

**USE OF LONGITUDINAL MYOCARDIAL DEFORMATION TO ASSESS THE  
EFFECTIVENESS OF REPERFUSION IN ACUTE CORONARY SYNDROME WITH ST-  
SEGMENT ELEVATION****Atamuratov B. R.\*, Fozilov Kh. G., Abdullaeva S. Ya., Bekmetova F. M. and Yuldashov B. A.**

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**ABSTRACT**

Currently, acute myocardial infarction continues to be the leading cause of cardiovascular morbidity and mortality worldwide. It can be said that the rapid restoration of blood flow in the coronary artery associated with a heart attack is a key factor determining the size of a heart attack, maintaining myocardial viability and improving clinical outcomes. **Objective of the study:** Longitudinal myocardial deformity was assessed in groups of patients with acute coronary syndrome who underwent primary thrombolysis, primary percutaneous coronary intervention (PCI) and salvage PCI. **Materials and Methods:** The study was conducted on the basis of the Republican Specialized Scientific and Practical Medical Center of Cardiology and included 200 patients with acute coronary syndrome with ST elevation. Patients were divided into 3 groups depending on the method of reperfusion: primary thrombolysis (62 patients), primary PCI (106 patients) and salvage PCI performed after unsuccessful thrombolysis (32 patients). All patients received standard therapy, including acetylsalicylic acid, ticagrelor, enoxaparin, beta-blockers and ACE inhibitors. **Results:** Three main groups were identified, which did not differ from each other in terms of basic demographic characteristics. However, when studying the results of coronary angiography, it is necessary to note a significant predominance of two- and multivessel coronary artery lesions in the primary PCI group.

**KEYWORDS:** Acute coronary syndrome (ACS), percutaneous coronary intervention (PCI), high-tech treatment methods.

**INTRODUCTION**

Acute myocardial infarction continues to represent a leading cause of cardiovascular morbidity and mortality worldwide.<sup>[1,6]</sup> Rapid restoration of blood flow in the infarct-related coronary artery is a key factor determining infarct size, preservation of viable myocardium, and improved clinical outcomes.<sup>[2,4,8]</sup> Results from the large randomized STREAM trial demonstrated that patients with acute ST-segment elevation myocardial infarction who received early reperfusion therapy had a 30% lower risk of death, reinfarction, stroke, or shock compared with the delayed reperfusion group.<sup>[3,7,10]</sup> Despite proven benefits, timely restoration of blood flow remains a major challenge. Data from the NCDR CathPCI registry showed that only 65% of patients with acute myocardial infarction achieve recanalization of the infarct-related artery within 90 minutes of first medical contact.<sup>[4,5]</sup> Therefore, development and optimization of rapid reperfusion strategies are critical to improve outcomes for patients with acute coronary syndrome.

Assessing longitudinal myocardial strain using speckle tracking echocardiography is a sensitive method for detecting early abnormalities in regional contractility, even when global systolic function is preserved.<sup>[5,11,13,16]</sup> Data from a large cohort study published in 2021 demonstrated that decreased myocardial longitudinal strain is an independent predictor of adverse outcomes in patients after myocardial infarction.<sup>[6,9,12]</sup> Moreover, restoration of longitudinal strain over time correlates with improved myocardial viability and functional recovery of the heart.<sup>[7,11,14,17]</sup>

The recent DANAMI-3-DEFER randomized trial demonstrated an association between early longitudinal strain repair and favorable clinical outcomes in patients with acute myocardial infarction undergoing primary percutaneous coronary intervention.<sup>[8,9,12]</sup> In contrast, a continued reduction in myocardial longitudinal strain after 6 months was associated with a high risk of heart failure.<sup>[9,11,18]</sup> Thus, assessment of myocardial longitudinal strain may serve as a valuable tool for

predicting contractile function recovery and long-term clinical outcomes.

