

Analysis on application timing of IABP in emergency PCI treatment of patients with combined acute myocardial infarction and cardiac shock

M. ZHOU¹, K. YU¹, X.-H. WANG¹, C.-S. YANG¹, Y.-P. LEI¹,
Y.-G. WANG¹, Y.-Z. XUE¹, H.-C. YAO¹, B. GAO²

¹Department of Cardiology of Liaocheng People' Hospital, Donghangxi Road, Liaocheng, China

²Department of Cardiology of Yanan University Affiliated Hospital, Baota District, Yanan, China

Min Zhou and Ke Yu, these authors contributed equally to this work and should be considered co-first authors

Abstract. – **OBJECTIVE:** To study the application timing and effect of intra-aortic balloon pump (IABP) in the emergency PCI treatment of patients with combined acute myocardial infarction (AMI) and cardiogenic shock (CS).

PATIENTS AND METHODS: 84 cases of patients with combined AMI and CS under PCI in emergency treatment were randomly divided into the control group (n=42) and observational group (n=42). The control group underwent IABP again, after the invalidation of internal medicine drug treatment, while the observational group underwent IABP before the operation. We compared the effects of treatment.

RESULTS: After the intervention, the averages of arterial pressure and urine volume were increased in both groups than before ($p < 0.05$). The average of heart rate was decreased, and the improvement in the observational group was more significant ($p < 0.05$). However, the mortality rate in the observational group during the perioperative period was decreased than the control group as well as, the success rate of off-respirator was significant ($p < 0.05$). The comparison of IABP complication occurrence rate as well as the survival rate after 1-year follow-up between both groups was not significantly different. Additionally, whereas the NYHA grouping in two groups was gradually improved, the difference was not statistically significant between both groups. However, in the observational group, the LVEF after one-month follow-up was significantly higher than in the control group ($p < 0.05$), but not when comparing 1-year. VEDd at each time point in two groups were also similar.

CONCLUSIONS: The early IABP can improve hemodynamics of patients with combined AMI and CS under emergency PCI. It can reduce perioperative mortality rate, improve the suc-

cess rate of off-respirator, but cannot increase IABP complication incidence rate while having little influence on the long-term survival rate and cardiac function indicator.

Key Words:

Intra-aortic balloon pump, Acute myocardial infarction, Cardiogenic shock, Emergency PCI.

Introduction

The mortality rate of the combined acute myocardial infarction (AMI) and cardiogenic shock (CS) is up to 80% to 95%¹. The emergency revascularization including percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) can significantly improve the survival rate. But the risk of operation is high, and the perioperative complications were increased, especially accompanied with the hemodynamic disorder and malignant arrhythmia in patients². The intra-aortic balloon pump (IABP), extracorporeal membrane oxygenation (ECMO) and left ventricular assist device (LVAD) have great value¹ in stabilizing circulatory hemodynamics as well as, in increasing coronary blood flow perfusion, reducing cardiac preload and afterload and seeking treatment time. But simultaneously, the IABP application range, timing, efficacy, and complications are still not uniformly clear. The too early application may increase thrombosis, malignant arrhythmia, heart failure, infection, pulmonary embolism risk, delay revascularization time and

increase perioperative mortality rate³. Too late application (the disease condition continues to become aggravated under the premise of optimized internal medicine active drug) may achieve less effect and increase mortality rate⁴. This study compared and analyzed the application IABP timing developed in our center. It also summarized the application experience and provided a reference for the correct clinical application.

Patients and Methods

Patients Information

The study was approved by the Ethics Committee of the hospital and we obtained the informed consent of patients and their families. 84 cases of patients firstly diagnosed as combined AMI and CS from January 2014 to January 2016 were continuously selected, and they were with the application characteristics of emergency PCI. According to the order of admission, they were randomly divided into the control group and the observational group of including 42 cases in each. The control group included 26 males and 16 females, aged from 42 to 78 years old with the mean of (56.7 ± 13.4) years old. The onset time was 0.5-12h, the mean (6.4 ± 3.5) h. There were 30 cases with ST-elevated myocardial infarction (STEMI) and 12 cases with NSTEMI. The coronary arteriography confirmed that the target vessels included anterior descending branch (19 cases), left circumflex artery (12 cases) and right coronary artery (11 cases). There were 85% to 100% of patients with luminal diameter stenosis, mean: $(95.3 \pm 6.4)\%$. The observational group included 28 males and 14 females, aged from 45 to 80 years old, with the mean of (57.2 ± 15.3) years old. The onset time was 1.0-13h, the mean: (6.6 ± 3.8) h. There were 32 cases with STEMI and 10 cases with NSTEMI. Left circumflex artery: 20 cases, circumflex artery: 10 cases, right coronary artery: 12 cases; there were 90% to 100% of patients with luminal diameter stenosis, mean: $(95.6 \pm 6.7)\%$. The baseline data of both groups were comparable.

