Severe Persistent Synovitis After Cobalt-chromium Total Knee Arthroplasty Requiring Revision

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abstract

Implant-related hypersensitivity is a well-established cause of failure after total hip arthroplasty but is a rare complication after total knee arthroplasty (TKA). It remains a relatively unpredictable and poorly understood cause of implant-related failure. This article describes 5 patients (6 knees) who presented with persistent pain and hypertrophic synovitis after TKA using a cobalt-chromium component. Extensive perioperative workup, including white blood cell count, erythrocyte sedimentation rate, C-reactive protein, joint aspiration, and intraoperative cultures, ruled out infection as a cause of the symptoms. All knees demonstrated appropriate ligamentous balance and were well aligned, with all components noted to be well fixed at revision. In all patients, the clinical condition improved dramatically after revision to zirconium femoral and titanium metal-backed tibial components. Pain and functional outcome scores improved in all patients. Intraoperative histopathology revealed a thickened synovium with either a predominantly lymphocytic or histiocytic monocellular response. Final pathology confirmed that no infection was present in any patient. The goal of TKA is to produce a well-performing, pain-free joint. When patients present with recurrent pain and synovitis after TKA, infection must be excluded. When infection and instability have been excluded, metal hypersensitivity should be considered as a cause of primary TKA failure. In these patients, revision to a zirconium femoral component can provide predictable and effective clinical improvement.

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Figure: Intraoperative photographs showing extensive synovitis prior to debridement (A) and a gross pathologic specimen of the hypertrophic synovitis removed during revision surgery (B).
Implant-related hypersensitivity is an infrequent complication of total knee arthroplasty (TKA). Although well documented in case and group studies, it remains a relatively unpredictable and poorly understood phenomenon of failure in the context of orthopedic implant materials. Most patients who have dermal sensitivity to metals (positive patch test) can safely receive an orthopedic implant without complications. Persistently knee joint irritation and inflammation following TKA may also be associated with infection, mechanical instability, gout, and pigmented villonodular synovitis.

Conversely, in vivo reactivity to metals is difficult to characterize in the clinical setting due to its infrequency and subtle nature. Implant-related sensitivity that results in revision is even more uncommon. Merritt and Rodrigo reported the incidence of clinically significant cases to be as little as 0.1% and noted that the incidence of premature device removal is low. The current article describes the cases of 5 patients (6 knees) who presented to 2 institutions with similar clinical features of pain and persistent swelling after receiving a cobalt-chromium implant and only improved after revision to a zirconium implant.

**Material and Methods**

After obtaining institutional review board approval from both institutions, the authors reviewed the records of 5 patients (6 knees) who presented to 2 institutions with similar clinical features of pain and persistent swelling after receiving a cobalt-chromium implant and only improved after revision to a zirconium implant.

**Patient 1**

A 78-year-old woman underwent a primary cemented TKA with a cobalt-chromium femoral component (Triathlon Total Knee System) for the treatment of osteoarthritis. Two months postoperatively, she developed increasing pain and effusion in her right knee. Routine infection workup was completed and her complete blood count (CBC) and erythrocyte sedimentation rate (ESR) were within normal limits. C-reactive protein (CRP) was mildly elevated at 1.8 mg/L (normal range, 0.5-1.5 mg/L). Knee aspiration revealed no organisms, and the culture was negative. Although she initially improved, pain and swelling resumed with activity. Repeat serum laboratory evaluation and knee aspiration were performed, and all were within normal limits.

Knee radiographs demonstrated appropriate position and fixation of the cemented implants (Figure 1). Magnetic resonance imaging revealed a chronically thickened synovium, and an indium-111 labeled leukocyte scan showed increased uptake around the implant with a slight mismatch to technetium-99m bone scan. Dermatological evaluation for allergy using a dermal patch revealed a nickel sensitivity.

A 2-stage revision procedure was planned due to the mildly increased CRP and continued concern for the possibility of indolent infection. During stage 1 of the surgery, the findings included marked hypertrophy and congestion of the synovium throughout the knee joint (Figure 2). The components were well fixed, no evidence of loosening or osteolysis were noted, and the soft tissues were well balanced. A thorough synovectomy (Figure 3), implant removal, collection of deep intraoperative specimens for culture, and placement of a temporary antibiotic spacer were performed. After deep cultures confirmed no growth, revision right TKA was performed using an Oxinium femoral component and titanium metal backed tibial component (Genesis II; Smith & Nephew, Memphis, Tennessee). Histopathology revealed marked synovial hypertrophy and hyperplasia with perivas-
cular lymphoplasmacytic aggregates and myxomatous degeneration.

