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Patient-Reported Metal Allergy: A Risk Factor for Poor Outcomes After Total Joint Arthroplasty?

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ABSTRACT

Background: Metal sensitivity after total joint arthroplasty has been of increased concern, but the impact of a patient-reported metal allergy on clinical outcomes has not been investigated. The purpose of this study was to report the incidence and impact of patient-reported metal allergy after total knee arthroplasty (TKA) and total hip arthroplasty (THA).

Methods: This was a retrospective, institutional review board–approved investigation of patients undergoing a primary, elective total joint arthroplasty between 2009 and 2011. All patients completed a preoperative questionnaire asking about drug and environmental allergies. In January 2010, a specific question was added regarding the presence of a metal allergy. University of California at Los Angeles Activity, Short Form 12 (SF-12), Modified Harris Hip, and Knee Society scores were collected preoperatively and at most recent follow-up. Overall cohorts of metal allergy and nonmetal allergy patients were compared, and a 1:2 matching analysis was also performed.

Results: Nine hundred six primary THAs and 589 primary TKAs were included. The incidence of patient-reported metal allergy was 1.7% before January 2010 and 4.0% after (overall 2.3% of THAs and 4.1% of TKAs); 97.8% of metal allergy patients were female. After TKA, postoperative Knee Society Function, Symptoms, Satisfaction, and Expectation scores were all decreased in the metal allergy cohort ($P < .001$ – $.002$). After THA, metal allergy patients had a decreased postoperative SF-12 Mental Component Score and less incremental improvement in their SF-12 Mental Component Score vs the nonmetal allergy cohort ($P < .0001$ and $P = .001$, respectively).

Conclusion: Patient-reported metal allergy is associated with decreased functional outcomes after TKA and decreased mental health scores after THA.

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With the recognition of catastrophic aseptic reactions and periprosthetic osteolysis associated with large-diameter metal-on-metal (MOM) bearings, taper-trunnion corrosion, and modular neck prostheses in total hip arthroplasty (THA), the clinical impact of metal sensitivity and allergic reactions has received increased attention [1–5]. However, metal sensitivity as a cause of persistent pain after total joint arthroplasty (TJA) has been studied in orthopedic surgery for decades [6–12]. In 1977, Benson et al [6] noted 28% of patients receiving an MOM McKee prosthesis to have a positive

skin patch test postoperatively, vs 2.6% receiving a Charnley prosthesis, noting a potential relationship between metal sensitivity and component loosening in patients who receive an MOM THA device.

In the absence of a clear source of metal debris, diagnosis of a true metal allergy as the cause of persistent pain and symptoms after TJA remains difficult. Based on positive skin patch testing, approximately 10%–20% of the population is metal sensitive, but the association between cutaneous reactions and response to an implanted orthopedic device remains unclear [13]. Therefore, attributing persistent symptoms after TJA to metal sensitivity remains a diagnosis of exclusion.

Recently, the potential impact of patient-reported allergies on outcomes after TJA has been studied, testing the hypothesis that multiple reported allergies may be a surrogate for mental health factors shown to be negative prognostic indicators [14–16]. However, the impact of a patient-reported metal allergy on clinical

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outcomes was not assessed. To our knowledge, neither the overall incidence of patients presenting for TJA who report a metal allergy nor its potential impact on clinical outcomes has been reported. This information could prove useful in addressing patient expectations and may impact risk adjustment for expected outcomes after TJA if clinical differences are significant. Therefore, the purposes of this study were to (1) identify the overall incidence of patients who report having a metal allergy who present for THA or total knee arthroplasty (TKA) and (2) assess the impact of reporting a metal allergy on clinical outcomes after TJA. Our hypothesis is that patient reporting of a metal allergy would be associated with worse outcomes after TJA.

Materials and Methods

This study was an institutional review board–approved retrospective review of a single institution's joint arthroplasty database between January 2009 and January 2011. Inclusion criteria were patients over the age of 18 years undergoing a primary, elective THA or TKA who agreed to participate in the joint arthroplasty registry. Exclusion criteria were patients who underwent a revision TJA procedure as their index procedure at our institution and at the time of inclusion in our institution's joint arthroplasty database, patients who required any reoperation on their affected joint or had signs of radiographic component loosening, or a prior history of infection in the affected joint. Of note, no patients who were enrolled for their primary TJA during this time period had undergone a revision TJA procedure for a diagnosis of metal allergy or aseptic lymphocyte predominant vasculitis-associated lesions. Exclusion criteria were selected to compare patients with presumably well-performing implants. Baseline patient demographics including gender, age, and body mass index (kg/m^2) were collected.

