Int J Clin Exp Med 2016;9(12):23634-23641
www.ijcem.com /ISSN:1940-5901/IJCEM0021425

Original Article

Effects of simultaneous or elective percutaneous coronary intervention for non-infarction related artery on clinical outcome in over 70-year-old patients with acute ST-elevation myocardial infarction combined with multi-vessel lesions

Yu Huang[1,3*], Xiao-Long Wang[2*], Chang-Wu Ruan[3], Deng-Hai Zhang[3], Gang Lin[4], Xiang-Jun Yang[1]

[1]Department of Cardiology, The First Affiliated Hospital of Soochow University, Suzhou 215006, China; [2]Department of Cardiology, Shuguang Hospital Affiliated Shanghai University of Traditional Chinese Medicine, Shanghai 200100, China; [3]Department of Cardiology, Shanghai Pudong District Gongli Hospital, Shanghai 200135, China; [4]Department of Cardiology, The First People's Hospital of Nantong City, Nantong 226001, China. [*]Equal contributors.

Received December 8, 2015; Accepted May 5, 2016; Epub December 15, 2016; Published December 30, 2016

Abstract: Objective: To compare the effects of simultaneous or elective percutaneous coronary intervention (PCI) for treatment of non-infarction related arteries (NIRA) on clinical outcome in over 70-year-old patients with ST-elevation myocardial infarction (STEMI) combined with multi-vessel lesions. Methods: A total of 70 patients aged over 70 yeas that had acute STEMI combined with multi-vessel lesions and received PCI between January 2010 and January 2015, were enrolled in this study. According to simultaneous emergency PCI or elective PCI for treatment of NIRA, the 70 patients were divided into simultaneous PCI group and elective PCI group. Clinical outcomes were compared between the both groups during one-year follow-up. Results: There were no statistical differences in sex, age, constituent ratio of diseases, risk factors of coronary artery disease (CAD), family history of CAD, heart function, cardiac functional grading, hepato-renal function indices, medication, time interval from symptom onset to balloon dilatation, time interval from seeing doctors to balloon dilatation, and related data of emergency coronary angiography and direct PCI between the both groups (all $P > 0.05$). During the follow-up of 1-3 months, 3-12 months and one year, there were respectively no statistical differences in the incidences of major cardiovascular events including recrudescent angina, re-hospitalization due to cardiovascular disease, heart failure, recurrent myocardial infarction, second revascularization, severe arrhythmia, all-cause mortality and cardiovascular mortality between the two groups (all $P > 0.05$). Conclusion: For over 70-year-old patients who have acute STEMI combined with multi-vessel lesions and receive emergency PCI for treatment of infarction-related arteries (IRA), we propose that simultaneous emergency PCI for treatment of NIRA be adopted instead of elective PCI for treatment of NIRA because it fails to increase heart-related events and also avoids another PCI.

Keywords: Acute ST-elevation myocardial infarction, multi-vessel lesions, percutaneous coronary intervention, non-infarct-related artery, major cardiovascular events

Introduction

Acute myocardial infarction (AMI) is one of the main diseases to threat human health in the world [1-5], and acute ST-elevation myocardial infarction (STEMI) is the most severe condition in AMI. Emergency percutaneous coronary intervention (PCI) has been become an important approach for AMI therapy and coronary revascularization [6]. It is documented that the incidence of multi-vessel lesions in the patients with AMI is as high as 40-50% [7]. Moreover, most of senile patients with AMI usually have diabetes mellitus, hypertension, cerebrovascular disease and renal diseases; so multi-vessel lesions are common, and coronary lesions are also complex in senile patients with AMI.

Most of previous studies do not support the viewpoint of simultaneous emergency PCI used for treatment of non-infarction related artery (NIRA) in acute STEMI combined with multi-ves-

sel lesions, so many guidelines propose emergency PCI only be used for treatment of infarction-related arteries (IRA) except the specific condition of cardiogenic shock [8-11]. However, in recent years, there has been considerable debate about whether emergency PCI is simultaneously used to treat NIRA for these patients, because some studies have displayed that emergency PCI used for treatment of NIRA is also beneficial to acute STEMI combined with multi-vessel lesions [12-17]. Therefore it is necessary to clarify this question.

