



OPEN ACCESS

# Effect of primary PCI on the recovery of atrioventricular block in inferior STEMI patients with late presentation (>12 hours): insights from a single center 10-year experience

Xiaojuan Fan , Prabindra Maharjan, Ping Liu, Ling Bai

Department of Cardiovascular Medicine, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an, Shaanxi, China

## Correspondence to

Professor Ling Bai, Department of Cardiovascular Medicine, Xi'an Jiaotong University Medical College First Affiliated Hospital, Xi'an 710061, China; 8587@xjtu.edu.cn

Accepted 25 February 2020  
Published Online First 25 March 2020

## ABSTRACT

There is no definite reperfusion time for inferior ST-elevation myocardial infarction (STEMI) patients presenting later than 12 hours after symptom onset and complicated by newly-developed atrioventricular block (AVB). It is not clear whether the percutaneous coronary intervention (PCI) could facilitate the recovery of AVB in this patient group. We conducted a retrospective study including 52 consecutive inferior STEMI patients with presenting time >12 hours and new onset second or third-degree AVB on admission. All of them underwent PCI. The clinical characteristics, time to PCI and time to AVB improvement after symptom onset were studied. There were 42 males and the mean age was  $61 \pm 10$  years. Median presenting time from symptom onset was 36 hours (ranging 13–192 hours). Median time to PCI was 6.0 days (ranging 1–15 days) and median time of AVB improvement from symptom onset was 5.0 days (ranging 1–15 days). 24 patients got improvement of atrioventricular conduction before PCI procedure (defined as preoperative group) while 28 patients got improvement of atrioventricular conduction after PCI procedure (defined as postoperative group). In the postoperative group, there was a strong association between time to PCI and time to AVB improvement ( $R^2=0.752$ ,  $p=0.000$ ). No adverse PCI procedure-related complications or death occurred and all the patients got complete AVB recovery at discharge. Early PCI is safe and should be recommended as the priority strategy for late presenting inferior STEMI patients when complicated by AVB. Successful reperfusion of the infarct-related artery is helpful to facilitate AVB recovery in this situation.

## INTRODUCTION

Optimal treatment for acute ST-elevation myocardial infarction (STEMI) within 12 hours after symptom onset includes primary percutaneous coronary intervention (PCI) or thrombolytic therapy. The latest research has reported that only about one third STEMI patients receive primary PCI within 12 hours in China.<sup>1</sup> For STEMI patients who present later than 12 hours, current guidelines do not recommend PCI except the presence of hemodynamic

or electrical instability or continuing ischemic symptoms.<sup>2,3</sup> But there is no statement regarding new onset of continuous atrioventricular block (AVB) as electrical instability. For late presenting patients who suffer from inferior STEMI and new onset of AVB on admission, a clear recommendation of PCI time is not available. Current data about the efficacy and the safety of early PCI in this situation are also lacking. So we conducted a retrospective study to learn if PCI could ameliorate AVB in inferior MI patients with late presentation.

## METHODS

We enrolled consecutive STEMI patients with late presentation involving the inferior wall and complicated by new onset AVB from January 2008 to December 2018. Inferior wall STEMI was defined as related symptom lasting longer than 30 min, ST-segment elevation  $\geq 1.0$  mm in more than two of continuous inferior leads (II, III, and aVF), and elevated serum troponin-T levels.<sup>4</sup> All patients should have undergone primary PCI. Those who refused PCI (seven patients) or died before PCI (three patients, one cardiogenic shock and two cardiac rupture) or underwent coronary artery bypass grafting (five patients) were excluded. Finally the study consisted of 52 patients. The clinical characteristics, laboratory data, PCI time, angiographic findings, improvement and recovery time of AVB, and in-hospital adverse events were studied.

The improvement of AVB was defined as from third-degree to second/first degree/normal, or from Mobitz type II to type I/first degree/normal, or from Mobitz type I to first degree/normal. Enrolled patients were divided into two groups: preoperative group and postoperative group according to the time of AVB getting improvement before or after PCI.

PCI related complications were identified as no-flow, slow flow, coronary perforation, stent thrombosis or cardiac death.

## Statistical analysis

Analyses were performed with SPSS V.18.0. Categorical variables were described using



© American Federation for Medical Research 2020. Re-use permitted under CC BY-NC. No commercial re-use. Published by BMJ.

