Postoperative Radiographs After ACL Reconstruction Are Not Cost-effective

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abstract

Postoperative radiographs have become standard after anterior cruciate ligament (ACL) reconstruction, even though few findings in the literature substantiate their efficacy. The goal of this study was to determine whether routine postoperative radiographs were cost-effective in patients undergoing ACL reconstruction. In addition, the authors sought to determine whether these radiographs provided meaningful clinical information that changed postoperative management. Between January and December 2010, the authors retrospectively reviewed all patients who underwent ACL reconstruction at their institution. The clinical course of all patients was reviewed to determine whether the results of the radiograph at the time of interpretation changed the plan of care. All radiographs were then scrutinized for abnormal findings that could have changed the plan of care if noted at the time of follow-up. Of 624 patients who underwent ACL reconstruction, 340 (54.4%) had a postoperative radiograph within 30 days. No radiograph showed a complication as interpreted by the surgeon at the time the radiograph was obtained, and no changes were made in routine postoperative care. On final review of each radiograph, none showed findings that would have changed management. The cost of performing and interpreting radiographs was $42.62 per patient, with a combined cost of $14,490.80. The findings of the study showed that postoperative radiographs after ACL reconstruction should not be considered “routine” practice. In addition, because these studies provided little clinical information, they are recommended only when symptoms suggest a mechanical complication and in cases of unforeseen postoperative trauma. [Orthopedics. 2015; 38(4):e339-e342.]

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As cost containment strategies continue to increase, there has been a focus on reducing the cost of surgical procedures. From the creation of clinical pathways to the standardization of postoperative protocols with evidence-based outcome measures, streamlining of costs has affected not just surgery itself but also preoperative and postoperative care. Studies have investigated the cost-effectiveness of routine postoperative radiographs in general surgery as well as total knee and hip arthroplasty, but no studies have evaluated the benefit or cost-effectiveness of postoperative radiographs in patients undergoing anterior cruciate ligament (ACL) reconstruction. The goal of this study was to determine whether routine postoperative radiographs were cost-effective in patients undergoing ACL reconstruction. In addition, the authors attempted to determine whether these radiographs provided clinically meaningful information that changed postoperative management. They hypothesized that these postoperative radiographs would be of limited utility.

**Materials and Methods**

This study was approved by the authors’ institutional review board. From January to December 2010, the authors retrospectively reviewed 624 consecutive patients who underwent ACL reconstructive surgery performed by 1 of 8 fellowship-trained sports medicine orthopedic surgeons at their institution. They included patients who underwent ACL surgery over the 1-year time frame who had a postoperative radiograph within 30 days after their surgical procedure. These “routine” radiographs were not ordered as a result of specific clinical indications. No patient in this study had intra- or postoperative imaging in the operating room. Patients who did not have a postoperative radiograph within 30 days of surgery were excluded. Office notes were reviewed to determine whether the results of the radiograph changed the plan of care. Specifically, the authors noted whether the surgeon, based on the results of the radiograph, changed the patient’s weight-bearing status, limited the patient’s range of motion, decided that additional surgery was needed, or changed or deviated from the routine postoperative course. The authors looked at whether any of these variables occurred for these patients, and then they determined whether the change was the result of the radiograph. At the time the radiograph was taken, all radiographs were reviewed by an attending orthopedic surgeon. At the time of data collection, all radiographs were independently reviewed on the authors’ online picture archiving and communication system by a trained medical student as well as an orthopedic sports medicine fellow (postgraduate year 6). These radiographs were reviewed first for technical quality (exposure, visibility, limb position), and those of satisfactory quality were scrutinized for abnormal findings (prominent hardware, malpositioned tunnels, fixation buttons or screws that were not adequately deployed or were abnormally placed). The impressions made during this study were compared with the operative surgeon’s impression based on the postoperative visit office notes, and whether any discrepancy was noted. The focus was on finding any abnormalities on the radiographs that may have been missed, may have been of value, or may have changed the plan of care if noted at the time of the postoperative visit. For complications directly discovered via routine radiographs at the time of the postoperative visit, the ratio of complications significant enough to warrant a change in postoperative care was calculated. Radiographs with any significant abnormalities found during this retrospective review that might have changed the postoperative plan were also noted. Furthermore, the amount of further diagnostic testing recommended as a result of such radiographs was evaluated. The total cost of performing and evaluating each radiograph was obtained. This figure represents the cost of performing the radiographs themselves, but does not include the cost of the radiograph technologist’s time, equipment maintenance, or repeat exposures.

