Original paper

Impact of intra-aortic balloon pump on long-term mortality of unselected patients with ST-segment elevation myocardial infarction complicated by cardiogenic shock

Artur Dziewierz[1], Zbigniew Siudak[2], Tomasz Rakowski[1], Paweł Kleczyński[1], Wojciech Zasada[1], Dariusz Dudek[2]

[1]2nd Department of Cardiology, Jagiellonian University Medical College, Krakow, Poland
[2]Department of Interventional Cardiology, Jagiellonian University Medical College, Krakow, Poland

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Abstract

Introduction: A large, randomised trial (IABP-SHOCK II) confirmed no benefit of intra-aortic balloon pump (IABP) on clinical outcomes of patients with ST-segment elevation myocardial infarction (STEMI) complicated by cardiogenic shock. However, the 'sickest' patients are often excluded from randomised clinical trials, so it is difficult to generalise expected outcomes from randomized clinical trials to the real life setting.

Aim: We sought to evaluate the impact of IABP on 1-year mortality of unselected patients with STEMI presenting in cardiogenic shock.

Material and methods: Data were gathered for 1,650 consecutive patients with STEMI transferred for primary angioplasty from hospital networks in 7 countries in Europe from November 2005 to January 2007 (the EUROTRANSFER registry population). Of them, 51 patients with cardiogenic shock on admission were identified and stratified based on the use of IABP. Outcome results were adjusted for age and sex, to control possible selection bias.

Results: At the discretion of the operators, IABP was applied in 30 patients (58.8%, IABP group). The remaining 21 patients were treated without IABP (no-IABP group). The use of IABP was more frequent among males, younger patients, and patients with STEMI of the anterior wall. There was no difference in 30-day mortality in patients with and without IABP (no-IABP vs. IABP: 38.1% vs. 33.3%; adjusted OR 1.79 (95% CI 0.43–7.52); $p = 0.43$). Similarly, IABP had no impact on 1-year mortality (42.9% vs. 33.3%; adjusted OR 1.27 (95% CI 0.32–5.09); $p = 0.74$). One-year mortality was comparable among patients who survived hospitalisation (14.3% vs. 13%; $p = 0.64$).

Conclusions: We observed no benefit of IABP on short – and long-term mortality of unselected patients with STEMI complicated by cardiogenic shock.

Key words: intra-aortic balloon pump, counterpulsation, cardiogenic shock, myocardial infarction, angioplasty, registries.

Introduction

Cardiogenic shock is the leading cause of death among patients hospitalised with ST-segment elevation myocardial infarction (STEMI) [1–7]. Early revascularisation, with both percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) leads to a survival benefit in these patients [8, 9]. According to current guidelines, additional intra-aortic balloon pump (IABP) support may be considered in patients with STEMI and cardiogenic shock [10, 11].

Intra-aortic balloon pump improves myocardial and peripheral perfusion, and reduces afterload, as well as myocardial oxygen consumption [6, 12–14]. These effects are believed to improve myocardial recovery during ischaemia and reperfusion. On the other hand, the benefit of IABP in patients with STEMI and cardiogenic shock undergoing primary PCI were not proven by a meta-analysis of cohort studies [15]. In addition, the impact of IABP on long-term survival of patients with STEMI and cardiogenic shock remains unclear because the majority of previous studies have focused on short-term outcomes [15–19]. Recently, a large, randomised IABP-SHOCK II trial confirmed no benefit of IABP on short – and long-term outcomes of patients with STEMI complicated by cardiogenic shock [20, 21]. However, the 'sickest' patients are often excluded from randomised clinical trials, so it is difficult to generalise expected outcomes from randomized clinical trials to the real life setting.

Corresponding author:
Dariusz Dudek MD, PhD, Department of Interventional Cardiology, Jagiellonian University Medical College, 17 Kopernika St, 31-501 Krakow, Poland, phone: +48 12 424 71 81, fax: +48 12 424 71 84, e-mail: mcdudek@cyfronet.pl
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Aim

We sought to evaluate the impact of IABP on 1-year mortality in an unselected cohort of patients with STEMI complicated by cardiogenic shock, based on data from the EUROTRANSFER (European Registry on Patients with ST-Elevation MI Transferred for Mechanical Reperfusion with a Special Focus on Upstream Use of Abciximab) Registry [22–24].

