Supination External Rotational Ankle Fracture Injury Pattern Correlates with Regional Bone Density

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Background/Purpose: Rotational ankle fractures (OTA 44) can present with an array of possible osseous and ligamentous injury combinations in reliable anatomic locations. Stage IV rotational ankle fractures have injuries posteriorly with either a posterior inferior tibiofibular ligament (PITFL) rupture or posterior malleolus fracture, and medially with either a deltoid rupture or medial malleolus fracture. What accounts for these different injury patterns and whether specific patient and injury factors underlie the different injury patterns is unclear. The purpose of this study was to determine whether causative factors exist that could account for the various injury patterns seen with rotational ankle fractures.

Methods: A prospective registry of operatively treated supination external rotation stage IV (SER IV) ankle fractures from 2014 through 2015 was used to identify patients. Patient demographics, medical comorbidities, and injury characteristics were recorded for each case. All patients included in the study had preoperative radiographs and CT imaging of the injured ankle. A GE Picture Archiving and Communication System was used to calculate regional bone density from CT scans by using average Hounsfield Unit measurements on axial images from the distal tibia and fibula. Preoperative MRI and intraoperative direct observations were used to define and record the precise osseous and ligamentous injuries. Patients were grouped into those with no posterior or medial malleolar fracture (equivalent group), those with either a posterior or medial malleolus fracture (bimalleolar group), and those with both posterior and medial malleolar fractures (trimalleolar group).

Results: Patients in the equivalent, bimalleolar, and trimalleolar groups had no significant differences in age, body mass index, medical comorbidities, mechanism of injury, dislocation rate, or open fracture rate. Female gender was less common in patients in the equivalent group compared to the trimalleolar group (55% vs 87%, $P = 0.03$) but not the bimalleolar group (55% vs 72%, $P = 0.4$). Regional bone density at the ankle, as measured with Hounsfield Units, was significantly higher in the equivalent group (371) compared to the bimalleolar group (271, $P < 0.0001$) and trimalleolar group (228, $P < 0.000001$). In addition, regional bone density was significant higher in the bimalleolar group compared to the trimalleolar group ($P = 0.02$). Logistic regression analysis controlling for age and gender supported these significant differences between the equivalent, bimalleolar, and trimalleolar groups. Similarly, after controlling for age and gender, logistic regression analyses identified regional bone density as a significant predictor of a medial malleolus fracture over a deltoid rupture ($P = 0.002$) and of a posterior malleolus fracture over a PITFL rupture ($P = 0.018$).

See pages 49 - 106 for financial disclosure information.

Conclusion: Rotational ankle fractures occur with a variety of osseous and ligamentous injuries, which may be indicative of underlying patient or injury characteristics. In our cohort of SER IV ankle fractures, regional bone density at the ankle significantly correlated with the presence and number of malleolar fractures compared to ligamentous ruptures. Treating surgeons can use this information to anticipate bone quality during operative fixation based on ankle fracture injury pattern. In addition, the presence of a trimalleolar ankle fracture is a significant indicator of poor bone quality and may represent the first clinical sign of abnormal bone metabolism in many patients. Clinicians should strive to optimize bone metabolism in patients with trimalleolar ankle fractures postoperatively.