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Original Article

Patient-Reported Allergies Predict Worse Outcomes After Hip and Knee Arthroplasty: Results From a Prospective Cohort Study

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ABSTRACT

Background: Retrospective analyses have demonstrated correlation between patient-reported allergies and negative outcomes after total joint arthroplasty. We sought to validate these observations in a prospective cohort.

Methods: One hundred forty-four patients undergoing total hip arthroplasty and 302 patients undergoing total knee arthroplasty were prospectively enrolled. Preoperatively, patients listed their allergies and completed the Medical Outcomes Study Short Form 36 (SF-36) and the Charlson Comorbidity Index (CCI) Questionnaire. At a mean of 17 months (range 12–25 months) postoperatively, SF-36, CCI, and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) were obtained by telephone survey. Regression analysis was used to determine the strength of correlation between patient age, comorbidity burden, and number of allergies and outcome measurements.

Results: In 446 patients, 273 reported at least 1 allergy. The number of allergies reported ranged from 0 to 33. Penicillin or its derivative was the most frequently reported allergy followed by sulfa, environmental allergen, and narcotic pain medication. Patients reporting at least 1 allergy had a significantly lower postoperative SF-36 Physical Component Score compared to those reporting no allergies (51.3 vs 49.4, $P = .01$). The SF-36 postoperative Mental Component Score was no different between groups. Multivariate regression analysis showed that age and patient reported allergies, but not comorbidities, were independently associated with worse postoperative SF-36 Physical Component Summary (PCS) and WOMAC score. Patients with allergies experienced the same improvement in SF-36 PCS as those without an allergy. Comorbidities did not correlate with patient-reported function postoperatively.

Conclusion: Patients who report allergies have lower postoperative outcome scores but may experience the same increment in improvement after total joint arthroplasty.

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Total joint arthroplasty remains one of the most successful surgeries with regard to patient outcome. Nevertheless, patient dissatisfaction rates after surgery are as high as 9% after total hip arthroplasty (THA) and 20% after total knee arthroplasty (TKA) [1–3]. As we move toward a quality-driven model for reimburse-

ment, hospitals and surgeons will ultimately be held accountable for negative outcomes after surgery. Therefore, it is important to identify risk factors for poor outcomes after total joint arthroplasty. Others and we have recently shown using retrospective analysis that the number of patient-reported allergies correlates with worse outcomes after total joint arthroplasty [4,5]. We sought to validate our retrospective results in a cohort of patients using a prospectively designed study.

Methods

Patients and Data Collection

Institutional Review Board approval was obtained for the study. Patients indicated for elective primary THA or TKA were enrolled

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prospectively into the study. Preoperatively, patients completed a general demographic form, which included age and general health status including self-reported allergies. These forms were filled out by patients upon enrolment in the study and were reviewed by a clinic nurse. Patients also completed the Charlson Comorbidity Index (CCI) Questionnaire [6] and the Medical Outcomes Study Short Form 36 (SF-36) [7,8]. The patients underwent elective total joint arthroplasty as indicated. Two surgeons performed all surgeries in a community hospital setting. Total joint arthroplasty and postoperative care were carried out in routine fashion according to the surgeon's practice. Postoperatively, patients were contacted by telephone and were asked to complete the CCI, SF-36, and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) [9,10] questionnaires. All patients who were indicated for TJA during the study period were invited to participate in the study. There were a total of 1295 patients who were offered inclusion. A total of 452 patients volunteered for the study, and 446 patients filled out the forms completely. Of these, 144 patients underwent total hip arthroplasty, and 302 underwent total knee arthroplasty. All were followed prospectively for a minimum of 12 months. Those who did not complete the forms entirely were excluded from analysis. Postoperative evaluation occurred at average 17 months (range 12–25 months).

Statistical Analysis

Patient age, sex, joint laterality, allergies, and comorbidity were included as independent variables. Preoperative and postoperative SF-36 scores were separated into Physical Component Summary (PCS) and Mental Component Summary (MCS). These, along with change in PCS and MCS, and postoperative WOMAC were included as dependent variables. Complete data were available for 446 patients who completed surveys. Missing data were excluded from analysis.

