The Heart Surgery Forum #2012-1142
16 (3), 2013 [Epub June 2013]
doi: 10.1532/HSF98.20121142

Online address: http://cardenjennings.metapress.com

Use of a Totally Artificial Heart for a Complex Postinfarction Ventricular Septal Defect

Ivan Knezevic, MD, MSc,[1] Matija Jelenc, MD,[1] Nenad Danojevic, MD,[3] Manca Racic, RN,[1] Gregor Poglajen, MD, PhD,[2] Jus Ksela, MD, PhD,[1] Vesna Androcec, RN,[2] Tomaz Mesar,[4] Ursa Mikuz,[4] Bojan Vrtovec, MD, PhD[2]

Departments for [1]Cardiovascular Surgery, [2]Cardiology, and [3]Anesthesiology, University Medical Center Ljubljana, Ljubljana; [4]Faculty of Medicine, University of Ljubljana, Ljubljana, Slovenia

ABSTRACT

The incidence of cardiac rupture complicating myocardial infarction has declined since the introduction of thrombolytic therapy. Despite the advances in the management of myocardial infarction, cardiac rupture remains an important cause of death among infarction-related fatalities. We discuss a patient who presented to our hospital with myocardial infarction and who subsequently developed a complex ventricular septal rupture, for which surgical repair was not feasible. Implantation of a CardioWest Total Artificial Heart (SynCardia Systems) allowed for immediate hemodynamic stabilization and served as a bridge to transplantation.

INTRODUCTION

The incidence of cardiac rupture complicating myocardial infarction has declined since the introduction of thrombolytic therapy. Despite the advances in the management of myocardial infarction, cardiac rupture remains an important cause of death among infarction-related fatalities. We discuss a patient who presented to our hospital with myocardial infarction and who subsequently developed a complex ventricular septal rupture, for which surgical repair was not feasible. Implantation of a totally artificial heart allowed for immediate hemodynamic stabilization and served as a bridge to transplantation.

CASE REPORT

On October 2011, a 60-year-old man with a history of tobacco abuse presented to our hospital with an episode of chest pain associated with dyspnea and exercise intolerance of 1 week's duration. Electrocardiographic findings at admission were consistent with a subacute inferior wall myocardial infarction; troponin and lactate dehydrogenase levels were 35.8 µg/L and 3.7 µkat/L, respectively. The patient was immediately taken to the cardiac catheterization laboratory, where complete occlusion of the distal third of the right coronary artery was found. A percutaneous coronary intervention was performed with the insertion of 2 bare-metal stents; however, a left ventriculography examination showed a ventricular septal defect (VSD). After the procedure the patient remained hemodynamically unstable (blood pressure, 84/71 mm Hg) and moderately tachycardic. We started a continuous infusion of norepinephrine and placed an intra-aortic balloon pump. A transthoracic echocardiography evaluation immediately after the procedure showed a large VSD in the posterior part of the interventricular septum, with an estimated size of approximately 1.5 cm and a pulmonary-to-systemic flow ratio of 2.1. The systolic function of the left ventricle was mildly depressed (estimated ejection fraction, 50%). Subsequent cardiac echocardiography studies revealed a progression in VSD size. On the third day, the diameter of the VSD had already increased to 3 cm, and a pulmonary-to-systemic flow ratio of 3.1 was measured. Additionally, the echocardiography examination showed that the VSD extended up to the mitral valve annulus, causing mitral regurgitation. Because of the size and location of the VSD along with its involvement of the mitral valve apparatus, we estimated that operative closure of the VSD was not feasible with current techniques, because VSD closure combined with mitral valve replacement, coronary artery bypass surgery, and possible pacemaker implantation was associated with a prohibitive risk of operative mortality. The patient was then presented as a candidate for a CardioWest Total Artificial Heart (SynCardia Systems, Tucson, AZ). A preoperative computed tomography scan of the chest showed a favorable distance between vertebrae and the sternum, so we decided to proceed with TAH implantation. The patient was taken to the operative theatre on the fourth day after admission. A median sternotomy was performed, the pericardial sac opened, and cardiopulmonary bypass established via aortic and bicaval cannulation. After cross-clamping of the aorta, the ventricles were cut to leave a small rim of ventricular myocardium at the mitral annulus and the tricuspid annulus. The 3-cm VSD was found near the mitral annulus with the necrosis of the septal myocardium extending to the fibrous trigones. We were afraid that the necrotic remnant of the ventricular septum would not hold the sutures used for the atrial cuffs. Therefore, generous amounts of mitral and tricuspid valve tissue were incorporated in the suture line to

