Original Article
Effects of esmolol on the heart function, heart rate, blood pressure and remission of chest pain in patients with acute STEMI and without emergency reperfusion therapy

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Abstract: Objective: This study was designed to explore the effects of esmolol on the heart function, heart rate, blood pressure, and remission of chest pain in patients with acute STEMI and without emergency reperfusion therapy. Methods: after retrospective analysis of clinical data, 89 patients with acute STEMI and without emergency reperfusion therapy in our hospital were divided into 2 groups, the CG for routine comprehensive treatment, and the OG for the additional treatment with esmolol on the basis of the routine comprehensive treatment. The 2 groups were compared for the fallback degree of elevated ST segment, remission of ischemic chest pain, preoperative and postoperative changes in left ventricular end systolic diameter (LVEDD), left ventricular ejection fraction (LVEF), brain natriuretic peptide (BNP), heart rate, DBP and SBP, as well as therapy safety. Results: (1) The total effective rates of fallback of elevated ST segment, and ischemic chest pain were 95.56% and 93.33% in the OG, 75.00% and 72.73% in the CG (P<0.05). (2) After treatment, except for similar DBP and SBP, the OG reported lower LVDD, BNP, and heart rate, but higher LVEF as compared with the CG (P<0.05). (3) The total incidence of adverse events during treatment was 11.11% in the OG, and 38.64% in the CG (P<0.05). Conclusion: The application of esmolol in the treatment of patients with acute STEMI and without emergency reperfusion therapy could effectively relieve the ischemic chest pain, improve heart function and drug use safety, and reduce the incidence of adverse events during treatment.

Keywords: Acute ST-segment elevation, esmolol, heart function, blood pressure, chest pain

Introduction

As a common acute MI in the clinic, ST-segment elevation myocardial infarction (STEMI) is characterized by typical syndromes of ischemic chest pain continuing for at least 20 min, elevated and dynamically evolving concentration of serum myocardial necrosis markers, and typical ST-segment elevation according to the electrocardiogram [1, 2]. On the pathological basis of acute obliterans thrombosis induced by coronary plaque injury, most of the acute MI patients have atherosclerotic plaques in their coronary arteries, which further lead to the formation of thrombus and block vessels [3].

The rapid development and high fatality rate of acute STEMI require unblocking the infarctus veins sufficiently and as early as possible to recovery the blood flow in the blocked coronary arteries and further limit the expansion of infarction area so as to achieve better prognosis of patients [4, 5]. In general cases, the major factor determining the prognosis of patients with acute STEMI is the duration from attacking to reperfusion. Emergency percutaneous coronary intervention and thrombolytic therapy have the designated windows which may be missed by some patients subject to various factors, making timely implementation of emergency reperfusion therapy impossible [6, 7]. Henceforth, for patients with acute STEMI but without emergency reperfusion therapy, a scientific and rational drug is the key to improve prognosis [8]. Esmolol is a short-acting type 1 receptor blocking agent which is highly selective and bio-available, but demands a shorter period of time to form long-term effects [9]. Accordingly, esmolol was adopted in this study to treat patients with acute STEMI and

without emergency reperfusion therapy for the purpose of improving prognosis.

Previous clinical studies have attempted to find a scientific and effective means to improve the prognosis of patients with acute STEMI, but paid little attention on the effective treatment of acute STEMI without emergency reperfusion therapy. Therefore, this study mainly focused on the effects of esmolol on the heart function, heart rate, blood pressure and remission of chest pain in patients with acute STEMI and without emergency reperfusion therapy to prove its dominant feasibility and innovation.

