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CASE REPORT

Artificial Heart (Clinical)

A case of HeartMate II implantation in non-dilated left ventricle

Akiko Mano[1] · Takashi Nishimura[1] · Tomohiro Murata[1] · Mitsuhiro Kawata[1] · Shunei Kyo[1]

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Abstract
Left ventricular assist device is an established therapeutic option for the patient with end-stage heart failure. Recently, durable continuous-flow devices have replaced earlier generation of pulsatile devices and their desirable features are accelerating the utilization of these devices. However, their powerful performance could sometimes induce unfavorable complications such as sucking, especially in not so dilated left ventricle. Special maneuvers such as cannula position and lower pump speed may be reasonable for patients with non-dilated left ventricular, however, those managements have not been established yet to date. Right ventricular failure is also another concern in these devices. We experienced a patient who got a HeartMate II in spade-shaped, non-dilated left ventricle concomitant with right ventricular dysfunction, and successfully managed her.

Keywords HeartMate II · Non-dilated left ventricle · Low pump speed

Introduction

Left ventricular assist device (LVAD) is an effective tool for refractory heart failure. It is usually applied to dilated ventricle and implantation in non-dilated ventricle is challenging because of high risk of sucking event. This situation may also disturb the balance between left ventricle (LV) and right ventricle (RV), thus change RV geometry, which finally leads to RV failure [1]. Lower pump speed would be a favorable way to avoid excessive LV unloading, however, this topic is still under discussion [2, 3]. We present a case of a 56-year-old female with HeartMate II in non-dilated, spade-shaped LV complicated by RV dysfunction, who was properly managed by careful pump speed setting and volume control.

✉ Akiko Mano
akiko_mano@tmghig.jp

✉ Takashi Nishimura
takashi_nishimura@tmghig.jp

[1] The Department of Cardiothoracic Surgery, Tokyo Metropolitan Geriatric Hospital, 35-2 Sakae-Cho Itabashi-ku, Tokyo 173-0015, Japan

Case presentation

A 56-year-female was transferred to our hospital for end-stage heart failure to seek for advanced therapies. She had been in good health until 45 years, when she developed heart failure. She was diagnosed with hypertrophic cardiomyopathy and was started guideline-directed medical therapy. She had been doing well; however, her echocardiogram revealed gradually decreased LV wall thickness, from 19 mm to 13 mm at septum, and ejection fraction (EF), from 61 to 41%, for the decade. She had the second admission for heart failure exacerbation at age of 55 when she needed temporary inotropes support and was implanted bi-ventricular pacing device. Her condition continued to deteriorate, required frequent admissions for heart failure exacerbation, and eventually became inotrope dependent. She was referred to our hospital for advanced therapies. Her echocardiogram showed non-dilated LV, LV end diastolic diameter (LVDD) of 56 mm and LV end diastolic volume of 76 ml with LVEF of 46% (Fig. 1). RV function was also reduced with fractional area change of 30%. Severe tricuspid regurgitation, moderate mitral regurgitation (MR), and trivial aortic insufficiency (AI) were detected by color Doppler study. Right heart catheter data were as follows, central venous pressure; 15 mmHg, pulmonary artery pressure; 43/21/29 mmHg, pulmonary capillary wedge pressure; 25 mmHg, and cardiac index; 2.1 L/min/m^2 on dobutamine 2

