

Dermatitis in patients undergoing the Nuss procedure for correction of pectus excavatum

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Summary

Background. The Nuss procedure was introduced in 1987 for the correction of pectus excavatum. In this procedure, a stainless steel bar is placed underneath the sternum.

Objectives. To report cutaneous reactions associated with Nuss bar placement.

Methods. Over a period of 30 months, 50 patients underwent the Nuss procedure. The study population was limited to those who developed clinically significant cutaneous reactions postoperatively. Patient information was obtained from electronic medical records. All patients had been patch tested preoperatively with stainless steel discs supplied by the bar manufacturer. When performed, expanded patch testing was carried out in accordance with the North American Contact Dermatitis Group guidelines.

Results. Postoperatively, 3 patients developed areas of protuberant granulation tissue at one or more incision sites. One patient developed localized oedema, dermatitis, and lymphadenopathy. Two of these 4 patients underwent further patch testing. Of these 2, 1 with dermatitis had a positive reaction to nickel and the other, with granulation tissue, tested negative for metal allergy.

Conclusions. Despite clinical evidence of cutaneous reactions or putative allergy, no patient required early removal of the bar(s). Cutaneous testing with stainless steel discs supplied by the bar manufacturer does not provide accurate screening for allergy to the implant used in the Nuss procedure.

Key words: nickel allergy; Nuss bar; Nuss procedure; pectus excavatum.

Pectus excavatum is a common chest deformity that can compromise cardiac and respiratory function. The incidence is reported to be as high as 1 in 1000 children, with a male predominance (1, 2). Although the exact pathophysiology of pectus excavatum is unknown, the underlying defect is thought to stem from overgrowth of the ribs and cartilage that creates an anterior chest wall depression. Associated signs and symptoms include a wide

spectrum of cardiopulmonary findings, including chest pain, shortness of breath, systolic murmurs, recurrent respiratory infections, and decreased endurance (3).

Surgical repair can improve quality of life, minimize psychological symptoms, improve cardiovascular function and increase oxygen uptake in symptomatic patients (4, 5). The Nuss repair method involves the implantation of a convex metal bar (produced by Biomet Microfixation, Jacksonville, FL, USA) behind the sternum that, over a period of years, allows for permanent remodelling of the chest (3, 6, 7). In this minimally invasive procedure, a curved metal bar is placed in a substernal position under thoracoscopic guidance, to remodel the contour of the chest wall (3, 6). The bars are fitted so that the ends meet the rib margin (Figure 1). A metal stabilizer is used to affix the bar to the chest wall. The bars are typically removed after 2–3 years (6).

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The popularity of the Nuss procedure can be attributed to its minimally invasive nature, short operating time, and earlier return to normal activity (6, 8, 9). Potential complications include residual pain at the placement site, the need for reoperation owing to displacement of the bar, and infection (3). The most common early postoperative complications include pneumothorax, drug reactions, suture site and bar infections, wire breakage, atelectasis, and bar flipping (6, 10). The most common late postoperative complications include bar displacement (5.8%) and overcorrection (3.2%) (6). In the large follow-up study reported by Nuss, 'bar allergy' was reported as a complication in 2.9% of patients. The diagnosis of bar allergy was based on either a clinical history of metal allergy or a positive patch test reaction to nickel in the TRUE Test™ (6, 11). Reported cutaneous complications include keloids, skin erosion, granulomas, erythema or seromas at the incision site (6, 11–14).

We report 4 patients who underwent the Nuss procedure for treatment of pectus excavatum with implantation of stainless steel Nuss bar(s) and stabilizer(s), and subsequently developed cutaneous reactions postoperatively.

Materials and Methods

After institutional review board approval, patient information was obtained from electronic medical records, which included surgical reports, pathology reports, and notes from outpatient encounters. Our inclusion criteria limited our study to patients who had been preoperatively patch tested with stainless steel alloy discs and were followed by surgeons at our institution postoperatively. Over a period of 30 months from March 2006 to September 2008, 50 patients underwent the Nuss procedure at our institution. The study population was limited to those who developed clinically significant cutaneous reactions along the bar site postoperatively.

Preoperative patch tests with stainless steel alloy discs supplied by Biomet Microfixation were applied in the surgeons' offices, and results were read by the patients' family after 48 hr. When performed, expanded patch testing with an abbreviated screening series and Cleveland Clinic prosthesis series was carried out in accordance with the guidelines established by the North American Contact Dermatitis Group (NACDG) (15, 16). Patch testing products were purchased from Chemotechnique® (Vellinge, Sweden) and from AllergEAZE™ (SmartPractice™, Calgary, Canada). Patch tests were applied to unaffected skin sites on the back with aluminium discs (Finn Chambers®; Epitest Ltd, Hyryla, Finland) on pressure-sensitive, acrylic-based adhesive

medical tape (Scanpor®; Norgesplaster AIS, Aksjeselskap, Norway). Patch tests were removed after 48 hr and read on day 2 or 3, and again on day 6 or 7. Interpretation of the patch test results were performed according to NACDG guidelines.

