SCIENTIFIC ARTICLE

Interpretation of Post-operative Distal Humerus Radiographs After Internal Fixation: Prediction of Later Loss of Fixation

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Purpose Stable fixation of distal humerus fracture fragments is necessary for adequate healing and maintenance of reduction. The purpose of this study was to measure the reliability and accuracy of interpretation of postoperative radiographs to predict which implants will loosen or break after operative treatment of bicolumnar distal humerus fractures. We also addressed agreement among surgeons regarding which fracture fixation will loosen or break and the influence of years in independent practice, location of practice, and so forth.

Methods A total of 232 orthopedic residents and surgeons from around the world evaluated 24 anteroposterior and lateral radiographs of distal humerus fractures on a Web-based platform to predict which implants would loosen or break. Agreement among observers was measured using the multi-rater kappa measure.

Results The sensitivity of prediction of failure of fixation of distal humerus fracture on radiographs was 63%, specificity was 53%, positive predictive value was 36%, the negative predictive value was 78%, and accuracy was 56%. There was fair interobserver agreement ($\kappa = 0.27$) regarding predictions of failure of fixation of distal humerus fracture on radiographs. Interobserver variability did not change when assessed for the various subgroups.

Conclusions When experienced and skilled surgeons perform fixation of type C distal humerus fracture, the immediate postoperative radiograph is not predictive of fixation failure. Reoperation based on the probability of failure might not be advisable. *(J Hand Surg Am. 2016;■(■):■−■. Copyright © 2016 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Diagnostic III.

Key words Interobserver study, elbow trauma, distal humerus fracture.

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The operative treatment of bicolumnar intra-articular fractures of the distal humerus is challenging owing to anatomic complexity, possible comminution, and the presence of multiple nerves in the surrounding area.[1–6] The quality of the reduction influences final motion and the propensity to develop arthritis. The quality of the fixation influences maintenance of reduction and healing.[7–10] Loosening or breakage of implants accounts for 6% of adverse events after treatment of bicolumnar intra-articular fractures of the distal humerus and reoperation is often indicated.[11] The number of adverse outcomes was too small in this study for statistical analysis, but technical deficiencies (eg, too-short or too-distal plates) in many of the patients who had reoperation were noted. The AO have taught suggested fixation techniques for half a century. O' Driscoll[12] suggested specific criteria for judging the quality of internal fixation. Because most trauma and upper-extremity surgeons receive instruction in techniques for internal fixation of bicolumnar fractures of the distal humerus and many have experience caring for such fractures, one would assume that these surgeons are skilled in judging the quality of internal fixation. If these criteria are accurate, surgeons might be able to predict which fracture fixation will fail.

The purpose of this study was to measure the reliability and accuracy of interpretation of postoperative radiographs to predict which implants would loosen or break after operative treatment of bicolumnar distal humerus fractures repaired by experienced surgeons using accepted surgical techniques. We hypothesized that surgeons cannot predict which implants will loosen or break after operative treatment of a bicolumnar fracture of the distal humerus based on the first postoperative radiographs. We also hypothesized that there would be no agreement among surgeons regarding which implants would loosen or break and that there would be no difference in interobserver agreement regarding which implants would loosen or break according to subgroups (eg, experience, location of practice).

MATERIALS AND METHODS

Study design and setting

The institutional research board at the principal investigator's hospital approved this study. All patients who underwent distal humerus fracture surgery at the principal investigator's level I trauma center from 2002 to 2014 were identified with Current Procedural Terminology codes. A total of 129 adult patients with intra-articular bicolumnar (AO type C) fractures were identified, 8 of whom had loosening or breakage of implants.[11] All surgeries were performed by attending surgeons in a level I trauma center. Patients were excluded if no anteroposterior or lateral radiographs were available, if they had a pathologic distal humerus fracture with poor image quality, and if both columns were not fractured. In total, 7 patients with eventual failure of fixation were identified. All 7 constructs loosened or broke within 4 months. Seventeen chronologically consecutive sets of direct postoperative radiographs without failure were also selected. In total, we included direct postoperative anteroposterior and lateral radiographs of 24 patients who had surgery for an AO type C distal humerus fracture. "Direct postoperative" was defined as the same day or the day after surgery. Radiographs were performed in the level I trauma centers where the patient had surgery. Four of the included patients had parallel plates (one loosened or broke) and 20 had 90-90 plating (6 loosened or broke). A research fellow who was kept from observing the radiographs removed all identifying information from them. Each included patient had a follow-up of at least 4 months.

Members of the Science of Variation Group (SOVG) were invited to evaluate the radiographs on a Web-based study platform (SurveyMonkey, Palo Alto, CA). Members of the SOVG are fully trained, actively practicing surgeons and residents from around the world. The SOVG aims to study variation in the definition and treatment of human illness without financial or other incentive.

Participants

A total of 706 invitations were sent (all members of the SOVG). Most observers on this list were not active participants and not of all of them treated elbow fractures. Two hundred thirty-nine members of the SOVG agreed to participate in the study, 232 of whom (92% men and 8% women) completed the online survey (97% of initial responders). About half the observers practiced in the United States (49%) and were specialized in shoulder elbow surgery (53%), and more than half had more than 5 years' experience (62%), treated more than 11 distal humerus fractures each year (68%), and had trainees in the operating room (88%) (Table 1).

Study description

After logon, observers were asked general information about their practices. Subsequently, they were asked, "Do you think these plates will loosen or break?" This question had to be completed to continue with the next case. Observers completed the study at their own pace in their own time, on various computers if necessary.