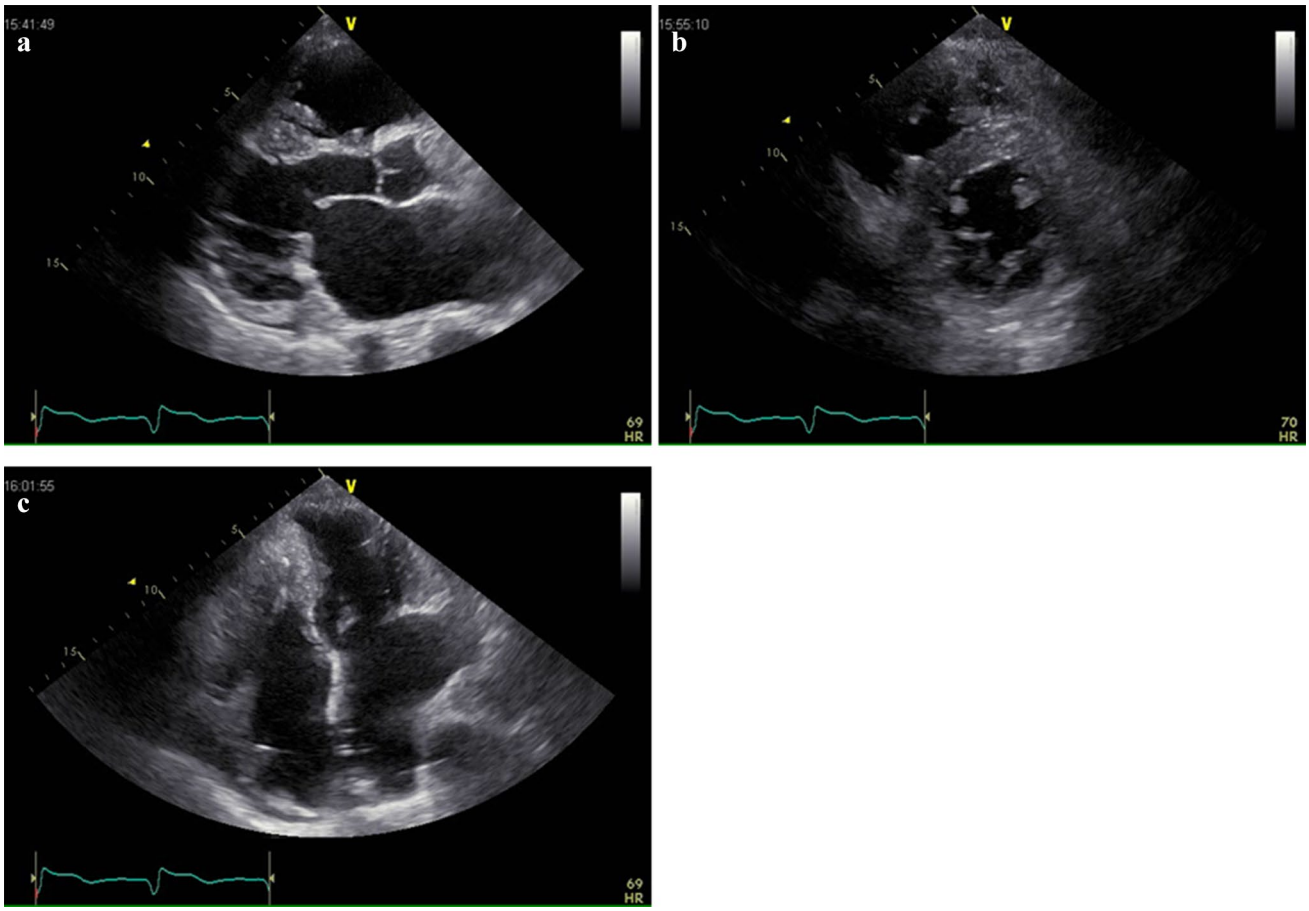

Fig. 1 Echocardiograms before LVAD implantation. a, parasternal long axis view. b, parasternal short axis view. c, apical four chamber view. Spade-shaped LV was not dilated with irregular wall thickness. *LVAD* left ventricular assist device, *LV* left ventricle