In this study, according to simultaneous emergency PCI or elective PCI for treatment of NIRA, the 70-year-old patients that had acute STEMI combined with multi-vessel lesions and received PCI, were divided into simultaneous PCI group and elective PCI group. We retrospectively analyzed data of these patients and compared clinical outcomes between the both groups in order to provide a basis for treatment strategy.

Subjects and methods

All study methods were approved by Institutional Review Board and Ethics Committee of the First Affiliated Hospital of Soochow University. All the subjects or their guardians enrolled into the study gave written formal consent to participate.

Subjects

A total of 70 patients aged over 70 yeas that had acute STEMI combined with multi-vessel lesions for the first time and received PCI between January 2010 and January 2015, were enrolled in this study.

Inclusion criteria were: ① 70 to 85-year-old patients of either sex; ② the patients who had STEMI combined with multi-vessel lesions within 12 h after AMI onset and underwent successful emergency PCI. Diagnostic criteria for STEMI: within 12 h of chest pain onset ① ST-segment elevation ≥ 0.2 mV in at least two adjacent chest leads or ST-segment elevation ≥ 0.1 mV in limb lead; or ② new left bundle branch block with or without elevation of myocardial injury markers.

Exclusion criteria: ① the patients who had no indications for emergency PCI, or refused emergency PCI or underwent unsuccessful emergency PCI (criteria for successful PCI is shown below); ② a history of AMI; ③ left main coronary lesion; ④ chronic occlusive disease; ⑤ coronary multi-branch occlusion; ⑥ severe coronary distortion and coronary calcification; ⑦ severe hepato-renal dysfunction; ⑧ malignant tumor; and ⑨ death occurring in the duration of hospital stay.

Grouping: According to simultaneous emergency PCI or elective PCI for treatment of NIRA, patients enrolled in this study were divided into simultaneous PCI group (22 patients) and elective PCI group (48 patients). In the elective PCI group, PCI for treatment of NIRA was performed within 1 to 4 weeks after emergency PCI for treatment of IRA.

Pre-PCI preparation and PCI procedures

All patients chewed 300 mg of enteric coated aspirin and 600 mg of clopidogrel once before operation; were given intravenous heparin (50-70 U/kg) during PCI; and then took aspirin (100 mg/d) and clopidogrel (75 mg/d), and were given intravenous low molecular heparin (70-100 U/kg, within 12 h) after operation for 3 to 5 days. IRA was identified by Judkins coronary angiography, and then balloon dilatation and stent implantation, or direct stent implantation was performed on the IRA.

Criteria for successful PCI

① diameters of residual stenosis < 20% on at least two orthogonal projection postures of coronary angiography; ② blood stream of grade 2 to 3 tested by thrombolysis in myocardial infarction (TIMI) [18]; ③ during operation, no severe cardiovascular events including death, apoplexy, tracheal cannula, emergency coronary artery bypass grafting and severe PCI-related complications such as coronary artery dissection, coronary laceration, coronary perforation, coronary bleeding and cardiac rupture.

Data collection and treatment after emergency PCI

General data was immediately collected from all patients after emergency admission. In the elective PCI group, PCI for treatment of NIRA was performed within 1 to 4 weeks after emergency PCI for treatment of IRA (during hospital

Table 1. Comparison of general data between the simultaneous PCI group and elective PCI group

	Simultaneous PCI group (n=22)	Elective PCI group (n=48)	χ^2 or t	P
Age (year)	61.62±10.17	62.82±10.38	1.12*	0.765
Sex (male, %)	19 (79.1)	41 (82)	0.06	0.823
Hypertension (%)	20 (83.3)	42 (84)	0.36	0.565
Diabetes (%)	14 (58.3)	30 (60)	0.02	0.931
Smoking (%)	17 (70.8)	36 (72)	0.82	0.378
Coronary disease (%)	4 (16.7)	8 (16)	0.04	0.848
Blood glucose (mmol/L)	7.15±1.23	7.23±1.35	-0.74*	0.736
Cholesterol (mmol/L)	4.58±1.26	4.60±1.35	2.23*	0.157
High density lipoproteins (mmol/L)	0.92±0.33	0.94±0.22	-0.42*	0.149
Low density lipoproteins (mmol/L)	3.20±1.07	3.19±1.04	0.77*	0.333
Triglyceride (mmol/L)	1.82±1.04	1.81±1.06	1.69*	0.282
Creatinine (umol/L)	73.13±43.15	72.12±43.23	3.57*	0.978
CKMB (μg/L)	177.68±78.28	178.56±78.34	-2.26*	0.958
cTnI (ng/ml)	17.28±9.36	17.15±9.22	1.56*	0.698
Left ventricular ejection fraction (%)	57.39±4.65	57.23±4.59	-2.85*	0.697
Cases with killip grading (III/V) on admission (n, %)	3 (12.5)	6 (12)	0.07	0.797
Statins (n, %)	22 (91.7)	45 (90)	0.29	0.611
ACEI (or ARB) (n, %)	19 (79.1)	41 (82)	1.15	0.286
BB-β (n, %)	19 (79.1)	40 (80)	0.14	0.687
ASA (n, %)	21 (87.5)	46 (92)	0.16	0.688
Clopidogrel (n, %)	22 (91.7)	48 (96)	0.06	0.803

