Objective Metric of Energy Absorbed in Tibial Plateau Fractures Corresponds Well to Clinician Assessment of Fracture Severity

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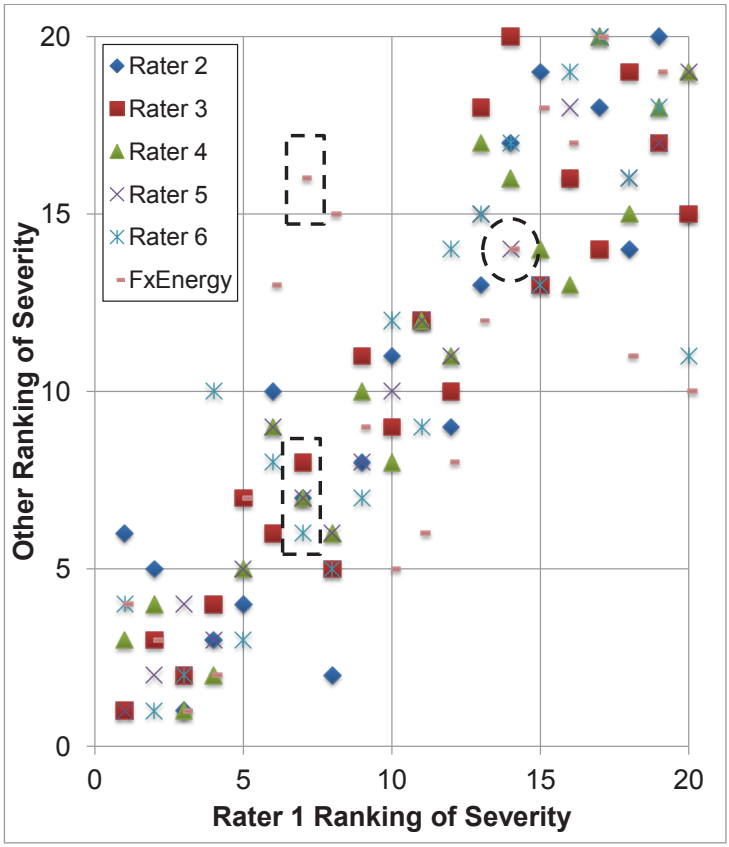
Background/Purpose: Outcomes of intra-articular fractures are influenced both by acute mechanical damage and by residual chronic changes in joint loading. The extent of damage sustained in the acute setting reflects the energy absorbed in creation of the fracture; therefore, fracture energy can be expected to substantially influence clinical outcomes. Previous investigations have demonstrated that objective CT-based quantification of fracture energy in pilon fractures correlates with surgeon assessment of injury severity and 2-year radiographic outcomes. It is not clear whether these findings can be extrapolated to other articular fracture types. In this work, we explored whether this technique of fracture energy measurement could be used to stratify the severity of tibial plateau fractures. Specifically, we hypothesized that a CT-based measure of fracture energy would correspond to subjective surgeon assessment of fracture severity. We tested the hypothesis by comparing surgeon rank ordering of fracture severity for a series of tibial plateau fractures with CT-based measurements of fracture energy.

Methods: Twenty fractures were selected from a series of 50 tibial plateau fractures to span a full spectrum of severity. Fracture classification ranged from OTA 41-B1 to 41-C3. Six fellowship-trained orthopaedic trauma surgeons independently rank-ordered the fractures in order of severity using AP and lateral knee radiographs. The only instructions given to the raters were to rank the cases in order of least to most severely injured. Subjectively, they used the number and size of fragments, the amount and direction of displacement, percentage of articular surface involved, and whatever other features they felt were important based on their clinical experience. CT-based image analysis techniques were used to quantify the fracture energy. The software identifies all fracture fragments on CT imaging and calculates the amount of bone surface area liberated by the fracture. The previously validated algorithm incorporates fracture liberated surface area and bone density to provide the fracture energy measurement. The agreement between fracture severity assessments made by the surgeons and the ranking by fracture energy measurement was tested by computing their concordance. A pair of cases' injury severity rankings was deemed concordant if the case with the higher ranking of injury severity for one rater also had the higher ranking for a second rater. Simply put, the rate of concordance is the number of concordant pairs divided by the total number of possible pairings.

Results: Concordance between the six orthopaedic surgeons ranged from 82% to 93%. Concordance between surgeon severity ranking and fracture energy ranged from 73% to 78% (Fig. 1).

See pages 47 - 108 for financial disclosure information.

Figure 1: Representative rank-ordering of fracture severity by six orthopaedic trauma surgeons and by fracture energy. The y-axis represents severity ranking as assigned by raters 2-6 and according to the calculated fracture energy. The x-axis represents the rank ordering of rater 1. As an example, there was high agreement between rater 1 and raters 2 – 6 at rater-1 injury number 7, but this fracture's rank according to fracture energy calculation was much higher (black dashed boxes). At rater-1 injury number 14, the rank according to fracture energy was the same as the rank assigned by raters 1 and 5 (dashed circle).



Conclusion: There is a high level of agreement between surgeon assessment of tibial plateau fracture severity and CT-based measurement of fracture energy. In addition, agreement among six surgeons with extensive clinical experience judging injury severity was excellent. Taken together, these results confirm that a CT-based method of calculating fracture energy accurately portrays fracture severity as judged clinically for tibial plateau fractures and provides an objective way to quantify injury severity. In addition, it is likely this tool will be clinically useful as there was excellent surgeon agreement on fracture severity. Further research is ongoing to characterize the relationship between fracture energy and clinical outcomes. Funding: Research reported in this abstract was supported by the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health under award number R21AR061808. The research was also aided by a grant from the Foundation for Orthopaedic Trauma.