A Catastrophic Implant Failure after Total Knee Arthroplasty

Total Diz Artroplastisi Sonrası Katastrofik İmplant Yetmezliği: Olgu Sunumu

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ABSTRACT

Wear of metallic surfaces after total knee arthroplasty is uncommon. In this case, we report a catastrophic failure of the knee prosthesis in a 60-year-old male patient who had undergone total knee prosthesis 7 years prior to his admission to our clinic. Genu recurvatum was observed in the affected knee. Surgical exploration of the knee showed wear of the polyethylene insert accompanied by metallic tibial component abrasion of the posterior-cruciate-retaining total knee prosthesis (Maxim, Biomet, Warsaw, IN, USA). Single-stage revision was performed, and a new total knee prosthesis was implanted (Legion, Smith & Nephew, Memphis, TN, USA). Postoperative examination showed improved stability and correction of recurvatum of the affected knee and follow-up examination showed improved weight bearing ability and better overall functional outcome.

Keywords: arthroplasty, reoperation, knee, Prostheses and Implants, Arthroplasty, Replacement

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ÖZET

Total diz artroplastisini takiben metalik yüzeylerin aşınması nadirdir. Bu vakada, kliniğimize başvurmadan 7 yıl önce total diz protezi uygulanan, 60 yaşında erkek hastadaki feci bir diz protezi yetmezliği olgusunu sunmaktayız. Etkilenen dizde genu recurvatum gözlenmekteydi. Dizin cerrahi eksplorasyonu, bağ koruyan total diz protezinin (Maxim, Biomet, Varşova, IN, ABD) polietilen insert'ünün aşınmasını ve buna eşlik eden metalik tibia komponentin aşınmasını gösterdi. Tek aşamalı revizyon yapıldı ve yeni total diz protezi yerleştirildi (Legion, Smith & Nephew, Memphis, TN, ABD). Ameliyat sonrası muayenede, etkilenen dizin rekurvatum'unun düzeldiği görüldü. Takiplerde, daha iyi yük taşıma kabiliyeti ve daha iyi genel fonksiyonel sonuçlar gözlendi.

Anahtar Sözcükler: Artroplasti, reoperasyon, diz, protez ve implantlar, implant yetmezliği

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INTRODUCTION

Metallosis is an immunologic and corrosive reaction of the metallic components of prosthetic devices (7, 15). Although, there have been reports of implant failures due to metallic wear of metal-on-metal articulating surfaces, only few cases of metallosis due to the failure of synthetic-insert components in knee prostheses are seen (8, 11, 14). Metallic wear after knee arthroplasty is a rare complication (11, 14). Polyethylene component failure may be related to surgical errors, patient habitus and the manufacturing process (12). Recently diagnosed polyethylene failure may propagate abrasive action among metallic components, resulting in metallic trituration. Metallic particles can cause severe complications, such as abscesses, necroses and solid or cystic tumor-like masses around the reconstructed joints (4, 10). These metal particles may trigger synovitis and inflammation, resulting in periprosthetic corrosive osteolysis and destruction of the bony architecture (4, 11, 12, 14). Early detection of failure in either polyethylene or metallic components may decrease these devastating complications (12).

We present a case of severe complications of total knee arthroplasty that occurred after polyethylene wear and failure which enabled precipitation of metallic trituration and caused metallosis.

CASE REPORT

A male patient at his 60s with the height of 182 cm and a weight of 85 kg (BMI= 25.9 kgs/cm^2) admitted to the outpatient clinic with complaints of pain and instability of his left knee. A cemented cruciate-retaining Maxim (Biomet, Warsaw, IN) total knee prosthesis was implanted 7 years ago. Four years following the first surgery, symptoms such as knee buckling or in patients own words “giving way” began to occur. As a countermeasure for this a hinged knee brace was prescribed by the operating surgeon. Later in time, recurvation of the left knee occurred, and the patient was unable to walk without the support of crutches.

