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Metal Allergy to Titanium Bars After the Nuss Procedure for Pectus Excavatum

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The Nuss procedure requires the placement of metal bars in the chest cage to repair pectus excavatum. Metal allergies are one of the complications associated with this procedure. Given that titanium is a biocompatible metal, it induces few allergic symptoms. Therefore, titanium bars are recommended for patients with metal sensitivity. We report the case of a 17-year-old boy with pectus excavatum who had a metal allergy to titanium bars, which occurred after the Nuss procedure. The administration of oral steroids is useful for treating metal allergies. Metal allergies to titanium bars are very rare; however, they can still occur.

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The Nuss procedure, introduced by Donald Nuss and associates in 1998, is widely accepted as a standard operation for repairing pectus excavatum [1–3]. However,

metal allergies to stainless steel bars are one of the complications associated with this procedure [2, 4]. Given that titanium is a biocompatible metal, it provokes few allergic reactions. Therefore, titanium bars are recommended for patients with a metal sensitivity [5]. However, titanium bars are actually made of titanium alloy, which contains a small amount of other metals. We report a rare case of a metal allergy to titanium bars that developed after the Nuss procedure.

A 23-year-old man with moderate pectus excavatum and a Haller computed tomographic index [6] of 5.38 visited our hospital. He had a history of metal allergies. Therefore, we confirmed the negative results for skin patch tests by using stainless steel and titanium alloy plates preoperatively. Owing to the negative results of the skin patch tests, the Nuss procedure was performed with the use of two stainless steel bars (Pectus bar, Biomet Corp, Jacksonville, FL) fixed with bioabsorbable sutures and no stabilizer.

Postoperatively, the patient experienced a high fever, chest pain, and bilateral pleural effusion (Fig 1). A small amount of *Staphylococcus epidermidis* was cultured from the pleural effusion. Various antibiotics were administered, and the next two bacterial cultures of the pleural effusion were negative. However, his symptoms continued. A blood count revealed a white blood count of 10,700/mm³ and an elevated eosinophil level of 9.4%. The pleural fluid studies also revealed an elevated eosinophil level of 10% and an elevated immunoglobulin E level of 165 IU/mL. Because a metal allergy to the stainless steel bars was suspected, oral steroid therapy (prednisone 30 mg/day) was initiated on postoperative day (POD) 14. The steroid therapy resolved his symptoms immediately. We replaced the stainless steel bars with titanium bars on POD 19 because of the initial severity of his allergic reaction. The pleural effusion disappeared after the redo operation, and the patient was discharged on POD 29. The oral steroids were tapered to 3 mg/day during the next three months, and continued until the bars were removed two years later. The allergic reaction did not recur, and no side effects of the steroid were

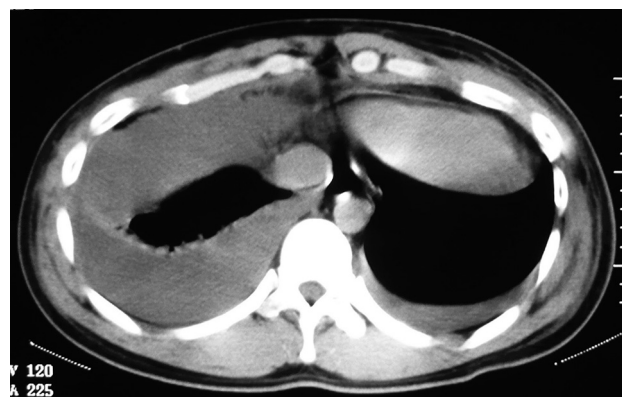


Fig 1. Chest computed tomography scan of the older brother on postoperative day 9, showing bilateral pleural effusion.

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Fig 2. The younger brother before the Nuss procedure, showing a moderate pectus excavatum.

observed. A recurrence of pectus excavatum did not occur for at least 5 years after the bar removal.

