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Case Report

Periprosthetic Femur Fracture Through a Large Osteolytic Lesion After Total Knee Arthroplasty

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ABSTRACT

Osteolysis due to polyethylene wear is a well-known complication associated with total knee arthroplasty (TKA). Here, we present the case of one failure that has been rarely reported. We report the case of a 51-year-old male who fractured through a large osteolytic lesion in his femur after a previous TKA. The patient presented 4 years after revision TKA after a fall and was found to have fractured through the large lesion. After a diagnostic workup, he was treated with open reduction and internal fixation (ORIF) of the distal femur fracture, and the fixation was augmented with a morselized femoral head allograft and ViviGen (LifeNet Health, Virginia Beach, VA). Osteolysis secondary to polyethylene wear and reactions to arthroplasty components continues to be an ever-present complication of TKAs.

Introduction

Periprosthetic osteolysis remains a common failure of total knee arthroplasties (TKAs). This osteolysis can result from an innate immune reaction of macrophage activation in response to particle wear leading to an increased inflammatory response [1-3]. Wear particles from polyethylene, polymethylmethacrylate, and metal are phagocytosed by macrophages, and this in turn drives an increase in osteoclastic activity. The increase in osteoclast activity results in the resorption of bone, and often this will impact the bone-implant interfaces. This inflammatory reaction can lead to extraosseous soft-tissue masses, intraosseous osteolytic pseudotumor lesions in the bone, or cause loosening of components with potential structural failures [2,3]. More recent advancements in polyethylene technology and sterilization processing including radiation exposure, incorporation of synthetic vitamin E, and component storage in oxygen-starved environments have all had positive impacts on polyethylene performance, decreasing the incidence of periprosthetic osteolysis [4,5].

There is limited literature regarding osteolytic lesions in the supracondylar region of the femur due to polyethylene wear. The incidence of femur fracture through polyethylene-induced osteolytic lesions is extremely rare. In the described cases, those patients were treated with distal femur replacements or hinge total knee with allografting as a revision TKA [3,6-9]. Here, we present a case in which a patient developed a large periprosthetic osteolytic lesion in the femur and subsequently fractured through the lesion, which we treated with open reduction and internal fixation (ORIF) of the femur. Written informed consent was obtained from the patient for publication of the de-identified information included in this case report.

Case history

The patient is a 51-year-old male who presented to the emergency department with left leg pain and knee swelling after a slip and fall on the ice where he landed directly on his left knee in 2021. Pertinent surgical history includes a previous left TKA in 2011, performed at an outside institution, which subsequently was complicated by aseptic loosening of the tibial component with an isolated tibia component revision in 2017. Since his revision surgery until the time of the fall, the patient had no complaints regarding his knee. At the time of his initial presentation, on physical examination, there was an effusion noted about the knee with soft-tissue swelling along the anteromedial thigh and significant shortening of the leg in comparison to the contralateral side. The patient was otherwise neurovascularly intact to the left lower extremity.

Radiographs of the left knee and femur demonstrated a pathologic, comminuted, periprosthetic supracondylar femur fracture

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about a well-fixed, cemented, posterior stabilized femoral component of a TKA (Fig. 1). At the level of the fracture, a large osteolytic lesion that measured approximately 5 × 9 cm was noted.

At the time of the initial presentation, imaging including magnetic resonance imaging of the left thigh was ordered, in addition to computed tomography of the chest, abdomen, and pelvis. Lab work also included erythrocyte sedimentation rate, c-reactive protein, serum protein electrophoresis, urine protein electrophoresis, thyroid-stimulating hormone, Lactate dehydrogenase, complete blood count, basic metabolic panel, and coagulation studies. At the time of the patient's initial presentation, the differential diagnosis for this lytic lesion included osteolysis secondary to polyethylene wear, primary sarcoma, metastatic disease due to unknown primary malignancy, and infection. MRI of the left thigh was without concern for neoplastic process. The computed tomography was negative for any signs of primary malignancy or metastatic disease, and all lab work was found to be within normal limits.

