“VICTOR BABEȘ” UNIVERSITY OF MEDICINE

AND PHARMACY FROM TIMIȘOARA

FACULTY OF MEDICINE

DEPARTMENT VI: CARDIOLOGY

LAZĂR MIHAI-ANDREI

PhD THESIS

THE ROLE OF SPECKLE TRACKING ECHOCARDIOGRAPHY IN THE ASSESSMENT OF EARLY AND LATE VENTRICULAR REMODELING PROCESS, RESPECTIVELY IN THE EVALUATION OF THE PATIENTS’ PROGNOSIS AFTER AN ACUTE MYOCARDIAL INFARCTION

ABSTRACT

Scientific Coordinator

PROF. UNIV. DR. PETRESCU LUCIAN

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ABSTRACT

GENERAL PART

The motivation for choosing this research topic resulted from the fact that, worldwide, coronary heart disease is the most common cause of death and, in the last decade, the prevalence of heart failure (HF) has increased, efforts are directed towards identifying methods to slow down cardiac remodeling. A decrease in acute and long-term mortality in patients with acute myocardial infarction (AMI) is noted, in parallel with the increase in the use of coronary reperfusion therapy, percutaneous coronary interventions, modern antithrombotic therapy, as well as secondary prevention measures. However, mortality remains high.

Heart failure is one of the main health problems at the international level, being the result of all conditions that disrupt the normal contractility of the myocardium. The interest in early diagnosis of this syndrome is understandable, with the goal of reducing progression to end stages and death. In this sense, imaging techniques, in general, and echocardiography, in particular, play an important role. Although tissue Doppler imaging has improved the early diagnosis of LV dysfunction, the method is limited by excessive computer processing of the images, an alignment as parallel as possible to the direction of movement of the structure to be analyzed, the need to obtain a high frame rate, good demarcation between myocardium and endocardium or global myocardial motion (translation, rotation, tilt), improved imaging assessment of ventricular remodeling was required. Thus, along with the need to quantify the intrinsic deformation of the myocardium, a new echocardiographic method appeared, which largely removes the limits of tissue Doppler: speckle tracking analysis. It allows the analysis of longitudinal deformation, as well as rotation and respectively torsion of the LV myocardium in the transverse plane. The general part is intended to understand the complex process of cardiac remodeling after an AMI. Moreover, it describes the main echocardiographic indices for evaluating cardiac function, especially the systolic one, from mechanics to echocardiographic data, emphasizing the speckle tracking technique.

EXEPRIMENTAL PART

1. WORK HYPOTHESIS AND GENERAL OBJECTIVES

Currently, echocardiography is the most used imaging technique in the assessment of ventricular function, due to the multitude of information it can provide, the proven accuracy of the method, its non-invasive nature, the cost-effectiveness ratio and the possibility of monitoring the dynamics of cardiac function, through repetition, without risks, of the examination.The research design involved the evaluation of patients with acute coronary syndromes (ACS), admitted to the Institute of Cardiovascular Diseases in Timișoara. In order to achieve the objectives, mainly to identify the most sensitive and specific echocardiographic parameters, capable of evaluating the progression towards adverse ventricular remodeling, but also the prognosis of patients after an ACS, we included in the study both patients with STEMI and those with NSTE-ACS, their characterization being performed separately. Thus, the present research is based on three studies: a study that included patients diagnosed with STEMI, in which an attempt was made to identify the echocardiographic parameters that can predict the progression of ventricular remodeling; the second study, which included patients diagnosed with NSTE-ACS, in which an attempt was made to identify the echocardiographic parameters capable of predicting the prognosis of these patients, and the third study, which evaluated the role of speckle tracking echocardiography in predicting ventricular remodeling left, in patients with preserved and moderately reduced left ventricular ejection fraction (LVEF), patients who underwent AMI revascularized by PCI, within the first 12 hours of symptom onset.