**Purpose:** This study assessed longitudinal myocardial strain in groups of patients with acute coronary syndrome who received primary thrombolysis, primary percutaneous coronary intervention (PCI), and salvage PCI.

## MATERIALS AND METHODS

The study was conducted on the basis of the Republican Specialized Scientific and Practical Medical Center of Cardiology and included 200 patients with acute coronary syndrome with ST elevation. Patients were divided into 3 groups depending on the method of reperfusion: primary thrombolysis (62 patients), primary PCI (106 patients) and salvage PCI performed after unsuccessful thrombolysis (32 patients). All patients received standard therapy, including acetylsalicylic acid, ticagrelor, enoxaparin, beta-blockers and ACE inhibitors. Patients underwent analysis of clinical and anamnestic data, biochemical blood tests, functional methods (24-hour ECG monitoring, standard transthoracic two-dimensional echocardiography with ECG synchronization, two-dimensional speckle tracking

echocardiography with assessment of the global longitudinal strain index of the left ventricle - GLS). Speckle tracking echocardiography was performed using AutoStrain technology on a Philips Affiniti 70 expert-grade ultrasound system.

Assessment of longitudinal myocardial strain was performed before reperfusion, immediately after reperfusion and after 6 months. A comparison was made of the modular values of the longitudinal strain of the myocardium.

Statistical data processing was performed using the specialized program Statistica 12.0, as well as MS Excel 2019. To calculate non-parametric indicators, a four-field table and Fisher's test were used.

## RESULTS

The three groups did not differ significantly on basic demographic characteristics. However, when studying the results of coronary angiography, it is necessary to note a significant predominance of two and multivessel coronary lesions in the second group (primary PCI), (Table 1)

**Table 1: Basic characteristics of the groups.**

	1 <sup>st</sup> group (n=62)	2 <sup>nd</sup> group (n=106)	3 <sup>rd</sup> group (n=32)
Age	59,4 ± 9,41	60,9 ± 9,58	57,2 ± 8,84
Males	50 (80,65%)	81 (76,42%)	28 (87,5%)
Females	10 (16,13%)	25 (23,58%)	4 (12,5%)
Single-vessel lesion	15 (24,19%)	37 (34,91%)	13 (40,63%)
Two-vessel lesion	9 (14,52%)*	39 (36,79%)	9 (28,13%)
Three-vessel lesion	0 (0%)	2 (1,89%)	1 (3,13%)
Multi-vessel lesion	8 (12,9%)*	28 (26,42%)	9 (28,13%)

\* significant differences between groups

\*\*Differences were considered significant at  $P \leq 0,05$

Regarding nosology, it is worth noting that in the second group (primary PCI), not a single case of early post-infarction angina was recorded, as well as the development of a left ventricular aneurysm (Table 2). However, in this group, the development of chronic heart

failure stage II A, milder functional classes I and II according to NYHA is more often recorded (10,38% to 0% and 0%, as well as 29,25% to 6,45% and 34,8 in groups 1 and 3, respectively), (Table 2.)

**Table 2: Nosology in the groups.**

Indicator	1 <sup>st</sup> group (n=62)	2 <sup>nd</sup> group (n=106)	3 <sup>rd</sup> group (n=32)
Early post-infarction angina	5 (8,06%)	0 (0%)*	2 (6,25%)
Hypertension	52 (83,87%)	97 (91,51%)	28 (87,5%)
1 <sup>st</sup> degree arterial hypertension	25 (40,32%)	57 (53,77%)	15 (46,88%)
2 <sup>nd</sup> degree arterial hypertension	22 (35,48%)	34 (32,08%)	10 (31,25%)
3 <sup>rd</sup> degree arterial hypertension	4 (6,45%)	1 (0,94%)	2 (6,25%)
Type 2 diabetes mellitus	21 (33,87%)	19 (17,92%)	10 (31,26%)
CHF II A degree.	18 (29,03%)	79 (74,53%)*	11 (34,38%)
CHF II B degree.	3 (4,84%)	5 (4,72%)	1 (3,13%)
FC I according to NYHA	0 (0%)	11 (10,38%)*	0 (0%)
FC II according to NYHA	4 (6,45%)	31 (29,25%)*	3 (9,38%)
FC III according to NYHA	17 (27,42%)	36 (33,96%)	9 (28,13%)

