

### **Δ The Relationship Between Intra-Articular Fracture Energy and a Patient's Inflammatory Response**

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**Purpose:** Intra-articular fracture (IAF) elicits a post-injury inflammatory response marked by elevated synovial fluid concentrations of inflammatory cytokines and degradative enzymes. Prior work has shown that posttraumatic osteoarthritis (PTOA) risk after IAF correlates with fracture energy, and this has not been previously accounted for in inflammatory phenotyping studies. The purpose of this study was to determine whether synovial fluid cytokine levels vary with fracture energy or overall trauma to the body.

**Methods:** Synovial fluid samples were prospectively collected from 87 patients with a tibial plafond, tibial plateau, or ankle fracture from 2012 to 2018. Patients older than 60 years, history of preexisting ankle OA or autoimmune disease, acute contralateral intra-articular injury, open fracture, non-English speaking, or injury greater than 24 hours prior to evaluation were excluded. Joint-specific fracture energy was objectively quantified by using validated CT-based image analysis methods. Demographics and ISS were recorded. Synovial fluid samples were assayed for inflammatory biomarkers (interleukin [IL]-1 $\beta$ , -1RA, -6, -8, -10, and matrix metalloproteinase [MMP]-1, -3, and -13) blinded to injury severity. Fracture energy and ISS values were analyzed for correlations with cytokine concentrations.

**Results:** Fracture energies ranged from 0.2 J to 32.4 J, indicating a wide range of severities. As expected, simple ankle fractures involved substantially less fracture energy (3.45 J, standard deviation [SD] 2.92 J) than plafond (16.86 J, SD 9.86 J) and plateau fractures (12.54 J, SD 8.1 J) ( $P < 0.001$ ). There were no differences in the amount of fracture energy associated with plafond and plateau fractures. IL-10 ( $r = 0.27$ ,  $P = 0.01$ ) and MMP3 ( $r = 0.41$ ,  $P = 0.01$ ) were both more highly correlated with fracture energy, while MMP1 ( $r = 0.29$ ,  $P = 0.045$ ) was more highly correlated with ISS. IL-1 $\beta$  ( $r = 0.30$ ,  $P = 0.09$ ) was more highly correlated with ISS than fracture energy.

**Conclusion:** Fracture energy is primarily a local measure of mechanical insult to the joint and has been previously associated with PTOA development. IL-10 and MMP3 were more highly correlated with fracture energy, while MMP1 more highly correlated with ISS. This study demonstrated a strong positive correlation between MMP3 and fracture energy, which highlights the need for future studies to investigate the role of MMP3 in PTOA development after IAF.