Intraobserver reproducibility of parameters of standard and 2D speckle tracking echocardiography, dynamics of global longitudinal strain I in patients with acute primary anterior STEMI

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Intraobserver Reproducibility of Parameters of Standard and 2D Speckle Tracking Echocardiography, Dynamics of Global Longitudinal Strain I in Patients with Acute Primary Anterior STEMI

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Abstract. The aim of this study was to assess the intraobserver reproducibility of parameters of standard and 2 dimensional speckle tracking echocardiography, dynamics of global longitudinal strain in patients with acute primary anterior STEMI. The study included 24 patients, mean age 58.46±10.2. Echocardiography with 2D speckle tracking imaging was performed on the 1st (T1), 7th (T2), 14th days (T3) after STEMI («Vivid E9»). Analysis of echocardiographic images was performed offline at the different periods by the two independent observers (EchoPac) – experienced and inexperienced. In order to assess the agreement between standard and 2D speckle tracking echocardiography, a correlation analysis (Pearson correlation, Spearman's rank correlation coefficient) and Bland-Altman analysis were undertaken. The 23 patients had urgent reperfusion therapy, 6 patients underwent primary PCI, 16 patients – PCI after successful fibrinolysis (68%). GLS and WMSI had the best intraobsever reproducibility. Dynamics of EDV LV, ESV LV, EF LV was without significant differences. Nevertheless, it was found positive dynamic of GLS: –12.65±3.53 (T1), -13.61±3.81 (T2), –14.27±4.1 (T3), p<0.05. GLS reduced 11.35% (p=0.0048) from T1 to T3. The best intraobserver reproducibility of parameters of 2 D speckle-tracking and standard echocardiography was revealed in GLS and WMSI. The modern management of STEMI patients limits adverse postinfarction remodeling and preserves of global left ventricular contractility detected by the EF LV. However, GLS had the positive dynamics and improved to the 14th day.

INTRODUCTION

Noninvasive assessment of regional myocardial function is more an approachable to the management of patients with cardiovascular diseases. Echocardiography is the safe, handy technology with high temporal resolution [1, 2]. At the present in clinical practice, standard echocardiography is more preference. However, this technique has some limitations-poor endocardial border definition, time-consuming, poor reproducibility, also sometimes a compensatory hyperkinesis, despite myocardial damage at the infarct zone [3]. The complex heart biomechanics and presence of aforementioned disadvantages of standard echocardiography motivate us to continue to look for the universal prognostic markers.

The new technology–2D speckle tracking echocardiography has a semiautomatic nature and shows us a myocardial deformation (strain) in 3 spatial directions: longitudinal, radial, circumferential. At the present we have

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the consensus document with a common standard of this technique already, but 2D speckle tracking is a research tool till now, because it requires the collection all dates about this technique [4].

Reproducibility in echocardiography is an important measure, because it is very subjective technique and it is the proximity of agreement between independent results, obtained with the same method, but under different specialist or under using various software. We research the reproducibility in special cohort–patients with acute primary anterior STEMI and we want to compare new and traditional technique of echocardiography.

METHODS

24 patients with primary anterior ST-elevated myocardial infarction were included in the study. Patients admitted to a general intensive care unit at the first 24th hours from the onset and all of them had percutaneous coronary intervention during current hospitalization. There were 9 women and 15 men at the age from 32 to 73 (mean age–58.46±10.2). Exclusion Criteria were severe comorbidity, severe heart failure with cardiogenic shock (T. Killip Class IV), hypotension-systolic blood pressure <90 mmHg, non Q-wave myocardial infarction, sinus bradycardia; atrial fibrillation, a permanent form; heart failure (NYHA functional class III–IV) in history, significant valvular defects, poor image quality. Current therapy, instrumental and laboratory researches carried out according to national guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. The study protocol was approved by local ethical committee; all patients signed the informed consent to participate in research.

Standard echocardiography with two-dimensional transthoracic echocardiography was performed on the 3d (T1), 7th (T2), 14th days (T 3) after STEMI («Vivid E9»). Data acquisitions were performed using a 1.7–4.6 MHz sectoral phased sensor with synchronized ECG in the parasternal and apical views. Peak systolic longitudinal strain and strain rate were assessed on apical two-chamber, four-chamber, five-chamber and long-axis views using speckle-tracking an analysis [6]. Analysis of echocardiographic images was performed offline by the two independent observers–experienced and inexperienced (EchoPac). The 1st researcher was the ultrasound diagnostic specialist; work experience is about 10 years, but without any information about history of the patient. The 2nd was the graduate student of emergency department of cardiology with work experience of 6 months, but with clinical information about patients. EDV, ESV, EF, WMSI-standard echocardiography; GLS, twist, apical and basal rotation-2D speckle tracking echocardiography, were in the area of our attention.