**To cite:** Fan X, Maharjan P, Liu P, et al. *J Invest Med* 2020;**68**:1011–1014.

## Brief report

**Table 1** The clinical characteristics and PCI related data compared between two groups.

	All (n=52)	Preoperative group (n=24)	Postoperative group (n=28)	P value
Age, y (M±SD)	61±10	64±10	59±9	0.101
Male, n (%)	42 (80.8%)	17 (70.8%)	25 (89.3%)	0.157
Hypertension, n (%)	28 (54.8%)	11 (45.8%)	17 (60.7%)	0.283
Diabetes mellitus, n (%)	15 (28.8%)	8 (33.3%)	7 (25%)	0.508
Temporary pacemaker, n (%)	34 (65.4%)	16 (66.7%)	18 (64.3%)	0.857
Vasopressor use, n (%)	15 (28.8%)	10 (41.7%)	5 (17.9%)	0.073
Presenting time from symptom onset, hours	36 (24–48)	36 (22–48)	28 (24–66)	0.912
Time to PCI from symptom onset, days	6.0 (4.0–8.0)	8.0 (6.0–9.0)	4.0 (3.0–6.0)	0.000
Time of AVB improvement from symptom onset, days	5.0 (4.0–7.0)	5.0 (4.0–6.0)	5.5 (4.0–7.0)	0.367
HR, bpm	50 (45–60)	51 (41–60)	52 (45–60)	0.741
SBP, mm Hg	99.5 (90–110)	94(84–110)	101(91–112)	0.185
DBP, mm Hg	64.5 (54.5–71)	64(53–71)	66 (57–74)	0.388
LVEF, %	50 (45–60)	53 (48–63)	49 (44–59)	0.181
NT-proBNP, pg/mL	1880(1119–3925)	2231(1091–4144))	1703(1149–3444)	0.830
Troponin-T, ng/mL	2.68 (2.08–4.96)	2.40 (1.91–5.76)	2.70 (2.19–4.95)	0.682
Glycated hemoglobin, %	5.8 (5.6–7.3)	5.8 (5.6–6.7)	5.9 (5.5–7.6)	0.732
LDL-C, mmol/L	2.02 (1.67–2.51)	1.84 (1.51–2.27)	2.32 (1.78–2.91)	0.032
Creatinine, umol/L	85.0 (67.8–110.3)	87.0 (68.3–116.0)	85.5 (66.8–108.8)	0.662
Alanine transaminase, U/L	45 (34–87)	56(35–122)	40(30–75)	0.129
Total occlusion at culprit vessel, n (%)	36 (69.2%)	14 (58.3%)	22 (78.6%)	0.115
Number of vessels with >50% stenosis				
Single vessel	8	4	4	
Two vessels	13	9	4	
Three vessels	31	11	20	
Discharge medications				
β blocker use, n (%)	21 (40.4%)	15 (62.5%)	6 (21.4%)	0.003
ACEI/ARB use, n (%)	35 (67.3%)	16 (66.7%)	19 (67.9%)	0.927

ACEI, ACE inhibitor; ARB, angiotensin receptor blocker; AVB, atrioventricular block; bpm, beat per minute; DBP, diastolic blood pressure (on admission); HR, heart rate (on admission); LDL-C, low-density lipoprotein cholesterol; LVEF, left ventricular ejection fraction; NT-proBNP, N-terminal pro brain natriuretic peptide; PCI, percutaneous coronary intervention; SBP, systolic blood pressure (on admission).

frequencies, while continuous variables were described as mean±SD or median and IQRs as appropriate. Simple linear analysis was used to calculate the correlation between time to PCI and time of AVB getting improvement in the postoperative group. Differences between groups were compared by the use of T-test or Mann-Whitney test for continuous variables and  $\chi^2$  test or the Fisher exact test for categorical variables as appropriate. A two-tailed  $p<0.05$  was regarded as statistically significant in all calculations.

## RESULTS

The baseline characteristics of 52 patients are summarized in [table 1](#). Among all the patients, 43 patients were complicated by third-degree AVB on admission, 7 patients with Mobitz typeII second AVB, and 2 patients with Mobitz type I second AVB. Thirty-four patients (65.4%) were implanted with a temporary pacemaker while 15 patients needed intravenous vasopressor during their hospital stay. The median presentation time from symptom onset was 36 hours, ranging from 13 to 192 hours. The median time to PCI was 6.0 days, ranging from 1 to 15 days. The median time of AVB getting improvement was 5.0 days, ranging from 1 to 15 days.

