

Comparative assessment of ECG dynamics in myocardial infarction according to reperfusion therapy approach (primary and facilitated coronary angioplasty) and timing of the procedure

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ABSTRACT

Objective: The aim of this study was to compare electrocardiogram (ECG)-12 dynamics depending on the methods of facilitated and primary angioplasty in patients with acute coronary syndrome. The ECG changes in 81 patients - 73 patients with acute myocardial infarction and 8 patients with unstable angina pectoris - were studied.

Methods: The ECG analysis before reperfusion therapy and after angioplasty included: dynamics of summary elevation (Σ ST+) and depression (Σ ST-) of ST segment and changes of summary value of R waves (Σ R) in 12 leads. The results were estimated with consideration for the length of the period from the beginning of pain syndrome till treatment and topics of the infarction-related artery.

Results: According to our data, there was no difference between facilitated and primary transluminal coronary angioplasty in their effect on focal myocardial variation dynamics and the size of peri-infarction zone.

Conclusion: A reliable decrease in elevation and depression of ST segment was observed in reperfusion therapy not later than 6 hours after the beginning of pain syndrome. When reperfusion therapy is begun later, dynamics of summary values of ST segment elevation and depression before and after treatment are not reliable. (*Anadolu Kardiyol Derg 2007; 7 Suppl 1; 171-4*)

Key words: electrocardiogram, angioplasty, thrombolytic therapy, acute coronary syndrome

Introduction

Acute myocardial infarction (AMI) is the main cause of mortality in most countries. Before the 70s, mortality was explained by cardiac rhythm disorders. The construction of intensive care complexes with electrocardiogram (ECG) variation monitoring and the use of antiarrhythmics have reduced the significance of arrhythmic events related to sudden death (SD) in AMI patients. However, another problem has become important today – how to decrease the retraction ability of the myocardium with developing acute cardiac failure. In the 80-90s, attempts were made to reduce mortality caused by AMI by active intervention in myocardial metabolism in order to reduce the area of peri-infarction zone and myocardial infarction itself. However, the problem of prevention of developing myocardial infarction was rather more important than treatment of developed infarction. It is known, that more than half AMI patients at the age under 65 die before the beginning of treatment. Acute myocardial infarction is induced by rupture or ulceration of atherosclerotic patch, which leads to occlusive coronary thrombosis. The recovery of anterograde blood flow in the infarction-dependent artery saves the myocardium and reduces mortality. In clinical practice reperfusion can be obtained by thrombolytic therapy or primary angioplasty. Each of these methods has its merits and demerits.

Thrombolytic therapy in spite of wide use, comparative technical simplicity and a long history of clinical application is confined due to high incidence of complications. Primary angioplasty recovers coronary blood flow and does not cause hemorrhagic complications. Traditionally ECG in 12 leads (ECG-12) is an alternative to clinical technique of estimating AMI dynamics. Numerous experimental investigations (1, 2) describe changing T wave, ST segment and QRS complex into acute, subacute and chronic stages of focal process. For comparative interpretation of ECG data, different modes of analysis are used. In the 70-80s, the size of infarction and peri-infarction zone were studied by extension of Q and QR zones respectively, and by significance of ST segment elevation or depression both in 12-axis and 35 precordial leads (3, 4). In the 90s, it was suggested that evaluation of ECG dynamics in AMI patients be made with different scale systems scoring the signs of current damage (5-7).

The aim of this study is to compare ECG dynamics by different methods of myocardial revascularization: transluminal coronary angioplasty (PTCA) and thrombolytic therapy with transluminal coronary angioplasty (primary and facilitated PTCA) in acute coronary syndrome (ACS) patients.

Methods

This investigation includes 81 patients with acute coronary syndrome (73 AMI patients and 8 patients with unstable angina

pectoris) who were subjected to PTCA with or without preliminary thrombolytic therapy. All the patients were divided into two main groups: Group 1 - patients who were subjected to primary PTCA (50 individuals) and Group 2 – facilitated PTCA patients who were subjected to thrombolytic therapy (TLT) before PTCA (31 individuals). Direct result of different combination of the two methods of reperfusion is presented on the basis of ECG dynamics, significance of necrotic and reparation syndromes. Evaluation of ECG dynamics was made taking into consideration the infarction-related artery and the length of the period from the beginning of pain syndrome to treatment.

