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Outcomes among patients requiring unplanned intra-aortic balloon pump reinsertion in cardiogenic shock

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ABSTRACT

Introduction: The intra-aortic balloon pump (IABP) is the most frequently utilized form of temporary mechanical circulatory support (MCS) in cardiogenic shock (CS). Withdrawal of IABP support may precipitate hemodynamic compromise such that IABP reinsertion is required. Data are scarce regarding the incidence and outcomes of patients undergoing IABP reinsertion in this setting.
Methods: In this single-center retrospective study, we identified consecutive patients with CS in whom IABP reinsertion was required for hemodynamic decompensation. These patients were compared to matched controls in whom IABP withdrawal was successful. The primary outcome measure was in-hospital mortality, while the secondary outcome measure was a composite of in-hospital death, need for advanced MCS or heart transplantation, or discharge to hospice.
Results: Among 222 patients requiring IABP for CS, we identified 20 case patients (incidence = 9.0%) and 38 matched controls. Baseline characteristics were similar for the two groups. In-hospital mortality was 70% in the reinsertion group and 31% in the controls (Odds ratio (OR) 5.2, 95% CI 1.4–18.9, P = 0.005). The composite secondary endpoint was also significantly more common in the reinsertion group than the controls (85% vs. 42%; OR 7.3, 95% CI 1.6–33.1, P = 0.002). On multivariate analysis, the need for IABP reinsertion was independently associated with in-hospital mortality (OR 7.7, 95% CI 1.6–36.2, P = 0.01).
Conclusion: Among patients with CS undergoing IABP removal, hemodynamic deterioration requiring IABP reinsertion is associated with extremely poor outcomes and, in appropriate patients, should prompt consideration of more advanced cardiac support.

1. Introduction

The intra-aortic balloon pump (IABP) is a simple, percutaneously placed device that provides afterload reduction, augmentation of cardiac output, and improved coronary perfusion [1]. It is therefore the most commonly used modality of mechanical circulatory support (MCS) for patients with cardiogenic shock (CS) [2]. Traditionally, weaning of IABP support in such patients has been accomplished by reducing the ratio of support from every cardiac cycle to every second or third cycle with monitoring of the hemodynamic response. Satisfactory hemodynamic status at a low support ratio then prompts IABP removal. Although this approach is generally successful, IABP removal after weaning is occasionally associated with rapid hemodynamic decompensation requiring unplanned IABP reinsertion [3]. Despite the widespread use of the IABP in CS, there are few published data regarding the outcomes of patients who require IABP reinsertion [4]. Therefore, we examined the incidence and outcomes of unplanned IABP reinsertion in patients with CS.

2. Methods

This study was approved by the Institutional Review Board of the MedStar Health Research Institute. We queried the Medstar Washington Hospital Center Coronary Care Unit (CCU) Database to identify all patients who underwent placement of an IABP in the setting of CS between the years 2003 and 2012. The diagnosis of CS was made by the treating intensivist based on standard clinical criteria (hypotension and oliguria along with signs of elevated left heart filling pressures, such as rales and congestion on chest radiography) and invasive hemodynamic criteria. Among these patients, we identified those in whom a second IABP was placed during the same hospital admission after the original IABP had been removed. The medical records of these patients were reviewed, and patients in whom the second IABP had been placed because of a new cardiac event (i.e. new myocardial infarction or stent thrombosis), subsequent planned procedure (i.e. elective replacement), or mechanical failure of the IABP (i.e. balloon rupture or device malfunction) were excluded. The reasons for exclusion of the remaining 14

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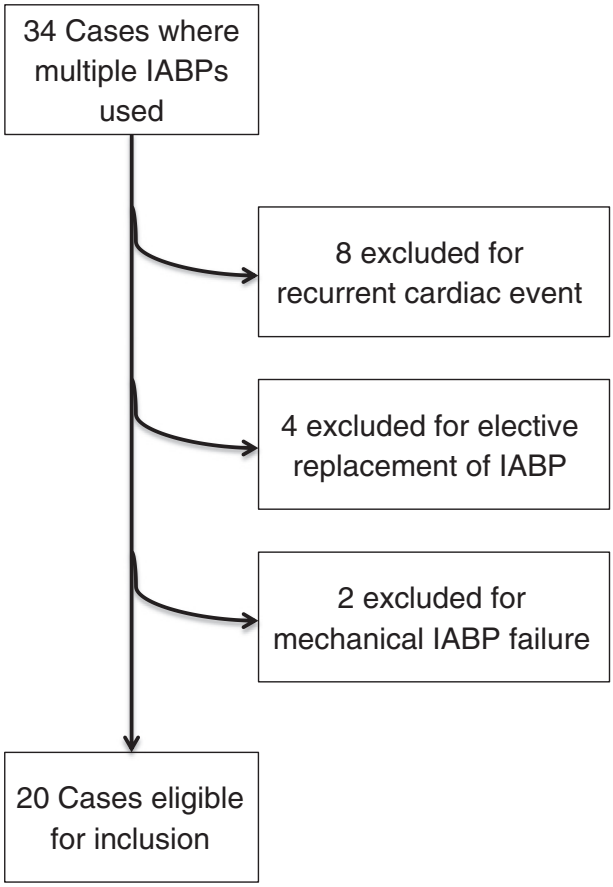

