Utility of Postoperative Imaging in Radial Shaft Fractures

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Abstract

Background: Postoperatively, radial shaft fractures are often followed clinically with serial radiographs to assess for fracture healing. Currently, there is no standard of care regarding postoperative imaging for these injuries. The purpose of this study is to determine whether imaging influences management decisions. **Methods:** Patients who presented to a level I trauma center between 2009 and 2014 with an operatively treated radial shaft fracture were retrospectively screened for inclusion in our study. Patients with ipsilateral ulna or radius fractures, or with inadequate imaging or inadequate follow-up, were excluded. Four blinded, board-certified, orthopedic surgeons reviewed the postoperative films twice for each patient and stated whether the imaging would influence management decisions. Images were separated into 3 groups based on time from surgery: 0 to 4 weeks, 4 to 8 weeks, and greater than 8 weeks. The number of times imaging influenced these hypothetical management decisions was recorded. Interobserver and intraobserver agreements were calculated using Fleiss's and Cohen's kappa coefficients, respectively. **Results:** One hundred eighteen patients underwent operative fixation for an isolated radial shaft fracture, of whom 38 met inclusion criteria. Imaging from 0 to 4 weeks, 4 to 8 weeks, and greater than 8 weeks postoperatively resulted in a change of management in 0%, 32%, and 16% of patients, respectively. After 4 weeks, changes were primarily for immobilization and activity-level modification. Intraobserver and interobserver agreement kappa coefficients were 0.761 and 0.563, respectively. **Conclusions:** Films obtained within 4 weeks of surgery for radial shaft fractures are unlikely to change postoperative management and may not be warranted during routine postoperative follow-up.

Keywords: radius, Galeazzi, radiographs, operative, fracture

Introduction

Compression plating has shown to be an effective method of treating most radial shaft fractures with good results demonstrated over the last 3 decades.^{11,16,18} Postoperatively, studies vary on recommendations for duration of immobilization. Kraus et al found equivalent results between no immobilization and plaster immobilization,⁸ whereas other authors have recommended rigid immobilization ranging from 2 to 8 weeks.^{5,10,12,13,15} Although the operative treatment of these fractures is generally agreed on, the optimal timing and frequency of postoperative imaging are less clear.

Several recent orthopedic studies questioning imaging in the early postoperative period have found that imaging during this time period may be of little benefit and may have significant cost implications.^{4,6,7} Currently, there is no standard of care regarding postoperative imaging for radial shaft fractures, and a study investigating the utility of early imaging for radial shaft fractures has not been previously reported. The purpose of this study was to investigate the

utility of imaging at common follow-up intervals. We hypothesize that follow-up imaging in the early postoperative period will not alter management and, as such, is of little clinical utility.

Materials and Methods

One hundred eighteen patients who presented to a level I trauma center between 2009 and 2014 with an operatively treated radial shaft fracture were retrospectively screened for inclusion in our study. Patients with ipsilateral ulnar shaft, distal radius, radial head, or radial neck fractures were excluded. In addition, patients younger than 18 years

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of age, patients with inadequate imaging or documentation, and patients with less than 8 weeks of follow-up were excluded. All patients underwent formal anteroposterior and lateral radiographs in the operating room immediately following surgery, which is standard practice at our institution. For the identified cohort, postoperative imaging was then de-identified and compiled into a single word processing file. Three blinded, board-certified, attending hand surgeons (including senior author AG) and one attending trauma surgeon were then asked to review the file on two separate occasions, 4 to 6 weeks apart. Reviewers were only told which postoperative image they were reviewing (first, second, third, etc) as well as how many days following surgery the radiographs were taken; no other clinical information was provided.

For each patient's postoperative image, reviewers were asked to state whether the image would influence hypothetical management decisions for that time period, including changes in immobilization, weight bearing, activity level, need for advanced imaging, or need for revision surgery. Images were separated into 3 groups based on time from surgery: 0 to 4 weeks, 4 to 8 weeks, and greater than 8 weeks. These time periods were chosen to try and capture time periods with minimal to no radiographic healing (0 to 4 weeks), during the beginning of radiographic healing (4 to 8 weeks), and with moderate or more radiographic healing (greater than 8 weeks). Reviewer decisions due to imaging findings were then documented at each time period for all reviewers. Interobserver and intraobserver agreements were calculated using Fleiss and Cohen's kappa coefficients, respectively. Institutional review board approval was obtained to perform this study.