Taking into account that the main criterion for functioning and maintenance of the retraction ability of the myocardium is R wave amplitude, we calculated summary of R indices (ΣR) before therapeutic procedures and 2 hours after primary and facilitated PTCA. The summary index of ST segment elevation ($\Sigma ST+$) and ST discordant shifts ($\Sigma ST-$) were evaluated before and after angioplasty depending on TLT. As blood supply of infarct-related artery depends on the topical coronary arteries, de- and re-polarization vectors are differently projected against the axes of ECG leads with different myocardial infarct localization. Different walls of the left ventricle and sometimes of the right ventricle can be affected. Therefore, ECG dynamics was investigated separately for occlusion of the left anterior descending artery (LAD), right coronary artery (RCA) and left circumflex artery (LCx), diagonal arteries (DA), and obtuse marginal artery (OM).

Results

According to coronary angiography data, among 81 ACS patients acute occlusion of LAD was observed in 51 patients, occlusion of RCA in 17 patients, isolated lesions of smaller branches (LCx, DA and OM) were detected in 13 patients. According to division of the patients into two groups depending

on TLT, the group of patients with primary angioplasty included 42 AMI and 8 unstable angina pectoris cases. The facilitated PTCA group included 31 patients with AMI. The most common lesion detected in both groups was LAD lesion; RCA being affected more rarely. Occlusions of LCx, OM and DA were noticeably rarer. The incidence of different localization of occlusions in the two groups of patients is cited in Table 1.

Investigation of ΣR dynamics depending on the infarct-related artery showed that LAD thrombosis induces considerable reduction of ΣR ; with RCA lesion, in case of LAD thrombosis ΣR reliably exceeds the same index both before and after treatment. The summary index ΣR with isolated lesion of smaller branches of coronary arteries is an intermediate value. The same is true for $\Sigma ST+$: the most elevation was observed with LAD occlusion. However, the least $\Sigma ST+$ was observed with LCx, OM- and DA occlusions. ST elevation with RCA occlusion was intermediate.

It attracts attention that ΣR in primary points in the facilitated PTCA group is smaller than in the primary PTCA group. As to R wave amplitude fall degree after treatment, it was the same in all the groups.

On the contrary, with LAD occlusion initial ST elevation in the second group was higher than in the first group.

As seen from Table 2 on average in the group with primary angioplasty there are no reliable differences in ΣR dynamics either before or after treatment. With facilitated PTCA the obtained differences were reliable, i.e. after facilitated PTCA a more significant reduction of ΣR was observed. $\Sigma ST+$, $\Sigma ST-$ dynamic variations were reliably observed ($p < 0.05$) decreasing after both modes of treatment.

ST variation dynamics was analyzed depending on the time of the beginning of reperfusion therapy. During reperfusion therapy started no later than 6 hours after the beginning of pain attack $\Sigma ST+$ and $\Sigma ST-$ dynamics was positively reliable. When reperfu-

Table 1. Localization of coronary occlusions in two groups of examined ACS patients

Diagnosis	Group 1 (primary PTCA)			Group 2 (facilitated PTCA)		
	LAD	RCA	LCx, DA, OM	LAD	RCA	LCx, DA, OM
MI	26	8	8	21	7	3
ACS	4	2	2	0	0	0

ACS- acute coronary syndrome, DA- diagonal artery, LAD- left anterior descending artery, LCx- left circumflex artery, MI- myocardial infarction, OM- obtuse marginal artery, PTCA- transluminal coronary angioplasty, RCA- right coronary artery

