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Case report

Early failure with massive metallosis and posteromedial wear following atraumatic anterior cruciate ligament rupture after medial unicompartmental knee arthroplasty

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ABSTRACT

Severe metallosis following medial unicompartmental knee arthroplasty (UKA) is relatively rare. It is usually due to long-standing wear of the polyethylene component, resulting in frictional wear between the femoral and tibial metallic components. Biomechanical and cadaveric studies have shown the effects of anterior cruciate ligament (ACL) transection following medial UKA. We describe a case of a 58-year-old male who developed attritional rupture of the ACL 16 months following medial UKA leading on to early accelerated failure over the next 8 months. The patient underwent revision to total knee arthroplasty with good outcome. The clinical effect of spontaneous ACL transection on medial UKA causing abnormal posteromedial wear of polyethylene component and tibial tray, massive metallosis, and worsening of mechanical axis can be demonstrated in this case report.

Introduction

Metallosis is the abnormal deposition of metallic debris and/or electrically active particles in the periprosthetic soft tissue secondary to metallic corrosion causing localized inflammatory reaction and synovitis and complications resulting from the same [1]. Accumulation of polyethylene particles from polyethylene wear is termed as plasticosis [2]. These phenomena are a result of friction and wear between the components implanted across a prosthetic joint and result in local osteolysis and loosening of the prosthesis.

Severe metallosis requiring revision is most common following a total hip arthroplasty (incidence of 2%-5%), especially with the use of metal-on-metal articulating surfaces [3]. It is less common following a total knee arthroplasty (TKA) and is even rare after a unicompartmental knee arthroplasty (UKA) and is due to long-standing polyethylene wear resulting in frictional wear between the metallic femoral and tibial components [4,5].

An intact anterior cruciate ligament (ACL) has been considered a prerequisite for a successful UKA and has been proven in biomechanical and cadaveric studies [6]. We report a 58-year-old male who developed a spontaneous attritional/degenerative rupture of the ACL 16 months following medial UKA. He developed progressively increasing instability with an abnormal posteromedial wear pattern over the polyethylene insert and metal backed tibial component, massive metallosis, osteolysis and component loosening, tibial tray subsidence, and progressive worsening of the mechanical axis. The clinical effect of a spontaneous ACL rupture on medial UKA causing early failure can be demonstrated through this case report.

Case history

A 58-year-old male presented with 8-month duration of increasing pain and swelling over the left knee. There was no localized erythema, increased temperature, or discharge that could suggest a septic etiology.

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Two years prior to this, he had presented with primary degenerative osteoarthritis involving both knees with a Knee Society Score (clinical, KSS) and Oxford Knee Score (OKS) of 72 and 35 (left knee) and 64 and 28 respectively (right knee) with predominant medial compartment involvement on the left knee. The overall University of California, Los Angeles (UCLA) activity score was 3. A medial UKA was performed on the ipsilateral (left) knee and a TKA was done for the right knee. The immediate postoperative radiographs of the left knee showed a well-fixed unicondylar implant in slight varus alignment with no evidence of retained cement or debris (Fig. 1).

At 1-year postoperative review, the functional scores were higher on the left knee (compared to right knee) (KSS 88 vs 84 and OKS 42 vs 39) and the UCLA score was 8, with history of preferential weight bearing on the left side especially during stair climbing. Radiographs done at this stage were similar to the immediate postoperative radiographs with no evidence of radiolucent lines, implant loosening, or metallic debris.

At 2-year follow-up, he complained of progressively increasing pain and persistent swelling over the left knee, which had been present for the past 8 months. He complained of instability and reduced confidence in bearing weight over the left knee (KSS 48, OKS 19). The contralateral knee was asymptomatic. He had a significant reduction in his activity levels (UCLA 3) due to left knee pain. There was no history of trauma although he gave history of minor twisting injury without fall while walking 8 months earlier following which his symptoms had started and increased progressively. He was of average built (basal metabolic index 29.4 kg/cm^2), nondiabetic, and without any medical comorbidities. Besides known allergy to sulfa group of drugs, there was no history of allergy to metal or other organic/inorganic materials.

Physical examination revealed tenderness over the medial joint line and a diffuse suprapatellar effusion over the left knee with a passive range of motion from 0° to 100°. Previous surgical wound was healthy with no local rise in temperature, erythema, or pigmentation over the knee. There was instability on anteroposterior and varus-valgus stress testing.

Knee radiographs revealed particulate densities behind the posterior femoral condyles. The medial joint space was completely diminished and the femoral component was in contact with the posterior aspect of the metal backed tibial component (Fig. 2). Radiolucent lines and cystic changes were seen underneath the metallic tibial tray and also surrounding the 2 tibial studs with evidence of loosening of the femoral and tibial components.