Intervention

After the initial workup appeared to be benign, the patient was taken for an open biopsy of the femoral lesion. Hematoma from the fracture site was sent for both cell count and culture, and the tissue biopsy was sent for both fresh-frozen and permanent section. The frozen section was called back from pathology to the operating room with no concerns for neoplastic process. Under fluoroscopy, the femur was pulled out to length, rotational stress was placed on the distal fragment, and the femoral component moved in congruity with intact femoral condyles. The patient was then returned to the surgical floor and without complication while awaiting final culture and pathology results.

Within 48 hours of open biopsy, final cultures remained negative, and in the final pathology, it was determined that this lytic lesion was due to osteolysis likely secondary to polyethylene wear and that there was little concern for a malignant or infectious process. The patient does have a mobile-bearing polyethylene tibial component, which is susceptible to wear on both surfaces in addition to any patellar wear. However, as his tibial component was revised in 2017, it was unlikely that the wear and osteolysis had all occurred within the past 4 years unless there was severe third body wear. Our plan was then for a 2-stage process with an initial ORIF of the distal femur with a subsequent revision TKA with debridement and polyethylene exchange once he healed both the fracture and prior incision. Our decision-making for a 2-stage procedure in part due to the availability of the polyethylene component, as it was not readily available locally, which would have required a special order, with an uncertain time frame, and within limitations in size availability. There was consideration for a single-stage procedure, but it was felt that the risks of surgical delay, while waiting on components, outweighed the benefits in this instance. The patient was then taken for curettage of the lytic lesion with subsequent ORIF with grafting of the lytic lesion. The bony defect was filled with a combination of 25 mL of ViviGen (LifeNet Health, Virginia Beach, VA) mixed with 0.5 g of vancomycin powder and morselized, fresh-frozen femoral head allograft that was ground via bone mill. A 16-hole stainless steel LCP Distal Femur Plate (Synthes, West Chester, PA) was used in a bridging pattern for fracture fixation (Fig. 2). In the acute postoperative period, the patient was made non-weight-bearing with no range of motion (ROM) of his knee and was placed in a knee immobilizer. He was started on apixaban 2.5 mg twice daily for venous thromboembolism prophylaxis. On postoperative day one, the patient was doing well, had passed physical therapy, and was safely discharged home.

Follow-up

At 2 weeks, the patient was able to start knee ROM from 0° to 90°, and then he was transitioned to toe-touch weight-bearing for