AMI was diagnosed based on clinical symptoms, typical ECG and evolution laws and positive cardiac injury markers. The clinical manifestations of CS included persistent hypotension (systolic blood pressure was less than 80mmHg or the basic blood pressure drop was more than 30 mmHg and continued for more than 30min)

accompanied with insufficient peripheral circulation perfusion, little or no urine, irritability or loss of consciousness. The patients who underwent emergency CABG and with severe arrhythmia, septic shock, anaphylactic shock, right ventricular infarction, severe diseases and less than one month expected survival time were excluded.

Study Methods

The operation of patients in both groups was completed by the same procedure and nursing team according to the standard medical process. In the control group, after the internal medicine drug treatment was invalid, the patients underwent IABP, the drug treatment included a vasoactive agent (dopamine, dobutamine $\geq 10 \mu\text{g}/\text{kg}/\text{min}$ or adrenaline $\geq 0.1 \mu\text{g}/\text{kg}/\text{min}$), cardiac stimulant, diuretics, fluid infusion. The patients in the observational group underwent IABP before the operation.

IABP Operation Method: The appropriate balloon pump catheter was selected according to the patient height and weight, percutaneous puncture of femoral artery was carried out with Seldinger technique under sterile conditions, 9F vascular sheath was inserted, the balloon catheter was inserted through the guide wire, the catheter top was located in the descending aorta and 1.0-2.0 cm below left subclavian artery opening. The counter pulsation balloon catheter was connected with ARROW-ACAT I Plus counter pulsation instrument (Arrow International, USA), electrocardiogram R-wave was taken as the trigger mode (arterial pressure trigger mode was adopted in case of unstable heart or arrhythmia), the counter pulsation proportion was adjusted according to the blood pressure and heart conditions of patients to achieve the best counter pulsation effect. After the catheter have been inserted, the IABP catheter central cavity was rinsed with heparin saline (5000 U heparins sodium + 500 ml normal saline) every hour, and the blood was heparinized by subcutaneous injection of 40 mg low molecular heparin. Meanwhile, the vasoactive drugs were applied, when hemodynamics was stabilized, adrenaline $<0.02 \mu\text{g}/\text{kg}/\text{min}$ or dopamine and dobutamine $<5 \mu\text{g}/\text{kg}/\text{min}$. The counter pulsation frequency was gradually decreased. The ratio of counter pulsation frequency and heart rate was 1:2. After the hemodynamics was sta-

Table I. Comparison of hemodynamic indicators.

Group category	Mean arterial pressure (mmHg)		Mean heart rate (beats/min)		Mean urine volume (ml/h)	
	Before intervention	After intervention	Before intervention	After intervention	Before intervention	After intervention
Control group	46.5±4.3	63.5±4.8	110.8±6.6	86.6±6.4	12.6±2.8	29.8±3.0
Observation group	46.0±4.5	72.4±5.0	112.4±6.2	82.3±6.0	12.3±2.6	33.4±3.2
<i>t</i>	0.237	5.237	0.421	5.126	0.362	5.524
<i>p</i>	0.659	0.033	0.754	0.036	0.825	0.030

bilized for 24h, the ratio of counter pulsation and heart rate was reduced to 1: 3 again. After observing for 15-30 min, the counter pulsation might be stopped for those with no significant changes in hemodynamics.

PCI Method: Transcardial artery pathway, Judkins method was used to carry out coronary arteriography in order to clear the target vessel. Also, to determine thrombus aspiration, balloon pre-dilatation, post-dilatation, stent size, length, as well as quantity were used. It prevents coronary spasm, reperfusion injury, no reflow, thrombosis, reinfarction, iatrogenic injury, coronary or myocardial perforation, and other complications.

Observation Indicators

The hemodynamic indicators included mean arterial pressure, mean heart rate and mean urine volume. Perioperative and mortality rate, success rate of off-respirator, IABP-related complication morbidity rate were also measured. Also, one-year follow-up survival rate, cardiac function indicators including NYHA grading, left ventricular ejection fraction (LVEF) and left ventricular end-diastolic diameter (LVEDd), were compared for both groups.

Statistical Analysis

SPSS20.0 software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. The measurement data was expressed as mean ± standard deviation (SD). The comparison between both groups and intra-group comparison was tested with paired *t* test or analyzed with repeatedly measured data variance. The counts data was expressed as the number of cases (%) and the comparison between the groups was tested with χ^2 -test; $p < 0.05$ means that the difference was statistically significant.

Results

Comparison of Hemodynamic Indicators

The mean arterial pressure and mean urine volume in both groups after the intervention were increased than before. The mean heart rate was decreased, and the patients in the observational group were improved more significantly ($p < 0.05$) (Table I).

Comparison of Perioperative Mortality Rate, Success Rate of Off-respirator, IABP Complication Incidence Rate

The perioperative mortality rate in the observational group was less decreased than in the control group. The success rate of off-respirator was increased, and the difference was statistically significant ($p < 0.05$). IABP complication occurrence rate between the two groups was not statistically different (Table II).

