An Original Study

# Utility of Judet Oblique X-Rays in Preoperative Assessment of Acetabular Periprosthetic Osteolysis: A Preliminary Study

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## Abstract

**Anteroposterior (AP) x-rays provide limited information about size and location of acetabular osteolytic lesions after total hip arthroplasty (THA). In the study reported here, we sought to determine the utility of oblique (Judet) x-rays in preoperative assessment of acetabular lesions. AP, anterior (obturator), and posterior (iliac oblique) x-rays of 10 patients (10 hips) who underwent revision THA were evaluated retrospectively. Mean osteolytic area was 790 mm$^2$ (SD, 520 mm$^2$) on anterior oblique x-rays and 384 mm$^2$ (SD, 396 mm$^2$) on AP x-rays ($P$ = .005). Mean osteolytic area on posterior oblique x-rays was 512 mm$^2$ (SD, 430 mm$^2$) ($P$ = .34). Judet x-rays were useful in determining size and location of acetabular osteolysis.**

Periprosthetic osteolysis due to wear debris is a major problem that compromises long-term implant viability after total hip arthroplasty (THA).[1] Osteolysis can occur within the first few years after implantation, especially in young, heavy, active, male patients, and can be extensive. Patients often remain pain-free, and the hip components may remain well fixed in spite of progressive bone destruction due to periprosthetic osteolysis. This asymptomatic phase of osteolysis has far-reaching clinical and economic implications.[2]

Preoperative assessment of acetabular bone stock before revision surgery is critical, as the amount and location of pelvic osteolysis can determine the type and success of revision surgery.[3] Surgeons routinely use an anteroposterior (AP) x-ray and a frog lateral x-ray to assess the extent of osteolysis before revision arthroplasty. However, plain AP and frog lateral x-rays provide limited information about the size and location of osteolytic lesions involving the acetabulum.[4] Indeed, the frog lateral x-ray provides additional information about the femur but not about the acetabulum. This shortcoming leaves the clinician unable to adequately determine the extent of osteolysis around the acetabular cup before surgery.

To solve the problem of limited visualization of acetabular bone loss, some have suggested that 1 or 2 oblique or Judet x-rays be used in preoperative assessment of acetabular osteolysis. In computer models and cadaveric studies, use of a 45° iliac (posterior) oblique x-ray and a 45° obturator (anterior) oblique x-ray[5] in combination with a standard AP x-ray has been shown useful in visualization of periacetabular osteolysis.[4,6]

The purpose of the present study was to determine the utility of plain x-rays and Judet oblique x-rays of the acetabulum in a cohort of patients with failed THA undergoing acetabular revision.

## Materials and Methods

### Radiographic Analysis

After obtaining Institutional Review Board approval, we retrospectively evaluated 10 patients (10 hips) who had undergone revision THA and had acetabular osteolysis. Mean time between initial THA and revision THA was 10.8 years (SD, 6.8 years; range, 3-26 years). For 8 of the 10 patients, this was their first revision THA; for the other 2 patients, it was their second revision and third revision, respectively. Eight of the 10 patients had uncemented cups, and 2 had cemented cups. The indication for revision THA in all 10 patients was pain in the affected hip and poor function. An AP x-ray and 45° anterior and posterior oblique (Judet) x-rays[5] were obtained in all cases to preoperatively assess acetabular bone stock. Osteolytic lesions were defined as well-demarcated lobulated lucencies adjacent to the acetabular component and screws not present on prior x-rays.

Each case was reviewed by the orthopedic surgeon in the case (Dr. Goodman), by 2 senior medical students (Dr. Thomas and Dr. Epstein were students at the time of this study), and by a musculoskeletal radiologist (Dr. Stevens). A computer program, Image™ (Research Services Branch, National Institute of Mental Health, Bethesda, Md), was used to outline the area of each lesion. Femoral heads were measured on the x-rays; for calibration purposes, these measurements were then compared against those of the actual femoral head components (previously recorded in the operative reports). The comparative data were used to

