

A Case of Catastrophic Failure of Tibial Component with Extensive Metallosis Following Total Knee Arthroplasty: A Case Report

Sharath Raj¹, Vivek P Ksheerasagar², Aditya Shah¹, Souvik Das¹, Vijay G Goni¹

Learning Point of the Article:

Extensive metallosis following total knee arthroplasty, though rare, can present years after an uneventful primary procedure with progressive deformity and instability, and warrants early radiographic suspicion ("cloud and bubble sign") so that revision with a constrained condylar system can be planned before severe bone loss develops.

Abstract

Introduction: Total knee arthroplasty (TKA) is commonly performed for severe knee disorders, but complications such as metallosis, though rare, can arise and lead to significant morbidity. Extensive metallosis following TKA is not well documented in the literature, and this report adds to the limited existing data on its clinical presentation and management.

Case Report: A 72-year-old woman who had undergone bilateral primary TKA in 2008 developed extensive metallosis after a twisting injury to the right knee in 2021, resulting in pain, swelling, and a progressive varus deformity. In September 2023, following a fall, she experienced acute pain and was found to have loosening of the prosthesis secondary to metallosis. Radiographs showed a loose tibial component with significant wear, and the "cloud and bubble sign" characteristic of metal-induced synovitis. After infection was excluded, a one-stage revision was performed using a cemented semi-constrained modular knee system. Surgery revealed severe synovial staining, metal debris, and extensive wear of the tibial base plate; the components were removed and the joint reconstructed with a constrained condylar prosthesis.

Conclusion: Postoperatively, the patient recovered well, achieving full weight-bearing and a range of motion from 0° to 100°. At 1-year follow-up, she remained symptom-free with no evidence of implant loosening or osteolysis. This case underscores the importance of long-term surveillance and early detection of metallosis in TKA patients so that revision can be undertaken before extensive bone loss occurs.

Keywords: Total knee arthroplasty, metallosis, revision arthroplasty, constrained condylar knee, osteolysis.

Introduction

Total knee arthroplasty (TKA) is a widely performed surgical procedure for managing end-stage osteoarthritis, rheumatoid arthritis, and other debilitating knee joint conditions. While generally associated with excellent outcomes, complications such as metallosis, though rare, can lead to significant morbidity. Metallosis is defined as the deposition of metal debris in periprosthetic tissues, leading to an inflammatory response that

may compromise joint function, cause pain, and necessitate revision surgery [1].

The etiology of metallosis after TKA is multifactorial, involving factors such as implant design, material wear, malalignment, or improper surgical technique. Nine different causes of metallosis (polyethylene liner dislocation, polyethylene liner wear, infectious failure, implant failure, metal-backed patellar failure, aseptic prosthesis loosening, saw blade debris, traumatic failure,

Author's Photo Gallery



Dr. Sharath Raj



Dr. Vivek P Ksheerasagar



Dr. Aditya Shah



Dr. Souvik Das



Dr. Vijay G Goni

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¹Department of Orthopedic Surgery, Postgraduate Institute of Medical Education and Research, Chandigarh, India,

²Satya Sai Orthopaedic and Multispecialty Hospital, Bangalore, India.

Address of Correspondence:

Dr. Sharath Raj,
Department of Orthopedic Surgery, Postgraduate Institute of Medical Education and Research, Madhya Marg, Sector 12, Chandigarh - 160012, India.
E-mail: sharathraj.pgi@gmail.com

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Figure 1: Anteroposterior and lateral radiographs of the right knee showing significant wear of the tibial component on the medial side after complete degradation of the polyethylene inlay.

and malalignment) have been identified in patients who have undergone TKA [2]. Metal-on-metal implants often cause progressive pain, swelling, and mobility issues. Imaging and histological findings reveal metallic debris deposits, cystic formations, and synovitis, which are crucial for diagnosis [3].

Extensive metallosis following TKA is less well documented. This paper presents a case of extensive metallosis following TKA, emphasizing its clinical presentation, diagnostic challenges, and management strategies. To the best of our knowledge, the degree of tibial component wear and bone loss in this case is among the more extensive reported, highlighting the need for vigilance in identifying early signs of metallosis and the role of surgical and non-surgical interventions in mitigating its progression.

