Comparative Analysis of Myocardial Work After Decongestion Therapy in a Patient With Acutely Decompensated HFrEF

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Introduction

Acutely decompensated reduced ejection fraction heart failure (HFrEF) is one of the leading causes of hospitalization in our setting, with a 90-day readmission rate of 50%.[1] The use of additional tools in the assessment of the left ventricular function, such as the measurement of myocardial deformation through the Global Longitudinal Strain of the left ventricle (GLS) has greater prognostic value than the evaluation of the left ventricular ejection fraction (LVEF) by the Simpson method.[2] Despite the analysis of the myocardial deformity through the GLS being considered an independent predictor of mortality in patients with HFrEF, it is a parameter that experiences changes in pre- and after-load and, therefore, has limitations regarding the assessment of ventricular performance.[2-4] Myocardial work (MW) has stood out in recent years as a complementary tool to access parameters of myocardial function from the GLS-derived analysis, with the benefit of incorporating afterload information through the interpretation of the dynamic curve of deformity due to non-invasive left ventricular (LV) filling pressure.[5] Hence, the analysis of MW has been encouraging in patients with HFrHF, and, when analyzed in combination with classic hemodynamic parameters, it can add information with greater accuracy and prognostic value in the cardiac decompensation scenario.[3-5]

Clinical Case

Male patient, 52 years old, hypertensive, dyslipidemic, former smoker, admitted to the emergency unit for progressive Dyspnea Functional Class IV (NYHA) approximately one month ago. He presented worsening of the clinical condition in the last few days associated with orthopnea, lower limb (LL) edema and reduced urinary volume. The patient was admitted to the intensive care unit (ICU), using low-flow oxygen through a nasal catheter, for investigation and standard treatment of decompensated heart failure, including decongestion therapy with intravenous diuretics and vasodilators. Electrocardiogram in sinus rhythm on admission, with first-degree atrioventricular (AV) block, signs of left chamber overload with LV strain pattern and QRS duration of 100ms. Transthoracic echocardiogram (TTE) showed significant LV systolic dysfunction (LVEF: 25%) and right ventricle with borderline diameters (basal segment: 42mm and medial segment: 34mm); RV S': 09 cm/s; TAPSE: 15mm; FAC: 30%; mild tricuspid valve reflux with estimated pulmonary artery systolic pressure (PASP) through tricuspid reflux of 75mmHg, considering right atrial pressure of 15mmHg (inferior vena cava measurement of 21mm with inspiratory collapse < 50%); in addition to mitral valve reflux of an important degree of functional etiology. During the examination, blood pressure was 140 x 80 mmHg. The GLS analysis resulted in a value of -04%, global MW index of 385 mmHg%, constructive MW of 678 mmHg%, wasted MW of 359 mmHg% and efficiency of MW of 65%.

From the laboratory point of view, the patient had plateau troponin I (TnI) (0.135 > 0.133μg/L), increased NT pro-BNP and creatinine (6670 pg/m and 1.5 mg/dl, respectively), with no signs of associated infection. Cardiac catheterization was indicated to investigate coronary disease, without evidence of obstructive lesions.

The patient evolved with progressive clinical and hemodynamic improvement, being discharged from the ICU within 48 hours and responding well to the therapy instituted, without the use of supplemental oxygen and maintaining a negative fluid balance. He remained stable after converting the diuretic to oral administration, showing improvement in objective laboratory parameters (TnI: 0.135> 0.133> 0.09 μg/L; NT pro-BNP: 6670> 5594> 3818 pg/m), function stability (Cr: 1.5> 1.4> 1.5 mg/dl), in addition to improvement in dyspnea (CF II NYHA) and LL edema, with good deambulation tolerance and estimated weight loss of 3.6 kg since admission and negative cumulative fluid balance of 4,000ml.

TTE was performed at the time of hospital discharge, 72 hours after admission, with evidence of maintenance of the LVEF (26%), however, it showed indirect signs of reduced venous pressure in the right chambers (measurement of the inferior vena cava of 16mm with inspiratory collapse > 50% and minimal tricuspid valve regurgitation with Doppler curve limitation for PASP estimation). At the time of the examination, the blood pressure measured was 130 x 80 mmHg, showing new parameters: GLS of -07%, global MW index of 614 mmHg%, constructive MW of 839 mmHg%, wasted MW of 152 mmHg% and efficiency of the MW of 80%.

