

## Outcomes of Humerus Nonunion Surgery in Patients with Initial Operative Fracture Fixation

*Noah James Harrison, MSc; Alexander Hysong, MD; Samuel Posey, MD; Ziqing Yu, MS; Andrew Chen MD, MPH; Patrick Pallitto, MD; Michael J. Gardner, MD; Roman M. Natoli, MD, PhD; John David Adams, MD; Robert D. Zura, MD; Lauren Maccormick Tatman, MD; Rachel Seymour, PhD; Joseph R. Hsu, MD; William T. Obremskey, MD, MPH; EMIT  
Atrium Health, Charlotte, North Carolina, UNITED STATES*

**Purpose:** Humerus nonunion develops following humerus fracture fixation in about 10% to 20% of cases. The only large case series of humerus nonunions to date is an expert single-surgeon series, which reported a failure rate of 22.8% after nonunion surgery in patients whose initial fracture was operatively treated. The purpose of this study was to provide a large multicenter series of patients with nonunions following initial operative management of humerus fractures and to identify risk factors for nonunion surgery failure.

**Methods:** We performed a retrospective analysis on a database of 118 aseptic humerus nonunions gathered from 9 Level I trauma centers. Every fracture was initially treated with operative fixation. Univariate regression analyses were performed to evaluate the success of nonunion surgery based on patient demographics, comorbidities, fixation type, use of bone graft/bone graft substitutes, fracture-related characteristics, and postoperative complications.

**Results:** Of the 118 humerus nonunions, we found that 27 (22.9%) failed to unite following nonunion surgery. Moreover, 44 patients (37.6%) experienced 1 or more postoperative complications (infection, deep vein thrombosis, hardware failure, reoperation, and/or readmission). Of the variables collected, only body mass index (<25 or >30 kg/m<sup>2</sup>) ( $P = 0.014$ ) and hypertrophic nonunion ( $P = 0.021$ ) were associated with successful nonunion surgery. Postoperative complications ( $P = 0.0001$ ) and the need for reoperation due to infection ( $P = 0.011$ ) were associated with an increased risk of nonunion surgery failure. Patient smoking status, diabetes, open fracture, and use of bone graft/bone graft substitutes were not associated with differences in the nonunion repair success rate.

**Conclusion:** This series, the largest and most generalizable to date, recapitulat

es the previously reported high rate of humerus nonunion surgery failure in patients whose fractures were initially treated with operative fixation. The higher rate of successful nonunion surgery found in hypertrophic nonunions suggests the importance of local biology within the fracture site. While it is not unexpected that postoperative complications were associated with recalcitrant nonunions, it is surprising that modifiable risk factors like smoking did not appear to influence the success rate of nonunion surgery. These findings can be used to give patients a realistic expectation of results and complications following humerus nonunion surgery. Research into the optimal treatment for nonunited humerus fractures after initial operative management is warranted.