Case Report

In 2008, a 72-year-old woman underwent successful bilateral total knee replacement with posterior-stabilized implants (DePuy Synthes/Johnson and Johnson) at a different hospital for osteoarthritis of both knees. A full range of motion was achieved during the index procedure and sustained postoperatively. The patient recovered well and remained healthy until 2021, when she sustained a twisting injury to her right knee, leading to pain and swelling. She was advised rest and oral medication by local physicians, and her symptoms improved within 2–3 weeks, allowing return to usual activities. Over the following year, she developed progressive bowing of the right knee and was advised to undergo revision surgery, which she

deferred. In September 2023, she slipped and fell while rising from a chair, sustaining severe pain in the right knee that prompted her to seek medical attention.

On examination, a well-healed midline scar from the previous surgery was noted, with minimal joint effusion in the right knee. A varus deformity of 30° was measured, fully correctable on examination with a firm end-point and no valgus instability. Range of motion was 0–100° of flexion. Tenderness was noted along the lateral joint line. No distal neurovascular deficit was present.

Radiographs revealed osteolysis affecting both the femur and tibia, with loosening of the tibial component. Amorphous, fluffy areas of increased density were seen within the periprosthetic soft tissues, along with bubble-like radiodensities outlining the supra- and retro-patellar capsule – findings characteristic of the ‘cloud and bubble sign’ associated with metallosis. A thin rim of linear increased density was also noted surrounding the infra- and retro-patellar regions. These imaging findings were consistent with advanced metallosis. Significant wear of the tibial component on the medial side was evident, occurring after complete wear-through of the medial polyethylene inlay (Fig. 1).

Laboratory evaluation showed hemoglobin of 12.3 g/dL, total leukocyte count of 6400/μL (within normal limits), C-reactive protein of 3.6 mg/L, and erythrocyte sedimentation rate of 16 mm/h.

A diagnosis of metallosis-induced prosthetic loosening was confirmed, and a one-stage TKA revision was performed using a cemented semi-constrained modular revision knee system (Zimmer Legacy constrained condylar knee [CCK]). Intraoperatively, extensive black staining was observed in the synovium, joint fluid, and surrounding soft tissue (Fig. 2). Thorough debridement and lavage were performed. Significant wear of the medial tibial tray was noted following complete



Figure 2: Intraoperative photograph showing extensive black staining of the synovium, joint fluid, and surrounding soft tissue, consistent with metallosis.



Figure 3: Intraoperative photograph showing significant wear of the medial part of the tibial tray and polyethylene inlay.

wear-through of the medial polyethylene inlay (Fig. 3). The components were removed using osteotomies; the femoral component showed aseptic loosening with severe distal femoral osteolysis, and there was significant bone loss posteriorly on the femur with metal fragments in the region of the femoral canal. Abnormal tissue was excised, and bone and soft-tissue samples were sent for histopathological and microbiological analysis. Residual cement was removed, and revision TKA was performed using press-fit diaphyseal stems and a constrained component with tibial wedges to reconstitute bone loss and restore the jointline (Fig. 4).

The patient had a smooth post-operative recovery and was allowed full weight-bearing. At 2 weeks, the wound

had healed well, and she was mobilizing with a walker, with a range of motion of 0–100° and no instability. She was followed with regular physiotherapy and monthly clinical and radiographic assessment for the first 6 months. At 1 year, she had achieved full recovery — pain-free, full range of motion, improved functional scores, and independent ambulation. The latest radiographs showed a well-positioned prosthesis with no evidence of instability, fracture, or bone loss, closely matching the immediate post-operative films (Fig. 5).

Discussion

A 72-year-old woman developed metallosis 13 years after undergoing TKA, as presented in this case report. Metallosis is not exclusive to knee replacements and can also occur after hip,

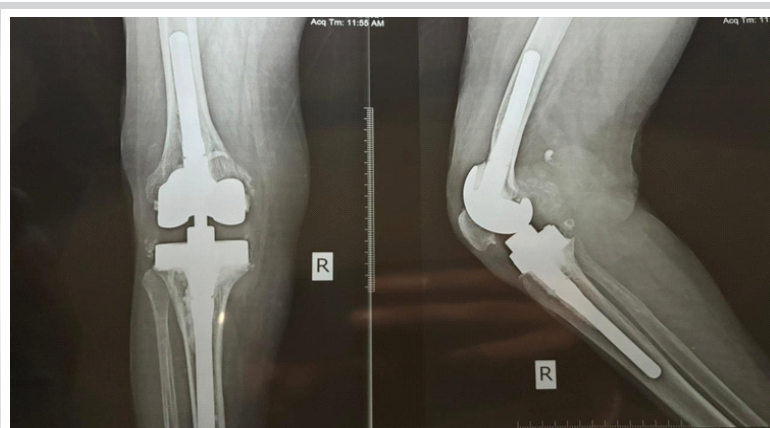


Figure 5: One-year follow-up radiographs of the right knee showing a well-positioned prosthesis with no evidence of loosening or osteolysis.

