

### **Small Residual Fracture Gaps Are Associated with Significant Delays in Healing in Diaphyseal Tibia Fractures Treated with Intramedullary Nailing**

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**Purpose:** Intramedullary nailing of diaphyseal tibial fractures has become the standard of care with excellent union rates. Despite advances in implants and technique, delayed and nonunion remain a difficult problem for both patient and surgeon. The purpose of this study was to investigate whether residual fracture gapping at time of intramedullary nail fixation for tibial shaft fractures is associated with delayed or nonunion.

**Methods:** The medical records of patients sustaining acute tibial shaft fracture underwent statically locked, reamed intramedullary nailing between 2006-2013. Inclusion criteria included patient age >18 years, definitive treatment within 7 days of injury, no pathologic or stress fracture, no segmental bone defect, and at least 6 months of radiographic follow-up. Baseline demographic, injury, and surgical data were recorded for each patient. Immediate postoperative radiographs were assessed for largest fracture gap on AP and lateral films as well as for angular deformity. Radiographs from each postoperative visit were assessed for healing using the Radiographic Union Scale for Tibial Fractures (RUST) and evaluated for implant failure. Clinic notes and subsequent operative notes were assessed for the diagnosis of nonunion and postoperative infection. Student t tests were used to evaluate significance of fracture gap, translation and other covariates on time to union (TTU). Covariates with  $P < 0.2$  in univariate analysis were incorporated into a multivariate logistic regression model to identify factors independently associated with increased TTU.

**Results:** After applying inclusion and exclusion criteria, we identified 209 patients who underwent intramedullary nailing during the study period and who had adequate follow-up. Fractures with mean AP/lateral gaps of <3 mm, 3.1-5 mm and >5 mm had an average TTU of 5.9, 6.5, and 8.4 months, respectively; fractures with larger residual gap sizes had a significantly longer TTU ( $P = 0.008$ ). Fractures with mean AP/lateral gaps of <3 mm, 3.1-5 mm and >5 mm had a nonunion rate of 2.87%, 3.83%, and 9.57%, respectively; fractures with larger residual gap sizes had a higher nonunion rate ( $P < 0.001$ ). In multivariate logistic regression analysis, only larger fracture gap and the presence of postoperative infection were found to significantly correlate with increased TTU ( $P < 0.001$  and  $P < 0.001$ ).

**Conclusion:** Residual gapping following intramedullary fixation of tibial shaft fractures is associated with an increase in likelihood of nonunion, especially in the setting of an average AP and lateral fracture gap of 5 mm. Surgeons are encouraged to critically evaluate fluoroscopic images and to use additional techniques to optimize intraoperative reduction and fracture site apposition.