Role of Speckle Tracking in the Evaluation of Left Ventricular Remodeling After Streptokinase Infusion in Patients with Acute Anterior Myocardial Infarction

Shereen Ibrahim Farag*, Khaled Emad El-Din El-Rabbat,
Mohamed Ali El-Awadi, AL-Shimaa Mohamed Sabry

Benha University
Fareed Nada Street, Benha, Qalubiya Governorate, 13511 Arab Republic of Egypt

Background. Left ventricular (LV) remodeling is an adverse consequence after acute myocardial infarction

Aim. To assess the role of speckle tracking in the evaluation of LV remodeling after streptokinase infusion in patients with acute anterior ST-segment elevation myocardial infarction (STEMI).

Material and methods. A total of 200 patients with first acute anterior STEMI received streptokinase as a reperfusion therapy were included. Conventional echocardiography and speckle tracking were performed within 3 days of admission and 3 months later. According to the development of LV remodeling, patients were classified into two groups. Group (I) patients with LV remodeling (60 patients) and group (II) patients without remodeling (140 patients).

Results. Patients with LV remodeling had lower global longitudinal (GLS) and circumferential (GCS) strain values (-13.19±4.57 vs. -18.90±4.23 % and -13.16±4.27 vs. -17.16±3.3 %, respectively, p<0.001). GLS cutoff value of >-13.5 was shown to have the best diagnostic accuracy (sensitivity =60.0% & specificity =87.1%) in predicting LV remodeling (AUC 0.816, 95% confidence interval [CI] 0.754-0.877, p<0.001). GCS cutoff value of >-16.21 was shown to have the best diagnostic accuracy (sensitivity =75.0% & specificity =71.4%) in predicting LV remodeling (AUC 0.785, 95%CI 0.719-0.85, p<0.001).

Conclusion. Speckle tracking echocardiography either longitudinal or circumferential strain has good sensitivity and specificity in predicting LV remodeling after acute myocardial infarction.

Keywords: ST-segment elevation myocardial infarction; speckle-tracking; ventricular remodeling.

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*Corresponding author: dr.shereenfarag@gmail.com

Introduction

Acute myocardial infarction (AMI) and its adverse sequelae remain one of the most common causes of morbidity and mortality worldwide. The prognosis of patients with AMI depends on the changes occurring in the left ventricular (LV) geometry [1].

Changes in LV geometry after AMI are a complex processwithdifferent phases. LV remodeling after AMI plays an important role in the developmentof advancing heart failure (HF), ventricular arrhythmia and subsequently increasing the mortality [2]. The identification of those patients is curial for risk stratification in early-stage [3].

Different studies reported the usefulness of speckle tracking echocardiography in detecting the degree of myocardial deformation and contractility in patients with different cardiac diseases [4].

This work aimed to assess the role of speckle tracking echocardiography in the evaluation of LV remodeling after streptokinase infusion in patients with acute anterior ST-segment elevation myocardial infarction (STEMI).

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Material and methods

Study design and patients selection:

A single center, prospective study that was conducted at the coronary care unit at "Benha University Hospital" during the period from August 2017 to March 2019 after approval from the local ethics committee. The study included patients presenting within 12hr with first acute anterior STEMI and received streptokinase as thrombolytic therapy. All patients had normal sinus rhythm. Informed consent was signed from all patients.

Patients with prior myocardial infarction (MI), percutaneous coronary intervention, or coronary artery bypass grafting, contra-indication to thrombolytic therapy, significant valvular heart disease, and poor echocardiographic images were excluded from the study.

Echocardiography

All echocardiographic examinations were performed within 3 days of hospital admission and 3 months later. All examinations were recorded for offline analysis using a Philips EPIQ 7C, Release 1.7 (Philips Healthcare, Andover, MA, USA) machine with Q lab 10.4. Left ventricular ejection fraction (LVEF) was calculated by modified biplane Simpson's method [5]. Pulsed tissue Doppler imaging was used to assess the mitral annular systolic (S), and diastolic (é) and (a`) velocities [6]. For speckle tracking echocardiography (STE), three consecutive cardiac cycles with breath-hold at high frame rates (>70 frames/sec) were obtained in the apical four-, apical two-chamber, and apical 3 chambers views. A semi-automated method was used in which 3 points were identified (basal septal, basal lateral, and apical). After that, the software generates automatically strain curves for different myocardial segments. The strain values for all the segments were recorded and averaged to obtain the global longitudinal strain (GLS) [7]. While global circumferential strain (GCS) was evaluated in parasternal short-axis views at the basal, papillary muscle, and apical levels [7].

