Over 1200-day support with dual Jarvik 2000 biventricular assist device

Daisuke Yoshioka*, Koichi Toda, Yasushi Yoshikawa and Yoshiki Sawa

Department of Cardiovascular Surgery, Osaka University Graduate School of Medicine, Suita, Osaka, Japan

* Corresponding author. 2-2 Yamadaoka, Suita, Osaka, Japan. Tel: +81-6-68793154; fax: +81-6-68793163; e-mail: djason55@gmail.com (D. Yoshioka).

Received 8 July 2014; received in revised form 1 August 2014; accepted 5 August 2014

Abstract

We report the successful longest biventricular support using dual Jarvik 2000 biventricular assist device (BVAD; Jarvik Heart, Inc., New York, NY, USA) as a bridge to transplant. A 27-year old woman with arrhythmogenic right ventricular cardiomyopathy underwent implantation of two Jarvik 2000s as a left ventricular assist device and right ventricular assist device. Although several BVAD-related complications including haemolysis, hepatic function, and pulmonary valve insufficiency developed at a very late stage, she was successfully bridged to heart transplantation after 1245 days of biventricular support, which is the longest in the literature. Despite advances in continuous-flow ventricular assist devices, their long-term use for biventricular support remains limited. We report a successful case of 1245 days of biventricular support with dual Jarvik 2000 axial flow pumps in a patient with a small body surface area.

Keywords: Heart failure • Circulatory assist device (biventricular assist device)

CASE

A 27-year old woman with biventricular heart failure due to arrhythmogenic right ventricular cardiomyopathy had undergone dual Jarvik 2000 implantation with pin-shaped bearings because of her small body size (body surface area, 1.38 m²) [1]. Her post-operative course was uneventful, and symptoms improved dramatically. However, 4 months after the implantation and 2 days after discharge from the hospital, she developed severe haemolysis caused by pump thrombosis. Subsequently, she underwent consecutive conversion of a dual Jarvik 2000 with a pin-shaped bearing to that with a conical bearing [2]. After the conversion, her serum lactate dehydrogenase (LDH) level rapidly decreased to 651 U/I, and she was discharged 3 months after the conversion.

The transition of laboratory data is presented in Fig. 1. During follow-up, she was doing well as an outpatient for 2 years after discharge. The pump speed of the left ventricular assist device (LVAD) was maintained at 10 000 rpm (dial 3), and that of the right ventricular assist device (RVAD) at 8000 rpm (dial 1). However, her LDH level gradually increased again to 1000 IU/I within 1 year and to 2000 IU/I within 2.5 years after conversion, despite strict control with anticoagulant therapy (aspirin 100 mg daily and warfarin with a target international normalized ratio between 2.5 and 3.0). Her serum LDH level finally peaked at 3720 IU/I. Her serum total bilirubin level peaked at 7.1 mg/dl. Her haemoglobin level could be maintained between 9.0 and 11.0 during biventricular assist device (BVAD) support without blood transfusion.

Furthermore, about 2 years after conversion, she gradually developed dyspnoea on exertion and easy fatigue despite no evidence of device malfunction. Finally, her cardiac symptoms gradually deteriorated to NYHA classification IV after 2.5 years of conversion, although she never developed pulmonary oedema. She required re-admission and was administered intravenous diuretics. Echocardiography showed that her left ventricular ejection fraction was 33%, with a left ventricular diastolic dimension of 44 mm and systolic dimension of 37 mm. The dimension of the right ventricle was dilated to 48 mm with almost no effective contraction. She had moderate pulmonary valve insufficiency. Her aortic valve regurgitation could not be evaluated because of a severe motion artefact of the Jarvik 2000 pump. It was supposed that she developed right heart failure with severe leg oedema, and her hepatic function was considered to be impaired due to liver congestion and severe haemolysis. Her symptoms never improved although the RVAD pump speed was altered from 8000 to 9000 rpm to prevent right-sided heart failure. Her six-minute walk test result just prior to her heart transplant was only 254 m.

Finally, after the long waiting period for heart transplantation in Japan, she underwent a successful heart transplant after 1245 days of BVAD support. Heart transplant surgery was performed through a median re-sternotomy with iliac artery perfusion and superior vena cava and iliac vein venous cannulation. Severe adhesion was encountered in the mediastinum and the pericardial space was carefully dissected before the heart and dual pumps were removed en bloc. There was no obvious thrombus in the pumps, regardless of a severe haemolysis episode (Fig. 2). Her post-heart transplant course was uneventful. Her serum LDH level immediately decreased to normal levels, and her hepatic function improved. Brain magnetic resonance imaging (MRI) revealed no small cerebral infarction on T2-weighted fluid-attenuated inversion recovery (FLAIR) imaging. She was discharged 47 days after transplantation, and she is now doing well as an outpatient.

DISCUSSION

Although the clinical results of LVADs for severe left heart failure patients are improving, the clinical results of BVAD for biventricular failure remains limited. Patients who received mechanical...
support for severe biventricular failure showed acceptable clinical results for the total artificial heart as a bridge to transplantation. However, the total artificial heart requires sufficient body size, and its long-term survival is limited [3]. An implantable BVAD provides alternative biventricular mechanical support, and several studies report the use of two implantable continuous-flow pumps for long-term biventricular support. In BVAD patients, small implantable VADs, such as Jarvik 2000 or HeartWare HVAD pumps (Heartware International, Inc., Framingham, MA, USA), which do not require a pump pocket, are usually implanted. In the largest study, the Berlin Heart Institute Group reported 17 patients who were implanted with two HeartWare HVAD pumps [4]. In those patients, the 30-day survival rate was 82%, with the longest survival period reaching 440 days. On the other hand, the first clinical case of BVAD with a dual Jarvik 2000 was reported by Frazier et al. [5], but clinical results of long-term use with Jarvik 2000 have not yet been reported.

Although our patient was successfully bridged to heart transplantation, we experienced several complications during long-term BVAD support. First, haemolysis, the detailed aetiology of which was unknown, occurred at a very late phase, even though there was no obvious thrombus in the new conical bearing at the time of heart transplantation. A new conical bearing is expected to decrease device-related haemolysis; however, it is important to be reminded that haemolysis can occur in a patient without visible thrombus at the bearing. Second, the patient gradually developed symptomatic heart failure, which was difficult to be treated by altering the flow balance between the LVAD and the RVAD. Although RVAD pump speed was increased because our patient had no pulmonary oedema but only leg oedema and RV dilatation, her symptoms did not improve. It was difficult to monitor and optimize the balance because central venous pressure and echocardiography were the only available parameters for monitoring BVAD balance. Finally, pulmonary valve insufficiency of unknown prevalence can cause the imbalance between the LVAD and the RVAD in BVAD patients. It is reasonable that the frequency of valve insufficiency is more common in the pulmonary valve than the aortic valve, because the pulmonary valve is histologically more fragile than the aortic valve. In conclusion, we experienced successful long-term dual Jarvik 2000 support for a patient of small body size with biventricular failure. According to our review, our case is the longest support case with an implantable BVAD.

**Funding**

This case was financially supported by Health and Labour Sciences Research Grants from the Ministry of Health, Labour, and Welfare of the Japanese government.

**Conflict of interest:** none declared.

**REFERENCES**


