How to Cite:
Gandhi, S., Khan, S., Wasim, A. U., Hassan, S. S. U., Anwar, A., Umar, S., & Afnan, M. (2023). The short-term outcomes of tirofiban use in primary percutaneous coronary intervention for acute ST-segment elevation myocardial infarction (STEMI). *International Journal of Health Sciences*, *6*(S8), 6867–6876.
https://doi.org/10.53730/ijhs.v6nS8.14036

The short-term outcomes of tirofiban use in primary percutaneous coronary intervention for acute ST-segment elevation myocardial infarction (STEMI)

Sanjay Gandhi
Department of Cardiology, DHQ Buner, Daggar, Pakistan
Corresponding author email: dr.gandhi86@yahoo.com

Sajjad Khan
Cardiology Unit, MTI Lady Reading Hospital, Peshawar, Pakistan

Asad Ullah Wasim
Department of Medicine, Fazaia Medical College, Islamabad, Pakistan & Division of Clinical and Translational Research, Larkin Community Hospital, South Miami, USA; ORCID: 0000-0002-5366-5482

Syed Saem Ul Hassan
Department of Medicine, Fazaia Medical College, Islamabad, Pakistan

Ayesh Anwar
Bachelor of Medicine and Bachelor of Surgery, Peshawar Medical College, Peshawar, Pakistan

Shafaq Umar
Department of Medicine, Gomal Medical College, Dera Ismail Khan, Pakistan; ORCID: 0000-0002-0045-5270

Muhammad Afnan
Department of Medicine, Khyber Medical Institute of Medical Sciences Kohat, Pakistan; ORCID: 0000-0001-9273-3364

***Abstract*---**Introduction: When patients suffering from acute ST-elevation myocardial infarction (STEMI) undergo for percutaneous coronary intervention, tirofiban is mostly prescribed. Objective: In this study, patients undergoing for primary percutaneous coronary intervention for ST-segment elevation myocardial infarction were evaluated to determine the impact of a high bolus dose (HBD) of

tirofiban on clinical outcomes. Methods: This study included 272 acute STEMI patients aged less than 79 years, admitted to the Hayatabad Medical Complex hospital, Peshawar from April 2021 to February 2022. According to the random number table, these patients were divided into four groups: the control group (n= 65), low-dose group (n=69), medium-dose group (n=71) and high-dose group (n=67). Results: After percutaneous coronary intervention, the high-dose group experienced higher rates of corrected TIMI frame count (CTFC), Thrombolysis In Myocardial Infarction (TIMI) grade 3, and total frequency of ST-segment resolution greater than 50% than the other 3 groups while compared to the low- dose group as well as control group, the CTFC were greater in the medium dose group. Furthermore, the LVEF of the medium-dose group was much better than that of the low-dose group, and as compared to other groups, the left ventricular end diastolic and end systolic dimensions of the high-dose group remained suggestively elevated. Conclusion: In light of the patient's circumstances and hemorrhagic risk, judicious dosage administration of tirofiban has become more important. Patients with low hemorrhagic risk may benefit from a medium dose of 10 μg/kg.

***Keywords*---**tirofiban, different dose, percutaneous coronary intervention, myocardial infarction.

Introduction

When someone has STEMI, blood flow in the arteries affected by the infarct is crucial. Blood flow must always be fully and instantly established in such a channel. The concurrent action of blood vessels static friction and nervous-humoral coordination drives a coronary atherosclerotic plaque to rupture, which resulting in STEMI. This rupture causes a chain reaction of events that eventually block the coronary arteries [1-2]. The principal purposes of STEMI management are to open up the infarct vasculature accurately, systematically, and immediately, to strengthen myocardial microcirculation, to ensure recovery of infarct myocardium as rapidly as conceivable, to treat the almost necrotic myocardium, and to improve cardiac function [3-4]. The two primary forms of management for reperfusion are intravenous thrombolysis (IT) and direct PCI [5].

