

Radiographic Scoring of Humeral Shaft Fractures Helps Identify Patients at Risk of Nonunion

*Steven Rivero, MD; Adam Michael Kurland, BA; Zuhdi Abdo, MD; Michael M. Vosbikian, MD; Irfan H. Ahmed, MD
Rutgers New Jersey Medical School, Newark, NJ, United States*

Purpose: Conservative treatment with a fracture brace is the gold standard for fractures of the humeral shaft. However studies have demonstrated nonunion rates ranging from 5% to 23%. Delayed surgical intervention for humeral nonunions has been associated with poor functional outcomes, suggesting that earlier diagnosis and intervention may be beneficial. Recently, studies have assessed an adaptation of the Radiographic Union Score for Tibial Shaft Fractures (RUST) for the humerus, demonstrating good inter- and intraobserver reliability. This scoring system aims to provide an objective measure of the progression of radiographic union and may aid in early identification of patients at risk of progression to nonunion. This study evaluates the reliability of this radiographic scoring system for conservatively treated humeral shaft fractures and assesses its utility in identifying patients at risk of nonunion.

Methods: A retrospective review of the electronic medical records of a Level I trauma center was conducted to identify patients treated for humeral diaphyseal fractures over 10 years. Patients treated surgically within 6 weeks of injury, age <18 years, follow-up of less than 3 months, and those lacking at least one set of orthogonal radiographs within 3 months of injury were excluded. Radiographs between 2 and 14 weeks post-injury were stratified into 3-week time intervals for comparison and assessed independently in a randomized order by 5 reviewers at various stages of training using the modified RUST (mRUST) scoring system. Radiographs were reassessed a minimum of 4 weeks later. Interobserver reliability was determined using intraclass correlation coefficient (ICC) and intraobserver reliability was measured using ICC and weighted kappa (κ_w). Statistical analyses were performed using SPSS.

Results: A total of 57 patients with 132 sets of orthogonal radiographs met the study criteria. 8 patients (14%) developed nonunion. Interobserver ICC from both time points was 0.827 (95% confidence interval [CI] 0.788-0.863). ICC from each round of scoring yielded 0.792 (95% CI 0.743-0.837) and 0.845 (95% CI 0.804-0.881) demonstrating a lack of statistically significant difference in interobserver agreement between the two rounds. Intraobserver ICC and κ_w demonstrated substantial to almost perfect agreement. Patients who failed to progress beyond a score of 8 by 5 to 7 weeks following injury were more than four times as likely to progress to nonunion as those who surpassed this threshold (odds ratio [OR] = 4.27, 95% CI 2.29-7.96, $P < 0.001$). Receiver operating characteristic curve demonstrated an area under the curve of 0.714 (95% CI 0.639-0.789), sensitivity = 0.365, specificity = 0.881, positive predictive value = 0.334, and negative predictive value = 0.895.

Conclusion: The results of this study advocate the use of the mRUST for conservatively treated humeral shaft fractures as both a reliable and reproducible objective measure of fracture healing. Additionally, fractures that scored ≤ 8 at 5 to 7 weeks post-injury should be considered at significantly increased risk of progression to nonunion and given greater consideration for early intervention.

See the meeting app for complete listing of authors' disclosure information. Schedule and presenters subject to change.