University of California at Los Angeles (UCLA) Activity Score [17], Short Form 12 Scores (SF-12; Physical Component Score [PCS] and Mental Component Score [MCS]) [18], Modified Harris Hip Score (MHHS; for THA patients) [19], and Knee Society Score (KSS; for TKA patients) [20] were collected for patients preoperatively and at each patient's most recent follow-up visit. KSSs were separated into the subdomains of Function, Symptoms, Satisfaction, and patient Expectation for analysis. This information was recorded into the institutional database using a Patient Analysis and Tracking System (Axis Clinical Software Inc, Portland, OR). In addition, all patients completed an intake patient questionnaire in which medical comorbidities and any environmental, food, or medication allergies are self-reported at their initial visit, with all responses recorded into the electronic medical record system (Allscripts, Chicago, IL). In January 2010, a question was added to the intake questionnaire specifically asking whether the patients believed they were allergic to any metals. Before this date, there was no specific query of metal allergy in the questionnaire. Presence or absence of a self-reported metal allergy was reviewed for each patient along with 21 commonly reported environmental and drug allergies. Specific skin patch or lymphocyte transformation testing was not performed for those reporting a metal allergy. Our study cohort consisted of patients who underwent primary TKA or THA in the interval from 1 year before this date to 1 year after the introduction of the metal allergy question to the intake form. During the study period, 5 surgeons enrolled patients with the majority using implants avoiding cobalt alloys (due to the presence of nickel, cobalt, and chrome) in patients reporting the use of a metal allergy. For TKA, this included the use of an Oxinium (Oxidized Zirconium; Smith and Nephew Inc, Memphis, TN) femoral component with a titanium alloy tibial baseplate. For THA, this included the use of an Oxinium or ceramic femoral head with titanium alloy acetabular and femoral components.

Statistical Analysis

Patients were divided into 2 cohorts: those with a self-reported metal allergy (metal allergy cohort) and those without. The incidence of metal allergy reporting was calculated for the interval before and after introduction of the metal allergy question to the intake questionnaire. Statistical analyses were performed using Microsoft Excel (Microsoft Corporation, Redmond, WA). Independent student's *t* tests were used to compare the overall mean and incremental improvement in outcome scores between the metal allergy and nonmetal allergy cohorts with a *P* value of $<.05$ considered statistically significant. Patients were included in the nonmetal allergy cohort if they did not report a metal allergy, regardless of the presence or absence of other environmental or drug allergies. Chi-square and Fisher's exact tests were used to compare categorical variables among cohorts, including the percentage of patients in each cohort reporting ≥ 4 allergies, with a *P* value of $<.05$ considered statistically significant.

A 1:2 case-matched analysis was also performed using Custom Excel Visual Basic scripts to match each patient in the metal allergy cohort to 2 patients in the nonmetal allergy cohort based on gender (same), age (± 7 years), body mass index (BMI; ± 5 units), preoperative SF-12 PCS and MCS (± 9 points), preoperative MHHS (for THA patients, ± 10 points), and preoperative KSS (for TKA patients, ± 10 points). Potential nonmetal allergy patients were filtered and prioritized based on similarities for each of the aforementioned criteria and selected to create a new matched patient list for comparison with preoperative clinical scores being considered of increased importance when matching. Statistical comparisons were then performed using the same method as with the overall metal allergy and nonmetal allergy cohorts.

Results

During the 2-year study period, 1495 primary TJA cases were identified and included in this investigation (906 primary THAs: 60.6% and 589 primary TKAs: 39.4%). The mean age of the overall cohort was 59.1 ± 13.6 years, the mean BMI was $30.5 \pm 6.6 \text{ kg}/\text{m}^2$, and 58.3% of patients were female.

