Relation between three-dimensional and two-dimensional echocardiography and biochemical analysis in patients with ST-segment elevation myocardial infarction percutaneously treated

Relação entre a análise bioquímica e ecocardiográfica tridimensional e bidimensional em pacientes com infarto do miocárdio com supradesnivelamento do segmento ST tratados por via percutânea

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ABSTRACT

Objective: The prognosis of patients with acute myocardial infarction depends on multiple features that can demonstrate myocardial injury degree (such as serum markers of cardiac necrosis), and also on adaptive mechanisms relative to the acute event. The aim of the study was to assess the relation between biochemical and echocardiographic findings from three-dimensional echocardiographic (3D Echo) analysis and echocardiographic two-dimensional (2D Echo) left ventricular ejection fraction in patients with ST-segment elevation acute myocardial infarction , submitted to primary percutaneous treatment. **Methods:** A prospective study with 2D Echo and 3D Echo of 23 patients (17 males, mean age of 57 ± 13 years) with ST-segment elevation acute myocardial infarction, primarily percutaneously treated (stent). Serum cardiac markers (creatine kinase MB, Troponin I and Myoglobin) and serum brain natriuretic peptide were compared to echocardiographic parameters (volumes, left ventricular ejection fraction and ventricular dyssynchrony index). The statistical analysis was performed using Pearson's correlation coefficient, 95% CI, $p < 0.05$, linear regression equation and Bland & Altman test. **Results:** Pearson's correlation coefficient (r)relative to 3D left ventricular ejection fraction: 1- brain natriuretic peptide: r: - 0.7427, $p < 0.0001$; 2- creatine kinase MB: r: - 0.660, p = 0.001. Left ventricular ejection fraction 2D (r) : 1- brain

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natriuretic peptide: r: - 0.5478, p = 0.001; 2- creatine kinase MB: r: - 0.4800, p < 0.0277. Other associations were not significant. **Conclusions:** In this series, it was observed better correlation in regard to serum creatine kinase MB , brain natriuretic peptide and 3D Echo left ventricular ejection fraction, when compared to 2D Echo left ventricular ejection fraction.

Keywords: Infarction; Myocardial infarction; Myocardial infarction/metabolism; Myocardial infarction /ultrasonography; Biochemistry/instrumentation; Biochemical reactions; Echocardiography; Echocardiography/instrumentation; Echocardiography, three-dimensional/methods; Biological markers; Administration, cutaneous; Coronary disease/therapy

RESUMO

Objetivo: O prognóstico dos pacientes portadores de infarto agudo do miocárdico depende de múltiplos aspectos que espelhem o grau de agressão ao miocárdio (como marcadores enzimáticos de necrose miocárdica), assim como dos mecanismos de adaptação ao evento agudo. O objetivo do estudo foi verificar a associação entre os achados bioquímicos e ecocardiográficos derivados da análise ecocardiográfica transtorácica tridimensional (ECO 3D) com a fração de ejeção do ventrículo esquerdo (ECO 2D) em pacientes acometidos por infarto agudo do miocárdio com supradesnivelamento do segmento ST, que tenham sido submetidos a tratamento primário percutâneo. **Métodos:** Estudo prospectivo com Eco 3D e 2D de 23 indivíduos (17 homens, 57 ± 13 anos), acometidos por infarto agudo do miocárdio com elevação do segmento ST, primariamente tratados com implante de stent coronariano. Foi feita a dosagem sérica de creatina cinase fração MB, Troponina I, Mioglobina e peptídeo atrial natriurético e comparada com os parâmetros ecocardiográficos (volumes, fração de ejeção do ventrículo esquerdo e índice de dissincronia ventricular). A análise estatística foi feita com a determinação do coeficiente de correlação (Pearson), IC = 95%, p < 0,05, com teste de regressão linear e teste de Bland & Altman. **Resultados:** Coeficiente de correlação (r) entre fração de ejeção do ventrículo esquerdo 3D: 1- peptídeo atrial natriurético: r: - 0,7427, p < 0,0001; 2- creatina cinase fração MB: r: -0,660, p = 0,001. fração de ejeção do ventrículo esquerdo 2D (r) : 1- peptídeo atrial natriurético: r: - 0,5478, p = 0,001; 2- creatina cinase fração MB: r: -0,4800, p < 0,0277. As demais associações entre os parâmetros ecocardiográficos e as dosagens séricas não foram significativas. **Conclusões:** Nesta série, foi observada correlação melhor entre a dosagem sérica de peptídeo atrial natriurético, de creatina cinase fração MB e a fração de ejeção do ventrículo esquerdo aferida por Eco 3D do que a correlação com a fração de ejeção do ventrículo esquerdo aferida por Eco 2D.