Received December 28, 2012; accepted May 27, 2013.

Correspondence: Matija Jelenc, MD, Department for Cardiovascular Surgery, University Medical Center Ljubljana, Zaloska 7, 1525 Ljubljana, Slovenia; 386-1-522-49-41; fax: 386-1-522-25-83 (e-mail: jelenc@gmail.com).

strengthen it. Otherwise the TAH implantation proceeded as described previously [Arabia 1999].

The patient's postoperative course was uneventful, and the patient was hemodynamically stable and making steady progress. He was discharged home on postoperative day 63 after receiving the Freedom Portable Driver (SynCardia Systems). After 8 months on TAH support, the patient underwent a successful transplantation.

DISCUSSION

The incidence of a VSD complicating an acute myocardial infarction has been declining since the introduction of reperfusion therapy. According to the GUSTO-I trial, a VSD complicates 0.2% of all acute myocardial infarctions in patients receiving thrombolytic therapy [Crenshaw 2000]. The surgical treatment for this challenging complication has been evolving since the 1950s, when Cooley and coworkers reported the first successful operative technique [Cooley 1957], and it has continued to be refined [Deja 2000]. The 30-day mortality rate remains high, however, ranging from 94% to 100% for those medically managed. The most common cause of death is pump failure [Crenshaw 2000; Poulsen 2008]. Surgical therapy has proved beneficial, because the 30-day and 1-year mortality rates in surgically treated patients in the GUSTO-I trial were 47% and 53%, respectively [Crenshaw 2000]. Patients who develop cardiogenic shock carry a particularly grave prognosis. The study of Menon et al [2000] found that only 7 of 55 patients with postinfarction VSD and concomitant cardiogenic shock survived.

Various strategies have been used for treating postinfarction ventricular septal rupture. The appropriate time for surgical repair has been a matter of debate. Early closure immediately eliminates the detrimental effect of blood shunting, but doing so risks exposing the usually hemodynamically unstable patient to the risk of surgery. Additionally, early operative management usually means operating in a friable myocardium. On the other hand, postponing surgical repair to a later time provides the theoretical advantage of time for myocardial recovery and scar tissue formation [Gregoric 2008]. Notable efforts have been made in the last decade to use mechanical circulatory support to impart hemodynamic stability and delay surgical treatment until the myocardium recovers and scar tissue forms around the defect. Gregoric et al [2008] were the first to report a case in which a percutaneous left ventricular assist device (LVAD) was used. A 2-stage surgical treatment has also been described, with the LVAD implanted first by surgical means, followed by a later definitive surgical closure of the septal rupture [Pitsis 2008]. Faber et al [2002] described 2 cases of the use of an LVAD as a bridge to transplantation after surgical VSD closure; however, our patient was not a candidate for surgical closure. Moreover, LVADs with an inflow cannula in the left ventricle of patients with VSDs have been associated with hypoxic brain injury due to high right-to-left shunting [Kshettry 1997].

The use of a TAH as a bridge to heart transplantation has become a viable option for those with end-stage heart failure and for whom transplantation represents the best treatment option. The CardioWest Total Artificial Heart (SynCardia Systems) is a pneumatic, biventricular, pulsatile blood pump that replaces the patient's native ventricles and all 4 cardiac valves orthotopically and allows a cardiac output of >9 L/minute. Copeland and colleagues reported a 68% survival rate to transplantation and a relatively low rate of complications with the CardioWest Total Artificial Heart [Copeland 2012].