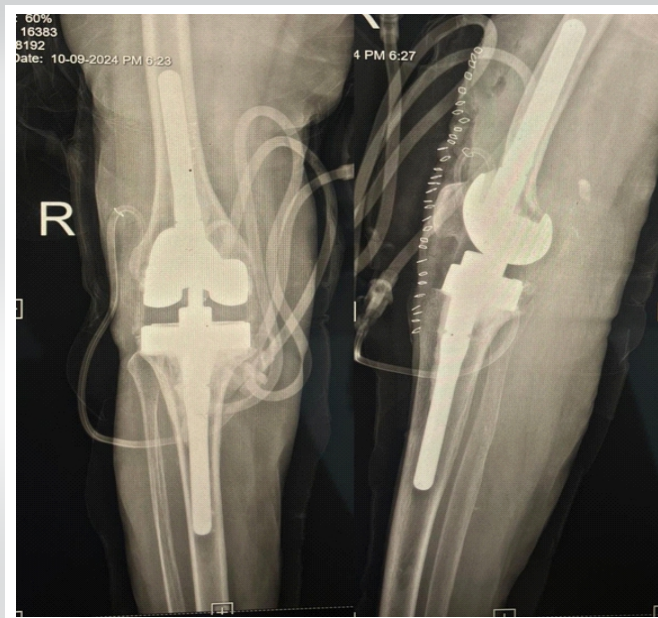


Figure 4: Intraoperative/radiographic image showing the revision implants, comprising press-fit diaphyseal stems and a constrained component with tibial wedges.

shoulder, elbow, and wrist joint replacement surgery. Its onset is thought to be triggered by mechanical factors, specifically abrasion between metal components or between metal and polyethylene surfaces, particularly in implants with a metal-backed patellar component. The likelihood of implant wear and metallosis is influenced by the materials used, with titanium components being more susceptible than cobalt-chromium components [4]. Metallic debris production is linked to the interaction between metal surfaces and polyethylene deformation; this debris infiltrates soft tissues such as the joint capsule and cavity, triggering a foreign-body reaction characterized by giant multinucleated cells. This infiltration also causes synovial fluid and surrounding tissue to appear blackish, as noted in previous studies [5]. Contemporary implants such as Smith and Nephew's Oxinium, constructed from oxidized zirconium, are designed to reduce metal wear and may lower the future incidence of metallosis [6].

In this case, post-operative knee varus instability likely led to persistent impingement, releasing metallic debris and causing chronic synovitis. This synovitis exacerbated joint destruction,

heightened instability, and accelerated wear in the medial compartment. On plain radiographs and computed tomography, three indicators – the “bubble sign,” “cloud sign,” and “metal-line sign” – have been described as useful in distinguishing metallosis from other complications following TKA, such as small-particle disease, infected prosthesis, or aseptic loosening [4, 7, 8]; osteolysis has also been noted in the context of metallosis. Metallosis can present with additional radiographic findings not observed in this case, such as reduced bone mineralization, fractures, and significant bone defects [8, 9]. These complications may be mitigated through careful debridement – synovectomy and excision of inflammatory tissue – together with revision arthroplasty [8].

Successful traditional TKA requires competent, functional collateral ligaments. In this patient, significant osteolysis due to metallosis was accompanied by notable bone deficiency on both the femoral and tibial sides. Revision surgery therefore used a CCK prosthesis incorporating wedges and stems to

provide inherent medial and lateral stability [10, 11].

Conclusion

This case report emphasizes the importance of long-term monitoring after TKA to facilitate early identification of potential complications. Early detection of metallosis allows intervention through surgical excision of affected tissue and joint revision, mitigating the risk of further joint deterioration.

Clinical Message

Extensive metallosis should be considered in any patient presenting with progressive deformity, instability, or pain years after an otherwise uneventful total knee arthroplasty. Recognition of the radiographic “cloud and bubble sign” allows early diagnosis, and a constrained condylar revision system can achieve a stable, functional joint even in the presence of severe bone loss.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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