Before the introduction of the specific metal allergy question on the intake questionnaire in January 2010, the incidence of patient-reported metal allergy in patients undergoing primary TJA was 1.7% (11 of 646 patients: 1.2% of THA and 2.5% of TKA patients, Table 1). This increased to 4.0% (34 of 849 patients: 3.2% of THA and 5.2% of TKA patients) after addition of a question asking specifically about a metal allergy. This difference in incidence was significant ($P = .01$).

Table 1
The Incidence of Patient-Reported Metal Allergy.

	Time Interval	# Reporting Metal Allergy	# Reporting No Metal Allergy	Total	Incidence of Self-Reported Metal Allergy (%)
THA	Pre metal allergy question	5	400	405	1.2
	Post metal allergy question	16	485	501	3.2
TKA	Pre metal allergy question	6	235	241	2.5
	Post metal allergy question	18	330	348	5.2
THA + TKA	Pre metal allergy question	11	635	646	1.7
	Post metal allergy question	34	815	849	4.0

THA, total hip arthroplasty; TKA, total knee arthroplasty.

Table 2

Comparison of Baseline Demographics Between the Metal Allergy and Nonmetal Allergy Cohorts in Patients Undergoing TKA.

TKA Cohort Characteristics	Metal Allergy (n = 24)	No Metal Allergy (n = 565)	P Value
Age	61.3 (9.6)	63.0 (10.8)	.5
BMI	32.3 (5.4)	32.9 (7.0)	.7
Gender (% female)	95.8	60.2	<.001
Percentage reporting >4 drug or environmental allergies	8.3	9.6	.8
Follow-up period	3.8 (1.7)	2.2 (1.1)	<.001

Values are presented as the mean with standard deviation in parentheses when applicable.

TKA, total knee arthroplasty; BMI, body mass index.

With the exception of one male, all patients who self-reported a metal allergy were female (97.8%); 88.9% of patients self-reporting a metal allergy received implants predominantly free of nickel.

When comparing patients with or without a metal allergy undergoing TKA, there was no significant difference in baseline demographics for age, BMI, or percentage of patients reporting >4 drug or environmental allergies (Table 2). However, as most patients reporting a metal allergy were female, a greater percentage of patients in the metal allergy cohort were female. Comparison of the 2 cohorts demonstrated no significant differences in preoperative, postoperative, or incremental improvement in the UCLA Activity or SF-12 PCS scores (Table 3). Patients in the metal allergy cohort had a decreased preoperative SF-12 MCS (44.7 ± 11.2 vs 51.8 ± 12.1 , $P = .01$) that contributed to a significant incremental improvement in their postoperative SF-12 MCS vs the nonmetal allergy cohort ($P = .01$), but there was no difference in the postoperative SF-12 MCS scores between the 2 groups ($P = .9$). However, the postoperative Knee Society Function Score was significantly lower in the metal allergy cohort (49.8 ± 17.5 vs 66.8 ± 23 , $P < .001$). Furthermore, the KSS Symptoms, Satisfaction, and Expectation subdomains were all lower in the metal allergy cohort ($P = .004$ –.02) which suggests that patient reporting of a metal allergy may be associated with decreased satisfaction after TKA.

Table 3

Comparison of Clinical Outcome Measures Between the Metal Allergy and Nonmetal Allergy Cohorts in Patients Undergoing TKA.

TKA Outcomes	Score Type	Metal Allergy (n = 24)	No Metal Allergy (n = 565)	P Value
UCLA Activity Score (out of 10)	Preoperative	3.5 (1.1)	3.8 (1.9)	.6
	Postoperative	4.4 (1.7)	4.9 (1.9)	.4
	Pre-op to post-op delta	1.3 (1.6)	1.3 (2.2)	.7
	post-op delta			
SF-12 PCS (National Mean: 50)	Preoperative	30.5 (8.1)	29.1 (8.8)	.5
	Postoperative	36.0 (9.6)	39.5 (11.8)	.3
	Pre-op to post-op delta	6.2 (9.7)	10.0 (10.8)	.1
	post-op delta			
SF-12 MCS (National Mean: 50)	Preoperative	44.7 (11.2)	51.8 (12.1)	.01
	Postoperative	51.8 (12.7)	52.1 (10.8)	.9
	Pre-op to post-op delta	9.2 (16.7)	0.07 (11.4)	<.001
	post-op delta			
KSS Function (out of 100)	Preoperative	43.8 (15.0)	48.3 (17.9)	.7
	Postoperative	49.8 (17.5)	66.8 (23.1)	<.001
KSS Symptoms (out of 25)	Postoperative	15.8 (5.8)	18.8 (6.4)	.02
KSS Satisfaction (out of 40)	Postoperative	25.5 (10.2)	30.8 (9.4)	.01
KSS Expectation (out of 15)	Postoperative	7.8 (2.8)	9.8 (3.3)	.004