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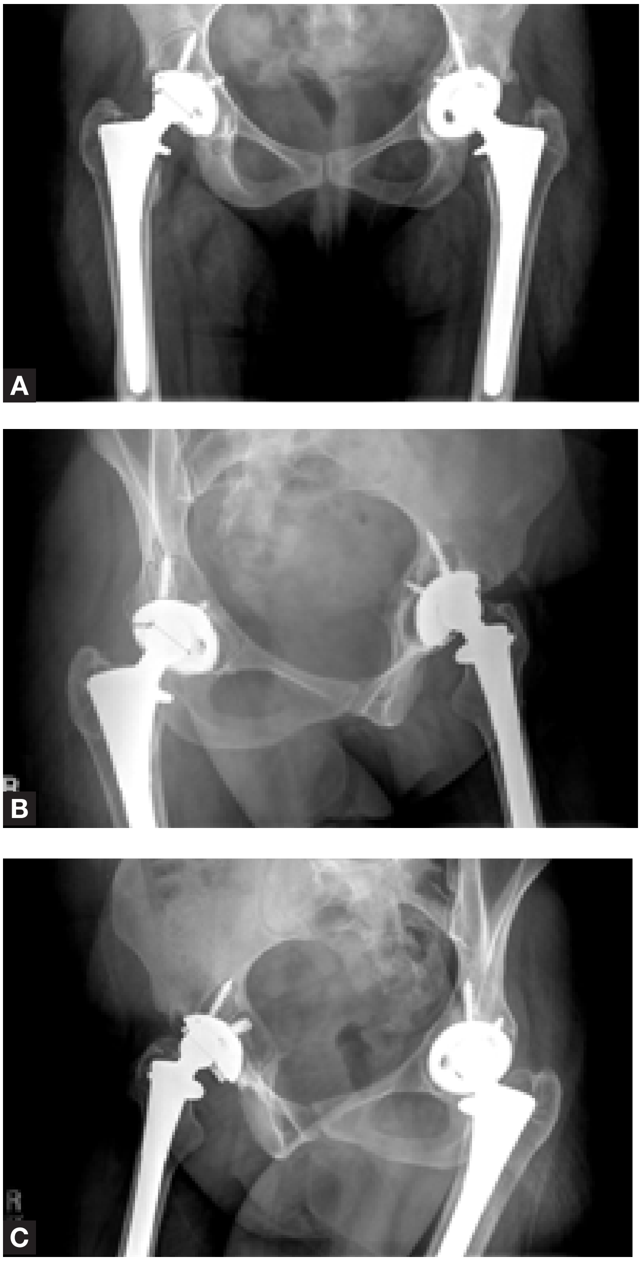


**Figure 1.** Anteroposterior **(A)**, right anterior oblique **(B)**, and right posterior oblique **(C)** x-rays of female patient's pelvis with bilateral uncemented hip arthroplasties, both showing evidence of polyethylene wear and osteolysis. On the right, there is significant periacetabular osteolysis, which has been outlined, and the transverse diameter of the femoral head has also been measured. At surgery, the osteolysis was shown to be posterior and medial, and the measured area of osteolysis was larger on the anteroposterior and right posterior oblique x-rays.

create a scale (in millimeters) to correct for radiographic magnification of each image. Each lesion was outlined, and total areas were calculated in square millimeters by the computer program. The lesions were first outlined and measured on the AP x-ray (Figure 1A), and then the lesions were similarly measured on the Judet x-rays (Figures 1B, 1C) by Dr. Thomas. Dr. Stevens independently verified the size and location of each lesion. All x-rays were reviewed without knowledge of the surgical findings. Operative reports from the THA revision were then used to assess the accuracy of the location of the lesions seen on the AP and Judet x-rays of the acetabulum.

