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Original Article

An analysis of the ischemia grades on admission electrocardiograms in patients with ST-segment elevation myocardial infarction

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Abstract: Objective: This study aimed to explore the clinical significance of the ischemia grades on the admission electrocardiograms (ECG) of patients with ST-segment elevation myocardial infarction (SEMI). Methods: A total of 136 patients with myocardial infarction admitted to our hospital from December 2018 to November 2019 were enrolled. According to their myocardial ischemia classifications, 58 patients with grade III ischemia were placed in the control group (the CG, administered 20 mg Lipitor, once daily for 12 weeks) and 78 patients with grade II ischemia were placed in the observation group (the OG, administered 80 mg Lipitor, once daily for 12 weeks). The deviations of the ST-segments and the baseline data as well as cardiac function and any complications after admission were compared. Results: The sum of the ST segment elevations in the CG was significantly higher than it was in the OG at admission (t=3.376, P<0.05). The TnT and myocardial infarction areas in the CG during the patients' hospitalization were significantly higher than they were in the OG (P<0.05), but the cardiac function indices, such as the left ventricular ejection fraction and the creatine kinase-MB levels in the CG were significantly lower than they were in the OG (P<0.05). There were 30 right coronary artery occlusion cases (51.72%) and 28 circumflex coronary artery branch occlusion cases (48.27%) in the CG, but in the OG, there were 29 proximal, mid anterior descending branch occlusion cases (37.17%), 38 right coronary artery occlusion cases (48.71%), and 11 mid, distal anterior descending branch cases (14.10%). The peak cTnI and NT-proBNP levels in the CG were significantly higher than they were in the OG (P<0.05). The serum hypersensitive troponin I levels in the CG were significantly higher than they were in the OG (P<0.05). Conclusion: Patients with grade III myocardial ischemia have a poorer prognosis than those with grade II, suggesting that ECG analysis and grading have an important diagnostic significance for the admission of patients with myocardial infarction and have a guiding significance for the prognoses of patients and their treatment selection.

Keywords: Myocardial infarction, grade of ischemic, electrocardiogram ST-segment elevation

Introduction

Acute myocardial infarction (AMI), also known a heart attack, is a life-threatening condition that occurs when blood flow to the heart muscle is suddenly interrupted, causing tissue damage. At present, electrocardiogram (ECG) examination is the primary tool for clinical diagnosis of AMI [1]. In the diagnosis of acute ST-segment elevation myocardial infarction (SEMI), fragmented wide QRS wave (fWQRS) of the corresponding lead has not received enough attention [2]. The emergency opening and occlusion of the blood vessels and the restoration of blood flow are the most effective methods to treat AMI. Generally, patients with AMI require percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), or thrombolytic therapy. However, PCI and CABG have not been widely implemented in small local hospitals due to the limitations in surgical facilities and resources. Patients have no time to transfer to technologically advanced hospitals for PCI or CABG treatment. On the basis of QRS, the drug regimen can also effectively open occlusive coronary arteries, significantly reduce the mortality and improve patients' arrhythmia in the early stage [3].

AMI is a sudden reduction or interruption in the coronary blood supply, resulting in irreversible ischemic necrosis caused by insufficient myo-

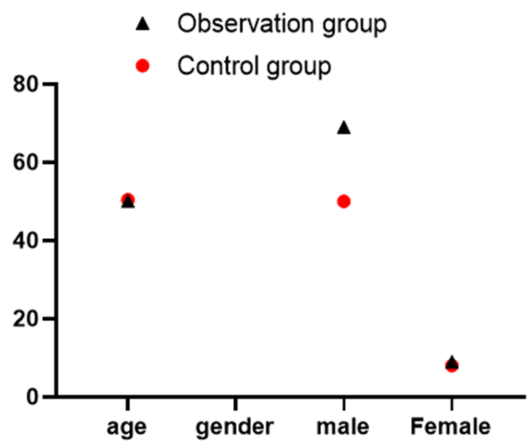

Figure 1. The baseline data of the two groups. There were no significant differences in age or gender between the two groups (P>0.05, t=1.776; P>0.05, X^2=0.083).

cardial perfusion, with angina pectoris as the precursor of onset. Clinical symptoms include pain, arrhythmia, hypotension and even shock [4]. Zheng et al. indicated that the prognoses of patients with myocardial infarction are closely related to ischemia grades, and ECGs are thought to play an important role in the diagnosis and evaluation of myocardial infarction [5]. When AMI patients are examined, healthcare providers pay much attention to the ST segment elevation displayed on the ECG and formulate a corresponding treatment plan. The dosing of drugs can be quantified according to the data displayed by the QRS [6]. This study retrospectively analyzed 136 AMI patients who were divided into a control group (the CG) (grade III) and an observation group (the OG) (grade II). The two groups' clinical prognoses and ECGs were compared to provide a reference for the clinic and to improve patients' clinical prognoses.