Results

One hundred eighteen patients underwent operative fixation for an isolated radial shaft fracture, of whom 38 met inclusion criteria (Figure 1). The average patient was 35 years old and 85% were male. The average radial shaft fracture was 7.89 cm from the radiocarpal joint. All fractures were of Orthopaedic Trauma Association classification 22-A2 (66%) or 22-B2 (34%). Imaging between 0 to 4 weeks, 4 to 8 weeks, and greater than 8 weeks postoperatively resulted in hypothetical changes in management in 0%, 32%, and 16% of patients, respectively (Figure 1). Intraobserver and interobserver agreements in the 0- to 4-week time period were both 1.00. All management decisions based on imaging between weeks 4 and 8 were for discontinuation of immobilization with or without advancement of weight bearing status due to adequate bony healing (Figure 2). At greater than 8 weeks, there were 12 decisions for advanced imaging (computed tomography [CT]), 14 for advancing activity, 34 for changes in immobilization, and 5

Figure 1. Flowchart of patient selection.

for revision procedures. In 1 patient, 2 of the reviewers recommended a revision procedure with bone graft due to minimal fracture consolidation after 8 weeks. The other reviewers both recommended CT scan. In 3 other patients, one reviewer recommended a revision for malunion. Overall intraobserver and interobserver agreements were moderate with a kappa coefficient of 0.761 and 0.563, respectively (Table 1).

Discussion

Much like prior studies in the orthopedic trauma literature, our findings suggest that routine imaging in the early postoperative period may be of little clinical utility in an otherwise normal postoperative course.^{4,17} Plain radiographs within 4 weeks of surgery did not lead any of the 4 board-certified, attending orthopedic surgeons to alter their management in any of the patients. As discussed in a recent review by Asetok et al, in contrast, radiographs in clinic visits at 4 to 8 weeks and greater than 8 weeks were more useful in management, with several reviewers recommending changes in immobilization, activity advancement, and advanced imaging based purely on the radiographic findings. Thus, our results question the utility of imaging in postoperative weeks 0 to 4, and support their usefulness in later clinic visits. The stark contrast

Figure 2. Summary of the total number of management decisions for time periods 4 to 8 weeks and greater than 8 weeks.

Note. Of note, 4 reviewers viewed 38 patients' radiographs for each time period and so the maximum number of management decisions for a given category is 152. The less-than-4-weeks time period was not included due to no changes in management.

Table 1. Interobserver and Intraobserver Reliabilities.

Follow-up, weeks	Intraobserver reliability	Interobserver reliability
0-4	1.00	1.00
4-8	0.571	0.219
>8	0.598	0.245
Overall	0.761	0.563

between the interobserver kappa coefficients before and after 4 weeks postoperatively lend further strength to the notion that imaging before 4 weeks postoperatively may be of little clinical utility whereas management decisions after 4 weeks are heterogeneous and can be influenced by imaging findings.

Our conclusions contrast those presented by Bohl et al, who defend the utility of imaging in the first clinic visit for distal radius fractures, citing changes in management in 3% of patients who had negative clinical findings.² Although we found a lower rate of management change in the early postoperative period, in their cohort all changes in management were a result of radiographically evident loss of reduction.² These findings may not be as pertinent to our patient population, as despite their proximity, distal radius and radial shaft fractures are inherently different injuries. As prior literature indicates, with appropriate implant selection, loss of reduction is not a common complication in radial shaft fractures.^{14,15,18}

The association between clinical and radiographic findings has been questioned in recent publications. Shau et al reviewed a large series of patients who underwent surgical correction for pediatric scoliosis and found little utility for routine radiographs in asymptomatic patients.¹⁷ Ghattas et al reviewed the surgical records for 200 fractures and found, based on history and physical exam alone, that 7.5% had clear indications for postoperative imaging, resulting in 1.5% of the total cohort having an altered postoperative care.⁴ Based on these findings, Ghattas et al argue for the removal of imaging at the initial postoperative visit.⁴ They cite the importance of providing cost-effective treatment and the increase in medical radiation exposure in the American population. An estimated 373,508 forearm fractures occur annually in the United States in patients aged 15 years and older with as high as 7% (26 146) occurring at the radial shaft.^{1,3} The Medicare cost of a forearm x-ray examination is \$23.49, which would result in a potential annual savings of \$614,170.⁹

Our study focused on the routine use of imaging in the absence of clinical indications and thus cannot be generalized to all postoperative radial shaft fractures. Early postoperative radiographs may certainly be indicated in select patients, particularly those with abnormal postoperative exams. In addition, some of our reviewers are practicing attendings at our institution who participated in the treatment of the patients reviewed. As such, their decisions may have been biased based on potential recognition of the images reviewed. Accordingly,

all identifying information and dates of treatment were removed to mitigate any possible bias. Unfortunately, a large number of patients were excluded due to poor follow-up and inadequate documentation, which can certainly introduce a selection bias. Isolated radiographic complications in the early postoperative period are uncommon and so we feel this bias does not significantly weaken the results; however, it is certainly worth mentioning. Finally, the retrospective nature of this study limits the power of our conclusions.

The results of our study suggest that in patients with an uneventful postoperative course, imaging is likely unnecessary in the first month. Decreasing the use of postoperative films in the first 4 weeks can help decrease the financial burden placed on the health care system, decrease the utilization of health care resources, and allow for more efficient use of both physician and patient time.⁴

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

As our study only involved the use of preexisting medical records and no patient identifiers were recorded, informed consent was not obtained.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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