Data analysis was performed by using SAS software, version 9.4 (SAS Institute, Inc, Cary, NC). Descriptive statistics such as mean, standard deviation, frequency, and percent were calculated. Between-group comparisons of continuous variables were analyzed using a 2-sample independent student *t* test. Categorical variables were compared using the chi-square test. Correlations among continuous variables were evaluated in terms of Pearson correlation coefficients. A general linear model was used to determine the effects of the independent variables on the continuous outcome scores (SF-36 PCS, MCS, delta PCS, delta MCS, and WOMAC), while a logistic regression model was applied to binary outcomes. For the purpose of multivariate regression, age, comorbidity score, and allergies were considered continuous variables. All *P* values were reported with the level of significance set at *P* < .05.

Results

Of 452 patients enrolled in the study, complete data were available for 446. There was a predominance of female patients (66%) in the study, commensurate with previously published demographic data in total joint arthroplasty [11]. Total knee arthroplasty was performed for 68% of the patients. Surgeries were fairly evenly divided between right (49.5%) and left side. There was no difference in age, type of arthroplasty (THA or TKA), laterality, or follow-up time between patients who reported allergy and those who did not. There was no difference in the number of allergies or SF-36 scores preoperatively between the 2 surgeons. Postoperative SF-36 and WOMAC scores in patients treated by the 2 surgeons in the study were statistically different, but surgeon did not have an independent effect on outcome on multivariate analysis.

At least 1 allergy was reported by 273 patients (61%), and 173 patients (39%) reported no allergies. The total number of allergies reported ranged from 0 to 33 (Fig. 1). Penicillin or its derivative was the most frequently reported allergy followed by sulfa derivative, environmental allergen, and narcotic pain medication. A complete list of the most commonly reported allergies is included in Table 1. Nickel or other metal allergy was reported by 7 patients.

We noted a general trend in lower postoperative outcome scores in patients who reported at least 1 allergy. Preoperative MCS and postoperative PCS were significantly lower in the allergy group (*P* = .01; Table 2). Furthermore, postoperative PCS decreased significantly as the number of reported allergies increased (Table 3). To eliminate the potential confounding influence of comorbidity on outcome scores, we performed multivariate regression analysis. Patient-reported allergies and age were independently associated with lower preoperative and postoperative PCS and MCS as well as postoperative WOMAC. Change in PCS and MCS after surgery was not affected by the presence of a patient-reported allergy. Comorbidity index did not affect PCS, delta PCS or MCS, or WOMAC (Table 4).

Discussion

Total joint arthroplasty is one of the most efficacious modern surgical procedures performed. Patient satisfaction after surgery is generally high [2,3,12]. Nevertheless, there remains a cohort of patients who are unhappy with the result of their surgery [1,2]. As we approach an era of quality-driven health care delivery, it is critical to identify predictors of patient dissatisfaction. Recent research has highlighted the importance of psychological factors in patient-reported outcomes after total joint arthroplasty [13–15]. A low sense of physical and mental well-being predicts worse outcomes after total joint arthroplasty. The authors hypothesized that patients who report multiple allergies may represent a population at risk for dissatisfaction after THA and TKA.

In a retrospective analysis, we showed that patients who reported 4 or more allergies had lower SF-36 MCS and PCS after surgery and reported less improvement in function [4]. Subsequently, others have noted the association between patient-reported allergies and dissatisfaction after hip and knee arthroplasty [5]. A criticism of retrospective research is that data are often collected in a

