The Journal of Arthroplasty xxx (2016) 1–5

Contents lists available at ScienceDirect

The Journal of Arthroplasty

journal homepage: www.arthroplastyjournal.org

Original Article

Fluoroscopically Assisted Radiographs Improve Sensitivity of Detecting Loose Tibial Implants in Revision Total Knee Arthroplasty

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ARTICLE INFO

Article history:
Received 2 June 2016
Received in revised form
29 July 2016
Accepted 2 August 2016
Available online xxx

Level of Evidence:
Level III

Keywords:
revision
total knee arthroplasty
radiographs
aseptic loosening
implant debonding
fluoroscopy

ABSTRACT

Background: Fluoroscopically assisted radiographs theoretically improve detection of total knee arthroplasty (TKA) implant loosening by providing a better evaluation of the true implant interface, but their utility has not been well studied. We sought to determine whether fluoroscopically guided radiographs improve the sensitivity, specificity, and interobserver reliability of determining TKA implant loosening compared to standard radiographs.

Methods: Standard anteroposterior and lateral and fluoroscopically assisted radiographs were retrospectively obtained from 60 patients within 6 months before revision TKA. Thirty knees were revised for aseptic loosening and 30 knees for other indications, most commonly instability. The radiographs were randomized. Four reviewers independently determined whether each tibial and femoral component was radiographically loose or stable. Intraoperative determination of implant stability was utilized as the gold standard.

Results: Fluoroscopically guided radiographs had a significantly higher sensitivity for detecting tibial component loosening compared to standard radiographs (85.3% vs 74.8%, $P = .02$). Sensitivity in detecting femoral component loosening was poor overall and not improved by fluoroscopic enhancement compared to standard radiographs (58.8% vs 66.5%, $P = .33$). Fluoroscopically guided radiographs did not improve the specificity of detecting well-fixed implants in either tibial or femoral components nor affect the mean interobserver reliability over standard radiographs (kappa = 0.58 vs kappa = 0.60, $P = .6$).

Conclusion: Fluoroscopically assisted radiographs increased the sensitivity of detecting tibial component loosening over standard radiographs, but this clinical significance is unclear. Fluoroscopically guided radiographs may provide benefit in diagnosing aseptic loosening in select patients with painful TKAs.

Aseptic loosening is the most common indication for revision total knee arthroplasty (TKA), accounting for up to 27% of revisions in recent reports [1-7]. However, the diagnosis of aseptic loosening in patients who present with a painful TKA can be challenging. While there is evidence that bone scans and single-photon emission computerized tomography (SPECT) can assist in detecting loosening of TKA components, these tests are expensive, require a higher radiation dose to patients, and often are not readily available in common practice [8,9]. Therefore, clinical history and plain radiographs remain the mainstay of diagnosing aseptic loosening [1-7]. Currently, there is no standard evaluation system or methodology universally used to diagnose implant loosening preoperatively [10-13].

While there is no universally used radiographic evaluation system to determine implant loosening, most evaluation systems and surgeons in clinical practice focus on the presence and extent of radiolucent lines at the bone-cement or cement-bone interface [10-15]. There is evidence that fluoroscopically guided radiographs can improve the detection of radiolucent lines on implant interfaces by limiting the error involved with the technique of obtaining standard radiographs and obtaining a more reliable, magnified view of the true implant interface [14,15]. However, few

Investigation was performed at the Mayo Clinic, Rochester, MN.

One or more of the authors of this paper have disclosed potential or pertinent conflicts of interest, which may include receipt of payment, either direct or indirect, institutional support, or association with an entity in the biomedical field which may be perceived to have potential conflict of interest with this work. For full disclosure statements refer to http://dx.doi.org/10.1016/j.arth.2016.08.005.

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http://dx.doi.org/10.1016/j.arth.2016.08.005
0883-5403/

Fig. 1. This image is an example of a fluoroscopically guided radiograph of a tibial knee component. Four of the 5 standard views (excluding the patella) are shown. The top left is the AP; the top right is the lateral of the femoral component; the bottom 2 are laterals of the tibial component in 15° and maximal flexion. The views are magnified and obtained on 4 to 1 collimation.

studies have analyzed the impact of this improved implant interface view and its clinical relevance in a surgeon's ability to detect known stable or loose total knee implants compared to standard radiographs.

The purpose of this study was to analyze the clinical utility of fluoroscopically assisted radiographs compared to standard anteroposterior (AP) and lateral radiographs in the detection of loose and stable tibial and femoral TKA implants using intraoperative assessment of implant stability as a gold standard. We compared surgeons' sensitivity for detecting loose implants, specificity of detecting stable implants, and interobserver reliability between standard radiographs and fluoroscopically assisted radiographs.

Methods

We obtained the records of patients undergoing revision TKA at our institution from 2009 to 2014 after institutional board review approval was obtained. There were several inclusion criteria. First, all patients included had standing AP and lateral standard radiographs as well as fluoroscopically assisted radiographs within 6 months before revision surgery. All patients also had a negative infection evaluation with inflammatory markers and/or joint aspiration preoperatively and negative intraoperative pathology and/or culture results. Intraoperative determination of implant fixation at the time of revision surgery was considered the gold standard of implant stability. While there was no standardization in how each surgeon evaluated implant fixation intraoperatively, each femoral and tibial component was individually manually tested by the surgeon after removal of the polyethylene component. Implants that were mobile at the implant interfaces with gross testing at revision were considered loose while implants that had no motion at the interfaces were considered well fixed. Patients with operative reports that did not specify implant fixation clearly were not included in this study.

Thirty patients (30 TKAs) who underwent revision TKA for aseptic loosening of either the tibial component or femoral component, or both components were identified that met inclusion criteria. Overall, there were 22 loose tibial components and 17 loose femoral components included in the study. Thirty patients (30 TKAs) who underwent revision TKA for other indications in order to obtain radiographic controls were also identified. Nineteen of these patients (63.3%) were revised for flexion instability, 5 patients for arthrofibrosis (16.7%), 3 patients (10%) for component malposition causing patellar maltracking, and 3 patients (10%) for global instability. All of these patients had well-fixed tibial and femoral components at the time of surgery. Twenty-seven patients (45%) had cruciate-retaining implants while 33 patients (55%) had posterior-stabilized (PS) knees. Thirteen of 17 (76%) of the loose femoral components were PS designs. All components were cemented.

Many surgeons at our institution routinely obtain fluoroscopically assisted radiographs in addition to standard AP and lateral radiographs simultaneously for the evaluation of a painful TKA rather than on a selective basis. Patients are scheduled for 30 minutes to complete the imaging instead of 15 minutes for standard radiographs. The radiology technicians use a fluoroscopy machine and standard radiography equipment to obtain this 5-view fluoroscopically guided radiograph. The images are non–weight bearing views. First, the radiology technician positions the patient's knee to obtain a fluoroscopic image with the goal of a