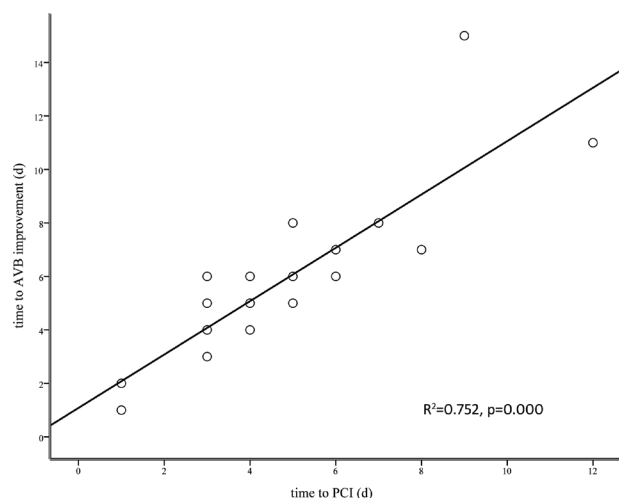
All patients underwent coronary angiography (CAG) and primary PCI. CAG showed single-vessel disease in eight

cases, double-vessel disease in 13 cases and triple-vessel disease in 31 cases. Right coronary artery was the culprit vessel in 50 patients, and the other two cases had infarct-related artery (IRA) at left circumflex. Twenty-four patients got AVB improvement before PCI (defined as preoperative group) while 28 patients got AVB improvement after PCI (defined as postoperative group). In the postoperative group, the median time to PCI was 4 days and there was a strong association between time to PCI and time of AVB improvement ( $R^2=0.752$ ,  $p=0.000$ ) by Simple linear analysis ([figure 1](#)).

There were three patients whose postprocedural angiographic thrombolysis in myocardial infarction (TIMI) flow at IRA was <3 (one was TIMI grade 1, two were TIMI grade 2). But no death or adverse cardiac event occurred. All the patients got complete AVB recovery at discharge (return of 1:1 AV conduction).

Although there was no intact follow-up information, by checking electronic medical records, we found that 36 patients had at least 1-month follow-up information at clinic. None of them had recurrence of heart block issues.

There were four patients (3 male and one female) who had persistent right bundle branch block (RBBB) after sinus rhythm returned completely. But it was not clear whether the RBBB was present before myocardial infarction. All of the



**Figure 1** Simple linear analysis model between time to PCI and time to AVB getting improvement in the postoperative group. The y-axis represents the time to AVB getting improvement after symptom onset. The x-axis represents the time to PCI after symptom onset. Twenty-eight patients in the postoperative group were enrolled in the analysis ( $R^2=0.752$ , 95% CI of slope 0.767 to 1.229,  $p=0.000$ ). AVB, atrioventricular block; PCI, percutaneous coronary intervention.

four patients had the culprit lesion at right coronary artery (RCA). The two of them started to received beta blockers at 1-month follow-up and had no adverse bradycardia event at a median of 2-years follow-up. The other two patients were lost to follow-up. Except the above four patients, the other 48 patients restored narrow QRS on ECG.

## DISCUSSION

There is no doubt that emergent PCI can ameliorate AVB in inferior STEMI patients within 12 hours after symptom onset. But no study has explored the effect of PCI on the late presenters with inferior MI and new onset AVB on admission outside the 12 hours. Through our work, we find that: (1) early PCI in delayed patients is helpful to promote AVB recovery without adverse cardiac event; (2) for late presenters, AVB in inferior STEMI patients can restore spontaneously under the temporary pacemaker protection if PCI is not available.

Contemporary management of STEMI is built around timely reperfusion therapies that aim to reduce infarct size and optimize patient outcome. As the more clinical evidences have showed up, the reperfusion time window for STEMI patients has been expanded from 12 hours to 48 hours.<sup>2,3</sup> As for those who present later than 48 hours, the Occluded Artery Trial has concluded that PCI cannot improve outcomes compared with medical therapy during long-term follow-up.<sup>5</sup> But some studies by using cardiac magnetic resonance technique have found that substantial salvageable myocardium can occur in patients presenting >48 hours.<sup>6</sup> Chinese researchers find that late presenters waiting 1 week or more to receive PCI have greater survival benefit and less adverse events.<sup>7</sup> As far as we know, there is no study that has focused on those late presenters with inferior MI and new onset AVB. Most delayed inferior MI patients with advanced AVB need temporary pacemaker

to maintain the hemodynamic stability according to the current guideline.<sup>8</sup> This specific patient group should be distinguished from other latecomers because even though successful PCI cannot prevent cardiac remodeling, it can restore blood perfusion to the conduction system and promote the recovery of AVB.