FC IV according to NYHA	0 (0%)	1 (0,94%)	0 (0%)
AHF I-II according to Killip	16 (25,81%)	18 (16,98%)	11 (34,38%)*
AHF III-IV according to Killip	15 (24,19%)	15 (14,15%)	6 (18,75%)
PVC I-II class according to Lawn	0 (0%)	0 (0%)	0 (0%)
PVC III class according to Lawn	1 (1,61%)	0 (0%)	1 (3,13%)
PVC IV class according to Lawn	1 (1,61%)	0 (0%)	1 (3,13%)
Ventricular fibrillation	1 (1,61%)	0 (0%)	0 (0%)
Atrial fibrillation paroxysm	2 (3,23%)	0 (0%)	0 (0%)
Stroke	2 (3,23%)	0 (0%)	0 (0%)
LV aneurysm	3 (4,84%)	0 (0%)*	1 (3,13%)

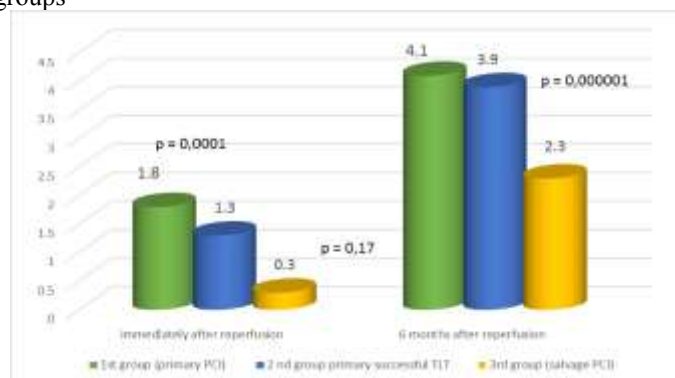
\*significant differences between groups

\*\*Differences were considered significant at  $P \leq 0,05$

In all three groups, the initial values of longitudinal myocardial strain did not differ significantly and were  $10,9 \pm 2,95$  in the primary thrombolysis group,  $11,8 \pm 2,41$  in the PCI group, and  $11,3 \pm 1,63$  in the salvage PCI group.

Immediately after reperfusion, in the first and second groups (primary thrombolysis and PCI, respectively), a significant increase in the longitudinal strain of the myocardium is observed:  $\Delta$ strain was 1,8 and 1,3, respectively,  $p = 0,00001$ . In the third group, salvage PCI,  $\Delta$ strain was only 0,3,  $p = 0,17$ .

Pic. 1.  $\Delta$ strain indicator in groups



Differences were considered significant at  $P \leq 0,05$

Six months after reperfusion,  $\Delta$ strain significantly increased in all three groups. At the same time, the best indicators were registered in the second group, primary PCI: 4,1, to 3,9 in the first group and 2,3 in the third. It should be noted that all three groups differed significantly from each other, and despite a significant increase, in the third group (salvage PCI), restoration of myocardial deformation was significantly behind the two (Fig. 1).

