Minimally invasive left ventricular assist device implantation with outflow graft anastomosis to the innominate artery

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Minimally invasive implantation techniques are continually gaining more and more acceptance as the new state of the art in left ventricular assist device (LVAD) surgery because of their reduction of perioperative complication rates. The common denominator of the various techniques is the avoidance of a full sternotomy, which represents a common trend in cardiac surgery. Minimally invasive LVAD implantation is a combination of accessing the apex of the left ventricle through a left anterior thoracotomy and a choice of possible outflow graft anastomosis positions. The most common outflow graft position is the ascending aorta, followed by the subclavian artery.¹⁻³ In the case described here, we modified the minimally invasive Hannover HVAD (HeartWare HVAD; HeartWare Inc, Framingham, Mass) implantation technique¹ by attaching the outflow graft to the innominate artery in the setting of severe aortic calcification in a patient who had previously undergone coronary artery bypass grafting. This is the first reported case of a minimally invasive LVAD outflow graft anastomosis to the innominate artery.

CLINICAL SUMMARY

We present the case of a 67-year old male patient who was admitted to our clinic for biventricular heart failure and multiple recurrent cardiac decompensations arising from ischemic cardiomyopathy.

The patient had undergone quadruple coronary bypass grafting as well as mitral valve reconstruction more than 6 years previously. The vascular status of the patient showed high-grade stenosis of both renal arteries, aortoiliac occlusive disease, and peripheral vascular disease. The preoperative computed tomographic scan revealed no signs of aortic anomalies.

Left ventricular ejection fraction was 10%, left ventricular end-diastolic dimension was 70 mm, and left ventricular end-systolic dimension was 67 mm. Right ventricular

FIGURE 1. Postoperative computed tomographic scan of the left ventricular assist device outflow graft anastomosis showing severe calcification of the aorta.

ejection fraction was 20% to 25%. Cardiac index was 2.12 L/min/m². The patient showed severe pulmonary hypertension (mean pulmonary arterial pressure of 42 mm Hg, pulmonary capillary wedge pressure of 41 mm Hg).

The minimally invasive HVAD implantation technique was applied by combining an upper hemisternotomy with an anterolateral thoracotomy.¹ The ascending aorta, however, showed severe calcification (Figure 1), resembling a porcelain aorta and necessitating an alternate outflow position. Cardiopulmonary bypass was established by cannulation of the femoral artery and vein. The innominate artery was exposed. Through anterolateral thoracotomy, the epicardial HVAD sewing ring was implanted on the left ventricle, and the pump was placed into the apex. The outflow graft was tunneled from the thoracotomy through the left pleural cavity to the upper incision site and anastomosed end-to-end to the innominate artery (Figure 2).

The postoperative course was uneventful. Echocardiography revealed a continuous outflow graft flow of 55 to 90 cm/s². The aortic valve did not open. The patient was discharged from the intensive care unit on postoperative day 3 and left the normal ward for rehabilitation in good general condition on postoperative day 24. The blood flow in the outflow graft showed no impairment at both the 3-month and 1-year follow-up examinations. The LVAD showed a flow of 6.8 L/m and 5.8 W at a speed of 2800 rpm.

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FIGURE 2. Computed tomographic reconstruction of the outflow graft anastomosis to the innominate artery.

DISCUSSION

Implanting LVADs “off the shelf” is an attractive alternative to transplantation. This applies especially to emergency cases as a bridge to transplant and to patients who do not fulfill the transplantation requirements.

Because of the many considerable positive advantages, minimally invasive implantation techniques have become a new standard in LVAD surgery. Alternative approaches to the anastomosis of the outflow graft thus are of major relevance. The positioning of the outflow graft plays an important role in the long-term outcome of the patient. False positioning leads to turbulences in the blood flow, resulting in a high risk of outflow graft thrombosis or

kinking.⁴ Osorio and colleagues⁵ suggest that the risk of stroke may be significantly reduced by as much as 50% by tailoring the outflow graft anastomosis according to a computational fluid dynamics analysis.

Positioning the outflow graft to the ascending aorta is still the criterion standard in LVAD surgery. The outflow graft anastomosis to the innominate artery is an alternative to the conventional target areas ascending aorta and subclavian artery. It is still not a first choice option, however, because of the lack of long-term results regarding the thromboembolic rate and outcome of the patients and should currently be considered a valid option in case of severe aortic calcification.

The anastomosis of the outflow graft to the innominate artery is a feasible option for LVAD implantation in the setting of aortic calcification, providing an alternative approach in challenging anatomic situations.

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