INTERNATIONAL JOURNAL OF ADVANCES IN SURGERY
IJAS

INCIDENCE OF METAL ALLERGIES IN ORTHOPAEDIC SURGERY PATIENTS WHO SELF-REPORT ALLERGY HISTORY

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ABSTRACT

Background: Metal allergy is reported in 10%-17% of the general population. There is inconclusive evidence on the role of metal allergy in painful/aseptic arthroplasty loosening.

Objective: To determine the incidence of metal allergy in orthopaedic patients who self-report and characterize which metals cause allergy.

Methods: This is a retrospective chart review. All patients were questioned about metal allergy history; all positive cases were patch tested for specific metals.

Results: 41 of 840 patients self-reported allergy. 34 tested positive. 32 (78.05%) reported inability to wear metal accessories. 30 (73.17% of tested, 93.75% of reporting) demonstrated allergy. 27 tested positive for nickel allergy, 4 to cobalt, 4 to gold thiosulfate, one to tin, one to titanium, and 7 to multiple metals. 6 had metal orthopaedic implants prior to testing.

Conclusion: Metal allergy can be concerning for surgeons. Greater awareness of sensitivity may prevent patient exposure to implants that may cause allergic reactions.

KEYWORD

Metal Allergy, Arthroplasty, Total Joint Replacement (TJR) Total Knee Arthroplasties Total Hip Arthroplasties

ARTICLE HISTORY

Submitted: 24-02-2018 **Accepted: 02-03-2018** **Published: 10-05-2018**

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INTRODUCTION:

Total joint replacement (TJR) has been a major advance in the treatment of joint arthritis, achieving predictably excellent results with relatively low perioperative morbidity.[1] The incidence of TJR's continues to increase, with over a million total hip arthroplasties (THA) and total knee arthroplasties (TKA) being performed annually in the United States.[2,3] Total shoulder arthroplasty (TSA) also is becoming more prevalent, with nearly 27,000 cases performed in 2008.[4]

As the incidence of TJR continues to increase, the potential impact of implant corrosion and metal ion release on patients with metal sensitivity has become a concern. About 10-20% of the population has metal sensitivity, as diagnosed by skin testing.[5] Approximately 10% of the population is sensitive to nickel specifically, with literature describing sensitivity to beryllium, cobalt, and chromium.[14] A recent study by Davis et al of 1,000 patients reported even higher incidence, with a positive reaction rate of 57% of tested patients.[15] Metals with the highest allergic patch-test reaction rates were nickel, gold, manganese, palladium, cobalt, ticonium, mercury, beryllium, chromium, and silver.

Metal debris from orthopaedic implants has been found in synovial fluid and soft tissues of patients with metal prostheses, as well as isolated in both blood and lymph samples.[6,7] Type IV hypersensitivity, mediated by T-lymphocytes, has been described as the most common hypersensitivity type related to TJR, with infiltrates of both T and B lymphocytes being documented in soft tissue after explant of hardware, suggestive of an immune response to the implant.[8-12]

Recently, the potential impact of metal sensitivity in the context of TJR has been reported. Multiple studies discuss patient-reported allergy to various metals and their effects on physical function, pain, systemic symptoms, and mental health for lower extremity TJR.[13] Patient-reporting of metal allergies has also been studied extensively in lower extremity TJR, but little literature exists on TSA. Nam et al. reported a case series of 906 THA's and 589 TKA's, where patients with self-reported metal allergies had lower overall Hip Society and Knee Society scores, as well as decreased post-operative SF-12 Mental Component Scores[14] Clinical findings of hypersensitivity reactions at the skin level may include dermatitis, generalized pruritis, and dyspnea, but the link between symptoms and metal sensitivity in patients with metal implants are poorly understood.[16,17]

No consensus or standard exists on how to screen or what changes in treatment plans need to be implemented when sensitivity is reported.[18] There is inconclusive evidence as to the role of metal sensitivity in persistently painful or aseptic loosening of arthroplasties, yet literature review suggests that preoperative testing may influence surgical practice.[19-23] The purpose of this study is to determine the incidence of metal allergy in orthopaedic surgery patients and to characterize which metals patients are most commonly allergic to.