Statistical analysis: Data management and statistical analysis were done using SPSS vs.25. (IBM, Armonk, New York, United States). Numerical data were summarized as means and standard deviations. Categorical data were summarized as numbers and percentages. Numerical data were assessed for normality using normality tests and direct data visualization methods. Comparisons between remodeling and non-remodeling were done using independent t-test for numerical data. Categorical data were compared using Chi-square test. ROC analysis was done for GLS and GCS for prediction of remodeling. Area under curve (AUC) with 95% confidence intervals were calculated for each. Best cutoff and diagnostic indices including sensitivity and specificity were calculated. Multivariate logistic regression analysis was done for the prediction of remodeling. Odds ratio (OR) with 95% confidence interval (CI) were calculated. All P values were two-sided. P values less than 0.05 were considered significant.

Results

A total of 200 patients with acute anterior STEMI treated with streptokinase as a thrombolytic therapy were evaluated. The patients were classified according to the presence of LV remodeling (defined as ⩾20% increase in LV end-diastolic volume [EDV] and/or LV end-systolic volume (ESV) at 3-month follow-up into 2 groups. Group (I): patients with LV remodeling (60 patients) and group (II): Patients without LV remodeling (140 patients). Baseline demographics and clinical characteristics of both groups were illustrated in table 1.

Echocardiographic parameters

LVEF was lower among patients of group I (46.07±15.38 vs. 54.13±11.56 %, p<0.001). LVEDV and LVESV were significantly higher in group I (115.66±10.62 vs. 86.20±15.49 ml and 66.82±22.38 vs. 40.6±16.6 ml, respectively, p<0.001). Patients with LV remodeling had lower GLS and GCS values (-13.19±4.57 vs. -18.90±4.23 % and -13.16±4.27 vs. -17.16±3.3 %, respectively, p<0.001; table 2).

In-hospital complication

Arrhythmias were more prevalent in patients with LV remodeling (48.3% vs. 31.4%, p=0.023). While, heart failure, cardiogenic shock, minor bleeding, cerebrovascular stroke, and re-infarction showed a non-significant statistical difference (table 3).

Multivariate analysis using the forward stepwise

Table 1. Demographics and general characteristics of patients with and without remodeling

Parameter	Group I (n =60)	Group II (n =140)	P-value
Age, years	61±13	56±14	0.023
Male gender, n (%)	36 (60.0)	52 (37.1)	0.003
Diabetes mellitus, n (%)	31 (51.7)	65 (46.4)	0.497
Dyslipidemia, n (%)	34(56.7)	80 (57.1)	0.95
Hypertension, n (%)	28 (46.7)	60 (42.9)	0.619
Smoking, n (%)			
Non-smoker	26 (43.3)	54 (38.6)	
Ex-smoker	16 (26.7)	23 (16.4)	0.089
Smoker	18 (30.0)	63 (45.0)	
Family history, n (%)	10 (16.7)	33 (23.6)	0.276
Successful reperfusion, n (%)	38 (63.3)	115 (82.1)	0.004
Heart rate, bpm 0.041		85±14	80±16
SBP, mmHg	119±30	125±30	0.18
DBP, mmHg	73±20	76±17	0.24
Killip class, n (%)			
I	36 (60.0)	98 (70.0)	
II	12 (20.0)	28 (20.0)	0.078
III	4 (6.7)	9 (6.4)	
IV	8 (13.3)	5 (3.6)	

Values are mean±standard deviation or number (%)

SBP – systolic blood pressure, DBP – diastolic blood pressure

Table 2. Echocardiographic parameters in study groups

Parameter	Group I (n =60)	Group II (n =140)	P-value
EF, %	46.07±15.38	54.13±11.56	<0.001
LVEDV, ml	115.66±10.62	86.20±15.49	<0.001
LVESV, ml	66.82±22.38	40.6±16.6	<0.001
WMSI	1.33±0.23	1.23±0.17	0.002
Swave ,cm/s	7.08±1.63	7.54±1.38	0.041
e'wave ,cm/s	7.07±1.35	7.53±1.25	0.022
a'wave ,cm/s	7.79±2.09	8.62±1.58	0.002
GLS, %	-13.19±4.57	-18.90±4.23	<0.001
GCS, %	-13.16±4.27	-17.16±3.3	<0.001