Material and methods

The EUROTRANSFER Registry (ClinicalTrials.gov number NCT00378391) design and main results have been published elsewhere [22–24]. In this registry, data on 1,650 patients with STEMI in 15 primary PCI networks from 7 European countries between November 2005 and January 2007 were collected. For the present analysis, the data of 51 (3.1%) patients with STEMI and cardiogenic shock on admission (systolic blood pressure < 90 mm Hg, heart rate > 100 bpm, and clinical signs of organ hypoperfusion) were assessed. Patients were stratified by use of IABP during index hospital stay: no-IABP vs. IABP. The treatment strategies, including the use of IABP and the timing of insertion, were at the discretion of operators. The study protocol and execution complied with the Declaration of Helsinki and was approved by the Institutional Review Board.

The primary endpoint was 1-year all-cause mortality. Secondary endpoints were: 30-day all-cause mortality, nonfatal reinfarction, urgent revascularisation (PCI or CABG), major bleeding requiring transfusion, and puncture site haematoma [22–24]. Thrombolysis In Myocardial infarction (TIMI) flow in the infarct-related artery before and after PCI, ST-segment resolution after PCI, and the rate of angiographic complications of PCI (no-reflow, distal embolisation) were assessed at the investigators' discretion.

Statistical analysis

Continuous variables were presented as medians (interquartile ranges). Categorical variables were expressed as numbers (percentages). Differences between groups (no-IABP vs. IABP) were tested using the χ^2 test and Fisher's exact test for dichotomous variables and the Mann-Whitney *U*-test for continuous variables. The effect of IABP vs. no-IABP on clinical outcomes was presented as odds ratios (OR) and 95% confidence intervals (CI). To adjust for possible selection bias, differences in clinical outcomes were adjusted for age and sex using logistic regression. Results were presented as adjusted OR with 95% CI. The survival curves were estimated by the Kaplan-Meier method and compared using log-rank test. All tests were 2-tailed, and a p value of < 0.05 was considered statistically significant. All statistical analysis was performed using SPSS software, version 15.0 (SPSS Inc., Chicago, Illinois).

Results

In total, 1,650 patients with STEMI from 15 primary PCI centres between November 2005 and January 2007 were included in the EUROTRANSFER Registry. Of these, 51 (3.1%) patients were in cardiogenic shock on admission. At the discretion of the operators, IABP was used in 30 patients (58.8%, IABP group). The remaining 21 patients were treated without IABP (41.2%, no-IABP group). As shown in Tables I and II, the use of IABP was more frequent among males, younger patients, and patients with the left anterior descending artery as the infarct-related artery.

Impact of intra-aortic balloon pump on clinical outcomes

Immediate PCI was performed in 30 (100%) patients from the IABP group, and in 18 (85.7%) patients from the no-IABP group (p = 0.06). Two patients from the no-IABP group were transferred for urgent CABG. The rate of stent implantation and thrombus aspiration was comparable between the two groups (Table II). Despite no difference in the rate of TIMI grade 3 flow after PCI, the rate of ST-segment resolution > 50% 60 min after PCI was numerically higher in patients from the no-IABP group (no-IABP vs. IABP: 47.6% vs. 26.7%; p = 0.15).

The overall 30-day and 1-year mortality for patients in cardiogenic shock was 35.3% and 37.3%, respectively. Even after adjustment for age and sex, there was no difference in short – and long-term mortality between patients treated with and without IABP (Table III, Figure 1). Similarly, no difference in 1-year mortality was observed when the infarct-related artery (left anterior descending artery (LAD) vs. no-LAD) and diabetes mellitus were added to the adjustment model – adjusted OR (95% CI) – 1.48 (0.30–7.33). There was also no difference in 1-year mortality between groups of patients who survived hospitalisation (no-IABP vs. IABP: 14.3% vs. 13.0%; p = 0.64). The rate of bleedings was comparable between groups (Table III).

Discussion

The main finding of the present study is that among patients with STEMI complicated by cardiogenic shock, treatment with IABP had no impact on short – and long-term survival. On the other hand, despite the higher risk attributed to patients from the IABP group, the long-term outcomes were comparable to those observed in lower-risk patients treated without IABP. This may suggest a beneficial effect of IABP in a selected group of patients.

The observed rate of cardiogenic shock on admission was comparable to that previously reported for patients with STEMI [3–5, 7]. Also, short – and long-term mortality rates were similar to those reported for patients undergoing early revascularisation in the setting of STEMI complicated by cardiogenic shock [4, 5, 8, 9, 17, 18, 25].