According to physical examination, the patient had effusion in the operated knee; there was grade II laxity with a valgus stress test, and the posterior drawer test was positive. The crepitation during flexion of the knee joint was audible. The range of motion was measured to be from -20 degrees to 120 degrees. There was no sign of neurovascular compromise.

All laboratory tests, including serological tests for the detection of an infection, were negative. On plain X-rays, posterior cruciate insufficiency was detected via posterior dislocation of the knee. Signs of metallic debris, such as the “bubble sign” and “cloud sign”, were mostly demonstrated on the posterior aspect of the knee. Periprosthetic osteolysis was not diagnosed preoperatively. A tiny metallic particle was also observed at the deep popliteal part of the knee on X-rays (Fig. 1a and 1b).

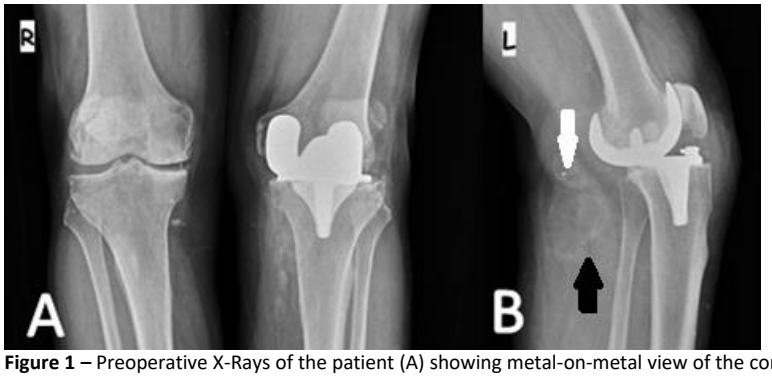

Figure 1 – Preoperative X-Rays of the patient (A) showing metal-on-metal view of the components (B)showing anterior dislocation of the tibia; Black arrow showing “cloud sign” and the white arrow showing metallic particle at the deep popliteal part of the knee

Histologic investigation of the debrided tissue showed inflammatory cells with fibrosis and foreign materials phagocytosed via multinucleated giant cells were diagnosed (hematoxylin-eosin stain × 10 magnification) (Fig. 2 A and B).

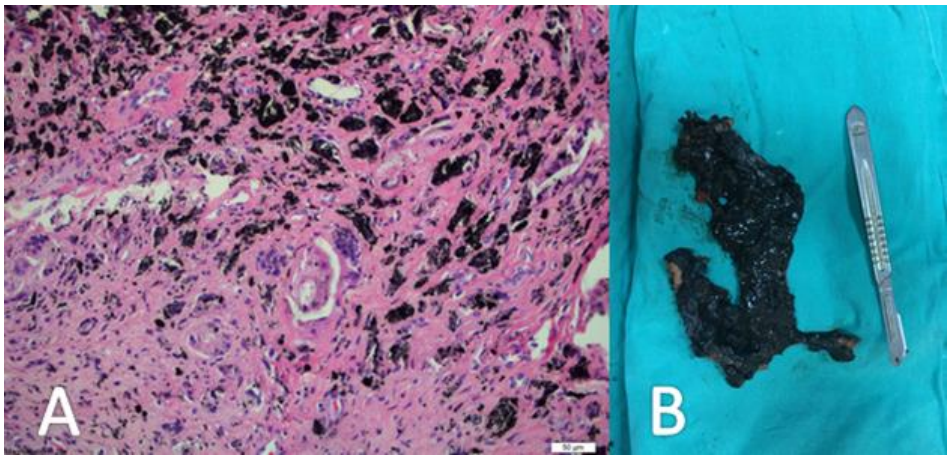

Figure 2 – (A) Microscopic view of the debrided tissue showed inflammatory cells with fibrosis and foreign materials (black) phagocytosed via multinucleated giant cells (hematoxylin-eosin stain × 10 magnification) (B) Excised black colored synovial tissue.

