Comment

Stainless steel bars were originally used in the Nuss procedure for pectus excavatum [1]. Stainless steel contains various metals, such as iron, chromium, nickel, molybdenum, which are not antigens themselves. However, some metals become ionized in the body and thereafter bind with natural proteins; they then cause allergic reactions. Nickel and chromium are common causes of metal allergies. Given that titanium is a biocompatible metal and rarely becomes ionized, it provokes few allergic symptoms. Therefore, titanium is widely used as a biomaterial for artificial joints and oral implants. Titanium biomaterials are also recommended for patients with a metal sensitivity [2, 4].

However, titanium bars are actually made of titanium alloy, which contains a small amount of other metals, such as aluminum and vanadium. These elements can be responsible for allergic reactions to titanium alloy. So far, a few reports have been published about metal allergy to titanium in patients treated with orthopedic and dental biomaterials [5]. However, a metal allergy to titanium Nuss bars has not been previously reported.

In these patients, their metal allergies had been known preoperatively. Therefore, skin patch tests were performed with the use of tiny plates that had the same composition as the titanium and stainless steel bars. However, the test results were negative in both patients. Skin patch tests for each metal component were needed in these cases, but skin patch tests do not always reveal a metal allergy [4]. In addition, the symptoms of metal allergies are similar to those of surgical infections; therefore, metal allergies are sometimes misdiagnosed as surgical infections [4]. The management of metal allergies is different from that of surgical infections.

In the younger brother, the symptoms and the laboratory data were similar to those in the patient's older brother, who had undergone the Nuss procedure 2 months before the patient's operation. Therefore, we easily recognized it as a metal allergy, and we initiated oral steroid therapy immediately. The oral steroids were very effective and quickly resolved the symptoms in both patients. It is recommended that the support bars remain in situ for 2 to 4 years because early bar removals are associated with a high rate of recurrence of pectus excavatum [2]. Therefore, the low dose of oral steroids was continued until the removal of the bars.

A metal allergy to titanium bars can occur even when the results of skin patch tests for titanium are negative. Therefore, surgeons should keep in mind that metal allergies can occur after the Nuss procedure even when a titanium bar is used.

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FEATURE ARTICLES

A Novel, Catheter-Based Approach to Left Ventricular Assist Device Deactivation After Myocardial Recovery

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We describe a case of catheter-based embolization and deactivation of a left ventricular assist device using an Amplatzer plug for a patient demonstrating myocardial recovery after diagnosis of nonischemic cardiomyopathy. This procedure can provide a minimally invasive, low morbidity solution for patients wishing to be separated from left ventricular assist device support who want to avoid invasive surgery for device removal.

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The HeartMate II left ventricular assist device (LVAD [Thoratec Corporation, Pleasanton, CA]) is the most commonly implanted ventricular assist device in the United States and Europe. It is the only Food and Drug Administration (FDA) approved ventricular assist device for destination therapy in heart failure patients and is used frequently for bridge to transplant. Here, we describe a catheter-based approach to LVAD deactivation to restore quality of life after myocardial recovery.

The patient was a 70-year-old obese woman in whom a HeartMate II had been implanted 3 years earlier as a bridge to transplant eligibility for severe nonischemic cardiomyopathy and New York Heart Association functional class IV symptoms with an ejection fraction of 20%, peak oxygen consumption of 7.8 cc $\cdot$ kg^{-1} $\cdot$ min^{-1}, mild

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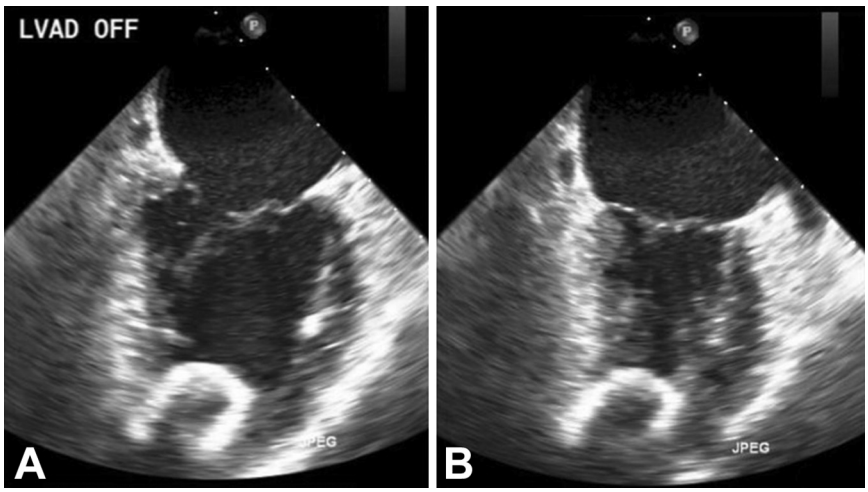

Fig 1. Transesophageal echocardiography with midesophageal two-chamber stills (A) at end diastole and (B) at end systole with left ventricular assist device (LVAD) at 0 rotations per minute (LVAD off).

to moderate mitral regurgitation, and a clean coronary angiogram. Her obesity and age made her a poor transplant candidate at the time of presentation.