Values are presented as the mean with standard deviation in parentheses. Statistically significant differences are highlighted with bold text.

TKA, total knee arthroplasty; UCLA, University of California at Los Angeles; PCS, Physical Component Score; MCS, Mental Component Score; KSS, Knee Society Score.

Table 4

Age, BMI, and Gender Comparison Between the Matched Metal Allergy and Nonmetal Allergy TKA Cohorts.

TKA Matching Cohort Characteristics	Metal Allergy	No Metal Allergy	P Value
Age	60.3 (4.0)	64.2 (2.9)	.03
BMI	31.9 (3.3)	31.9 (4.2)	.98
Gender (% female)	83.3	83.3	1

Values are presented as the mean with standard deviation in parentheses. Statistically significant differences are highlighted with bold text.

TKA, total knee arthroplasty; BMI, body mass index.

Demographic comparisons after matching of our metal allergy TKA patients to nonmetal allergy TKA patients are presented in Table 4. Unfortunately, with the patients available and eligible for inclusion, there remained a difference in mean age between the 2 cohorts, as several patients could not be matched for both their age and preoperative clinical outcome scores. Matching was successful for the UCLA, SF-12 PCS, and SF-12 MCS scores (Table 5). After matching TKA metal allergy to TKA nonmetal allergy patients, postoperative KSS Function, Symptoms, Satisfaction, and Expectation domains continued to be decreased in the metal allergy cohort (Table 5). In addition, patients in the metal allergy cohort had less incremental improvement in their SF-12 PCS score vs the metal allergy cohort (6.2 ± 9.7 vs 16.6 ± 10.2 , $P < .001$).

When comparing patients with or without a metal allergy undergoing THA, there was no significant difference in baseline demographics for age, BMI, or percentage of patients reporting >4 drug or environmental allergies (Table 6). Comparison of the 2 cohorts demonstrated no significant differences in preoperative, postoperative, or incremental improvement of the UCLA Activity, SF12-PCS, or MHHS scores (Table 7). However, patients in the metal allergy cohort had a decreased postoperative SF-12 MCS score and less incremental improvement in their SF-12 MCS score vs the metal allergy cohort ($P < .001$ and $P = .001$, respectively).

Demographic comparisons after matching of our metal allergy THA patients to nonmetal allergy THA patients are presented in

Table 5

Comparison of Clinical Outcome Measures Between Matched Cohorts of Metal Allergy and Nonmetal Allergy Patients Undergoing TKA.

TKA Outcomes	Score Type	Metal Allergy	No Metal Allergy	P Value
UCLA Activity (out of 10)	Preoperative	3.5 (1.1)	3.6 (1.6)	.8
	Postoperative	4.4 (1.7)	5.0 (1.6)	.1
	Pre-op to post-op delta	1.3 (1.6)	1.5 (1.2)	.3
	post-op delta			
SF-12 PCS (National Mean: 50)	Preoperative	30.5 (8.1)	27 (3.0)	.4
	Postoperative	36.0 (9.6)	43.6 (9.5)	.002
	Pre-op to post-op delta	6.2 (9.7)	16.6 (10.2)	<.001
	post-op delta			
SF-12 MCS (National Mean: 50)	Preoperative	44.7 (11.2)	48.7 (7.1)	.07
	Postoperative	51.8 (12.7)	54.5 (9.5)	.3
	Pre-op to post-op delta	9.2 (16.7)	5.8 (8.6)	.3
	post-op delta			
KSS Function (out of 100)	Preoperative	43.8 (15.0)	50.8 (7.9)	.01
	Postoperative	49.8 (17.5)	73.3 (8.9)	<.001
KSS Symptoms (out of 25)	Postoperative	15.8 (5.8)	19.3 (3.9)	.003
KSS Satisfaction (out of 40)	Postoperative	25.5 (10.2)	34.7 (3.3)	<.001
KSS Expectation (out of 15)	Postoperative	7.8 (2.8)	10.7 (3.1)	<.001

Values are presented as the mean with standard deviation in parentheses. Statistically significant differences are highlighted with bold text.