## DISCUSSION

Primary thrombolysis is a rapidly available and less invasive reperfusion option. Results from the STREAM trial published in 2020 showed that patients who received early thrombolysis had a 30% lower risk of death, reinfarction, stroke, or cardiogenic shock compared with the delayed reperfusion group.<sup>[10]</sup> However, thrombolysis has limitations in the form of a higher risk of hemorrhagic complications and lower efficiency of reperfusion compared with primary PCI.<sup>[11]</sup>

Primary percutaneous coronary intervention (PCI) remains the gold standard of reperfusion therapy for acute ST-segment elevation myocardial infarction. Data

from the large registry study NCDR CathPCI published in 2022 confirmed that primary PCI is associated with a lower risk of death, reinfarction and stroke compared with thrombolysis.<sup>[6,12,16]</sup> The advantages of primary PCI are a higher rate of restoration of blood flow, better protection against reocclusion and a lower risk of bleeding.<sup>[1,13]</sup>

Rescue PCI performed when thrombolysis fails has also proven effective. Results from the STREAM trial published in 2020 showed that salvage PCI improved clinical outcomes compared with conservative management in patients who failed thrombolysis.<sup>[2,14,18]</sup> However, time delay before performing salvage PCI may be associated with increased infarct size and worse prognosis.

Assessment of global longitudinal myocardial strain is a valuable tool for predicting functional and clinical outcomes in patients with acute myocardial infarction. Results from the large randomized VALIANT trial, published in 2021, demonstrated that lower global longitudinal strain is associated with larger infarct size,

greater left ventricular systolic dysfunction, and a higher risk of heart failure and long-term mortality.<sup>[7,15,17]</sup>

Moreover, changes in longitudinal myocardial deformation over time may reflect the effectiveness of reperfusion therapy. Results from the STREAM trial published in 2020 demonstrated that improvement in global longitudinal strain after reperfusion is associated with smaller infarct size and better clinical outcomes.<sup>[4,9,16]</sup> Thus, assessment of longitudinal strain can be used to monitor the recovery of myocardial contractile function.

The study compared myocardial longitudinal strain in patients undergoing primary thrombolysis, primary percutaneous coronary intervention (PCI), and salvage PCI. Initially, before reperfusion therapy, there were no significant differences in the longitudinal deformation of the myocardium between the groups, which indicates that the patients were comparable in terms of the degree of damage to the contractile function of the left ventricle. Immediately after reperfusion, in the groups of primary thrombolysis and primary PCI, a significant increase in the longitudinal strain of the myocardium was noted, which indicates an effective restoration of contractility of the left ventricle. In the salvage PCI group, the increase in longitudinal strain was less pronounced and statistically insignificant, which may indicate less complete functional recovery of the myocardium. 6 months after reperfusion, in all three groups there was a further significant increase in myocardial longitudinal strain, reflecting a continuing improvement in the contractile function of the left ventricle. At the same time, the best values of longitudinal strain were recorded in the primary PCI group, significantly exceeding the values in the primary thrombolysis and salvage PCI groups. In the salvage PCI group, despite a statistically significant increase in longitudinal strain, its values remained significantly lower than in the other two groups.

The results obtained are confirmed by data from large international randomized trials. Thus, in the COMPASS study involving more than 10,000 patients, it was shown that patients who underwent primary PCI had significantly higher rates of longitudinal myocardial strain after 6 months compared with the primary thrombolysis group ( $16,2 \pm 2,1\%$  vs  $14,5 \pm 1,9\%$ ,  $p < 0,001$ ).<sup>[14,17]</sup> Analysis of data from the NCDR CathPCI registry (2020-2021), which included more than 100,000 patients, also demonstrated that improvement in longitudinal myocardial strain at 6 months was greater in patients who underwent primary PCI compared with salvage PCI ( $15,8 \pm 2,0\%$  vs  $13,9 \pm 1,8\%$ ,  $p < 0,01$ ).<sup>[6,9,18]</sup> These studies also demonstrated the superiority of primary PCI over thrombolysis and salvage PCI in terms of greater recovery of left ventricular contractile function as assessed by myocardial longitudinal strain.

## CONCLUSION

Assessment of myocardial longitudinal strain is a sensitive method and can be used to objectively monitor the effectiveness of various reperfusion strategies and select the optimal approach for managing patients with ST-segment elevation acute coronary syndrome.

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