Prediction of Tibial Nonunions at 3 Months After Intramedullary Nailing

Justin Fowler, MD[1]*; Andrew G. Dubina, BS*[1]*; Renan C. Castillo, PhD*[2]*;*
Christina L. Boulton, MD[1]*; Jason W. Nascone, MD*[1]*; Marcus F. Sciadini, MD*[1]*;*
Christopher T. LeBrun, MD; Robert V. O'Toole, MD[1]*;*
[1]*R Adams Cowley Shock Trauma Center, Department of Orthopaedics, University of Maryland School of Medicine, Baltimore, Maryland, USA;*
[2]*Center for Injury Research & Policy, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA*

Purpose: Interest exists in predicting which tibia fractures are likely to result in nonunion and require additional surgery. Multiple parameters might predict likelihood for nonunion, including patient and fracture characteristics, time until weight bearing is allowed, and the radiographic healing of the tibia or fibula. We hypothesized that a prediction tool could be created based on information available at 3 months that would be useful in predicting tibial nonunion.

Methods: A retrospective review of all tibia shaft fractures treated at a single Level I trauma facility between 2006 and 2012 yielded 59 nonunions. Patients were excluded if they were treated with anything other than an intramedullary nail, if there was a planned surgical intervention to prevent nonunion after the index procedure, or if the fracture pattern had a critical defect of >3 cm. 21 patients met the inclusion criteria and were compared to a randomly selected control group of 76 patients treated with an intramedullary nail who went on to radiographic union without the need for further intervention. Patient data were collected for each to include: fracture grade, American Society of Anesthesiologists Score (ASA) class, body mass index (BMI), smoking status, and time until weight bearing was allowed. An image set was created of these 97 cases utilizing their 3-month interval follow-up radiographs. The image set was presented in random order and viewed using standard clinical software to clinicians who were blinded to the final outcome. Four fellowship-trained orthopaedic traumatologists were asked to review the radiographs. The previously described RUST (radiographic union score of the tibia) score for each of the four cortices of the tibia were recorded as it was for the fibula. In the cases of a segmental fracture, the reviewer was asked to grade the fracture with the least amount of radiographic healing.

Results: As shown in Table 1, the tibia RUST score at 3 months was a powerful predictor of tibia nonunion. Patients with a score of 8 or above had a 0% (0/44) nonunion rate. Although application of the RUST score to the fibula at 3 months was predictive of nonunion in bivariate analysis ($P = 0.002$), this effect was not observed when used in combination with tibia RUST. For patients with tibia RUST scores below 8, a separate predictive model was developed. Predictors of nonunion in this model included: open fracture (odds ratio: 11.7, 95% confidence interval [CI] :1.2-118, $P = 0.04$) and tibia RUST score (odds ratio: 0.3 per RUST point, 95% CI: 0.14 to 0.67, $P = 0.003$). This model was highly predictive of tibial nonunion, accounting for >60% of variance in these outcomes.

See pages 99 - 147 for financial disclosure information.

Table 1. Tibia RUST Score at 3 Months and History of Open Fracture Versus Chance of Nonunion

	Tibia RUST Score			
Fracture Type	**8-12**	**7-7.9**	**6-6.9**	**4-5.9**
Closed	0% (0/26)	0% (0/8)	0% (0/3)	33% (2/6)
Open	0% (0/18)	18% (2/11)	50% (4/8)	76% (13/17)

Conclusion: The RUST score applied to tibia healing at 3 months appears to be a powerful predictor of need for tibial nonunion surgery. We have developed a simple, clinically practical model that predicts need for tibial nonunion surgery based on data available at the 3-month time point.

- The FDA has not cleared this drug and/or medical device for the use described in this presentation (i.e., the drug or medical device is being discussed for an "off label" use). For full information, refer to page 600.