Materials and methods

Baseline data

Altogether 136 patients with AMI admitted to our hospital from December 2018 to November 2019 were recruited for this study. They included 60 males and 76 females 50-78 years old, with an average age of (53.3 ± 10.1) years. The AMI patients with grade III myocardial ischemia were included in the CG (n=58), and the patients with grade II myocardial ischemia were enrolled in the OG (n=78). Inclusion criteria: Ischemic chest pain ≥ 30 mg, which could not be relieved by rest or nitroglycerin, the ECG showed two adjacent leads with ST-segment elevation ≥ 0.1 MV, an onset time in the non-thrombolytic patients of ≤24 hours, and an onset time in the thrombolytic patients of ≤12 hours. Exclusion criteria: Patients who have had a previous myocardial infarction, patients with cardiac insufficiency due to other causes, patients with incomplete ECG data, and patients with bundle branch block. All the patients or their families signed a written informed consent. This study was conducted with the approval of the ethics committee of our hospital.

Diagnostic method

According to the diagnostic criteria for acute myocardial infarction recommended by the American College of Cardiology/American Heart Association in 2004, ischemic grading was performed according to the Sclarovsky-Birnbaum Ischemia Grading (SB-IG) criteria [7, 8]. Grade II ischemia: Elevation of the ST segment in two adjacent leads ≥ 0.1 mV, chest pain ≥ 30 min, changes in the concentration of the serum creatine kinase isozyme (CK-MB). Grade III ischemia: Emergence of the J point ≥ 50% of the R wave in the leads with qR configuration, or the disappearance of the S wave in the leads with a Rs configuration. The patients in the CG were administered 20 mg Lipitor, once daily, with continuous treatment for 12 weeks. The patients in the OG were administered 80 mg Lipitor, once daily, with continuous treatment for 12 weeks.

Outcome measurement

The patients' ECGs were monitored by a professional physician, and the echocardiography was performed within 4 weeks of admission. The GEVivid7 color ultrasonic diagnostic instrument was used with a probe frequency of 2.5 MHz. The left ventricular ejection fraction (LVEF) was measured using the biplane method, and the movement of the ventricular wall was observed. Cardiac troponin I (cTnI): Fasting venous blood samples (3 ml) from the two groups were collected in the early morning, centrifuged with 15 cm as the centrifugal radius at 2500 r/min for 10 min. The serum was separated and stored at -20°C for testing. A Troponin I kit (Shanghai Jianglai Biotechnology Co., Ltd.) was used in strict accordance with

Table 1. The occurrence of comorbidities in the two groups [($\bar{x}$ ± s), n (%)]

Group	n	Hypertension	Diabetes	Pre-infarction angina	Anterior wall infarction	Inferior wall infarction	ECG ∑ST (mV) on admission	Elective PCI
Control group	58	33 (56.90)	17 (29.31)	13 (22.41)	37 (63.79)	21 (36.21)	0.49 ± 0.31	27 (46.55)
Observation group	78	43 (55.13)	23 (29.49)	15 (19.23)	54 (69.23)	28 (35.90)	0.74 ± 0.55	35 (44.87)
t/X^2	-	X^2=0.043	X^2=0.761	X^2=0.899	X^2=0.305	X^2=0.305	t=3.376	X^2=0.272
P		>0.05	>0.05	>0.05	>0.05	>0.05	<0.05	>0.05

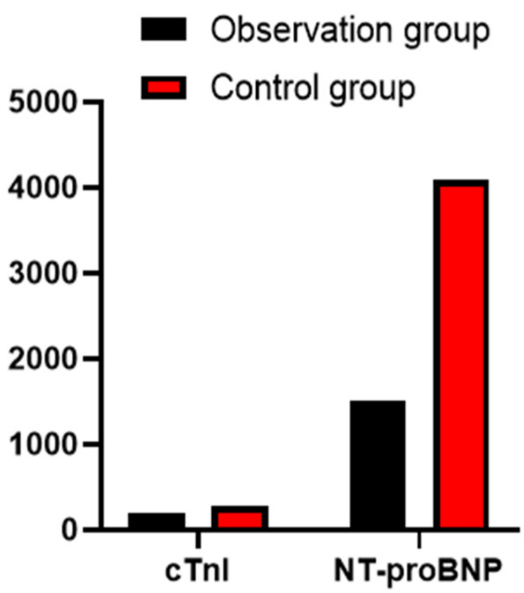

Figure 2. The cardiac function indicators of two groups. The cTnI and NT-proBNP levels in the control group were significantly higher than they were in the observation group (X^2=0.588, 0.080, P=0.001, 0.002).

