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Comparison of complete vs. culprit-only revascularization in acute myocardial infarction

Ran Chen[1] and Jingping Lu[1*]

Abstract

Background The diagnosis and treatment of acute myocardial infarction (AMI) complicated with multivessel disease (MVD) by percutaneous coronary intervention (PCI) has been well recognized. However, the use of PCI in non–infarct-related coronary arteries remains controversial. We aimed to study the clinical outcome of complete vs. culprit-only revascularization for AMI with MVD before discharge.

Methods 173 AMI with MVD who received emergent PCI between January 2013 and December 2018 were retrospectively analyzed. Patients were divided into complete revascularization (CR) group ($n=85$) and culprit-only revascularization (COR) group ($n=88$). Major adverse cardiovascular and cerebral events (MACCE) at 1, 6, and 12 months after PCI were compared, including recurrent angina, recurrent MI, in-stent thrombosis, new-onset atrial fibrillation (AF), and worsen heart failure (HF).

Results Baseline characteristics of two groups were comparable. There was no significantly statistical difference in MACCE between COR group and CR group, 36.2% vs. 33.3% ($P=0.715$), 42.0% vs. 29.7% ($p=0.125$) and 44.9% vs. 36.5% ($p=0.304$) at 1-, 6- and 12-month follow up respectively. Compared with the CR group, a higher rate of recurrent angina was in COR group (20.3% vs. 5.4%, $P=0.007$) at the 6th month. Subgroup analysis showed that hypertensive patients benefited more from complete revascularization at the 6- (OR:0.31, 95%CI: 0.13–0.76) and 12-month (OR:0.38, 95%CI: 0.16–0.90) follow up.

Conclusions Complete revascularization before discharge does not supply additional benefit on long time MACCE as compared with culprit-only intervention strategy in patients presenting with AMI for urgent PCI with multivessel disease.

Keywords Acute myocardial infarction, Multivessel disease, Percutaneous coronary intervention, Complete revascularization, Culprit-only revascularization

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Introduction

Acute myocardial infarction (AMI), a major disease threatening human health and causing death, is characterized by acute coronary occlusion and myocardial ischemic necrosis, with a high risk of death. Emergency percutaneous coronary intervention (PCI) should be performed as soon as possible to open the blood vessels of criminals and realize vascular reperfusion, which can shrink the infarct area and reduce the mortality rate. However, 30–60% of AMI patients are often accompanied by MVD [1, 2], which significantly increases the risk of disease, the incidence of MACCE, and greatly worsens the prognosis of patients [3–5]. Routine revascularization of non–infarct-related artery lesions in AMI patients with MVD received a class IIA recommendation from 2017 ESC guidelines. Studies have shown that for AMI patients with MVD, complete revascularization is safe and effective, which can improve the prognosis of patients and reduce the risk of reoperation [6].Some studies also believe that complete revascularization therapy has no obvious benefit for the prognosis of patients [7, 8]. However, these studies have not comprehensively examined the optimal strategy for AMI with MVD. There is still a great controversy about intervention strategies for AMI patients with MVD at present. The purpose of this study was to compare the clinical outcomes of complete revascularization or culprit-only revascularization in patients with AMI complicated with MVD.

Methods

Participants

173 AMI patients with MVD who arrived at Jiangsu Province Hospital of Chinese Medicine for emergent PCI within 12 h after onset were retrospectively enrolled from January 2013 to December 2018. The diagnosis was confirmed according to criteria published by the European Society of Cardiology (ESC) in 2007, combined with clinical symptoms, electrocardiogram changes and biochemical marker elevation [9]. Once diagnosed, oral antiplatelet agents were administered (aspirin 300 mg plus clopidogrel 600 mg loading dose followed by 75 mg maintenance, or ticagrelor 180 mg loading dose and 90 mg twice daily). Emergency coronary angiography (CAG) was performed, and PCI was performed by fractional flow reserve. Whether to treat non-culprit coronary arteries defined as QCA ≥ 70% was determined by treating physicians. Only infarct-related coronary arteries treated were considered as COR group ($n = 88$) while concurrent PCI in non-culprit coronary arteries was considered as CR group ($n = 85$) before discharge. Patients in both groups took oral beta-blockers, angiotensin-converting enzyme inhibitors (ACEI), and statins, if not contraindicated, for long-term treatment. The study was approved by the institutional research ethics committee of the Jiangsu Province Hospital of Chinese Medicine.

Follow-up and outcomes

The follow-up deadline was December 2019. Patients in both groups were followed up at 1, 6, and 12 months after revascularization. The primary endpoint was major adverse cardiovascular and cerebral events (MACCE), including recurrent angina, recurrent MI, in-stent thrombosis, new-onset AF, and worsen HF. The other endpoints were individual events of MACCE.