Table 2. ECG changes with primary (Group 1) and facilitated (Group 2) PTCA

Coronary artery involvement	Group 1			Group 2		
	ΣR	$\Sigma ST+$	$\Sigma ST-$	ΣR	$\Sigma ST+$	$\Sigma ST-$
LAD before treatment	56.0	15.7	4.1	46.3	20.7	4.3
LAD after treatment	49.6	7.8	1.7	34.3	9.6	1.2
RCA before treatment	83.1	7.7	6.9	74.6	7.9	11.3
RCA after treatment	86.4	5.4	1.5	70.2	5.1	6.2
LCx, DA, OM before treatment	67.0	2.4	7.0	71.7	4.8	11.0
LCx, DA, OM after treatment	71.3	1.2	3.3	76.7	1.3	5.8
Total before treatment	63.8	11.5	5.3	55.2	16.3	6.5
Total after treatment	61.5*	6.0*	2.0*	46.5	7.8	2.8

* $p < 0.05$ – differences are significant between Group 1 and Group 2

ECG- electrocardiogram, DA- diagonal artery, LAD- left anterior descending artery, LCx- left circumflex artery, OM- obtuse marginal artery, PTCA- transluminal coronary angioplasty, RCA- right coronary artery

sion started later than that ST elevation, the depression indices did not change substantially (Table 3).

The most rapid dynamics of ST elevation fall was observed with primary and facilitated PTCA at 2 hours of the beginning of pain attack. In that case, the reduction of $\Sigma ST+$ after treatment in the first group was three times lower, while in the second - 2.5 times. With reperfusion started 2-6 hours later, elevation decreased: $\Sigma ST+$ decreased twice irrespective of the mode of therapy. When treatment was initiated still later, no reliable $\Sigma ST+$ variations were observed with $\Sigma ST+$ index being even somewhat higher.

Group average statistical parameters of ECG variations are illustrated with the following clinical examples:

Case 1. (Fig. 1) A 65-year-old patient was hospitalized in the intensive care complex of the Research Center on 17th December 2005 with diagnosis: AMI of anterior localization 3 hours after beginning of anginal pain. Diagnosis of AMI was confirmed on the basis of bedside diagnosis, ECG data, cardiac specific enzymes dynamics, and echocardiogram. Streptase thrombolytic therapy was performed. Emergency coronary angiography detected occlusion of proximal LAD and PTCA with stenting of the LAD was performed.

Decreasing size of the peri-infarction zone, which can be judged by almost three-fold reduction of ST elevation degree and disappearance of reciprocal depression of ST segment, was accompanied by considerable fall of ΣR amplitude – almost twice as compared with the initial value.

Case 2. (Fig. 2) A 50-year-old patient was hospitalized in the intensive care complex on 25th August 2005 with diagnosis: AMI of anterior localization 5 hours after the onset of disease. Diagnosis was confirmed by bedside diagnosis, ECG data, cardiac specific enzymes dynamics, and echocardiogram. Emergency coronary angiography detected LAD stenosis up to 80% with signs of thrombosis. The PTCA with stenting of the LAD was performed. As seen from the Figure 2, in this case there are no any differences in ECG dynamics from the previous example, though it should be noted that ΣR reducing degree was 1.1 times lower.

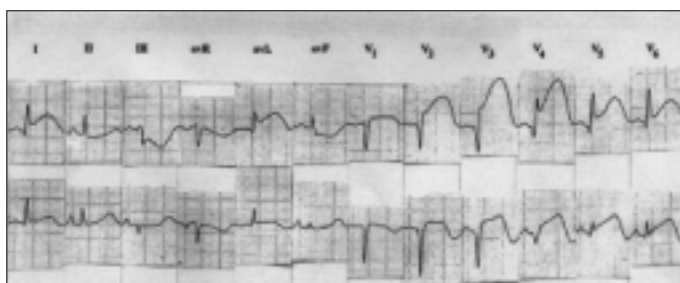
Discussion

Thus, we have managed to detect distinct reliable dependence between the mode of reperfusion therapy performed and ECG dynamics. Data of numerous investigations are contradictory. In CAPTIM study (8), AMI patients with ST elevation were demonstrated to have an inconsiderable decrease in adverse cases in the PTCA group (6.2%) as compared with the group of pre-hospitalization thrombolysis (8.2%) (p=0.29). The results of randomized investigations at experimental centers of interventional cardiology (9) practically have no patients whose transportation took a long time, which shows that PTCA with or without stenting is the best reperfusion strategy with AMI patients.