According to previous data from the prethrombolytic era, second or third degree AV block could last as long as 16 days before return of 1:1 AV conduction.<sup>9</sup> One research in 1968 recorded that sinus rhythm returned in a mean of 4.3 days, ranging 0–19 days.<sup>10</sup> Sutton and Davies reported results of serial section of the conduction system in patients dying with AVB and MI, the pathological examination revealed major structural damage to the conduction system was absent in most, suggesting that ischemia not necrosis was responsible for AVB.<sup>11</sup> Our study showed that there was a large proportion of patients (46.2%) who got AVB improvement before delayed PCI. In this preoperative group, the median time to PCI was 8 days and the median time of AVB getting improvement was 5 days. It indicated that even no reperfusion was achieved, those patients could get AVB recovery spontaneously. It was meaningful in clinical practice, especially for some local non-PCI-capable hospital. However, more remarkable, in the postoperative group we found that there was a close association between time to PCI and time of AVB getting improvement ( $R^2=0.752$ ,  $p=0.000$ ), which meant the earlier the PCI was performed, the sooner the AVB recovered. Successful reperfusion at AV node is beneficial to the conduction system.

This study is a retrospective study based on a single-center experience. Inferior STEMI patients with late presentation and new onset of AVB on admission were relatively rare. Only 52 patients were finally enrolled from about 10,000 STEMI patients spanning ten years. One third patients lost follow-up. But it is meaningful to confirm the effect of early PCI on the atrioventricular conduction and provide some guiding significance for clinical practice in contemporary PCI era.

In conclusion, through our work we find that early PCI is safe and helpful for late presenting inferior STEMI patients when complicated by new onset of AVB. Early PCI should be recommended as the priority strategy in this situation.

**Contributors** XF and LB researched literature and conceived the study. XF and PL collected and analyzed the data. XF wrote the first draft of the manuscript. PM revised the grammar of this manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

**Funding** The study was supported by the Clinical Research Award of The First Affiliated Hospital of Xi'an Jiaotong University, China (No. XJTU1AF-CRF-2019-011).

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** The study was approved by the ethics committee of the first affiliated hospital of Xi'an jiaotong university (XJTU1AFRC2019SJ-011).

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, an indication of whether changes were

made, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

# ORCID iD

Xiaojuan Fan <http://orcid.org/0000-0001-7002-4671>

# REFERENCES

- 1 Huo Y. Current status and development of percutaneous coronary intervention in China. *J Zhejiang Univ Sci B* 2010;11:631–3.
- 2 Ibanez B, James S, Agewall S, et al. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: the task force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of cardiology (ESC). *Eur Heart J* 2018;39:119–77.
- 3 O’Gara PT, Kushner FG, Ascheim DD, et al. ACCF/AHA guideline for the management of ST-elevation myocardial infarction: a report of the American College of cardiology Foundation/American heart association Task force on practice guidelines. *J Am Coll Cardiol* 2013;2013:e78–140.
- 4 Thygesen K, Alpert JS, Jaffe AS, et al. Fourth universal definition of myocardial infarction (2018). *J Am Coll Cardiol* 2018;72:2231–64.
- 5 Hochman JS, Lamas GA, Buller CE, et al. Coronary intervention for persistent occlusion after myocardial infarction. *N Engl J Med* 2006;355:2395–407.
- 6 Busk M, Kaltoft A, Nielsen SS, et al. Infarct size and myocardial salvage after primary angioplasty in patients presenting with symptoms for <12 h vs. 12–72 h. *Eur Heart J* 2009;30:1322–30.
- 7 Zheng W, Yu C-M, Liu J, et al. Patients with ST-segment elevation of myocardial infarction miss out on early reperfusion: when to undergo delayed revascularization. *J Geriatr Cardiol* 2017;14:524–31.
- 8 Kusumoto FM, Schoenfeld MH, Barrett C, et al. 2018 ACC/AHA/HRS guideline on the evaluation and management of patients with bradycardia and cardiac conduction delay: a report of the American College of Cardiology/American heart association Task force on clinical practice guidelines and the heart rhythm Society. *Circulation* 2019;140:e382–482.
- 9 Barold SS. American College of Cardiology/American heart association guidelines for pacemaker implantation after acute myocardial infarction. What is persistent advanced block at the atrioventricular node? *Am J Cardiol* 1997;80:770–4.
- 10 Sutton R, Chatterjee K, Leatham A. Heart-Block following acute myocardial infarction. treatment with demand and fixed-rate pacemakers. *Lancet* 1968;2:645–8.
- 11 Sutton R, Davies M. The conduction system in acute myocardial infarction complicated by heart block. *Circulation* 1968;38:987–92.