Operation was carried out under spinal anesthesia. After a standard midline incision, medial parapatellar arthrotomy was performed. All the inflamed synovial tissue with foreign particles was macroscopically debrided, and components were removed with ease. The posterior part of the polyethylene insert was destroyed, and the tibial metallic component beneath the insert was

eroded by the rolling force of the cobalt chromium femoral component (Fig. 3 A and B).

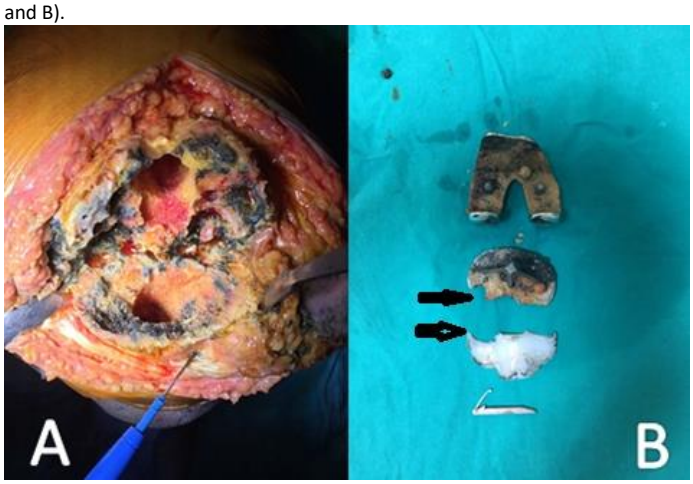

Figure 3 – (A) The cemented surface of the bones after removal of implants on both sides were filled with dark-colored material. Macroscopic osteolysis was observed in the cancellous parts of the distal femur and proximal tibia. The cortical bones were preserved on either side. (B) Removed implants; posterior part of the polyethylene insert was destroyed, and the tibial metallic component beneath the insert was eroded by the rolling force of the cobalt chromium femoral component.

The cemented surface of the bones on both sides were filled with dark-colored material. Macroscopic osteolysis was observed in the cancellous parts of the distal femur and proximal tibia. However, the cortical bones were preserved on either side. All the destructed osseous structures were debrided, and irrigation was performed with
pulsatile lavage. A Legion Revision Knee System (Smith & Nephew, Memphis, TN, USA) was used to reconstruct the knee, while metallic augmentation blocks were used to reconstruct the defects on the femoral side, and cement was used for the same purpose on the tibial side (Fig. 4).

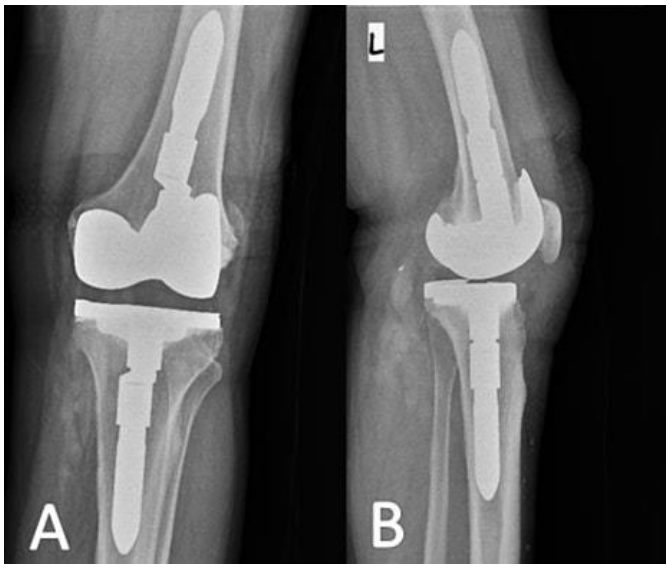

Figure 4 – *Postoperative X-ray showing revised total knee prosthesis system (A) AP (B) Lateral view*

On 1st day postoperatively patient was mobilized with a walker allowed to bear weight on the affected knee and was encouraged to perform passive and active range of motion exercises. Patient was discharged on the 2nd day of operation.