Descritores: Infarto; Infarto do miocárdio; Infarto do miocárdio/metabolismo; Infarto do miocárdio/ultrassonografia; Bioquímica/instrumentação; Reações bioquímicas; Ecocardiografia; Ecocardiografia/instrumentação; Ecocardiografia tridimensional/métodos; Marcadores biológicos; Administração cutânea; Doença das coronárias/terapia

INTRODUCTION

The prognosis of patients with ST-segment elevation acute myocardial infarction is based on multiple features reflecting myocardial injury degree (enzyme markers of myocardial necrosis), as well as adaptive mechanisms of the acute event. Increased values of brain natriuretic peptide (BNP) and its precursor (pro-BNP) also characterize an independent factor of poor evolutive long-term prognosis in patients affected by myocardial infarction with left ventricular dysfunction. The study LEVEREM, involving 834 post myocardial infarction patients, published in 2004, showed that the initial measurements of pro-BNP were related to a poor prognosis three months after the acute event[1]. However, in this same study, the left ventricular volumes, measured by two-dimensional echocardiography, were not indicative of poor prognosis for the analysis three months after the myocardial infarction.

The level of dilation (ventricular remodeling) mirrored by the measurement of ventricular volumes, as well as ventricular geometry and left ventricular ejection fraction (LVEF) are parameters used to analyze the prognosis in these patients[2-5]. Progressive left ventricular dilation in patients with ejection fraction < 40% is a strong predictor of poor prognosis in the clinical course[5-6]. Left ventricular remodeling can also be predicted by the elevation magnitude of the enzyme markers of myocardial necrosis and by the number of pathological Q waves observed on the ECG.

Echocardiography has been the diagnostic method chosen for the morphofunctional study of cardiac structures due to their great anatomical equivalence, easy performance, low cost and minimum risk for the procedure. Echocardiography evolved with the advent of the first techniques, such as analysis in unidimensional mode, followed by the potential ultrasound structural observation in two-dimensional mode and several types of blood flow analysis with Doppler technique[7]. However, two-dimensional echocardiography analysis presents limitations in the observation of cardiac anatomy, which result from geometric inferences assumed for calculation of cardiac chamber volumes, ventricular mass and (LVEF) from the analyses of a limited number of observation plans[8-14]. Greater inadequacies occur when the cardiac chambers are dilated and after acute ischemic events, not classified as specific geometrical models. Therefore, three-dimensional echocardiography was developed to allow identification of cardiac structure in real-time movement on multiple simultaneous observation planes. Three-dimensional echocardiography allows greater proximity to the cardiac anatomy, leading to great convergence of results with the use of nuclear magnetic resonance[15-16]. Three-dimensional echocardiography also allows measuring the left ventricular dyssynchrony index[2]. In this method, the left ventricle is studied in a model of 16 parietal segments with analysis of the regional and global systolic contraction. Ventricular dyssynchrony index represents the standard deviation of the mean time of end-systolic contraction of each of the 16 segments compared to the global end-systolic contraction (lower index represents less dyssynchrony). Measurement of the dyssynchrony index allows the observation of synchrony level in ventricular contraction, which is generally high in patients with heart failure and widened QRS complex (left bundle branch block). Reproducibility and accuracy in measuring the different echocardiographic parameters, obtained with the use of three-dimensional echocardiography, have already been shown in different anatomical sites[17]. However, there is no information in the literature about the relation to ventricular dyssynchrony index in patients with acute myocardial infarction.

Therefore, we planned a study to assess the association between biochemical markers and the echocardiographic findings derived from the three-dimensional echocardiographic analysis in patients affected by myocardial infarction.

OBJECTIVE

To assess the association between the biochemical and echocardiographic findings derived from the real-time three-dimensional transthoracic echocardiographic analysis in patients with ST-segment elevation acute myocardial infarction, who were submitted to primary percutaneous treatment with coronary implantation of an endoprosthesis (stent).