Statistical analysis

All data was analyzed with SPSS 26.0 software, T test was used for numeric data while chi-square test was used for categoric variables. Logistic regression and subgroup analysis were performed to explore the effect of complete revascularization on MAACE at 1-, 6-, 12-month follow up. Logistic regression analysis was adjusted for the covariates ($P < 0.05$) presented in Table 1. Missing data was treated with multiple imputation. Two-sided P values < 0.05 were considered statistically significant.

Results

From Tables 1 and 88 (50.9%) patients were in COR group while 85 (49.1%) patients were in CR group. 67 (76.1%) male received culprit-only revascularization while 69 (81.2%) received revascularization. The demographics, comorbidities, examinations, echocardiographic results, medicines, and operations were comparable between two groups. However, COR group had a higher age compared with CR group ($p = 0.019$).

Clinical outcomes in hospital, 1 month, 6 months or 12 months after in-hospital PCI were shown in Table 2. Clinical events had no significant statistical difference at 1, 6 and 12 months of follow-up, both in MACCE and recurrent MI, in-stent thrombosis, new-onset AF or worsen HF. However, compared with the CR group, a higher rate of recurrent angina was evidenced in COR group at 6th month (20.3% vs. 5.4%, $P = 0.007$). To identify the subgroup population who could benefit from complete revascularization before discharge, we performed a subgroup analysis (Fig. 1), which showed that patients with hypertension had a less percent of MACCE in CR group at 6th (OR = 0.31, 95% CI: 0.13–0.76) and 12th months (OR = 0.38, 95% CI: 0.16–0.90).

Discussion

In our study, we found that complete revascularization did not decrease long time MACCE compared with culprit-only intervention strategy in AMI patients received urgent PCI. However, patients with hypertension could benefit more from complete revascularization, which need further investigation.

Table 1 Baseline characteristics of patients

	COR	CR	*P* value
N (%)	88	85	
Male, n	67(76.1)	69(81.2)	0.419
Age, years	67.4 12.4	63.1 11.8	**0.019***
Smoking	47(53.4)	46(54.1)	0.926
Comorbidity			
HBP	52(59.1)	56(65.9)	0.356
DM	20(22.7)	18(21.2)	0.805
HL	5(5.7)	6(7.1)	0.711
Stroke	13(14.8)	12(14.1)	0.902
CKD	2(2.3)	2(2.4)	
Killip classification III/IV	9(10.2)	6(7.1)	0.068
sBP	126.6 27.5	124.9 19.0	0.634
dBP	80.1 18.3	82.3 13.1	0.372
HR	76.4 16.1	80.2 16.2	0.125
BNP, pg/mL	335.9 446.7	261.8 271.5	0.276
HB, g/L	129.5 16.7	135.3 15.0	**0.020***
PLT,10^9	196.2 75.6	190.8 54.9	0.594
Glucose, mmol/L	6.6 2.7	6.9 2.7	0.442
BUN, mmol/L	6.5 3.1	5.9 2.2	0.137
T-Chol, mmol/L	4.3 0.9	4.4 0.9	0.365
LDL, mmol/L	4.3 16.1	2.6 0.7	0.336
HbA1c, %	6.4 1.4	6.2 1.2	0.562
CK-MB, U/L	185.5 102	211.7 158.0	0.195
D-B, min	130.7 175.7	141.4 218.2	0.726
Echocardiography			
LAD, mm	3.99 0.37	3.98 0.33	0.927
LVDd, mm	5.30 0.37	5.37 0.41	0.200
IVSTd, mm	0.90 0.13	0.90 0.14	0.909
E/A	0.96 0.37	1.02 0.40	0.301
EF, %	46.35 6.25	45.47 5.20	0.316
Medicines			
Aspirin	82(94.3)	84(98.8)	0.102
Clopidogrel	69(79.3)	56(65.9)	**0.048***
Ticagrelor	14(16.1)	28(32.9)	**0.010***
Statin	82(94.3)	80(94.1)	0.970
β-blocker	65(74.7)	75(88.2)	**0.023***
ACEI/ARB	44(50.6)	54(63.5)	0.086
CCB	4(4.6)	1(1.2)	0.182
Nitrates	33(37.9)	27(31.8)	0.396
Furosemide	22(25.3)	22(25.9)	0.929
Spironolactone	18(20.7)	20(23.5)	0.654
Culprit vessel			0.801
LAD	27(30.7)	30(35.3)	
LCX	18(20.5)	17(20.0)	
RCA	43(48.9)	38(44.7)	
Operations			
Predilation	69(78.4)	61(71.8)	0.312
Postdilation	58(65.9)	45(52.9)	0.082
IABP	12(13.6)	12(14.1)	0.927
Vasopressors	10(11.4)	5(5.9)	0.200
Pacemaker	4(4.5)	3(3.5)	0.735
Aspiration	53(60.2)	46(54.1)	0.417

