1. Introduction

Implantable left ventricular assist devices (LVADs) are increasingly used for end-stage heart failure patients with broadening indications due to the rapid advancement in device technology [1, 2]. These devices are not ideal for a patient who is acutely decompensating from cardiogenic shock. Rather, short-term support devices, which allow biventricular, easier and quicker insertion, are the device of choice. The latter devices are, however, not designed to be used in an ambulatory setting, and thus the supported patients are usually bed-bound. Among short-term support devices, CentriMag technology is becoming popular due to its ease in insertion and maintenance as well as conceptual advantage of a bearingless pump [3–5]. We have inserted CentriMag devices in over 70 patients with satisfactory outcomes, and the CentriMag biventricular assist device (BIVAD) is currently our first choice device in acute cardiogenic shock. Some of the patients were supported for a relatively long time, during which they participated in ambulatory rehabilitation once the general condition had stabilized (Fig. 1). Here we describe our insertion technique that allows this ambulatory management.

2. Operative technique

The right ventricular assist device (RVAD) is usually established with the right atrium as the inflow and the main pulmonary artery as the outflow. The outflow of the LVAD is the ascending aorta except in unusual cases where the descending aorta or a more peripheral branch may be considered. The inflow of the LVAD is chosen based on the patient’s condition. The inflow cannula is inserted into the left ventricle when myocardial recovery is a possibility. This is done either through left ventricular apical cannulation or by advancing the left atrial cannula into the left ventricle through the mitral valve. Otherwise, the left atrium is cannulated. Although the apical cannulation provides most reliable decompression of the left ventricle, it requires mobilization of the left ventricle, which compromises the hemodynamics. Our most common choices of cannulas are as follows: 20–24 Fr elongated on-piece arterial cannula (Medtronic, Inc, MN, USA) for the pulmonary artery, 31 Fr DLP right angle metal tip venous cannula (Medtronic, Inc, MN, USA) for the right atrium or right ventricle, 7–8 mm Sarns soft flow aortic cannula (Terumo Corp., Tokyo, Japan), 31 Fr right-angle metal tip venous cannula for the left atrium, and 36–40 Fr DLP malleable single stage venous cannula (Medtronic, Inc, MN, USA) for the left ventricle (either through the left atrium or the left ventricular apex). The procedure is performed without cardiopulmonary bypass support whenever feasible.

After a median sternotomy, double purse-string sutures with 2-0 or 3-0 polypropylene buttressed with bovine pericardial pledges are placed at the cannulation sites and passed through DLP tourniquets (Medtronic, Inc, MN, USA). The cannulae are introduced into the pericardial cavity through separate stab wounds at the upper abdomen. Cannulation is performed and the cannulae are secured to the tourniquets with 0 silk ties. These tourniquets are folded and tied with another 0 silk tie on to the cannulae at their entry point to the posterior aspect of the rectus
abdominis muscle fascia (Fig. 2). This looks like a ‘Fleur-de-Lis’ and works as an anchor, and further secures and immobilizes the cannulae. When there is enough length, the tourniquets are folded back again for better anchoring. Securing the folded tourniquets at an appropriate point onto the cannulae is the key of this technique. This point is determined at the level of the posterior rectus fascia to leave appropriate length of the cannulae in the pericardial space. This immobilizes the cannulae and prevents migration during aggressive physical activity with rehabilitation. Attention is paid to ensure the folded tourniquets are working as secured anchors by forcefully pulling back the cannulae. Each cannula is sutured onto the skin at three points, connected to the BiVAD circuit, and the BiVAD is actuated. Drains are placed and the sternotomy wound is closed in the usual fashion.

Postoperatively, an abdominal binder is used at the upper abdomen. The patients are allowed to be out of the bed as soon as they are extubated, and early rehabilitation is initiated by the physical therapists. Further rehabilitation is facilitated to walk as the patients tolerate either in the intensive care unit or in the general floor. The longest support with the CentriMag was 144 days. From January 2007 until August 2009, 63 patients underwent surgical CentriMag ventricular assist device (VAD) placement for cardiac support. The majority of those who recovered from acute illness were mobilized out of the bed, and 14 patients were able to ambulate and participated in rehabilitation. There was no adverse event associated with physical activity.

3. Discussion

Although CentriMag VADs are designed and approved only for short-term support, our insertion technique allows long-term use, when needed, without forced bed rest. Ambulatory rehabilitation has many advantages and prepares the patients for the next stage of the treatment, such as implantable long-term VADs or heart transplantation. A highly redundant safety system is achieved by maximizing the immobilization of the cannulae through several stages; 1) securing the cannulae to the tourniquets, 2) folding the tourniquets at the fascia level as an anchor, 3) multiple secure sutures on the skin, and 4) abdominal binder. After the early postoperative period, adhesion is formed around the cannula inside of the pericardium, and this eventually further secures the cannulae.

References