Materials and methods

Materials

89 patients with acute STEMI but without emergency reperfusion therapy in our hospital were retrospectively analyzed for clinical data, and divided into 2 groups based on the treatment method, the CG (n=44) for routine comprehensive treatment, and the OG (n=45) for the additional treatment with esmolol on the basis of the routine comprehensive treatment. The CG consisted of 29 males and 15 females, while the OG included 30 males and 15 females. (1) Inclusion criteria: patients who complied with the diagnosis criteria of Chinese Medical Association on acute STEMI but didn't receive emergency reperfusion therapy due to various reasons were included and provided their informed consents to participate in the study. The study has been approved by the medical ethnic committee of our hospital. (2) Exclusion criteria: some patients were excluded as they had malignant tumors, acute or chronic infection, severe liver or kidney insufficiency, concurrent valvulopathy, CHD, cardiac shock, refractory cardiac insufficiency, sinus bradycardia, severe chronic obstructive pulmonary disease, and a history of bronchial asthma or as they have received coronary artery bypass grafting (CABG).

Methods

CG: after hospitalization, patients in the CG were subject to reinforced monitoring on degree of blood oxygen saturation, blood pressure and electrocardiogram. In addition to sufficient oxygen supply and 24 h accurate recording of breathing in/out amount, those patients also received routine comprehensive treatment to

nourish myocardium, adjust lipids, and resist myocardial ischemia, arrhythmia, and platelet aggregation as well as anticoagulation. Active measures were adopted to recover the balance of acid and bas, as well as electrolytes in their body, and sedative medicine, such as stabilizing agent, were given for treatment if and when necessary. In case of ventricular fibrillation and tachycardia, therapies including initial defibrillation, emergency electric cardioversion, and cardio-pulmonary resuscitation were provided and supported with noninvasive ventilators for assisted respiration as the case maybe.

On the basis of treatment provided to CG, patients in the OG were additionally treated with esmolol (manufacturer: Qilu Pharmaceutical Co., Ltd., approval document No.: GYZZ H19991059, specification: 10 ml, 0.1 g/piece) by I.V. at 0.5 mg/kg in 1 min, and by intravenous drip at 0.05-0.2 mg/(kg·min) for 24 to 48 h. In this process, the dose was flexibly adjusted according to changes in the patients' heart rate, blood pressure and heart function. Before and after administration, patients were subject to continuous monitoring for blood pressure and electrocardiogram changes. In case of SBP lower than 90 mmHg or heart rate lower than 60 times/min, the dose was reduced, and a small dose of dopamine was given to effectively maintain the blood pressure.

Observation indicators

(1) Fallback degree of elevated ST segment: the treatment is judged as invalid if the fallback of elevated ST segment is less than or equal to 50%, or effective if the fallback of selected ST segment falls between 50% (inclusive) and 80% (inclusive), or markedly effective if the fallback of elevated ST segment is greater than 80% or approaches 100% [10]. The total effective rate = effective rate + marked effective rate.

(2) Remission of ischemic chest pain: the treatment is judged as ineffective if the remission of chest pain is less than or equal to 50%, effective if it falls between 50% (inclusive) and 80% (inclusive), or markedly effective if it is greater than 80% or totally disappears [11]. The total effective rate = effective rate + marked effective rate.

(3) Indicators of heart function and BNP: before and after treatment, the left ventricular end

Table 1. Comparison between the 2 groups for general data [n(%)]/($\bar{x} \pm$ sd)

Data		OG (n=45)	CG (n=44)	t/X^2	P
Gender (n)	Male	30 (66.67)	29 (65.91)	0.006	0.939
	Female	15 (33.33)	15 (34.09)		
Age (y)		62.58±2.28	62.52±2.25	0.125	0.901
Concurrent disease					
Hypertension		15 (33.33)	14 (31.82)	0.028	0.968
Diabetes		12 (26.67)	13 (29.55)		
Hyperlipemia		10 (22.22)	11 (25.00)		

Table 2. Comparison between the 2 groups for the fallback degree of elevated ST segment [n(%)]

Group	n	Markedly effective	Effective	Ineffective	Total effective
CG	44	20 (45.45)	13 (29.55)	11 (25.00)	33 (75.00)
OG	45	35 (77.78)	8 (17.78)	2 (4.44)	43 (95.56)*
X^2					7.536
P					0.006

Note: *indicates P<0.05 as compared with the CG.

systolic diameter (LVEDD) and left ventricular ejection fraction (LVEF) in both groups were measured by a LOGIQ7 color doppler ultrasound imager with the probe frequency set to 8 MHz. Secondly, 2 ml blood was drawn from the veins of all patients in a fasting status in the morning before and after treatment. The blood was then centrifuged at 3000 r/min, and quantitatively detected for BNP by the immunoassay system. All operations were carried out in strict accordance with the instructions stated on the test kits provided by ReLIA Bioengineering (Shenzhen) Co., Ltd.