PCI is a crucial and efficient procedure which used vascularize the target artery and save the lives of STEMI patients [6-7]. Clinical experimental studies and survey design have shown that the adjunct infusion of glycoprotein IIb/IIIa blockers is associated with enhanced clinical outcomes and lower morbidity in STEMI patients [8-10]. An intravenous bolus, an intracoronary bolus dosage, and a 12- to 72-hours IV infusion make up a typical Tirofiban prescription [11-12]. It is unclear whether giving Tirofiban for an extended length of time would improve their clinical outcomes and lower their risk of complications. Considering this, a case-controlled study was conducted using a total of 272 STEMI patients who already had PCI and administered a diversity of tirofiban regimens in order to investigate short-term treatment benefit, cardiac function, and safety profiles.

Material and Methods

This retrospective study included 272 acute STEMI patients aged less than 79 years, admitted to the Hayatabad Medical Complex hospital, Peshawar (Pakistan) during April 2021 and February 2022, who had PCI. The inclusion criteria was: Patients seen between age ranges of 45 and 78; clinical signs including nausea, vomiting and chest pain; electrocardiography demonstrating ST-segment elevation greater than 0.2 mV in at least 2 leads; elevated concentrations of creatinine kinase-MB and Troponin-I.

The following conditions disqualified patients from engaging in the study: a cardiac function class III or IV (Killip classification); a history of cerebral haemorrhage or cerebral infarction during the last six months or visceral bleeding in the past month; severe hypertension (blood pressure greater than 180/110 mmHg); a clear resistance to or allergy to anti-platelet medicines; non-STEMI, PCI, or coronary artery bypass grafting during the last six months; greater than 45% left main artery stenosis or a significant triple vascular lesion; hemodialysis patients with blood clotting disorders and a platelet count of 178 millimoles per litre (mmol/L); hemodialysis patients with blood clotting issues and a platelet count of 178 mmol/L; inability to perform the surgery through the radial artery and a lack of interest in taking part in the trial.

According to the random number table, these participants were assigned arbitrarily to the control group (65 patients, 0 milligram/kg), low-dose group (LDG) (69 patients, 5 μg/kg), medium-dose group (MDG) (71 patients, 10 μg/kg), and high-dose group (HDG) (67 patients, 20 μg/kg). All patients were given clopidogrel (600 mg) and aspirin (300 mg) prior to being catherized with 3500 IU heparin and vaccinated via the radial artery. As a result, no tirofiban was given to the control group. A bolus of 5 μg/kg tirofiban was intravenously vaccinated to the LDG in 5 minutes after which it was injected constantly for 36 hours at a rate of 0.5 μg/kg. In the MDG, a bolus of 10 μg/kg tirofiban was intravenously inoculated around 10 minutes, proceeded by a 36-hour period of continual intravenous injection at a rate of 0.10 μg/kg. In the HDG, a bolus of 20 μg/kg tirofiban was intravenously supplied approximately 10 minutes, followed by a 36-hour period of continuous intravenous administration at 0.220 μg/kg. All participants undergo oral clopidogrel (75 mg/daily) and aspirin (100 mg/daily) for at least a year subsequent PCI. Coronary angiography was conducted out after the catheter was implanted to view the infarcted arteries then use a puncture through the right radial artery.

Patients had routine balloon dilation medication based on the target lesions, continued by the routine implant of stents with the proportion of stent diameter to vessel diameter. During surgery, just the artery leading to the infarction was severed. These participants then had a coronary arteriography evaluation. In respect of myocardial reperfusion parameters, PCI medication was applied to evaluate myocardial reperfusion. There were three assessments made: the 90-minute sum-ST-segment resolution (sumSTR), corrected TIMI frame count, and thrombolysis in myocardial infarction (TIMI) grade 3 flow. The left ventricular end systolic diameter (LVESD), left ventricular end diastolic diameter (LVEDD) and the left ventricular ejection fraction (LVEF) were evaluated using the cardiac function

indexes. Major adverse cardiac events (MACE), such as myocardial infarction, angina pectoris, abrupt heart failure, target vessel revascularization (TVR), cardiac mortality and others, were reported for the study's primary clinical end point after 1 month following the PCI. Considering haemorrhage and thrombocytopenia: After PCI, haemorrhage has been mostly caused by bleeding at the puncture site and tunica mucosal bleeding, cerebral bleeding, gastrointestinal bleeding and other types of bleeding. A record of the thrombocytopenia was also made.

