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ORIGINAL ARTICLE

Utility of postoperative radiography in routine primary total shoulder arthroplasty

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Background: The medical relevance and cost-benefit of routine radiographs after primary anatomic total shoulder arthroplasty (TSA) up to a year postoperatively are unknown. This study was performed to assess the medical relevance and cost-benefit of radiography after TSA during the first postoperative year.

Methods: During the period 2010 to 2015, 160 consecutive patients undergoing anatomic TSA by a single fellowship-trained surgeon had radiographs obtained at 2 weeks, 6 weeks, 4 months, and 1 year postoperatively. Radiographs and clinic notes were assessed to determine if a change in postoperative care happened because of radiographic findings, including postoperative fracture, hardware complication, or any concerning radiographic feature. Cost data and amount billed were obtained.

Results: Patients underwent radiography at 1.8 ± 0.2 weeks, 6.5 ± 1.2 weeks, 14.9 ± 2.9 weeks, and 46.8 ± 19.5 weeks postoperatively. Findings on the radiologist's reading were normal/unremarkable for 100.0%, 96.8%, 95.9%, and 95.2%, respectively, at each visit. Results were documented in the note for 92.5%, 97.4%, 98.0%, and 92.4%, respectively, at each visit. Review of the radiographs yielded no change in management based on these parameters. The amount billed for radiographs was $284,281 ($1776.76 per patient).

Conclusions: A lack of clinically meaningful impact from routine postoperative radiography does not justify the per-patient expense, as routine imaging did not cause a change in postoperative management. The available data suggest that routine radiographs after primary anatomic TSA may be unnecessary or perhaps the described frequency in which radiographs are obtained is in excess.

Level of evidence: Level IV; Economic Study without Sensitivity Analysis

Keywords: Primary total shoulder arthroplasty; radiography; X-ray; cost-effectiveness; utility; health care economics

During the last decade, there has been a significant increase in the incidence of shoulder arthroplasty, with an associated improvement in techniques and outcomes.[3] There is a lack of evidence supporting routine postoperative radiography obtained after total shoulder arthroplasty (TSA).[12] Declining complication rates call into question the medical relevance of repeated radiography during the first postoperative year.[4] Previous studies have demonstrated robust survivorship of modern TSA for the first 5 years postoperatively.[1,12]

This study meets exempt criteria of our Institutional Review Board for Health Sciences Research (UVA IRB-HSR) for the following reasons, as described on the UVA IRB-HSR website:

5: Research involving materials (data, documents, records, or specimens) that have been collected solely for non-research purposes (such as medical treatment and/or diagnosis).

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Other orthopedic subspecialties have critically assessed the use of repeated postoperative imaging. Total hip and total knee arthroplasty literature has found limited value in using immediate postoperative imaging.[1,6,10,11,14,18] In addition, studies in the spine literature have demonstrated minimal value in repeated radiographs following spine procedures in asymptomatic patients.[7,9,15,16,19]

Cost-effective resource allocation is a crucial issue that is pivotal in providing high-quality orthopedic care. Excessive routine radiography is a costly variable that might be removed without negatively affecting clinical outcomes. The purpose of this study was to evaluate the medical relevance and cost-benefit of routine radiography after primary anatomic TSA within 1 year postoperatively. The hypothesis of the current study states that there is limited medical relevance of routine radiographs with substantial avoidable costs.

Materials and methods

A retrospective chart review was performed of all patients who underwent TSA (*Current Procedural Terminology* code 23472) from August 2010 to February 2015 by a single fellowship-trained orthopedic surgeon. Inclusion criteria for this study included (1) having undergone primary TSA between August 2010 and February 2015 and (2) a minimum of 1 year of follow-up. In addition, a lesser tuberosity osteotomy was used for all selected patients for subscapularis management and glenoid exposure. Patients undergoing reverse TSA or revision shoulder arthroplasty were excluded. Any patients with a noted precipitating factor that would require a radiograph, such as a fall or a recent trauma, were likewise excluded. A total of 170 patients were identified; 10 patients were excluded because of a precipitating factor, leaving 160 available for final data analysis. Of the 10 excluded patients, 8 sustained a ground-level fall and 2 sustained a twisting injury to the operative arm that prompted a clinic visit and nonroutine radiographs. Of these 10 patients, 2 had abnormal findings on radiography; 1 of the 8 patients sustained a greater tuberosity fracture with associated rotator cuff insufficiency requiring conversion to a reverse TSA; 1 of the 2 patients sustained a nondisplaced glenoid fracture that was treated conservatively. The following variables were obtained: demographic data, clinic notes, complications, and radiologist reports. Patient characteristics and implant data are presented in Table I.

A retrospective chart and imaging review was performed evaluating all postoperative radiographs, radiologist interpretations, and clinic notes. In this clinical practice, a single postoperative Grashey anteroposterior (AP) view of the shoulder was obtained in the postanesthesia care unit. Subsequent to discharge, patients were evaluated and routine radiographs were obtained at approximately 2 weeks, 6 weeks, 4 months, and 1 year postoperatively. Radiographs were obtained at the radiology department adjacent to the clinic before being seen in the form of a Grashey AP view at neutral humeral rotation, an external rotation Grashey AP view, and a true axillary view of the shoulder. These were obtained postoperatively to accurately assess component placement, alignment, and version. Evaluation of each radiograph included the radiologist's reading and clinic notes, which included the surgeon's reading of the radiographs at the time of the visit, to determine if it was a "normal" or "abnormal" study. All films were reviewed by a radiologist after they were obtained within a 24-hour period. However, immediate review of radiographs could be obtained by the surgeon using the on-site radiologist if there were any immediate questions about the radiographs. Next, each follow-up clinic note was reviewed to determine if the radiology results were documented. The clinic note was then examined to decide if the radiographic finding caused a change in clinical management. Management was changed if any the following radiologic parameters were met: humeral or scapular fracture; hardware complication on the humeral side, including early loosening or frank component dissociation; hardware complication on the glenoid side, including early loosening or frank component dissociation; and any other concerning radiographic feature to include shoulder dislocation or displacement of lesser tuberosity osteotomy.

Cost was determined by obtaining Medicare reimbursement data from the Centers for Medicare and Medicaid Services from the years 2010 to 2015. Reimbursement was determined from the *Current Procedural Terminology* (CPT) code 73030 (radiograph 2 views of the shoulder). Cost data included total cost, professional fee, and technical fee. Actual amount billed was obtained from the billing records of our institution's department of radiology. The medical center billed for the radiographs and the radiologist billed for the reading according to typical practice at our medical center.

Table I Cohort characteristics

Patient demographics	
Age (years)	66.7 ± 10.9
Male gender	100 (62.5)
Body mass index (kg/m^2)	30.1 ± 6.8
Laterality	96 (60.0)
Primary osteoarthritis	156 (97.5)
Comorbidities (%)	
Diabetes mellitus	25.9
Active smoker	15.4
Chronic obstructive pulmonary disease	3.7
Hypertension	63.0
Hyperlipidemia	35.8
Congestive heart failure	1.2
Coronary artery disease	6.8
Chronic kidney disease	4.9
Depression	22.8
Chronic pain	5.6
Operative details	
Component type	
DePuy	72 (45.0)
Biomet	83 (51.9)
Stryker	5 (3.1)
Cemented (%)	
Glenoid	100
Humerus	4.4

Categorical variables are presented as number (%) except as noted. Continuous variables are presented as mean ± standard deviation.

Results

There were 160 patients who had routine shoulder radiography at an average of 1.8 ± 0.2 weeks, 6.5 ± 1.2 weeks,