mcg/kg/min. We performed elective HeartMate II implantation for bridge to transplantation with concomitant bioprosthetic mitral valve replacement and tricuspid annulus plasty, when her Interagency Registry for Mechanically Assisted Circulatory Support (INTERMACS) profile was three with dobutamine 3 mcg/kg/min and milrinone 0.25 mcg/kg/min. We took special care for inflow cannula position because her LV was not dilated. We put an inflow cannula in pulling-up position and fixed it in rib to avoid deeper insertion. We set pump speed at 8000 rpm and had kept that speed. Clinical course after operation was uneventful. She was extubated on post operative day (POD) 1 and was weaned off inotropes on POD 10. She was started coumadin with target international normalized ration of 2.5 to3 and acetylsalicylic acid at dose of 100 mg on POD 3. Because of moderate RV dysfunction and small LV dimension, we maintained adequate intravascular volume. Echocardiogram on POD 14 showed LVDD 52 mm with EF of 38% (Fig. 2). MR grade was only mild. RV was mild dilated, but not compressed LV. Aortic valve did not open, but AI was not detected. Carvedilol and Lisinopril were retitrated to maintain mean blood pressure under low 80′ on POD 13 and POD 50, respectively. During hospitalization, she had never experienced hemolysis, thrombus, or RV failure. She was discharged from hospital on POD 37.

Discussion

LVAD has been developed as a primary therapeutic option for the growing number of patients with end-stage heart failure [4]. Historically, the size of device was large, which had limited the use of LVAD for the smaller patients. Current continuous-flow (CF) LVAD is much smaller compared to previous pulsatile LVAD, and this feature has made it easier to use CF-LVAD for the patients who were not candidate for larger device. There are several studies which investigated the relationship between BSA and outcomes. Komoda et al. reported that lower BSA is an independent risk factor for mortality due to stroke or systemic bleeding [2]. They speculated that smaller BSA patients tend to be managed by a lower pump speed which may lead to thrombus formation.

