

Use of intra-aortic balloon pump in cardiac surgical patients; the Cleveland Clinic experience, 1975–1976

Leonard R. Golding, M.D.
Floyd D. Loop, M.D.
Daniel Phillips, M.D.
Paul C. Taylor, M.D.

*Department of Thoracic and
Cardiovascular Surgery*

The intra-aortic balloon pump (IABP) has become a widely accepted means of managing patients with unstable cardiac perfusion and poor left ventricular function.¹⁻⁷ Originally applied to patients with cardiogenic shock secondary to myocardial infarction, the IABP has more recently been used in a variety of clinical states that cause poor cardiac function. Our experience with IABP support has been limited almost entirely to patients who cannot be weaned from cardiopulmonary bypass or to those who experience severe circulatory failure in the immediate postoperative period.

The criteria for use of IABP in this series were refractory left ventricular failure unresponsive to manipulation of blood volume, cardiotonic drugs, and catecholamines and occurring either as an intraoperative event following the withdrawal of cardiopulmonary bypass or as a postoperative complication. Cardiac function in all patients was monitored routinely by direct assessment of left atrial, central venous and mean atrial pressures, and determination of cardiac output (CO) by thermodilution. Progressive elevation of left atrial and central venous pressures with declining arterial pressure and CO, despite full pharmacologic support,

identified the candidate for IABP support. When low cardiac output could not be reversed or stabilized pharmacologically, IABP support was instituted.

Clinical material

From April 1975 to April 1976, the Datascope System 80 was used in 33 patients aged 31 to 71 years. Twenty-eight of the 33 had significant coronary artery disease. Support by extracorporeal perfusion and IABP was unsuccessful in five patients who died in the operating room; insertion and support by IABP were successful in 28.

Twenty-one of 28 patients stabilized by IABP had undergone a primary myocardial revascularization procedure. Five of the 21 experienced cardiac arrest preoperatively and were brought to the surgical suite during active cardiopulmonary resuscitation. Cardiac arrest occurred in two patients during coronary arteriography, in two during induction of anesthesia, and in one patient during mobilization of the left carotid artery prior to endarterectomy. Three patients with left main coronary artery obstruction were in the early stages of acute myocardial infarction with clinical evidence of deteriorating left ventricular function. Four patients required insertion of IABP postoperatively in the cardiac unit; three of the four experienced cardiac arrest within 2 hours postoperatively and could not be stabilized despite open chest resuscitation. The fourth patient deteriorated on the 2nd postoperative day with progressive low cardiac output and acute renal failure.

Seven patients were stabilized on IABP support after prosthetic valve

replacement. In five of the seven the balloon was inserted intraoperatively and in two postoperatively, because of cardiac arrest and instability and low cardiac output.

Results

Sixteen of 28 patients (57%) survived and were discharged. Table 1 shows the results in primary revascularization procedures. In the group of 21 patients supported postoperatively with IABP, 14 survived (66.7%). Table 2 indicates the results in seven patients who underwent valve operations. The survivor group included three of the five patients who had experienced cardiac arrest before the surgical procedure and both patients who had cardiac arrest during coronary arteriography.

Three patients died while on IABP; one died 2 hours postoperatively from intractable arrhythmia, and the remaining two died 20 and 30 hours postoperatively from progressive low cardiac output, despite all usual measures. Table 3 lists the causes of death in the nine patients

Table 1. Revascularization procedures

4 postoperative	17 intraoperative
↓	↓
4 weaned	15 weaned
↓	↓
3 survivors	11 survivors

Stabilized, 21; attempts failed, 3; 14 of 21 patients (66.7%) stabilized on IABP survived.

Table 2. Valve procedures

2 postoperative	5 intraoperative
↓	↓
2 weaned	4 weaned
↓	↓
1 survivor	1 survivor

Stabilized, 7; attempts failed, 2; 2 of 7 patients (28.6%) stabilized on IABP survived.