Values are mean±standard deviation

EF – ejection fraction, LVEDV – left ventricular end diastolic volume, LVESV – left ventricular end systolic volume, WMSI – wall motion score index, GLS – global longitudinal strain, GCS – global circumferential strain

method revealed that LVEF, LVEDV, GLS, and GCS were independent predictors of LV remodeling in patients with acute anterior myocardial infarction

Table 3. In-hospital complication in patients with and without left ventricular remodeling

Parameter	Group I (n =60)	Group II (n =140)	P-value
Heart failure, n (%)	12 (20.0)	15 (10.7)	0.078
Pulmonary Edema, n (%)	4 (6.7)	12 (8.6)	0.649
Cardiogenic shock, n (%)	4 (6.7)	2 (1.4)	0.067
Arrhythmia, n (%)	29 (48.3)	44 (31.4)	0.023
Bleeding, n (%)	12 (20.0)	17 (12.1)	0.148
Re-infarction, n (%)	6 (10.0)	7 (5.0)	0.189
Stroke, n (%)	6 (10.0)	11 (7.9)	0.619

treated with streptokinase. Concerning LVEF, for each one unit decrease, risk of remodeling increase by 12.9% (OR=1.129, 95%CI 1.053-1.21, p=0.001), and for each one-unit increase in LVEDV, risk of remodeling increase by 21.1% (OR=1.211, 95%CI 1.126-1.303, p<0.001).

Regarding GLS for each one-unit decrease, the risk of remodeling increase by 39% (OR=1.39, 95%CI 1.2-1.62, p<0.001). On the other hand, for each one unit decrease in GCS, the risk of remodeling increases by 42% (OR=1.42, 95%CI 1.16-1.75, p=0.001; table 4).

ROC curve was used to test the diagnostic value (overall accuracy) of global longitudinal strain (GLS) and GCS in predicting LV remodeling in patients with acute myocardial infarction treated with streptokinase. GLS cutoff value of >-13.5 was shown to have the best diagnostic accuracy (sensitivity =60.0% & specificity =87.1%) in predicting LV remodeling (AUC 0.816, 95%CI 0.754-0.877, p<0.001). GCS cutoff value of >-16.21 was shown to have the best diagnostic accuracy (sensitivity =75.0% & specificity =71.4%) in predicting LV remodeling (AUC 0.785, 95%CI 0.719-0.85, p<0.001). AUC of GLS was higher than that of GCS, so GLS was more accurate in predicting LV remodeling (fig. 1).

Discussion

Left ventricular remodeling is a complex process related to multiple changes occurring in the structure and function of cardiac muscles. Different studies stated the negative prognostic value and poor outcome of LV remodeling following AMI as it is reported to predispose to heart failure and death [8].

Table 4. Multivariate logistic regression analysis for prediction of remodeling

Parameter	Wald	OR	95%CI	P value
LVEF	11.591	1.129	1.053 - 1.21	0.001
LVEDV	26.462	1.211	1.126 - 1.303	<0.001
GLS	17.442	1.39	1.2 - 1.62	<0.001
GCS	11.27	1.42	1.16 - 1.75	0.001

LVEF – left ventricular ejection fraction,
LVEDV – left ventricular end diastolic volume,
GLS – global longitudinal strain, GCS – global circumferential strain,
OR – odds ratio, CI – confidence interval

LV remodeling is characterized by a progressive increase in LV volumes either ESV or EDV. The increase in ESV may occur first due to impaired systolic function [9].

Early predictors of remodeling are still under investigation. It is important to know which of the data collected during hospital admissioncan help in identifying patients with high-riskcriteria for developing LV remodeling. Conventional echocardiography is widely available, but its value for predicting LV remodeling is low [10].

The study aimed to assess the role of speckle tracking in the evaluation of left ventricular remodeling in patients with acute anterior myocardial infarction received streptokinase as thrombolytic therapy.

We found that patients with LV remodeling had lower GLS and GCS (p<0.001), which was concordant with T. Bochenek et al. [10] who reported that patients with LV remodeling after primary PCI for STEMI had lower GLS value than those without remodeling (-12.9± 5.9 vs. -15.9± 3.6 %; p =0.01). Also, D. Mele et al. [11] found significantly lower GLS in the remodeling group (-11.2± 2.5 vs. -14.8± 3.2; p =0.003).