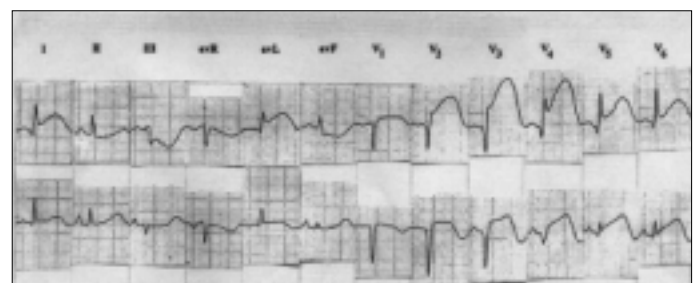
Table 3. ECG variations primary (Group 1) and facilitated (Group 2) PTCA depending on the time of the beginning of treatment

ECG variables	Up to 2 hr. before		Up to 2-6 hr. before		More than 6 hr. before	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Before treatment						
ΣR	68.0	76.5	59.4	52.8	68.0	47.7
$\Sigma ST+$	12.9	17.4	11.7	18.0	8.6	5.4
$\Sigma ST-$	4.5	8.4	6.1	6.1	4.3	7.0
After treatment						
ΣR	65.7	62.5	59.8	43.6*	59.4	47.7
$\Sigma ST+$	4.1*	6.6	5.5*	8.0*	9.8	7.6
$\Sigma ST-$	1.4*	0.9	1.8*	2.3*	3.3	7.3

: * - p<0.05 differences are significant before and after treatment
 ECG- electrocardiogram, hr.- hours, PTCA- transluminal coronary angioplasty



	ΣR	$\Sigma ST+$	$\Sigma ST-$
before treatment	36	21	6
after treatment	17	8	0



	ΣR	$\Sigma ST+$	$\Sigma ST-$
before treatment	58	14	3
after treatment	50	9	2

Figure 1. Clinical example: ECG of a patient with acute myocardial infarction and facilitated coronary angioplasty

ECG- electrocardiogram

Figure 2. Clinical example: ECG of a patient with acute myocardial infarction and primary coronary angioplasty

ECG- electrocardiogram

Moreover, even in such a most studied question, as time from the onset of ACS to the performance of angioplasty and therapeutic thrombolysis there is no definite answer. What is "the golden hour" (10) to begin TLT and PTCA, and facilitated PTCA? The answer to this question may be the starting point in the choice of tactics and strategy of AMI treatment.

Meta-analysis of 23 investigations aimed at evaluation of the effectiveness of thrombolysis in treatment of AMI patients reliably confirms dependence between the time from symptoms manifestation to the performance of thrombolysis and mortality (9). It was found, that thrombolysis performed in the first 6 hours of AMI development, leads to a decrease in mortality by 3% during 35 next days, while with thrombolytic therapy started 12 and more hours from symptoms manifestation, the effect of the operation is minimal (11).

According to our data, the most favorable time for the beginning of reperfusion intervention is within 2 hours from the onset of pain syndrome. Treatment started 2-6 hours later gives somewhat worse results according to Σ ST+, while treatment started 6 hours later than that does not tell on ECG dynamics at all.

Conclusions

1. Reliable positive dynamics of ECG criteria of effective reperfusion (a decrease in ST segment elevation and depression) was observed in reperfusion therapy started not later than 6 hours from the onset of pain attack. At later hours of the beginning of reperfusion therapy, dynamics of elevation and depression summary indices before treatment and 2 hours after PTCA are unreliable.

2. Facilitated and primary PTCA have an equal effect on dynamics of formation of myocardial focal variations and the size of peri-infarction zone

3. The method of facilitated PTCA manifests in a more significant reduction of the summary R wave amplitude as compared with primary angioplasty.

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