2. STUDY I: CONTRIBUTIONS TO THE ASSESSMENT OF VENTRICULAR REMODELING IN PATIENTS WITH STEMI

2.1. DEFINING STUDY OBJECTIVES

The proposed study is a prospective observational one and aims to identify and implement speckle tracking parameters to evaluate ventricular remodeling in STEMI patients. The objectives of this first study were the following: the identification of the optimal echocardiographic evaluation parameters in patients with STEMI, the prognostic evaluation of clinical, laboratory, echocardiographic and invasive data at inclusion and during the follow-up, as well as the determination of the speckle tracking parameters able to identify early adverse ventricular remodeling (AVR).

2.2. MATERIALS AND METHODS

The study included patients with acute coronary syndromes with persistent ST-segment elevation, diagnosed according to the Guidelines for the management of acute myocardial infarction in patients presenting with ST- segment elevation of the European Society of

Cardiology, from the year 2017, admitted to the Institute of Cardiovascular Diseases Timișoara during December 2018-December 2021.We prospectively analyzed a number of 200 patients with STEMI. After evaluating the exclusion criteria, 151 patients formed the study population. Unfortunately, due to issues related to the Covid-19 pandemic, we were unable to re-evaluate all these patients, and the final cohort consisted of 60 patients. After the follow-up period, the patients were divided into two groups: a group of patients who underwent adverse ventricular remodeling, respectively a group of patients who registered a reverse remodeling process. Those that did not fit into either category were defined as normal (or no remodeling).

2.3. ECHOCARDIOGRAPHY

Patients underwent a transthoracic echocardiography within the first 12 hours of admission, at rest, in left lateral decubitus. All echocardiograms were performed before myocardial revascularization. Both conventional two-dimensional echocardiography and speckle tracking echocardiography were performed at baseline and follow-up. AVR is defined as a 15% increase in LVEDV and/or LVESV. In contrast, reverse ventricular remodeling, which involves recovery of myocardial function, is defined as an improvement in the parietal contractility index (WMSI) or an increase in LVEF greater than 5% or a decrease in LVESV by more than 15%.To evaluate both the three types of deformation (longitudinal, circumferential, and radial) and the specific deformation of each layer (endocardial, middle, and epicardial), we used four-chamber, three-chamber, and two-chamber apical incidences, as well as parasternal short-axis incidences (at the level of the mitral valve, the papillary muscles and the apex of the heart). After manually tracing the LV endocardial border in three apical incidences, global longitudinal strains (GLS) and endocardial, mid, and epicardial segmentation were obtained using LSendo, LSmid, and LSepi, respectively. Peak radial and circumferential (RS and CS) basal and apical strains of the LV were defined as the mean value of the strains of the six basal and four apical segments, from the parasternal short-axis incidence.Rotation (in degrees) was obtained at the basal level and at the apex of the LV. The ratio of endocardium to epicardium was also calculated as a function of LSendo and LSepi. LV twist was defined as the net difference (in degrees) of apical and basal rotations at identical time points and was automatically calculated by the software using values of basal and apical rotations.

2.4. RESULTS

At follow-up, after 6 months, there was a significant difference in the LV end-diastolic diameter ($p < 0.001$) and LV end-diastolic volume ($p = 0.033$), with both of the values being higher. As far as the right ventricular systolic function is concerned, both the RVFW s’ and

TAPSE increased in 6 months (0.15 m/s, 24 mm, respectively; p = 0.036 for RVFW s' and p = 0.002 for TAPSE).

Median LVEF was 46.00% (40.75, 51.00) and GLS was -13.25% (-14.57, -11.55) at baseline. At re-evaluation, these two parameters increased significantly: LVEF was 50.00% (41.75, 53.00) (p = 0.018) and global longitudinal strain was -15.60% (-18.25 , -12.38) (p <0.001). At baseline, longitudinal strain increased from the epicardial layer (LS epi) to the endocardial layer (LS endo) (LSendo and LSepi were -15.15 (-16.50, -13.20) and -11 .00 (-12.72, -9.80)). This pattern was also observed at 6 months, when LS endo was -18.10 (-20.62, -14.10) (p < 0.001) and LS epi was -13.80 (-16.45, -10.88) (p < 0.001).