Notes: *indicates t value and others are χ^2 value. PCI: percutaneous coronary intervention; CKMB: MB isoenzyme of creatine kinase; cTnI: cardiac troponin; ACEI: angiotensin converting enzyme inhibitor; ARB: angiotensin II receptor blocker (ARB); BB-β: β-receptor blocker; ASA: aspirin.

stay or after being discharged). In both groups, patients were given dual anti-platelet drugs, statins, angiotensin converting enzyme inhibitor (ACEI)/angiotensin II receptor blocker (ARB) and β receptor blocker if they did not have contraindication.

Follow-up

All patients were routinely followed up for one-year or until death. Major cardiovascular events were recorded, including recrudescent angina, re-hospitalization due to cardiovascular disease, recurrent myocardial infarction, second revascularization for the target vessel, severe arrhythmia, heart failure, all-cause death and cardiovascular death. Cardiovascular death was caused by heart failure, lethal myocardial infarction or sudden death. Major adverse cardiovascular events (MACEs) included recurrent myocardial infarction, second revascularization for the target vessel, all-cause death and cardiovascular death.

Statistical analysis

Statistical treament was performed with SPSS 18.0 software. Measurement data were expressed as x±S, and then t test and one-way ANOVA was used in the comparison between two groups. For numeration data, χ^2 test was used in the comparison between two groups. Sstatistical significance was established at $P < 0.05$.

Results

Comparison of data between both groups

A total of 70 patients were enrolled in this study. Simultaneous PCI group contained 22 patients and elective PCI group contained 48 patients. Between both groups, there were no significant differences in general data (**Table 1**), time interval from symptom onset to balloon dilatation, time interval from seeing doctors to balloon dilatation, conditions of emergency coronary lesions and stent implantation, pre- and

Table 2. Comparisons of emergency coronary lesions between the simultaneous PCI group and elective PCI group

	Simultaneous PCI group (n=22)	Elective PCI group (n=48)	χ^2 or t	P
Lesion in 2 vessels (n, %)	12 (54.5)	27 (56.2)	0.35	0.555
Lesion in 3 vessels (n, %)	10 (45.5)	21 (43.8)	0.47	0.586
Site of IRA (n, %)				
LAD (n, %)	7 (29.1)	17 (34)	0.15	0.721
LCX (n, %)	7 (29.1)	19 (38)	1.29	0.256
RCA (n, %)	10 (41.7)	22 (44)	0.37	0.575
Complete occlusion of IRA (n, %)	18 (75)	37 (74)	0.23	0.755
Site of NIRA (n, %)				
LAD (n, %)	9 (37.5)	18 (36)	0.50	0.398
LCX (n, %)	11 (45.8)	23 (46)	0.75	0.382
RCA (n, %)	12 (50)	24 (48)	0.18	0.597
SOTB (h, x±s)	8.8±7.4	8.9±7.5	1.88*	0.465
SDTB (min, x±s)	85.0±29.4	85.0±31.5	-0.55*	0.412
Pre-PCI TIMI (n, %)				
Grade 0-1	18 (75)	40 (80)	0.15	0.150
Grade 2	5 (20.8)	8 (16)	0.67	0.687
Grade 3	1 (4.2)	2 (4)	0.28	0.594
Post-PCI TIMI (n, %)				
Grade 2	4 (16.7)	6 (12)	0.02	0.889
Grade 3	20 (83.3)	44 (88)	0.03	0.856

Notes: *indicates t value and others are χ^2 value. PCI: percutaneous coronary intervention; IRA: infarction-relative arteries; NIRA: non-infarction related artery; LAD: left anterior descending; LCX: left circumflex artery; RCA: right coronary artery; SOTB: time interval from symptom onset to balloon dilatation; SDTB: time interval from seeing doctors to balloon dilatation; TIMI: thrombolysis in myocardial infarction.

post-PCI TIMI blood-stream grades, and pre- and post- PCI minimal lumen diameters (all $P > 0.05$) (**Table 2**).

