

Case Report

Successful Bridge to Transplantation with the Abiomed BVS 5000 Ventricular Assist Device Following Double Valve Replacement: A Case Report

Louis E. Samuels, MD; Marla S. Kauffman, BA; Rohinton J. Morris, MD; Michael D. Strong, MD; Stanley K. Brockman, MD

Department of Cardiothoracic Surgery, Allegheny University Hospitals, Hahnemann Division, Philadelphia, PA

Keywords: Abiomed BVS 5000 ventricular assist device, double valve replacement, bridge to transplantation

ABSTRACT

We report the successful use of the Abiomed BVS 5000 to provide myocardial support following double valve replacement. Discontinuation of cardiopulmonary bypass (CPB) following aortic and mitral valve replacement was unsuccessful because of severe left ventricular dysfunction and ventricular arrhythmia. Insertion of an intra-aortic balloon pump, initiation of inotropic drugs, and institution of anti-arrhythmic agents were unable to reverse the situation. The Abiomed BVS 5000 ventricular assist device was implanted. The patient was easily weaned from CPB with maximal assist (5.0 L/min) and minimal inotropic (dobutamine 5 mcg/kg/min) support. Orthotopic heart transplantation took place on the fifth postoperative day. The explanted native heart was examined and found to have heavy thrombus deposition on the mechanical valves despite high dose anticoagulation.

Address correspondence to:
Louis E. Samuels, MD
Allegheny University Hospitals, Hahnemann Division
Broad and Vine Streets, MS 111
Philadelphia, PA 19102-1192

INTRODUCTION

Ventricular assist devices (VAD) have been used in a variety of postcardiotomy settings. The most common indication for VAD implantation has been related to the inability to wean from cardiopulmonary bypass. The Abiomed BVS 5000 VAD^a has been utilized at our institution for ventricular support following coronary artery bypass grafting (CABG), left ventricular aneurysm (LVA) repair, and post-infarction ventricular septal defect (VSD) repair. The device has also been used as a bridge to transplantation and for right ventricular assistance following transplantation (2). The following describes successful support of the myocardium as a bridge to transplantation with the Abiomed BVS 5000 VAD following double valve replacement.

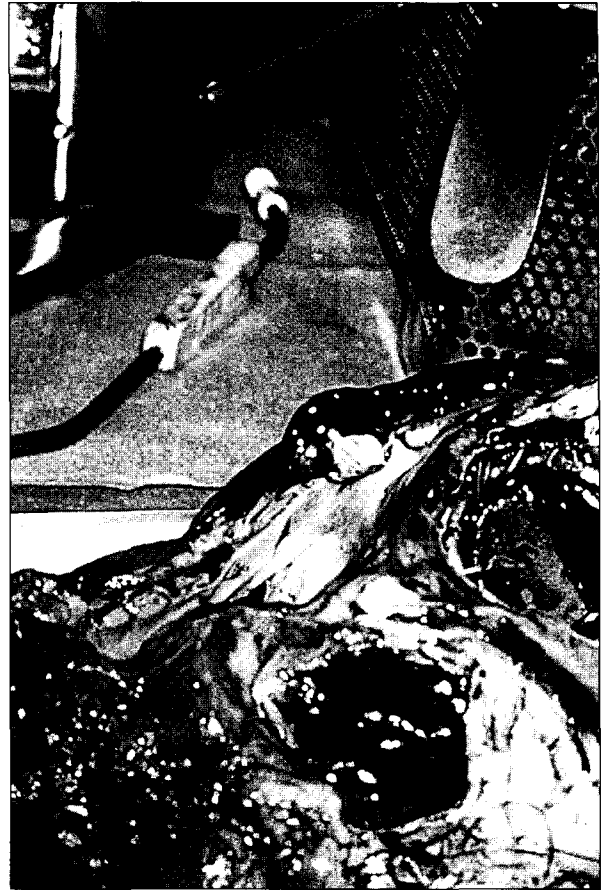
CASE REPORT

A 33 year old female with a prior history of rheumatic fever presented to Allegheny University Hospitals, Hahnemann Division, Philadelphia, PA, in December 1996 with progressive dyspnea. On physical examination, there was a high-pitched decrescendo diastolic rumble. There was an increased cardiac silhouette with left atrial (LA) enlargement on chest roentgenography. There was normal sinus rhythm with p-mitrale on the electrocardiogram. Left atrial enlargement, left ventricular dilatation, severe mitral stenosis (MS), and aortic insufficiency (AI) were demonstrated on echocardiography. Cardiac catheterization showed normal coronary arteries, severe MS, and moderate AI. The pulmonary artery pressure was 40/20 mmHg, pulmonary capillary wedge pressure 20 mmHg, and left ventricular end-diastolic pressure 12 mmHg. The left atrium and left ventricle (LV) were dilated with moderate reduction in the ejection fraction.