After 2 years, she was still not a transplant candidate. Her symptoms had improved to New York Heart Association functional class I. She intensely desired to return to aquatic activities and regain a quality of life that was limited by her LVAD. Extensive counseling and psychiatric evaluation confirmed her insight into her condition and willingness to proceed. Functional studies were obtained. Right-side heart catheterization showed minimal increase in right ventricular (RV) pressures and a cardiac index of 2.1 when rotations per minute were decreased from 8,400 to 6,000. Results of a 6-minute walk test were 890 feet at 8,400 rotations per minute, and 1,080 feet at 6,000 rotations per minute. Hemodynamic data during a ramped catheterization study at 6,000 rotations per minute were as follows: right atrial pressure 5 mm Hg, pulmonary artery pressures 33/15/23 mm Hg, pulmonary capillary wedge pressure 12 mm Hg, and cardiac output/index 4.5/2.15. Age and RV dysfunction made decannulation extremely high risk, and a less invasive strategy was devised that the patient and her care team agreed upon.

The patient was bridged to operation with a heparin drip. In the catheterization suite, a transesophageal echocardiogram was performed and showed mild to moderate RV dysfunction and dilation. Volumetric left ventricular ejection fraction was 53% and 62%, in two-dimensional and three-dimensional mode, respectively. The device was turned off, and her RV dysfunction worsened from mild to moderate, and her RV became more dilated. Pulmonary artery pressures and right atrial pressure rose while LV function remained normal (Fig 1). Initiation of milrinone and epinephrine infusions improved the RV function. The LVAD outflow graft was then accessed under fluoroscopy through the right femoral artery. A 22-mm Amplatzer Vascular Plug II (St. Jude Medical, St. Paul, MN) was deployed in the distal outflow graft 1 cm proximal to the aortic anastomosis. Completion angiogram revealed trace contrast filling proximal to the plug (Fig 2) without flow through the LVAD. Stasis was confirmed with transesophageal echocardiogram Doppler flow imaging.

The driveline, which had been prepared in a sterile fashion, was then addressed. A circumferential incision approximately 2 cm in diameter encompassing all chronically inflamed tissue was made around the driveline and carried 3 cm into the abdominal fat pad. The driveline was retracted out of the wound and cut. The wiring retracted into the Gore-Tex (W. L. Gore & Assoc, Newark, DE) sheath, which was then irrigated with betadine and vancomycin solutions. The dead space within the driveline was filled with BioGlue (CryoLife Technologies, Kennesaw, GA), and an 8-mm tubular segment of Gore-Tex was placed overtop the driveline stump, then folded over and tightly tied down to cap the open end of the driveline. The wound was closed and a vacuum dressing applied.

After the procedure, the patient was given anticoagulation therapy with heparin and coumadin for thromboembolic prophylaxis. She was weaned from her

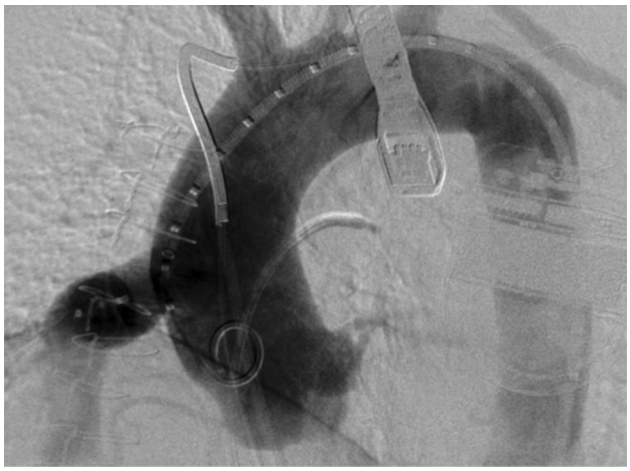

Fig 2. Aortogram in left anterior oblique projection after deployment of occluding plug demonstrates minimal retrograde flow of contrast media through the occluded left ventricular assist device outflow cannula.