METHODS

Population

Inclusion and exclusion criteria

The patient was considered eligible for the study after evaluation by the attending physician at the emergency room, presenting at least two of the following criteria for diagnosis of myocardial infarction:

1. clinical parameters compatible with myocardial infarction;
2. ST segment elevation > 1 mm in at least 2 leads in a 12-lead ECG;
3. measurement of myocardial necrosis markers compatible with myocardial infarction.

In addition to the criteria of myocardial infarction, the patient should present:

1. primary percutaneous coronary treatment with “balloon time” up to 90 minutes;
2. hemodynamic stability during the percutaneous coronary intervention;
3. signature of the informed consent form to participate in the study.

The exclusion criteria to the study were:

1. echocardiographic image inadequate to the three-dimensional analysis;
2. presence of atrial fibrillation or major irregularity of the cardiac rhythm before percutaneous intervention (due to the difficulty of analysis of the ventricular dyssynchrony index);
3. absence of coronary lesions able to receive percutaneous treatment.

Echocardiography

Two-dimensional echocardiographic analysis was performed with conventional Doppler, tissue Doppler and with real-time three-dimensional transthoracic echocardiography. Two-dimensional echocardiographic exams were performed according to the recommendations of the American Society of Echocardiography, in a commercially available device (Philips IE33, Andover, MA, USA), equipped with a 2-5 MHZ transducer and X3 matrix transducer to acquire three-dimensional images. The echocardiographic parameters studied were, as follows:

I – Two-dimensional echocardiogram:

1. left ventricular end-diastolic volume (LVEDV);
2. left ventricular end-systolic volume (LVESV);
3. left ventricular ejection fraction (LVEF) (Simpson method). Left ventricular diameters were also measured with the use of unidimensional mode oriented by two-dimensional echocardiography.

II- Three-dimensional echocardiography:

1. left ventricular end-diastolic volume (LVEDV);
2. left ventricular end-systolic volume (LVESV);
3. left ventricular ejection fraction (LVEF) (Figure 1);
4. left ventricular three-dimensional dyssynchrony index (DI) % (Figure 2). The three-dimensional DI corresponds to the percentage standard deviation of mean time of end-systolic contraction of left ventricular segments. Therefore, the three-dimensional DI for the LV basal segments corresponds to 3D 6 DI (%); three-dimensional DI for the middle and basal segments correspond to 3D 12 DI (%) and the three-dimensional DI for all left ventricular segments corresponds to 3D 16 DI (%). A model of 16 ventricular segments was used for the analysis of left ventricular contractility.

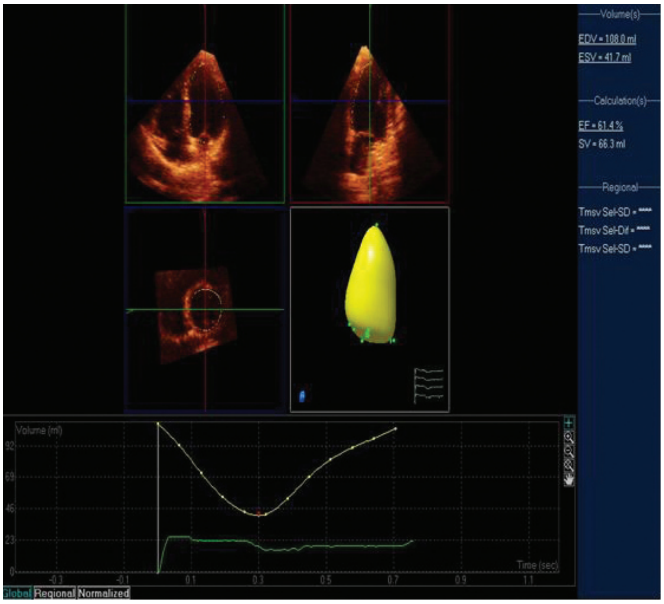

Figure 1. Ventricular volumes and left ventricular ejection fraction measured by real-time three-dimensional transthoracic echocardiography. Demonstrating coronal, sagittal and cross-sectional plans of left ventricle observation. EDV (end-diastolic volume): 108 ml; ESV (end-systolic volume): 41.7 ml; EF (ejection fraction): 61.4 %; SV (systolic volume): 66.3 ml

