ROLE OF FIBULAR FIXATION IN DISTAL TIBIAL FRACTURE STABILIZED WITH STATIC-LOCKED INTRAMEDULLARY NAIL

Introduction: Closed locked intramedullary nailing can be used successfully in fractures of the distal tibia metaphysis. The incidence of late valgus malunion of the tibia after initial anatomic stabilization with a nail can be as high as 32%. The suggested causes of malunion in distal fractures include fracture instability, failure, distal interlocking of the tibia, premature weight bearing, lack of stability because of flaring of distal tibia, and the associated fibular fracture at the same level. The purpose of this study was to determine the experimental effect of fibular plate fixation on rotational stability in distal tibial fractures stabilized with a Russell Taylor® (RT) nail. We tested our specimens with a torsional loading because the nail is weaker in torsion and because the normal gait cycle results in both internal and external rotation moments on the tibia and ankle joints. We felt that repetitive rotation stress at the fracture site was the cause of late valgus malunion.

Methods: Seven matched-pair embalmed specimens (cadaveric legs) and seventeen fresh frozen and then thawed specimens (including one matched pair) were tested under torque control on a biaxial mechanical testing machine. Donor data included age and gender. The tibia-fibula interosseous membranes and surrounding muscle were maintained during specimen preparation. A simulated fracture (5 mm transverse segmental defect of the membranes and surrounding muscle were maintained during specimen preparation. A simulated fracture (5 mm transverse segmental defect of the tibia and fibula) was created 7 cm above the ankle joint and stabilized with a 9 mm RT nail, statically locked with 2 proximal and 2 distal screws. The fibula was fixed with a six-hole semitubular plate. X-ray films were made of all specimens to rule out pathologic fractures and to check adequacy of fixation. For mechanical testing, specimens were held proximally at the tibial condyles and distally at the foot with specially designed grips. An initial axial load of 53 to 71 N (<10% body weight) was applied to the tibial condyle of the specimens and maintained throughout the tests. Each specimen was tested twice, once with the fibular plate and once without. The order of testing was reversed from one specimen to the next. Displacement at the fracture site was determined for applied torques from 0.56 to 4.52 N-m. Data were collected as degrees of rotation and converted to mm displacement at the bone surface. Mean displacements as a function of applied torque were analyzed using an independent samples T-test for plated versus non-plated groups. Fresh frozen and embalmed specimens were examined separately.

Results: There was no linear correlation between donor age and fracture displacement in the plated versus non-plated groups (p = 0.010 and p = 0.14, respectively). There was no significant difference between specimens taken from opposite sexes. Plated specimens produced significantly less displacement initially (at torque 0.56 N-m) compared to non-plated specimens (p = 0.004 for embalmed and p = 0.031 for fresh frozen). However, the difference between plated and non-plated specimens did not increase as torque increased (see Figures 1 & 2).

Discussion: It has been reported that fixation of a segmental defect of the tibia with an intramedullary nail results in a construct stiffness in torsion of only 6.5% of the intact tibia, compared to 40 to 64% with external fixation (1). During the gait cycle, the tibia (relative to the femur) internally rotates about 12° and externally rotates during the toe-off phase. Resultant torsional stresses promote rotational displacement at the fracture site, and may encourage malunion when fracture stability is inadequate, or when there is a delayed union or nonunion. The role of fibular fixation is controversial. A long-term clinical outcome study (follow-up ≥29 years) found that distal-third tibial malunion greater than 10° altered tibial-talar contact stresses significantly (2). This resulted in symptomatic articular changes at the ankle joint. Although less angular malunion has been reported after fibular fixation, there is some incidence of plate-related wound complications. Our clinical experience suggests that fibular fixation increases the stability of distal tibial fractures enough to markedly reduce late malalignment. Intrinsically, the RT nail permits 5 to 6° of axial rotation between the screws and the holes for distal interlocking. This motion could be minimized with minor changes to the current design. Also, late valgus malalignment is worsened by nail axial translation and consequent distal fragment translation. In addition, the angular deformity can increase if there is loosening at the bone/screw interface.

Conclusions: In our laboratory simulation, fibular fixation initially increased stability by decreasing initial rotational displacement in nailed distal third tibial fractures. These data support our clinical observations that fibular fixation may decrease late valgus malalignment in distal third comminuted tibial fractures with a fibular fracture at the same level.

References

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