Comparison of major cardiovascular events between both groups

All patients were followed up for 360±17 days. During the whole follow-up, one patient died of heart failure in simultaneous PCI group; while in elective PCI group, one patient died of malignant tumor and two patients died of heart failure. There were no significant differences in recrudescent angina, re-hospitalization due to cardiovascular disease, recurrent myocardial infarction, second revascularization for the target vessel, severe arrhythmia, heart failure, all-cause mortality and cardiovascular mortality (all $P > 0.05$) (**Table 3**). During the follow-up of 1-3 months and 3-12 months, there were also no significant differences in all major cardiovascular events, respectively (all $P > 0.05$) (**Tables 4** and **5**).

Discussion

Although there is difficulty in the treatment of AMI for senile patients due to poor heart function and low physiological reserve [19, 20], PCI has proved to be beneficial to senile patients with AMI [21]. However, it is tough to determine whether PCI is used for senile patients with AMI, so it is more difficult to determine whether emergency PCI is also used in treatment of NIRA for the senile patients who have AMI combined with multi-vessel lesions [22, 23].

Compared with the patients with single-vessel lesion, the patients with multi-vessel lesions readily have a longer history of coronary disease, and higher incidences of hypertension, diabetes mellitus and hyperlipidemia; so clinical symptoms caused by myocardial ischemia is more severe, post-PCI complications and fatality rate are higher, and prognosis is poorer in the patients with multi-vessel lesions than in the patients with single-vessel lesion [24-26]. There has been considerable debate on the therapeutic strategy for AMI combined with multi-vessel lesions, and simultaneous use of emergency PCI in the treatment of NIRA for the patients with STEMI has become the focus of much interest and debate. A HORIZONS-AMI study displayed that emergency PCI simultaneously used in the treatment of NIRA for the patients with STEMI patients increased mortality, and incidences of chronic heart failure, stent thrombosis and shock [27]. Some studies also showed that emergency PCI simultaneously used in the treatment of NIRA failed to improve prognosis and to decrease the incidence of MACE [28-31]. Moreover, multivariate regression analyses indicated that em-

Table 3. Comparisons of major cardiovascular events between the simultaneous PCI group and elective PCI group during whole one-year follow-up

	Simultaneous PCI group (n=22)	Elective PCI group (n=48)	χ^2	*P*
All-cause mortality (n, %)	1 (4.2)	3 (6)	0.11	0.744
Cardiogenic mortality (n, %)	1 (4.2)	2 (4)	0.00	0.973
Recurrent myocardial infarction (n, %)	1 (4.2)	2 (4)	0.00	0.973
Recrudescent angina (n, %)	3 (12.5)	8 (16)	0.32	0.368
Second revascularization (n, %)	3 (12.5)	6 (12)	0.06	0.834
Second PCI	2 (8.3)	5 (10)	0.05	0.833
Second PCI for IRA	1 (4.2)	2 (4)	0.00	0.973
Second PCI for NIRA	0 (0)	1 (2)	0.49	0.485
Second PCI for other arteries	1 (4.2)	2 (4)	0.00	0.973
Coronary artery bypass grafting	1 (4.2)	1 (2)	0.29	0.591
Heart failure (n, %)	4 (16.7)	7 (14)	0.27	0.652
Severe arrhythmia (n, %)	1 (4.2)	1 (2)	0.29	0.591
Re-hospitalization due to CD (n, %)	4 (16.7)	6 (12)	0.30	0.583
MACEs (n, %)	5 (20.8)	11 (22)	0.01	0.909

Notes: PCI: percutaneous coronary intervention; IRA: infarction-relative arteries; NIRA: non-infarction related artery; CD: cardiogenic disease; MACEs: major adverse cardiovascular events.

