Alexandria Journal of Medicine (2015) **51**, 353–358

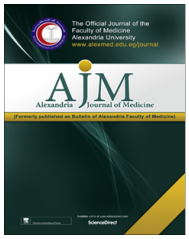
HOSTED BY

ELSEVIER

Alexandria University Faculty of Medicine

Alexandria Journal of Medicine

http://www.elsevier.com/locate/ajme



Short term follow-up of culprit only revascularization versus total revascularization in primary percutaneous coronary intervention in patients with multivessel disease

Mohamed Salem *, **Ali Galal, Ahmed Ramzy, Reda Biomay, Mohamed Zaki**

Department of Cardiology, Benha University Hospital, National Heart Institute, Cairo, Egypt

Received 30 June 2014; accepted 18 December 2014
Available online 14 January 2015

KEYWORDS

Myocardial infarction;
Reperfusion;
Primary PCI

Abstract *Background:* Patients with ST-segment elevation myocardial infarction (STEMI) and multivessel coronary artery disease are common. It is unknown whether complete revascularization in these patients is superior.

Objectives: This study evaluated the short term outcome of culprit only revascularization compared to total revascularization in the setting of primary percutaneous coronary intervention in patients with STEMI.

Methods: The study included 40 patients with acute STEMI who were presented within 12 h from onset of symptoms. All patients had multivessel disease on emergency coronary angiography. Primary PCI was performed in all patients. According to study protocol, patients were divided into 2 groups: group A (20 patients) included patients who underwent culprit artery only revascularization, while group B (20 patients) had total revascularization. In-hospital and 30 days outcome (mortality, re-infarction, heart failure, recurrence of angina symptoms, cerebrovascular stroke, need for revascularization) were reported.

Results: All cause mortality was reported in one patient from group B (5%). No re-infarction. Recurrence of ischemic symptoms was reported in 15% of patients (25% versus 5% in groups A and B respectively, $P = 0.2$). Heart failure was evident in 15% of all patients (15% in each group). Composite end point of adverse cardiovascular events was reported in 37.5% of all patients (40% versus 35% in groups A and B respectively, $P = 0.5$). Contrast induced nephropathy was evident in

* Corresponding author at: Department of Cardiology, Benha Faculty of Medicine, Benha University, Benha, Egypt. Tel.: +20 133106725, mobile: +20 01092773227.
E-mail address: masalem@yahoo.com (M. Salem).

Peer review under responsibility of Alexandria University Faculty of Medicine.

http://dx.doi.org/10.1016/j.ajme.2014.12.006

47.5% of patients (10% versus 35% in groups A and B respectively, $P = 0.08$), subacute stent thrombosis occurred in 2 patients (5%), (10% in group B but not in group A, $P = 0.4$).
Conclusion: Both treatment strategies carry equivalent short term outcome among patients with STEMI treated with PPCI.

1. Introduction

Primary percutaneous coronary intervention (PPCI) is the most effective available method to reestablish coronary perfusion in patients presenting with STEMI. It is associated with greater patency of infarct related artery and lower rates of death, re-infarction and stroke when compared to fibrinolysis.[1] The prevalence of multivessel disease (MVD) in patients presented with STEMI approaches 40%.[2] The conventional strategy of PPCI in the setting of STEMI usually involves selective intervention of infarct related artery (IRA, culprit only revascularization) with treatment of significant lesions in non-IRA in patients with MVD, to be performed later as staged PCI procedure (staged revascularization).[3] Early revascularization of IRA by PPCI is recommended according to recent guidelines. But strategy for treatment of non-IRA lesions in the acute setting remains unclear.[4]

In this prospective, controlled study we compared short term outcome between PPCI to IRA (culprit only revascularization) and that for both infarct related artery and noninfarct related artery (total revascularization) in STEMI patients with MVD.