In addition, there were higher values at 6 months of the following parameters: basal CS, apical CS and apical RS (at inclusion: -10.80 (-13.40, -6.40), -11.70 (-16 ,40, -8.80), and 21.00 (13.00, 31.20), respectively -11.40 (-14.20, -9.40), -13.20 (-18.45, -9.50), and 24.33 (16.10, 40.05), at 6 months) (p = 0.004, p = 0.033 and 0.009). Multivariate linear regression analysis was used to assess independent predictors of LSendo at follow-up. Our results highlight that baseline LVEF and E/e' ratio among diabetics receiving thrombolytic therapy and ACEI/ARB treatment explained 61.1% of LSendi variance (R2 = 0.611).Remodeling was classified as reverse (n = 13, 21.67%) and adverse (n = 26, 43.33%), and patients who did not fit into either category were defined as normal (no remodeling) (n=21, 35%). Patients with adverse remodeling had a higher incidence of hypertension (p = 0.035). Furthermore, there was no difference in the distribution of age, sex, smoking, diabetes and obesity between the three groups.

Patients with adverse remodeling had a smaller body surface area and a higher incidence of previous myocardial infarction, but also more frequent involvement of the circumflex artery as the culprit lesion of the infarction.To assess independent factors predicting the risk of developing adverse remodeling in the study population, we used a multivariate logistic regression model. Akaike information criteria (AIC) were used to determine the best model. Odds ratio (OR) and a 95% confidence interval (CI) were calculated. Our regression equation was found to be a good fit for the model, explaining 36.2% of adverse remodeling (R2 = 0.286). The risk of adverse remodeling increases with age (1.1-fold), triglycerides (1.009-fold) and RS mid (1.06-fold). An increased initial twist decreases the odds of adverse remodeling (by 0.847 times). Multivariate logistic regression of independent risk factors for adverse remodeling showed us that baseline twist has a large impact when it comes to predicting AVR at 6 months. For this reason, we used an ROC analysis to find the threshold value that predicts AVR. The AUROC (area under the receiver operating characteristic) of the

twist for the adverse remodeling was 0.648; 95% CI [0.506;0.789], p = 0.04. The Youden index indicates an optimal limit value of 11° for twist. A twist value greater than 11° has a specificity of 76.9% and a positive predictive value of 72.7% for normal remodeling at 6 months.

2.5. DISCUSSIONS AND CONCLUSIONS

To the best of our knowledge, this is the first study to evaluate twist as a predictor of cardiac remodeling after STEMI. The importance of predicting prognosis in patients with STEMI has increased significantly in recent years. LV remodeling is the main process responsible for the onset and progression of heart failure after AMI. Speckle tracking echocardiography can detect early changes in myocardial deformation and predict the progression of long-term left ventricular remodeling. The aim of this study was to identify echocardiographic parameters useful in predicting LV remodeling after PCI, in patients with STEMI. Achieving the proposed objectives represents the milestone conclusions deriving from this research topic. At both baseline and 6 months postinfarction, longitudinal strain increased from the epicardial to the endocardial layer. Our results highlight that baseline LVEF and E/e' ratio among diabetics receiving thrombolytic therapy and ACEI/ARB treatment explained 61.1% of LSendo variation. Among the clinical parameters, arterial hypertension recognizes a higher prevalence among patients who develop adverse remodeling. The risk of adverse remodeling increases with age (1.1 times), triglyceride value (1.009 times) and SR mid (1.06 times).An increased initial twist decreases the odds of adverse remodeling (by 0.847 times). A twist value greater than 11° has a specificity of 76.9% and a positive predictive value of 72.7% for normal remodeling at 6 months.

