Metal Hypersensitivity in Orthopaedic Implants

A Position Statement from the Canadian Orthopaedic Association

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Key Messages

- Contact metal hypersensitivity is observed clinically in up to 11% for nickel and less than 2% for cobalt and chrome in the general population.
- Patch testing can return positive results for up to 20% of individuals for nickel with lower percentages for other metals. However, reactions to implanted metals remain rare.
- This statement focuses exclusively on metal hypersensitivity in static implanted fixation devices (e.g., plate and screw fixation) and excludes joint replacements or articulating

Non-Technical Summary
Metal hypersensitivity refers to a rare immune reaction in response to implanted metal devices. While contact metal hypersensitivity is relatively common, reactions to orthopaedic implants are rare and unpredictable. Symptoms may include skin rashes, swelling, pain and implant loosening, though a clear cause-and-effect relationship has not been definitively established. Testing methods such as patch testing and lymphocyte transformation tests (LTT), lack specificity and predictive accuracy. Current research suggests that removing implants may resolve symptoms, but the evidence supporting this is limited. Additionally, hypoallergenic implants have not demonstrated superior outcomes and may carry higher risks due to unfamiliar surgical techniques. Given the uncertainties surrounding metal hypersensitivity, clinical decisions should involve shared decision-making with patients, considering the low incidence of metal reactions and the limitations of existing diagnostic tools.

Background
Metal implants are widely used in orthopaedic surgery for fracture fixation, trauma repair, and reconstructive procedures. Despite the high prevalence of contact metal hypersensitivity, documented cases of true hypersensitivity reactions to implanted static devices are rare. The mechanisms behind these reactions involve metal ion release and immune responses, but a direct cause-and-effect link remains unproven.

Clinical Questions

Can patients experience clinical reactions to in-vivo metal implants?

- Yes. Symptoms may include cutaneous eruptions, impaired wound healing, pain, swelling, chronic inflammation and implant loosening. (5,7)
- Localized reactions are more common in static implants and often resolve after implant removal. (5, 8)

What is the incidence of metal hypersensitivity reactions to implanted static devices?

- Rare (exact percentage uncertain).

Does implant removal result in symptom resolution?

- Yes, as suggested by case reports. Patients may develop sensitivity due to pre-existing conditions or de novo reactions resulting from implant wear and corrosion. (7, 18-22)

Is there a proven cause-and-effect relationship between implanted metal devices and clinical reactions?

- No. Metal corrosion can release ions that trigger localized or systemic immune responses, but the mechanisms remain unclear. (5, 6)
- Cutaneous reactions are typically delayed-type hypersensitivity mediated by T-lymphocytes, while non-cutaneous responses involve complex immune processes. (6)

Is patch testing a reliable predictor of in-vivo metal reaction?

- No. Patch testing is commonly used for diagnosing metal hypersensitivity, but it is limited by interpretation bias and lacks predictive accuracy for deeper tissue immune responses. (7, 11-15)

Is there a clinical test to diagnose metal allergy in suspected in-vivo metal reactions?

- No, diagnosis is primarily by exclusion.
- Lymphocyte transformation tests (LTT) offer a more specific method but suffer from high costs, inter-laboratory variability, limited availability, and undefined sensitivity/specificity thresholds. (11, FDA 2019)

What we Found:

- The relationship between metal hypersensitivity and implant failure remains uncertain.
- Registry results show no difference to implant failure rates between patients with positive and negative patch tests.
- Even in patients with known metal hypersensitivity, standard implants rarely lead to complications requiring revision.
- Hypoallergenic implants have uncertain long-term outcomes and may introduce technical risks due to surgeon unfamiliarity.
- Further research is needed to clarify the cause-and-effect relationship between metal sensitivity and implant failures.