All statistical assessments were made using STATA version 12.0. Counts or proportions (%) or mean values with standard deviation (SD) were utilized to depict continuous data. When predicted cell values were less than 5, quantitative information was compared through using Chi-Square test or Fisher's accurate test. P value under 0.05 was deemed significant.

Ethical Statement

The guidelines of the National Institutes of Health's Guide for the Care and Use of Laboratory Animals were strictly followed when conducting this study. The DHQ Daggar Buner approves the research. Written consents were obtained from participants and every attempt was made to lessen pain during sample collection.

Results

Between April 2021 and February 2022, our institution treated 272 acute STEMI sufferers who had PCI. Patients were sorted into four groups at random: the control group (65 cases), the LDG (69 instances), the MDG (71 cases), and the HDG (71 cases) (67 cases). General findings for the 4 groups did not demonstrate any appreciable differences (table 1). The HDG considerably outperformed the LDG and MDG and control groups in terms of CTFC, TIMI grade 3 flow and sumSTR greater than 50%, whereas the MDG significantly outperformed the LDG, control group in terms of CTFC. However, there were no statistically significant changes between the control group, LDG, and MDG when TIMI grade 3 flow and sumSTR (>50%) were compared (table 2).

Table 1: Evaluations of patient demographic information

Variables	Control group (n= 65)	LDG (n= 69)	MDG (n= 71)	HDG (n= 67)	P value
Age in years: Mean±SD	57.63 ± 9.77	56.48 ± 10.51	56.62 ± 11.27	55.84 ± 10.29	.785
Sex category					
Men: Frequency (%)	47 (72.31)	41 (59.42)	53 (74.66)	37 (55.22)	
Women: Frequency (%)	18 (27.69)	28 (40.58)	18 (25.34)	30 (44.78)	.249
Diabetes: Frequency (%)	11 (16.92)	16 (23.18)	14 (19.71)	15 (22.38)	.617
Smoker: Frequency (%)	41 (63.07)	46 (66.67)	51 (71.83)	45 (67.16)	.632
BMI: Mean±SD	23.48 ± 3.69	24.56 ± 3.49	24.35 ± 2.32	23.66 ± 3.45	.231
Hyperlipidemia: Frequency	31 (47.69)	28 (40.57)	35 (49.29)	34 (50.74)	.787

(%)					
Hypertension: Frequency (%)	43 (66.15)	49 (71.01)	47 (66.19)	48 (71.64)	.736
CRUSADE bleeding risk score: Mean±SD	31.23 ± 7.25	30.49 ± 7.48	±28.71 7.51	±29.08 8.61	±.178
Killip class					
Class I: Frequency (%)	41 (63.09)	45 (65.24)	48 (67.62)	42 (62.68)	
Class II: Frequency (%)	13 (20.0)	16 (23.18)	14 (19.71)	16 (23.88)	
Class III: Frequency (%)	7 (10.76)	5 (7.24)	6 (8.45)	6 (8.95)	
Class IV: Frequency (%)	4 (6.15)	3 (4.34)	3 (4.22)	3 (4.49)	.863
Infarct-related artery					
Right coronary artery: Frequency (%)	15 (23.07)	18 (26.09)	19 (26.76)	17 (25.38)	.952
Circumflex artery: Frequency (%)	18 (27.70)	23 (33.33)	21 (29.57)	21 (31.34)	
Anterior descending: Frequency (%)	32 (49.23)	28 (40.58)	31 (43.67)	29 (43.28)	
Diseased vessels					
1: Frequency (%)	24 (36.92)	29 (42.02)	32 (45.07)	31 (46.27)	
2: Frequency (%)	29 (44.62)	24 (34.79)	25 (35.21)	19 (28.35)	.876
3: Frequency (%)	12 (18.46)	16 (23.19)	14 (19.7)	17 (25.38)	
intra-aortic balloon pump	11 (16.92)	19 (27.53)	16 (22.53)	13 (19.40)	.435
Pacemaker: Frequency (%)	23 (35.38)	22 (31.88)	28 (39.43)	24 (35.82)	.763
Onset-to-PCI time (h): Mean±SD	5.68 ± 1.49	5.34 ± 1.59	±5.76 1.48	±5.61 1.70	±.349