3. STUDY II: CONTRIBUTIONS REGARDING THE ASSESSMENT OF THE PROGNOSIS OF PATIENTS WITH ACUTE MYOCARDIAL INFARCTION, USING SPECKLE TRACKING ECHOCARDIOGRAPHY TECHNIQUES

3.1. DEFINING STUDY OBJECTIVES

Acute coronary syndrome (ACS) is responsible for a significant proportion of deaths from cardiovascular disease and is an important contributor to morbidity and mortality during and after hospitalization. Risk stratification in these patients is important, in order to correctly undergo an intensified treatment strategy and to prevent further hospital readmissions. 2D speckle tracking echocardiography with measurement of global longitudinal strain (GLS) and mechanical dispersion (MD) of the LV has been shown to be useful for predicting adverse outcomes in ACS. MD is also a marker derived from 2D-STE and reflects contraction

heterogeneity. MD is described as a predictor of ventricular arrhythmias, independent of LVEF, and is significantly associated with sudden cardiac death (SCD). Our group proposed a new index, GLS/MD, to predict cardiac events in patients with a history of NSTE-ACS. We aimed to examine the relationship between GLS/MD ratio and cardiac events and the value of GLS/MD worsening during follow-up in a population of patients with NSTE-ACS after undergoing PCI therapy.The proposed study is a prospective observational one and aims to identify and implement speckle tracking parameters to evaluate the prognosis of patients with an NSTE-ACS. The objectives of the study are the following: the identification of the optimal echocardiographic evaluation parameters in patients with NSTE-ACS, the prognostic evaluation of clinical, laboratory, echocardiographic and invasive data at inclusion and during follow-up, as well as the determination of the echocardiographic parameters capable of predicting the prognosis of patients with NSTE - ACS.

3.2. MATERIALS ȘI METHODS

This prospective study included patients with acute coronary syndromes without persistent ST-segment elevation, diagnosed according to the European Society of Cardiology's 2015 Guidelines for the management of patients presenting without persistent ST-segment elevation, admitted to the Institute of Cardiovascular Diseases from Timișoara during January 2018- May 2019.Thus, we prospectively examined 402 patients with NSTE-ACS, in sinus rhythm, who were successfully treated by PCI techniques while hospitalized in our clinic.

3.3. ECHOCARDIOGRAPHY

Apical four-, two-, and three-chamber views were obtained in 2D mode. For each view, three cardiac cycles were recorded. The moment of aortic valve closure was determined using tissue Doppler by placing the sample volume at the level of the aortic valve. The systolic peak of the longitudinal strain curve was measured for all LV segments, and the GLS was calculated by averaging the values of each segment. MD was calculated as the mean time between the peak of the R wave on the electrocardiogram and the peak of the negative strain curve in the different LV segments. Four to six weeks after discharge, measurements were taken again.

3.4. RESULTS

Higher NT-proBNP levels, SPAP, E, E/A, E/e’ ratio, GLS, and GLS/MD ratio and greater surface and diameter of the LA, LAV, and LAVI, as well as end-diastolic LV diameter and longer MD, were seen in patients who experienced cardiac events. Their LVEF, A, e’, and s’ velocities were decreased.

Patients without incidents had a mean GLS/MD at discharge of 0,418±0,2, while those who had an incident had a mean GLS/MD at discharge of 0,239±0,13 ($p < 0,001$).

The maximum accuracy for the GLS/MD index was determined by the area under the ROC curve (AUC = 0.849, 95%CI = 0.805–0.893, $p < 0.001$). The baseline E/e' ratio, MD, and GLS (AUC = 0.794, 95%CI= 0.741–0.847, $p < 0.001$; AUC = 0.738, 95%CI = 0.684–0.792, $p < 0.001$; and AUC = 0.652, 95%CI = 0.587–0.717, $p < 0.001$, respectively) were significant for prediction of composite outcomes.

