



When it is not an infection: metal allergy after the Nuss procedure for repair of pectus excavatum

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Abstract

Purpose: Increasing use of implantable bars for minimally invasive pectus excavatum repair has introduced metal allergy (nickel and chromium) to pediatric surgeons. Metal allergy is a well-recognized entity in neurologic, orthopedic, and craniofacial surgery. This study was performed to evaluate metal allergy and its effects on treatment with the Nuss procedure in 862 patients.

Methods: After institutional review board approval, we undertook a retrospective review of a prospectively gathered database of patients undergoing the Nuss procedure. Metal allergy was diagnosed either with the use of dermal patch or clinically, based on rash, fever, elevated erythrocyte sedimentation rate, cultures, and pathology specimens. Data collection included demographics, an allergy to jewelry, and history of atopy. Clinical outcomes including need for reoperation, removal of stainless steel bar, and replacement with titanium bar were evaluated.

Results: Over an 18-year period (1987-2005), 862 patients underwent the Nuss procedure. Nineteen (2.2%) were diagnosed with metal allergy, with an average age of 14.7 years (9-23 years). Eighteen (95%) were males. A history of atopy was present in 9 (56%) patients. Ten (63%) patients presented with rash and erythema, 1 (6%) with granuloma, 5 (32%) with pleural effusion, and 3 (15%) were diagnosed on preoperative screening. Stainless steel bars were removed because of allergic skin breakdown in 3 patients, with 2 patients requiring replacement titanium bars. In all 3 of these patients, symptoms resolved after removal of stainless steel bars. Titanium bars were placed in the 3 patients who were diagnosed preoperatively with metal allergy, without event.

Conclusions: Allergy symptoms often are misdiagnosed as infection, but require different treatment. If a history of metal allergy or atopy is suggested preoperatively, the patient should be tested for metal allergy, and if positive, a titanium bar used. Because the consequences of metal allergy may include the need to replace the bar, pediatric surgeons should be aware of this occurrence.

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Increasing use of implantable devices for surgical corrective procedures has led to a new awareness of metal allergies. Jewelry and dental procedures are no longer the sole cause of metal implants. Craniofacial, neurosurgical, orthopedic, and other surgeons often perform corrective

procedures with metal devices. Implants occasionally cause metal allergies. As many as 13% of patients are sensitive to nickel, cobalt, or chromium [1-3]. Physicians who care for patients who undergo these procedures need to be aware of this potential complication.

Metal allergy (specifically nickel) is the most common contact allergy in the United States and Europe [4,5]. The use of nickel jewelry in these populations is thought to be the main cause of allergen exposure. This is typically a delayed type IV hypersensitivity reaction, and T lymphocytes are the key to a patient's reaction. Both CD8⁺ and CD4⁺ T cells are responsible for the cytotoxic and inflammatory aspects of tissue damage, respectively [6-8]. In healthy people whose skin test is negative for nickel allergy, nickel-reactive CD4⁺ T cells are present, but the corresponding specific CD8⁺ T cells are absent [9]. This finding supports the theory that nickel allergen-specific CD8⁺ T cells are required to develop an allergic reaction after exposure to nickel. More recent evidence suggests that some CD4⁺ T cells actually are regulatory and help suppress nickel antigen stimulation [10,11].

The link between metal allergies and history of atopy has been described in the literature, although the exact association has not been fully elucidated. Atopy consists of allergic rhinitis, asthma, and eczema with varied clinical manifestations. Rash can present as urticarial or eczematous. Symptoms of inflammation such as pain, warmth, erythema, and swelling over the implant can be seen. Thoracic placement can cause symptoms of pericarditis or pleural effusion.

Nickel allergy has been extensively studied in European communities. On that continent, laws were enacted to reduce its occurrence. Significant decreases in nickel allergy were seen in Danish teenagers after nickel content in jewelry was limited [12,13]. The amount of nickel released was

limited to 0.5 $\mu\text{g}/\text{cm}^2$ per week from products such as earrings, bracelets, necklaces, wristwatches, and costume jewelry. The European Union adopted similar mandates in 1994 [14]. Exposure to nickel can also be seen in patients who work in manufacturing or industrial jobs. No such measures to limit nickel exposure have been adopted in the United States.

Our interest in metal allergy began with patients undergoing the minimally invasive Nuss procedure for repair of pectus excavatum. In this procedure a stainless steel bar is placed under the sternum for correction of the thoracic defect. A few patients developed complications during the postoperative period that we originally thought were either infectious or nonspecific. We discovered that these patients had a metal allergy. These patients made us question the optimal screening and treatment methods for metal allergy in the pediatric population undergoing minimally invasive repair of pectus excavatum with a metal bar.

1. Materials and methods

This study is a retrospective review of patients who presented with concerns for metal allergy after undergoing minimally invasive repair of pectus excavatum by the pediatric surgery service at Eastern Virginia Medical School, a tertiary referral center. Institutional review board approval was obtained for this study (01-05-EX-0175). All data collection complied with HIPAA regulations. Inclusion criteria were (1) repair of pectus excavatum with the minimally invasive Nuss procedure and (2) concern for metal allergy either on preoperative screening or postoperative follow-up. Concerns for metal allergy arose when symptoms of fever, rash, erythema, effusion, and granuloma



Fig. 1 The TRUE test skin patch system.

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