The Value of Electrocardiographic Changes in Evaluating the Prognosis of Acute ST-Elevation Myocardial Infarction (STEMI) After PCI

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Abstract: To explore the relationship between the changes of ECG indexes and the prognosis after PCI in patients with acute ST-elevation myocardial infarction (STEMI), and to develop the evaluation method and analyze the advantages and characteristics. 420 patients with acute myocardial infarction (AMI) were admitted to our hospital from March 2017 to April 2020. They were divided into the observation group (ST segment elevation type) with 220 patients and control group (non-ST segment elevation type) with 200 patients according to whether ST segment elevation was or not. ECG was detected before and 1 hour after operation, evaluation of thrombolytic effect, 6-minute walking test and echocardiography were performed 3 months after operation. Compared with the control group, the ECG of the observation group showed St Compared with the control group, the thrombolytic effect of the observation group was significantly improved, and the difference was statistically significant (P < 0.05); compared with the control group, the thrombolysis effect of the observation group was significantly improved, the difference was statistically significant (P < 0.05); ECG index can effectively reflect the recovery of cardiac function after PCI in patients with acute STEMI, and can effectively indicate the improvement of symptoms in patients with AMI, which is worthy of clinical application.

Keywords: Electrocardiogram; acute ST-elevation myocardial infarction; PCI
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Acute Myocardial Infarction (AMI) is types of coronary heart disease, which is a serious threat to the health of people in developed countries such as Europe and the United States and our country. Its incidence rate is increasing year by year in China. Especially in the past 10 years, the incidence of AMI in our country is obviously on the rise, which is close to the international average. The disease has great harm and influence. AMI is divided into ST segment elevation myocardial infarction (STEMI) and non- ST segment elevation myocardial infarction (NSTEMI) according to surface electrocardiogram. The pathological feature of STEMI is the formation of fibrin-based thrombosis in the coronary artery, causing acute complete occlusion of the coronary artery and resulting in penetrating myocardial injury. The specific manifestations of ECG are ST segment dorsal arch elevation and pathological Q wave formation. A number of studies have shown that single branch lesions are common in STEMI patients. Due to the lack of ischemic preconditioning, the myocardium is more sensitive to ischemia, the area of myocardial infarction is large, the peak value of myocardial enzyme is high, and the incidence of malignant arrhythmia, cardiogenic shock and sudden death in the course of disease is more significant than NSTEMI. For STEMI, early reperfusion of infarct related artery (IRA) is an important life-saving measure. The main reperfusion therapy includes