At 1-year follow-up, the patient reported no knee pain; mild residual swelling and a knee range of motion from 0° to 100° were recorded. She was ambulatory without support and was able to reciprocate stairs with no assistive device. No KSS scores were available for this patient.

**Patient 2**

A 64-year-old man presented with persistent right knee pain and swelling of his 2 years after an uneventful primary TKA for osteoarthritis using a cobalt-chromium femoral component (Triathlon Total Knee System). On presentation, the patient’s Knee Society knee score (KSS) was 43 and function score was 45. Routine infection workup, including CBC, ESR, CRP, and 2 separate aspirations, were within normal limits. Radiographs confirmed the implants were in good alignment and well fixed. Magnetic resonance imaging revealed a moderate bulky hypertrophic synovium and a capsular burden of particle disease.

The patient had a positive history of allergy to nickel and cobalt. This raised suspicion of metal sensitivity as the cause of his continued symptoms. A dermatology evaluation was obtained, and a patch test was positive for cobalt. The patient was not tested for nickel allergy because of the known history. A single-stage revision procedure was performed due to continued symptoms and negative infection workup. Intraoperative findings included marked hyperplasia and congestion of the synovium throughout the knee joint. The components were well fixed. The implant was removed with minimal damage to the bone stock and was revised using an Oxinium femoral component and titanium metal backed tibial component (Genesis II). Histology revealed a chronic histiocytic reaction to birefringent small particulate material and methyl methacrylate bone cement.

Two years postoperatively, a marked decrease in symptoms with occasional pain and minimal swelling were reported. The KSS knee score improved to 91, and the function score improved to 85.

**Patient 3**

A 56-year-old woman underwent a left TKA using a cobalt-chromium femoral component (Triathlon Total Knee System) in June 2007 for osteoarthritis. She reported no fever, chills, or constitutional symptoms. Her KSS knee score was 66, and function score was 70. She had a knee range of motion from full extension to 120° of flexion, and both knees were stable throughout the range.

Routine infection workup, including CBC, ESR, and CRP, were within normal limits, and a bone scan was unremarkable. Magnetic resonance imaging revealed no evidence of component loosening or bone resorption. Dermatology evaluation demonstrated a strong sensitivity to cobalt and manganese. Staged bilateral TKA revision was performed. The left knee was revised first, and the right knee was revised 4 months later. Both knees were revised using Oxinium femoral components. Intraoperative findings included marked hyalitis and congestion of the synovium throughout the knee joint with well-fixed implants. Histopathology confirmed synovial hypertrophy and hyperplasia associated with diffuse mononuclear and giant cell reaction to small particulate cement and polyethylene debris. Slight periarticular chronic inflammation was present.

At 1-year follow-up, she reported no pain and had a range of motion of 0° to 120° in both knees. Her KSS knee score was 90, and function score was 85.

**Patient 4**

A 56-year-old woman underwent a left TKA using a cobalt-chromium femoral component (Triathlon Total Knee System) in June 2007 for osteoarthritis. Five months postoperatively, she presented with increasing pain, difficulty walking, and mild knee swelling. Examination revealed 3° of flexion contracture, with flexion to 105°. Mild soft tissue swelling but no tenderness was noted. The KSS knee score was 78 and function score was 55. The knee was stable and radiographs showed satisfactory alignment and fixation of the components. Infection workup, including CBC, ESR, and CRP, and a knee aspiration were all within normal limits. Magnetic resonance imaging demonstrated no evidence of osteolysis or loosening. A moderate-sized joint effusion with distal patellar tendinosis was noted. Because her symptoms persisted, she underwent revision TKA using an Oxinium femoral component and titanium metal backed tibial component (Genesis II). Histopathological findings included marked hyperplasia and congestion of the synovium throughout the knee joint. The components were well fixed. Histology revealed synovial hyperplasia with chronic histiocytic response.