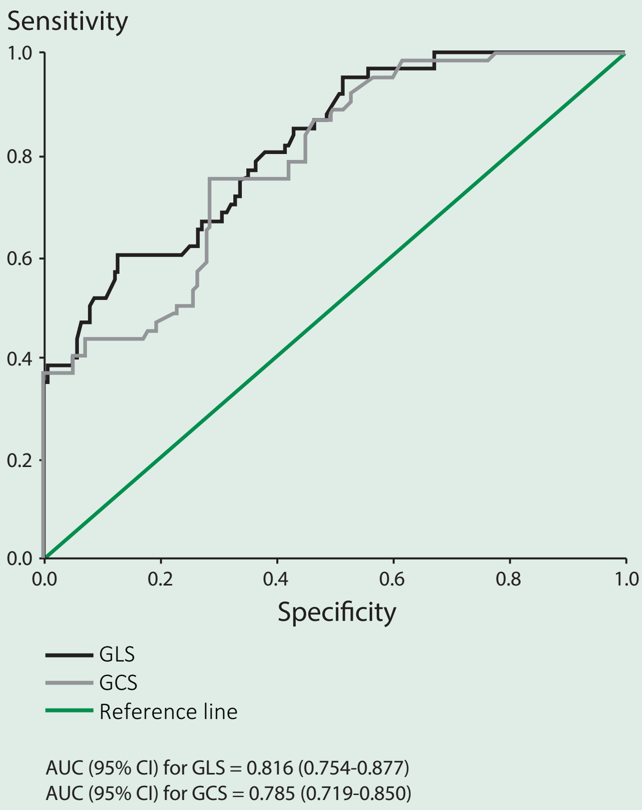
In multivariate analysis LVEF, LVEDV, GLS, and GCS were independent predictors of LV remodeling in patients with acute myocardial infarction treated with streptokinase.

This is concordant with A. D'Andrea et al. [12] who found that GLS is a reliable predictor of LV remodeling with a sensitivity of 84.8% and specificity of 87.8%. Also, M.L. Antoni et al. [13] reportedthat GLS has a strong prognostic value in terms of all-cause mortality, re-infarction, hospitalization due to heart failure, or revascularization in patients after acute MI. T. Cong et al. [14] confirmed that GLS has sensitivity 89.7%, specificity 91.7%, P<0.01 in the prediction of LV remodeling.

A. Paul et al. [15] stated that GLS is an excellent predictor of adverse LV remodeling and cardiac events in patients with acute myocardial infarction.

In our study, the value of GLS > -13.5% and GCS > -16.21% had the best diagnostic accuracy in predicting LV remodeling after acute STEMI. This finding is consistent with J. Lacalzada et al. [16] who found that a GLS cutoff value -12.46% had the best diagnostic accuracy in predicting LV remodeling after acute MI. Similarly, T. Bochenek et al. [10] found that GLS > -12.5% could predict LV remodeling. Also, I. Bastawy et al. [17] showed that average peak systolic GLS > -12.5% was found to be an independent predictor of LV remodeling.

Also, M.L. Antoni et al. [13] declared that patients with impaired GLS were 18times more likely to suffer from a composite endpoint of mortality, re-admission



AUC – Area under curve, GLS – global longitudinal strain, GCS – global circumferential strain, CI – confidence interval

Figure 1. ROC curve for global longitudinal and circumferential strain in predicting left ventricular remodeling

due to heart failure, revascularization, or re-infarction after acute myocardial infarction.

Conclusion

Speckle tracking echocardiography either longitudinal or circumferential strain has good sensitivity and specificity in predicting LV remodeling after acute anterior myocardial infarction.

