Plate and Screw Fixation of Bicolumnar Distal Humerus Fractures: Factors Associated With Loosening or Breakage of Implants or Nonunion

Femke M. A. P. Claessen, MD,* Yvonne Braun, MD,* Rinne M. Peters, BSc,*
Gregory P. Kolovich, MD, MPH,* David Ring, MD, PhD*

Purpose To identify factors associated with reoperation for early loosening or breakage of implants or nonunion after operative treatment of AO type C distal humerus fractures.

Methods We retrospectively analyzed 129 adult patients who had operative treatment of an isolated AO type C distal humerus fracture at 1 of 5 hospitals to determine factors associated with reoperation for early loosening or breakage of implants or nonunion.

Results Within 6 months of original fixation, 16 of 129 fractures (12%) required reoperation for loosening or breakage of implants (n = 8) or nonunion (n = 8). In bivariate analyses, the Charlson comorbidity index, smoking, a coded diagnosis of obesity, diabetes mellitus, and radiographic osteoarthritis were significantly associated with reoperation for early loosening or breakage of implants or nonunion.

Conclusions With the numbers available, patient factors rather than technical factors were associated with reoperation for loosening or breakage of implants and nonunion. Because of the relative infrequency of fixation problems and nonunion, a much larger study is needed to address technical deficiencies. *(J Hand Surg Am. 2015;40(10):2045–2051.*

Type of study/level of evidence Therapeutic IV.

Key words Elbow trauma, distal humerus fracture, nonunion, failure of fixation.

Additional material is available online.

DISTAL HUMERUS FRACTURES ARE relatively uncommon in adults (about 6/100,000 persons per year) and usually benefit from operative treatment.[1,2] They are challenging to treat owing to anatomic complexity, fragmentation, and multiple nerves at risk. Operative treatment of intra-articular bicolumnar (AO type C) distal humerus fractures is associated with reoperation for loosening or breakage of implants or nonunion in 2% to 21% of patients.[3–8] In a few small studies, factors associated with early loosening or breakage of implants included technically inadequate fixation, severe comminution,[7,9] and open fracture.[10]

We used a database of patients treated at 5 hospitals to study the primary null hypothesis that no factors were associated with early loosening within 6 months after surgery or breakage of implants and nonunion for AO type C (intra-articular bicolumnar) distal humerus fractures.

*From the *Department of Hand Surgery, Massachusetts General Hospital, Boston, MA.*

Received for publication March 25, 2015; accepted in revised form July 6, 2015.

No benefits in any form have been received or will be received related directly or indirectly to the subject of this article.

Corresponding author: David Ring, MD, PhD, Department of Orthopaedic Surgery, Massachusetts General Hospital, Massachusetts General Hospital, Yawkey Center, Suite 2100, 55 Fruit Street, Boston, MA 02114; e-mail: dring@partners.org.

0363-5023/15/4010-0016$36.00/0
http://dx.doi.org/10.1016/j.jhsa.2015.07.009

MATERIALS AND METHODS

Study design and participants

In this institutional review board–approved retrospective study, we used a multi-institutional database to identify 636 patients who underwent open reduction

internal fixation of a distal humerus fracture (using Current Procedural Terminology codes) (Appendix A, available on the *Journal's* Web site at www.jhandsurg.org) between January 2002 and May 2014 at 5 area hospitals: 400 at hospital 1, 189 at hospital 2, 34 at hospital 3, 12 at hospital 4, and 1 at hospital 5. The first 2 hospitals are Level I trauma centers, the third is a community hospital tied to a Level I trauma center, and the latter 2 hospitals are community hospitals.

For patients who had more than one distal humerus fracture surgery, we considered the first distal humerus fracture surgery to be the index procedure. We excluded patients younger than age 18 years (n = 63). We excluded 401 patients after review of radiographs because of extra-articular or diaphyseal fracture; single-column fracture; associated fracture of the olecranon, radial head, or coronoid; pathological fracture; or prior surgery at another institution. Among the 172 qualifying patients, 43 (25%) were observed for fewer than 4 months, which left a total of 129 adult patients with intra-articular bicolumnar (AO type C) fractures for review.

Statistical analysis

Our primary outcome variable was reoperation for loosening or breakage of fixation within 6 months of surgery or reoperation for nonunion.[11–14]

We studied the following explanatory variables on review of the medical record: age at time of operative treatment, sex, open fracture,[10] other fracture of the same limb, other fractures elsewhere, head injury, abdominal or thoracic injuries, surgeon, hospital, and surgeon's experience in years since graduation from residency (all were identified by text search and chart review). We also studied explanatory variable-based International Classification of Diseases, Ninth Revision codes in the multi-institutional database: obesity, smoking status, alcohol dependence, diabetes mellitus, osteoarthritis, rheumatoid arthritis, and the modified Charlson Comorbidity Index (CCI) (Appendix B, available on the *Journal's* Web site at www.jhandsurg.org). The CCI is a score ranging from 0 to 24 based on 12 weighted comorbidities.[15] A higher score indicates a more severe comorbidity status. Head injuries were analyzed only if they occurred within 1 month of the distal humerus fracture. Finally, we studied the following explanatory variables based on a review of radiographs: the AO group (C1, C2, and C3), comminution of the lateral and/ or medial column, the level of each column fracture (top or base of the olecranon fossa), the location of the plates, the number of plates, use of precontoured plates (yes/no), the use of locking plates (yes/no), the number of screws outside the plate, and the fracture side.

We performed bivariate analysis using Fisher exact test for dichotomous and categorical variables and unpaired *t* test for continuous variables. There were too few failure events for multivariable analysis (high risk of overfitting the model).

RESULTS

Eight patients had reoperation for loosening or breakage of implants within 6 months of surgery and 8 had reoperation for nonunion (12%). In bivariate analysis, factors associated with reoperation included higher CCI ($P = .047$), obesity ($P = .040$), diabetes mellitus ($P = .039$), osteoarthritis ($P = .040$), and smoking ($P = .002$), but not the surgeon, surgeon's years of experience, or specific technical factors (Table 1).

DISCUSSION

Small case series of specific techniques of fixation may underestimate the incidence of reoperation for loosening or breakage of implants or nonunion. The increasing availability of databases makes it possible to study larger numbers of patients. Isolated intra-articular bicolumnar fractures of the distal humerus are relatively uncommon and usually are treated at Level I trauma centers. Approximately 1 in 8 patients had reoperation for loosening or breakage of implants or for nonunion. Infirmity, smoking, and obesity were associated with reoperation, but the number of reoperations was too small to address technical factors.

This study has several limitations. First, we used International Classification of Diseases, Ninth Revision and Current Procedural Terminology codes to identify the initial diagnoses and procedures rather than a review of the medical records. There is likely a small amount of miscoding as is typical of studies based on databases. Second, the incidence of reoperation for loosening or breakage of implants and nonunion is low, which makes it difficult to study the influence of surgeon and surgeon's experience and impossible to account for interactions between variables in multivariable statistical analysis. Larger data sets should be used to study early loosening or breakage of implants and nonunion after operative fixation of a type C fracture of the distal humerus, with the caveat that radiographic confirmation seems important and data sets need to include evaluations up to at least 1 year after surgery—something not available in most large data sets. Third, this study did not capture adverse events not associated with reoperation (eg, loosening of fixation without nonunion) or functional outcomes. Fourth, because of the relatively low number of adverse events in this study, we may