

Metal Sensitivity After TKA Presenting With Systemic Dermatitis and Hair Loss

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abstract

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Recent problems with metal-on-metal bearings in total hip arthroplasty have highlighted a connection between metal particles and allergic responses. Metal sensitivity associated with total knee arthroplasty (TKA) is less understood and poorly characterized. However, metal sensitivity can lead to TKA failure. Accurate and reliable testing for this phenomenon is elusive; therefore, the diagnosis of metal sensitivity remains one of exclusion. Only skin testing and lymphocyte transformation testing are commonly available to assess hypersensitivity, and neither test is reliable.

This article describes a woman who presented with severe whole-body dermatitis and hair loss. After prolonged pain and progressive stiffness, including failed manipulation while under anesthesia and open synovectomy, the patient had a positive skin test, but the lymphocyte transformation test was negative. She was treated for metal sensitivity with TKA revision to nonallergenic components, and all symptoms resolved. One year after revision, she had good range of motion, complete dermatitis resolution, and hair loss restoration.

To the authors' knowledge, this is the only report that describes hair loss as a symptom of metal sensitivity secondary to TKA and hair regrowth after revision. The authors now include metal sensitivity in a differential of causes of pain and other unusual symptoms after TKA that are otherwise unexplained.

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Figure 1: Photograph showing some of the systemic dermatitis, including a rash on the patient's face.



Figure 2: Photograph showing the dermatitis and hair loss on the scalp.

Recent problems with metal-on-metal bearings in total hip arthroplasty have highlighted a connection between metal particles and allergic responses. Pseudotumors and localized soft tissue reactions appear to be the result of an immune response to increased concentrations of metal particles associated with metal-on-metal total hip arthroplasty.¹ The recent popularity of metal-on-metal bearings has increased the awareness of metal sensitivity as a potential problem in joint arthroplasty. Metal sensitivity associated with total knee arthroplasty (TKA) is less understood and poorly characterized. Systemic metal ion levels are elevated in association with TKA compared with baseline levels,² but the lack of a metal-on-metal articulation in TKA is thought to protect against metal ion levels sufficient to cause an allergic reaction.

Several case reports have indicated a connection between early TKA failure and metal sensitivity.³⁻⁶ However, diagnosing metal sensitivity is difficult; clinically, it is often only arrived at as a diagnosis of exclusion. Only skin testing and lymphocyte transformation testing are commonly available to assess hypersensitivity, and both tests are inherently flawed as a measure of immune response to an implant.⁷ Most published case reports have cited stiffness and pain and the onset of a rash as indicative findings of metal sensitivity.³ Some authors have described dermatitis associated with metal allergy and TKA.

The current article describes a woman who presented with severe whole-body dermatitis and hair loss associated with an allergic response to TKA. These symptoms improved following revision. To the authors' knowledge, this is the first case report that describes hair loss as a symptom of metal sensitivity secondary to TKA and improvement after revision.

CASE REPORT

A 55-year-old woman underwent routine TKA in March 2008 for symptoms related to posttraumatic arthropathy.



Figure 1: Photographs showing some of the systemic dermatitis, including a rash on her face (A), and dermatitis and hair loss on the scalp (B).

Prior to TKA, she underwent multiple arthroscopic and open procedures for chondromalacia and a torn meniscus. Her TKA was complicated by postoperative stiffness, which required manipulation under anesthesia twice and an open synovectomy to improve range of motion. She reported continuing knee pain, stiffness, and difficulty walking until presentation in June 2011.

Her history was only significant for asthma and a sensitivity to inexpensive jewelry, which frequently resulted in a rash and itching. The patient was disabled after an unrelated back injury. She was 5'6" tall and weighed 240 lb (body mass index, 38 kg/m²). Examination revealed a rash over most of her face (Figure 1A) and hair loss on top of her scalp (Figure 1B). Knee range of motion was -5° of full extension to 70° of flexion. She had lateral instability with the application of varus force. Radiographs showed a well-fixed, cementless TKA prosthesis with the tibial component in excessive valgus. Erythrocyte sedimentation rate, C-reactive protein, and aspirate were negative for infection. A presumptive diagnosis of arthrofibrosis with systemic dermatitis secondary to metal allergy was made.