the kit's instructions. NT-proBNP determination: Venous blood was collected within 1 h of admission with EDTA as an anticoagulant and was immediately sent for examination. The blood NT-proBNP concentration was measured using a Dimension integrated chemistry system (Siemens, Germany), and the baseline data were recorded at the same time.

Statistical analysis

SPSS 17.0 was used for the data analysis. The measurement data were expressed as the mean ± standard deviation ($\bar{x}$ ± s), and t tests were used for the comparisons between groups. The measurement data were expressed as a percentage (%), and X^2 tests were used for the comparisons between groups. P<0.05 was considered statistically significant.

Results

Comparison of the baseline data

The average ages in the OG and the CG were (59.1 ± 8.7) years and (61.3 ± 11.2) years, respectively. There were 69 males and 9 females in the OG, and 50 males and 8 females in the CG. There were no significant differences in age or gender between the two groups, which were comparable (P>0.05, t=1.776; P>0.05, X^2=0.083) (**Figure 1**).

Complications at admission

The OG showed higher ∑ST and a lower incidence of pre-infarction angina than the CG (P<0.05). There were 30 cases of occlusion of the right coronary artery (51.72%) and 28 cases of occlusions of a circumflex coronary artery branch (48.27%) in the CG. Meanwhile, in the OG, there were 29 cases of proximal occlusion of the mid anterior descending branches (37.17%), 38 cases of occlusions of the right coronary artery (48.71%), and 11 cases of mid, distal anterior descending branches (14.10%) (**Table 1**).

Changes in cardiac function during the hospitalization in both groups

The area of myocardial infarction and TnT of the OG after hospitalization were significantly lower than they were in the CG (P<0.05), and the LVEF and CK-MB levels of the OG were higher than they were in the CG (P<0.05). The CG showed significantly upregulated peak cTnI and NT-proBNP levels than the OG (P<0.05), indicating that the cardiac function indicators in the CG were worse than they were in the OG (**Figure 2**).

Complications during the hospitalization in both groups

The CG showed increased arrhythmia, heart failure or shock, inpatient mortality, and ven-

Table 2. The incidences of complications in the two groups [n (%)]

Group	Arrhythmia	Heart failure or shock	Inpatient mortality	Ventricular aneurysm	Reinfarction rate
Control group (n=58)	14 (24.14)	16 (27.59)	10 (17.24)	12 (20.69)	8 (13.79)
Observation group (n=78)	10 (12.82)	11 (14.10)	7 (8.97)	9 (11.54)	5 (6.41)
P	<0.05	<0.05	<0.05	<0.05	<0.05

Table 3. A comparison of the changes in the serum hypersensitive troponin I levels in both groups ($\overline{x}$ ± s)

Group	n	Hypersensitive troponin I (μg/L)
OG	78	14.89 ± 3.14
CG	58	31.64 ± 4.56
t		18.440
P		<0.05

tricular aneurysms, and a higher reinfarction rate compared with the OG (P<0.05), indicating that the OG showed a better prognosis than the CG (**Table 2**).

Changes in the serum hypersensitive troponin I levels in both groups

The hypersensitive troponin I level in the CG was 31.64 ± 4.56, which was significantly higher than the level of 14.89 ± 3.14 in the OG, showing a significant difference (P<0.05) (**Table 3**). This indicated that the more severe the myocardial ischemia, the higher the hypersensitive troponin I level.

Discussion

Myocardial infarction, also known as acute myocardial, occurs when a thrombosis or spasm in one or more vessels of the coronary artery leads to the interruption of blood flow, which causes myocardium and eventually ischemic necrosis in the blood supply area [9, 10]. If the onset of AMI is diagnosed and the blood vessels are cleared promptly, it is a reversible disease. If not treated in time, it will enter into an irreversible necrosis process [11, 12]. The manifestation of myocardial infarction is myocardial necrosis, which is characterized by ST segment elevation and T wave inversion on the ECG. Previously, the absolute height of ST elevation, the number of leads, and the width of the Q wave were measured to evaluate the risk of infarction, thereby predicting the infarct size [13, 14].