Table 2: Acute myocardial reperfusion parameter evaluations

	Control group (n = 65)	LDG (n= 69)	MDG (n= 71)	HDG (n= 67)	P value
SumSTR >50%	47 (72.30)	52 (75.36)	53 (74.64)	61 (91.04)[a,b,c]	<0.001
CTFC	26.05 ± 6.97	24.21 ± 4.59	21.87 ± 4.23[a,b]	19.03 ± 5.09[a,b,c]	<0.001
TIMI grade 3	52 (80.00)	55 (79.71)	57 (80.28)	61 (91.04)[a,b,c]	0.04

a,b and c compared with control group, LDG and MDG respectively (P value less than 0.05); CTFC, Cardiac Thin Filament Complex; TIMI, Thrombolysis in Myocardial Infarction.

There were no differences between the 4 groups when evaluating LVEDD, LVEF, and LVESD before the PCI. The LVEF, LVESD, and LVEDD of the HDG were all better than those of the control group, LDG, and MDG at 1 week and 1 month following the PCI. The LVEDD, LVESD, and LVEF of the MDG were superior to those of the control group at one month following the PCI, and the LVEF of the MDG was higher to that of LDG. The differences noted above indicated statistical

significance (Table *3*). Within a month, there were 43.07%, 33.33%, 21.12%, and 11.94% cases of MACE in the control group, LDG, MDG, and HDG, respectively. The incidence of MACE in the HDG was much lower than that in the LDG, MDG, and control groups. The MDG was also considerably lower than the control group (Table *4*). The incidence of haemorrhage was 12.30%, 7.24%, 12.67%, and 34.32% in the control group, LDG, MDG, and HDG, respectively. The incidence of thrombocytopenia was 4.61%, 7.24%, 14.08%, and 26.86% in each group. As compared to the control group, LDG, and MDG, the incidence of haemorrhage and thrombocytopenia was considerably greater in the HDG. However, there was no discernible difference in the occurrence of haemorrhage and thrombocytopenia between the control group, LDG, and MDG (Table *5*).

Table 3: Parameter evaluations for cardiovascular output

Control group (n = 65)			LDG (n= 69)	HDG (n= 67)	MDG (n= 71)	P value
	Earlier PCI	48.56 ± 5.68	46.64 ± 4.69	49.17 ± 4.71	48.79 ± 4.25	.856
LVEDD	1week afterward PCI	44.96 ± 6.58	44.30 ± 5.29	43.81 ± 5.34	41.34 ± 4.95 a,b,c	< .001>
	1 month afterward PCI	44.32 ± 6.19	43.64 ± 4.11	42.38 ± 4.62a	40.32 ± 4.13 a,b,c	< .001>
	Earlier PCI	37.82 ± 4.23	37.14 ± 3.16	35.82 ± 4.24	36.76 ± 3.21	.140
LVESD	1 week afterward PCI	36.15 ± 3.43	34.12 ± 3.51	33.81 ± 4.41	31.15 ± 4.20 a,b,c	< .001>
	1 month afterward PCI	33.56 ± 3.19	32.53 ± 4.76	31.43 ± 3.23a	30.92 ± 3.43a,b,c	< .001>
	Earlier PCI	43.18 ± 5.78	43.34 ± 5.18	43.68 ± 5.15	44.91 ± 5.71	.247
LVEF	1 week afterward PCI	52.79 ± 5.87	53.34 ± 5.12	54.95 ± 3.23	56.65 ± 5.73a,b,c	< .001>
	1 month afterward PCI	51.35 ± 5.93	52.12 ± 5.59	54.43 ± 5.76a,b	58.98 ± 6.16a,b,c	< .001>

a, b and c compared with control group, LDG and MDG respectively (P value less than .05). left ventricular end systolic diameter: LVESD, left ventricular end diastolic diameter: LVEDD, left ventricular ejection fraction: LVEF, percutaneous coronary intervention: PCI.

