

Case Report

Conversion to Biventricular Pulsatile Assist as a Bridge to Cardiac Transplantation : A Case Report

Dale L. Ruby, BS, CCP; J. Lancelot Lester, MD

JFK Heart Institute, JFK Medical Center, Atlantis, Florida

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ABSTRACT

A 42 year old male patient presented with chest pain. Cardiac catheterization revealed multivessel coronary disease with a decreased ejection fraction. Following cardiac revascularization, the patient's condition deteriorated and the patient was placed on a Biomedicus left ventricular assist device in the intensive care unit. The following day, an Abiomed BVS 5000 cardiac support system was obtained by the hospital. The patient was brought back to the operating room for implantation of a biventricular pulsatile cardiac assist device and removal of a nonpulsatile left ventricular assist device as a bridge for possible cardiac transplantation. The patient tolerated the procedure well and was transported back to the intensive care unit in stable condition. The patient was accepted for consideration for cardiac transplantation and transported by helicopter to the cardiac transplant center without incident.

Address Correspondence to:
Dale L. Ruby, CCP
Baxter Perfusion Services
16818 Via Del Campo Court
San Diego, Ca. 92127

INTRODUCTION

The use of a ventricular assist device is often indicated in patients who undergo cardiac surgery and cannot be weaned from the heart lung machine despite the use of inotropic support and counterpulsation devices. A ventricular assist device is a circulatory support system which is designed to provide mechanical cardiac output for a patient who is experiencing low cardiac output. Indications for the use of a cardiac assist device include postcardiotomy low output syndrome, cardiomyopathy, cardiogenic shock, and myocarditis. Postcardiotomy ventricular failure can include perioperative myocardial infarction as well as stunned myocardium. These patients may be difficult to wean from the heart lung machine or may require intraaortic balloon pump assistance as well as pharmacological support. These patients may experience isolated left ventricular failure, isolated right ventricular failure, or biventricular failure. The use of a left ventricular assist device is associated with a high incidence of right ventricular failure without the use of right heart assist (1). In many patients, a biventricular cardiac assist may be the therapy of choice for long term support or bridge to cardiac transplantation (2).

CASE REPORT

A 42 year old male presented with chest pain. The patient was evaluated and cardiac catheterization was performed. Coronary angiography demonstrated a 95% left main coronary artery obstruction as well as a 100% right coronary artery obstruction. The patient's ejection fraction was calculated to be 25%. The patient was referred to the cardiac surgery service for coronary artery bypass surgery. The cardiopulmonary bypass circuit was prepared using a Biomedicus centrifugal arterial pump^a, a membrane oxygenator^b, a blood cardioplegia system^b, a 40 micron arterial line filter^b, and a custom tubing pack which included 3/8 inch arterial tubing and 1/2 inch venous line tubing^b. The patient was heparinized with 300 IU/kg of beef lung heparin. The patient was cannulated and placed on cardiopulmonary bypass in the usual fashion. The heart was arrested with a high potassium blood cardioplegic solution. Cardioplegia was administered throughout the procedure at ten minute intervals. The patient received six bypass grafts, including four vein grafts and two internal mammary grafts.

After completion of the operation, the patient was successfully weaned from cardiopulmonary bypass with minimal inotropic support. The heparin was reversed with protamine, and hemostasis was achieved. The cannulae were removed and the sternum was closed. Prior to leaving the operating room, the patient developed systemic hypotension. The chest was reopened for exploration. The heart appeared to be distended, and the patient did not respond to pharmacological therapy. The patient was reheparinized with the original loading dose and placed back on cardiopulmonary bypass. After further evaluation, the right

internal mammary artery to the left anterior descending artery was revised. An intraaortic balloon was inserted into the right femoral artery to assist the heart. The patient was weaned from cardiopulmonary bypass again with inotropic and intraaortic balloon support. The heparin was reversed with protamine. The cannulae were removed, and hemostasis was achieved. The chest was closed and the patient was transported to the intensive care unit in stable condition.

Shortly after arrival in the intensive care unit, the patient developed heart failure for no discernible reason. The chest was opened and explored in the intensive care unit. The bypass grafts appeared to be patent. Despite maximal inotropic support and intraaortic balloon pump assistance, the patient remained hypotensive. The decision was made to put the patient on left ventricular assist. The patient was reheparinized in the intensive care unit. A 22 fr. Carmeda coated cannula^a was placed in the ascending aorta and a 36 fr. Carmeda coated cannula^a was placed in the left ventricular apex. The patient was placed on a Biomedicus left ventricular assist device in the intensive care unit. The chest was packed opened with lap sponges and a sterile plastic drape was placed over the wound. A heparin infusion was started to maintain the activated clotting times at 180-200 seconds.