Our patient presented with a large, complex postinfarction VSD, which was not feasible for surgical closure because of the location and size of the VSD and because the mitral annulus and the posteromedial papillary muscle were involved. The patient was deteriorating rapidly despite an intra-aortic balloon pump and was placed on the high-urgency list for heart transplantation. However, the mean waiting time on the high-urgency list in the Eurotransplant region is approximately 40 days, and the patient needed a bridge to transplantation. The options at our institution were a venoarterial extracorporeal membrane oxygenator, a surgically placed left or biventricular assist device, and a TAH. In Eurotransplant, unlike the United Network for Organ Sharing, a patient with mechanical circulatory support can be placed on the high-urgency list only when complications of the mechanical support occur. Having a patient on extracorporeal membrane oxygenation or a paracorporeal assist device while the patient is waiting for the heart on a regular transplantation list is most likely to involve a long support time and the occurrence of complications that lead to a worse prognosis. The best option for our patient appeared to be the placement of a TAH, which allowed immediate recovery of end-organs and a discharge from the hospital, followed by a longer complication-free support time while the patient waited for the donor heart [Copeland 2012].

CONCLUSION

The presented strategy presents a novel approach in patients for whom a surgical repair of a postinfarction ventricular septal rupture is not feasible. Implantation of a TAH allows for immediate hemodynamic stabilization and restoration of peripheral organ perfusion and at the same time provides a bridge to later transplantation. To the best of our knowledge, only 5 cases worldwide (including ours) have involved the use of a TAH as the sole means of surgical treatment for a postinfarction VSD; however, none of the other cases have been reported in the literature.

REFERENCES

Arabia FA, Copeland JG, Pavie A, Smith RG. 1999. Implantation technique for the CardioWest Total Artificial Heart. Ann Thorac Surg 68:698-704.

Cooley DA, Belmonte BA, Zeis LB, Schnur S. 1957. Surgical repair of ruptured interventricular septum following acute myocardial infarction. Surgery 41:930-7.

Copeland JG, Copeland H, Gustafson M, et al. 2012. Experience with more than 100 total artificial heart implants. J Thorac Cardiovasc Surg 143:727-34.

Crenshaw BS, Granger CB, Birnbaum Y, et al. 2000. Risk factors, angiographic patterns, and outcomes in patients with ventricular septal defect complicating acute myocardial infarction. GUSTO-I (Global Utilization of Streptokinase and TPA for Occluded Coronary Arteries) Trial Investigators. Circulation 101:27-32.

Deja MA, Szostek J, Widenka K, et al. 2000. Post infarction ventricular septal defect - can we do better? Eur J Cardiothorac Surg 18:194-201.

Faber C, McCarthy PM, Smedira NG, et al. 2002. Implantable left ventricular assist device for patients with postinfarction ventricular septal defect. J Thorac Cardiovasc Surg 124:400-1.

Gregoric ID, Bieniarz MC, Arora H, et al. 2008. Percutaneous ventricular assist device support in a patient with a postinfarction ventricular septal defect. Tex Heart Inst J 35:46-9.

Kshettry VR, Salerno CT, Bank AJ. 1997. Risk of left ventricular assist device as a bridge to heart transplant following postinfarction ventricular septal rupture. J Card Surg 12:93-7.

Menon V, Webb JG, Hillis LD, et al. 2000. Outcome and profile of ventricular septal rupture with cardiogenic shock after myocardial infarction: a report from the SHOCK Trial Registry. Should we emergently revascularize Occluded Coronaries in cardiogenic shock? J Am Coll Cardiol 36:1110-6.

Pitsis AA, Kelpis TG, Visouli AN, et al. 2008. Left ventricular assist device as a bridge to surgery in postinfarction ventricular septal defect. J Thorac Cardiovasc Surg 135:951-2.

Poulsen SH, Praestholm M, Munk K, et al. 2008. Ventricular septal rupture complicating acute myocardial infarction: clinical characteristics and contemporary outcome. Ann Thorac Surg 85:1591-6.