Table 4: Evaluations of the frequency of MACE

Control group (n = 65)	LDG (n= 69)	MDG (n= 71)	HDG (n= 67)	P value
Angina pectoris	12 (18.46)	8 (11.59)	6 (8.45)	4 (5.97)	
Myocardial infarction	9 (13.84)	7 (10.14)	5 (7.04)	3 (4.47)	
Cardiac death	0 (0.00)	2 (2.89)	0 (0.00)	0 (0.00)	
Acute heart failure	10 (15.38)	8 (11.59)	5 (7.04)	3 (4.47)	
MACE	28 (43.07)	23 (33.33)	15 (21.12)a	8 (11.94)a,b,c	

TVR	6 (9.23)	5 (7.24)	3 (4.22)	0 (0.00)	< .001

a, b and c compared with control group, lower dose group: LDG and medium dose group: MDG respectively (P value less than .05). Major adverse cardiac events: MACE, target vessel revascularization: TVR.

Table 5: Evaluations of the prevalence of the thrombocytopenia and hemorrhage

	Control group (n = 65)	LDG (n= 69)	MDG (n= 71)	HDG (n= 67)	P value
Hemorrhage					
Intracranial hemorrhage	0	0	0	3 (4.47)	
Gastrointestinal hemorrhage	2 (3.07)	0	3 (4.22)	6 (8.95)	
Hemorrhage at puncture place	2 (3.07)	3 (4.34)	5 (7.04)	9 (13.43)	
Extra hemorrhage	4 (6.15)	2 (2.89)	1 (1.40)	5 (7.46)	Less than 0.01
Total prevalence	8 (12.30)	5 (7.24)	9 (12.67)	23 (34.32)[a,b,c]	
Thrombocytopenia	3 (4.61)	5 (7.24)	10 (14.08)	18 (26.86)[a,b,c]	

a, b and c compared with control group, LDG and MDG respectively (P value less than .05).

Discussion

Past study established the astonishing effect of PCI on STEMI patients, which may restore myocardial ischemia reperfusion injuries and enhance the patency of infarction relevant blood vessels [13-15]. Studies have discovered that applying IIb/IIIa receptor antagonists in combined effect with PCI for patients with acute myocardial infarction can dramatically improve post - operative myocardial TIMI discharge categorization of endorse myocardial perfusion, infarction-linked coronary artery and decrease the MACE frequency [16-18]. Tirofiban can improve early microcirculation, minimize the incidence of MACE, and inhibit inflammatory and vasoconstrictive components [19]. The effectiveness of tirofiban in the therapy of STEMI has gained consideration on a global scale. The common clinical dosage is 10 μg per kg, followed by a 0.15 μg per kg continuous subcutaneous injection, which is frequently linked by a high risk of MACE recurrence [20]. As a result, there is still debate over the ideal tirofiban dose.

In this study, at 1 week and 1 month, the LVESD, LVEF and LVEDD of the HDG remained completely higher than those of the control group, LDG, and MDG. Additionally, the MDG's LVEDD, LVEF, and LVESD were all better than those of the control group, and the MDG's LVEF was better than that of LDG at 1 month following PCI. These findings, which are in line with other studies, imply that increasing the dosage of tirofiban may have some links to improving efficacy [21]. The biggest issue with tirofiban's safety is the possibility of bleeding. Tirofiban use increases the danger of bleeding-linked problems, particularly plain ones such

cerebral haemorrhage, which could be fatal in some individuals. Tirofiban use can also result in thrombocytopenia [22,23]. For STEMI patients having PCI, multiple doses of tirofiban were utilized to examine the clinical impact and safety of the drug. The findings showed that the MACE occurrence in HDG was suggestively lesser compare to control group, MDG and LDG, and that improvements in cardiac function and myocardial ischemia-reperfusion injury were significantly better in HDG than in control group, MDG and LDG. This suggests that higher dosage of tirofiban can enhance Heart task and lesser the MACE prevalance. The substantial inhibitory action of large doses of tirofiban on platelets, which can enhance myocardial cell blood supply and improve coronary artery flow, may be the mechanism behind this effect. More significantly, it can induce ST segment down-regulation and lower the area of myocardial infarction [24]. However, the HDG had a considerably greater incidence of bleeding than the control group, LDG, and MDG [25]. According to Fabris et al [26], prehospital therapy with tirofiban can lower MACE incidence and death at 1 month and 1 year. The Velibey et al [27] noted that tirofiban was linked to decreased short- and long-term mortality despite a greater frequency of comorbidities during hospitalization. In line with this claim, the MACE Prevalence in the HDG group was also significantly greater at 1 month (11.94% vs 43.07%, 33.33%, and 21.12%), associated with increased haemorrhage complications (34.32 vs 12.30%, 7.24%, and 12.67%). These results indicated that the patient's hemorrhagic risk should be taken into consideration while giving the correct dosage of tirofiban.