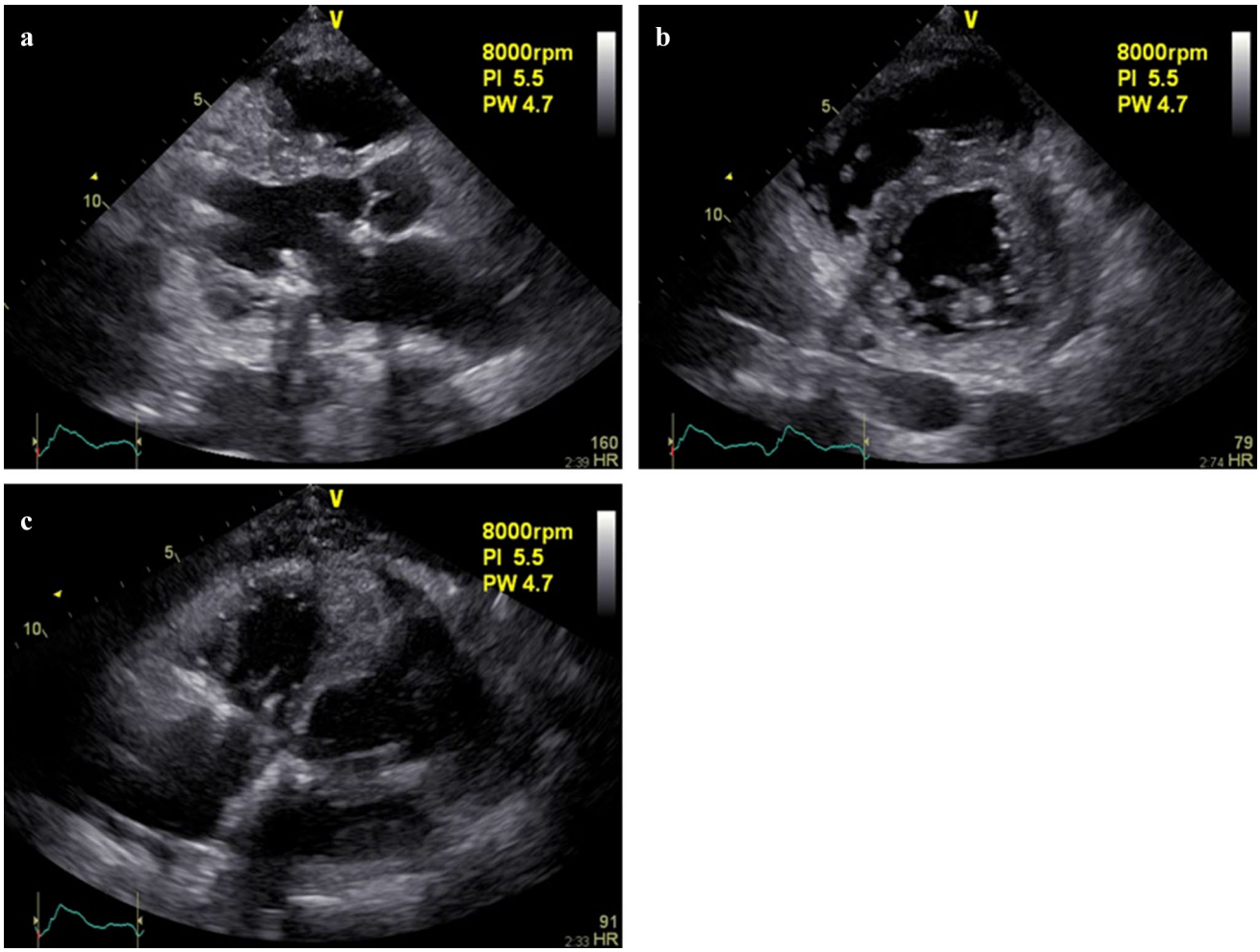

Fig. 2 Echocardiograms after LVAD implantation at pump speed of 8000 rpm. **a** Parasternal long axis view. **b** Parasternal short axis view. **c** Apical four chamber view. LV scanned by short axis view showed round-shaped. The balance of LV and RV was maintained. *LVAD* left ventricular assist device, *rpm* revolution per minutes, *LV* left ventricle, *RV* right ventricle, *PI* pulse index, *PW* power

Another possible cause they suggested is anatomical aspect. The possibility of kinking or deformation of inflow as well as outflow cannula would be higher in smaller BSA patients. Furthermore, inflow cannula malposition within LV should occur more often in smaller patients. Lee at al reported that survival, functional status improvement, and adverse event profile were comparable between small BSA patients and non-small BSA patients [5]. They also showed that more hemolysis was noted in small BSA patients implanted LVAD for destination therapy (DT). They speculated that cannula position as well as smaller relative circulating blood volume passing through the pump may be related to hemolysis although they failed to show a higher rate of thrombus in small BSA patients. In most studies, small BSA is defined as < 1.5 m^2. In our case, the patient's BSA was 1.54, so was not included in small BSA. However, LV size tends to be smaller in small BSA patients, thus the situation of our patients, non-dilated LV, would be very similar to small BSA patients. Actually, LV end diastolic diameter (EDD) of small BSA patients in the report by Volkovicher was 5.93 ± 1.09 cm, which is very close to our case, LVEDD of 5.6 cm before LVAD implantation [6]. Furthermore, LV in our patient showed spade-shaped, so we were very concerned about inflow cannula position to avoid sucking. We place an inflow cannula in pulling-up position by fixing it in a rib to avoid deeper insertion. In addition to smaller LV size and spade-shaped, she had moderate RV dysfunction that would be at high risk of RV failure after LVAD. Based on these findings, we decided to keep pump speed at 8000 rpm, permitted lowest speed. We maintained INR around 2.5–3.0, higher than recommended range to prevent thrombus on lower pump speed. Ono et al. reported the experience of HeartMate II implantation for small BSA patients with BSA range of 1.23–1.49 and LVEDD of 5.99 ± 1.23 cm in Japan and showed excellent survival and functional status improvement on these population [3]. The average pump speed in

their patients was 8524 ± 4166 rpm, which is still higher compared to our patient. They also controlled INR very strictly, at 2.0–2.5, lower than our case. We payed careful attention to volume status because hypovolemia reduces LV cavity, which would accelerate sucking as well as change of RV geometry. We could maintain appropriate volume based on CVP and body weight.

Conclusion

We implanted HeartMate II in patient with spade-shaped, non-dilated LV accompanied by RV dysfunction and successfully treated by lower pump speed with careful INR and volume control in addition to cogitated inflow cannula position. Durable CF-LVAD would be safely and effectively applied to small BSA / heart patients by proper management.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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