2. Patients and methods

2.1. Study design

This prospective, controlled, nonrandomized study included 40 patients with STEMI who were admitted to the coronary care unit of cardiology department at the National heart institute, Egypt, during the period from October 2010 to March 2012. All patients signed an informed consent and the study was approved by the local ethics committee. Key inclusion criteria were as follows: 1. STEMI patients presented within 12 h of onset of symptoms. 2. MVD disease on coronary angiography, which are suitable for PCI. MVD was defined as the presence of at least one lesion $\geqslant 70\%$ diameter stenosis in a major epicardial vessel, or one of its branches other than the infarct related artery (IRA). Key exclusion criteria were as follows: cardiogenic shock, pulmonary edema, severe renal impairment (creatinine > 3.0 mg/dl), any contraindication to anti platelet therapy, left main coronary artery disease, patients in whom non-IRA is < 2.5 mm, or is totally occluded or showing extensive calcification.

2.2. Methods

2.2.1. Baseline evaluation

All patients had review of their medical history on admission to emergency department including the following: analysis of demographic data (age, sex), presence of risk factors of coronary atherosclerosis, associated comorbidities, general and cardiac examination, 12 leads ECG which was performed immediately on admission and every 6 h during the first 24 h, and once daily until discharge, routine laboratory investigations including the following: cardiac biomarkers (Troponin I & CK-MB), kidney function tests (S. Creatinine), lipid profile including (total cholesterol, low density lipoprotein (LDL) high density lipoprotein (HDL), triglycerides), random blood sugar.

2.2.2. Coronary angiography and PPCI

Aspirin (300 mg loading dose, then 150 mg daily) and clopidogrel (600 mg loading then 150 mg/day maintenance dose) were given on admission. Un-fractionated heparin (UFH) (10,000 units) bolus dose was injected after sheath insertion. The procedure was performed according to the standard technique for coronary angiography and PCI. Femoral approach was used in all patients using 6–7 Fr sheaths. Diagnostic coronary angiography was done to detect the culprit vessel and eligibility to the study. XB guiding catheters were used for left coronary lesions and JR catheters for right coronary lesions. Aspiration devices and glycoprotein inhibitors were used in lesions with heavy thrombus burden and or impaired TIMI flow after PCI. Bare metal stents (BMS) were used in all patients. The operator determined the size and length of the stent. Sheaths were removed 6 h after PCI and compression was done manually.

2.2.3. Study protocol

After diagnostic coronary angiography, patients were subsequently divided into the following:

Group A: culprit only revascularization (COR).
Group B: total revascularization (TR).

2.2.4. Study end points

Thirty days combined end point of all cause mortality, re-infarction, heart failure, recurrence of angina symptoms, cerebrovascular stroke, need for revascularization (Repeat PCI or bypass surgery).

2.2.5. Study definitions

1. Contrast induced nephropathy: 25% rise in serum creatinine from baseline within 48–72 h from the procedure.
2. Major bleeding: intracranial bleeding, GIT bleeding, decrease hemoglobin concentration by more than 5 gm/dl.
3. Minor bleeding: puncture site bleeding, decrease hemoglobin concentration by less than 3 gm/dl.
4. Reinfarction: recurrent chest pain associated with new ECG changes such as ST segment re-elevation or new pathologic Q waves.

5. Successful PCI: less than 20% residual diameter stenosis after stent implantation with TIMI 3 flow, but without procedure related complications.

3. Statistical analysis

Data are presented as mean ± SD for continuous data and as number (%) for categorical data. Between groups analysis was done using student *t*-test for continuous data and Chi-square test (or Fischer exact test) for qualitative data. Level of evidence was detected to be significant at *P* value <0.05. Data were collected and analyzed by SPSS (version 17).

4. Results

4.1. Study population

The mean age was 56 ± 10 years (59.05 ± 10.2 years versus 53.1 ± 10.7 y in groups A and B respectively, $P = 0.08$), 80% were males (60% versus 90% in groups A and B respectively, $P = 0.23$). All data are presented in Table 1. Between groups comparison did not show statistically significant differences in baseline characteristics.

4.2. Clinical presentation on admission

Chest pain was the main symptom on admission in all patients (100%), 35% of patients were presented with dyspnea (30% in group A versus 40% in group B, $P = 0.5$), 22.5% of patients were presented with palpitations (15% in group A versus 30% in group B, $P = 0.4$).

4.3. Clinical examination on admission

The mean heart rate was 98.7 ± 32.4 bpm (92 ± 29 versus 106 ± 35 bpm in groups A and B respectively, $P = 0.15$), the mean systolic blood pressure was 150 ± 23 mmHg (139 ± 21 mmHg versus 160 ± 19 mmHg in groups A and B respectively, $P = 0.02$), the mean diastolic blood pressure was 89 ± 10 mmHg (84.5 ± 11 mmHg versus 93 ± 8 mmHg, in groups A and B respectively, $P = 0.03$).