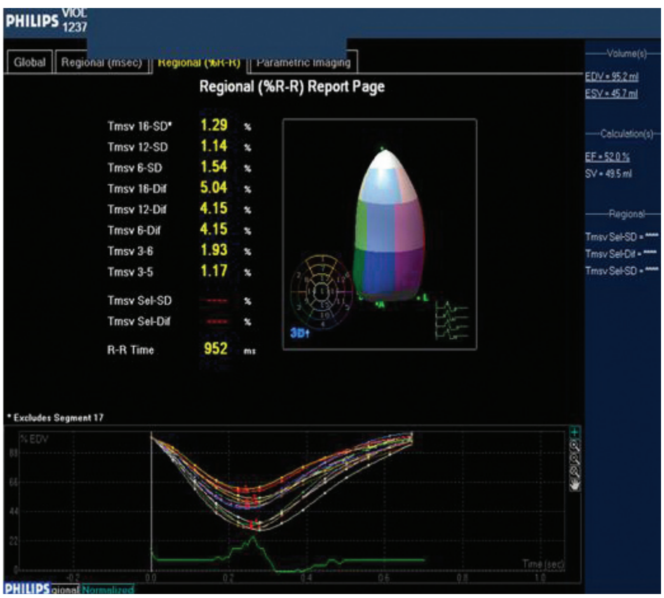

Figure 2. Demonstrating measurement of three-dimensonal dyssynchrony index of the left ventricle (Tmsv 16-SD): 1.29% (NV < 5%)

The acquisition of three-dimensional images was performed after the use of two-dimensional echocardiographic exam. Three-dimensional images were obtained with the same echocardiographic equipment, with the use of matrix transducer and with the patient in expiratory apnea, and the image was attached to the electrocardiographic record. The images were stored in a hard disk of the echocardiographic equipment and were analyzed offline in the equipment´s own specific software. The analyses were performed by two independent examiners. Patients presenting two-dimensional or three-dimensional echocardiographic images considered as of inadequate technical quality for analysis of the studied parameters or those presenting major irregularity of the cardiac rhythm were excluded from the study.

Laboratory analysis

Serum markers of myocardial necrosis were analyzed (taking into account their higher volumes during the clinical course of acute myocardial infarction) and the brain natriuretic peptide (BNP. Thus, the following serum measurements were performed:

1. creatine kinase MB fraction (CKMB) and CKMB mass;
2. myoglobin;
3. troponin I;
4. brain natriuretic peptide (BNP).

Statistical analysis

The statistical analysis was carried out for the quantitative variables, by means of observation of minimum and maximum values and the calculation of means and standard deviations. Absolute and relative frequencies were calculated for the qualitative variables. For the analysis of correlation between biochemical findings and two-dimensional and three-dimensional echocardiographic findings, the Pearson (r) correlation method was used with a 95% confidence interval. Comparison between methods was performed with the use of Bland & Altman test. Linear regression test was also performed between the parameters derived from the three-dimensional echocardiographic analysis and the biochemical findings. Intraobserver and interobserver variation was calculated for the three-dimensional parameters measured. The p values < 0.05 were considered as significant. Data were processed with the MedCalc system of statistical analysis, Mariakerke, Belgium.

The study was approved by the Ethics committee of Hospital Israelita Albert Einstein nº 293-07

RESULTS

From March 2007 to March 2008, a total of 23 patients were prospectively studied, 17 (73%) men, mean age 57 ± 13 (41-89) years, who suffered ST-segment elevation acute myocardial infarction treated with primary percutaneous coronary intervention (implantation of coronary endoprosthesis or stent) with a balloon time up to 90 minutes. None of the patients presented a previous history of myocardial infarction. Five out of 30 (16%) patients were excluded, two (6%) due to presenting an image considered inadequate for analysis and three (10%) for not accepting to participate in the study.

Demographic and clinical features, as well as hemodynamic findings before and after primary percutaneous treatment of the studied population are shown in table 1. Most patients who suffered ST-segment elevation acute myocardial infarction were males (17/23 patients) and had a past history of high blood pressure (52.1%). The evidence of family history of atherosclerotic disease was also significant (43.4%). There was a predominance of anterior descending artery (12/23 cases) involvement, with total occlusion of the coronary artery involved in the acute ischemic event in eighteen (78.1%) cases. The result of interventional therapy was considered satisfactory in all cases with evidence of TIMI 3 flow in 23 (100%) cases.

