Metal hypersensitivity reactions and adverse local tissue reactions due to wear in metal-on-metal total hip arthroplasty have resulted in extensive debate at scientific meetings, as well as in the national media.1,2 Although they have been primarily observed in metal-on-metal bearings for total hip arthroplasty, they are not limited to this bearing type alone and have been observed in joint arthroplasty of the knee, elbow, and shoulder.3-7 An adverse reaction to metal debris or an adverse local tissue reaction can occur as a consequence of metal wear at multiple types of interfaces, including nonarticulating surfaces such as modular taper junctions or third-body wear at articulating surfaces.8-10 Metal debris can travel anywhere in the effective joint space and may result in synovitis, soft-tissue lesions, and elevated serum metal ion levels.11,12 However, to the authors’ knowledge, no articles report damaged cementless tantalum knee components resulting in extra-articular regional migration of tantalum particles.

**Case Report**

A 59-year-old women presented 28 months after a left cementless total knee arthroplasty (TKA). She previously underwent a Hauser procedure on the same knee at approximately 20 years of age. She underwent a cemented right TKA at age 52 years. At age 56 years, she underwent a left TKA with a cemented femoral component and cementless tibial component that used highly porous tantalum for fixation. Postoperatively, knee pain progressively worsened, with increasing effusion and instability that caused the knee to give away. Over 2 years, her symptoms progressed and eventually prevented her from participating in numerous activities of daily living due to pain, discomfort, and soft-tissue swelling.

On evaluation at 2-year follow-up, she demonstrated clear signs of pain and instability. She had a body mass index (BMI) of 36.8 kg/m², and the left knee incision was well healed. Range of motion was from 5° to 100°, and she had diffuse medial and lateral retinacular tenderness and joint line tenderness with mild patellofemoral crepitus.
Ligamentous evaluation of the knee with a valgus/varus stress test demonstrated 2+ lateral collateral ligament laxity and 1+ medial collateral ligament laxity. Evaluation of the right knee, which was asymptomatic and had undergone a cemented TKA when the patient was age 52 years, revealed a range of motion of 5° to 110°. She was unable to perform an unassisted chair rise, walked with an antalgic gait, and required support for stairs. She had limitations of gait, avoided uneven surfaces, and required assistance for long walks, with a maximum distance of approximately 2 blocks.

Radiographic Evaluation
Radiographs showed a right cemented TKA and a left hybrid TKA with cementless tantalum tibia and cemented femur with a resurfaced patella (Figure 1). The left knee showed the old Hauser procedure with a screw in position. The tibial component appeared to be radiographically stable, with a slight posterior slope of approximately 9°. The cemented femoral component had a notch on the anterior femoral cortex and a radiolucent line at the posterior femoral condyles.

Aspiration and Laboratory Evaluation
Diagnostic studies included aspiration of 10 mL of clear yellowish fluid. Cultures and Gram stain were negative. White blood count, C-reactive protein, Westergren erythrocyte sedimentation rate, and complete blood count with differential were all within normal limits (white blood count threshold, less than 3,000 cells/µL; ESR threshold, 30 mm/h; C-reactive protein threshold, 10 mg/L).

Revision Total Knee Arthroplasty
Options were discussed with the patient, and she decided to proceed with possible revision for the working diagnosis of instability. She underwent revision TKA with a cemented component 28 months after the index primary TKA (Figure 2).

The previous midline incision was used. After completion of the initial incision in the subcutaneous tissue, numerous areas of grayish staining of the soft tissue were identified (Figure 3A). Some of these areas of discoloration extended 8 to 10 cm proximal to the joint in the extra-articular muscle and adipose tissue. Soft tissue specimens were taken for histopathological assessment.

After a medial arthrotomy, a moderate amount of grayish-stained soft tissue and synovium was suspicious for metallosis. The most prominent staining was noted along the tibial component. After complete synovectomy, the femoral component was examined and found to be grossly loose at the cement-bone interface; this component was easily removed without marked bone loss. The patellar component was stable, with no evidence of marked polyethylene wear, although a small lateral bone prominence was noted and removed. On examination of the tibial component, micromotion and a hydraulic effect along the lateral tibial plateau was noted, whereas the medial portion appeared to be stable. On initial inspection of the lateral aspect of the tibial component, approximately 1 mm of movement and slight component flexion were noted, which were believed to be a consequence of deficient ingrowth. However, on closer examination, the ingrowth surface was noted to be delaminating anterolaterally from the tibial baseplate, and the greatest amount of grayish of soft tissue and bone discoloration was noted to surround this portion of the component.