Keywords

Heart Failure; Ventricular Dysfunction, Left; Echocardiography

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Discussion

In the context of assessing ventricular performance in patients with HFrHF, the GLS has become a tool with prognostic information for the follow-up of this population.[3] Nevertheless, one of the limitations of the Longitudinal Strain is the dependency on pre- and post-load, whose variations can lead to alterations in its values with subsequent interference in the results.[3] Usually, the WM can allow an in-depth evaluation of the systolic performance of the myocardium through a wide range of physiological and pathological conditions in addition to traditional echocardiographic techniques.[5] In this context, a recent study using MW in HFrEF showed greater sensitivity in the assessment of ventricular systolic function when using speckle tracking analysis of myocardial deformation combined with the measurement of non- invasively, LV ventricular pressure, reducing load-dependent limitation on myocardial contraction.[4,6]

The quantification of cardiac work occurs through the following indexes: global MW index (GWI), constructive MW (GCW), wasted MW (GWW) and global efficiency (GWE).[4] There is growing evidence about the evaluation of constructive work (GCW) after optimization of therapy in heart failure, suggesting the identification of patients at increased risk of major cardiovascular events, as well as good correlation with conventional laboratory prognostic parameters, such as NT pro-BNP and troponin values.[5] Nevertheless, reference values for patients with HFrEF have not been described, so comparative analysis of parameters before and after decongestion therapy was used. Some studies also suggest a greater sensitivity of global MW index values related to functional improvement, demonstrated by the increase in the distance covered in 6 minutes without changes in LVEF and GLS.[5]

Comparatively in the case described, there was clinical improvement, reduction in the value of NT pro-BNP, improvement in all ventricular performance parameters analyzed, as well as an increase in GLS after decongestion therapy. In the analysis of the area of the deformity-pressure curve, there was an increase in the area correlated with the improvement in metabolism and the total amount of work performed by the LV, expressed through the reduction of global wasted work and increase of global constructive work (Figure 1). Additionally, there was an increase in overall efficiency of MW from 65% to 85%, with a reduction in overall wasted work from 359 mmHg% to 152 mmHg% (Figure 2), findings in line with published studies.[3,5] The described report demonstrates the use of this tool, through the recognition of the increase in GCW and GWE with a reduction in the rate of wasted MW, which can detect early markers of the effectiveness of therapy for decompensated HFrEF.

In the context of acute decompensation of heart failure, non-invasive dynamic assessment using MW is more sensitive than GLS in characterizing myocardial performance, adding prognostic value to other parameters already established.[3,5] Additionally, the joint assessment of WM with the patient's clinical condition and laboratory tests, such as NT pro-BNP and troponin values, can help in decisions regarding the adjustment of pharmacological therapy, diuretic conversion, evaluation of hospital discharge and even in the follow-up clinical.[5]

Although it is a technique with encouraging applicability in this scenario of assessing ventricular performance in HFrEF, there are intrinsic limitations to the method that must be considered. The measurement of myocardial deformation depends on the quality of the 2D image and the frame rate, and may generate inaccurate results in the presence of limited acoustic windows as well as in the presence of non-sinusal rhythm. The software for MW analysis is owned by a single company, with low reproducibility so far; alterations in ventricular geometry, as well as the presence of aortic stenosis are conditions in which the measurement of wall stress should be included in the assessment of WM instead of, exclusively, the non-invasive estimation of LV pressure.[4] In addition, the technique does not allow the performance evaluation, combined with the speckle tracking analysis, of