The next day, an Abiomed BVS 5000 ventricular support system was obtained by the hospital^c. The decision was made to convert the patient from nonpulsatile left ventricular support to biventricular pulsatile support. The patient was neurologically responsive and appeared to have no other organ system failure. The hope was to stabilize the patient on the Abiomed for several days and either attempt weaning or consider the patient for cardiac transplantation. The patient was transported to the operating room on the Biomedicus left ventricular assist device. The standard heart lung machine was set up and primed. The Abiomed system was set up in the operating room and both ventricles were primed. The patient was reheparinized with 300 IU/kg and placed on cardiopulmonary bypass using the existing 22 fr. aortic cannula. A 46/34 fr. venous cannula was placed in the right atrium for venous drainage^d. The Abiomed cannulae were inserted into the pulmonary artery, right atrial appendage, left atrial appendage, and aorta. The patient was placed on Abiomed biventricular support without incident. The patient was weaned from cardiopulmonary bypass. The 22 fr. aortic cannula and 46/34 fr. venous cannula were removed, and protamine was given to reverse the heparin. Hemostasis was achieved and the patient was transported to the intensive care unit.

The patient was monitored closely to achieve the necessary parameters for optimal cardiac assist. These parameters included a central venous pressure of 15-16 mmHg or a pulmonary artery wedge pressure of 10-15 mmHg. These parameters were required for optimal filling of the Abiomed atrial chamber.

a Medtronic Cardiopulmonary, Anaheim, CA 92807

b Bentley Cardiopulmonary, Irvine, CA 92807

c Abiomed Cardiovascular, Danvers, MA 01923

d Sarns/3M Health Care, Ann Arbor, MI 48103

When the patient became hypovolemic, the atrial chamber did not fill properly, because the blood pump is passive and relies on gravity drainage. The system works by providing a constant stroke volume (approximately 70-80 ml) and adjusts to changes in afterload. As the afterload increases, the ejection time increases, which lengthens the systolic time and slows the blood pump rate, ultimately decreasing the flow rate or delivered cardiac output. Therefore, the attempt was made to reduce the afterload and maintain adequate hydration of the patient to provide the maximal support possible.

The patient remained hemodynamically stable, and a heparin infusion was started to maintain the activated clotting times at 180-200 seconds. After further evaluation, the decision was made to consider the patient for cardiac transplantation. The patient's hemodynamic data and operative reports were faxed to the nearby transplant centers, and a receiving facility was located. The patient was prepared for air transport. The receiving facility dispatched an air ambulance to transport the patient on the Abiomed.

The air transport provided our team with additional challenges. The first challenge was to insure that the air ambulance could provide the proper electrical support needed to power the Abiomed as well as the ventilator and infusion pumps. Other considerations included compensating for the added weight of the Abiomed in addition to the weight of the patient, providing the necessary staff to ensure adequate patient safety during transport, and stabilizing all of the equipment while on-board the air ambulance. After much debate, the decision was made to transport by helicopter rather than fixed wing aircraft. It was determined that it was safer for the patient, since the helicopter could land at the hospital and ground ambulance would not be needed. We felt that moving the patient from the hospital to an ambulance then to an airplane would expose the patient to additional risk. When the helicopter arrived, we transported the patient to the helipad. We loaded the Abiomed into the helicopter first, then loaded the patient and infusion pumps. During this procedure, the Abiomed was disconnected from the drive console for a brief time, but the patient tolerated the procedure well. The transport was staffed with a perfusionist, an intensive care nurse, a physician assistant, and a paramedic. The transport went well, and the patient arrived in stable condition at the receiving facility.

DISCUSSION

The use of ventricular assist devices has been crucial to the practice of cardiac surgery. With the technology available today, patients can be stabilized for long periods of time while the heart recovers from injury or as a means to preserve the other organs until cardiac transplantation can be performed (3). While many patients' primary component of heart failure is left-sided, the use of a left ventricular assist device alone is associated with a high incidence of right ventricular failure (4). In many of these postcardiotomy patients, the use of biventricular support may be the intervention of choice (5). Although there are many risks

associated with right ventricular support, the benefit of early and aggressive intervention may far outweigh these risks. Right-sided heart failure in the immediate postoperative phase remains a common source for cardiac related mortality and morbidity.

The use of centrifugal ventricular assist devices have over time been proven effective for treating patients with left- and/or right-sided heart failure. There are many risks associated with these types of devices. These include mechanical failure which may result in component exchange, fibrin degradation, and multi-system organ failure (6). While pulsatile assist devices may also carry some of these risks, the flow pattern is more physiologic and results in less hemolysis and improved organ preservation.

We elected to perform an implantation of a pulsatile biventricular support device in a patient who was on left ventricular nonpulsatile support because we felt that it would provide the patient with the highest probability of survival. Our goal was to stabilize the patient hemodynamically and achieve hemostasis while the patient was bridged for cardiac transplantation. Since we did not have access to the Abiomed system at the time of surgery, we did not have the option of implanting the system in the immediate postoperative phase. By using the system that was available to us, we were able to bridge the patient until the system was available and then use the Abiomed as a bridge to cardiac transplantation.

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