The patient underwent revision TKA and conversion to an oxidized Zirconium

component (Oxinium; Smith & Nephew, Memphis, Tennessee). Her postoperative course was unremarkable, and she was discharged to a rehabilitation center on postoperative day 3. At 6-week follow-up, she was rash free (Figure 2A) and her hair had begun to return (Figure 2B). Range of motion was from -5° of full extension to 90° of flexion. At 1-year follow-up, range of motion was from full extension to 105° of flexion, she had no rash, her hair had returned, she was pain free, and she was happy with the results. Postoperative lymphocyte transformation testing showed mild reactivity to chromium but no reactivity to nickel and cobalt. However, skin testing showed a severe allergic reaction to the alloy in the resected TKA.

DISCUSSION

Metal sensitivity affects an estimated 10% to 15% of the general population.⁷ This is most often described as an intolerance to inexpensive jewelry and is generally accepted as a nickel allergy.⁷ Although most TKA components contain nickel and cobalt, the 2 most common metallic allergens, the incidence of metal sensitivity in patients undergoing TKA is less than the 10% to 15% incidence in the general population. This fact highlights the difficult nature of diagnosing and

characterizing metal sensitivity associated with TKA.

The most common methods of measuring metal sensitivity are skin testing and lymphocyte transformation testing. Each has inherent problems measuring the immune response of an *in vivo* metal protein complex. Skin testing is limited by the fact that the skin acts as a natural barrier and the metal contacting the skin may have different antigenic properties than the metal protein complex causing the immune response inside the body. This problem makes it inconsistent and unreliable for testing metal sensitivity to orthopedic implants.^{8,9} Lymphocyte transformation testing is more sensitive for measuring sensitivity to implants¹⁰ but is limited by cost and availability. Lymphocyte transformation testing is not performed at the authors' institution and has an out-of-pocket cost of approximately \$500.

A lack of definitive testing for diagnosing metal sensitivity associated with orthopedic implants makes characterizing metal sensitivity difficult. Published clinical guidelines exist, but the criteria vary.¹¹ Allergic responses are rarely clinically apparent. In the current case, the traditional infection workup was negative, and mechanical factors were ruled out by examination and radiographs. Allergic reaction was the only explanation. The postoperative resolution of symptoms further substantiated the diagnosis of metal sensitivity.

Most reported cases of metal sensitivity have described stiffness and pain that resolved with revision to titanium or other nonimmune materials.³⁻⁶ Few cases were reported of localized dermatitis associated with TKA that resolved with implant revision or removal.¹¹ One report described systemic dermatitis that resolved with revision.⁶ In each case, the diagnosis of metal sensitivity was made after excluding other TKA failure causes and was validated when symptoms improved following revision. This phenomenon was also observed in the current case.



Figure 2: Photographs of the patient 6 weeks after revision showing the dermatolities completely resolved (A) and her hair beginning to regrow (B).

The current patient had an allergy to inexpensive jewelry. Despite this allergy, she underwent additional procedures short of complete revision after the index operation to improve her ROM. In the current workup, the combination of a skin rash and hair loss and her history of stiffness after TKA made a metal allergy the likely cause of her symptoms. Her symptoms completely resolved after revision. Postoperative lymphocyte transformation testing was negative and showed the same level of reactivity to nickel and cobalt as it did to aluminum and zirconium, components of her revision prosthesis. The authors obtained skin testing that had a positive response to the metal alloy contained in the explanted prosthesis.

During revision, the patient was converted from traditional cobalt chrome (Nexgen TKA; Zimmer, Warsaw, Indiana) to an Oxinium femoral component with a hardened titanium tibial baseplate. The Oxinium component eliminated the exposure of metal ions to the *in vivo* environment through a ceramic outer surface, thereby preventing sensitization and an allergic response. Other treatment options in this setting include a full ceramic knee or a hardened titanium tibial and femoral component. Although full ceramic TKA

components are available, their usefulness is limited by cost. Titanium is less likely to cause metal sensitivity, but its tribologic properties, including surface roughness, make it less than ideal as a bearing surface.

The current patient had an allergic reaction to TKA components that contained nickel and chromium. Her symptoms began with stiffness and pain but progressed to a severe systemic allergic response, including major hair loss. The authors assume that this increase in symptoms was related to increased metal ion levels from prolonged *in vivo* exposure. However, the authors did not document serum metal ion levels because no correlation between ion levels and metal sensitivity has been established.⁶ This level of progressive systemic allergic reaction was unusual, distressing, and painful.

CONCLUSION

Metal sensitivity after TKA should be considered when a traditional workup of a patient with painful TKA symptoms, including arthrofibrosis and dermatitis, is negative. The authors found excellent results with the use of the Oxinium component and propose its use for other patients with allergic-type symptoms associated with TKA. 

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