Occlusions of the coronary artery caused by AMI lead to corresponding changes on the ECG. Therefore, the continuous changes of the ECG can be measured from the leads in the area of the ischemia [15, 16]. On basis of the changes in the ECG, the patients are usually classified into 3 grades. In this study, the patients were divided into grade II and III myocardial ischemia according to their ECGs. The results showed that there was no difference in the common symptoms such as hypertension, diabetes, pre-infarction angina, *etc*. It was found that the anterior wall myocardial infarction occurred at the proximal end of the anterior descending branch, and the ST segment of the infarction shifted toward the bottom of the myocardium, so the inferior wall leads points away from lateral wall, resulting in the ST segment decreasing. The myocardial infarction was located proximal to the descending branch, thereby enlarging the area of ischemic infarction and directly affecting the left ventricular function [7, 17]. 80%-90% of patients with acute inferior myocardial infarction are accompanied by ST segment elevations in leads II, III, and avF due to RCA blockage, and some patients have ST segment elevation due to LCX circumflex branch occlusion [18, 19].

Studies have shown that the classification of myocardial ischemia at admission has an important clinical significance. Myocardial ischemia is closely related to hospital complications, ventricular function, infarct size and mortality. Patients with grade III ischemia have a significantly faster progression or a larger area of necrosis than patients with grade II ischemia, which may be related to the ischemia and to less lateral circulation [20, 21]. Some studies have used 99mTeSPECT to estimate the infarct size, and it was found that the differences in overall left ventricular function in patients with grade III and grade II ischemia are significantly related to the severity of the dysfunction in the area involved [16, 22, 23].

In summary, patients with grade III myocardial ischemia have a poorer prognosis than the patients with grade II myocardial ischemia, suggesting that the use of ECGs to classify patients with myocardial infarction when admitted has an important clinical diagnostic significance for the evaluation of the prognosis and the selection of the treatment.

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Disclosure of conflict of interest

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References

[1] Birnbaum Y, Criger DA, Wagner GS, Strasberg B, Mager A, Gates K, Granger CB, Ross AM and Barbash GI. Prediction of the extent and severity of left ventricular dysfunction in anterior acute myocardial infarction by the admission electrocardiogram. Am Heart J 2001; 141: 915-924.

[2] Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, Hochman JS, Krumholz HM, Kushner FG, Lamas GA, Mullany CJ, Ornato JP, Pearle DL, Sloan MA, Smith SC Jr, Alpert JS, Anderson JL, Faxon DP, Fuster V, Gibbons RJ, Gregoratos G, Halperin JL, Hiratzka LF, Hunt SA and Jacobs AK. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction--executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 1999 Guidelines for the Management of Patients With Acute Myocardial Infarction). Circulation 2004; 110: 588-636.

[3] Birnbaum Y, Maynard C, Wolfe S, Mager A, Strasberg B, Rechavia E, Gates K and Wagner GS. Terminal QRS distortion on admission is better than ST-segment measurements in predicting final infarct size and assessing the potential effect of thrombolytic therapy in anterior wall acute myocardial infarction. Am J Cardiol 1999; 84: 530-534.

[4] Jiang S, Ji X and Zhang Y. The American College of Cardiology and the American College of Cardiology issued guidelines on the treatment of ST-segment elevation acute myocardial infarction (revised version in 2004). Chin Med J 2005.

[5] Zheng K and Ke Z. The predictive value of ischemic grading on patients with acute ST segment elevation myocardial infarction after PCI. Clinical Medical Engineering 2017; 24: 893-894.

[6] Sejersten M, Birnbaum Y, Ripa RS, Maynard C, Wagner GS and Clemmensen P. Influences of electrocardiographic ischaemia grades and symptom duration on outcomes in patients with acute myocardial infarction treated with thrombolysis versus primary percutaneous coronary intervention: results from the DANAMI-2 trial. Heart 2006; 92: 1577-1582.

[7] Curila K, Stros P, Herman D, Vesela J, Prochazkova R, Osmancik P and Widimsky P. Electrocardiogram changes due to myocardial infarction in a patient with selective His bundle pacing. Kardiol Pol 2019; 77: 237.