The study's findings showed that using tirofiban to treat STEMI patients who had PCI might reduce myocardial ischemia-reperfusion damage, encourage quick restoration of cardiac function, and have higher clinical effectiveness. An additional study, Zhang et al [28] came to the conclusion that 10 μg/kg tirofiban may safely manage hemorrhagic risk, successfully avoid stent thrombosis, and reduce the inflammatory response in PCI patients.

Study limitations

Only individuals without a risk of hemorrhaging were included in this study because patients with a risk of hemorrhaging could not have been studied using this approach. Additionally, this study's sample size was too small, which might have caused some statistical bias.

Conclusion

Tirofiban’s effectiveness in treating STEMI patients who had PCI showed a good dose-response relationship. The risk of bleeding rises along with the clinical symptoms when the dosage was high. As a result, the optimal dose might be determined by taking into account the unique circumstances of the individuals whose hemorrhagic risk is being evaluated. For patients with a low risk of hemorrhagic, a 10 μg/kg of average dosage may be adequate.

References

1. Agarwal SK, Agarwal S: Role of intracoronary fibrinolytic therapy in contemporary PCI practice . Cardiovasc Revasc Med. 2019, 20:1165-71.

2. Ahmed N, Carberry J, Teng V, et al.: Risk assessment in patients with an acute ST-elevation myocardial infarction. J Comp Eff Res. 2016, 5:581-93.
3. Boden WE, Eagle K, Granger CB: Reperfusion strategies in acute ST-segment elevation myocardial infarction: a comprehensive review of contemporary management options. J Am Coll Cardiol. 2007, 50:917- 929.
4. Chen GX, Wang HN, Zou JL, Yuan XX: Effects of intracoronary injection of nicorandil and tirofiban on myocardial perfusion and short-term prognosis in elderly patients with acute ST-segment elevation myocardial infarction after emergency PCI. World Journal of Emergency Medicine. 2020, 11:157.
5. De Luca G, Dirksen MT, Spaulding C, et al.: Meta-analysis comparing efficacy and safety of first generation drug-eluting stents to bare-metal stents in patients with diabetes mellitus undergoing primary percutaneous coronary intervention. Am J Cardiol. 2013, 111:1295-1304.
6. De Winter RJ: Anticoagulation and antiplatelet therapy in acute coronary syndromes: choosing between the Scylla of bleeding and the Charybdis of ischaemic events. Neth Heart J. 2018, 26:287-8.
7. Dongxing M., Huiliang L., Hongying Y., et al.: Effects of Intracoronary Tirofiban Injection on Myocardial Perfusion and Near-Future Cardiac Function in STEMI. Patients in Emergency Percutaneous Coronary Artery Intervention, J. Chinese General Practice. 2010, 5:476-478.
8. Erdim R, Erciyes D, G€ormez S, et al.: Comparison of intracoronary versus intravenous administration of Tirofiban in primary percutaneous coronary intervention. Anadolu Kardiyol Derg. 2010, 10:340-345.
9. Fabris E, Kilic S, Schellings DAAM, et al.: Long-term mortality and prehospital tirofiban treatment in patients with ST elevation myocardial infarction. Heart. 2017, 103:1515-20.
10. Gao R, Wang J, Zhang S, et al.: The value of combining plasma D-dimer and endothelin-1levels to predict no-reflow after percutaneous coronary intervention of ST-segment elevation in acute myocardial infarction patients with a type 2 diabetes mellitus history. Med Sci Monit. 2018, 24:3549-56.
11. Gershlick AH, Banning AP, Myat A, et al.: Reperfusion therapy for STEMI: is there still a role for thrombolysis in the era of primary percutaneous coronary intervention?. The Lancet. 2013, 17;382:624-32.
12. Hermanides RS, Kilic S, van't Hof AWJ: Optimal pharmacological therapy in ST-elevation myocardial infarction-a review: a review of antithrombotic therapies in STEMI. Neth Heart J. 2018, 26:296-310.
13. Karathanos A, Lin Y, Dannenberg L, et al.: Routine glycoprotein IIb/IIIa inhibitor therapy in ST-segment elevation myocardial infarction: a metaanalysis. Can J Cardiol. 2019, 35:1576-88.
14. Lang SH, Manning N, Armstrong N, et al.: Treatment with Tirofiban for acute coronary syndrome (ACS): a systematic review and network analysis. Curr Med Res Opin. 2012, 28:351-370.
15. Lei Z, Xiaoming Z, Yan H, et al.: Analysis of the Best Timing for Applying Tirofiban in PCI Operation for the Patients with ST Segment Elevation Myocardial Infarction. Open Medicine. 2015, 10. https://doi.org/10.1515/med-2015-0065
16. Liu Y, Liu H, Hao Z, et al.: Efficacy and safety of different doses of tirofiban combined with ticagrelor on diabetic patients withAMI receiving in emergency percutaneous coronary intervention (PCI). Int J Clin Exp Med. 2015, 8:11360-9.