Table 4. Comparisons of major cardiovascular events between the simultaneous PCI group and elective PCI group during one to three-month follow-up

	Simultaneous PCI group (n=22)	Elective PCI group (n=48)	χ^2	*P*
All-cause mortality (n, %)	1 (4.2)	1 (2)	0.29	0.591
Cardiogenic mortality (n, %)	1 (4.2)	0 (0)	2.11	0.146
Recurrent myocardial infarction (n, %)	1 (4.2)	0 (0)	2.11	0.146
Recrudescent angina (n, %)	2 (8.3)	4 (8)	0.00	0.961
Second revascularization (n, %)	1 (4.2)	2 (4)	0.00	0.973
Second PCI	1 (4.2)	2 (4)	0.00	0.973
Second PCI for IRA	1 (4.2)	0 (0)	2.11	0.146
Second PCI for NIRA	0 (0)	1 (2)	0.49	0.485
Second PCI for other arteries	0 (0)	1 (2)	0.49	0.485
Coronary artery bypass grafting	0 (0)	0 (0)	-	-
Heart failure (n, %)	2 (8.6)	4 (8)	0.00	0.961
Severe arrhythmia (n, %)	1 (4.2)	0 (0)	2.11	0.146
Re-hospitalization due to CD (n, %)	2 (8.3)	2 (4)	0.60	0.440
MACEs (n, %)	3 (12.5)	3 (6)	0.92	0.338

Notes: PCI: percutaneous coronary intervention; IRA: infarction-relative arteries; NIRA: non-infarction related artery; CD: cardiogenic disease; MACEs: major adverse cardiovascular events.

ergency PCI simultaneously used in the treatment of NIRA was an independent risk factor of MACE, and most meta-analyses also didn't support the viewpoint of emergency PCI simultaneously used in the treatment of NIRA.

However, it is reported that the incidence of MACE and hospital mortality were significantly lower in both IRA and NIRA PCI group than in only IRA PCI group [13]. Navarese et al [14] also found that emergency PCI simultaneously used in the treatment of NIRA significantly reduced the incidence of second revascularization, but failed to decrease rates of death and recurrent myocardial infarction. A PRAMI study of 23-month follow-up indicated that the incidence of MACE decreased by 65% in both IRA and NIRA PCI group as compared to only IRA PCI group [15]. A CvLPRIT study exhibited that the total incidence of MACEs (all-cause death, recurrent myocardial infarction, heart failure and second vascularization) dropped by 55% (10.0% vs. 21.2%, *P*=0.009) in both IRA and NIRA PCI group as compared to only IRA PCI group one-year after PCI [16]. In 2015, a PRAGUE trial included 214 patients with STEMI and multi-vessel lesions who were randomly divided into both IRA and NIRA PCI group (n=106) and only IRA PCI group (n=108), and were followed up for 38 weeks with all-cause death, nonfatal myocardial infarction and cerebral apoplexy as main outcomes and with re-hospitalization due to unstable angina,

Table 5. Comparisons of major cardiovascular events between the simultaneous PCI group and elective PCI group during three to twelve-month follow-up

	Simultaneous PCI group (n=22)	Elective PCI group (n=48)	χ^2	*P*
All-cause mortality (n, %)	0 (0)	2 (4)	0.99	0.321
Cardiogenic mortality (n, %)	0 (0)	2 (4)	0.99	0.321
Recurrent myocardial infarction (n, %)	0 (0)	2 (4)	0.99	0.321
Recrudescent angina (n, %)	1 (4.2)	4 (8)	0.38	0.539
Second revascularization (n, %)	2 (8.3)	4 (8)	0.00	0.961
Second PCI	1 (4.2)	3 (6)	0.11	0.744
Second PCI for IRA	0 (0)	2 (4)	0.99	0.321
Second PCI for NIRA	0 (0)	0 (0)	-	-
Second PCI for other arteries	1 (4.2)	1 (2)	0.29	0.591
Coronary artery bypass grafting	1 (4.2)	1 (2)	0.29	0.591
Heart failure (n, %)	2 (8.3)	3 (6)	0.14	0.708
Severe arrhythmia (n, %)	0 (0)	1 (2)	0.49	0.485
Re-hospitalization due to CD (n, %)	2 (8.3)	4 (8)	0.00	0.961
MACEs (n, %)	2 (8.3)	8 (16)	0.41	0.523

Notes: PCI: percutaneous coronary intervention; IRA: infarction-relative arteries; NIRA: non-infarction related artery; CD: cardiogenic disease; MACEs: major adverse cardiovascular events.

therapeutic schedule change, treatment for NIRA, death due to cardiovascular disease and re-hospitalization due to heart failure as secondary outcomes. The results of this trial indicated that there were no significant differences in all-cause death, non-fatal myocardial infarction and cerebral apoplexy between the two groups [17].