Two-dimensional and three-dimensional echocardiographic measurements and serum measurements of enzyme markers and BNP of the study population are displayed in table 2. Measurements of left ventricular volume and left ventricular ejection fraction, analyzed with three-dimensional echocardiography, were lower than the volumes and ejection fraction measured with two-dimensional echocardiography. The left ventricular dyssynchrony index (% DI) showed great variation (0.51-15.8%) with a mean (6.62%) above the normal values (NV < 5%). Serum measurements of myocardial necrosis markers showed increased mean values, especially for CKMB and Troponin I (90.41 ng/ml and 12.90 ng/ml, respectively). The mean value of serum BNP was slightly increased (264.90 pg/ml).

Table 1. Demographic. clinical and angiographic characteristics before and after percutaneous coronary procedure. and risk factors for coronary artery disease of the studied population

Characteristics	Population total (n = 23)
Age (years)	51±12 (41-89)
Sex (M/F)	17/6
Smoking	6 (26%)
Diabetes Mellitus	5 (21.7%)
Systemic arterial hypertension	12 (52.1%)
Previous CAD	4 (17.3%)
Dyslipidemia	6 (26%)
Family history of CAD	10 (43.4%)
Involved coronary artery (%)	AD: 12 cases (52.1%)
	Cx: 6 cases (26%)
	RC: 5 cases (21.9%)
Secondary coronary lesion	AD: 6 cases (26 %)
	Diagonal: 3 cases (13 %)
	Cx: 3 cases (13 %)
AMI - site	
Anterior	10 cases (43.4%)
Anterolateral	1 case (4.3 %)
Inferior	4 cases (17.2 %)
Inferolateral	3 cases (12.9%)
Lateral	3 cases (12.9%)
Obstruction of involved coronary artery (%)	100%: 18 cases (78.2 %)
before the procedure	95%: 3 cases (13 %)
	99%: 2 cases (8.8 %)
Obstruction of involved coronary artery (%)	0%: 16 cases (69.9%)
after the procedure	10%: 6 cases (25.8%)
	20%: 1 case (4.3 %)
TIMI flow of involved coronary artery	TIMI 0: 18 cases (78.2%)
before the procedure	TIMI 2: 5 cases (21.8%)
TIMI flow of treated coronary artery	TIMI 3: 23 cases (100%)
before the procedure	

M – male; F – female; CAD – coronary artery disease; AD – anterior descending artery (anterior interventricular); Cx – circumflex artery; RC – right coronary artery. AMI – acute myocardial infarction

Table 2. Echocardiographic measurements and serum levels enzyme markers and BNP of the studied population

Parameters	Population total (n = 23)
3D Echo LVEF	0.50 ± 0.06 (0.36-0.70)
3D Echo LVESV (ml)	44.5 ± 10.4 (29.6- 59.4)
3D Echo LVEDV (ml)	100.2 ± 26.7 (72.5-159.6)
3D Echo 17 %DI	6.62 ± 5.15 (0.51-15.8)
2D Echo LVDD (cm)	4.9 ± 0.3 (4.5 - 6)
2D Echo LVEF (Simpson method)	0.54 ± 0.08 (0.40-0.71)
2D Echo LVESV (ml)	47.7±19.4 (19.43- 42.5)
2D Echo LVEDV (ml)	104.4 ± 31.8 (57.1 – 165.6)
Troponin I (ng/ml) NV (0-0,04)	12.90 ± 9.21 (2.30- 33.60)
CKMB (ng/ml) NV (0-3,40)	90.41 ± 77.43 (5.73 - 258)
Myoglobin (ng/ml) NV (0-62.5)	569.89 ± 245.60 (107-890)
BNP (pg/ml) NV (5-100)	264.90 ± 128 (25-1058)

LVEF – left ventricular ejection fraction; LVESV - left ventricular end-systolic volume; LVEDV - left ventricular end-diastolic volume; LVDD – left ventricular diastolic diameter; NV- normal value; 17% DI - dyssynchrony index of 17 left ventricular segments.