4.4. Site of infarction detected by ECG

Fifty-seven percent (57%) had anterior infarction (50% versus 65% in groups A and B respectively, $P = 0.2$), inferior infarction was reported in 40% of patients (50% versus 30% in groups A and B respectively, $P = 0.1$). Lateral infarction was evident in only 1 patient (5%) from group B.

4.5. Time from onset of symptoms to admission

The mean time was 7.1 ± 2.7 h in all patients (7.7 ± 2.9 h in group A, versus 6.45 ± 2.4 h in group B, $P = 0.16$), 40% of all patients were presented less than 6 h (35% versus 45% in groups A and B respectively, $P = 0.5$).

4.6. Door to balloon time

The mean door to balloon time was 80.2 ± 38.5 min in all patients (87 ± 44.5 min in group A, versus 73.5 ± 31.1 min in group B, $P = 0.3$) Fig. 1.

4.7. Coronary angiography before PPCI

Two vessel disease was reported in 65% of all patients, and 3-vessel disease in 35% of patients. The culprit artery was left anterior descending (LAD) in 55% of all patients (45% versus 65% in groups A and B respectively, $P = 0.3$), right coronary artery (RCA) was the culprit artery in 35% of patients (45% versus 25% in groups A and B respectively, $P = 0.39$), while left circumflex (LCX) was the culprit artery in 10% of patients (10% in each group). Noninfarct related artery was LAD in 15% of patients (15% in each group), while RCA in 27.5% of all patients (30% versus 25% in groups A and B respectively, $P = 0.8$), LCX in 22.5% of patients (20% versus 25% in groups A and B respectively, $P = 0.81$), while LAD and LCX were present in 10% of all patients (15% versus 5% in groups A and B respectively), LCX and RCA were present in 25% of all patients (20% versus 30% in groups A and B respectively, $P = 0.8$). Thrombolysis in myocardial infarction (TIMI) flow before PCI was zero in 70% of all patients (65% versus 75% in groups A and B respectively $P = 0.4$), while TIMI flow 1 was reported in 30% of all

Table 1 Baseline characteristics of study population.

	All patients	Group A	Group B	*P* value
	$n = 40$	$n = 20$	$n = 20$	
Age mean ± SD	56.07 ± 10.71	59.05 ± 10.22	53.10 ± 10.71	0.08
Male sex, *n* (%)	32 (80%)	14 (60%)	18 (90%)	0.23
Family history of CAD	8 (20%)	3 (15%)	5 (25%)	0.4
DM	21 (52%)	8 (40%)	13 (65%)	0.11
Hypertension	32 (80%)	14 (70%)	18 (90%)	0.23
Smoking	32 (80%)	14 (70%)	18 (90%)	0.23
Dyslipidemia	20 (50%)	11 (55%)	9 (45%)	0.52
Prior CAD	28 (70%)	16 (80%)	12 (60%)	0.16
Prior PCI	2 (5%)	0 (0%)	2 (10%)	0.48
Prior CABG	0 (0%)	0 (0%)	0 (0%)	–

CAD: coronary artery disease.
PCI: percutaneous coronary intervention.
DM: diabetes mellitus.
CABG: coronary artery bypass grafting.

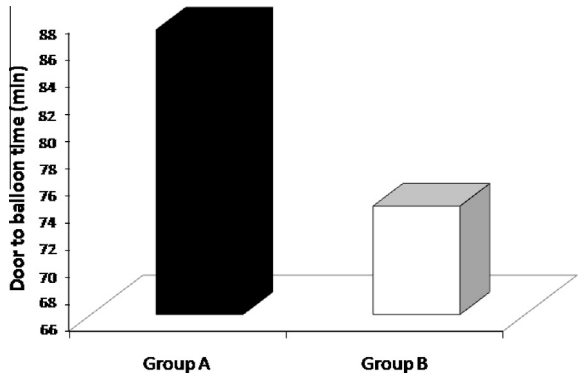


Figure 1 Door to balloon time.

Table 2 Coronary angiography before PPCI.

