Allergy Assessment Provides Clinically Relevant Results in Joint Replacement Patients

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Abstract

Purpose: Commonly accepted causes of total knee arthroplasty failure include infection, aseptic loosening, and technical or design problems. There is controversy as to whether allergy to arthroplasty components is a cause of failure. We hypothesized that allergy to arthroplasty components, established by patch testing, can contribute significantly to joint failure, and surgery based on allergy evaluation results will improve outcomes in both primary and revision arthroplasty. Methods: We recruited patients referred for possible allergy to joint components into an IRB approved study, and examined follow-up data on patients enrolled between 10/2010 and 05/2012. All patients completed patch testing to metals and bone cement components, a questionnaire on implant type, medical/surgical history, and symptoms. At 9-12 months post-evaluation, we contacted subjects by telephone to complete an outcome survey based on the Knee Society Score. Comparisons between groups used chi-square analysis, with significance set at <0.05. Results: Of 131 patients, 77% (n=101) were evaluated because of failed joint for which no other cause was identified by the referring orthopedic surgeon. Most (72%) had a failed knee. Twenty-three percent (n=30) were seen pre-operatively for possible allergy. We were able to contact 63% (n=82) for the follow-up survey. Those lost to follow-up did not differ significantly by age, gender, implant, or patch test results. Eighteen of 34 patients (52%) with positive patch tests used those results to revise their implant, of whom 78% (n=14/18) reported doing "moderately" or "a lot better" versus 19% (n=3/16) in the group that either did not undergo revision or did not utilize their patch test results to do so (p=0.0002). Among the 32 implant patients who were patch test negative, 47% (n=15) reported doing "moderately" or "a lot better" and 53% (n=17) reported doing "a little" or "not at all better" (p=ns). Of the 16 patients evaluated pre-operatively, 69% (n=11) were patch test positive and 73% had index arthroplasty based on the patch results. All reported doing "moderately" or "a lot better". Conclusion: Among patients referred by orthopedic surgeons for otherwise unexplained joint failure, revision surgery based on patch test results was associated with significantly improved self-reported outcomes. Preoperative evaluation can help guide choice of compatible hardware, which might reduce the risk of joint failure.

Background

- Currently > 1 million joint replacements/yr in US – expected to double by 2015.
- Largest Medicare expenditure; rates of joint replacement rising in 45 – 65 age group.
- About 10% of joint replacements will fail and require revision.
- Commonly accepted causes of failure include infection and biomechanical or design issues.
- There is controversy as to whether allergy to joint components is a significant cause of joint failure.

Hypotheses

1. Allergy to arthroplasty components, established by patch testing, can contribute significantly to joint failure.
2. Surgery based on allergy evaluation results will improve outcomes in both primary and revision arthroplasty, compared to those not revised, or revised not using patch test results.

Methods: Patient Selection

Patients were referred by their orthopedic surgeon for one of the following reasons:
- Preop patients reporting a history of metal reactions, or
- Post-implant patients with implant failure not due to infection or biomechanical problem.

Enrolled n=179 into IRB-approved study between Oct 2010 – September 2012.

Patients underwent a brief medical evaluation, and we collected demographic information, co-morbidities, and surgical history.

Surgical history was verified by review of hospital records.

Implant components and alloys were verified through the company representative.

Comparison between groups was based on chi-square analysis with significance set at p=0.05.

The authors would like to thank the many patients for their willing participation in this study, and the many orthopedists who referred their patients to us for this evaluation.

Methods: Patch Testing

1. Patch testing was performed and scored according to International Contact Dermatitis Research Group guidelines.
2. All reactions were photographed and archived.
3. Patch test extracts were bought commercially from allergEAZE/SmartPractice® and included the metal and bone cement derivatives listed below.
4. Bone cement powder and liquid samples were donated by orthopedic implant companies.

- Aluminum
- Chromium
- Cobalt
- Copper
- Nickel
- Manganese
- Molybdenum
- Tantalum
- Titanium
- Vanadium
- Zirconium

- Methyl methacrylate
- Hydroxy-ethyl methacrylate
- Hydroxy-propyl methacrylate
- Benzoyl peroxide
- N,N-dimethyl-p-toluidine
- Hydroquinone

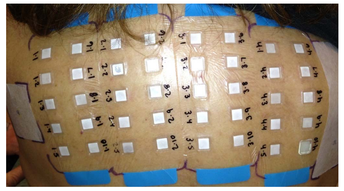


Photo of patch test panels

Patient Demographics

	All (n=179)	Follow-up (n=106)	Lost to follow-up (n=73)	p
Age (Range)	61 (18-84)	62 (42-83)	60 (19-88)	0.202
Male (%)	58 (32%)	35 (33%)	23 (32%)	0.872
Pre-op Patients (%)	41 (23%)	23 (22%)	18 (25%)	0.718
Post-implant Patients (%)	138 (77%)	83 (78%)	55 (75%)	
Positive to any metal	63 (35%)	40 (38%)	23 (31%)	0.429
Positive to any bone cement	43 (26%)	29 (27%)	17 (23%)	0.604
Any positive patch test	97 (54%)	61 (58%)	36 (49%)	0.290