The correlation analysis (Pearson: r) between the echocardiographic parameters measured and the serum measurements of myocardial necrosis markers and BNP are shown in table 3. A good inverse correlation (negative) was observed between serum BNP and LVEF assessed with three-dimensional echocardiography (r: -0.7427, $p < 0.0001$), better

Table 3. Pearson´s correlation (r), 95% CI, between echocardiographic parameters and serum levels of myocardial necrosis and BNP in the studied population (n: 23)

Parameter	CKMB	Troponin I	Myoglobin	BNP
2D Echo LVEF	r: - 0.4800. CI: -0.7522 até -0.6090 $p < 0.0277$	NS	NS	r: - 0.5478. CI: -0.7922 até -0.1521 $p = 0.001$
3D Echo LVEF	r: - 0.660. CI: -0.8528 até -0.3295 $p = 0.001$	NS	NS	r: - 0.7427. CI: -0.8893 até -0.4780 $p < 0.0001$
3D Echo 17 DI %	NS	NS	NS	NS

2D Echo LVEF – Left ventricular ejection fraction measured with two-dimensional echocardiography (Simpson method); 3D Echo LVEF - Left ventricular ejection fraction measured with real-time three-dimensional Echocardiography; 3D Echo 17 %DI - Three-dimensional dyssynchrony index 17 left ventricular segments; CI – confidence interval; NS – not statistically significant.

than the correlation noted with the ejection fraction measured with two-dimensional echocardiography (r: -0.5478, $p = 0.001$). An inverse correlation was also verified between serum CKMB and LVEF measured with three-dimensional echocardiography (r: -0.660, $p = 0.001$) also with a better correlation than that observed with the ejection fraction measured by two-dimensional echocardiography (r: -0.4800, $p < 0.0277$). In regard to the markers troponin I and myoglobin, no correlation was seen with the echocardiographic parameters measured. Agreement (r) between the measurements of LVEF 3D and LVEF 2D (r) was 0.6844, $p < 0.0001$, CI = 0.6613 to 0.8934.

Linear regression test and the concordance test (Bland & Altman) for the serum measurement of CKMB, BNP and for the measurements of LVEF 3D are shown in figures 3, 4, 5 and 6.

All patients presented clinical progression in groups I (18 patients) or II (5 patients) of Killip and Kimball class during the hospital stay. There was no report of new left bundle branch block during the intrahospital clinical course.

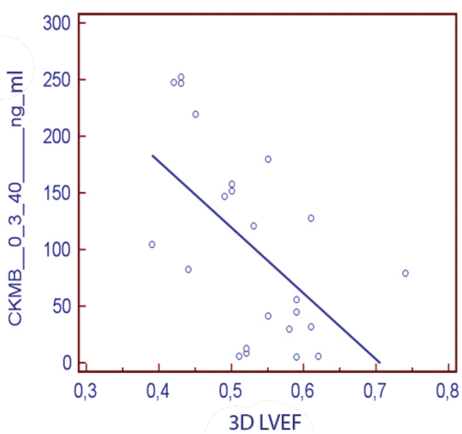

Figure 3. Linear regression test between left ventricular ejection fraction measured by three-dimensional echocardiography (LVEF 3D) and the serum levels of CKMB in the population studied, where y (CKMB) = 411.629 ± 583.938 x (LVEF 3D)

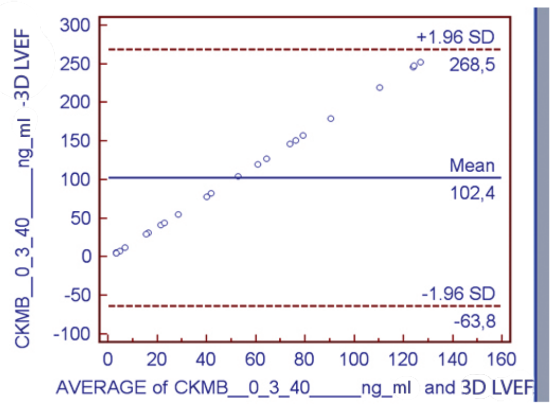

Figure 4. Agreement (Bland & Altman test) in analysis between left ventricular ejection fraction measured by three-dimensional echocardiography (LVEF 3D) and the serum levels of CKMB in the population studied