In this study, there were no significant differences in general data including sex, age, constituent ratio of diseases, risk factors of coronary hear disease, family history of coronary heart disease, cardiac functional grading, hepato-renal function indices, medication, time interval from symptom onset to balloon dilatation, time interval from seeing doctors to balloon dilatation, emergency coronary angiography and direct PCI-related data between the two groups (all $P > 0.05$). This study is comparable.

During the follow-up of 1-3 months, 3-12 months and one year, there were respectively no statistical differences in the incidences of major cardiovascular events including recrudescent angina, re-hospitalization due to cardiovascular disease, heart failure, recurrent myocardial infarction, second revascularization, severe arrhythmia, all-cause mortality and cardiovascular mortality between the two groups (all $P > 0.05$), suggesting that simultaneous emergency PCI for treatment of NIRA is safe for over-70-year-old patients with STEMI and multi-vessel lesions because it failed to increase major cardiovascular events. Our findings are similar to those in PRAMI [15], CVLPRIT [16] and PEAGUE [17] studies. However, in this study, we neither found the result that simultaneous PCI for treatment of NIRA decreased the incidences of cardiovascular death, non-fatal myocardial infarction and recrudescent angina in PRAMI study, nor found the result that simultaneous PCI for treatment of NIRA decreased the incidences of all-cause death, recurrent myocardial infarction, heart failure and second revascularization in CVLPRIT study. Only in PEAGUE study, the result is the same as that in this study, namely that simultaneous emergency PCI for treatment of NIRA had neither positive nor negative effects on clinical outcomes. The comparability between PEAGUE study and this study is worth discussing because in PEAGUE study, complete revascularizations was performed on most patients 3 to 40 days after emergency PCI, simultaneous emergency PCI for treatment of NIRA was performed on a few patients.

Our study also has several limitations such as small sample and a retrospective study. Therefore, our results remain to be further confirmed by large-sample, prospective and randomized studies.

Acknowledgements

This study was supported by grant from Jiangsu Province's Outstanding Medical Academic Leader program (No. LJ201140), the Health Science and Technology Key Cooperation Projects of Department of Social Development, Pudong District, Shanghai (No. PW2009D-2)

and National Natural Science Foundation of China (No. 81573647).

Disclosure of conflict of interest

None.

Address correspondence to: Xiang-Jun Yang, Department of Cardiology, The First Affiliated Hospital of Soochow University, No. 188, Shizi Street, Suzhou 215006, China. Tel: +86-0512-65223637; Fax: +86-0512-65223637; E-mail: h204308@aliyun.com

References

[1] World Health Organization. Regions for health network in Europe: Actions towardshealth equity, http://www.euro.who.int/document/e89941.pdf (accessed 21 August, 2009).

[2] Yasuda S, Shimokawa H. Acute Myocardial Infarction: the enduring challenge for cardiac protection and survival. Circ J 2009; 73: 2000-2008.

[3] Kumar A, Cannon CP. Acute coronary syndromes: diagnosis and management, part I. Mayo Clin Proc 2009; 84: 917-938.

[4] Kumar A, Cannon CP. Acute coronary syndromes: diagnosis and management, part II. Mayo Clin Proc 2009; 84: 1021-1036.

[5] Pesaro AE, Serrano CV Jr, Nicolau JC. Acute myocardial infarction: acute coronary syndromewith ST-segment elevation. Rev Assoc Med Bras 2004; 50: 214-220.

[6] Park KH, Ahn Y, Jeong MH, Chae SC, Hur SH, Kim YJ, Seong IW, Chae JK, Hong TJ, Cho MC, Bae JH, Rha SW, Jang YS; Korean acute myocardial infarction registry investigators. different impact of diabetes mellitus on in-hospital and 1-year mortality in patients with acute myocardial infarction who underwent successful percutaneous coronary intervention: results from the Korean Acute Myocardial Infarction Registry. Korean J Intern Med 2012; 27: 18018-8.