All statistical analyses were performed using the software STATISTICA 10. All results expressed as means ± standard deviation (M±SD) or number and percentage. We compared dynamics of all parameters during hospitalization using t-tests for normally distributed continuous variables (Student’s t-test); in case of abnormal distribution, the Freadman's test was used. A value of $p < 0.05$ was considered statistically significant [7].

Intraobserver reproducibility of standard and 2D speckle tracking echocardiography was assessed by the Bland–Altman method. It were represented as mean value of difference of measurements between 1st and 2nd specialist (M%), standard deviation of this difference (STD,%) and the coefficient of variation (CV,%) [7]. All parameters also were compared using a correlation analysis (Spearman's rank correlation coefficient–in normal distribution, Pearson's coefficient in abnormal).

GLS had the best reproducibility between other investigated parameters. It is an average of the deformation of all segments in all analyzed sections [3]. In previous studies normal range of GLS marked by 15.9% to 22.1% [2]. Depending on value of GLS on T1 pts were divided into 2 groups: 5 pts with GLS<-15% and 19 pts with GLS >-15% (1st and 2nd group respectively) [18].

RESULTS

23 patients had urgent reperfusion therapy, 6 patients underwent primary PCI, 16 patients - PCI after successful fibrinolysis (68%). 25% pts had patency of IRCA achieved during the first 3 hours, 75% during 6 hours. Average reperfusion time was 4.21±0.94 h. The most frequently infarct-related artery was the left anterior descending artery (96% of events), the 4% of events it was the I diagonal branch of left anterior descending artery. Recurrent myocardial infarction and mortality were not observed after AMI. Table 1 shows the clinical characteristics of the study groups.

Then we compared the agreement between measures by the Bland–Altman method and compared dates by correlation analysis (Spearman rank correlation coefficient and Pearson's correlation coefficient).The mean difference was the least in WMSI and GLS. Correlation coefficient was the highest in GLS and WMSI too. It should be noted, that all parameters had a direct correlation: the strong correlation had GLS, WMI, BR, EDV (r> 0.7), other parameters have an average power of communication (0.5-0.7). Coefficient of variation characterized the relative measure of the deviation of the measured values from the arithmetic mean and it was the less at GLS and WMSI (allowable value for medical research <10% for good intraobserver reproducibility). Characteristics reproducibility of results by standard and 2D speckle tracking echocardiography are presented in tab.2. All aforementioned indicate that the best intraobserver reproducibility was found at GLS and WMSI.

Dynamics of parameters of standard echocardiography was without significant differences. Dynamics of twist, basal and apical rotation of 2D speckle tracking echocardiography was without significant differences too. Nevertheless, it was found positive dynamic of GLS: -12.65±3.53 (T1), -13.2±3.54 (T2), -13.72±3.96 (T3), $p<0.05$. Dynamics of GLS was positive, its value reduced on 11.35% from T1 to T3 ($p=0.0048$). There were no dynamics in GLS between T1 and T2, T2 and T3 ($p>0.05$).

Then we divided the patients into 2 groups: the 1st- patients with initially normal value of index global longitudinal strain and the 2d-with reduced value of index.

In the 1st group the value of GLS became more negative to T3, it was the positive dynamics ($p=0.038$). It value reduced to T3 on 16%: -16.9±0.83 (T1);-17.72±1.89 (T2); -19.6±1.5 (T3). In the 2d group significant dynamics of GLS was no observed: -10.7±2.25 (T1); -11.4±2.08 (T2); -11.9±2.2 (T3) %.

TABLE 1. Baseline characteristics.