The patient was taken to the operating room where a median sternotomy and ascending aortic and bicaval cannulation were performed. Moderate hypothermic (26°C) cardiopulmonary bypass (CPB) with retrograde sanguinous cardioplegia was instituted. The aortic and mitral valves were replaced with 23 mm and 27 mm St. Jude^b prostheses, respectively. The cross-clamp time was 62 minutes. Discontinuation of CPB was unsuccessful because of severe left ventricular dysfunction and ventricular arrhythmia. Insertion of an intra-aortic balloon pump (IABP), initiation of inotropic drugs, and institution of anti-arrhythmic agents were unable to reverse the situation. The Abiomed BVS 5000 VAD was implanted. Cannulation of the LA appendage with the 36 French cannula and end-to-side graft anastomosis to the ascending aorta above the aortotomy was performed (Figure 1). The patient was easily weaned from CPB with maximal VAD flows of 5.0 L/min and minimal inotropic support of 5 mcg/kg/min of dobutamine.

The patient was extubated on the first postoperative day.

Figure 1: Abiomed BVS 5000 VAD placement



The hemodynamics were stable with normal vital signs, pulmonary pressures, and central venous pressure: MAP > 70 mmHg, CVP 12-15 mmHg, SVR 900-1200 dynes/sec/cm⁵, CI > 2.0 L/min/m². The VAD output was 4.0 L/min to 5.0 L/min. Transthoracic echocardiography showed no improvement in left ventricular function on the second postoperative day; thus, the patient was listed for heart transplantation. An attempt to wean the VAD on the third postoperative day was unsuccessful. When VAD flows were reduced to allow ventricular ejection, no spike on the arterial pressure tracing was present, nor native ejection on echocardiography. On the fourth postoperative day, the patient suffered a transient ischemic attack. No clot was observed in the VAD cylinders; however, prosthetic valve immobility suggested thrombosis of the leaflets. Anticoagulation was therapeutic (PTT > 90 sec). On the fifth postoperative day, a donor organ became available and orthotopic heart transplantation took place.

The native heart was found to be akinetic and there was heavy thrombus deposition on the aortic and mitral valve prostheses (Figure 2). The donor organ was implanted using the biatrial cuff anastomosis technique. Normal sinus rhythm with satisfactory hemodynamics was observed upon removal of the aortic crossclamp. The patient was weaned from CPB on

a Abiomed Cardiovascular, Inc., Danver MA
b St. Jude Medical, Inc., St. Paul, MN

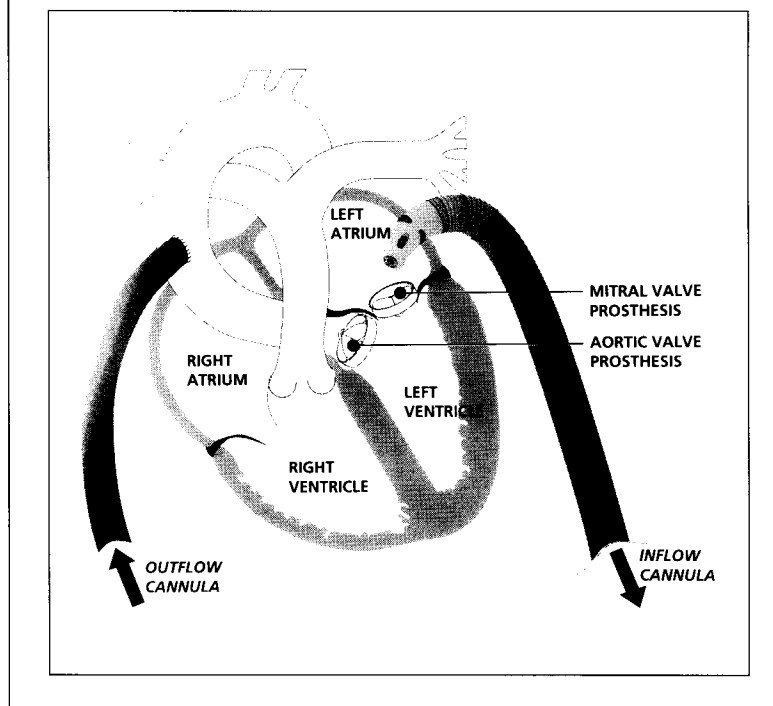
dobutamine and isoproterenol. The remainder of the hospital course was uneventful. The patient was discharged 11 days after the transplant.