[8] Grandjean T, Degrauwe S, Tessitore E and Iglesias JF. The 'de Winter' electrocardiogram pattern as a ST-elevation myocardial infarction equivalent: a case report. Eur Heart J Case Rep 2019; 3: 1-5.

[9] Chanvorachote P, Pongrakhananon V, Wannachaiyasit S, Luanpitpong S, Rojanasakul Y and Nimmannit U. Curcumin sensitizes lung cancer cells to cisplatin-induced apoptosis through superoxide anion-mediated Bcl-2 degradation. Cancer Invest 2009; 27: 624-635.

[10] Birnbaum Y, Kloner RA, Sclarovsky S, Cannon CP, McCabe CH, Davis VG, Zaret BL, Wackers FJ and Braunwald E. Distortion of the terminal portion of the QRS on the admission electrocardiogram in acute myocardial infarction and correlation with infarct size and long-term prognosis (Thrombolysis in Myocardial Infarction 4 Trial). Am J Cardiol 1996; 78: 396-403.

[11] Tamura A, Nagase K, Watanabe T and Nasu M. Relationship between terminal QRS distortion on the admission electrocardiogram and the time course of left ventricular wall motion in anterior wall acute myocardial infarction. Jpn Circ J 2001; 65: 63-66.

[12] Ibrahim AM, Mansour IM, Wilson MM, Mokhtar DA, Helal AM and Al Wakeel HM. Study of survivin and X-linked inhibitor of apoptosis protein (XIAP) genes in acute myeloid leukemia (AML). Lab Hematol 2012; 18: 1-10.

[13] Zhang L, Fan Y, Xu J, Yan J, Ruan Q and Jiang X. De Winter syndrome may be an early electrocardiogram pattern of acute myocardial infarction, two cases report. Ann Noninvasive Electrocardiol 2020; 25: e12729.

[14] Xu WW, Lu L and Jin MJ. de Winter electrocardiogram pattern-an unusual ST-segment elevation myocardial infarction equivalent pattern. JAMA Intern Med 2019; [Epub ahead of print].
[15] Taherinia A, Ahmadi K, Bahramian M, Khademhosseini P, Taleshi Z, Maghsoudi M, Badkoubeh RS, Talebian MT and Rezaee M. Diagnostic value of standard electrocardiogram in acute right ventricular myocardial infarction. Eur J Transl Myol 2019; 29: 8184.
[16] Travaglio N, Tini G, Arboscello E and Spallarossa P. Cardiac metastasis presenting with an ischaemic electrocardiogram pattern mimicking anterior myocardial infarction. Eur Heart J Case Rep 2018; 2: yty025.
[17] Liu W, Huang Q, Chang S, Wang H and He J. Multiple-feature-branch convolutional neural network for myocardial infarction diagnosis using electrocardiogram. Biomed Signal Process 2018; 45: 22-32.
[18] Shukla RS and Aggarwal Y. Electrocardiogram in lung cancer patients envisage as pseudo-myocardial infarction and ischemic heart disease. J Clin Eng 2018; 43: 48-52.
[19] Namdar H, Imani L, Ghaffari S, Aslanabadi N, Reshadati N, Samani Z, Davarmoin G, Moayyednia N, Nazer Y, Sarhangzadeh S and Separham A. ST-segment depression in left precordial leads in electrocardiogram of patients with acute inferior myocardial infarction undergoing primary percutaneous coronary intervention. Interv Med Appl Sci 2018; 10: 191-197.
[20] Noll S, Alvey H, Jayaprakash N, Paranjpe A, Miller J, Moyer ML and Nowak R. The utility of the triage electrocardiogram for the detection of ST-segment elevation myocardial infarction. Am J Emerg Med 2018; 36: 1771-1774.
[21] Mezhonov EM, Vyalkina YA, Vakulchik KA and SHalaev SV. Predictors of acute heart failure in patients with ST-segment elevation myocardial infarction of the electrocardiogram after PCI. Kardiologiia 2018; 58: 20-28.
[22] Tanguay A, Lebon J, Brassard E, Hébert D and Bégin F. Diagnostic accuracy of prehospital electrocardiograms interpreted remotely by emergency physicians in myocardial infarction patients. Am J Emerg Med 2019; 37: 1242-1247.
[23] Cheung KS, Leung LP, Siu YC, Tsang TC, Tsui MSH, Tam CC and Chan RHW. Prehospital electrocardiogram shortens ischaemic time in patients with ST-segment elevation myocardial infarction. Hong Kong Med J 2019; 25: 356-362.