TKA, total knee arthroplasty; UCLA, University of California at Los Angeles; PCS, Physical Component Score; MCS, Mental Component Score; KSS, Knee Society Score.

Table 6

Comparison of Baseline Demographics Between the Metal Allergy and Nonmetal Allergy Cohorts in Patients Undergoing THA.

THA Cohort Characteristics	Metal Allergy (n = 21)	No Metal Allergy (n = 885)	P Value
Age	56.2 (12.3)	56.6 (14.7)	.9
BMI	28.2 (5.5)	29.1 (5.9)	.5
Gender (% female)	100	55	<.001
Percentage reporting >4 drug or environmental allergies	4.8	6	.8
Follow-up period	3.0 (2.0)	1.8 (1.1)	<.001

Values are presented as the mean with standard deviation in parentheses when applicable.

TKA, total knee arthroplasty; BMI, body mass index.

Table 8. Patients were successfully matched for age, BMI, gender, and all preoperative clinical outcome scores (**Table 9**). After matching THA metal allergy to THA nonmetal allergy patients, the postoperative SF-12 MCS score and incremental improvement in the SF-12 MCS score continued to be decreased in the metal allergy cohort ($P = .006$ and $P = .03$, respectively; **Table 9**). However, the incremental increase in the UCLA Activity Score was greater in the metal allergy cohort ($P = .05$) but with no difference in the postoperative UCLA scores between the 2 groups ($P = .8$).

Discussion

Despite the effectiveness of THA and TKA in relieving pain and restoring function, there are a subset of patients who express dissatisfaction after these elective procedures [21,22]. Recent reports have noted that multiple, patient-reported allergies may be a surrogate for mental health factors that are negative prognostic indicators for patient dissatisfaction postoperatively [14–16]. Graves et al [23] reported on 459 patients undergoing THA or TKA and noted patients reporting ≥ 4 allergies (14% of the entire cohort) to have less improvement in their Western Ontario and McMaster Universities Osteoarthritis Index function scores, with similar nonsignificant trends in their SF-36 Mental and Western Ontario and McMaster Universities Osteoarthritis Index pain scores vs those who reported 0–3 allergies. Furthermore, with

Table 7

Comparison of Clinical Outcome Measures Between the Metal Allergy and Nonmetal Allergy Cohorts in Patients Undergoing THA.

THA Outcomes	Score Type	Metal Allergy (n = 21)	No Metal Allergy (n = 885)	P Value
UCLA Activity (out of 10)	Preoperative	4.2 (1.8)	4.9 (2.2)	.1
	Postoperative	6.2 (1.7)	6.1 (2.0)	.8
	Pre-op to post-op delta	2.3 (1.8)	1.2 (2.6)	.1
SF-12 PCS (National Mean: 50)	Preoperative	29.5 (10.2)	30.9 (9.2)	.5
	Postoperative	48.0 (10.0)	45.4 (12.2)	.5
	Pre-op to post-op delta	16.3 (15.9)	14.2 (11.7)	.6
SF-12 MCS (National Mean: 50)	Preoperative	47.8 (13.2)	50.3 (12.8)	.4
	Postoperative	46.6 (13.4)	53.8 (9.6)	<.001
	Pre-op to post-op delta	−3.4 (12.2)	3.0 (11.9)	.001
MHHS (out of 100)	Preoperative	44.9 (16.6)	47.0 (16.0)	.6
	Postoperative	82.3 (18.2)	86.1 (17.5)	.6
	Pre-op to post-op delta	42.5 (17.1)	37.3 (19.1)	.2

Values are presented as the mean with standard deviation in parentheses. Statistically significant differences are highlighted with bold text.