Statistical comparison of the ROC curves shows substantial differences between GLS/MD and MD ($p = 0.029$) and between GLS/MD and E/'e ($p = 0.015$). The AUC was lower for every other echocardiographic parameter that was examined. The composite outcome can be predicted using GLS/MD at discharge with an appropriate cut-off value of 0.229 (82% sensitivity and 73% specificity).

The greatest independent echocardiographic predictor of composite outcome was GLS/MD before discharge (HR = 3.621, 95%CI = 2.167–5.075, $p < 0.001$).

We found that in 100 patients (30.1%), four to six weeks after hospital release, the GLS/MD ratio had worsened. A total of 33 (33%) of these patients had a GLS/MD starting value greater than -0.229. However, regardless of the GLS/MD value at study inclusion, GLS/MD worsening was associated with lower event-free survival rates (18.2% versus 35.1% in patients with initial GLS/MD > -0.229 and 76.1% vs. 88% in those with GLS/MD ≤ -0.229 at hospital discharge, respectively; log-rank, $p < 0.001$). The worst prognosis was shown for the composite outcome of cardiac mortality, and ventricular arrhythmia, which occurred during follow-up in the subgroup of patients with an initial GLS/MD ratio > -0.229 and deteriorating after 4–6 weeks. Regardless of the severity of the condition, the group of patients with baseline GLS/MD > −0.229 showed a greater likelihood of hospital readmission.

3.5. DISCUSSIONS AND CONCLUSIONS

To our knowledge, this is the first study evaluating the value of this index in predicting cardiac events (cardiac death, ventricular arrhythmia, and hospital readmission rate) in patients with NSTE-ACS who were successfully treated by PCI techniques. In our study, the GLS/MD ratio provided the best independent echocardiographic prediction of the composite outcome, showing the highest accuracy. Patients with a baseline GLS/MD ratio > -0.229 and worsening after four to six weeks had the worst prognosis in terms of composite outcome, cardiac death, and ventricular arrhythmias. The group of patients with an initial GLS/MD ratio > -0.229 showed a higher incidence of hospital readmission, regardless of its aggravation. We investigated the prognostic value of a two-dimensional foreign index that combines a

parameter that evaluates systolic function, being a measure of infarct size, i.e. GLS, and a parameter that can predict ventricular arrhythmias in patients with different heart diseases, being a measure of myocardial deformation heterogeneity, i.e. MD.

The aim of this study was to evaluate the role of echocardiography in general, and speckle tracking echocardiography in particular, in predicting the prognosis of patients who have suffered non-ST-segment elevation acute coronary syndrome. Achieving the proposed objectives represents the final conclusions deriving from this research theme. Thus, conventional echocardiography provides important prognostic data in patients with NSTE-ACS. MD, GLS and GLS/MD ratio are prognostic factors in NSTE-ACS patients. The best independent echocardiographic predictor of the composite endpoints was the GLS/MD ratio before discharge. The predictive threshold value of the GLS/MD ratio is -0.229; moreover, its worsening correlates with a worse prognosis.

4. STUDY III: CONTRIBUTIONS REGARDING THE ASSESSMENT OF THE RISK OF LEFT VENTRICULAR REMODELING IN PATIENTS WITH ACUTE MYOCARDIAL INFARCTION AND PRESERVED OR MODERATELY REDUCED LVEF, USING SPECKLE TRACKING ECHOCARDIOGRAPHY TECHNIQUES

4.1. DEFINING STUDY OBJECTIVES

Patients with acute myocardial infarction are at high risk of developing left ventricular remodeling as well as heart failure. The aim of this study was to evaluate the role of GLS and SR in predicting LV remodeling, in patients with preserved and moderately decreased LVEF, patients who underwent AMI revascularized by PCI, within the first 12 hours of symptom onset.