17. Niu XW, Zhang JJ, Bai M, et al.: Combined thrombectomy and intracoronary administration of glycoprotein IIb/IIIa inhibitors improves myocardial reperfusion in patients undergoing primary percutaneous coronary intervention: a meta-analysis. J Geriatr Cardiol. 2017, 14:614-23.
18. Ren LH, Peng JJ, Ye HM, Wang ZY, Chen C: High-dose Tirofiban in patients with acute ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. Chin Med J. 2012, 92:1981- 1983.
19. Tu Y, Hu L, Yang C, et al.: Optimal antithrombotic therapy for patients with STEMI undergoing PCI at high risk of bleeding. Curr Atheroscler Rep. 2019, 21:22-30.
20. Ulus T, S¸enol U, Tahmazov S, et al.: High-dose bolus tirofiban versus lowdose bolus in patients with acute coronary syndrome undergoing percutaneous coronary intervention. Turk Kardiyol Dern Ars. 2017, 45:126-33.
21. Velibey Y, Guvenc TS, Demir K, et al.: Effects of bailout Tirofiban on inhospital outcomes and long-term mortality in patients with ST-segment elevation myocardial infarction undergoing primary percutaneous intervention. Angiology. 2019, 70:431-9.
22. Vogel B, Claessen BE, Arnold SV, et al.: ST-segment elevation myocardial infarction. Nature reviews Disease primers. 2019, 5:39-10. 10.1038/s41572-019-0090-3
23. Wang J, Wang DZ: Evaluation on the safety and efficacy of high-dose tirofiban in the primary percutaneous coronary intervention on patients with acute ST-elevation myocardial infarction. Chin Gen Prac. 2015, 18:3276-82.
24. Wang Y, Wu B, Shu X: Meta-analysis of randomized controlled trials comparing intracoronary and intravenous administration of glycoprotein IIb/IIIa inhibitors in patients with ST-elevation myocardial infarction. Am J Cardiol. 2012, 109:1124-1130.
25. Wojtukiewicz MZ, Hempel D, Sierko E, et al.: Antiplatelet agents for cancer treatment: a real perspective or just an echo from the past?. Cancer Metastasis Rev. 2017, 36:305-29.
26. Yang XC, Zhang DP, Wang LF, et al.: Effects of intracoronary or intravenous Tirofiban administration in patients with acute STelevation myocardial infarction undergoing primary percutaneous coronary intervention(Chin). Zhonghua Xin Xue Guan Bing Za Zhi. 2007, 35:517-522.
27. Zhang Y, Shao T, Yao L, et al.: Effects of tirofiban on stent thrombosis, Hs-CRP, IL-6 and sICAM-1 after PCI of acute myocardial infarction. Exp Ther Med. 2018, 16:3383-8.
28. Zhao C, Cheng G, He R, et al.: Effects of different routes of tirofiban injection on the left ventricular function and prognosis of patients with myocardial infarction treated with percutaneous coronary intervention. Exp Ther Med. 2015, 9:2401-5.