Fig. 1. Identification of case patients.

patients are described in Fig. 1. The remaining patients were those in whom the IABP was replaced due to unexpected hemodynamic deterioration, and these were considered the case patients for this analysis. Case patients were then matched to a control population of patients with CS in whom a single IABP had been placed. Patients were matched for age (±3 years), year of admission (±1 year), and primary diagnosis (acute myocardial infarction (AMI) vs. other diagnosis). For two very young patients, the age matching criterion was expanded to ± 5 years.

The primary outcome measure was in-hospital mortality. The secondary outcome measure was a composite of in-hospital death, need for advanced MCS (left ventricular assist device (LVAD) or veno-arterial extracorporeal membrane oxygenation (ECMO)) or heart transplantation, or discharge to hospice. CCU and in-hospital length of stay were also assessed. Baseline data are presented as median and interquartile range (IQR) for continuous variables and as percentages for categorical variables. Baseline characteristics for case and control patients were compared using the Wilcoxon Signed-Rank test for continuous variables and the Cochran–Mantel–Haenszel method for categorical variables. Conditional logistic regression analysis was utilized to determine the relationship between selected baseline variables and in-hospital death among a pooled cohort of case and control patients. All variables significant at $P \leq 0.1$ on univariate analysis were included in the multivariate analysis. A P value <0.05 was considered to represent statistical significance.

3. Results

We identified 222 patients in whom at least one IABP had been placed in the setting of CS. Among these, there were 34 patients in whom more than one IABP was required during a single hospital admission. Upon medical record review, 20 patients were identified in whom the second IABP was placed because of unanticipated hemodynamic decompensation following removal of the first IABP; these were included as case patients. Therefore, the incidence of unplanned IABP reinsertion due to hemodynamic decompensation among patients with CS was 9.0% (20 of 222). A total of 38 matched controls were identified, 2 for each of 18 case patients and 1 for each of 2 case patients (in whom only 1 satisfactory match could be identified). The median age was 61 years, 57% were male, and 42% were black. The primary diagnosis was AMI in 67% of patients. Baseline characteristics were similar for cases and controls (Table 1).

Duration of initial IABP support was longer in case patients (median 3 vs 1.5 days, P = 0.01). CCU length of stay was greater for case patients (median 9 days, IQR 6–16) than for controls (median 4 days, IQR 2–5) (P < 0.001). Hospital length of stay was also numerically greater among case patients (median 20 days, IQR 12–38) than control patients (median 12 days, IQR 4–22), although this difference was not statistically significant (P = 0.3). In-hospital death occurred in 70% of case patients and 31% of controls (odds ratio (OR) 5.2, 95% CI 1.4–18.9, P = 0.005). Cause of death in all patients was primary pump failure. Death rates for the 14 excluded patients were also evaluated separately and 4 (28.6%) suffered in-hospital death, which was similar to the control patients (p = 0.3). The composite secondary endpoint of in-hospital death, need for advanced MCS or heart transplantation, or discharge to hospice also occurred more commonly among case patients than controls (85% vs. 42%; OR 7.3,

Table 1
Baseline characteristics.

Characteristic	IABP Reinsertion (Cases, n = 20)	No IABP Reinsertion (Controls, n = 38)	P value
Demographics:			
Male (%)	60	55	0.7
White (%)	55	47	0.6
Age, years	61 (52–71)	60 (54–69)	0.3
Body mass index (kg/m^2)	30 (24–36)	28 (25–31)	0.1
Diabetes (%)	73	82	0.7
Hypertension (%)	73	69	1.0
End-stage renal disease (%)	5	8	1.0
Smoking (%)	15	8	0.4
Coronary artery disease (%)	40	34	0.7
Congestive heart failure (%)	25	26	0.9
Primary diagnosis:			
Acute myocardial infarction (%)	65	53	0.6
Nonischemic cardiomyopathy (%)	20	18	1.0
Ischemic cardiomyopathy (%)	5	16	0.4
Acute myocarditis (%)	0	8	0.5
Ventricular fibrillation (%)	0	5	0.5
Aortic stenosis (%)	5	0	1.0
Hypertrophic cardiomyopathy (%)	5	0	1.0
Concomitant therapies:			
Mechanical ventilation (%)	40	34	0.7
Pulmonary artery catheter (%)	80	55	0.1
Physiologic measurements:			
Systolic blood pressure, mmHg	104 (96–112)	108 (91–115)	1.0
Heart rate, beats/minute	85 (74–94)	84 (77–99)	0.5
Ejection fraction, %	22.5 (20–27.5)	25 (20–33.75)	0.1
Creatinine, mg/dL	1.6 (1.2–2.5)	1.2 (1.0–2.3)	0.5