CONCLUSIONS

The presence of right ventricular dysfunction on echocardiography was not associated with a greater number of signs and symptoms of heart failure. Patients with right ventricular dysfunction had a worse left ventricular ejection fraction. It was not possible to analyze right ventricle-arterial coupling by echocardiography with the presence of signs and symptoms of heart failure

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