THA, total hip arthroplasty; UCLA, University of California at Los Angeles; PCS, Physical Component Score; MCS, Mental Component Score; MHHS, Modified Harris Hip Score.

Table 8

Age, BMI, and Gender Comparison Between the Matched Metal Allergy and Nonmetal Allergy THA Cohorts.

THA Matching Cohort Characteristics	Metal Allergy	No Metal Allergy	P Value
Age	53.1 (10.7)	53.6 (9.4)	.9
BMI	28.4 (5.2)	27.9 (5.1)	.8
Gender (% female)	100	100	1

Values are presented as the mean with standard deviation in parentheses.

THA, total hip arthroplasty; BMI, body mass index.

increased recognition of potential sources of metallosis after THA, the clinical impact of metal sensitivity and allergic reactions has continued to receive increased attention. However, in the absence of a clear source of metal debris, diagnosis of a true metal allergy remains difficult as examinations such as skin patch testing and in vitro lymphocyte transformation tests are not direct corollaries of clinical symptoms [2,24,25]. Surprisingly, little information is available regarding the overall incidence of self-reporting of a metal allergy in patients undergoing TJA and its potential impact on clinical outcomes. Therefore, the purposes of this study were to identify the overall incidence of patients who report having a metal allergy who present for a primary, elective TJA and to assess the impact of patient-reported metal allergy on clinical outcomes after TJA. This study demonstrates that 1.7% of patients before addition of a specific metal allergy question to our intake questionnaire, and 4.0% of patients after, presenting for a primary TJA report a history of metal allergy, and patient-reported metal allergy is associated with decreased functional outcomes after TKA and decreased mental health scores after THA vs patients not reporting a metal allergy.

There are several limitations of this study that must be recognized before interpretation of our results. First, this was a retrospective review, and thus, our data were limited only to what was available via chart review. Given its retrospective nature, we are also unable to determine whether patient-reported metal allergy directly impacts clinical outcomes but can only infer an association. Second, no testing was performed in patients reporting a metal allergy to confirm that a metal sensitivity truly was present.

Table 9

Comparison of Clinical Outcome Measures Between Matched Cohorts of Metal Allergy and Nonmetal Allergy Patients Undergoing THA.

THA Outcomes	Score Type	Metal Allergy	No Metal Allergy	P Value
UCLA Activity (out of 10)	Preoperative	4.2 (1.8)	5.0 (2.1)	.1
	Postoperative	6.2 (1.7)	6.3 (1.7)	.8
	Pre-op to post-op delta	2.3 (1.8)	1.3 (1.9)	.05
SF-12 PCS (National Mean: 50)	Preoperative	29.5 (10.2)	29.0 (8.0)	.8
	Postoperative	48.0 (10.0)	47.1 (12.9)	.8
	Pre-op to post-op delta	16.3 (15.9)	18.2 (13.9)	.6
SF-12 MCS (National Mean: 50)	Preoperative	47.8 (13.2)	49.0 (12.4)	.7
	Postoperative	46.6 (13.4)	55.3 (10.7)	.006
	Pre-op to post-op delta	−3.4 (12.2)	5.2 (15.3)	.03
MHHS (out of 100)	Preoperative	44.9 (16.6)	47.7 (9.6)	.4
	Postoperative	82.3 (18.2)	81.2 (22.5)	.8
	Pre-op to post-op delta	42.5 (17.1)	37.1 (23.1)	.3

Values are presented as the mean with standard deviation in parentheses. Statistically significant differences are highlighted with bold text.

THA, total hip arthroplasty; UCLA, University of California at Los Angeles; PCS, Physical Component Score; MCS, Mental Component Score; MHHS, Modified Harris Hip Score.