Table I. Baseline clinical characteristics of patients with and without intra-aortic balloon pump

Variable	Intra-aortic balloon pump		Value of *p*
	No (*n* = 21) *n* (%)/median (range)	Yes (*n* = 30) *n* (%)/median (range)	
Age [years]	72 (62–81)	64.5 (52–74)	0.018
Age ≥ 65 years	14 (66.7)	15 (50.0)	0.24
Men	8 (38.1)	25 (83.8)	0.001
Body mass index [kg/m^2]	26.9 (23.2–28.5)	27.4 (24.7–29.3)	0.24
Diabetes mellitus	1 (4.8)	8 (26.7)	0.06
Previous myocardial infarction	4 (19.0)	8 (26.7)	0.74
Previous heart failure symptoms	1 (4.8)	2 (6.7)	0.99
Previous percutaneous coronary intervention	1 (4.8)	2 (6.7)	0.99
Previous coronary artery bypass grafting	0 (0.0)	0 (0.0)	–
Current smoker	5 (23.8)	8 (26.7)	0.82
Peripheral arterial disease	1 (4.8)	0 (0.0)	0.41
Previous stroke	2 (9.5)	0 (0.0)	0.17
Chronic kidney disease	1 (4.8)	0 (0.0)	0.41
Time from symptoms onset to diagnosis [min]	92 (53–133)	80 (45–293)	0.72
Aspirin before cathlab	15 (71.4)	26 (86.7)	0.28
Clopidogrel before cathlab	2 (9.5)	7 (23.3)	0.28
Unfractionated heparin before cathlab	13 (61.9)	16 (53.3)	0.54
Abciximab before cathlab	5 (23.8)	14 (46.7)	0.14

Values are presented as numbers (percentages) or medians (inter-quartile range)

Table II. Invasive treatment details of patients with and without intra-aortic balloon pump

Variable	Intra-aortic balloon pump		Value of *p*
	No (*n* = 21) *n* (%)/median (range)	Yes (*n* = 30) *n* (%)/median (range)	
Femoral access	20 (95.2)	27 (90.0)	0.63
LAD as infarct-related artery	8 (38.1)	20 (66.7)	0.044
Multi-vessel disease	16 (76.2)	20 (69.0)	0.57
TIMI grade 2 to 3 flow before PCI	3 (14.3)	3 (10.0)	0.68
Time from symptoms onset to PCI [min]	226 (139–352)	220 (136–460)	0.87
Immediate PCI	18 (85.7)	30 (100)	0.06
Number of stents implanted:			
1	11 (68.8)	17 (65.4)	0.69
2	3 (18.8)	7 (26.9)	
3	2 (12.5)	1 (3.8)	
≥ 4	0 (0.0)	1 (3.8)	
Thrombus aspiration	1 (5.6)	5 (16.7)	0.39
Drug-eluting stent	7 (38.9)	8 (26.7)	0.52
Non-infarct-related artery PCI	2 (11.1)	4 (13.3)	0.99
TIMI grade 3 flow after PCI	16 (88.9)	24 (80.0)	0.81
Angiographic complications of PCI:			
No-reflow	0 (0.0)	2 (6.7)	0.52
Distal embolisation	0 (0.0)	2 (6.7)	0.52

Values are presented as numbers (percentages) or medians (inter-quartile range). LAD – the left anterior descending artery, PCI – percutaneous coronary intervention, TIMI – Thrombolysis In Myocardial Infarction

Table III. Clinical outcomes of patients with and without intra-aortic balloon pump

Variable	Intra-aortic balloon pump		OR (95% CI)	Value of *p*	Adjusted OR (95% CI)	Value of *p*
	No (*n* = 21) *n* (%)	Yes (*n* = 30) *n* (%)				
30-day:						
Death	8 (38.1)	10 (33.3)	0.81 (0.25–2.60)	0.73	1.79 (0.43–7.52)	0.43
Death + nonfatal reinfarction	9 (42.9)	11 (36.7)	0.77 (0.25–2.41)	0.66	1.45 (0.36–5.78)	0.60
Death + nonfatal reinfarction + urgent revascularisation	9 (42.9)	14 (46.7)	1.17 (0.38–3.59)	0.79	2.53 (0.61–10.45)	0.20
Major bleeding requiring transfusion	1 (4.8)	1 (3.2)	0.69 (0.04–11.68)	0.99	1.36 (0.05–38.88)	0.86
Puncture site haematoma	2 (9.5)	2 (6.7)	0.68 (0.09–5.24)	0.99	1.08 (0.11–11.13)	0.95
1-year:						
Death	9 (42.9)	10 (33.3)	0.67 (0.21–2.11)	0.49	1.27 (0.32–5.09)	0.74

Values are presented as numbers (percentages) and as odds ratios (OR) with 95% confidence intervals (CI), unadjusted and adjusted for age and sex