[7] Sorajja P, Gersh BJ, Cox DA, McLaughlin MG, Zimetbaum P, Costantini C, Stuckey T, Tcheng JE, Mehran R, Lansky AJ, Grines CL, Stone GW. Impact of multivessel disease on reperfusion success and clinical outcomes in patients undergoing primary percutaneous coronary intervention for acute myocardial infarction. Eur Heart J 2007; 28: 1709-1716.

[8] Levine GN, Bates ER, Blankenship JC, Bailey SR, Bittl JA, Cercek B, Chambers CE, Ellis SG, Guyton RA, Hollenberg SM, Khot UN, Lange RA, Mauri L, Mehran R, Moussa ID, Mukherjee D, Nallamothu BK, Ting HH. 2011ACCF/AHA/SCAI guideline for percutaneous coronary intervention: a report of the American College of Cardiology Foundation/American Heart Association task force on practice guidelines and the society for cardiovascular angiography and interventions. Circulation 2011; 124: 2574-2609.

[9] Toma M, Buller CE, Westerhout CM, Fu Y, O'Neill WW, Holmes DR Jr, Hamm CW, Granger CB, Armstrong PW; APEX-AMI Investigators. Non-culprit coronary artery percutaneous coronary intervention during acute ST-segment elevation myocardial infarction: insights from the APEX-AMI trial. Eur Heart J 2010; 31: 1701-7.

[10] Widimsky P, Holmes DR Jr. How to treat patients with ST-elevation acute myocardial infarction and multi-vessel disease? Eur Heart J 2011; 32: 396-403.

[11] O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, Ettinger SM, Fang JC, Fesmire FM, Franklin BA, Granger CB, Krumholz HM, Linderbaum JA, Morrow DA, Newby LK, Ornato JP, Ou N, Radford MJ, Tamis-Holland JE, Tommaso CL, Tracy CM, Woo YJ, Zhao DX, Anderson JL, Jacobs AK, Halperin JL, Albert NM, Brindis RG, Creager MA, DeMets D, Guyton RA, Hochman JS, Kovacs RJ, Kushner FG, Ohman EM, Stevenson WG, Yancy CW. 2013 ACCF/AHA guideline for the management of ST-elevation mvocardial infarction: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2013; 6l: e78-e140.

[12] Kereiakes DJ. Reassessing the importance of complete versus incomplete coronary revascularization. Rev Cardiovasc Med 2014; 15: 24-30.

[13] Mylotte D, Morice M C, Eltchaninoff H, Garot J, Louvard Y, Lefèvre T, Garot P. Primary percutaneous coronary intervention in patients with acute myocardial infarction, resuscitated cardiac arrest, and cardiogenic shock: the role of primary multivessel revascularization. JACC Cardiovasc Interv 2013; 6: 115-125.

[14] Navarese EP, De Servi S, Buffon A, Suryapranata H, De Luca G. Clinical impact of simultaneous complete revascularization vs. culprit only primary angioplasty in patients with ST-elevation myocardial infarction and multivessel disease:a meta-analysis. J Thromb Thrombolysis 2011; 31: 217-225.

[15] Toth GG, Kala P, Lansky A, Baumbach A. Will this trial change my practice? PRAMI-treatment of bystander coronary lesions in patients undergoing primary PCI for acute STEMI. Euro Intervent 2014; 10: 411-4112.

[16] Gershlick AH, Khan JN, Kelly DJ, Greenwood JP, Sasikaran T, Curzen N, Blackman DJ, Dalby M, Fairbrother KL, Banya W, Wang D, Flather M,

Hetherington SL, Kelion AD, Talwar S, Gunning M, Hall R, Swanton H, McCann GP. Randomized trial of complete versus lesion-only revascularization in patients undergoing primary percutaneous coronary intervention for STEMI and multivessel disease: the CvLPRIT trial. J Am Coll Cardiol 2015; 65: 963-972.

[17] Máchal J, Pávková-Goldbergová M, Hlinomaz O, Groch L, Vašků A. The PRAGUE Trial. Euro PCR 2015; Epub.

