Δ Validation of the Radiographic Union Score for Tibial Fractures (RUST) Using Medical Imaging and Biomechanical Testing in an In Vivo Rat Model

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Purpose: The Radiographic Union Score for Tibial Fractures (RUST) and its modified counterpart are gaining popularity as a standard for assessing fracture healing progress. RUST (score between 4-12) and modified RUST (score between 4-16) are based on callus formation and fracture line visibility at each of the 4 visible cortices in 2 radiographs. This study aims to validate the score's ability to accurately assess a bone's healing progression using imaging and biomechanical parameters.

Methods: A group of 30 male rats underwent a standardized osteotomy with noncritical gap stabilized with a PEEK (polyetheretherketone) bone plate. At their assigned end point ranging from 5-17 weeks, the healing femur was radiographed in the lateral and AP direction prior to being sacrificed and both femurs dissected. Two fellowship-trained orthopaedic surgeons independently assigned RUST and modified RUST scores to the healing femurs. Agreement among the 2 principal reviewers was calculated using intraclass correlation coefficients (ICCs). A microCT scan and torsional testing was performed on the fracture callus and contralateral femur. A Spearman's rank correlation coefficient was determined for the healing femur's scores and imaging and mechanical parameters.

Results: The ICC of the 2 reviewers was 0.89 (95% confidence interval [CI] 0.78-0.94) for RUST and 0.86 (95% CI 0.74-0.93) for modified RUST, which fall within the "almost perfect agreement" ICC category. The resulting RUST scores ranged from 6 to 12 and modified RUST scores ranged from 5 to 16. A moderate differential between the correlations of the 2 scoring systems with microCT parameters suggests that the modified score better characterizes the fracture callus in comparison to traditional RUST. Significant variability in mechanical properties was observed within individual RUST score groups, which may limit the score's ability to accurately predict the strength of an individual sample. However, it is noted that greater than 90% of contralateral load at failure is achieved by all samples at RUST ≥10 or modified RUST 15. This may provide a threshold above which a plated bone may be considered "healed".

Conclusion: RUST and modified RUST have strong relationships with imaging and biomechanical parameters providing evidence of the accuracy of the scores as assessment tools for fracture healing. Such a validated scoring system will provide researchers with a clinically relevant and widely comparable end point for studies pertaining to fracture healing.

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See pages 401 - 442 for financial disclosure information.