COMMENTS

The Abiomed BVS 5000 VAD, a pneumatically driven, dual-chamber device which provides pulsatile hemodynamic support, has been used clinically since 1987 (1). Since then, several reports (3-6) have documented its efficacy in a variety of conditions, including postcardiotomy shock (7-15), bridge to transplantation (16-18), myocardial support following myocardial infarction (19), and RV support following transplantation (2). Although there is extensive experience with mechanical ventricular assistance after CABG, experience with the Abiomed VAD in patients with heart valves is limited. According to the Abiomed BVS Worldwide Registry (21), there have been a total of seven cases where the device was placed in patients with prosthetic heart valves. There were four mitral valve replacements (MVR) (two discharged, two expired), two aortic valve replacements (AVR) (both expired), and one AVR/MVR (expired). Several investigators have described their experience with other VADs in the setting of prosthetic heart valves (22-25).

Myers et al. (22) described the successful use of a Pierce-Donarchy LVAD following AVR/MVR in 1981. In that case, fusion of the bioprosthetic aortic valve leaflets, but no thrombi, was observed. They postulated that a tilting disc-type valve prosthesis would be better suited in the setting of an LVAD, since fibrin deposition would be less likely to cause the valve mechanism to stick. In 1984, Beppu and colleagues (23) described LV thrombus formation and cuspal fusion in a prosthetic mitral valve in a patient with a Bio-Medicus LVAD^c. Echocardiography demonstrated that the pulmonary and tricuspid valves functioned with each heart beat, but that the aortic and prosthetic mitral valves did not open. Contrast study showed prosthetic valve stenosis. Fusion of its cusps by fibrin was confirmed on repeat surgery. Formation of LV thrombus in postcardiotomy patients supported with Bio-Medicus LVADs, particularly following valve replacement, was further demonstrated echocardiographically by Nakatani and colleagues (24). Because of these concerns, Matsuwaka and others (25) described direct heparin infusion through an LV catheter in a patient with an LVAD following MVR with a mechanical prosthesis. A 20 gauge catheter was placed through and 18 gauge cannula across the RV and septum into the LV. Heparin was continuously given to achieve an activated clotting time (ACT) of 150-200 sec in the systemic blood. The ACT of LV blood was found to be 50 to 100 sec

Figure 2: Aortic and mitral valve procedures: (a) Mitral valve; (b) Aortic valve, demonstrating heavy deposition of thrombus



higher. Thrombus was not observed in the LV cavity by transesophageal echocardiogram. The patient was successfully weaned from the VAD without any neurologic complications and was discharged from the hospital.

In general, native aortic valve motion is minimal while on full LVAD support. In an assessment of cardiac function in patients with a Novacor^d LVAD, the aortic valve remained closed throughout systole in five of nine patients, with partial opening in the other four. At an assist ratio of 1:3, complete opening of the aortic valve was noted in all nine cases. However, the LV ejection fraction was reduced to 31% (26). Thus, washing of the aortic valve to prevent thrombus formation was achieved with partial LVAD support at the expense of cardiac output.

In summary, VADs have been successful in supporting the myocardium in a variety of conditions including post-heart valve replacement. The literature is limited with respect to experience in this setting. There is no consensus on how to avoid prosthetic valve thrombosis. Although this case represents a successful application of the Abiomed BVS 5000 VAD as a bridge to transplantation following double valve replacement, the application of ventricular assistance in this condition is still problematic. Application of VADs in the setting of prosthetic heart valves is not approved and is not reimbursable. Possible solutions to this problem include direct heparin infusion into the LV to achieve higher levels of local anticoagulation and partial mechanical support to allow some native cardiac ejection in order to prevent thrombus formation and allow for prosthetic valve leaflet mobility.