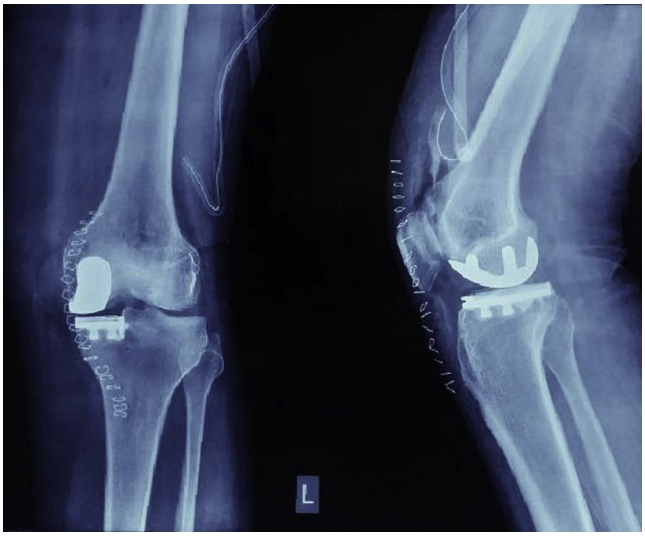

Figure 1. Immediate postoperative radiographs following index medial compartmental arthroplasty surgery showing well-fixed and well-aligned femoral and tibial components.

Figure 2. At 2 years of follow-up, anteroposterior and lateral radiographs of medial UKA knee showing posterior displacement of femur, absent medial joint space, and increased femorotibial contact area.

A blackish tinged synovial fluid was aspirated with a white blood cell count of 5400/mm^3 and 35% neutrophils. Leucocyte esterase was not detected and 2 days of culture did not reveal any organism. The erythrocyte sedimentation rate was 7 and C-reactive protein <0.6 g/dL. A diagnosis of aseptic loosening of the implant with metallosis was made and a revision to a TKA was planned.

Intraoperatively, extensive blackish staining of the synovium, capsule, and the surrounding tissue was noted (Fig. 3). The synovium was rubbery in consistency and blackish staining of the synovial fluid was noted. Complete synovectomy was performed along with debridement of the surrounding tissue to debulk the metallic debris without compromising the integrity of the collateral ligaments. The ACL was found to be deficient which may have occurred due to an attritional rupture since there was no significant history of trauma or fall. There was full thickness wear of the posterior one-third and posteromedial aspect of the polyethylene component and the tibial tray (Fig. 4). The femoral component was loose but the anterior half of the tibial tray was well fixed. There was evidence of osteolysis underneath the femoral component and posterior aspect of tibial component with subsidence of the metallic tibial tray.

Figure 3. Intraoperative image showing black rubbery synovium due to massive metallosis.

Figure 4. Full thickness wear of the tibial polyethylene insert and metallic tray.

Closer inspection of the prosthesis revealed full thickness erosion of the posterior one-third to one-half of the polyethylene component and the tibial tray (Figs. 5 and 6). The prosthesis retrieved included a cobalt-chrome femoral component, a titanium tibial tray, and a fixed flat 8-mm polyethylene insert (Zimmer unicondylar knee prosthesis; Zimmer Biomet, Warsaw, IN).

Intraoperative culture samples were negative. Histological examination revealed fibrosis and a granulomatous reaction with multinucleated giant cells and histiocytes consistent with metallosis (Campbell-ALVAL [aseptic lymphocyte-dominated vasculitis-associated lesion] score 4).

A revision TKA was performed using a posterior-stabilized cemented total knee prosthesis (Zimmer NexGen, Warsaw, IN) with the use of long cemented stem extension on the tibial side (Fig. 7).

Figure 6. Metallic tibial component showing full thickness wear over the posterior one-third.

The patient was started on immediate weight bearing as tolerated. Active and passive range of movement exercises were started from the third day postoperatively. At last follow-up after 2 years, the patient had good functional outcome (KSS 82 and OKS 40), UCLA score of 7, and an active range of movement from 0° to 100°.

A written informed consent was taken from the patient to be included in this case report.

Discussion

UKA is an appealing and usually preferred treatment option in young and middle-aged patients suffering from symptomatic osteoarthritis involving a single compartment. A fixed-bearing polyethylene insert was used in our case and the survivorship in such designs has been reported to be up to 95% at 6 years, 92% at 11 years [7] and 85%-90% at 20 years [8]. The most common complications following a fixed-bearing insert include progression of

Figure 5. Polyethylene insert showing full thickness wear over the posterior half.

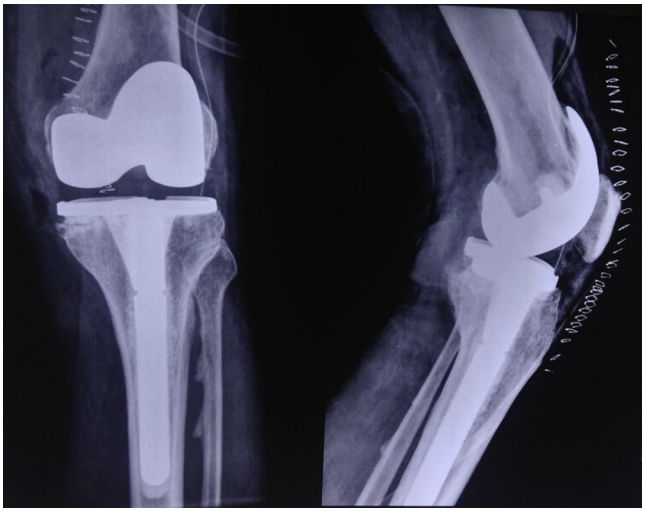

Figure 7. Postoperative radiographs after revision with a posterior-stabilized total knee prosthesis with tibial stem extension.

contralateral compartment arthritis (0.29%) and component loosening (0.22%) [9].