intravenous drug thrombolysis and percutaneous coronary intervention (PCI) [1]. Regardless of the treatment method, the most important thing is to effectively and timely open IRA, restore the forward blood flow, save the dying myocardium, and thus improve the heart function and long-term prognosis of patients. Therefore, for STEMI patients, whether they choose drug thrombolysis or interventional therapy, it is particularly important to urgently open "criminal" blood vessels to prevent sudden cardiac death. Nowadays, PCI has become a hot spot in the field of STEMI treatment, and its advantages are that it can fully and quickly and effectively open IRA, solve the residual stenosis of coronary artery, obtain a good timi blood flow grade, and finally relieve the symptoms of angina pectoris, improve cardiac function, improve the quality of life of patients, and prolong life. Looking back on the history of PCI, interventional cardiology began in 1929 when German doctor Wemer Forssmann performed the first human cardiac catheterization on himself [2]. After 1980s, interventional cardiology and drug clinical trials became the two most active areas of cardiovascular disease. Percutaneous transluminal coronary angioplasty (PTCA) was first performed by AndressGruentzig in 1977. From then on, the PTCA -based coronary intervention technology developed rapidly and became an important treatment for coronary heart disease. In addition to PTCA, PCI covers a variety of other techniques that can relieve coronary stenosis, including not only stent placement, but also spinning, directional rotation, thrombus aspiration, distal protection, etc. [2] Moreover, intra-aortic balloon pump (IABP) has been widely used in clinical practice as an auxiliary cardiac support system and as an auxiliary diagnostic method of intra vascular ultrasound (IVUS). A study published at the 2012 World Congress of Cardiology by researchers at the Beijing Institute of Cardiopulmonary and Vascular Diseases and Beijing Anzhen Hospital affiliated to Capital Medical University showed: The hospital mortality rate among stemi patients without percutaneous coronary intervention (PCI) in Beijing was 12.7%, compared with 1.8% in PCI patients [3]. In the early stage of STEMI, emergency PCI can quickly open infarct-related blood vessels (IRA), restore effective myocardial reperfusion, improve cardiac function, inhibit left ventricular remodeling, relieve chest pain symptoms, and significantly reduce the mortality rate of patients. Especially with the continuous development of interventional techniques and equipment, the improvement of preoperative and postoperative antiplatelet therapy and the application of thrombotic aspiration catheter, emergency PCI plays an extremely dominant role for the first-line treatment. The rapid development of PCI interventional therapy makes the field of AMI treatment very active. Accordingly, the diagnostic level of AMI has also made great progress. In particular, the detection of biochemical markers of myocardial necrosis is becoming more and more sensitive and specific, which makes the clinical diagnosis of myocardial microinfarction less than 1G become a reality. At the same time, the progress of ECG in AMI is also surprising, which further improves and expands the value of ECG in the qualitative, location and prognosis evaluation of AMI. However, the relationship between electrocardiogram and AMI, especially the role in PCI of acute ST segment elevation myocardial infarction, has not been reported at home and abroad. This study aims to explore the relationship between the changes of ECG indexes and the prognosis after PCI in patients with acute ST segment elevation myocardial infarction, and to develop the evaluation method and analyze the advantages and characteristics. It is reported as follows:

General data

A total of 420 patients with AMI admitted to our hospital from March 2017 to April 2020 were divided into observation group (ST segment elevation type) with 220 patients and control group (non-ST segment elevation type) with 200 patients according to whether ST segment elevation was or not.

Inclusion criteria: Age<75 Starting time: Persistent chest pain during onset ＞30 min; ECG showed two or more adjacent lead ST segments improved ＞ 0. 1 mV; There was no contraindication and PCI surgery was performed within 12 h; Myocardial enzyme level was 2 times higher than normal level.

Exclusion criteria: Patients with a history of myocardial infarction; Patients with left main trunk

lesion; Patients with severe cardio-cerebrovascular disease; 5) The expected survival time＜1 month.

PCI thrombolysis method

All patients orally took 300mg aspirin (Bayer HealthCare AG; approval document No.: GYZ H20120236) and 600mg load dosage of plavix (Sanofi (Hangzhou) Pharmaceutical Co., Ltd.; specification: 75mg; approval document No.: GYZZ H20056410) before operation. Approval No.: At the same time, femoral artery puncture was performed after hypodermic injection of low molecular weight heparin, and stent placement was performed according to the conventional method. The sheath tube was pulled out 4 h after operation. Anti-coagulant, lipid-lowering drugs and nitrate ester preparations were used during postoperative follow-up.

ECG and Echocardiography

ECG were measured once before operation, 1h and 24h after operation. ST segment was measured from 0.04 s after J point to the beginning of T wave, and the degree of ST segment fall is the percentage of the total fall of elevated ST segment in ECG before and 1 h after operation

Echocardiography: Echocardiography was performed on two groups of patients 6 months after operation with color Doppler diagnostic instrument (philips iE33, USA). Patients were in left lateral and supine position. Diagnostic instrument parameter was 1-3 MHz frequency. Three dimensional echocardiographic indexes were measured in long axis section of left ventricle, two chamber and four chamber sections of apex and short axis of papillary muscle: left ventricular ejection fraction (LVEF), left ventricular end diastolic diameter (LVD). The velocity mode of Doppler imaging (DTI) was used to adjust the depth gain compensation (DGC) curve. The wall motion of interventricular septum, anterior wall, inferior wall and lateral wall was observed in the same section above. The peak velocity (Em) in the early diastolic phase and the peak velocity (Am) in the late diastolic phase were measured and EM / AM was calculated by ECG.