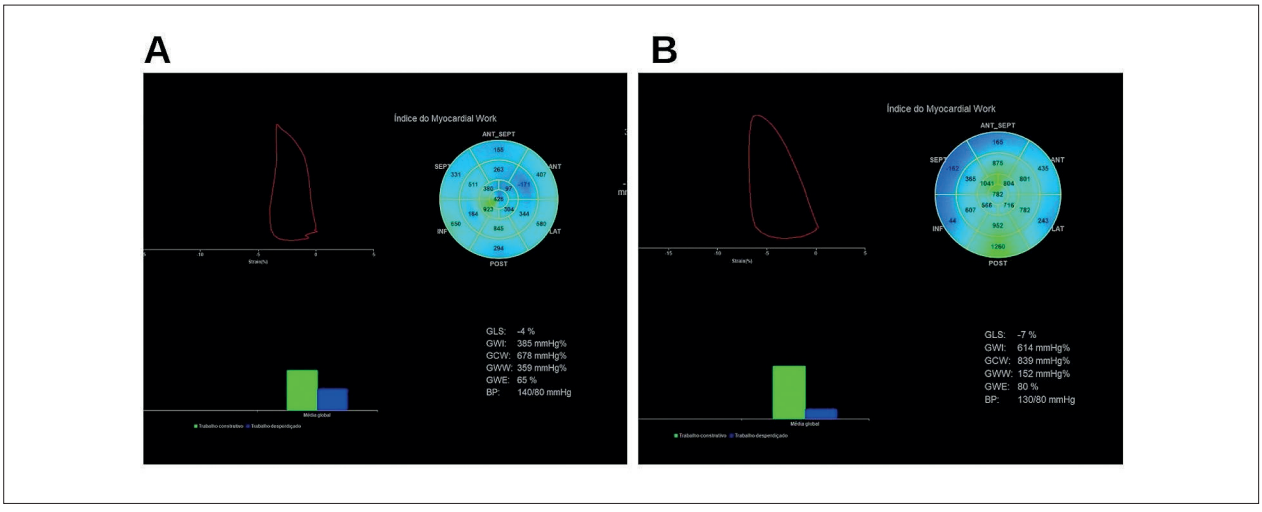

Figure 1 – *Comparative analysis of MW before and after decongestion therapy. Evaluation of the pressure-deformity curve of the left ventricle and bull's eye of the 17 segments in patients with dilated cardiomyopathy with severe ventricular dysfunction before (A) and after (B) decongestion therapy.*

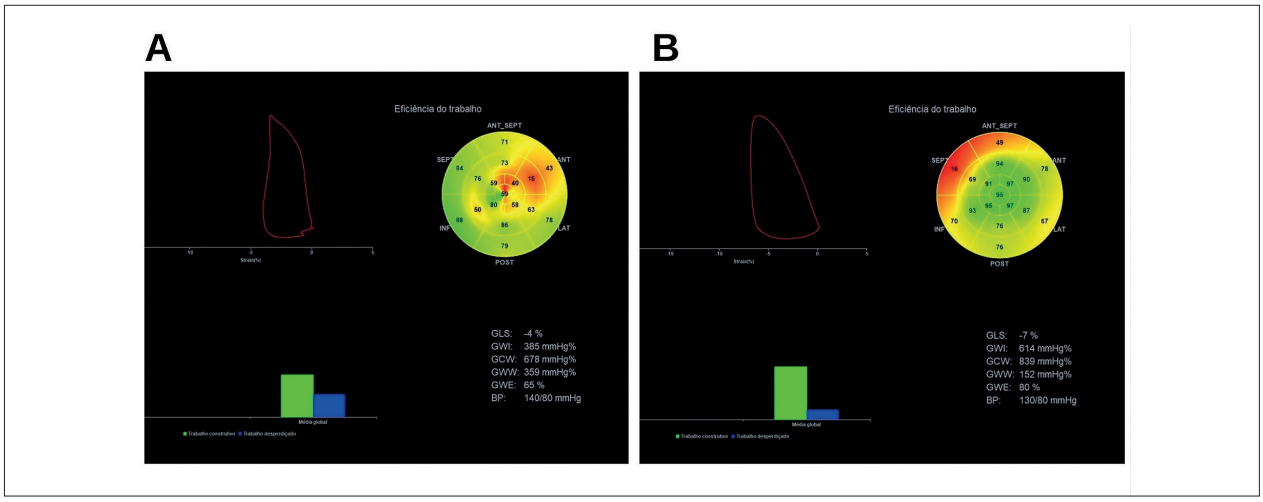

Figure 2 – *Comparative analysis of MW before and after decongestion therapy. Evaluation of the pressure-deformity curve of the left ventricle and bull's eye of the 17 segments in patients with dilated cardiomyopathy with severe ventricular dysfunction before (A) and after (B) decongestion therapy.*

other chambers, such as the right ventricle and left atrium, which are important for the global evaluation of the prognosis of patients with HFrHF.[4,5]

Additional studies are required to validate these parameters and their correlation with clinical and laboratory markers, with the possibility of adding prognostic value to this patient profile, being able to identify patients at greater risk of readmissions, as well as monitoring the response to clinical therapy.[5]

Author Contributions

Conception and design of the research: Costa A; acquisition of data: Drubi S, Chaves A; writing of the manuscript: Drubi S, Junqueira B; critical revision of the manuscript for intellectual content: Macedo CT, Guedes R.

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Ethics Approval and Consent to Participate

This article does not contain any studies with human participants or animals performed by any of the authors.

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