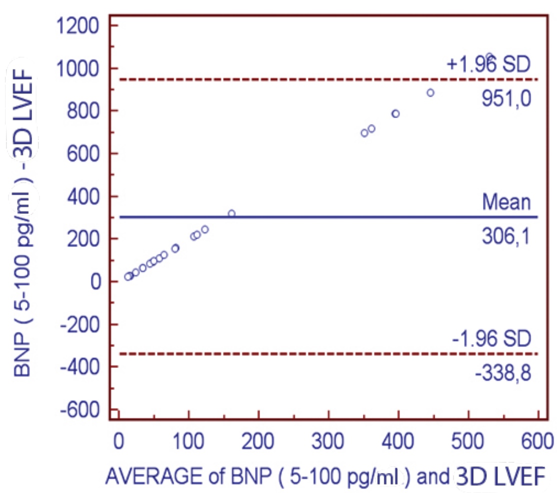

Figure 6. Agreement (Bland & Altman test) in analysis between left ventricular ejection fraction measured by three-dimensional echocardiography (LVEF 3D) and the serum levels of BNP in the population studied

DISCUSSION

Coronary artery disease remains nowadays as a very prevalent disease in the Western world, requiring attention at public health level. According to data from

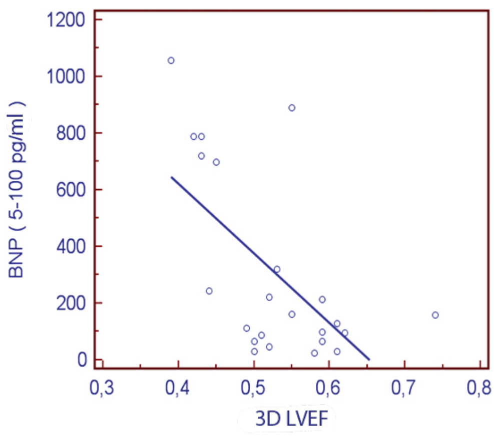

Figure 5. Linear regression test between left ventricular ejection fraction measured by three-dimensional echocardiography (LVEF 3D) and the serum levels of BNP in the population studied, where y (BNP) = 1607± 2459.58 x (LVEF 3D)

the TIMI II study, analyzing patients submitted to fibrinolysis, the predictive factors of death likelihood at thirty days of patients with ST-segment elevation acute myocardial infarction take into account the age group (higher mortality in patients aged over 75 years), clinical parameters (blood pressure, heart rate and Killip and Kimball assessment classes), ST-segment elevation shown in the anterior wall or occurrence of a new total left bundle branch block, as well as the previous history of diabetes or systemic high blood pressure[18]. The mean age of the study group was below 75 years (57 ± 13 years); anterior wall involvement was observed in 10 (43.4%) cases with no evidence of a new total left bundle branch block during intrahospital clinical course. Twelve patients (52.1%) were hypertensive and 5 (21.7%) had diabetes. Therefore, the study population had some aspects favoring the likelihood of good clinical course thirty days after the ischemic event (mean age, clinical assessment according to Killip and Kimball classes) and other aspects involving more risk to unfavorable clinical course (anterior wall involvement e significant evidence of hypertension). Another significant aspect is that all patients underwent successful percutaneous coronary treatment less than 90 minutes after the onset of the event.

Serum markers of myocardial injury have a prognostic value in the analysis of patients with myocardial infarction. This current study showed a greater negative correlation observed between serum measurement of CKMB and LVEF measured with three-dimensional echocardiography (r: -0.660, $p = 0.001$) than the correlation with ejection fraction measured with two-dimensional echocardiography (r: -0.4800, $p < 0.0277$). For the other serum markers of myocardial injury (troponin I and myoglobin), no significant correlation was observed with the LVEF (measured both with 3D and 2D echocardiography). Two aspects can be analyzed from this observation:

1. better association with the three-dimensional echocardiographic functional analysis (ejection fraction);
2. association with serum release of CKMB and absence of association with other markers. The first aspect may be understood from the evidence that the three-dimensional echocardiographic analysis takes into account the multiangular and multiplanar analyses of the left ventricle thus allowing the structural observation not only from conventional orthogonal planes but also oblique and intermediate planes of space visualization[9-14]. This broad possibility of structural observation is especially useful in dilated ventricles or in patients with non-homogeneous anatomy who have undergone events causing possible imbalance in ventricular contraction mechanisms (such as in the setting of ischemic events). In the future, the analysis of left ventricular contractility in the setting of ischemic events will possibly be performed with the use of three-dimensional echocardiography and no longer with two-dimensional echocardiography. In regard to the more pronounced association between serum release of CKMB and LVEF, in relation to measurement of troponin I and myoglobin, this aspect must be understood taking into account the release kinetics of each specific marker. CKMB levels rise about 4 to 6 hours after the ischemic event, with an elevation peak around 18 hours, while myoglobin starts to be released roughly two hours after the event and with an elevation peak between 6 and 9 hours. Troponin I starts being released 4 to 8 hours after the onset of the event, with a release peak between 36 and 72 hours. It is normal to understand that the correlation between CKMB and three-dimensional ejection fraction also considers the specific type of treatment which patients were submitted to (primary percutaneous treatment).