**Results**

Of the 624 patients who underwent ACL reconstruction at the authors’ institution in 2010, 340 (54.4%) had a postoperative radiograph within 30 days of surgery. These 340 surgical procedures were performed by 8 attending orthopedic surgeons, all fellowship trained in sports medicine. A total of 262 patients were excluded because postoperative radiographs were not obtained, 21 patients were excluded because they did not have radiographs within 30 days of surgery, and 1 patient was excluded because of poor quality of the lateral radiograph.

None of the radiographs showed a complication as interpreted by the surgeon at the time of the radiograph. No patients had their postoperative care changed as a result of these radiographs. There were no changes in weight-bearing status, no limitations in range of motion, no unplanned surgical procedures, and no changes to the postoperative protocol. On review, no radiographs showed findings that would have changed postoperative management. Thus, no discrepancies were found between the initial review and the retrospective review of radiographs.

The authors looked at all documented complications during this time frame and specifically reviewed them for predisposing factors that may have been missed on postoperative evaluation. Three patients (0.8%) had re-tear of the graft at 9, 11, and 14 months postoperatively. Two patients underwent manipulation under anesthesia, and 3 underwent arthroscopic lysis of adhesions. Two patients underwent removal of hardware for prominent tibial screws, which were removed 2 years postoperatively in both cases. Retrospectively, this hardware was deemed prominent, but it was not noted on postoperative office notes. One patient had a postoperative pa-
tella fracture 2 months after patellar tendon autograft harvest after a fall. On final analysis, no complications were related to findings that could have been seen on postoperative imaging.

Total cost of the radiographic evaluation was $14,490.80. For each patient, the typical radiographic series of 3 views (Current Procedural Terminology code 73562) was billed at $42.62, which represents the standard Medicare reimbursement fee, including technical and professional components.

DISCUSSION

Postoperative radiographs are commonly obtained after ACL reconstruction, yet there are no specific guidelines for their timing or indications. Generally, they provide feedback on surgical technique and are used as a method for education and improvement. By “learning” from these radiographs, surgeons strive to perform the best procedures with the most optimal outcomes. The justification for performing radiographs is the “clinical benefit, convenience, availability, and cost” of the investigation.6

If these radiographs are obtained primarily as a tool for surgeon education, even this use has been challenged. Specifically, evaluation of tunnels with radiographs has not been shown to be effective. Because conventional radiographs are a 2-dimensional projection of 3-dimensional bone geometry, accurate measurements are dependent on alignment of the bone within the imaging plane, which can introduce errors in estimated tunnel position.7,8 Meuffels et al9 evaluated 50 ACL reconstructions postoperatively with standard radiographs, computed tomography (CT) scans, and 3-dimensional virtual reality images and found CT scans and 3-dimensional virtual reality images more reliable for assessing postoperative bone tunnel placement. They reported inter- and intraobserver agreement of 0.39 to 0.83 for standard femoral and tibial tunnels. They noted difficulty visualizing the tunnels themselves; 48% of femoral tunnels and 18% of tibial tunnels could not be visualized on anteroposterior projections. They attributed this difficulty with visualization to radiolucent bioabsorbable interference screws. Another study evaluated the reliability of measurements on the lateral femur, reporting an intraclass correlation coefficient of 0.68, even with fluoroscopically controlled pin placement before drilling of the femoral tunnel.10

Recently, Warne et al11 found variable reliability of radiographic measurements based on postoperative radiographs, with most results fair to moderate. Their intraclass correlation coefficients ranged from 0.06 to 0.79. The practice of obtaining radiographs for academic or instructional purposes is not necessarily supported by the preponderance of evidence in the literature. Although obtaining CT scans, 3-dimensional virtual reality images, or magnetic resonance imaging scans for every postoperative patient would not likely be efficient, their yield when analyzing new techniques and instrumentation may be worthwhile. Intraoperative fluoroscopy performed at the time of tunnel positioning and graft fixation may be more educational and meaningful for the surgeon; however, this tenet has also been challenged.12