We Conclude That:

- No clear causal link has been established between metal allergy and orthopaedic implant failure.
- Patch testing and immunological tests lack predictive reliability for in-vivo metal reactions.
- Hypoallergenic implants have not been shown to provide superior outcomes and come with additional risks.
- Clinical decision-making should involve discussions with patients regarding implant selection and associated risks.
- Further research is necessary to establish clearer guidelines for metal sensitivity in orthopaedic implants.

Current data do not support routine screening or special precautions for metal hypersensitivity in orthopaedic fixation. Despite widespread use of metal implants and high rates of contact dermatitis, true implant reactions remain extremely rare.

Testing methods (patch tests, LTT) are unreliable for predicting in-vivo responses.

Consent processes should focus on common risks, as hypersensitivity reactions fall below the legally required threshold for inclusion (<0.001%)
Unless patients explicitly report a documented metal allergy, discussing hypersensitivity risks is not typically necessary in routine informed consent.
Further research is required to better understand immune responses to implanted metals, ensuring more definitive recommendations for surgeons and patients.

References:

1. Alinaghi F, Bennike NH, Egeberg A, Thyssen JP, Johansen JD. Prevalence of contact allergy in the general population: A systematic review and meta-analysis. Contact Dermatitis 2019; 80: 77-85. DOI: 10.1111/cod.13119.
2. DeKoven JG, Silverberg JI, Warshaw EM, Atwater AR, Reeder MJ, Sasseville D, et al. North American Contact Dermatitis Group Patch Test Results: 2017-2018. Dermatitis 2021; 32: 111-123. DOI: 10.1097/DER.0000000000000729.
3. Uter W, Ramsch C, Aberer W, Ayala F, Balato A, Beliauskiene A, et al. The European baseline series in 10 European Countries, 2005/2006--results of the European Surveillance System on Contact Allergies (ESSCA). Contact Dermatitis 2009; 61: 31-38. DOI: 10.1111/j.1600-0536.2009.01572.x.
4. Rui F, Bovenzi M, Prodi A, Fortina AB, Romano I, Peserico A, et al. Nickel, cobalt and chromate sensitization and occupation. Contact Dermatitis 2010; 62: 225-231. DOI: 10.1111/j.1600-0536.2009.01650.x.
5. Basko-Plluska JL, Thyssen JP, Schalock PC. Cutaneous and systemic hypersensitivity reactions to metallic implants. Dermatitis 2011; 22: 65-79.
6. Thyssen JP, Menne T, Schalock PC, Taylor JS, Maibach HI. Pragmatic approach to the clinical work-up of patients with putative allergic disease to metallic orthopaedic implants before and after surgery. Br J Dermatol 2011; 164: 473-478. DOI: 10.1111/j.1365-2133.2010.10144.x.
7. van der Merwe JM. Metal Hypersensitivity in Joint Arthroplasty. J Am Acad Orthop Surg Glob Res Rev 2021; 5. DOI: 10.5435/JAAOSGlobal-D-20-00200.
8. Thyssen JP, Johansen JD, Menne T, Liden C, Bruze M, White IR. Hypersensitivity reactions from metallic implants: a future challenge that needs to be addressed. Br J Dermatol 2010; 162: 235-236. DOI: 10.1111/j.1365-2133.2009.09526.x.
9. Munch HJ, Jacobsen SS, Olesen JT, Menne T, Soballe K, Johansen JD, et al. The association between metal allergy, total knee arthroplasty, and revision: study based on the Danish Knee Arthroplasty Register. Acta Orthop 2015; 86: 378-383. DOI: 10.3109/17453674.2014.999614.
10. Mitchelson AJ, Wilson CJ, Mihalko WM, Grupp TM, Manning BT, Dennis DA, et al. Biomaterial hypersensitivity: is it real? Supportive evidence and approach considerations for metal allergic patients following total knee arthroplasty. Biomed Res Int 2015; 2015: 137287. DOI: 10.1155/2015/137287.
11. Schalock PC, Crawford G, Nedorost S, Scheinman PL, Atwater AR, Mowad C, et al. Patch Testing for Evaluation of Hypersensitivity to Implanted Metal Devices: A Perspective From the American Contact Dermatitis Society. Dermatitis 2016; 27: 241-247. DOI: 10.1097/DER.0000000000000210.

