ISAKOS

International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine

11th Biennial ISAKOS Congress • June 4-8, 2017 • Shanghai, China

Paper #184

A Novel MRI-Based Classification System for Tibial Eminence Fractures in Pediatric Patients: An Improvement from Meyers and McKeever?

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Summary:
The most common system for classifying pediatric tibial spine fractures is based on X-Rays. We propose an MRI-based system. Our results show a moderate intra-rater and fair inter-rater reliability of the new system. In 1/3 of our cases, assessment using MRI substantially modified the treatment. This new system may be a helpful tool for planning the treatment of tibial spine fractures in children.

Abstract:
BACKGROUND: The Meyers and McKeever Classification (MMC) is typically used to classify pediatric tibial spine fractures on plain radiographs. While MRI images can provide important information about the fractures, there is currently no system for classifying these fractures on MRI.

OBJECTIVES: The aims of this study were: (1) propose a new MRI-based system for classifying tibial spine fractures and (2) assess how often using an MRI-based system changes the treatment plan compared to the MMC, which is based on X-Rays. Our hypothesis is that an MRI-based system allows for more precise identification and treatment of tibial spine fractures.

METHODS: The new MRI-based system has three grades.
- Grade I fractures are defined as non- or minimally-displaced fractures with < 2 mm of displacement.
- Grade II fractures are posterior-hinged fractures with > 2 mm displacement of the anterior aspect of the fracture and < 2 mm displacement of the posterior aspect of the fragment.
- Grade III fractures are displaced fractures (> 2 mm of displacement of the posterior aspect of the fragment), any tibial spine fracture that results in meniscal entrapment (where the meniscus or intra-meniscal ligament is underneath a fracture fragment), or any tibial spine fracture extending to the weight-bearing surface of the medial or lateral tibial plateau with > 2 mm of displacement.

We considered three scenarios as “changes in treatment”: when use of the MRI-system (1) allowed raters to identify a fracture that had been graded as “no fracture” using X-Rays, (2) changed the treatment from non-operative to operative, and (3) changed the treatment from operative to non-operative. The number of cases that experienced a change was reported as raw counts and percentages.

Four independent observers (one attending orthopaedic surgeon, one attending radiologist, a senior orthopaedic surgery resident, and a junior orthopaedic surgery resident) classified the images of 20 patients according to the MMC using plain X-Rays. Each observer graded images at two time points at least one week apart. Next, raters repeated their assessments on MRIs using the MRI-based system. The inter-rater and intra-rater reliability of each system was assessed (Stata 14.0 software).

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RESULTS: Based on the Altman threshold, there was moderate intra-rater correlation between the observers when using MRI-based classification (avg = 0.60; range = 0.45-0.75) and a fair inter-rater correlation (k = 0.33).
Following the evaluation of MRIs with the new system, we observed “changes in treatment” in 33% (26 of 80) of grades after the first grading and 34% (27 of 80) after the second compared to the initial evaluation using X-Rays. In 11 grades (20%), MRI recognized previously unnoticed fractures; in 21 grades (40%), MRI assessment upgraded the lesion to operative treatment; in 21 grades (40%) formerly operative candidates were re-assigned to conservative treatment.

CONCLUSION:
There is moderate intra-rater and fair inter-rater reliability of the new system. In one third of the cases, assessment using MRI substantially modified the treatment recommendations. This MRI-based system may become a helpful tool for diagnosing and planning the treatment of tibial spine fractures in children.