(4) Blood pressure and heart rate: before and after treatment, a fixed vertical standard Riva-Rocci sphygmomanometer was used to measure the SBP and DBP of all patients. Their heart rate was listened for 1 min at tranquillization.

(5) Safety: the 2 groups were compared for the incidence of adverse events during treatment.

Statistical method

Statistical analysis was performed with SPSS22.0. In case of numerical data expressed as mean ± standard deviation, comparison studies were carried out through independent-samples T test for data which were normally distributed, and Mann-Whitney U test for data which were not normally distributed, paired test for pre-and-pro comparison in the group. In case of nominal data expressed as [n(%)], comparison studies were carried out through X^2 test for intergroup comparison. For all statistical comparisons, significance was defined as P< 0.05.

Results

Comparison between the 2 groups for general data

There was no statistical difference in terms of general materials such as gender, age and concurrent diseases between the two groups (P>0.05, **Table 1**).

Comparison between the 2 groups for fallback degree of elevated ST segment

The OG yielded a total effective rate of 95.56%, with 35 marked effective, 8 effective and 2 ineffective cases, which was higher than that of 75.00% in the CG, with 20 marked effective, 13 effective and 11 ineffective cases (P<0.05, **Table 2**).

Comparison between the 2 groups for remission of ischemic chest pain

The OG yielded a total effective rate of 93.33% on the basis of 34 marked effective, 8 effective and 3 ineffective cases, higher than that of the CG which was 72.73% calculated from 22 marked effective, 10 effective and 12 ineffective cases (X^2=6.741, P<0.05, **Table 3**).

Comparison between the 2 groups for indicators of heart function and BNP

The LVDD, LVEF and BNP were 48±5 mm, 38±5% and 2458±201 pg/ml in the OG, 47±4 mm, 36±6%, and 2461±199 pg/ml in the CG before treatment (t=1.040, t=1.709, t=0.071, P>0.05), 41±2 mm, 48±4% and 2002±21 pg/ml in the OG, 46±5 mm, 40±2%, and 2215±52 pg/ml in the CG after treatment (t=4.975, t=11.891, t=25.440, P<0.05) (**Figures 1**-**3**).

Comparison between the 2 groups for blood pressure and heart rate

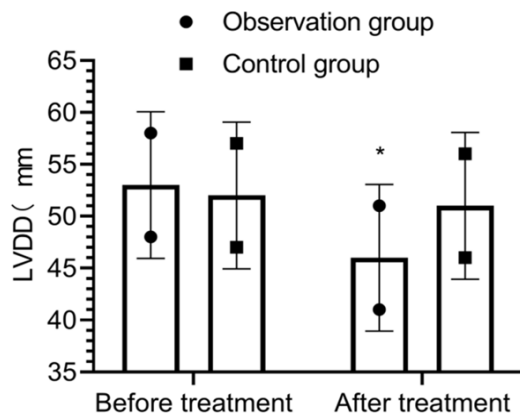Before treatment, the 2 groups had no statistical difference in DBP, SBP and heart rate
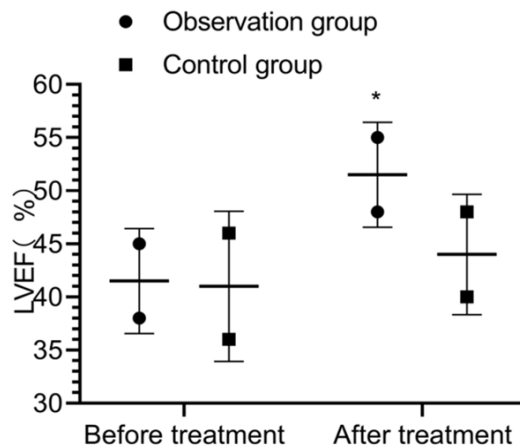
Table 3. Comparison between the 2 groups for remission of ischemic chest pain [n(%)]