Results

Of the 50 patients who underwent the Nuss procedure from March 2006 to September 2008, 4 developed cutaneous reactions following implantation of Nuss bar(s) and stabilizer(s) (Figure 2). All 4 were male teenagers who sought surgical repair owing to cardiovascular and/or respiratory compromise stemming from pectus excavatum. The mean and range of onset of cutaneous findings from the time of the procedure were 9.5 months and 3–14 months, respectively. Two patients underwent expanded patch testing with an abbreviated screening series and Cleveland Clinic prosthesis series.

Our 4 patients are summarized in Tables 1 and 2.

Discussion

Because the traditional stainless steel Nuss bar is composed of 61% iron, 18% chromium, 14% nickel, 2.5% molybdenum, 2% manganese, and small amounts (less than 1%) of carbon, phosphorus, sulfur, nitrogen, copper, and silicon, metal allergy is an important consideration when evaluating patients presenting with cutaneous complications following insertion of the Nuss bar and stabilizers (17). Each of our 4 patients was patch tested preoperatively with a stainless steel disc, which was supplied by the manufacturer, applied in the office, removed at home by the patient's family at 48 hr, and read once by them; each of the 4 patients was reported to be negative. After bar placement and subsequent development of skin reactions, patients 1 and 2 were patch tested more extensively in the dermatology clinic. Patient 1 was patch test negative for nickel. Patient 2 was confirmed to have nickel sensitivity, and presented with signs that were suspicious for systemic allergic dermatitis including lymphadenopathy. Both patients 1 and 2 were also patch test negative for iron, chromium, molybdenum, and manganese salts. Patients 3 and 4 did not undergo further patch testing, so it is not known whether their skin eruptions were caused by metal allergy.

Patients 1, 3 and 4 developed localized protuberances of granulation tissue over the stabilizer or over the Nuss bar. Patient 2 developed a diffuse plaque of erythema and oedema over the lateral ends of the Nuss bars. Patient 4 experienced persistent cutaneous complaints that did

Table 1. Patients with pectus excavatum evaluated for cutaneous complications associated with the Nuss procedure

Case	Age (years)/sex	Clinical description of chest findings	Postoperative onset	History of atopy/metal allergy/prior implant(s)	Preoperative patch testing with stainless steel disc	Expanded patch test results
1	13/M	4 × 1.5-cm plaque of protuberant purplish granulation tissue with yellow discharge, central opening and surrounding erythema	14 months	Childhood eczema/none/none	Negative	3+, thimerosal
2	13/M	Erythema and oedema over the lateral ends of the bar Mild right axillary lymphadenopathy measuring 1.9 × 2.3 cm	8 months	None/none/none	Negative	1+, nickel sulfate
3	17/M	Brawny skin changes 1-cm area of protuberant pink granulation tissue Collection of yellow subcutaneous fluid	3 months	None/none/none	Negative	Not performed
4	14/M	2 × 1-cm area of protuberant, pink granulation tissue	13 months	None/none/none	Negative	Not performed

Table 2. Clinical course and outcome of patients with pectus excavatum evaluated for cutaneous complications associated with the Nuss procedure

Case	Clinical course	Bacterial culture results	Treatment of cutaneous findings	Outcome	Pathology findings at time of bar removal
1	Intermittent erythema/chronic drainage	Negative	Cephalexin Ibuprofen	Cutaneous findings resolved with scheduled Nuss bar removal	Fibrosis, haemosiderin, and mild chronic inflammation
2	Intermittent oedema and erythema	Negative	Observation alone	Cutaneous findings resolved with scheduled Nuss bar removal	Inflammatory pseudocapsules with dense fibrous tissue; foreign body giant cell reaction; chronic inflammation, granulation tissue, and pseudosynovial hyperplasia
3	Intermittent fluid collection, skin discoloration, and protuberant granulation tissue	Negative	Cephalexin Prednisone 5 mg/day long term with intermittent higher dosage with flares of skin disease	Cutaneous findings resolved with scheduled Nuss bar removal	Atrophic skeletal muscle, scar formation, and focal pigment deposition
4	Persistent protuberant granulation tissue	Negative	Cephalexin Prednisone – short course beginning with 20 mg/day, tapered to 5 mg/day over 2 weeks	Cutaneous findings resolved with Nuss bar removal	Evidence of ulceration, acute inflammation, and granulation tissue formation

not change significantly while the bar was in place. In the remaining 3 patients, the cutaneous findings were intermittent.

Patient 1 had a history of childhood eczema, and none of the patients had prior implants or metal piercings, although patient 2 received metal dental braces after receiving the Nuss bar. Prior reports have shown that nickel ions can be leached in sufficient quantities from nickel-containing braces to induce nickel sensitization

or elicit allergic contact dermatitis, which could possibly have contributed to this patient's reaction (18).