Comparison of Follow-up Indicators

By comparing the survival rates of 1-year follow-up in both groups, the difference was not statistically significant. The NYHA grading in two groups was gradually, but non significantly, improved. The LVEF in the observational group after one-month follow-up was significantly higher than the control group ($p < 0.05$). However, the LVEF levels of 1-year follow-up, as well as the LVEDd levels at each time point, were not significantly different (Table III).

Discussion

Several studies^{5,6} have confirmed that the early application of AMI on patients with AMI and CS who had undergone PCI could significantly

Table II. Comparison of perioperative mortality rate, success rate of off-respirator and IABP complication occurrence rate [n (%)].

Group category	Case number	Perioperative mortality rate	Success rate of off-respirator	Thrombus	Aggravating heart failure pedis pulse	Reduced dorsalis	Malignant arrhythmia	Local hematoma	Complication occurrence rate
Control group	42	3 (7.1)	40 (95.2)	0	2	1	0	2	5 (11.9)
Observation group	42	10 (23.8)	34 (81.0)	1	2	1	1	1	6 (14.3)
χ^2		4.459	4.086						
p		0.035	0.043						

improve hemodynamics and peripheral circulation. Its effect was better than the remedial application. The mortality rate of combined AMI and CS in the hospital is closely related to the failure to carry out timely revascularization and circulatory support. Accordingly, USA AHA/ACC recommends IABP as the class I indications of combined AMI and CS⁷. Data showed that after the intervention the mean arterial pressure and urine volume in both groups were increased that before. The mean heart rate was decreased, and the patients in the observational group were significantly improved. These suggest that the early IABP could more effectively stabilize the hemodynamics. Indeed, the hemodynamic disorder was an important factor reducing the success rate of revascularization and increasing mortality rate and complications⁸. The perioperative mortality rate in the observational group was significantly decreased than the control group. The success rate of off-respirator was significantly increased in the observational group. By comparing IABP complication incidence rates between the two groups, the difference was not statistically significant, suggesting that early IABP might be safe and effective⁹. By comparing survival rates of 1-year follow-up in the two groups, the difference was not statistically significant; the NYHA grading in two groups was gradually improved. The LVEF of 1-month follow-up in the observational group was significantly higher than the control group, while comparing the LVEF levels of 1-year following up, the difference was not statistically significant; by comparing the LVEDd levels at each time point between the two groups and the difference was not statistically significant. This suggests that IABP could have a positive role in improving the acute cardiac function and circulatory disturbance, but a minor role in improving ventricular remodeling and long-term

survival benefit¹⁰. Considering the reasons that the combination of AMI with CS could cause serious cardiac injury, even after early PCI and IABP intervention, there would be still the majority of myocardial necrosis or apoptosis. As well, the cardiac function could not be restored, and the continuing role of neuroendocrine regulation would play a key role in ventricular remodeling and long-term prognosis¹¹. The drug treatment with neuroendocrine antagonism as action targets such as β -blockers, ACEI or ARB, spironolactone had been proven to have a confirmation role¹² in reducing the long-term mortality rate. The NYHA grading in both groups was gradually improved, the increased LVEF and not further expanded LVEDd might be more likely to benefit from optimal internal medicine drug intervention.

It is stressed that the IABP must be applied before the irreversible myocardial ischemic injury has not yet occurred in cardiac muscle. Otherwise, it would be ineffective. Application of IABP needs to prevent complications, and in the femoral artery puncture¹³. The vascular injury rate was 1 to 7%, and the thrombosis occurrence rate was 10 to 40%¹⁴. The actions should be gentle, the arteries and dorsalis pedis arterial pulse of lower extremities should be examined before, during and after the operation, the clotting time (ACT) should be controlled in 160-200s¹⁴. It should be fully pressurized after pulling out the catheter to avoid dissection and wound hematoma formation, infection.

Conclusions

The early IABP can improve hemodynamics of patients with combined AMI and CS under emergency PCI. It can also reduce the perioperative mortality rate, improve the success rate of

Table III. Comparison of follow-up indicators.

Group category	Case number	Survival rate	NYHA grading			LVEF (%)			LVEDd (mm)		
			Before intervention	1-month follow-up	1 year	Before intervention	1-month follow-up	1 year	Before intervention	1-month follow-up	1 year
Control group	42	30 (71.4)	3.3±0.6	2.5±0.8	1.8±0.6	32.6±3.4	36.3±3.6	45.9±4.1	56.3±2.6	56.6±2.5	56.8±2.7
Observation group	42	26 (61.9)	3.4±0.5	2.3±0.7	1.6±0.5	32.5±3.3	42.6±3.5	47.8±4.0	56.2±2.3	56.5±2.5	56.7±2.8
<i>t</i> (χ^2)		0.857	0.234	0.521	0.216	0.265	5.327	0.639	0.214	0.236	0.324
<i>p</i>		0.355	0.865	0.529	0.874	0.954	0.036	0.427	0.754	0.769	0.825

off-respirator, cannot increase IABP complication occurrence rate. But, it has less influence on the long-term survival rate and heart function indicators. Hens, IABP indications, and contraindications should be controlled strictly and applied duly and safely.

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Conflict of interest

The authors declare no conflicts of interest.

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