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References

1. Mannaerts H.F., van der Heide J.A., Kamp O., et al. Early identification of left ventricular remodeling after myocardial infarction, assessed by transthoracic 3D echocardiography. Eur Heart J. 2004;25:680 7. DOI:10.1016/j.ehj.2004.02.030.
2. Konstam M.A., Kramer D.G., Patel A.R., et al. Left ventricular remodeling in heart failure: current concepts in clinical significance and assessment. JACC Cardiovascular Imaging. 2011;4(1):98-108. DOI:10.1016/j.jcmg.2010.10.008.
3. Solomon S.D., Glynn R.J., Greaves S., et al. Recovery of ventricular function after myocardial infarction in the reperfusion era: the healing and early afterload reducing therapy study. Ann Intern Med. 2001;134(6):451-8. DOI:10.7326/0003-4819-134-6-200103200-00009.
4. Leitman M., Lysyansky P., Sidenko S., et al. Two-dimensional strain-a novel software for real-time quantitative echocardiographic assessment of myocardial function. J Am Soc Echocardiogr. 2004;17:1021-9. DOI:10.1016/j.echo.2004.06.019.
5. Lang R.M., Badano L.P., Mor-Avi V., et al. Recommendations for cardiac chamber quantification by Echocardiography in Adults: An Update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. Journal of the American Society of Echocardiography. 2015:28(1):1-39. DOI:10.1016/j.echo.2014.10.003.
6. Ancona R., Comenale Pinto S., Caso P., et al. Left Atrium by Echocardiography in Clinical Practice: From Conventional Methods to New Echocardiographic Techniques. Scientific World Journal. 2014;2014:451042. DOI:10.1155/2014/451042.
7. Yingchoncharoen T., Agarwal S., Popović Z.B., et al. Normal ranges of left ventricular strain: a meta-analysis. J Am Soc Echocardiogr. 2013;26(2):185-91. DOI:10.1016/j.echo.2012.10.008.
8. Jang J.Y., Woo J.S., Kim W.S., et al. Serial assessment of left ventricular remodeling by measurement of left ventricular torsion using speckle tracking echocardiography in patients with acute myocardial infarction. Am J Cardiol. 2010;106:917-23. DOI:10.1016/j.amjcard.2010.05.042.
9. Lund G.K., Stork A., Muellerleile K., et al. Prediction of left ventricular remodeling and analysis of infarct resorption in patients with reperfused myocardial infarcts by using contrast-enhanced MR imaging. Radiology. 2007;245(1):95-102. DOI:10.1148/radiol.2451061219.
10. Bochenek T., Wita K., Tabor Z., et al. Value of speckle-tracking echocardiography for prediction of left ventricular remodeling in patients with ST-elevation myocardial infarction treated by primary percutaneous intervention. J Am Soc Echocardiogr. 2011;24:1342-8. DOI:10.1016/j.echo.2011.09.003.
11. Mele D., Nardozza M., Chiodi E. Early speckle-tracking echocardiography predicts left ventricle remodeling after acute ST-segment elevation myocardial infarction. J Cardiovasc Echography. 2017;27:93-8. DOI:10.4103/jcecho.jcecho_2_17.
12. D'Andrea A., Cocchia R., Caso P., et al. Global longitudinal speckle tracking strain is predictive of left ventricular remodeling after coronary angioplasty in patients with recent non-ST elevation myocardial infarction. Int J Cardiol. 2011;153:185 91. DOI:10.1016/j.ijcard.2010.08.025.
13. Antoni M.L., Mollema S.A., Delgado V., et al. Prognostic importance of strain and strain rate after acute myocardial infarction. Eur Heart J. 2010;31:1640-7. DOI: 10.1093/eurheartj/ehq105.
14. Cong T., Sun Y., Shang Z., et al. Prognostic Value of Speckle Tracking Echocardiography in Patients with ST-Elevation Myocardial Infarction Treated with Late Percutaneous Intervention. Echocardiography. 2015;32(9):1384-91. DOI:10.1111/echo.12864.
15. Paul A., George P.V. Left ventricular global longitudinal strain following revascularization in acute ST elevation myocardial infarction - A comparison of primary angioplasty and Streptokinase-based pharmaco-invasive strategy. Indian Heart Journal. 2017;69:695-9. DOI:10.1016/j.ihj.2017.04.010.
16. Lacalzada J., de la Rosa A., Izquierdo M.M., et al. Left ventricular global longitudinal systolic strain predicts adverse re¬modeling and subsequent cardiac events in patients with acute myocardial infarction treated with primary percutaneous coronary intervention. Int J Cardiovasc Imaging. 2015;3:575-84. DOI:10.1007/s10554-015-0593-2.
17. Bastawy I., Ismail M., Hanna H.F., et al. Speckle tracking imaging as a predictor of left ventricular remodeling 6 months after first anterior ST elevation myocardial infarction in patients managed by primary percutaneous coronary intervention. The Egyptian Heart Journal. 2018;70:343-52. DOI:10.1016/j.ehj.2018.06.006.

About the Authors:
Shereen Ibrahim Farag *– MD, Cardiovascular Medicine Department, Faculty of Medicine, Benha University*
Khaled Emad El-Din El-Rabbat *– MD, Cardiovascular Medicine Department, Faculty of Medicine, Benha University*
Mohamed Ali El-Awadi *– MBBCH, Cardiovascular Medicine Department, Faculty of Medicine, Benha University*
AL-Shimaa Mohamed Sabry *– MD, Cardiovascular Medicine Department, Faculty of Medicine, Benha University*