HBP, high blood pressure; DM, diabetes mellites; HL, hypercholesterolemia; CKD, chronic kidney diseases; sBP, systolic blood pressure; dBP, diastolic blood pressure; HR, heart rate; D-B, door to balloon; IABP, intra-aortic balloon pump. *$P<0.05$, **$P<0.01$

With the increasing risk factors of coronary heart disease, such as diabetes, hypertension and the aging of the population, AMI patients with MVD increased significantly and were closely related to poor prognosis [10–12]. MVD was an independent risk factor for predicting death and recurrent MI. The APEXAMI study [13] showed that the single-vessel and multi-vessel mortality in AMI at 90 days were 3.1% and 6.3%, respectively. Angiographic results of patients with AMI undergoing PCI showed that non–infarct-related arteries can develop from critical lesions to severe lesions and from stable plaques to unstable plaques, leading to an increased incidence of MACCE [14].

The selection of revascularization strategies for AMI patients with MVD has become a hot research topic in the cardiovascular field recently, in terms of which artery and when to perform. Even numerous studies, there is a debate on whether to complete revascularization or culprit-only revascularization. Early studies have shown that concurrent intervention by emergency PCI in non–infarct-related arteries increased the incidence of adverse events, while complete revascularization during hospitalization increased the in-hospital mortality in AMI patients [15]. Domestic and foreign guidelines have not recommended optimal treatment regimens currently. Previous guidelines indicated that except than patient with cardiogenic shock or severe electrical instability, emergency PCI only dealt with infarct-related arteries [16–18]. However, The PRAMI study [19] published in 2013 showed that the treatment of non-infarct-related vessels with greater than 50% stenosis in AMI patients on the emergency significantly reduced the adverse endpoint events compared with those patients only interfered with infarct-related vessels. CvLPRIT study [20] also suggested that complete revascularization significantly reduced the incidence of adverse end events at 12 months, suggesting that complete vascularization was a feasible and effective treatment for AMI patients with MVD.

Our study showed that there was no difference in the incidence of MACCE in AMI patients with MVD between undergoing complete revascularization and culprit-only revascularization. Complete revascularization was found to reduce the incidence of angina recurrence only at follow-up 6th month after PCI. Interestingly, subgroup analysis showed that patients with hypertension benefited from complete revascularization at follow-up

Table 2 Clinical outcomes of patients in hospital, 1 month, 6 months or 12 months after PCI

	COR	CR	*P* value
In hospital			
Angina	33(37.5)	24(28.2)	0.195
MI	3(3.4)	3(3.5)	0.966
In-stent thrombosis	0	1(1.2)	0.491
New-onset AF	7(8.0)	3(3.5)	0.212
Worsen HF	37(42.0)	37(43.5)	0.844
MACCE	52(59.1)	47(55.3)	0.122
1 month			
Angina	10(14.5)	4(5.3)	0.064
MI	0	1(1.3)	1.000
In-stent thrombosis	0	0	0
Restenosis	0	0	0
New-onset AF	0	0	0
Worsen HF	20(29.0)	21(28.0)	0.896
MACCE	25(36.2)	25(33.3)	0.715
6 months			
Angina	14(20.3)	4(5.4)	**0.007****
MI	0	0	0
In-stent thrombosis	0	0	0
New-onset AF	1(1.4)	1(1.4)	0.960
Worsen HF	20(29.0)	18(24.3)	0.528
MACCE	29(42.0)	22(29.7)	0.125
12 months			
Angina	18(26.1)	12(16.2)	0.147
MI	0	1(1.4)	0.333
In-stent thrombosis	0	0	0
New-onset AF	0	1(1.4)	0.333
Worsen HF	19(27.5)	19(25.7)	0.801
MACCE	31(44.9)	27(36.5)	0.304

MI, myocardial infarction; HF, heart failure; AF, atrial fibrillation; MACCE, major adverse cardiovascular and cerebral events. ***$P < 0.001$

to 6 and 12 months. Therefore, optimal treatment strategies should be tailored to subgroups in the future.

This study had some limitations. The sample size of the included study was relatively small and the present subgroup analysis can be underpowered and incur false negative conclusions. Secondly, in view of the non-randomized retrospective study design, it should be emphasized that the present data must be interpreted as observational and exploratory. Finally, a 12-month follow-up may be insufficient to capture long-term differences in MACE and mortality. Future studies with extended follow-up durations are necessary to assess the sustainability of treatment benefits and potential late complications.

