Predictors of Nonunion After Operative and Nonoperative Management of Humeral Shaft Fractures in a Level I Trauma Center

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Purpose: Humeral shaft fractures occur commonly, often caused by high-energy trauma in young males and low-energy falls in elderly females. Historically, most were treated nonoperatively with a more recent trend toward more operative treatment, even for isolated injuries. Our aim is to identify predictors of nonunion after operative and nonoperative management of humeral shaft fractures.

Methods: Records of 603 adult patients with humeral shaft fracture were reviewed, and 326 patients with adequate clinical and radiographic records were included. Multivariate logistic regression analysis was used to identify significant predictors of outcome.

Results: Mean age was 44.1 ± 18.7 years, with female/male ratio 0.71, and mean body mass index (BMI) 29.1 ± 6.9. Comorbidities were present in 154 (47.4%) patients; a large proportion were smokers (41.1%) and used alcohol (42.9%). Motor vehicle collision was the most common mechanism of injury (28.1%), followed by fall from standing (26.5%), fall from height (13.2%), motorcycle collision (8.8%), and gunshot wound (8.2%). Shaft fractures most often occurred in the middle third (43.8%), with 30.8% in distal and 25.4% in proximal thirds. 72 (22.3%) were open fractures. Nerve palsy was present in 91 patients (27.9%) with radial nerve the most commonly injured nerve (76.9%). Overall, 138 patients (42.3%) were initially treated nonoperatively, and 188 (57.7%) underwent acute (<10 days) open reduction and internal fixation (ORIF). Surgical patients were younger (41.3 vs 46.9 years, P = 0.006), had fewer comorbidities (40.4% vs 56.5%, P = 0.004), and had similar gender, BMI, and substance use profile. Nonunion developed in 25 (18.1%) patients after nonoperative management and 19 (10.1%) after primary ORIF, while malunion was observed in 7 (5.1%) patients with nonoperative treatment and one (0.5%) operative case (P = 0.04). Simple fracture patterns had the highest risk of nonunion (transverse [A3] 30.0%) versus 17.6% for wedge (B) and 8.8% for complex (C) fractures (P = 0.07). Patients with malunion and nonunion had mean angulation of 29.0° (±8.2°) and 20.5° (±15.6°), respectively, compared to 14.1° (±11.6°) for healed fractures (P = 0.01). Chronic liver disease increased risk of nonunion in both groups (5.1% vs 0%, for operative, P <0.003; and 24.0% vs 3.5% for nonoperative, P = 0.001). In surgical patients cardiovascular disease, smoking, and alcohol use were associated with 2 to 3-fold increase in nonunion rate. Nerve recovery was observed in 79%, regardless of treatment, with mean time to recorded complete recovery 75.0 days. 29 patients (15.4%) had complications after ORIF, including iatrogenic nerve palsy (8.0%), infection (4.8%), and hardware failure/prominence (4.7%), and three patients (2.2%) had to undergo revision plate fixation.

Conclusion: Over half of our patients underwent ORIF. The surgical population had younger mean age and fewer comorbidities, and more commonly had high-energy injuries. Nonunion and malunion were more frequent with nonoperative treatment; especially transverse fracture patterns. Isolated comminuted fractures often achieve union after nonoperative care, while certain simple patterns at high risk may benefit from early ORIF. Comorbidities,

especially chronic liver disease, tobacco, and alcohol use were associated with high rates of nonunion, even after ORIF. Complication rates with surgery are concerning, and modifiable patient risks should be addressed.

See pages 47 - 108 for financial disclosure information.