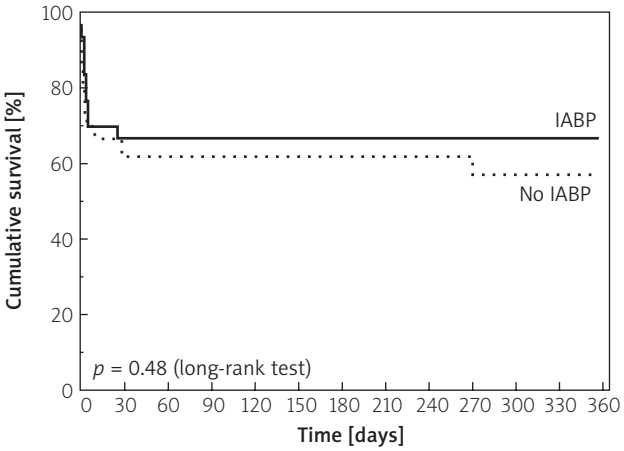

Figure 1. Kaplan-Meier survival curves for patients treated with (solid line) and without (dotted line) intra-aortic balloon pump

In our study, IABP was used in up to 60% of patients with STEMI and cardiogenic shock on admission. Conversely, it was used in 25% of patients with cardiogenic shock included between May 2005 and April 2008 in the Euro Heart Survey on PCI [18]. A more recent report from the ALKK-PCI registry confirms significant differences in the use of IABP between various German hospitals, ranging from 0 to 70%, with an overall rate of 25.5% [17]. The recent decrease in the use of IABP in Europe [17, 18, 26] is probably related to the results of a meta-analysis of cohort studies from Sjauw *et al*. published on 2009 [15]. In this meta-analysis no mortality benefit of IABP in patients with STEMI complicated by cardiogenic shock treated with primary PCI was confirmed. Importantly, the use of IABP was associated with an increase in major bleeding complications and stroke [15]. In the largest study to date on IABP support in patients with STEMI complicated with cardiogenic shock (the IABP-SHOCK II trial), no reduction of 30-day and 1-year mortality was observed in patients treated with IABP, as compared to patients without IABP [20, 21]. Also, there was no difference in other clinical endpoints, including stroke. In the updated meta-analysis from Romeo *et al*. (13 observational studies, 4 randomised clinical trials) a significant increase of in-hospital mortality was observed in patients with cardiogenic shock undergoing primary PCI supported by IABP [19]. Interestingly, the benefit of IABP was limited to patients with STEMI and cardiogenic shock treated with thrombolytic therapy [19].

Using the data from the EUROTRANSFER registry, we observed no impact of IABP on short-term mortality of patients with STEMI and cardiogenic shock on admission. Our study may also suggest that IABP support in patients with STEMI and cardiogenic shock on admission did not improve long-term clinical outcomes compared to no IABP. Importantly, observed 1-year mortality rates for patients who survived hospitalisation were low, and comparable between groups. This finding is in line with the results of the study from Singh *et al*. [27] In this study, the long-term mortality of patients with STEMI and cardiogenic shock, and who survived hospitalisation, was low and similar to that reported for patients with STEMI without cardiogenic shock [28, 29].

Our study has a number of potential limitations. This is a non-randomised study with the potential of selection bias. The two groups were not balanced for important factors affecting long-term outcomes in patients with STEMI (gender, age, infarct location, and diabetes mellitus). Due to the very small sample size, the study was underpowered for the assessment of clinical endpoints. We were unable to calculate propensity scores or to control patient-, operator-, and centre-related factors influencing the association between IABP use and patient outcomes. The analysed 1-year outcomes were limited to

mortality only, and important data on heart failure symptoms or neurological outcomes were not available. Also, we were unable to assess the impact of IABP timing on clinical outcomes because no data on the timing of IABP insertion (before, during, or after angiography/PCI) were available. The study by Abdel-Wahab *et al*. suggests that patients with cardiogenic shock (either on admission or during hospitalisation) undergoing primary PCI assisted by IABP have a more favourable in-hospital outcome and lower in-hospital mortality than patients who receive IABP after PCI [30]. Conversely, no association between the time of IABP insertion (before PCI vs. after PCI) and 30-day mortality was reported for patients with cardiogenic shock on admission [31]. In addition, no data on the use of antithrombotic and antiplatelet drugs, as well as inotropes/vasopressors during index hospital stay, were collected in the EUROTRANSFER registry, and no data on important admission laboratory predictors of mortality in cardiogenic shock, such as glucose, lactate, and creatinine clearance, were available.

Conclusions

We observed no benefit of IABP on short – and long-term mortality of unselected patients with STEMI complicated by cardiogenic shock.

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