Notably, our results provide the evidences that complete revascularization did not advantage over culprit-only intervention except for among hypertension population. This result has implications for therapeutic strategies in AMI with MVD. Future research should explore the mechanism, further validating our findings and consider them for inclusion in clinical practice guidelines, especially for conditions where early intervention is crucial.

In conclusion, the statistical significance of complete revascularization in reducing recurrent angina does not necessarily imply large-scale clinical benefits for all patients. Clinical decisions should incorporate both statistical data and patient-specific factors, ensuring that the chosen treatment strategy is aligned with the patient's individual health needs and preferences.

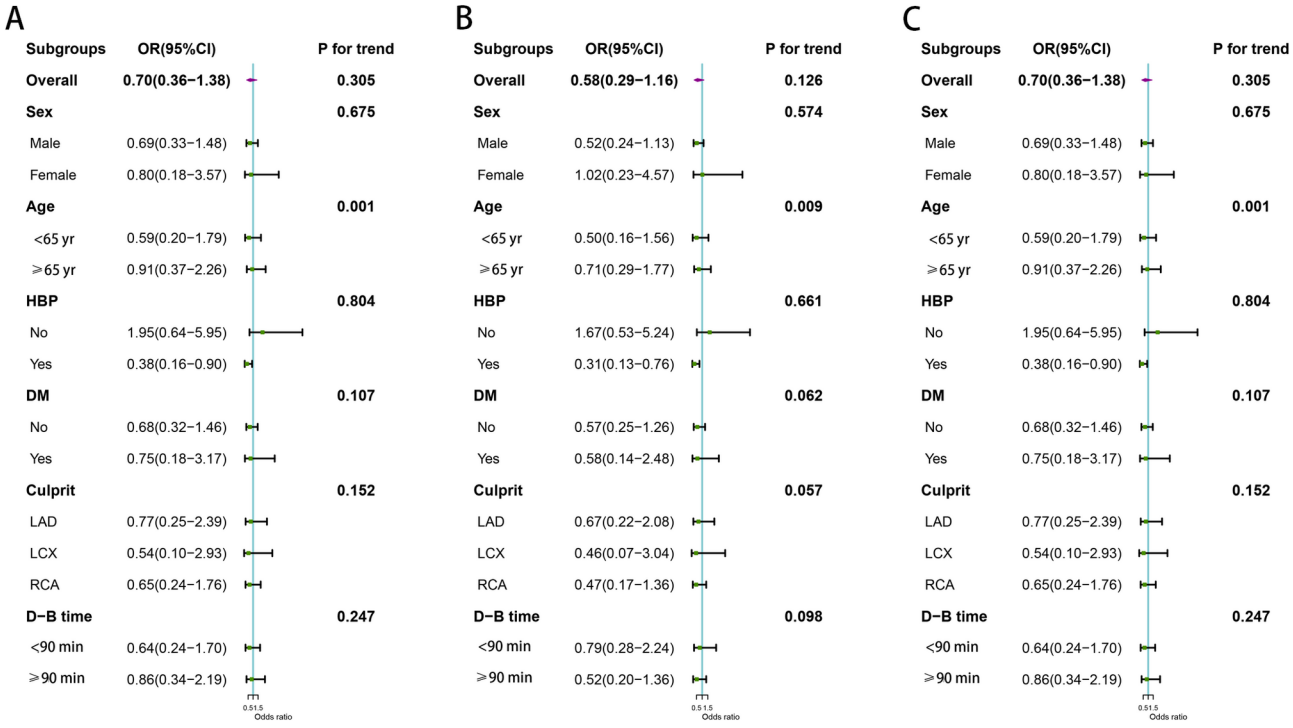

Fig. 1 The forest plot of subgroup analysis of MACCE between two groups at 1st (**A**), 6th (**B**), and 12th (**C**) month of follow-up. HBP, high blood pressure; DM, diabetes mellites; D-B, door to balloon; MACCE, major adverse cardiovascular and cerebral events. *$P < 0.05$, **$P < 0.01$

Author contributions
R C: involved in data collection, study design, manuscript preparation and statistical analysis. J L: involved in data collection and manuscript review.

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Data availability
Data are available on reasonable request. Please contact the corresponding author.

Declarations

Ethics approval and consent to participate
The study was approved by the institutional research ethics committee of the Jiangsu Province Hospital of Chinese Medicine and all participants provided written informed consent. All methods were carried out in accordance with Helsinki regulations.

Consent for publication
Not applicable.

Clinical trial number
Not applicable.

Competing interests
The authors declare no competing interests.

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