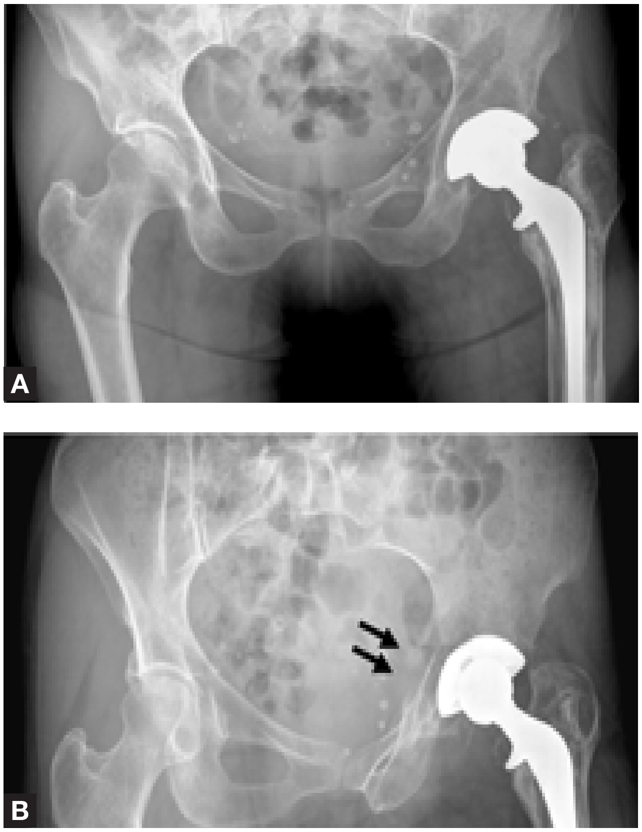


**Figure 2.** **(A)** Anteroposterior x-ray of pelvis shows periacetabular osteolysis medially. Extensive osteolysis is also seen around the cemented femoral prosthesis. **(B)** Left posterior oblique x-ray shows osteolysis involving the posteromedial acetabulum, with discontinuity of the medial pelvic wall (arrows).

### Data Analysis

An analysis of variance and a 2-tailed paired *t* test were used to test for significant differences between the areas measured on the AP and Judet x-rays.

## Results

Ballooning acetabular osteolysis was identified on the x-rays of all 10 patients. Standard AP x-rays of the pelvis showed a mean lesion area of 384 $mm^2$ (SD, 396 $mm^2$; range, 0-1231 $mm^2$); the mean lesion area on the anterior oblique x-rays, 790 $mm^2$ (SD, 520 $mm^2$; range, 8-1307 $mm^2$), was significantly larger ($P$ = .005). In 7 of the 10 hips, the area of osteolysis on the anterior oblique x-ray was more than double that on the AP x-ray.

Osteolytic lesions on posterior oblique x-rays measured a mean of 512 $mm^2$ (SD, 430 $mm^2$; range, 0-1280 $mm^2$) ($P$ = 0.34). Area of osteolysis doubled in 5 of the 10 hips. In 1 hip, the posterior oblique x-ray showed a posterior column discontinuity that was not visible on the AP x-ray (Figure 2).

Two patients had posterior and medial acetabulum osteolysis that appeared larger on the AP x-ray than on the posterior oblique x-ray.

## Discussion

Oblique x-rays of the acetabulum have been used in evaluating acetabular fractures and acetabular insufficiency secondary to metastatic disease and in assessing osteolysis before revision THA.[3,7,8] Oblique x-rays provide the relatively effective 3-dimensional picture that is often necessary in assessing the location and extent of acetabular osteolysis. Being able to see these lesions is critical, as the surgeon can then follow the progression of osteolysis, especially in asymptomatic cases. If a THA later requires revision, adequate visualization of periacetabular osteolytic lesions is vital in preoperative planning.

Currently, some recommend combining 1 or 2 oblique x-rays of the acetabulum with standard AP x-rays before revision surgery.[4,6,9] Claus and colleagues,[9] using cadaveric specimens, showed that single AP x-rays were very specific but not very sensitive in detecting osteolysis. However, when multiple x-rays (specifically, oblique x-rays) were implemented, overall sensitivity increased from 41% with the AP x-ray alone to 73%, with specificity remaining high.[9] Using a cadaveric pelvis and a computer simulation, Southwell and colleagues[4] showed that linear osteolysis was obscured over 83% of the cup when only an AP x-ray was obtained, but only 7% of the cup surface was obscured when 3 x-rays were obtained.