4.2. MATERIALS AND METHODS

This was an observational case-control study that included all patients consecutively hospitalized with a first AMI (high-risk STEMI/NSTEMI), from January 2019 to January 2020, within the Institute of Cardiovascular Diseases in Timișoara, who were treated successfully through a PCI technique within the first 12 hours of symptom onset. High-risk NSTEMI patients were considered those with at least one of the following criteria: GRACE score >140, dynamic ST-segment/T-wave changes, or a relative increase or decrease in biomarkers of myocardial necrosis.LV remodeling was defined as a ≥ 20% increase in LVEDV from baseline to 6-month follow-up.

4.3. ECHOCARDIOGRAPHY

Baseline echocardiography was performed 1.3 ± 0.6 days after PCI, and follow-up echocardiography 6 months after the onset of AMI, using a GE Vivid E7 echocardiography system (GE Health Medical, Milwaukee, WI, USA). A modified version of Simpson's formula was used to calculate LVEF from two- and four-chamber apical incidences. LVEF was considered preserved when it recorded values of at least 50%, and moderately low when it recorded values between 40 and 49%. Two-dimensional speckle-tracking echocardiography was used to assess LV deformation. Data were analyzed off-line, using EchoPAC system version 11.0.1 (GE Vingmed). Strain and SR were measured in longitudinal, circumferential and radial directions. Segments affected by ischemia (H-harmed) were considered those that had an LS<-15%.

4.4. RESULTS

Of the 271 patients who were initially enrolled, 18 were excluded and were not evaluated for LV remodeling. Finally, the study group included 253 patients, aged between 32 and 92 years (mean age 66±13 years), 185 (73%) being men. At 6-month echocardiography, 61 (24%) were detected with LV remodeling and were included in group II, while the remaining 192 (66%) were included in the group without remodeling (group I). Patients with LV remodeling were older, more often hypertensive, with higher Killip functional classes, higher peak values of CK-MB isozymes and lower values of eGFR. They also had multivessel coronary artery disease more often. The proportion of patients with STEMI was higher in group II than in group I, but this result was not statistically significant (94% vs 89%). Regarding the echocardiographic data, we found that, at baseline, LVEDV and LVESV were significantly lower in the remodeling group, while the differences between mean LVEF and stroke volume, respectively the E/A ratio, were not significant. At 6-month follow-up, we found that in the remodeling group, LVESV and WMSI became significantly higher, while LVEF and stroke volume index became significantly lower than in group I. The odds ratio of developing LV remodeling a was 1.81 when comparing STEMI patients with high-risk NSTEMI patients (95% CI: 0.66-5.00, P = 0.24). At the 6-month reassessment, LV strain performance was significantly more impaired, as shown by significantly lower values of GLSR (P=0.02), SR (P<0.01), and GRSR (P=0.02) , compared to group I.

In univariate logistic regression, we found 15 predictors for LV remodeling (P<0.001) in patients with AMI revascularized by PCI and having an LVEF of at least 40%. These included age, systemic hypertension, hypercholesterolemia, smoking history, admission systolic and diastolic blood pressure, Killip class, estimated glomerular filtration rate, peak CK-MB isoenzymes, bi- or trivascular coronary disease, LVEDV, LVESV, as well as HLS and HLSR.

Multivariate logistic regression selected 5 independent predictors for LV remodeling and these were: Killip class, trivascular coronary disease and LVESV, but also baseline HLS and HSR. For independent predictors of LV remodeling, ROC curves were analyzed and compared. The strongest predictors of LV remodeling were HLS (AUC=0.85, sensitivity 83%, specificity 84%, P<0.001) and HLSR (AUC=0.77, sensitivity 93%, specificity 61%, P<0.001) . The other independent predictors were LVEDV (AUC=0.66, sensitivity 67%, specificity 58%, P<0.001), trivascular coronary disease (AUC=0.62, sensitivity 39%, specificity 84%, P<0.001) and class Killip (AUC=0.61, sensitivity 88%, specificity 34%, P<0.001). ROC analysis revealed as infarct-related GLS and GLSR cut-off values predicting LV remodeling -11% and -0.65 s-1, respectively. On Cox regression analysis, the odds ratios for LV remodeling were 1.4 for baseline HLS < -11% (95% CI 0.66 to 0.78, P<0.0001 and 2.16 for baseline). HLSR<-0.65s-1 (95% CI 0.10 to 0.33, P<0.001).