Variable M±SD, n, %
Smoking (+) 10 (42 %)
Obesity (+) 10 (42%)
Arterial hypertension(+) 19 (79%)
Unstable angina before hospitalization 12 (50%)
Infarct-related artery (LAD, I DA) 23 (96%)/1(4%)
Coronary artery disease (1, 2, 3 –vessel CAD) 10 (42%) / 8 (33%) / 6 (25%)
Killip class (I, II, III, IV) 15 (62%) / 1 (4%) / 2(34%)
Total revascularization 5 (21%)
The six minute walk test, m 459.3±91
HF FC (NYHA) I, II a/IIb 17(71%)/ 6(25%), 1(4%)

TABLE 2. Characteristics reproducibility of results by standard and 2D speckle tracking echocardiography

Index	**Mean difference (MD)**	**Standard Deviation (STD)**	**Coefficient of variation (CD)**	**Correlation coefficient**	**P**
Global longitudinal strain	-0.12	0.53	0.78±3.6%	0.99	<0.005
WMSI	0.03	0.13	1.87±7.9%	0.87	<0.005
Basal rotation	-0.15	2.53	3.83±59.6%	0.84	<0.005
Apical rotation	-0.74	3.37	10.72±38.3%	0.68	<0.005
Twist	-0.36	5.47	11.12±43.1%	0.63	<0.005
EF LV	3.71	14.41	3.96±16.8%	0.63	<0.005
EDV	3.81	7.92	8.32±108%	0.85	<0.005
ESV	9.72	7.91	6.56±19.9%	0.54	<0.005

DISCUSSION

Recently, in clinical practice to noninvasive diagnostics of cardiovascular diseases, assess therapeutic interventions, and predict prognosis of patients with STEMI we preferred to use standard echocardiography, because it is portability, low cost and risk for health, rapidity of procedures [1, 2, 18]. But this technique has some limitations - it is subjective, operator-depend and requires long training. A new tool-2D speckle tracking echocardiography has semiautomatic nature and let to assess quantitatively the regional deformation (strain) in 4th courses-longitudinal, radial, circumferential, and rotational and strain rate [8, 9, 18].

The analysis of intraobserver reproducibility between the measures of standard and 2D speckle tracking echocardiography have to determine which technique and parameter more useful to beginner specialist. It should be noted, that researches recommended interpreting all results at the same machine and software or versus vendor-specific reference values and we did it similarly [5].

There is a research, where was examined if the GLS improve the interpretation of WMSI for expert and non-expert observers. Intraobserver agreements between the experts were excellent while the non-expert showed better agreement for GLS than WMSI [13]. At the same time, the best intraobserver reproducibility of measures between experienced and inexperienced specialist was in GLS and WMSI in our study.

Cheng et al. observed very good or excellent reproducibility of GLS and GCS, because it was measured at or near the level of the endocardium [12]. Subendocardial longitudinal fibers are more sensitive to hypoperfusion at the early phase of ischemia, but integrated endocardial and epicardial tracking may be more sensitive to alterations in more advanced stage of disease. [6].

In our interest was the special group–it was the patients with acute primary anterior STEMI. It is known that adverse remodeling (increase in EDV or ESV at least 20%) assessed 3 month after AMI, has the link with poor prognosis after STEMI [6, 14, 15, 16]. We did not reveal adverse remodeling in our group, because the modern management of STEMI patients limits it and preserves of global left ventricular contractility, notwithstanding we plane to check it after 6 month after STEMI [19, 20]. However, GLS had the positive dynamic from baseline to discharge in research group. D'Andrea et al. found that the GLS is a reliable predictor of LVR ($\geq$ 15% increase in LV EDV at 6 months after AMI) [17]. In our research, we revealed that the patients with initially normal value of GLS had the positive dynamics, it can be explained by the presence more viable cardiomyocytes [6]. But the other patients with initially reduced value of GLS had no any dynamic and probably this group require more detailed and aggressive secondary prevention [6].

CONCLUSION

The present study indicates that parameters of 2 D speckle-tracking and standard echocardiography has a high reproducibility, among of them the GLS and WMSI has the best index. Although, the modern management of STEMI patients limits adverse postinfarction remodeling and preserves of global left ventricular contractility detected by the EF LV, we found the nonlinear dynamics of GLS. There was strain improvement to T3 in patients with GLS<-15% on T1. In contrast, patients with GLS >-15% on T1 had no any dynamics. Thus, GLS is more sensitive to the alterations at the early stage of STEMI.

ABBREVIATIONS

2D–two dimensional; I DA-the first diagonal artery; AMI–acute myocardial infarction; AR–apical rotation; BR–basal rotation; CAD-coronary artery disease; ECG–electrocardiogram; EDV LV–end diastolic volume of left ventricular; EF LV–ejection fraction of left ventricular; GCS-global circumferential strain; GLS-global longitudinal strain; HF FC-functional classes of heart failure; ICU-intensive care unit; IRCA-infarct related coronary artery; LAD-left anterior descending artery; LV–left ventricular; LVR-left ventricular remodeling; PCI-primary coronary intervention; STEMI–myocardial infarction with ST elevation; WMSI-wall motion score index.

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