Our study results clearly demonstrate that Judet x-rays are more effective than routine plain AP x-rays in determining the extent of periacetabular osteolysis during the preoperative assessment for acetabular revision. The data demonstrate significant improvement in lesion detection by anterior oblique x-rays, particularly in lesions that intraoperatively were found in the superior acetabular wall. Posterior oblique x-rays also yielded important information about the weight-bearing portion of the acetabulum, especially in cases of cortical encroachment of the posterior column. To our knowledge, our study is the first to assess the relative size of the acetabular lesion area on patients' x-rays. Cadaveric and computer studies have established the usefulness of Judet x-rays in lesion analysis but are lacking in the obscuring artifacts that soft tissue and bowel gas can present. In our study, an independent musculoskeletal radiologist confirmed the lesions outlined, without knowledge of the patient's actual lesion location.

According to previous studies, the size of lesions seen on plain AP x-rays has been underestimated.[3,4,10-12] Lesion area has been noted to be statistically correlated with actual lesion volume.[9] Nonetheless, Claus and colleagues[9] found that, in cadavers, the 2-dimensional areas identified radiographically typically were a mean of 2 to 3 times smaller than actual 3-dimensional volumes. In our study, osteolytic lesion areas were determined from a cohort of patients, and, according to our estimates, actual lesion volumes were 2 to 3 times larger than the areas seen radiographically—which could drastically improve preoperative evaluation of the need for bone grafting and specialized implants.

One limitation of this preliminary study is its small sample size. Another limitation is retrospective data collection. With data collected postoperatively, we could not measure lesion size intraoperatively, or create a true correlation with radiographic lesion area and lesion volume in vivo.

In the past, cross-sectional imaging with computed tomography (CT) and magnetic resonance imaging (MRI) was not thought to be particularly useful in assessing periprosthetic osteolysis, because of the significant metallic artifact associated with the hardware. However, recent advances in imaging techniques now makes visualization and quantification of osteolysis feasible with both CT and MRI, particularly if titanium alloy prostheses are used.[13-16] One recent study compared the accuracy of radiography, CT, and MRI in assessing periacetabular osteolysis in cadaveric models, showing a sensitivity of 51.7%, 74.5%, and 95.4%, respectively.[14] MRI was the most effective in demonstrating small areas of osteolysis, whereas CT was the most accurate in calculating lesion volume. CT and MRI are generally widely available in clinical practice and are certainly useful in serial assessment and preoperative planning. However, both techniques are expensive and usually require that patients make additional visits to the hospital for imaging, whereas plain x-rays can generally be obtained on the same day as the initial clinic visit. CT examinations involve a fairly substantial radiation dose, particularly with the parameters used to minimize metallic artifacts—obviously undesirable in younger patients and in patients needing multiple follow-up examinations. Multiplanar reformations can elegantly demonstrate periacetabular osteolysis but involve complex postprocessing techniques, yielding large volumes of images for review. CT can be used to calculate the volume of osteolysis,[16] but doing so is extremely time-consuming and may not be practical in the routine clinic setting. MRI does not involve ionizing radiation and is therefore more appropriate for younger patients needing serial assessments, but, again, reviewing its numerous images can be time-consuming. There are also numerous MRI contraindications, including cardiac pacemakers, aneurysm clips, and intraocular metallic foreign bodies, which may preclude using this technique for many of the patients presenting with arthroplasty complications. The susceptibility artifact from the metallic prosthesis can make assessment of periacetabular osteolysis challenging, and images are prone to motion artifact, particularly if the patient is uncomfortable lying in a fixed position for a prolonged period. Radiography is extremely cost-effective and can be performed while the patient is attending the clinic, even if the patient is debilitated and relatively immobile. X-rays are therefore ideally suited for initial assessment of prosthesis complications; they can also then be used to determine whether further cross-sectional imaging with CT or MRI is required for either diagnosis or preoperative planning.

## Conclusions

We have shown that Judet x-rays are useful in determining the size and location of acetabular osteolytic lesions before acetabular revision surgery, and AP x-rays alone may not be sufficient in assessing periacetabular osteolysis.

## Author's Disclosure Statement and Acknowledgement

The authors report no actual or potential conflict of interest in relation to this article.

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