

Case Report

Magnetic Resonance Imaging to Evaluate Osteolysis Around Total Knee Arthroplasty

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Abstract: Wear-induced osteolysis remains a common problem after total knee arthroplasty and may be particularly difficult to detect clinically or radiographically around the femoral component. We describe the use of magnetic resonance imaging to identify particulate-induced osteolysis around the distal femur and proximal tibia in 2 patients with total knee arthroplasties. The extent of the osteolysis was not apparent from standard x-rays, and the information provided by the magnetic resonance imaging facilitated preoperative discussion with the patient as well as preoperative planning for the surgery. **Key words:** total knee arthroplasty, osteolysis, magnetic resonance imaging, revision, polyethylene wear.

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Polyethylene wear remains a common problem after total knee arthroplasty and may result in severe osteolysis requiring revision of the total knee components and bone grafting with particulate bone grafts or structural bone graft [1-4]. Although osteolysis around tibial components is often readily evident on routine x-rays, osteolysis around the femoral component of a total knee arthroplasty can be difficult to visualize behind the

femoral component. In addition, osteolysis, which is apparent on the preoperative x-ray, is often found to be more extensive at the time of surgery than it appeared to be on the preoperative x-ray [5]. Modification of clinical magnetic resonance imaging (MRI) acquisition techniques has made it possible to visualize structures adjacent to orthopedic hardware [6]. In this report, we describe 2 patients with significant osteolysis around the distal femur that was not readily evident on preoperative x-rays but was clearly demonstrated by MRI.

Case Report

Case 1

Patient 1 is a 62-year-old woman who underwent bilateral cruciate-substituting total knee arthroplasty in 1998 (PFC Total Knee System, DePuy Orthopedics, a Johnson&Johnson Co, New Brunswick, NJ). She did well postoperatively and continued to be pain-free. At her most recent

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Fig. 1. A, Anteroposterior x-ray demonstrating in satisfactory alignment without evidence of osteolysis. B, Lateral x-ray demonstrating well-fixed components in mild hyperextension with slight lucency in the central distal femur.

routine follow-up visit in July 2004, she was noted to have increased recurvatum of both knees with moderate instability of the left knee and large popliteal fluid collections bilaterally.

Radiographs demonstrated mild recurvatum with effusions of each knee and perhaps some slight lucency in the distal femur on the lateral view of the right knee (Fig. 1). As the physical examination changes of increased hyperextension, instability, and cyst formation as well as the lateral



Fig. 2. Turbo spin-echo PD-weighted coronal image of the right knee of patient 1, demonstrating a large area of central lysis on the femur. No lysis is evident around the tibia.

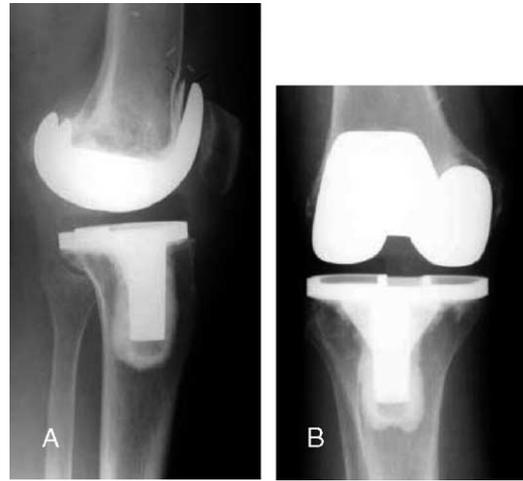


Fig. 3. A, Lateral x-ray demonstrating lift-off of the anterior flange of the femoral prosthesis because of loosening with little evidence of osteolysis on the femur or the tibia. B, Anteroposterior x-ray demonstrating mild osteolysis along the medial femoral condyle and proximal lateral tibia.

x-ray were suspicious for polyethylene wear, MRI of each knee was ordered.

MRI examinations of the knee were obtained using a Philips Intera 1.5-T magnet and a dedicated phased array knee coil (MRI Devices, Orlando, Fla). The MRI demonstrated large popliteal fluid collections around both knees, large joint effusions bilaterally, and an area of osteolysis in the central portion of the distal femur of the right knee (Fig. 2). At the time of revision surgery, severe polyethylene



Fig. 4. Turbo spin-echo PD-weighted coronal image of right knee of patient 2, demonstrating a large area of osteolysis of the lateral and medial condyles of the femur and in the proximal lateral tibia.

damage was noted on each knee, and a large defect was identified behind the femoral component of the right knee.