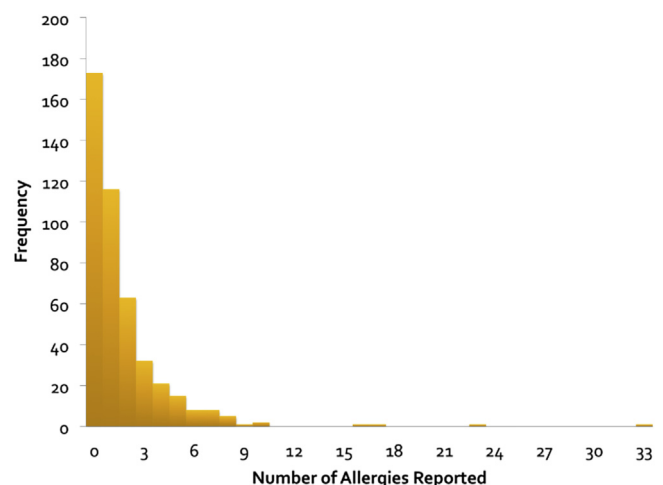


Fig. 1. Allergy Frequency in the total joint arthroplasty cohort. Histogram shows the frequency of number of allergies reported. In the cohort, 173 patients reported no allergies, while 273 reported at least 1 allergy. A single patient reported 33 total allergies.

Table 1
Frequency Distribution of Reported Allergies.

Allergen Category	Frequency
Penicillin or derivative	96
Sulfa derivative	81
Environmental/seasonal	79
Narcotic pain medication	55
Antibiotics (other)	30
Tape/adhesive	29
Non-steroidal anti-inflammatory drugs	27
Animals	19
Latex	16
Fish/shellfish	13
Nuts	8

The top 11 most frequent allergies are listed in order from greatest to lowest.

disorganized fashion, leaving significant room for bias in analysis of the results. To eliminate this source of bias, we designed the present study and enrolled patients prospectively.

The results of our prospective study were similar to those previously reported. Like the retrospective study, our prospective results showed lower SF-36 scores both preoperatively and postoperatively among the patients who reported allergies. However, in the present study, a single reported allergy placed the patients at risk of having significantly lower PCS, whereas differences were not seen between cohorts until patients reported 4 or more allergies in the retrospective study. In contrast to the retrospective study, patients who reported an allergy in the present study had similar improvement in PCS (15.7 vs 16.7, $P = .3$) and MCS (6.8 vs 5.1, $P = .1$) postoperatively compared with those who did not report an allergy. This result suggests that although satisfaction may be lower among patients who report allergies, they should still expect significant improvement after their joint arthroplasty.

It is important to recognize that allergy is often a misnomer in the setting of patient reporting. Indeed, only 15% of those adverse drug reactions reported by patients in a community database represented true immunoglobulin E-mediated hypersensitivity reactions. This fact suggests that psychological phenomena may affect a patient's interpretation of undesirable experiences as allergies [16]. In another study, patients were screened for allergies in a preoperative anesthesia clinic setting. Among the allergies recorded into the medical record, only 15.8% reported represented severe drug allergies. The authors concluded that a great majority of allergies reported by patients were simply adverse effects of the drugs concerned [17]. The association between psychiatric disorders and allergy reporting by patients has been well documented in cross-sectional epidemiologic studies. In a community-based data collection study, there was an adjusted odds ratio for major depression of 1.8 in patients who reported food allergies and 1.5 in

Table 2
Outcomes in Patients Without Allergy and With Allergy.

Outcome	0 Allergies	≥1 Allergy	P Value
Pre-PCS; mean (SD)	34.44 (7.90)	33.59 (8.30)	.2815
Pre-MCS; mean (SD)	53.1 (8.93)	50.8 (10.68)	.01
Post-PCS; mean (SD)	51.30 (7.27)	49.46 (7.19)	.01
Post-MCS; mean (SD)	58.15 (6.31)	57.94 (6.05)	.7347
Δ PCS; mean (SD)	16.73 (9.91)	15.72 (9.01)	.2818
Δ MCS; mean (SD)	5.09 (10.35)	6.79 (10.70)	.1065
Post-WOMAC; mean (SD)	95.12 (9.36)	94.44 (7.88)	.4479

Dependent variables were compared with the Student *t* test between patients who did not report an allergy and those who reported at least 1 allergy. Values represent mean ± standard deviation (SD). *P* values <.5 were considered statistically significant.