c Bio-Medicus, Minneapolis, MN

d Baxter Healthcare Corporation, Novacor Division, Oakland, CA

REFERENCES

1. Dreyfus G, Guilleman R, Couetil JP, et al. First clinical use of a new biventricular bridging support: The Abiomed BVS System 5000. *J Heart Transplantation*. 1988; 84:7.
2. Samuels LE, Sharma S, DeSesa VJ, et al. Successful support of the right ventricle following orthotropic heart transplantation using the Abiomed BVS 5000 System: A case report. *J Extra-Corpor Technol*. 1996; 28: 154-7.
3. Minami K, et al. Improvement of survival rate in patients with cardiogenic shock by nonpulsatile and pulsatile ventricle assist device. *J Cardiovasc Surg*. 1991; 92: 32.
4. Dixon JF, Farris CD. The Abiomed BVS 5000 System. *Crit Care Nurs*. 1991; 2: 552-61.
5. Minami K, el-Banayosy A, Posival H, et al. Improvement of survival in patients with cardiogenic shock by using nonpulsatile and pulsatile ventricular assist device. *Int J Artif Organs*. 1992; 15: 715-21.
6. Jett G. Abiomed BVS 5000 assist device: experience at Baylor University Medical Center. *BUMC Proc*. 1993; 6: 3-20.
7. Kaan GL, Noyez L, Vincent JG, et al. Management of postcardiotomy cardiogenic shock with a new pulsatile ventricular assist device. Initial clinical results. *ASAIO Trans*. 1991; 37: 559-63.
8. Guyton R, Schonberger J, Everts P, et al. Postcardiotomy shock: A multicenter evaluation of treatment with the BVS 5000 bi-ventricular support system. *J Am Coll Cardiol*. 1993; 21: 18A.
9. Guyton RA, Schonberger JP, Everts PA, et al. Postcardiotomy shock: Clinical evaluation of the BVS 5000 biventricular support system. *Ann Thorac Surg*. 1993; 56: 346-56.
10. Jett G. Postcardiotomy support with ventricular assist device: Selection of recipients. *Seminars Thorac Cardiovasc Surg*. 1994; 6: 136-139.
11. Everts P. Clinical experience with the Abiomed BVS 5000 for treatment of postcardiotomy cardiogenic shock. *NeSECC J*. 1994; 1: 19-22.
12. Kesler KA, Pruitt MW, Turrentine W, et al. Temporary left-sided mechanical cardiac support during acute myocarditis. *J Heart Lung Transplantation*. 1994; 13: 268-270.
13. Marquardt P, Sievers HH, von Helm A, et al. Clinical use of the Abiomed BVS 5000 ventricular assist device. *Int Congress Series #1049: Third Int Symposium*. Elsevier Science Publishers.
14. Gray LA Jr., Champsaur GG. The Abiomed BVS 5000 biventricular assist device. The Worldwide Registry experience. *ASAIO J*. 1994; 40: M460-M464.
15. Minami K, Posival H, el-Bynayosy A, et al. Mechanical ventricular support using pulsatile Abiomed BVS 5000 and centrifugal Biomedicus-Pump in postcardiotomy shock. *Int J Artif Organs*. 1994; 17: 492-8.
16. Champsaur G, Ninet J, Vigneron M, et al. Use of the Abiomed BVS System 5000 as a bridge to cardiac transplantation. *J Thorac Cardiovasc Surg*. 1990; 100: 122-8.
17. Ashton RC, Goldstein DJ, Rose EA, et al. Abiomed ventricular assist device as a bridge to transplantation. *J Amer Coll Cardiol*. 44th Ann Scientific Session, New Orleans, LA.
18. Castells E, Calbet JM, Fantanillas C, et al. Ventricular circulatory assistance with the Abiomed system as a bridge to cardiac transplantation. *Transplant Proc*. 1995; 27: 2343-2345.
19. Von Sesseger LK, et al. Myocardial recovery during mechanical circulatory support after acute myocardial ischemia. *J Extra-Corpor Technol*. 1992; 23: 39-42.
20. ABIOMED's temporary artificial heart system reaches 1,000 patient milestone. *Pulse: ABIOMED Cardiovascular, Inc*. 1995; 3:3.
21. Abiomed BVS Worldwide Registry. ABIOMED Cardiovascular, Inc. Danver, MA.
22. Myers JL, Bull A, Kastl DG, et al. Fusion of prosthetic valve during left heart bypass. *J Thorac Cardiovasc Surg*. 1981; 82: 263-276.
23. Beppu S, Nakatani T, Sakakibara H, et al. Left ventricular thrombus formation and cuspal fusion of the prosthetic valve during left heart bypass: Their pathological significance and echocardiographic observations. *J Cardiology*. 1984; 14: 623-631.
24. Nakatani T, Takano H, Beppu S, et al. Natural heart recovery under left ventricular assist device pumping studied by echocardiography. *ASAIO Transactions* 1986; 32: 461-6.
25. Matsuwaka R, Matsuda H, Kaneko M, et al. Benefit of heparin infusion through left ventricular catheter in patient undergoing mechanical valve replacement with the aid of a left ventricular assist device. *J Thorac Cardiovasc Surg*. 1991; 102: 804-5.
26. Charron M, Follansbee W, Ziady GM, Kormos RL. Assessment of biventricular cardiac function in patients with a Novacor left ventricular assist device. *J Heart Lung Transplantation*. 1994; 13: 263-267.