

Objective Skin Perfusion Measurements Using Fluorescence Imaging Correlates With the Tscherne Classification for Severity of Soft-Tissue Injury in Tibia Fractures

Aresh Sepehri MD; Gerard Slobogean MD; Phillip McKegg BA; Joshua Rudnicki BS; Nathan N O'Hara; Robert V O'Toole MD; Marcus F Sciadini MD; Christopher T LeBrun MD; Jason Warren Nascone MD; Aaron J Johnson MD; Ida Leah Gitajn MD; Jonathan Elliott PhD; John Alan Scolaro MD; Raymond A Pensy MD
University of Maryland, Baltimore, MD, United States

Purpose: Tibial plateau and pilon fractures are often associated with extensive damage to the soft-tissue envelope, leading to increased postoperative wound healing complications and infection. Currently there is no objective method for evaluating the soft tissues and surgeons rely on subjective clinical examination to guide timing of fixation. As a result, the majority of these fractures are fixed in a delayed fashion, albeit at the expense of a reoperation and delayed rehabilitation. Laser-assisted Indocyanine Green Angiography (LA-ICGA) is a novel method for objectively quantifying soft-tissue perfusion used in other surgical specialties. The primary aim of this study was to determine whether skin perfusion measured by LA-ICGA was associated with the severity of soft-tissue injury as determined by the Tscherne classification. The secondary aim is to determine if soft-tissue perfusion improves from the time of injury to the time of definitive fracture fixation.

Methods: This prospective study was conducted at a Level-I Trauma Center between 2018 and 2019. Patients over the age of 18 years with a closed tibial plateau or pilon fracture undergoing open surgical management (acutely or delayed) were included. LA-ICGA was performed assessing skin perfusion over the surgical site prior to incision at the time of definitive fixation and external fixation (if required). 10 mg of ICG dye was injected through peripheral IV and perfusion was quantified using the charge coupled camera that specifically measures ICG dye concentration in the skin in fluorescence units (fu). The threshold perfusion of the injured area was measured during the arterial phase of dye distribution. Severity of soft-tissue injury was graded using the Tscherne classification at the time of injury. Linear regression modeling was performed to determine the association between tissue perfusion and Tscherne grade. For patients undergoing delayed fixation, paired t test was performed to assess whether soft tissue improves from the time of injury to time of delayed fixation.

Results: 27 patients (19 tibial plateau) with a mean age of 48.3 years were enrolled in the study. Six patients were classified as Tscherne grade 0, 9 as grade 1, 10 as grade 2, and 2 as grade 3. Perfusion decreased by 14 fu (95% confidence interval [CI]: -21 to -6, $P < 0.01$) with each point increase in Tscherne grade. The mean perfusion of grade 3 injuries was 5 fu compared to 44.3 fu for grade 0. 16 patients underwent delayed fixation with an external fixator (mean delay 14.1 days). The mean perfusion at the time of external fixation was 23.1 fu. This increased significantly at the time of definitive fixation by a mean of 13.9 fu (95% CI 4.8 to 22.9; $P = 0.01$).

Conclusion: Early results demonstrate that LA-ICGA perfusion measures are associated with severity of soft-tissue injury surrounding orthopaedic trauma fractures. Further research is warranted to investigate whether objective perfusion measures are predictive of postoperative wound healing complications and whether this tool can be used to effectively guide timing of safe surgical fixation.

OTA Grant