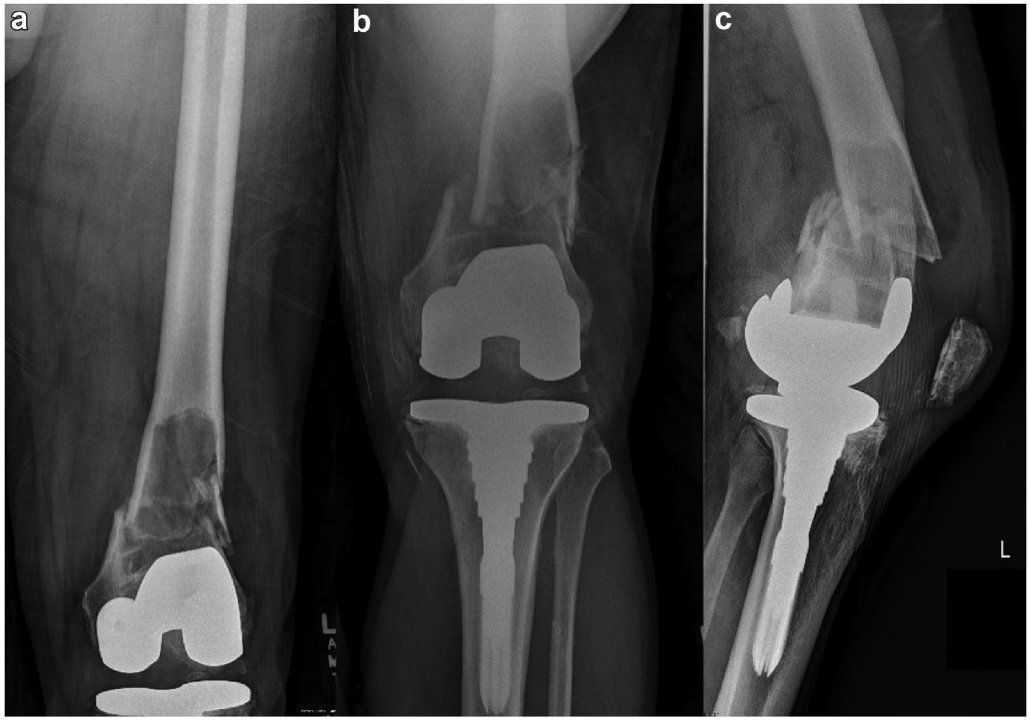

Figure 1. (a and b) Anteroposterior (AP) and (c) lateral radiographs of the left femur demonstrating a comminuted, periprosthetic supracondylar fracture about a well-fixed, cemented posterior-stabilized femoral component of a total knee arthroplasty through a massive osteolytic lesion measuring 5 × 9 cm.

Figure 2. (a and b) AP and (c and d) lateral, immediate postoperative radiographs of the left femur demonstrating fracture fixation with lateral plating and allograft augmentation of the osteolytic lesion. Of note, the plate was placed more posteriorly within the distal segment of the fracture to attempt to achieve a better fixation in the limited bone stock remaining, which was quite poor directly behind the femoral flange.

balance and started physical therapy. By 8 weeks, he began advancing his weight at 25% intervals every 2 weeks until 100% weight-bearing. At 15 weeks, the patient was doing well with minimal pain and was continuing to work with physical therapy with active knee ROM 10°-95°. After extensive work with physical therapy and a prolonged period without weight-bearing restrictions, the patient was able to gain full extension of his knee. At the 28-week follow-up, knee ROM was 0°-105°, otherwise normal strength and gait on examination. Radiographs at 28 weeks showed increased callus formation at the fracture site with continued bony remodeling at the site of the lytic bone lesion.

The patient moved out of state shortly after the 28-week visit but returned for follow-up at 2.75 years postoperatively. At the time of follow-up, he was doing well with mild occasional pain and was complaining mainly of anterior thigh and trochanteric bursal pain. Radiographs at the 2.75-year follow-up demonstrated a broken proximal cortical screw with bony overgrowth about the proximal aspect of the plate with an abundant amount of callus and exuberant healing over the known previous distal femoral lesion. There were no growth signs of loosening fracture or dislocation; however, there is cement around the mobile-bearing polyethylene most prominent posteriorly (Fig. 3).

The patient was sent for additional physical therapy for the quadriceps pain and trochanteric bursitis for strengthening and stretching of the left quadriceps and iliotibial band. He denied any pain about the knee joint, and the patient was advised to follow up on an annual basis for monitoring. We have discussed with the patient the likely need for revision TKA for the exchange of the