	All patients	Group A	Group B	*P* value
	n = 40	*n* = 20	*n* = 20	
TIMI flow before PCI				
0	28 (70%)	13 (65%)	15 (75%)	0.5
I	12 (30%)	7 (35%)	5 (25%)	
Culprit artery				
LAD	22 (55%)	9 (45%)	13 (65%)	0.4
RCA	14 (35%)	9 (45%)	5 (25%)	
LCX	4 (10%)	2 (10%)	2 (10%)	
Other noninfarct related artery				
LAD	6 (15%)	3 (15%)	3 (15%)	0.8
RCA	11 (27.5%)	6 (30%)	5 (25%)	
LCX	9 (22.5%)	4 (20%)	5 (25%)	
LAD – LCX	4 (10%)	3 (15%)	1 (5%)	
LCX – RCA	10 (25%)	4 (20%)	6 (30%)	

patients (35% versus 25% in groups A and B respectively $P = 0.4$) Table 2.

4.8. Procedural data

Femoral approach was done in all patients. Predilatation was done in 55% of all patients, aspiration devices were used in 12.5% of all patients, glycoprotein inhibitors were used in 50% of all patients (40% versus 60% in groups A and B respectively, $P = 0.2$). The mean number of stents implanted was 1.8 ± 0.3, 1.2 ± 0.1, 2.5 ± 0.9 in all patients, groups A and B respectively. The number of stents was one stent in 42.5% of all patients (85% versus 0% in groups A and B respectively, $P = 0.001$), two stents in 35% of all patients (15% versus 55% in groups A and B respectively), three stents were implanted in 20% of all patients (0% versus 40% in groups A and B respectively), while four stents were implanted in 2.5% of patients (0% versus 5% in groups A and B respectively). The mean stent length was 21.8 ± 5.6 mm (23.95 ± 5.11 mm versus 20.7 ± 5.6 mm in groups A and B respectively, $P = 0.03$). The mean stent diameter was 2.87 ± 0.28 mm (3.0 ± 0.3 mm versus 2.8 ± 0.28 mm in groups A and B respectively, $P = 0.01$). TIMI flow in the culprit artery after PPCI was III in 97.5% of all patients (95% versus 100% in groups A and B respectively), TIMI flow II in 2.5% of all patients (5% versus 0% in groups A and B respectively). The mean procedural time was 47.7 ± 13.5 min in all patients (41.5 ± 8.5 min versus 54 ± 14.7 min in groups A and B respectively, $P = 0.003$), the mean contrast volume was 215 ± 78.6 ml (172.5 ± 73.4 ml versus 257.5 ± 59.1 ml in groups A and B respectively, $P = 0.001$). No reported cases of procedure related complications in either group.

4.9. In hospital outcome

No reported cases of cardiogenic shock, stroke, or major bleeding in either group. Recurrence of angina pain was reported in 7.5% of all patients (10% versus 5% in groups A and B respectively, $P = 0.8$), minor bleeding occurred in 17.5% of all patients (10% versus 25% in groups A and B respectively, $P = 0.1$), contrast induced nephropathy was evident in 23% of patients (10% versus 35% of groups A and B respectively, $P = 0.08$) with a mean serum creatinine 0.9 ± 0.3 mg%, 1.3 ± 0.5 mg% in groups A and B respectively. Subacute stent thrombosis occurred in 2 patients (5%) (10% of group B but not in group A, $P = 0.4$), in the two patients, stent thrombosis occurred in LAD which was the culprit artery and was treated by re-intervention. One patient in group B (5%) had sudden cardiac death but not in group A, heart failure occurred equally in both groups (10%).

4.10. 30 days outcome

Combined end point of adverse cardiovascular events was reported in 43% of all patients (40% versus 45% in groups A and B respectively, $P = 0.6$). All cause mortality occurred in one patient from group B (5%). Re-infarction was evident in 2 patients from group B but not in group A. Recurrence of angina pain was reported in 15% of patients (25% versus 5% in groups A and B respectively, $P = 0.2$). Heart failure was evident in 15% of all patients (15% in each group), the need for re-intervention was reported in 10% of patients in group B but not in group A, no reported cases of cerebrovascular stroke.