6min walking experiment (6MWT)

During the follow-up period, 6MWT was performed 3 months after drug treatment. Draw a straight-line distance of 30 m on the flat indoor ground, and set signs at different positions. At 30 m, the patient moved freely and freely, with unlimited speed. The detection personnel altered once every 2 min and recorded the patients' discomfort during the experimental period: shortness of breath, chest tightness, chest pain, etc. The experiment can be terminated in severe cases and the walking distance of 6 min (6 MWD) was calculated.

Group	Male (n)	Female (n)		
Control group	105	95	67.54±1.29	3.54±1.25
Observation group	112	108	68.27±1.34	4.27±0.36
t/F	15.235	20.685	8.43	9.91
P	0.96	0.93	0.82	0.73

The blood flow classification of myocardial infarction thrombolysis test (TIMI) was compared before and 12 hours after operation between the two groups. Level 0: Distal vascular occlusion without anterior flow; (Level 1) The contrast agent partially passed through the occluded site but cannot fill the distal vessel; Class 2: The contrast agent can fill the distal end, and the velocity is slower than the normal coronary artery. Class 3: The contrast agent rapidly fills the distal vessels and rapidly clears. The values of LVEF, LVD and EM / Am of the two groups were compared before and 1 hour after the operation, and the values of 6MWD at 3 months after the operation were compared.

RESULTS

Comfort degree comparison between the two groups of patients

See Table 2.

Table 7
Comparison of Satisfaction between Two Groups of Patients [n (%)]

Group	Cases of ST segments returning to equipotential lines
Control group	104(52.0)
Observation group	165(75.0)
t value	9.210
P value	0.033

Comparison of surgical results of patients in two groups

compared with the control group, the thrombolysis effect of the observation group was significantly reduced, the difference was statistically significant (P < 0.05); See Table 3.

Table 3
Comparison of thrombolytic effect between two groups [n (%)]

Group	Recanalization rate	Chest pain disappeared	Complication
Control group	120(60.0)	146(73.0)	90(45.0)
Observation group	209(95.0)	220(100.0)	11(5.0)
t value	12.199	14.006	10.573
P value	0.032	0.021	0.033

Comparison of 6 min walking test results between two groups

Comparison of echocardiography between two groups

See Table 5.

Table 4
Comparison of walking test results between two groups

Group	
Control group	263.16±24.93
Observation group	385.35±35.19
t value	10.27
P value	0.033

Group	LVEF	LVD (mm)	Em/Am
Control group	47.56±3.24	39.27±4.14	0.86±0.52
Observation group	53.50±2.10	52.24±3.22	2.10±2.46
t value	9.23	12.342	9.342
P value	0.037	0.021	0.032

DISCUSSIONS

It is the basic principle of treating patients with AMI to restore the hemoperfusion of myocardium as soon as possible, save the dying myocardium, prevent the expansion of infarct focus, narrow the range of myocardial ischemia and protect and maintain the function of heart. Early revascularization is a treatment measure that can significantly reduce mortality. Since 1977, when the first percutaneous transluminal coronary angioplasty (PTCA) was successfully carried out by German physician Gruentzig, various PTCA -based coronary interventions have been rapidly extended worldwide [4]. Because of its small trauma, PCI can quickly restore blood perfusion, improve myocardial ischemia, and significantly reduce the rate of ischemia recurrence and re-infarction. Due to no abosulate contraindication and high success rate, it has become an important method for the treatment of AMI and the main measure of coronary revascularization. It has also become a hot spot in public research. American College of Cardiology (ACC) and American Heart Association (AHA) guidelines have been recommending this as category I for patients under 75 years of age since 1999. Femoral artery puncture is PCI classic routine route in emergency department. However, it is often necessary to stay in bed for a long time, stop the local brake, compress and stop bleeding. In recent years, with the use of anticoagulant and antiplatelet drugs, the vascular complications such as local hemorrhage and hematoma formation increased significantly, the average length of stay prolonged, and the pain and cost of patients increased [5]. Since Campeau, a Canadian scholar, first reported transradial coronary angiography in 1989 and Keimeneij, a Dutch physician, successfully performed the first transradial stent implantation in 1993, PCI through radial artery has been gradually applied to clinical practice. Compared with the femoral artery, the radial artery is small and is easy to press and stop bleeding with the superficial anatomical position. There is no significant peripheral vascular nerve, and the risk of postoperative bleeding and vascular complications decreases. It does not affect the application of anticoagulants. Immediate extubation poses no restrictions to braking and posture. It is widely approved in clinic because it can increase the patient's comfort and improve the patient's compliance. Especially in recent years, as the equipment designed for radial artery surgical route has been updated continuously, and the operation technology of radial artery emergency PCI has been improved continuously, it has become an important surgical route for emergency PCI. The new PCI guidelines, developed in 2001 by the American College of Cardiology Foundation (ACCF), the American Heart Association (AHA) and the American Society for Cardiovascular Imaging and Intervention (SCAI), first suggested that transradial approaches could reduce vascular complications as recommended for category IIa.