Group	n	Markedly effective	Effective	Ineffective	Total effective
CG	44	22 (50.00)	10 (22.73)	12 (27.27)	32 (72.73)
OG	45	34 (75.56)	8 (17.78)	3 (6.67)	42 (93.33)*
X^2					6.741
P					0.009

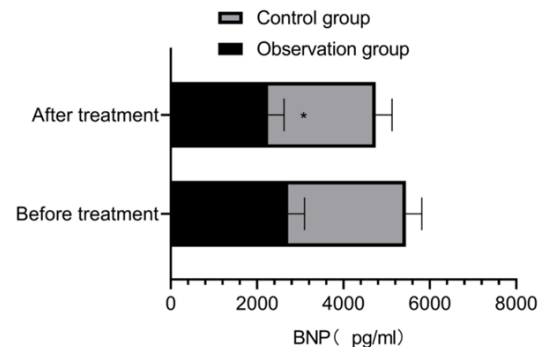Note: *indicates P<0.05 as compared with the CG.

Figure 1. Comparison between the 2 groups for LVDD before and after treatment. While no statistical difference was observed before treatment, the OG yielded a lower LVDD after treatment as compared with the CG (P<0.05). *indicates *P*<0.05 as compared with the CG.

Figure 3. Comparison between the 2 groups for BNP before and after treatment. Before treatment, there was no statistical difference between the 2 groups (P>0.05); after treatment, the BNP in the OG was lower than that of the CG (P<0.05). *indicates *P*<0.05 as compared with the CG.

Figure 2. Comparison between the 2 groups for LVEF before and after treatment. Statistical difference was not observed between the 2 groups before treatment (P>0.05); after treatment, the OG demonstrated higher LVEF than the CG (P<0.05). *indicates *P*<0.05 as compared with the CG.

(P>0.05). After treatment, both groups achieved a reduction in DBP, SBP, and heart rate (P<0.05). Statistical difference was not observed between the 2 groups in terms of DBP and SBP, but heart rate which was lower in the OG (P<0.05, **Table 4**).

Comparison between the 2 groups for drug use safety

In the OG, 2 patients suffered from acute heart failure, and 2 had blood pressure reduced to a level below 90/60 mmHg, which were then improved by the reduced administration of esmolol, while in the CG, the reported cases were 8 and 7 respectively, and the adopted measures included heart failure treatment and noninvasive respirator for assisted respiration in the first situation, and the reduced administration of dopamine in the second situation. In addition, 2 patients in the OG, and 1 patient in the CG reported III° atrioventricular heartblock, which were resolved by temporary pacemaker implantation and drug treatment. Furthermore, 1 patient was attacked by malignant arrhythmia, and treated with amiodarone accordingly (**Table 5**).

Discussion

Clinically, acute myocardial infarction is a common angiocardiopathy developing on the basis

Table 4. Comparison between the 2 groups for blood pressure and heart rate ($\bar{x} \pm sd$)

Group	Heart rate (times/min)		DBP (mmHg)		SBP (mmHg)	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
OG (n=45)	119±12	62±3[#,*]	86±5	66±2[#]	126±10	91±4[#]
CG (n=44)	118±13	109±8[#]	85±6	67±3[#]	125±12	92±5[#]
t	0.377	36.853	0.855	1.854	0.427	1.043
P	0.707	0.000	0.395	0.067	0.670	0.299

Note: [#]indicates P<0.05 as compared with the conditions before treatment; [*]indicates P<0.05 as compared with the CG.