4.5. DISCUSSIONS AND CONCLUSIONS

The aim of this study was to evaluate the role of echocardiography in general, and speckle tracking echocardiography in particular, in predicting LV remodeling after ACS in patients with preserved or moderately reduced LVEF. In conclusion, 24% of high-risk STEMI or NSTEMI patients develop left ventricular remodeling 6 months after the acute coronary event. STEMI patients have a 1.57 times higher risk of developing LV remodeling than high-risk NSTEMI patients. The threshold values of HLS and HLSR predicting LV remodeling at baseline echocardiographic examination were -11% for HLS and -0.65 s-1 for HLSR. A baseline HLS < -11% increased the risk for remodeling 1.4-fold, while AMI patients with a baseline HLSR < -0.65 s-1 were 2.16 times more likely to develop remodeling . 2D-STE has been shown to be an effective, practical and reliable non-invasive technique to predict LV remodeling in this category of patients.

5. CONCLUSIONS AND ORIGINAL CONTRIBUTIONS

The role of speckle tracking echocardiography in the evaluation of left ventricular remodeling, respectively the prognosis of patients with ACS, represents the central point around which the entire design of this research was built. Achieving the proposed objectives represents the final conclusions deriving from this research topic:

I. Speckle tracking echocardiography has an essential role in the assessment of ventricular remodeling after an acute myocardial infarction with ST-segment elevation. Moreover, the best speckle tracking parameter capable of early identification of progression to

adverse remodeling is twist. A twist value greater than 11° has a specificity of 76.9% and a positive predictive value of 72.7% for normal remodeling at 6 months.

II. Anticipating the prognosis of patients after an ACS is possible using speckle tracking echocardiography. From here results the second major hypothesis of the study, that of grouping a deformation parameter, in this case GLS, with a contraction inhomogeneity parameter, mechanical dispersion, in a parameter obtained by making the ratio of the two ultrasound indices.

III. The analysis of the prognostic impact of the new speckle trackig echocardiographic techniques on global mortality, cardiac mortality, but also the global incidence of cardiac events in patients, shows that MD, GLS and the GLS/MD ratio are prognostic factors in patients with NSTE-ACS .

IV. The best independent echocardiographic predictor of composite endpoints was pre-discharge GLS/MD ratio.

V. The GLS/MD ratio is a strong indicator of clinical evolution in patients with NSTE-ACS, especially if it is accompanied by a deterioration from the value since the acute coronary event.

VI. The predictive threshold value of the GLS/MD ratio is -0.229.

VII. Threshold values of HLS and HLSR predicting LV remodeling at baseline echocardiographic examination were -11% for HLS and -0.65 s-1 for HLSR in the group of patients with high-risk STEMI or NSTEMI in whom LVEF has a value of at least 40%.

The present research is characterized by at least two original elements. First, it is differentiated by assessing, as a whole, depressed myocardial function after a STEMI, taking into account the effect of contraction of all layers of the left ventricular myocardium. This global contraction was characterized by measuring longitudinal, circumferential and radial strain. Moreover, we identified a threshold value predicting adverse remodeling after STEMI for left ventricular twist, a parameter that evaluates the rotational motion of the heart.

Second, we imagined a new ultrasound parameter that groups two parameters of speckle tracking echocardiography, in this case the GLS/MD ratio. In addition, we succeeded, also in this situation, in identifying a threshold value for predicting patient prognosis after an NSTE-ACS.

Moreover, we imagined the first study in Romania that evaluated the role of speckle tracking echocardiography in patients with high-risk STEMI or NSTEMI, in which the LVEF has a value of at least 40%.