

### Optimal Nail Diameter to Medullary Canal (ND/MCD) Ratio in Diaphyseal Tibia Fractures Treated with Intramedullary Nailing

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**Purpose:** Up to 17% of diaphyseal tibia fractures result in delayed union. Most patients achieve excellent outcomes with intramedullary nailing and it is unknown why some experience delayed healing. The goal of our study was to assess potential risk factors that may influence fracture healing in these patients with an emphasis on the nail diameter to medullary canal (ND/MCD) ratio.

**Methods:** 1050 adult patients who underwent operative treatment of tibia fractures between 2006 and 2018 were retrospectively reviewed. Exclusion criteria were inadequate follow-up (<12 months), additional lower extremity fractures, additional hardware, and nondiaphyseal and pathologic fractures. All fractures were classified using AO/OTA and Gustilo-Anderson schemas. Postoperative AP and lateral radiographs were used to calculate the ND/MCD ratio. Regression analyses were used to identify demographic and clinical variables associated with complications. A receiver operating characteristic curve analysis was used to identify the ND/MCD ratio that best differentiated between subjects who developed a nonunion and those who did not.

**Results:** The majority of patients included in the study presented with 42B fracture type (50 of 95, 53%). 27 patients had open fractures and grade III was the most prevalent injury pattern (11 of 27, 41%). The cumulative incidence of complications was 29.5%. Complications included nonunion, delayed union, infection, valgus deformity, symptomatic hardware, and compartment syndrome. Nonunion was noted in 18 patients (19.0%). In the univariate analysis, prescription medication use ( $P=0.0137$ ), open fractures ( $P<0.0001$ ), and a decrease in the ND/MCD ratio ( $P=0.0425$ ) were significantly associated with the development of a complication. The odds of a complication among open fractures were 10.1 times (95% confidence interval [CI]: 3.2 to 32.1,  $P<0.0001$ ) the odds of a complication among closed fractures. ND/MCD ratio cutoff of 85% was associated with the highest area under the curve value (sensitivity = 44%, specificity = 79%) in an exploratory analysis differentiating between the subjects that developed nonunion and the ones that did not.

**Conclusion:** A large proportion of patients with tibia fractures smoke (38%) and have comorbidities (54%). Patients who sustain open fractures, use prescription medications, and those with lower ND/MCD ratios are at higher risk for complications. ND/MCD ratio of <85% should be avoided as it may lead to nonunion development.