Although determining tunnel position radiographically has not been shown to be effective, there are other possible benefits of postoperative radiographs. Fracture of bone plugs or plug donor sites after patellar tendon autograft reconstruction can be detected on radiographs. In this case, it is likely that patients would report pain or trauma at the donor site that would alert the clinician to the necessity of obtaining radiographs. However, hairline fracture could be within the realm of normal postoperative pain, and thus radiographs would be beneficial. In the case of suspensory femoral fixation, radiographs can provide information about whether the button has flipped and whether it is seated properly against cortical bone. Devices that have not deployed or that show soft tissue interposition between the cortical bone and the button may require further surgery or a more gentle postoperative rehabilitation protocol. The authors’ analysis did not find any devices that were improperly deployed or that had significant soft tissue interposition to necessitate a change in postoperative management.

Medicolegal implications are associated with the use of postoperative radiographs. Because of their radiopaque nature, bones and metallic hardware can be documented with radiographs after surgical intervention. After a surgeon permanently alters a patient’s joint, practicing “good medicine” suggests that this intervention should be documented. However, the American Board of Orthopaedic Surgery has no official recommendation for the appropriate documentation of hardware. In the event of litigation after ACL reconstruction, a radiograph could potentially document the position of the tunnels and hardware. However, the success of an ACL reconstruction, as opposed to fracture healing or corrective osteotomy, depends primarily on clinical assessment and functional examination of the patient. Also, because it is standard practice to take arthroscopic photographs of the tunnels and the graft position, the postoperative radiographic picture is redundant and less useful. Intraoperative fluoroscopy is another method to aid in accurate placement of tunnels. Adding minimal time and no cost to the procedure, fluoroscopy has been shown to be effective.13 Thus, standard postoperative radiographs may have limited medicolegal value.

Limitations

The authors noted some limitations of their analysis. First, visualization of tunnels and fixation, even with perfect radiographs, is often difficult, especially with the use of bioabsorbable/composite or polyether ether ketone screws. This difficulty in visualizing fixation confounds the interpretation of images. In some re-
pects, this limitation further strengthens the authors’ ultimate conclusion that radiographs are not cost-effective. Therefore, surgeons who use fixation devices or methods that cannot be adequately visualized on postoperative radiographs should avoid routine use of this modality. Second, the current study included radiographs from multiple surgeons with different surgical techniques. This limitation was mitigated by the inclusion of a large number of patients treated by each surgeon. In this way, the authors could apply their findings across a broad spectrum of techniques (anteromedial vs transstitial femoral tunnel drilling, allograft and autograft reconstruction) and fixation devices (suspensory, interference screw, post fixation) that are routinely used by ACL surgeons. Because there were no standardized postoperative protocols between surgeons with regard to the timing of radiographs, the authors included only radiographs taken within 30 days to ensure inclusion of only standard postoperative radiographs. Patients whose images were obtained beyond 30 days postoperatively were considered to be out of the immediate postoperative period. Thus, their radiographs were unlikely to change immediate postoperative decision making, which was the subject of the study. Also, because all surgeons included in this study worked within an academic institution, some radiographs were ordered (or not ordered) by the resident or fellow on service at that time, accounting for the large number of patients who had no radiographs.

CONCLUSION

The authors evaluated a large number of postoperative radiographs and found that none of the radiographs in their series changed patient management. In their practice, in a postoperative patient, symptoms suggestive of a mechanical complication would necessitate a nonroutine radiograph. Differentiating between normal and abnormal postoperative symptoms is left to the clinical acumen of the surgeon, taking into account the limited amount of possible information to be gleaned from a radiograph. Otherwise, standard intraoperative arthroscopic photographs or fluoroscopy should suffice for confirmation of graft, tunnel, and hardware placement. Thus, as has been found in total knee arthroplasty and hallux valgus surgery, the value of postoperative radiographs after ACL surgery is questionable.5,14 The practice of obtaining routine postoperative knee radiographs in the absence of specific clinical indications does not provide additional or meaningful clinical information, is not cost-effective, and does not appear to benefit patient care. As physicians partner with patients, insurers, and health care delivery systems to contain costs, further analysis is warranted to determine whether reducing this practice is a worthwhile cost-saving endeavor.

REFERENCES