Figure 1: Preoperative anteroposterior (A) and lateral (B) radiographs of the knee showing bilateral total knee arthroplasty components.

Figure 2: Postoperative anteroposterior (A) and lateral (B) radiographs of the knee showing left revision total knee arthroplasty.

Figure 3: Evaluation of the soft tissues showing extra-articular punctuate grayish discolorations (A) and intra-articular grayish discoloration of the bone and soft tissue, which was suspicious of metallosis (B).
An osteotome was then used to remove the tibial component. After the tibial tray was freed, an oscillating saw was used to cut through the pegs to remove the implant. Following removal, delamination of the ingrowth surface from the tibial tray was confirmed, and metallosis staining of the bone below the implant interface was performed (Figures 3B, 4A). The medial aspect of the baseplate (Figure 4B) and the medial peg showed some bony ingrowth, whereas the lateral peg and lateral aspect of the baseplate demonstrated no bone ingrowth.

Pathological specimens were obtained intraoperatively, and all showed less than 5 white cells per high-powered field. Revision was performed to a fully cemented, stemmed single-radius revision TKA femoral and tibial component (Triathlon TS Knee System; Stryker Orthopaedics, Mahwah, New Jersey) (Figure 2).

The patient was discharged 3 days postoperatively, and at her 2-year follow-up visit had a range of motion of 1° to 122° with no pain and no instability. She was able to perform functional activities of daily living, including kneeling, stair climbing, and walking unrestricted, and had Knee Society functional and objective scores of 100 points each.

Pathology
To minimize the risk of contamination with metal debris from removal of the implant with osteotomies and an oscillating saw, all samples were collected from the peripheral soft tissues prior to performing an arthrotomy. Pathological specimens obtained from the extra-articular soft tissues were analyzed with hematoxylin-eosin stain polarized light microscopy, as well as with scanning electron microscopy using a carbon planchet to minimize background signal and facilitate analysis with energy dispersive x-ray spectroscopy. Analysis of the metal particles showed a porosity consistent with the porous tantalum of the tibial baseplate (Figure 5), and energy dispersive x-ray spectroscopy confirmed its tantalum composition.

DISCUSSION
Cementless TKA is often used for younger, more active patients. In this case, although the implants appeared to be radiographically stable and well fixed, at the time of surgery the femoral component was loose and the tibial component showed anterolateral delamination of porous tantalum from the metal baseplate. Reactive synovitis associated with the disseminated metal debris may have contributed to progressive instability and painful effusions and may have played a role in the loosening of the femoral component.

An important concern was that the porous tantalum was identified in the extra-articular soft tissue prior to performing the arthrotomy. The extra-articular migration of these tantalum particles indicates regional dissemination of metal. The implications of locally continuous dissemination are worrisome and may have contributed to the local soft tissue reaction, pain, and implant failure. Extra-articular dissemination from knee implants is a rare finding, but until now has always been associated with polyethylene wear-through in a unicompartmental or total knee arthroplasty. Furthermore, the systemic effects and long-term consequences of elemental tantalum are currently unknown and likely warrant further study.

Delamination of the ingrowth interface despite normal radiographs is also concerning and may suggest a new mechanism of failure for cementless TKA, particularly porous tantalum-coated prostheses. This metal articulation...
may be at risk for regional or systemic migration of the porous tantalum and may have implications in the use of augments and wedges where tantalum metal debris may be generated.

To the authors’ knowledge, this is the first report of regional migration of tantalum particles from delaminated porous ingrowth material from the backside of a cementless tibial baseplate. Although this has not been reported with the use of tantalum augments, the authors caution that these cementless components may risk delamination of the tantalum surface, which could result in metallosis or systemic metal hypersensitivity. Further study and implant surveillance are necessary to determine whether this was a chance event or is indicative of a future trend with this method of implant fixation.

REFERENCES