When acute ST segment elevation myocardial infarction, myocardial necrosis presents a process of progression from epicardium to endocardium, which usually takes more than 6 h to develop into full-thickness transmural necrosis. Therefore, the treatment guidelines advocate early reperfusion therapy. The early reperfusion therapy within 12 h after onset, especially within 6 h, can not only open the subcardiovascularization, but also effectively improve the perfusion level of myocardial tissue in order to strive for more viable myocardium, prevent the expansion of infarct size, prevent heart failure and improve prognosis[6]. Numerous studies have shown that the shorter the vasculature opening time, the earlier the reperfusion, the more ischemic myocardium is saved. It can reduce the incidence of cardiac adverse events and reduce mortality, improve the prognosis and quality of life of patients. Some studies suggested that there was also a negative correlation between reperfusion time and myocardial survival. If the time of reperfusion is <2h, a large number of dying cardiomyocytes can be saved; if the time is more than 2 h, the number of cardiomyocytes that can be saved will be reduced. Sheiban et al. found that early reperfusion therapy (within 4 h) can significantly reduce infarct size, inhibit ventricular remodeling, terminate the vicious circle of ischemia and systolic dysfunction, and promote the recovery of cardiac arrest muscle. Terkelsen CJ et al. showed a positive correlation between reperfusion time and mortality. As symptoms delay to balloon dilation, the fatality rate increases. For each 60 min of delay, the relative risk of death is 1.10[7]. With the rapid development and application of catheter intervention technology in the field of diagnosis and treatment of heart disease, electrocardiogram has also been developed rapidly, which has improved the understanding of the disease and provided a reliable clinical treatment plan. Electrocardiogram can not only make staging, localization and diagnosis to infarcted myocardium, but also make specific analysis to infarct related artery (IRA). The electrical activity of cardiomyocytes supplied by IRA direct blood supply and oxygen supply arouses various changes due to a series of changes in cardiomyocytes - reversible congestion, edema, degeneration, multiple inflammatory cell infiltration, to irreversible coagulative necrosis or apoptosis. These changes are electrophysiological activity in the pathological state of abnormal cardiomyocytes. These changes vary according to the quadrant, phase and intensity of the heart. Any electrical couple in any direction formed at any time in the heart can be transmitted to the body surface, amplified and recorded in real time. The mechanical movement of the myocardium is coupled with these electrical activities. Information related to the activity of myocardial contraction can also be transmitted to the cell membrane through organelles, which affect the formation of electrical activity. Macroscopically, the closer the infarcted blood vessels are to the trunk, the larger the infarcted myocardium is, the more obvious the uncoordinated movement of the heart is, the more serious the condition is and the worse the prognosis is. Therefore, in order to classify the risk of myocardial infarction and establish appropriate and effective measures of reperfusion treatment, it is necessary to accurately determine IRA. At the same time, the prognosis of the patients was significantly related to the size of the damaged area of myocardium, the production of collateral circulation, the ability of cardiomyocytes to withstand strike, and the timely treatment. Electrocardiogram is very valuable for accurate location of STEMI infarct location, especially for single vessel lesions. However, it is difficult to judge blood vessels according to ECG because of the complex and changeable electrocardiogram in multiple lesions. Therefore, the patients with two or more lesions were excluded, and the single vessel was analyzed, and then the relationship between the number of diseased vessels and ECG was analyzed. The study found that the most important treatment of acute myocardial infarction should not be delayed until Q wave appeared, but should be performed in ST segment elevation or no elevation period before the appearance of Q wave. Therefore, in the new concept of acute coronary syndrome, the classification methods of acute myocardial infarction with ST elevation and non-elevation were proposed in recent years. Complete occlusion of coronary arteries often occurs in patients with acute myocardial infarction with ST elevation. Most of the thrombus is red thrombus (composed of red blood cells and fibrin). Thrombolytic therapy is more beneficial at this point. Coronary artery occlusion often occurs in patients with non- ST elevation acute myocardial