12. Thomas P, Schuh A, Ring J, Thomsen M. [Orthopedic surgical implants and allergies: joint statement by the implant allergy working group (AK 20) of the DGOOC (German association of orthopedics and orthopedic surgery), DKG (German contact dermatitis research group) and dgaki (German society for allergology and clinical immunology)]. Orthopade 2008; 37: 75-88. DOI: 10.1007/s00132-007-1183-3.
13. Johansen JD, Aalto-Korte K, Agner T, Andersen KE, Bircher A, Bruze M, et al. European Society of Contact Dermatitis guideline for diagnostic patch testing - recommendations on best practice. Contact Dermatitis 2015; 73: 195-221. DOI: 10.1111/cod.12432.
14. Bruze M, Conde-Salazar L, Goossens A, Kanerva L, White IR. Thoughts on sensitizers in a standard patch test series. The European Society of Contact Dermatitis. Contact Dermatitis 1999; 41: 241-250. DOI: 10.1111/j.1600-0536.1999.tb06154.x.
15. Ale SI, Maibach HI. Reproducibility of patch test results: a concurrent right-versus-left study using TRUE Test. Contact Dermatitis 2004; 50: 304-312. DOI: 10.1111/j.0105-1873.2004.00351.x.
16. Richards LJ, Streifel A, Rodrigues JM. Utility of Patch Testing and Lymphocyte Transformation Testing in the Evaluation of Metal Allergy in Patients with Orthopedic Implants. Cureus 2019; 11: e5761. DOI: 10.7759/cureus.5761.
17. Eftekhary N, Shepard N, Wiznia D, Iorio R, Long WJ, Vigdorchik J. Metal Hypersensitivity in Total Joint Arthroplasty. JBJS Rev 2018; 6: e1. DOI: 10.2106/JBJS.RVW.17.00169.
18. Swiontkowski MF, Agel J, Schwappach J, McNair P, Welch M. Cutaneous metal sensitivity in patients with orthopaedic injuries. J Orthop Trauma 2001; 15: 86-89. DOI: 10.1097/00005131-200102000-00002.
19. Teo WZW, Schalock PC. Metal Hypersensitivity Reactions to Orthopedic Implants. Dermatol Ther (Heidelb) 2017; 7: 53-64. DOI: 10.1007/s13555-016-0162-1.
20. Hallab N, Merritt K, Jacobs JJ. Metal sensitivity in patients with orthopaedic implants. J Bone Joint Surg Am 2001; 83: 428-436. DOI: 10.2106/00004623-200103000-00017.
21. Granchi D, Cenni E, Trisolino G, Giunti A, Baldini N. Sensitivity to implant materials in patients undergoing total hip replacement. J Biomed Mater Res B Appl Biomater 2006; 77: 257-264. DOI: 10.1002/jbm.b.30445.
22. Frigerio E, Pigatto PD, Guzzi G, Altomare G. Metal sensitivity in patients with orthopaedic implants: a prospective study. Contact Dermatitis 2011; 64: 273-279. DOI: 10.1111/j.1600-0536.2011.01886.x.
23. Granchi D, Cenni E, Giunti A, Baldini N. Metal hypersensitivity testing in patients undergoing joint replacement: a systematic review. J Bone Joint Surg Br 2012; 94: 1126-1134. DOI: 10.1302/0301-620X.94B8.28135.
24. Amini M, Mayes WH, Tzeng A, Tzeng TH, Saleh KJ, Mihalko WM. Evaluation and management of metal hypersensitivity in total joint arthroplasty: a systematic review. J Long Term Eff Med Implants 2014; 24: 25-36. DOI: 10.1615/jlongtermeffmedimplants.2014010277.
25. Thyssen JP, Jakobsen SS, Engkilde K, Johansen JD, Soballe K, Menne T. The association between metal allergy, total hip arthroplasty, and revision. Acta Orthop 2009; 80: 646-652. DOI: 10.3109/17453670903487008.
26. Bravo D, Wagner ER, Larson DR, Davis MP, Pagnano MW, Sierra RJ. No Increased Risk of Knee Arthroplasty Failure in Patients With Positive Skin Patch Testing for Metal Hypersensitivity: A Matched Cohort Study. J Arthroplasty 2016; 31: 1717-1721. DOI: 10.1016/j.arth.2016.01.024.