MATERIALS AND METHODS:

This study is a retrospective chart review of patients from the senior author's practice over a 1 year period. All patients

were routinely questioned about their history of metal allergy during initial history and physical and also during the planning paperwork for surgery. Patients were specifically asked about symptoms of rash, pruritus, or skin discoloration with jewelry or watch use, of symptoms with metal snaps, belt buckles or buttons on clothing, of earliest onset of symptoms, and of family history of metal allergy. Patients were also asked about their surgical history and about receiving metal-containing orthopaedic implants in previous surgeries. All patients who admitted to metal sensitivity were sent for metal allergy patch testing for specific metals (Figure 1). The metals tested were nickel, cobalt, chromium, beryllium, gold, tin, silver, manganese, vanadium, zirconium, and titanium. All metal patch testing was performed by a single physician who was board-certified by the American Board of Allergy and Immunology.

RESULTS:

A total of 41 patients were sent for metal allergy testing out of 840 new patients that were seen over a 1 year period. 34 patients tested positive for metal allergy (4% of patients). 32 patients (78.05% of tested patients) reported sensitivity to wearing metal costume jewelry or watches; of these, 30 patients (73.17% of tested patients and 93.75% of patients who reported sensitivity to jewelry use) demonstrated allergy to metals. 2 patients reported having family members with known metal sensitivities. 27 patients tested positive for metal sensitivity to nickel (79.4% of positive patients). 4 patients tested positive for metal sensitivity to cobalt (11.8% of positive patients), 4 patients to gold (11.8% of positive patients), one to tin (2.9% of positive patients), one to chromium (2.9% of positive patients), and one to titanium (2.9% of positive patients). 7 patients tested positive to multiple metals, and all of these patients were also sensitive to nickel (20.6% of positive patients). 6 patients who tested positive for metal sensitivity had metal orthopaedic implants prior to allergy testing (17.6% of positive patients) (Figure 2). Four of the patients who had previous history of orthopaedic surgery using metal implants who had positive patch testing for metal allergy reported persistent edema, erythema, and pain post-operatively. Three of these patients underwent revision operations for suspected infection, all with negative cultures, and immediate alleviation of symptoms after revision to metal implants the patients had no sensitivity to.

DISCUSSION:

The majority of implants used in orthopaedic operations are metal. Most of these implants are made from alloy metals, containing varied amounts of metals that patients have displayed hypersensitivity, such as nickel, cobalt, and chromium[19]. The incidence of complication due to metal allergy is complex: a combination of the patient's immune status and hypersensitivity to specific metals with the metal's corrosion properties are theorized to contribute to such complications.[22]

From the patients tested in this study, nearly all with a history of metal allergy due to skin hypersensitivity from metal on clothing or jewelry were hypersensitive on metal patch testing. The majority of patients with metal hypersensitivity were allergic to nickel (n = 27), cobalt (n = 4), and gold (n = 4). This incidence is consistent with published literature and suggests that routine questioning for history of anecdotal skin hypersensitivity may be an effective screening tool for true metal allergy.[13,19, 22] In the Davis et al study, their results concluded that metals with the highest allergic patch-test reaction rates are nickel, gold, manganese, palladium, cobalt, ticonium, mercury, beryllium, chromium, and silver. Metals causing no allergic patch-test reactions include titanium, vitallium, and aluminum powder. Metals with extremely low rates of allergic patch-test reactions include zinc, ferric chloride, and tin. Allergy to palladium and silver were determined to be cross-reactive with nickel[15]. Despite the results of this study, our results found one patient with a titanium allergy, which has also been reported in published case reports.[19]

Nickel and cobalt are commonly used in metal alloys to confer stability and are present in the majority of orthopaedic implants available to surgeons. The amount of metal in these implants varies by company and product, but stainless steel plates and screws used for fracture contain high amounts of nickel, while high levels of cobalt are present in most arthroplasty implants, which are typically often cobalt-chrome.[24] The most commonly used implants that are considered "allergen-free" are titanium and zirconium-niobium, which in arthroplasty can be used with polyethylene and ceramic bearing surfaces in metal allergic patients.[25] Zirconium-niobium does not contain nickel and has been associated with fewer wear particles, but it is significantly more expensive when compared to other metal implants.[26] Titanium alloy metals are marketed as "nickel-free", but often contain trace amounts of nickel and are also at risk for metal contamination during production.[27]