Case 2

Patient 2 is a 60-year-old woman who underwent right total knee arthroplasty (PFC Total Knee System, DePuy Orthopedics, a Johnson&Johnson Co) on January 14, 1997, for varus gonarthrosis. She did well for approximately 4 years, at which point, she experienced increasing pain, and radiographs demonstrated loosening of the femoral component with rotation of the femoral component into a more flexed position (Fig. 3). She appeared to have mild osteolysis along the medial femoral condyle and proximal lateral tibia as well. MRI at that time demonstrated severe osteolysis of the medial and lateral femoral condyles and a smaller area in the proximal lateral tibia (Fig. 4). This was much more extensive than suggested by the routine radiographs. The patient underwent revision of the femoral component of her total knee arthroplasty, which was found to have separation of the femoral component from the cement mantle. Severe bony defects of the medial and lateral femoral condyles were revealed consistent with the MRI findings. A structural femoral head allograft was used to reconstruct the defect in the lateral femoral condyle.

Recommendations for Optimizing MRI Technique

The loss of MRI signal around metallic implants is a result of magnetic field distortion caused by differences in magnetic susceptibility of metal and tissue. With relatively simple modifications to the MRI protocol, which are available on most clinical scanners, this artifact can be substantially reduced. First, gradient-echo imaging techniques will lead to substantially larger artifact and should be avoided. Fast spin-echo proton density (PD)-weighted or T1-weighted images are preferred because they are the least sensitive to artifact from metal. Using the maximum receiver bandwidth setting, a high image matrix, and reducing the interecho spacing will further reduce the artifact. Second, when possible, the long axis of the hardware should be positioned parallel to the direction of the main magnetic field, and the direction of the frequency-encoding axis should be directed away from the region of interest. Around curved components, it is useful to acquire 2 separate images, swapping the frequency and phase encoding directions to allow circumferential

visualization of tissue around the prosthesis. In certain cases, it is useful to obtain fluid-sensitive sequences to evaluate for bone marrow edema, joint effusion, or periarticular fluid collections. In this setting, the short tau inversion recovery technique is preferred because it is less sensitive to magnetic field inhomogeneity compared with chemical shift fat suppression techniques.

The imaging protocols used for our patients consisted of sagittal, coronal, and axial turbo spin-echo PD-weighted images with the following acquisition parameters: time to repetition/time to echo (TR/TE), 2000/20 ms; echo train length of 4, maximum receiver bandwidth; field of view, 16 cm; image matrix, 512 × 288; 4-mm section thickness, with 4 signal averages and a SENSE factor of 1.4. Sagittal turbo spin-echo short tau inversion recovery images were obtained using a TR/TE of 3300/55 ms; echo train length, 12; 16-cm field of view with a 256 × 256 matrix and 4-mm section thickness, and 3 signal averages. Imaging time for the entire examination was approximately 25 minutes.

Discussion

Polyethylene wear and osteolysis remain significant problems around total knee arthroplasties. The extent of osteolysis can be difficult to determine radiographically, particularly around the femoral component; thus, it is common to underestimate the degree of osteolysis. MRI has shown potential for evaluating osteolytic lesions around total hip arthroplasty components [6-9]; however, there are few reports in the literature of its use to evaluate total knee arthroplasties [10]. Sofka et al [10] recently reported their experience with MRI to evaluate the periprosthetic soft tissues around total knee arthroplasty. They found that MRI was effective for evaluating periprosthetic soft tissues and impacted clinical management in all patients studied.

In the cases presented here, the MRI scan revealed large osteolytic defects around the distal femur that were not evident on the preoperative x-rays. This information facilitated clinical decision making in Case 1 as the patient was not having much pain and would have declined revision without the evidence for bone loss. The information facilitated preoperative planning for Case 2 as it became clear that a more complex reconstruction, potentially with specialized implants and structural allografts, would likely be necessary to achieve a satisfactory outcome. It also permitted

more complete discussion with the patient regarding the difficulty of the procedure and the risk of complications.

In many instances, it is not necessary to obtain an MRI to evaluate osteolysis around total joint implants. The osteolysis may be clearly evident on the preoperative x-rays, and the preoperative planning can be satisfactorily performed without additional imaging. In some instances, however, particularly around the distal femur, the use of MRI may be beneficial to more accurately evaluate the extent of osteolysis as the component may obscure portions of the bone. This is especially true in situations where revision components and structural allografts are not routinely available, because it would be important to recognize the extent of osteolysis preoperatively, to have these materials available for the reconstruction. MRI may also facilitate the preoperative discussion with the patient so that the physician can more accurately relate to the patient the difficulty of the surgery and the potential complication rate. Finally, some surgeons who are not experienced with complex revision arthroplasty may choose to refer patients with more extensive osteolysis to more experienced joint replacement surgeons.

Conclusion

Magnetic resonance imaging can be a beneficial tool for evaluating osteolysis around a total knee arthroplasty, particularly around the femoral component. We obtain an MRI in selected patients when we suspect significant osteolysis in areas that are obscured on routine radiographs. It facilitates clinical decision making, preoperative planning, and preoperative patient discussions. It

is particularly valuable in those situations where revision components and structural allografts may not be routinely available.

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