On the 3rd week of postoperative follow-up 0° active extension and 120° active flexion was observed. Recurvatum of the knee was corrected and posterior drawer test was negative. Patient was still mobilized with a walker. On the 6th week postoperatively patient was allowed to move without support and was able to carry out most of his routine tasks relying less on analgesics.

DISCUSSION

Metallosis is an immunologic and osteolytic reaction induced by the metallic particles around metallic implants (7, 8, 15). This complication has been rarely reported after joint replacement surgery (11, 12, 14). Regardless of the advent of metal-on-metal surface materials, inflammation induced by metal particles is a complication that has been reported earlier in the literature(4). Pathologic reactions, such as osteolysis, aseptic loosening and periprosthetic fractures due to cellular toxicity have been reported as the challenging problems leading to implant failure occur after successful prosthetic joint replacement (10, 14). However, very few cases describing metallic-component failure after successful prosthetic knee implantation have been reported.

Technological practice of the production of implants is an important issue affecting the expected in vivo longevity. The irradiation and subsequent annealing or re-melting of polyethylene decreases free radicals while increasing its mechanical properties (3, 9). On the other hand, reported studies show that annealing or gamma ray sterilization unfavorably affects the microstructure of the polyethylene insert and may result in unpredictable outcomes (12). In a recent study, it was shown that implants that are gamma irradiated and stored in air or in an inert environment had a higher damage rate than inserts sterilized by ethylene oxide gas in gas-permeable packaging (3). The polyethylene insert used in our patient (Maxim, Biomet, Warsaw, IN, USA) was gamma irradiated by argon in a gas permeable packaging. Although there was no evidence regarding which of the components failed first, it seemed to us that synthetic component failure might have occurred prior to metallic tray failure, leading to trituration of the metallic components and metallosis.

Patient-related factors such as age, sex, weight and activity level in addition to surgical factors such as ligament balancing and alignment may also be related to the longevity of implants (1, 13).

Synovitis induced by worn particles is a common symptom; however, hypersensitivity due to metal ions and toxic reactions have also been observed in rare cases. Although there are multiple factors contributing to metallosis, metal particles inducing chronic inflammation leading to osteolysis have been reported in numerous studies (2, 6). We did not observe any toxic or hypersensitivity reactions in our patient; however, inflamed and dark-colored synovial tissue was observed during the surgical procedure. Histologic examination of the tissue showed multinucleated giant cells that had phagocytosed foreign material and inflammatory cells, corroborating osteolysis induced by wear of the metal and synthetic components.

Metallosis shows signs of failure on radiographic analysis. The “metal-line sign”, “cloud sign” and “bubble sign” are described as radiographically abnormal signs for suspected metallosis. These appearances on X-rays are suspected to be microscopic abrasion particles seated in the soft tissue around the knee. We were able to observe a “cloud sign” around the knee joint and a tiny metallic particle break from the tibial tray in the “cloud” (5).

Wear of the components in knee arthroplasty is uncommon and is attributed to many factors, as discussed above. Although we had no information about our patient’s preoperative condition in the primary surgery, the patient was not evaluated as overweight prior to the revision procedure. It seems that the synthetic components could not resist loading during daily activities and failed uneventfully, leading to the trituration of metallic components.

CONCLUSION

Early polyethylene failure after successful knee arthroplasty is multifactorial. We report a catastrophic failure of the synthetic and metallic components of a knee prosthesis in a male patient. Inflammation triggered by the wear of metallic and synthetic components destroyed the osseous structure beneath the implants. Improvement in the manufacturing and packaging processes of polyethylene inserts should be encouraged to decrease complications due to the failure of synthetic material. Patients should be carefully evaluated during outpatient visits even if successful surgery has been performed.

Conflict of interest

No conflict of interest was declared by the authors.

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