Table 3. Mortality in patients weaned

Operation	Died (postoperative days)	Cause of death
Redo AVR	45	Respiratory failure, renal failure
Redo LAD, RCA	15	Renal failure, gross sepsis
L-L, S-Cx, Dg	13	Renal failure
S-LAD, Cx	10	Cerebral
S-LAD, Cx	10	Renal failure
AVR, MVR, S-L	4	Low CO, ischemic bowel
AVR	3	Low CO
S-LAD, Cx, RCA	6	Renal failure
AVR	17	Renal failure, sepsis

who were weaned from bypass and who subsequently died.

In this series, complications of IABP were uncommon. One patient had thromboembolism following removal of the balloon and routine use of a Fogarty embolectomy catheter. This patient had an excellent pedal pulse following removal of the balloon but had patchy areas of superficial gangrene of the toes below the insertion site. A second patient had transient ischemia of the lower limb which reversed upon removal of the balloon catheter. In three other patients the Fogarty catheter returned thrombi from the distal segment of the femoral artery, but no clinical evidence was apparent. Another patient suffered neuropathy in the leg utilized for the balloon insertion; recovery occurred after several weeks. Five patients required reoperation for excessive postoperative bleeding within the first 24 hours of surgery. Hemostasis was readily achieved on reexploration and no untoward effects occurred. Acute renal failure occurred in eight and six died. When renal dialysis was required, none survived.

Discussion

Fortunately, one of the infrequent problems occurring during cardiac

surgery is the inability to discontinue cardiopulmonary bypass because of left ventricular failure. In most instances, reinstitution of a period of bypass, adequate volume expansion, cardiotonic agents and vasodilators with or without cardiac pacing result in improved contractility, and the patient can be successfully withdrawn from cardiopulmonary bypass. Deterioration of cardiac function during repeated periods of bypass support is poorly tolerated. Our records indicate that in almost all patients undergoing primary revascularization, resumption of full cardiopulmonary bypass more than two times prior to insertion of IABP support resulted in death. This observation has been corroborated by Bolooki et al⁶ who showed a relationship between survival and the time of IABP insertion.

Our best results were obtained following early institution of IABP support, and this fact emphasizes the need for identifying potential IABP candidates before the cycle of progressive cardiac deterioration has begun. Failure to wean from total bypass on the first attempt is an indication of further complications, and IABP should be instituted when the patient cannot be effectively supported by drug therapy after trial extracorporeal circulatory support.

Summary

IABP has been utilized as postoperative support in 28 patients; 16 have been long-term survivors. These initial results are similar to those obtained by others and represent a further attempt at improving the survival rate in open heart surgery.

References

1. Kantrowitz A, Tjonneland S, Freed PS, et al: Initial clinical experience with intraaortic balloon pumping in cardiogenic shock. *JAMA* **203**: 113-118, 1968.
2. Bregman D, Parodi EN, Edie RN, et al: Intraoperative unidirectional intra-aortic balloon pumping in the management of left ventricular power failure. *J Thorac Cardiovasc Surg* **70**: 1010-1023, 1975.
3. Mundth ED: Discussion of Bregman D, Parodi EN, Edie RN, et al: Intraoperative unidirectional intra-aortic balloon pumping in the management of left ventricular power failure. *J Thorac Cardiovasc Surg* **70**: 1039, 1975.
4. Serry C, Miley R, Golin M, et al: Intra-aortic balloon counter-pulsation (IABCP). (Abstr) *Circulation* **52**: Suppl II: 72, 1975.
5. Scanlon P, O'Connell J, Johnson S, et al: Balloon counterpulsation following surgery for ischemic heart disease. (Abstr) *Circulation* **52**: Suppl II: 72, 1975.
6. Bolooki H, Thurer R, Vargas A, et al: Intra-aortic balloon pump (IABP) for heart failure in cardiac surgery. (Abstr) *Circulation* **52**: Suppl II: 163, 1975.
7. Buckley MJ, Craver JM, Gold HK, et al: Intra-aortic balloon pump assist for cardiogenic shock after cardiopulmonary bypass. *Circulation* **47** and **48**: Suppl III: 90-94, 1973.
8. Parker FB Jr, Neville JF, Hanson EL, et al: Intraaortic balloon counterpulsation and cardiac surgery. *Ann Thorac Surg* **17**: 144-151, 1974.