Radiographic Union Scoring for Humeral Shaft Fracture (OTA/AO 12) Predicts Non-Operative Treatment Failure

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Purpose: The purpose of this study is to develop a model that calculates the probability of nonoperative treatment failure in humeral shaft fractures (OTA/AO 12) based on 6- and 12-week modified Radiographic Union Scores (mRUS) and assess predictive capabilities of risk factors for failure of nonoperative treatment of these fractures.

Methods: This is a retrospective review of all patients ≥18 years with isolated OTA/AO 12 fractures treated nonoperatively for at least 12 weeks at two Level I trauma centers from 2011 to 2018. Nonoperative management was considered successful if both clinical and radiographic union was documented. Nonoperative treatment failure was defined as concurrent fracture site mobility and lack of interval callus formation on radiographs beyond 12-week follow up. Patient, fracture, and treatment characteristics were collected. Blinded mRUS values were calculated at 6- and 12-week follow up. Inter- and intraobserver reliability was assessed via Intraclass Correlation Coefficients (ICC). All variables were tested for multicollinearity, with mRUS scores indicating a strong correlation necessitating individual models for each time point. A bootstrapped backward selection binary logistic regression analysis was performed individually for both 6- and 12-week mRUS values. This was then used to calculate predicted outcome probabilities based on score magnitudes.

Results: A total of 102 patients was included in final analyses; nonoperative treatment failed in 26 patients. Excellent interobserver (ICC = 0.85) and intraobserver (ICC = 0.94) agreement of mRUS values was demonstrated. In multivariate analysis, mRUS was the only predictor for failure of nonoperative management. Age ($p = 0.956$), body mass index (BMI, $p = 0.908$), tobacco use ($p = 0.305$), diabetes ($p = 0.389$), and fracture type ($p = 0.181$) did not correlate with nonoperative fracture union. At 6-week follow up, mRUS<7.5 demonstrated increased risk of nonoperative failure (OR = 3.3; CI: 1.9–5.6; $p<0.001$) with sensitivity 72.3%, specificity 83.8%, positive predictive value (PPV) 58.6%, negative predictive value (NPV) 92.5%, and 82.3% accuracy. At 12-week follow up, mRUS<9.5 demonstrated increased risk of nonoperative failure (OR = 18.2; CI: 2.8–111.4; $p<0.001$) with sensitivity 96.2%, specificity 93.0%, PPV 83.3%, NPV 98.5%, and 93.8% accuracy.

Conclusion: 6- and 12-week mRUS scores are predictive of nonoperative treatment failure in patients with isolated OTA/AO 12 fractures, with 12-week scores being more discriminative.