5. Discussion

Prior studies suggest that acute coronary syndromes, including acute myocardial infarction (AMI), may result from a systemic inflammatory process, causing multiple unstable lesions. Thus, a strategy of multivessel PCI in the peri-infarct period may be important in improving the outcomes of PPCI. Such an attempt of complete revascularization may prevent recurrent ischemia from 'non-infarct-related' lesions, obviating the need for repeat intervention, and also possibly improves the late outcome by reducing the ischemic burden following myocardial damage.[5]

This study evaluated the short term outcome of culprit only revascularization compared to total revascularization in the setting of STEMI with MVD. We reported higher incidence of stent thrombosis and contrast induced nephropathy in patients who were assigned to total revascularization. However this was not of significant differences. In addition, we did not report significant differences in 30 days outcome between both treatment strategies.

Anterior wall infarction was reported in 55% of patients. Prior trials[2,3,6,7] reported similar incidence of anterior

infarction. We reported 2-vessel disease and 3-vessel disease in 65%, and 35% of the study population respectively. In the study by Toma et al.[6], 2-vessel disease represented 68%, while 3-vessel disease represented 32%. However, Di Mario et al.[2] showed that 2-vessel disease was evident in 53% and 3-vessel disease in 47%. This variation in the number of vessels affected may be explained by the difference in the profile of risk factors between different studies. The mean PCI time was significantly longer in patients assigned to total revascularization (54 ± 14 min) versus 41.5 ± 8.5 in those who had culprit only PCI. In addition, there was larger volume of contrast material in total revascularization patients (257 ml) compared to culprit only patients (172 ml). This was logic, because some extra time and contrast were needed to treat the nonculprit artery lesions. The mean number of stents was 1.8 ± 0.3, 1.2 ± 0.1, 2.5 ± 0.9 in all patients, groups A and B respectively. In other studies[2,8], the number of stents per patient in COR group was 1.76 ± 1.1 versus 2.9 ± 1.3 in TR patients. We reported higher incidence of stent thrombosis in TR group (10%) while no stent thrombosis occurred in COR group (0%). This could be related to the higher number of stents in TR group with associated hypercoagulable state in these patients. In addition, the small sample size in our study compared to others, and difference in study population may have an impact Contrast induced nephropathy in TR group (35%) was more frequent than COR patients (10%). Larger amount of contrast used in the TR patients is the main obvious cause. Prior trials[3,9,10] suggested that multivessel intervention in patients not in cardiogenic shock undergoing PPCI did not improve the in-hospital outcomes, and was also associated with a longer, more complex procedure, increased radiation exposure and increased incidence of acute renal failure secondary to increased contrast dye load.

We did not report differences between both treatment strategies considering the 30 days outcome except that more patients in COR group had recurrent chest pain but without statistically significant difference between groups.

Prior trials[11–13] revealed that 30 days follow-up of patients who underwent TR had more fatal re-infarction and more adverse events than patients who underwent COR strategies. However, others[14,15] found that multivessel approach had better outcome by decreasing the need for further revascularization. Recently, a meta analysis[16] reported that, if multivessel PCI during index catheterization was performed, hospital mortality was increased (OR 1.35, 95% CI 1.19–1.54, $P < 0.001$). However, when multivessel PCI was performed as a staged procedure, hospital mortality was lower (OR 0.35, 95% CI 0.21–0.59; $P < .001$; $P < 0.001$). The differences in both in-hospital and 30 days outcome between previously mentioned studies may be explained by the differences in study populations, sample size, associated co-morbidities, left ventricular functions, lesions complexity, skills of the operators, and finally the after PCI care.

6. Conclusion

In patients with STEMI and MVD undergoing PPCI, complete revascularization strategy has similar 30 days outcome compared to a strategy of culprit lesion only revascularization. Higher rates of stent thrombosis and CIN were observed in complete revascularization strategy.

7. Recommendation

Further studies with larger sample size are required to evaluate safety and efficacy of infarct-related artery only PCI compared to total revascularization in the setting of STEMI patients with MVD.

8. Study limitation

Small sample size and lack of randomization may have impact on the validity of our results due to possible investigators bias in analyzing the results. In addition, short follow-up period is considered another limitation of the study.

Conflict of interest

The authors declare that there are no conflict of interests.