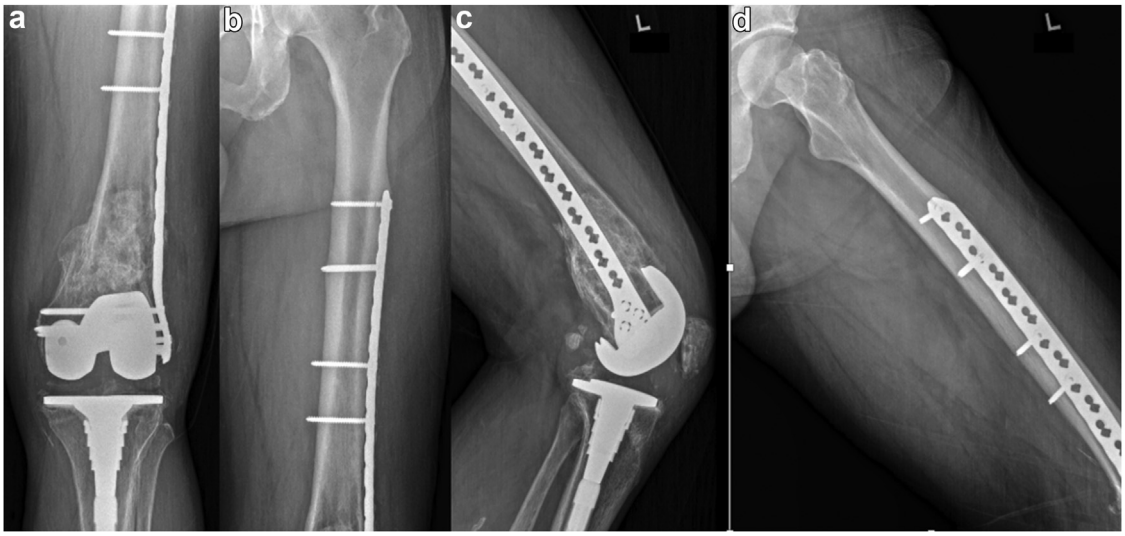

Figure 3. (a and b) AP and (c and d) lateral, 2.75-year postoperative radiographs of the left femur demonstrating abundant fracture callus and healing of the previous osteolytic lesion. Of note, the most proximal cortical screw is broken at the level of the threads with bony overgrowth at the most proximal aspect of the plate.

polyethylene and removal of potential debris leading to third body wear to prevent further osteolysis in the future. However, currently, the patient is not interested in further operations as he is currently asymptomatic in his knee, and there are no further signs of progression of the osteolysis on most recent imaging.

Discussion

There are many reports in the literature regarding periprosthetic osteolysis about TKAs, but there is more evidence regarding the tibial rather than the femoral side. In the limited cases with massive osteolytic lesions within the femur, all previously reported cases were treated with distal femur replacements or hinge total knee with allografting as a revision TKA [3,6-9]. This case is the only reported case of fracture treated with ORIF supplemented with allograft rather than primarily treating the patient with a distal femoral replacement.

In our case, the knee components were stable in this young patient, and the tibial component was revised 4 years before the fracture for aseptic loosening. On his radiographs immediately prior to knee revision in 2017, there was subtle evidence of a lytic lesion within the supracondylar region of the femur but was not mentioned in clinic notes. His tibial component was revised to a mobile-bearing polyethylene tibial component, which is susceptible to wear, especially backside wear if debris were to be stuck between the tibial tray and the polyethylene bearing. In the 2-year follow-up radiographs in 2019, the large osteolytic lesion in the femur was more pronounced than it was in his preoperative radiographs (Fig. 4), but it was not mentioned in the clinic notes. While we were concerned that this lesion was an osteolytic reaction to third body wear, there were multiple considerations made when deciding on ORIF alone rather than ORIF with polyethylene exchange. In previous cases in the literature, the patients were all 62 years or older [3,8,9], while our patient was 51 years old. Given his age and his higher demand activities, a revision distal femoral replacement was not the ideal choice. As previously stated, some of the decision-making process was based on product availability, and the polyethylene component was not readily available and would have further delayed patient care. The closed-box design of this particular posterior stabilized implant limited the ability for retrograde nail usage in combination with our fixation construct. The fracture was fixed through a large, open lateral extensile approach, and a new incision would have had to be made to access the knee joint for polyethylene exchange. In this case, due to the patient's history of previous TKA and TKA revision for tibial component loosening, our goal was to avoid the introduction of additional close or intersecting incisions over the knee due to the risk of devascularization of the skin and wound-healing complications. An approach such as the swashbuckler can be considered in some instances; however, there was concern for further stripping and devascularizing the distal segment in this case. In addition to the concern for an additional incision, any other procedures would have added to an already prolonged operative time with a greater infection risk as the fracture was. Therefore, we elected for fracture fixation with a lateral femoral locking plate with curettage and subsequent grafting that went on to heal well with significant remodeling of the bony void. Performing fracture fixation alone first would then allow for immediate full weight-bearing and aggressive therapy for ROM following a future revision TKA procedure. If a single-stage procedure was performed with fracture fixation and polyethylene exchange done with one incision, weight-bearing status would still have been limited and therefore potentially hindered proper rehabilitation of his knee revision. The second stage of treatment for this patient will be a revision TKA,

