Pulsatile flow for improved myocardial protection

David Bregman, M.D.
New York, New York

The potential importance of pulsatile cardiopulmonary bypass (CPB) has been reemphasized within the past few years by Berger and Pappas. A new valveless pulsatile assist device (PAD®) has been developed which converts roller pump flow into synchronized atraumatic pulsatile flow. In addition, the PAD can also be used as an arterial counterpulsator before and after CPB in a manner similar to the intra-aortic balloon pump. The PAD is inserted into the arterial line close to the aortic root. The device consists of a flexible, valveless balloon conduit through which the arterial blood flows. The balloon is contained within a rigid plastic housing which is connected to a standard intra-aortic balloon pump.

The PAD has been employed in 200 adult patients undergoing elective open heart surgery for coronary artery and/or valvular heart disease at the Columbia-Presbyterian Medical Center during the last 2 years. One hundred forty of these patients were either NYHA Class III or IV preoperatively, or had ejection fractions of less than 0.3 or left ventricular end-diastolic pressures of 18 mm Hg or higher on their preoperative cardiac catheterization. One hundred twenty-three patients had multiple

coronary bypasses alone, 43 had valve replacements alone, 6 had ventricular aneurysm resections alone, 17 had combined coronary bypass grafting in conjunction with aortic valve replacement, and 11 had combined ventricular aneurysm resection and coronary artery bypass surgery. The device functioned as a hemodynamically effective arterial counterpulsator before and after CPB. During CPB pulse pressures of 40 to 50 mm Hg were readily obtained. Urinary output during CPB was increased on the PAD when compared to a control group (9.8 ± 0.68 cc/min versus 3.90 ± 0.35 cc/min). In addition, during CPB coronary graft blood flow increased an average of 2.4% ± 6.1% with the PAD. Free plasma hemoglobins after bypass were not elevated. One hundred ninety-eight (99%) patients could be weaned from CPB with the pulsatile assist device alone. The two intraoperative deaths (1%) included a patient with severe pulmonary hypertension and another who died from an iatrogenic aortic injury. Only three patients (1.5%) experienced perioperative myocardial infarction in the perioperative period as defined by new Q waves. One of these patients required postoperative intra-aortic balloon pumping 2 hours after the completion of CPB and this patient survived. There were two late deaths (1%), one from an arrhythmia at 3 weeks and one from an anaphylactic drug reaction in the recovery room.

A subgroup of these 200 patients included 50 patients with left main or equivalent left main coronary artery lesions who had been assisted intraoperatively with the PAD. None of these patients were placed on the intra-aortic balloon pump prior to surgery. Seventy-eight percent of these 50 patients had impaired preoperative left ventricular function. All 50 patients could be weaned from the heart-lung machine after coronary revascularization surgery, and only a single patient died in the recovery room from an anaphylactic drug reaction. Only one of the postoperative patients was noted to have an acute perioperative myocardial infarction.

It is suggested from these data that the use of the PAD may obviate the need for prophylactic intra-aortic balloon pumping in selected high risk patients and that it will probably decrease both the incidence of perioperative myocardial infarctions and the need for postoperative intra-aortic balloon pumping.