References

1. Antman EM, Anbe DT, Armstrong PW, Bates ER, Green LA, Hand M, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to Revise the 1999 Guidelines for the Management of patients with acute myocardial infarction). *J Am Coll Cardiol* 2004;**44**:671–719.
2. Di Mario C, Mara S, Flavio A, Imad S, Antonio M, Anna P, et al. Single versus multivessel treatment during primary angioplasty: results of the multicentre randomized Hzpecoat'' - for culprit or multivessel stenting for Acute Myocardial Infarction (HELP AMI) study. *Int J Cardiovase Intervent* 2004;**6**:128–33.
3. Qarawani D, Nahir M, Abboud M, Hazanov Y, Hasin Y. Culprit only versus complete coronary revascularization during primary PCI. *Int J Cardiol* 2007;**123**:288–92.
4. Ijsselmuiden AJ, Ezechiels J, Westendorp IC, Tijssen JG, Kiemeneij F, Slagboom T, et al. Complete versus culprit vessel percutaneous coronary intervention in multivessel disease: a randomized comparison. *Am Heart J* 2004;**148**:467–74.
5. Goldstein JA, Demetriou D, Grines CL, Pica M, Shoukfeh M, O'Neill WW. Multiple complex coronary plaques in patients with acute myocardial infarction. *N Engl J Med* 2000;**343**:915–22.
6. Toma M, Buller CE, Westerhout CM, Fu Y, O'Neill WW, Holmes Jr DR, et al. Nonculprit 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.
7. Varani E, Balducelli M, Aquilina M, Vecchi G, Hussien MN, Frassineti V, et al. Single or multivessel percutaneous coronary intervention in ST-elevation myocardial infarction patients. *Catheter Cardiovasc Interv* 2008;**72**:927–33.
8. Khattab A, Abdel-Wahab M, Röther C, Liska B, Toelg R, Kassner G, et al. Multi-vessel stenting during primary percutaneous coronary intervention for acute myocardial infarction. A single-center experience. *Clin Res Cardiol* 2008;**97**:32–8.
9. Mohamad T, Bernal JM, Kondur A, Hari P, Nelson K, Niraj A, et al. Coronary revascularization strategy for ST elevation myocardial infarction with multivessel disease: experience and results at 1-yearfollow-up. *Am J Cardiol* 2010;**18**:92–100.
10. Cavender MA, Milford-Beland S, Roe MT, Peterson ED, Weintraub WS, Rao SV. Prevalence, predictors, and in-hospital outcomes of non-infarct artery intervention during primary percutaneous coronary intervention for ST-segment elevation

myocardial infarction (from the National Cardiovascular Data Registry). *Am J Cardiol* 2009;**104**:507–13.
11. Corpus RA, House JA, Marso SP, Grantham JA, Huber Jr KC, Laster SB, et al. Multivessel percutaneous coronary intervention in patients with multivessel disease and acute myocardial infarction. *Am Heart J* 2004;**148**:493–500.
12. Roe MT, Cura FA, Joski PS, Garcia E, Guetta V, Kereiakes DJ, et al. Initial experience with multi vessel percutaneous coronary intervention during mechanical reperfusion for acute myocardial infarction. *Am J Cardiol* 2001;**88**:170–3.
13. Moreno R, García E, Elízaga J, Abeytua M, Soriano J, Botas J, et al. Results of primary angioplasty in patients with multivessel disease. *Rev Esp Cardiol* 1998;**51**:547–55.
14. Ijsselmuiden AJ, Ezechiels J, Westendorp IC, Tijssen JG, Kiemeneij F, Slagboom T, et al. Complete versus culprit vessel percutaneous coronary intervention in multivessel disease: a randomized comparison. *Am Heart J* 2004;**148**:467–74.
15. Politi L, Sgura F, Rossi R, Monopoli D, Guerri E, Leuzzi C, et al. A randomized trial of target-vessel versus multi-vessel revascularization in ST-elevation myocardial infarction: major adverse cardiac events during long-term follow-up. *Heart* 2010;**96**:662–7.
16. Bainey K, Mehta S, Lai T, Welsh R. Complete vs culprit-only revascularization for patients with multivessel disease undergoing primary percutaneous coronary intervention for ST-segment elevation myocardial infarction: a systematic review and meta-analysis. *Am Heart J* 2014;**167**(1):1–14.