Implant History

Type of implant and history of metal allergy

	All (n=106) Planned/Problem	Pre-op Eval (n=23)	Post-Implant Eval (n=83)	p
Type of implant		Planned	Problem	
Knee	81 (76%)	19 (83%)	62 (75%)	0.719
Hip	19 (18%)	3 (13%)	16 (19%)	
Other (shoulder, spine, etc.)	6 (6%)	1 (4%)	5 (6%)	
Prior history of metal allergy				
Yes	23 (22%)	10 (43%)	13 (16%)	<0.001
No	41 (39%)	1 (4%)	46 (55%)	
No response/Not sure	36 (36%)	12 (53%)	24 (29%)	

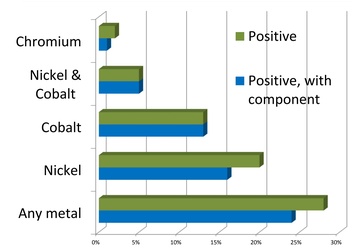
Patch Test Results

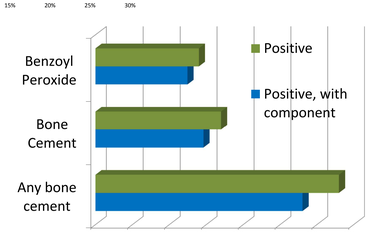
Patch Test Results (follow up patient subset n =106 only)

	All Patients (n = 106)	Pre-op Eval (n = 23)	Post-implant Eval (n=83)	p
Any positive patch test	61 (58%)	17 (74%)	44 (53%)	0.096
Any metal	40 (38%)	16 (70%)	24 (29%)	<0.001
Nickel	32 (30%)	15 (65%)	17 (20%)	<0.001
Cobalt	21 (20%)	10 (43%)	11 (13%)	0.003
Nickel & Cobalt	14 (13%)	10 (43%)	4 (5%)	<0.001
Chromium	3 (3%)	1 (4%)	2 (2%)	0.524
Any bone cement extract	30 (28%)	3 (13%)	27 (33%)	0.073
Bone Cement	14 (13%)	0 (0%)	14 (17%)	0.037
Benzoyl Peroxide	14 (13%)	2 (9%)	12 (14%)	0.730

Clinical Relevance

Clinical relevance of positive responses in post implant patients





Summary of Patch Test Results

1. Sensitization to implant components was found in 58% of all patients.
2. Positive patch tests to metals were significantly more likely in pre-op patients.
3. Sensitization to one or more components of bone cement was significantly more likely in post-implant patients.
4. Sensitization in post-implant patients was highly correlated with having the component contained in the implant.

Outcomes: Patch Test +

Patient Type	Have you improved?					
All Patch Test Positive Patients (n = 61)	A lot	Moderately	A little	Not at all	No response	
Implant chosen based on patch test results: YES (n=37)						p
Index arthroplasty (n = 15)	13	1	0	1	0	p<0.001
	87%	**6.5%**	0%	6.5%	0%	
Revision arthroplasty (n = 22)	13	3	2	4	0	
	59%	**14%**	9%	18%	0%	
Implant chosen based on patch test results: NO (n=24)						
No revision (n = 20)	0	3	4	12	1	
	0%	15%	**20%**	**60%**	5%	
Revision not dictated by patch tests OR other surgery: spinal cord stim, scar tissue (n=4)	0	0	0	4	0	
	0%	0%	0%	**100%**	0%	

Patch Test –

Patient Type	Have you improved?					
All Patch Test Negative Patients (n= 45)	A lot	Moderately	A little	Not at all	No response	p
Index arthroplasty (n = 5)	5	1	0	0	0	p=ns
	83%	**17%**	0%	0%	0%	
Revision arthroplasty (n = 16) Failure attributed to biomechanical factors	9	2	0	4	1	p=0.04
	56%	**12.5%**	0%	25%	6.5%	
Post-implant, no revision (n = 24) Minor surgery, no change implant hardware	5	2	3	13	1	
	21%	8%	**12.5%**	**54.5%**	4%	

Summary of Outcome Results

1. Among a highly selected group of patients with prosthetic joint failure in whom infection and biomechanical factors had already been considered and ruled out, we observed:
   a) a high prevalence of sensitization to implant components.
   b) revision surgery based on positive patch test results was associated with significantly better self-reported outcome.
2. Among a group of patients with suspected metal allergy identified pre-operatively, we observed:
   a) a high prevalence of sensitization to metal implant components.
   b) no significant difference in the good index arthroplasty outcomes in patch test positive patients who were not implanted with the component(s) to which they were allergic ,and the patch test negative patients.

Conclusions

1. Sensitization to implant components may be another cause of implant failure, and testing for sensitization to implant components should be considered in patients with otherwise unexplained joint failure.
2. Pre-operative evaluation of patients with a history of allergy to metal can help inform choice of implant and might prevent some cases of implant failure.