Polyethylene wear is usually seen at an average of about 8.3 years following fixed-bearing UKA [10] and is not the most common cause of failure. Epinette et al [11] in their review of 418 failed UKAs noted that the main causes of failure include component loosening (45% of cases) and progression of contralateral osteoarthritis (15% of cases), while polyethylene wear constituted 12% of the cases.

Early onset polyethylene wear causing significant metallosis has been described following TKA [4] but is rare following UKA. Progressive lengthening of the ACL leading to increasing instability has been recognized in the literature [12]. Increasing instability, accelerated polyethylene wear, catastrophic metallosis, and aseptic loosening developed over 8 months in our case report. The clinical and radiological evaluation at 1 year post-operative follow-up was unremarkable with no evidence of retained cement, metallic debris, reduction of medial joint space, or evidence of implant loosening. Based on the clinical history of progressively increasing symptomatic instability, intraoperative finding of an absent ACL, and a posterior wear pattern of the polycomponent and the tibial tray, we attributed the cause of failure to an atraumatic attritional rupture of the ACL causing eccentric (posterior) loading of tibial insert and progressive worsening of the mechanical axis. In this context, a brief discussion on the importance of ACL in medial compartmental UKA deserves mention.

An intact ACL is considered a prerequisite for performing a UKA [13]. Clinical and biomechanical/kinematic studies conducted on UKA in ACL deficient knees have documented higher rates of aseptic tibial loosening and polyethylene wear [14] and hence reduced survivorship.

The effect of ACL transection after medial (fixed-bearing) UKA was studied in a robotic study carried out in intact cadaveric knees buy Suggs et al [6]. They demonstrated an increased posterior displacement of the femur (average 5.4 mm) over the tibia maximal at low flexion angles between 0° and 30° flexion following ACL transection after medial UKA. This resulted in a posterior femorotibial contact point and increased range of articular contact on polyethylene component. The femorotibial contact point should be less than or equal to 4 mm from the middle of the tibial plateau. Eccentric point of contact >4 mm leads to abnormal wear [15].

This posterior shifting of femur (and eccentric point of contact) explains the abnormal posteromedial wear of the insert and the tibial component retrieved in our case, which is in contrast to the characteristic anteromedial wear seen in UKA with intact ACL reproducing the anteromedial osteoarthritis pattern seen in knees with intact ACL and medial compartment osteoarthritis [16].

Abnormal loading of the posterior one-third of the tibial component combined with localized osteolysis leads to progressive subsidence of the tibial tray and gradual increase in the posterior tibial slope and varus alignment of the tibial component. This is proven to lead to an increase in the anterior tibial translation [17]. Suero et al [18] noted that 8° decrease or leveling of the slope reduced the magnitude of tibial translation in ACL deficient UKA knees by approximately 5 mm. It has been recommended to keep the tibial slope below 7°, particularly in ACL deficient knees to reduce the chance of failure of UKA [19].

It has been observed that tibial component malalignment leads to tray subsidence and wear even with a neutral limb alignment. Srivastava et al [20] by retrieval analysis of tibial insert (average implantation duration of 7.7 years) showed that tibial components initially placed at greater than 3° varus were associated with almost twice the volumetric penetration and increased wear.

These above factors acting in concert seem to have caused progressive varus alignment and the accelerated wear and severe metallosis seen in our case. While the effects on ACL transection has been studied in cadaveric and biomechanical models, this case report demonstrates the actual effects of ACL deficiency (acute) on the outcome of medial UKA.

Although the importance of ACL in UKA is considerable, patients with absence of functional impairment and instability due to ACL deficiency (termed as “copers”) seem to have excellent survival rates without any higher rate of polyethylene wear or tibial component loosening [21]. Excluding patients with symptomatic instability, Engh and Ammeen [22] reported a survival rate at 6 years to be 94% in ACL deficient knees (68 fixed-bearing UKAs) and 93% in ACL intact knees (706 fixed-bearing UKAs). It is still a matter of debate of conducting UKA in ACL deficient knees. Isolated UKA without ACL reconstruction can be considered in carefully selected patients, with no preoperative clinical instability, and especially in older individuals.

Summary

The case presented in this report highlights the biomechanical and clinical importance of ACL after a medial UKA. It is necessary for surgeons to keep a high degree of suspicion to recognize a spontaneous atraumatic ACL rupture following UKA at an early stage. The chances of rapid progression of failure with implant loosening and metallosis should be explained to such patients and a revision surgery should be carried out at an early date.

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