One year postoperatively, she was doing well from her left revision TKA but was experiencing increasing symptoms of right knee arthritis. She was mobilizing independently with no pain in the left knee and left knee range of motion was 0° to 110°. She was using the rails when going down stairs because of her right knee pain. The KSS knee score improved to 91 and function score to 80.
Patient 5

A 64-year-old woman reported continued persistent pain and swelling after undergoing right TKA (Triathlon Total Knee System). Her knee extended fully and flexed to 95°. Moderate atrophy of the quadriceps muscle with evident synovial thickening and effusion was noted. Her KSS knee score was 76 and function score was 60. Laboratory evaluation, including CBC, ESR and CRP, were within normal limits. Sixty milliliters of slightly blood-tinged fluid was aspirated from her knee. The cell count was within normal limits, and the gram stain and culture were negative. Allergy patch testing indicated no significant reaction to nickel or cobalt. Magnetic resonance imaging was inconclusive because of interference with metal and motion artifact. In addition, the arthritis in her left knee had progressed with severe symptoms, and she underwent a left TKA with an Oxinium femoral component (Genesis II). She continued to have symptoms in her right knee despite a successful left TKA.

She underwent revision of her right TKA 2 years after the index procedure. The synovium was thick and congested, and the implants were well fixed. The knee was revised using an Oxinium femoral component (Genesis II). Histopathology revealed a foreign body reaction to colorless refractile material with synovial cell hyperplasia and foci of myxoid degeneration.

Four months after revision of her right TKA, the patient reported improvement in symptoms with mild occasional pain and slight residual swelling. The KSS knee score improved to 94 and function score to 90.

DISCUSSION

Arthroplasty usually results in a well-performing, pain-free joint. When patients present with recurrence of symptoms after TKA, infection must be excluded first. Persistent pain and recurrent effusion, although most commonly associated with infection, may also be secondary to instability. Other rare causes include gout and pigmented villonodular synovitis.

In the current series, all patients underwent preoperative evaluations to exclude infection. Normal ESR and CRP levels are good screening tools to exclude peri-prosthetic infection. Joint aspiration is also commonly used; however, a false-negative culture is not uncommon. The gold standard for diagnosing infection is taking intraoperative cultures. Specimens from the current patients showed no organisms, and all cultures were negative.

Pathologic evaluation in each patient confirmed the absence of infection. Patients with instability can present with varied symptomatology, including recurrent effusions and pain. However, all patients had well aligned and stable, fixed implants and stable joints.

Metal sensitivity is a relatively poorly understood mechanism of failure in joint arthroplasty. Histological studies by Willert et al on patients with failed metal-on-metal implants have shown a diffuse collection of perivascular lymphocytes and plasma cells in patients with metal hypersensitivity. However, the predominant reaction in patients with a metal-on-polyethylene implant was a histiocytic response. Peri-implant lymphohistiocytic infiltrates can indicate intolerance reactions. In the current study, 3 patients had a lymphocytic response whereas the others had a predominantly histiocytic response.

Granchi et al reported that the frequency of positive skin reactions to metals increases significantly after TKA, whether stable or loose. The high frequency of sensitization in a stable TKA correlated with the presence of clinical symptoms: individuals who reported moderate pain showed a higher frequency of sensitization to metals, especially to vanadium. Three of 5 patients in the current study had a positive skin patch test that confirmed metal sensitivity. However, patients may have a negative test despite being sensitive to metals. Hindssén et al reported individual variation in nickel reactivity in the same patients when tested on different occasions. The reason for variation is probably multifactorial and can include drugs, hormones, and ultraviolet radiation.

Several authors have reported cases of revision to alternative bearing surfaces as treatment once metal sensitivity is identified. Bergschmidt et al reported the successful revision of a painful TKA to a ceramic femoral component with good results. Special surface coatings have also been reported with similarly good results. In the current patients, the authors revised patients to Oxinium femoral components, which also resulted in relief of the presenting symptoms and positive clinical outcomes.

The features common to this group of patients included the use of same implant for primary TKA. All patients presented with similar clinical symptoms of persistent pain and recurrent effusion in the knee. Preoperative workup for infection and intraoperative cultures taken at the time of revision surgery were negative for infection. All patients reported significant improvement in symptoms and knee function following revision to Oxinium femoral and titanium tibial components. In previous series of patients with metal sensitivity, patients often had implant loosening; however, the implants were solidly fixed in the current patients. The authors believe that these patients represent the subgroup of patients reported by Granchi et al as having stable implants with hypersensitivity to metallic implants, and the symptoms were severe enough to warrant revision surgery in these cases.

REFERENCES