PCS, Physical Component Summary; MCS, Mental Component Summary; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

Table 3
SF-36 Score as a Function of Number of Reported Allergies.

Number of allergies	0	≥1	P
Post-PCS; mean, (SD)	51.30 (7.27)	49.46 (7.19)	.01
Number of allergies	≤1	≥2	<i>P</i>
Post-PCS; mean, (SD)	50.71 (7.11)	49.17 (7.49)	.036
Number of allergies	≤2	≥3	<i>P</i>
Post-PCS; mean, (SD)	50.60 (7.08)	48.47 (7.77)	.014

Student *t* test was used to compare post-operative SF-36 PCS scores between patients with different numbers of reported allergies. Values are presented as mean with standard deviation (SD) in parentheses. *P* values <0.5 were considered statistically significant.

SF-36, Short Form 36; PCS, Physical Component Summary.

those who reported other allergies [18]. In the present study, patients who reported allergies had lower SF-36 MCS both preoperatively and postoperatively, and the presence of allergies was independently associated with significantly lower MCS preoperatively and postoperatively. The preoperative difference in MCS was statistically significant. In contrast, a recent prospective study comparing outcomes among allergy reporters and nonreporters after TKA showed that depression scores were similar in both groups [19]. It is likely that the factors which influence patients to report multiple allergies also affect their satisfaction after total joint arthroplasty and are yet to be determined. Interestingly, although comorbidity score was determined by a patient questionnaire in our present study, this measure did not predict lower functional outcome scores after surgery.

Our study has several limitations. First, the outcomes we used were limited to subjective measures, so we cannot comment on whether patient-reported allergies affect objective criteria such as muscle strength and joint range of motion. Likewise, because of the subjective nature of the data, we cannot distinguish perfectly between allergy and comorbidity. Finally, we only analyzed outcomes at 1–2 years postoperatively. It is unclear whether presence

Table 4
Multivariate Regression Analysis.

Dependent Variable	Independent Variable	Estimate	P Value
Preop PCS	Age	−0.03	.3191
	Comorbidity	−0.03	.647
	Number of allergies	−0.33	.0318
Preop MCS	Age	0.13	.0011
	Comorbidity	−0.17	.0273
	Number of allergies	−0.47	.0097
Postop PCS	Age	−0.03	<.0001
	Comorbidity	−0.06	.1556
	Number of allergies	−0.13	.0028
Postop MCS	Age	−0.06	.0093
	Comorbidity	−0.11	.0328
	Number of allergies	−0.3	.01
Delta PCS	Age	−0.15	.0001
	Comorbidity	−0.05	.5412
	Number of allergies	−0.05	.7616
Delta MCS	Age	−0.19	<.0001
	Comorbidity	0.06	.5156
	Number of allergies	0.15	.4594
Postop WOMAC	Age	−0.12	.0007
	Comorbidity	−0.06	.4312
	Number of allergies	−0.36	.0328

Independent correlation between age, comorbidity, or number of allergies and outcome measures was determined by multivariate regression analysis. Independent correlation is reported as “estimate.” Negative quantity denotes an inverse correlation. *P* values <.5 were considered statistically significant. Bold, italicized print denotes significant risk factors.

PCS, Physical Component Summary; MCS, Mental Component Summary; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index.

of patient-reported allergies would affect long-term outcomes such as implant survival.

The greatest strength of the present study is that it serves as an example of an effort by a single research group to validate results from a retrospective study in a prospective cohort. Strength of recommendations resulting from a research study depends on the quality of study design. Prospective testing of retrospectively ascertained hypotheses is a standard we should strive for as the quality era in orthopedic surgery approaches. The results of the present study suggest that patients who report allergies belong to a cohort at risk for lower satisfaction after total joint arthroplasty. The data have implications for patient counseling and risk adjustment, important components in the age of patient-centered care.

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