Patient 3 was treated with long-term prophylactic antibiotics and low-dose oral corticosteroids, which allowed him to tolerate the bars and stabilizers long enough for the chest wall contours to be corrected. Patient 4 was given shorter courses of cephalexin and prednisone. Patient 4 appeared to have developed a second cutaneous reaction along the site of his implanted bar in the weeks

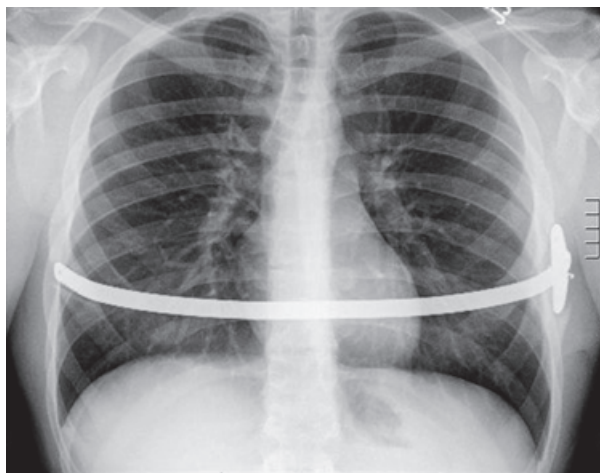


Fig. 1. Chest radiograph of case 4, showing the position of the Nuss bar in the chest cavity.



Fig. 2. Case 2 with dermatitis over the lateral end of an implanted Nuss bar. The patient had a positive patch test reaction to nickel sulfate.

prior to his scheduled device removal, which prompted the decision to remove his implant 6 weeks earlier. It is unclear whether more widespread skin changes would be seen if a metal-sensitive patient retained the implant for a longer period. It has been our experience that patients who develop cutaneous reactions secondary to the Nuss bar can be managed medically for a time period long enough to allow for correction of the chest wall deformity.

Following the Nuss procedure, nickel sensitivity can present with the onset of an erythematous patch along the anterior chest wall or take the form of non-cutaneous complications such as pericarditis and pleural effusion (6). A retrospective review of Nuss bar recipients conducted

by the originator of the procedure showed that 19 of 862 patients were diagnosed with nickel allergy. Of these patients, 10 presented with rash and erythema, 5 with pleural effusions, and 1 with a granuloma. The remaining 3 patients were diagnosed preoperatively and received titanium implants, which were well tolerated (11).

Rushing et al. recommend that patients with known nickel allergy be fitted with titanium bars (11). Anecdotally, it has been our experience that patients who receive titanium implants have fewer cutaneous reactions postoperatively. During a preoperative consultation, we had one other patient who reported a history of a skin rash around the periumbilical area, possibly arising from metal sensitivity. After preoperative patch testing in our dermatology clinic had verified metal allergy to nickel (2+) and cobalt (1+), the patient received bars and stabilizers fashioned from titanium, and experienced no cutaneous complications with his pectus excavatum repair.

At some institutions, titanium Nuss bars have become the standard of care in order to avoid the complications of nickel allergy. Other advantages of the titanium bar include the possibility of undergoing magnetic resonance imaging examination, its translucent appearance on X-rays, and its ability to pass through metal detectors (19). Although these practical advantages of the titanium bar seem promising, some argue that titanium bars are less practical for use, as they must be bent into shape with a computer-assisted manufacturing technique to fit the patient's computed tomography scan, and are more expensive to manufacture (11).

It is interesting to speculate on the infrequency of cutaneous reactions among Nuss bar patients, given the prevalence of nickel allergy, which is estimated to be 17% for females but much lower (3%) for males, as they have less ear piercing (20). Based on our experience and on other reports, it is clear that most patients undergoing the Nuss procedure have uneventful postoperative courses, accompanied by satisfactory cosmetic results and favourable correction of the chest wall contours (6, 9, 21, 22). We suspect that the discrepancy may be attributable to some patients developing such mild reactions along the incision sites, which may be overlooked or attributed to slowly healing wounds. Additionally, as the bars are in place for only 2–3 years, it is possible that implants are not in place long enough to elicit a response in a previously sensitized patient.

Although the prevalence of nickel allergy among the general population is significant, many individuals, even nickel-sensitized patients, will tolerate low levels of metals in implants without adverse reactions. It is generally believed that there is no need for widespread preoperative patch testing when an orthopaedic implant

is implanted, in the absence of a history of metal allergy or intolerance (23). Because the Nuss procedure used in the correction of pectus excavatum is relatively new, there have been few studies of cutaneous complications or ways to manage patients who develop dermatitis after Nuss bar implant. However, Nuss (11) reported bar allergy in 29 of 1015 patients (2.9%), including evidence of systemic allergic dermatitis. Consequently, some paediatric surgeons have been routinely patch testing with metal discs

supplied by the manufacturer, with the intent of placing a titanium bar in those who may be found to have sensitivity to nickel. Among our patients, all 4 were patch test negative to stainless steel discs preoperatively. Thus, we recommend patch testing with metal salts, which is the preferred method in most patch test clinics. This includes the use of petrolatum-based allergens or TRUE Test™ as utilized by Nuss (6, 11), if patients and surgeons suspect metal allergy.

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