27. Carlsson A, Moller H. Implantation of orthopaedic devices in patients with metal allergy. Acta Derm Venereol 1989; 69: 62-66.
28. Niki Y, Matsumoto H, Otani T, Yatabe T, Kondo M, Yoshimine F, et al. Screening for symptomatic metal sensitivity: a prospective study of 92 patients undergoing total knee arthroplasty. Biomaterials 2005; 26: 1019-1026. DOI: 10.1016/j.biomaterials.2004.03.038.
29. Atwater AR, Reeder M. Hypersensitivity reactions to orthopedic implants: what's all the hype? Cutis 2020; 105: 68-70.
30. Atanaskova Mesinkovska N, Tellez A, Molina L, Honari G, Sood A, Barsoum W, et al. The effect of patch testing on surgical practices and outcomes in orthopedic patients with metal implants. Arch Dermatol 2012; 148: 687-693. DOI: 10.1001/archdermatol.2011.2561.
31. Reed KB, Davis MD, Nakamura K, Hanson L, Richardson DM. Retrospective evaluation of patch testing before or after metal device implantation. Arch Dermatol 2008; 144: 999-1007. DOI: 10.1001/archderm.144.8.999.
32. Cristofaro C, Pinsker EB, Halai F, Wolfstadt J, Daniels TR, Halai M. Metal hypersensitivity in foot & ankle orthopaedic surgery: A systematic review. J Clin Orthop Trauma 2023; 44: 102249. DOI: 10.1016/j.jcot.2023.102249.
33. Penumarty S, Tuong LA, Khianey R, Oppenheimer J. Metal hypersensitivity in total joint arthroplasties. Ann Allergy Asthma Immunol 2020; 124: 546-547 e541. DOI: 10.1016/j.anai.2020.02.012.
34. Pacheco KA, Thyssen JP. Contact Dermatitis From Biomedical Devices, Implants, and Metals-Trouble From Within. J Allergy Clin Immunol Pract 2024; 12: 2280-2295. DOI: 10.1016/j.jaip.2024.07.016.
35. Akil S, Newman JM, Shah NV, Ahmed N, Deshmukh AJ, Maheshwari AV. Metal hypersensitivity in total hip and knee arthroplasty: Current concepts. J Clin Orthop Trauma 2018; 9: 3-6. DOI: 10.1016/j.jcot.2017.10.003.
36. Aquino M, Mucci T. Systemic contact dermatitis and allergy to biomedical devices. Curr Allergy Asthma Rep 2013; 13: 518-527. DOI: 10.1007/s11882-013-0365-9.
37. Faschingbauer M, Renner L, Boettner F. Allergy in Total Knee Replacement. Does It Exist?: Review Article. HSS J 2017; 13: 12-19. DOI: 10.1007/s11420-016-9514-8.
38. Phedy P, Djaja YP, Boedijono DR, Wahyudi M, Silitonga J, Solichin I. Hypersensitivity to orthopaedic implant manifested as erythroderma: Timing of implant removal. Int J Surg Case Rep 2018; 49: 110-114. DOI: 10.1016/j.ijscr.2018.06.011.
39. Thomas P, Summer B, Krenn V, Thomsen M. [Allergy diagnostics in suspected metal implant intolerance]. Orthopade 2013; 42: 602-606. DOI: 10.1007/s00132-012-2033-5.