The patient's younger brother, a 17-year-old boy with moderate pectus excavatum and a Haller computed

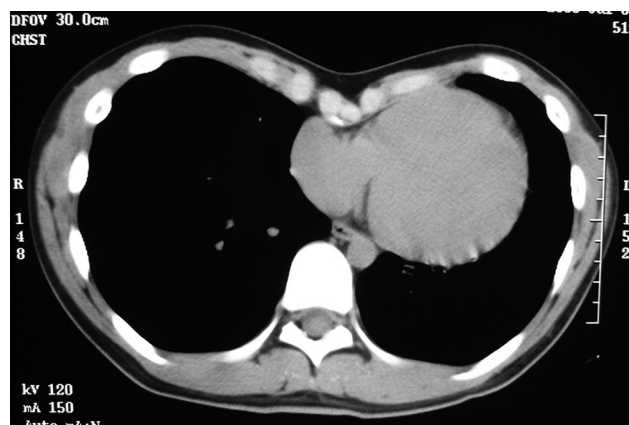


Fig 3. Chest computed tomography scan of the younger brother, showing moderate symmetric pectus excavatum with cardiac compression.

tomographic index of 4.5, visited our hospital (Figs 2 and 3). He also had metal allergies. Therefore, we preoperatively confirmed the negative results of a skin patch test by using a tiny titanium alloy plate. This time, the Nuss procedure was performed with two titanium bars (Chestway, Solve Corp, Yokohama, Japan) fixed with bioabsorbable sutures without a stabilizer.

Postoperatively, the patient experienced a high fever and pleural effusion (Fig 4). His blood count revealed a white blood cell count of 5,700 /mm² and elevated eosinophils of 9.3%. The pleural fluid studies also revealed elevated eosinophils at 25% and an elevated immunoglobulin E level of 493 IU/mL. Bacterial cultures of the pleural effusion were negative. The symptoms and the laboratory data were similar to those of the patient's older brother, who had undergone the Nuss procedure 2 months earlier. Owing to the similarities in symptoms between the brothers, a metal allergy to the titanium bars was suspected. Oral steroid therapy (prednisone 20 mg/day) was initiated on POD 4. The patient's symptoms quickly improved, and the pleural effusion disappeared on POD 7. He was discharged on POD 8. The oral steroids were tapered to 3 mg/day during the next 2 months and continued until the bars were removed 2 years later. The allergic reaction did not recur, and no side effects of the steroid were observed. About 5 years after the removal of the bars, no recurrence of pectus excavatum has been noted.

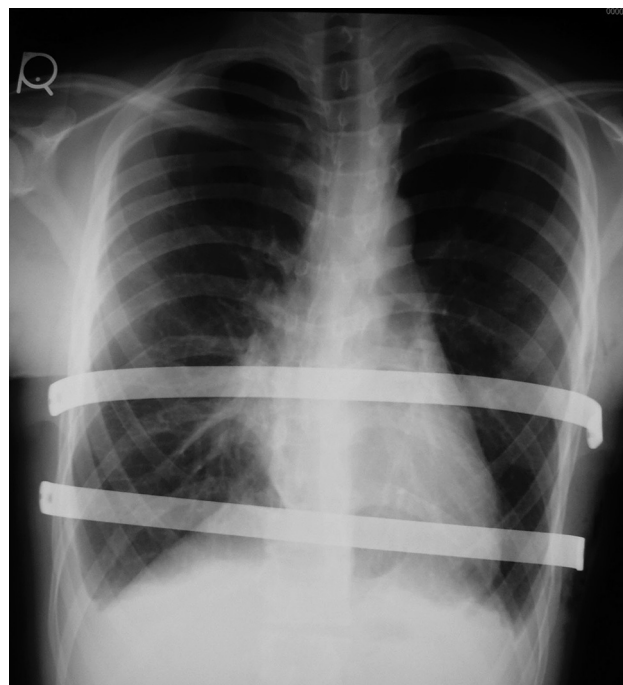


Fig 4. Chest roentgenogram of the younger brother on postoperative day 4, showing two titanium bars inserted in the thoracic cage and bilateral pleural effusion.

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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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 $7.8 \text{ cc} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$, mild

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