As to the association between serum release of BNP and LVEF, a better correlation was observed with ejection fraction measured with three-dimensional echocardiography than with two-dimensional echocardiography (r: -0.7427, $p < 0.0001$; r: -0.5478, $p = 0.001$, respectively). Likewise the analysis of association between serum values of CKMB and measurement of ejection fraction, the grade of myocardial dysfunction observed with BNP release may be more closely associated to the global method (three-dimensional) of left ventricle study. The ability to analyze the relative variation of ventricular volumes (ejection fraction) in a global and real-time manner, without assuming geometrical forms distant from the anatomical reality, empowers three-dimensional echocardiography with possibilities to be used in different clinical settings.

In observing echocardiographic parameters derived from the three-dimensional analysis, it was expected to find a correlation between the ventricular dyssynchrony index and the serum release of myocardial injury markers. It was exemplified this possibility (Figure 7) in a patient with preserved ejection fraction (66.5%) and abnormal ventricular dyssynchrony index (14.28%, normal value < 5%). During the intrahospital course, the patient presented normalization of cardiac dyssynchrony (V < 5%). Induced ischemic dyssynchrony may be one of the mechanisms involved in myocardial dysfunction observed at the initial moments following the ischemic event. With a higher number of patients this pathophysiological aspect may possibly be better analyzed.

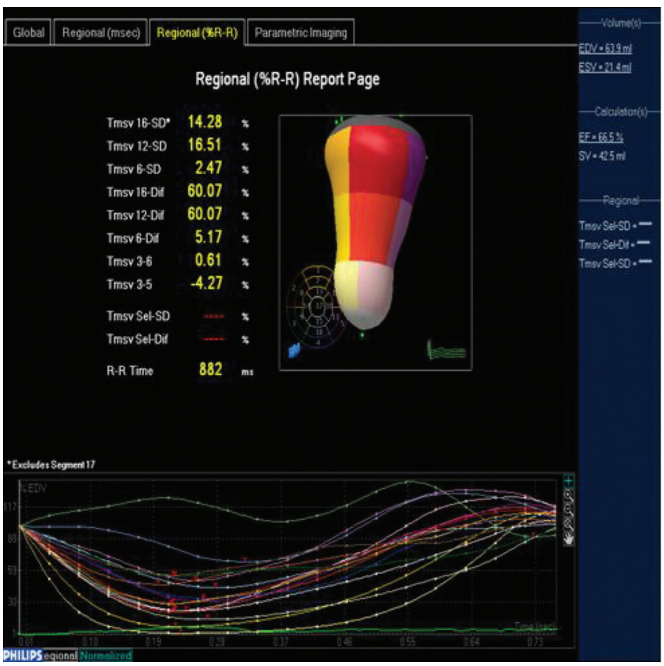

Figure 7. Demonstrating measurement of three-dimensional dyssynchrony index of the left ventricle (Tmsv 16-SD): 14.28%, in patient with preserved three-dimensional ejection fraction, 3D LVEF: 66.5%

Study limitation

This study had a small number of patients with ST-segment elevation acute myocardial infarction. It is still necessary to have good echocardiographic images for the three-dimensional echocardiography analysis to be performed (2 patients, 6% of the initial series, were excluded from the study).

Patients with myocardial infarction in several ventricular segments (involvement of different coronary beds) were studied. Therefore, future studies with a larger number of patients with myocardial infarction are necessary, with specific observation of the involvement of different coronary arteries.

CONCLUSIONS

In this series of patients with ST-segment elevation acute myocardial infarction, treated by percutaneous route, a better correlation was observed between serum measurements of BNP, CKMB and LVEF measured by 3D Echo than the correlation with LVEF measured by 2D Echo.

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