infarction, and the thrombus is mostly white thrombus (mainly platelets). Thrombolytic therapy is often useless at this point. Elevation of ST segments caused by severe ischemic myocardial injury often occurs quickly after complete interruption of coronary blood flow, so this typing method is beneficial to the early diagnosis and treatment of acute myocardial infarction. Early and effective treatment can reduce the infarct area, greatly improve the survival rate of patients with acute myocardial infarction, improve the course of disease and prognosis. [8]

Compared with the control group, the thrombolysis effect of the observation group was significantly reduced, the difference was statistically significant ($P < 0.05$); ST segment elevation appears after chest pain in AMI, reached peak within a few hours, and gradually decreases after several days, indicating that the infarct-related coronary artery is completely blocked, the microcirculation of myocardium is not re-perfused early, and myocardial ischemia continues. It is common in blocking coronary artery without early effective reperfusion intervention (thrombolysis or PCI), or ineffective intervention (thrombolysis is not successful or no recurrence after PCI) or no autolysis in thrombus [9]. If the ST segment is continuously elevated for more than 2 weeks, the formation of ventricular aneurysm should be suspected. When the elevation of ST segment falls ≥50% within 2 h, it indicates that the coronary artery recanalization and the effective reperfusion of myocardial tissue level. The earlier ST segment falling, the greater the falling amplitude, suggesting that the adequate myocardial tissue level of reperfusion is beneficial to the recovery of cardiomyocyte function and the improvement of cardiac function. It is more common in early cases of successful reperfusion (thrombolysis or pci). Some patients are autolysis of thrombus or timely establishment of collateral circulation. ST segment rises and falls quickly: It is common in the opening of blocked blood vessels upon preferfusion and the elevated ST segment in case of reperfusion injury. The effect of reperfusion injury disappears or improves. After the myocardial microcirculation performs effective reperfusion, ST segment falls and decreases continuously [10]. The recovery of cardiomyocyte function in these patients is relatively fast and the prognosis is better. ST elevation and fall alternate: Most of them are found in the second hyperfunction of fibrinolytic system and anticoagulant system within 24 hours after thrombus formation or thrombolysis. When they occupy the upper peak alternately, the occlusion and opening of coronary vessels occur alternately, and the patients are prone to reinfarction. Reinfarction should be considered when re-elevation of ST segment occurs after 24 h. After the short-term fall of ST segment, it continues to rise again: This change suggests that after the myocardial tissue level is reperfusion, continuous and effective blood perfusion is lost, which can be seen after thrombolysis and reocclusion of coronary artery. After the opening of blood vessels in PCI operation, reperfusion injury occurs without reflow, that is, excessive oxygen free radical injury, microvascular embolism, microvascular spasm and so on, result in no blood flow perfusion at the myocardial tissue level. The long-term prognosis and cardiac function of such patients are poor. The myocardial ischemic region belongs to non- ST segment elevation myocardial infarction when ST segment continues to move down more than 24 h. It suggests that the infarct site is located under the endocardium, the so-called subendocardial myocardial infarction. Reperfusion therapy is a milestone in the progression of acute myocardial infarction treatment. It is very important to restore the blood supply, save the dying myocardium and improve the prognosis of the patients. Electrocardiogram has always been a noninvasive index to evaluate the effect of reperfusion. Myocardial reperfusion is divided into two levels, the first is infarction-related coronary opening and coronary blood flow recovery; The second is the recovery of microcirculation blood flow in myocardial tissue. Only the second level of reperfusion can really benefit the ischemic myocardium and improve the prognosis of patients. Electrocardiogram ST- T change is the "gold standard" for evaluating myocardial microcirculation blood flow reperfusion, which provides more prognostic information than simple coronary angiography. Electrocardiogram of coronary thrombolytic recanalization shows that: elevated ST segment falls >50% within 2 h or every 30 min; A reperfusion arrhythmia occurs. ST segment changes are reliable and important indicators to evaluate whether effective reperfusion