However, as noted earlier, diagnosis of a metal sensitivity is often a diagnosis of exclusion. Hallab et al [25] have noted skin patch testing to be very subjective, nonstandardized, limited to cutaneous rather than deep tissue and perhaps most importantly an assessment of an exposure mechanism in which Langerhans cells initiate a hypersensitivity reaction, which differs from the macrophage or lymphocyte-mediated response which occurs in the periprosthetic environment. Furthermore, the purpose of this study was to determine the potential impact of a patient-reported metal allergy (and not necessarily its true presence) and whether this factor alone was associated with clinical outcomes. Third, the size of our metal allergy cohort is relatively small because of the prevalence reported during our study period. In addition, it could be argued that our definition of a self-reported metal allergy is different during our 2 time periods analyzed, as during the second period, patients were specifically queried about its presence. However, one of the purposes of this study was to demonstrate the difference in “reporting” of a metal allergy if patients are specifically queried. Fourth, we are unable to compare the incremental improvement in KSSs from preoperatively to postoperatively in the 2 cohorts. This is due to introduction of the new KSS Function scoring system in 2011 in which activities contributing to the function score and weightings of each activity differed from the old KSS scoring system. Per the Knee Society, these 2 scores are not intended to be numerically compared. However, we feel that the clear difference in postoperative KSSs for all subdomains demonstrates patient-reported metal allergy to be a potentially negative prognostic indicator for outcomes after TKA. Fifth, although we attempted a 1:2 matching analysis and were able to successfully achieve this for our THA cohort, we had difficulty matching the metal allergy TKA patients for all demographics and clinical scores of interest. We placed greater weight on attempting to match preoperative clinical outcome scores rather than age or BMI, and thus, even after our matching protocol, the patients in the metal allergy TKA cohort were slightly younger than their matched counterparts. However, we believe that despite this setback, our data still suggest patient-reported metal allergy to be associated with worse outcomes after TKA based on KSS assessments. Sixth, given the size of our metal allergy cohort and the fact that 89% received implants free of nickel, we cannot comment on the impact of the use of different implant designs and materials in this patient population as the percentage of patients receiving implants with nickel was too small. Finally, we acknowledge that there were no other psychometric measures collected (other than the SF-12 MCS) to further elucidate the relationships between anxiety/depression, allergy-reporting, and TJA outcomes in this study.

This study demonstrates that patient reporting of a metal allergy more than doubled after the introduction of a specific metal allergy question on our patient intake forms in January 2010 (1.7%–4%). Not surprisingly, almost all patients reporting a metal allergy were female (97.8%) which is consistent with estimates of metal allergy demographics in the general population [26]. This trend has predominantly been explained by ear piercing and jewelry exposures in women increasing their environmental exposure to nickel and awareness of a potential sensitivity [26]. Although it remains unclear if all patients self-reporting a metal allergy should receive implants free of nickel and cobalt alloys during their surgical procedures, and our investigation is unable to elucidate this, we believe it is reasonable that this should be done when possible. Prior investigations have noted that despite well-fixed and well-aligned THA and TKA components, patients may experience residual symptoms and pain after TJA [27,28]. Thus, in a patient with a reported metal allergy, it may be beneficial to use implants free of nickel and cobalt alloys to preemptively eliminate this as a potential source of pain.

Prior investigations have noted patient-reported outcome measures to be heavily influenced by factors other than physical, mechanical, or biomedical issues, particularly mental state [29]. It has also been suggested that excessive allergy reporting is associated with psychiatric disorders, including depression and anxiety disorders [30]. This study found an association between patient-reported metal allergy and decreased KSS Function, Symptoms, Satisfaction, and Expectation scores after TKA, and decreased SF-12 MCS scores after THA. Theoretically, reporting of a metal allergy may not be as susceptible to overreporting or false reporting as drug or environmental allergies, as recognition of a metal allergy often involves a cutaneous reaction to jewelry or metals, and may be less ambiguous than nondescript adverse reactions such as nausea. Patients in the metal allergy cohort also predominantly received implants free of nickel, cobalt, and chrome, elements most commonly associated with cutaneous reactions seen on skin patch testing [31]. Nevertheless, our results suggest that patient-reported metal allergy was associated with decreased satisfaction after TKA and THA. Whether this is due to an association with anxiety or mental state requires further investigation.

In conclusion, patient reporting of a metal allergy is associated with lower KSSs after TKA and decreased postoperative and incremental increase in mental health scores after THA. As patient satisfaction following TJA is closely tied to preoperative expectations and whether those expectations are met [21], surgeons should consider counseling patients who report a metal allergy that while they will see significant improvements in most outcome measures after TJA, but they may not be equal to those who do not report a metal allergy.

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