[18] TIMI Study Group. The Thrombolysis in Myocardial Infarction (TIMI) trial. Phase I findings. N Engl J Med 1985; 312: 932-936.

[19] Garg S, Stone G, Kappetein AP, Sabik JF 3rd, Simonton C, Serruys PW. Clinical and angiographic risk assessment in patients with left main stem lesions. JACC Cardiovas Interv 2010; 3: 891-901.

[20] Berger JS, Petersen JL, Brown DL. Vascular disease burden and in-hospital outcomes among patients undergoing percutaneous coronary intervention in New York State. Circ Cardiovasc Interv 2009; 2: 317-322.

[21] Halkin A, Singh M, Nikolsky E, Grines CL, Tcheng JE, Garcia E, Cox DA, Turco M, Stuckey TD, Na Y, Lansky AJ, Gersh BJ, O'Neill WW, Mehran R, Stone GW. Prediction of mortality after primary pereulaneous coronary intervention for acute myocardial infarction: the CADILLAC risk score. J Am Coll Cardiol 2005; 45: 1397-1405.

[22] Aronow HD, Steinhubl SR, Brennan DM, Berger PB, Topol EJ; CREDO Investigators. Bleeding risk associated with 1 year of dual antiplatelet therapy after percutaneous coronary intervention: Insights from the Clopidogrel for the Reduction of Events During Observation (CREDO) tria. Am Heart J 2009; 157: 369-374.

[23] Polewczyk A, Janion M, Gasior M, Gierlotka M, Poloński L. Benefits from revascularisation therapy in the elderly with acute myocardial infarction. Comparative Analysis of Patients Hospitalised in 1992-1996 and in 2005-2006. Kardiol Pol 2010; 68: 873-881.

[24] Parodi G, Memisha G, Valenti R, Trapani M, Migliorini A, Santoro GM, Antoniucci D. Five year outcome after primary coronary intervention for acute ST elevation myocardial infarction: Results from a single centre experience. Heart 2005; 91: 1541-1544.

[25] Pasterkamp G, Vink A, Borst C. Multiple complex coronary plaques in patients with acute myocardial infarction. N Engl J Med 2000; 343: 915-922.

[26] Datey K, Nanda N. Hyperglycemia after acute myocardial infarction: its relation todiabetes mellitus. N Engl J Med 1967; 276: 262-265.

[27] Kornowski R, Mehran R, Dangas G, Nikolsky E, Assali A, Claessen BE, Gersh BJ, Wong SC, Witzenbichler B, Guagliumi G, Dudek D, Fahy M, Lansky AJ, Stone GW; HORIZONS-AMI Trial Investigators. Prognostic impact of staged versus "one-time" multivessel percutaneous intervention in acute myocardial infarction: analysis from the HORIZONS-AMI (harmonizing outcomes with revascularization and stents in acute myocardial infarction) trial. J Am Coll Cardiol 2011; 58: 704-711.

[28] Zapata GO, Lasave LI, Kozak F, Damonte A, Meiriño A, Rossi M, Carbó S, Pollice A, Paolasso E, Picabea E. Culprit-only or multivessel percutaneous coronary stenting in patients with non-ST-segment elevation acute coronary syndromes: one-year follow-up. J Interv Cardiol 2009; 22: 329-335.

[29] Toma M, Buller CE, Westerhout CM, Fu Y, O'Neill WW, Holmes DR Jr, Hamm CW, Granger CB, Armstrong PW; APEX-AMI Investigators. Non-culprit coronary artery percutaneous coronary intervention during acute ST-segment elevation myocardial infarction: insights from the APEX-AMI trial. Eur Heart J 2010; 31: 1701-1707.

[30] Corpus RA, House JA, Marso SP, Grantham JA, Huber KC Jr, Laster SB, Johnson WL, Daniels WC, Barth CW, Giorgi LV, Rutherford BD. Multivessel percutaneous coronary intervention in patients with multivessel disease and acute myocardial infarction. Am Heart J 2004; 148: 493-500.

[31] Hueb W, Lopes NH, Gersh BJ, Soares P, Machado LA, Jatene FB, Oliveira SA, Ramires JA. Five-year follow-up of the medicine, angioplasty, or surgery study (MASS II) a randomized controlled clinical trial of 3 therapeutic strategies for multivessel coronary artery disease. Circulation 2007; 115: 1082-1089.