Table 5. Comparison between the 2 groups for the incidence of adverse incidences during treatment [n(%)]

Group	n	Acute heart failure	Reduced blood pressure	III° atrioventricular heart-block	Malignant arrhythmia	Total
CG	44	8 (18.18)	7 (15.91)	1 (2.27)	1 (2.27)	17 (38.64)
OG	45	2 (4.44)	1 (2.22)	2 (4.44)	0 (0.00)	5 (11.11)[*]
X^2						9.058
P						0.003

Note: [*]indicates P<0.05 as compared with the CG.

of coronary artery disease, and characterized by interrupted or sharply decreased blood supply in coronary arteries, leading to severe hypoxia and ischemia in corresponding myocardium, and finally myocardial necrosis [12]. Acute STEMI is a common acute myocardial infarction type featuring rapid progression and high fatality rate [13, 14]. Emergency reperfusion therapy, especially percutaneous coronary intervention, is capable of rapidly unblocking the infarct arteries to promote reperfusion of myocardium, recover forward blood flow, restrict the expansion of infarct size, and save dying cardiomyocytes to conserve heart function, reduce the incidence of heart complications, and improve prognosis as far as possible [15, 16]. Secondly, after identifying the "center of pain chest", multiple disciplines cooperated with each other to provide the most appropriate and accurate clinical treatment method for patients with acute STEMI, so as to promote the early diagnosis rate of acute coronary syndrome, and reduce the case fatality rate of patients with acute MI [17]. Because of the close correlation between myocardial cell necrosis and vascular occlusion time, the earlier the percutaneous coronary intervention was performed after the patient was attacked, the earlier the occluded vessels were unblocked, and the lower the mortality would be [18]. The percutaneous coronary intervention is sup-

posed to be performed in 12 h after the patient is attached by acute MI. However, due to various factors, it may be delayed in some patients [11]. In this study, 65 patients were transferred from other hospitals at least 12 h after the disease onset. 5 patients missed the best operation window due to no direct relatives on the spot to sign the informed consent before the operation, 17 due to excessive long observation at home that when they were sent to the emergency department, 12 h has elapsed, and 2 due to family members' shortage of knowledge and understanding on the disease that they failed to seek for doctor's advices timely.

For patients with acute STEMI who received no emergency reperfusion therapy, scientifically rational application of drugs can also achieve the purpose of life saving [12]. In this study, the total effective rate in OG was higher than that in CG, and heart function index in OG was better than that in CG, suggesting that the application of esmolol in patients with acute STEMI who had not received emergency reperfusion therapy could effectively relieve them from ischemic chest pain and improve heart function. The possible mechanism of action may be because β1 receptor blocker could selectively block the β1 receptor in the heart to slow down heart rate, inhibit myocardial contraction, and reduce the infarct size. Furthermore, it can sup-

press the increase in the concentration of catecholamin in blood, and the sympathetic excitability during myocardial infarction, so as to attain higher ventricular fibrillation threshold and lower risk of sudden death [14, 19]. Esmolol is an extremely short-acting fat-soluble B1 receptor blocker which can take effect rapidly and be removed 10 min after stopping administration [20]. Besides, the incidence of adverse events in OG was lower than that in CG (P<0.05), which further demonstrated the safety of esmolol. This may be because the arrangement of VI before continuous pumping resulted in more ideal effects, and effects on the heart function as expected during the treatment can be alleviated after stopping the drug, increasing the drug safety. Instead of being metabolized through the kidney and liver, the drug plays membrane stabilizing action to avoid tissue necrosis and autocytolysis, which effectively protects ischemic myocardial cells and reduces the incidence of adverse reactions [21, 22].

In conclusion, for patients with acute STEMI but without emergency reperfusion therapy, esmolol could effectively remove ischemic chest pain, improve heart function and drug use safety, and reduce the incidence of adverse events during treatment.

However, the limited sample size in this study may render its results less representative. In the future, more in-depth studies based on a larger sample size would be appreciated.

Disclosure of conflict of interest

None.

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