occurs in acute myocardial infarction. ST some extent, ST segment changes can reflect whether the microcirculation of myocardial tissue is effectively supplied with blood. In 2004, Schroder proposed a maximum ratio (STR) of single-lead ST segment regression to evaluate reperfusion efficacy and prognosis. The most obvious lead of ST segment elevation was selected and the maximum ratio of ST segment fall after 90 min reperfusion was calculated [STR=(ST segment elevation before reperfusion - ST segment elevation after reperfusion/ST segment elevation before reperfusion ×100%][11]. At STR≥70%, the blood flow recovered completely, the blocked coronary artery recanalized completely, and the microcirculation of myocardial tissue level was effectively reperfused. At STR<50% (inferior wall <20%), the blood flow was not recovered, suggesting that the reperfusion therapy was not successful, the blocked coronary artery was not recanalized or the microcirculation of Myocardial tissue level was not effectively perfused although it is recanalized. Between them, the blood flow was partially restored, and the microcirculation at myocardial tissue level was partially restored. Early T wave inversion after reperfusion therapy is a new index to evaluate the effect of reperfusion. T wave inversion within 24 h after reperfusion is another electrocardiogram manifestation of infarct-related vascular recanalization and effective reperfusion of myocardial tissue level. Early inversion of T wave may be related to reperfusion of injured myocardium, reduction of ischemia degree and prolongation of action potential time history. 967 patients with AMI who received thrombolytic therapy were observed. The time of chest pain relief, ST segment depression, T wave inversion and CK-MB peak advance were prospectively analyzed to determine the value of effective reperfusion. The results showed that T wave inversion within 24 hours was an independent index reflecting the recanalization of infarct related coronary artery and related to the survival rate of patients during hospitalization [12]. The fall ≥50% of ST segments in ECG index is a non-invasive objective index to reflect myocardial tissue level reperfusion and myocardial tissue gets early reperfusion to affect the prognosis of myocardial infarction. The calculated value Em/Am echocardiography can predict diastolic dysfunction earlier, identify the pseudo-normal blood flow spectrum, and is not affected by recombination to evaluate left ventricular function more comprehensively. LVEF is the ratio of stroke output to ventricular end-diastolic volume. When the body is in normal resting state, LVEF is about 55-65%. The stronger the myocardial contractility, the greater the ejection fraction [13]. High LVD suggests cardiac dysfunction. The results show that there are significant differences in LVEF, LVD, Em/Am and other ECG indexes in patients with AMI with different fall degree of ST segment after PCI operation. The results of this study are consistent with the conclusions of related studies [14,15]. Moreover, the results of this experiment further show that LVEF, LVD, Em/Am and other ECG indicators can effectively reflect the recovery of cardiac function[16].

CONCLUSION

In conclusion, ECG has been widely used in the diagnosis of acute myocardial infarction. In recent years, there has been a deeper understanding of the application of electrocardiogram in acute myocardial infarction, including the diagnostic criteria of myocardial infarction, the evolution of stages and clinical significance, the evaluation of myocardial microcirculation blood flow reperfusion, the judgment of infarct-related arteries and the evaluation of prognosis. ECG can provide rich and important information that cannot be replaced by other examination methods. We believe that with the further development of clinical research, ECG will play a more important role in the diagnosis and PCI treatment of acute ST segment elevation myocardial infarction, and become an important index to evaluate and predict acute coronary ST segment elevation myocardial infarction. It is worthy carrying out the further studies.

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