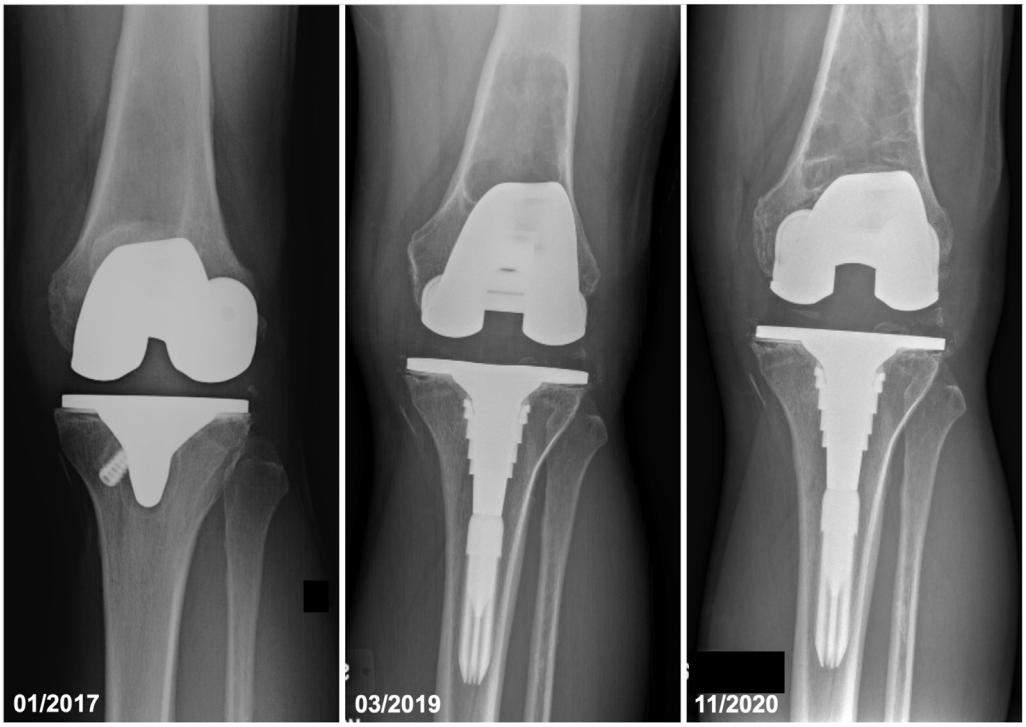

Figure 4. Multiple AP radiographs of the left knee demonstrating the progression of the massive osteolytic lesion within the left distal femur captured during follow-up visits for revision left total knee arthroplasty and right total knee arthroplasty.

which would include a minimum of irrigation and debridement of any debris with polyethylene exchange. At this time, however, the patient is not yet willing to consent to revision, despite recommendations as he does not wish to undergo surgery when he is currently asymptomatic and with his current life circumstances. While there are valid concerns about waiting on revision surgery, we have extensively discussed this with the patient throughout his fracture follow-up, and we still plan to perform a TKA revision with polyethylene exchange and will closely monitor him in routine follow-ups with radiographs. The results, in this case, have allowed the patient to maintain more native femoral bone stock and leave more revision options available if he ever goes on to future prosthetic failure. Based on pathology and microbiology results, we believe that this lesion was the result of an immune response to foreign material; however, there is a remote possibility that the lesion could be due to a chronic, culture-negative infection, although this seems unlikely as he was infection free nearly 3 years later.

Even with advances in implant technology, the etiologies of periprosthetic osteolysis and aseptic loosening are still not well understood [1]. There is no current consensus on osteolytic lesions and when it is acceptable to monitor lesions vs surgical intervention based on lesion size. These seem to be more clinical decisions based on the progression of lesions and any associated symptoms. It has been suggested that metaphyseal lesions without cortical involvement can be managed with stemmed revision components and bone grafting [2]. For large lesions and those that do have cortical involvement, using mega-prosthetics or revision prosthetics with allografting would allow for greater levels of stability and the possibility of removing all affected bone and tissue [3].

Summary

As there continues to be a growing population of patients receiving TKAs, periprosthetic osteolysis will likely continue to be a large contributor to TKA failure. One must continue to be vigilant in the postoperative period looking for possible periprosthetic osteolysis in an attempt to avoid significant complications, as seen in this case.

Conflicts of interest

D.M. is a paid consultant for Stryker Orthopedic Instruments. H.P. has nothing to disclose.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2024.101446.

Informed patient consent

The author(s) confirm that written informed consent has been obtained from the involved patient(s) or if appropriate from the parent, guardian, power of attorney of the involved patient(s); and, they have given approval for this information to be published in this case report (series).

CRediT authorship contribution statement

Haley Prough: Writing – review & editing, Writing – original draft. **Daniel Mesko:** Writing – review & editing, Supervision.

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