A recent meta-analysis regarding metal hypersensitivity and TKA suggested that despite multiple case studies describing metal hypersensitivity reactions in patients who underwent TKA with a cobalt-chromium prosthesis, the lack of evidence-based medicine on metal allergy made it a diagnosis of exclusion, with patch testing or surgical intervention rarely indicated.[28] In our series, four of the patients who tested positive for metal allergy already had metallic orthopaedic implants from prior surgery. All of these patients had nickel allergies, and their implants were all made from stainless steel. Three of these patients underwent revision surgery for suspected infection versus metal allergy, and were revised to titanium implants (none of these three patients were allergic to titanium). Two of these patients underwent revision arthroplasty and the other patient underwent revision open reduction and internal fixation, with negative cultures and no sign of implant loosening or failure. Their pre-operative symptoms of edema and erythema over their incision sites and pain with use resolved within a month of their operations, suggesting that in the absence of loosening or infection, that metal allergy could have been the source of their symptoms. This anecdotal data is consistent with multiple case reports where revision to a non-allergic prosthesis resulted in alleviation of symptoms, and strengthens the argument for testing and intervention.[19]

With increasing concern over how metal hypersensitivity affects metallic implants used in orthopaedic surgery, investigation into bone cement hypersensitivity may be of value. Bone cements are made of polymhethyl methacrylate and contain additives such as dibenzoyl-peroxide, N,N-dimethyl-p-toluidine and 2-(4-[dimethylamino]-phenyl) ethanol, colorants (such as copper-chlorophyll-complex) antibiotics such as gentamicin.[20] Blood tests and patch testing for acrylates have recently become available for use in the United States, and are available in Europe and Asia currently.[29]

CONCLUSION:

Metal allergy in orthopaedic surgery patients can be a concern for treating surgeons and patients. More evidence is needed to establish a connection between metal sensitivity and risk of complications in procedures where metallic implants are used. Greater awareness of history to sensitivity may prevent patient exposure to implants containing metals that they may react to. Non-metal containing or non-reactive metal implants are an option for patients where metal allergy

is either suspected or confirmed. Investigation of hypersensitivity to bone cement may also be of value to orthopaedic surgeons.

Figures and Tables

Figure 1: Patch Test for Metal Sensitivity (A), and test being administered on a patient (B)

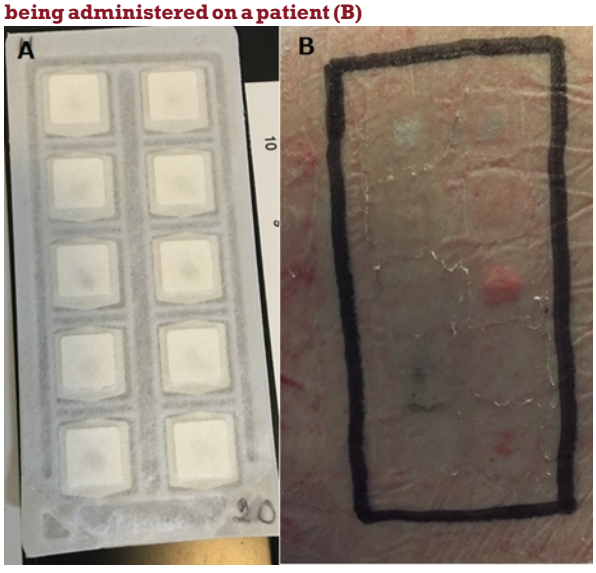
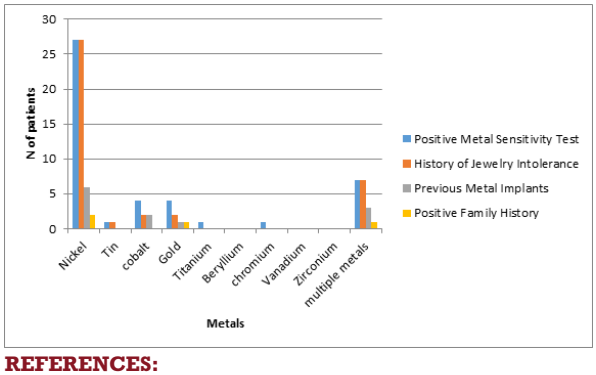


Figure 2: Metal Allergy Incidence



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