Dynamic Imaging of Glenohumeral Instability with Open MRI

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Introduction: Instability of the glenohumeral (GH) joint leads to pain and functional impairment in a large number of individuals (1). Multiplanar imaging in open MRI devices, especially those that combine rapid imaging with a wide range of physiologic motion and physical examination during MR, has the potential to better characterize and understand GH instability. The goal of this study was to begin to characterize MRI patterns of GH instability in individuals with unilateral symptoms. A subgroup of patients constitutes an ongoing, blinded study comparing MRI results with clinical examination, examination under anesthesia, and arthroscopic findings.

Methods: A total of 17 patients (mean 27 y.o. range 19-49 y.o.) were studied. Nine patients were in an initial clinical trial, and 8 were in a specific study comparing MRI with clinical and arthroscopic findings in a blinded manner. Imaging was performed on an open configuration, 0.5 T MRI scanner (Signa SP, GE Medical Systems, Milwaukee, WI). Subjects were evaluated in the upright, sitting position with a flexible transmit-receive coil and active scan-plane registration (MR tracking) (2). Dynamic imaging was performed during active shoulder abduction and internal/external rotation and during application of glenohumeral force by an examiner. The MR tracking coil was applied to the lateral aspect of the acromion for abduction, to the coracoid process for internal/external rotation and to the coracoid for imaging during applied anteroposterior or posterior force on the humeral head. Fast gradient echo scans were used: TR 19.8 msec, TE 7.2 msec, flip angle 30-40 degrees, 256 x 128 matrix, FOV 24-30 cm, slice thickness 7 mm. Imaging time was ~2.5 sec/image. Total examination time was 30-45 minutes for bilateral shoulder examination. Humeral head position on the glenoid was measured using methods previously described (3,4) and applied to studies of normal volunteers (5).

Results: With physiologic shoulder motion or stress maneuvers, grossly abnormal glenohumeral translation was observed in four patients, including patterns of posterior subluxation (2), multidirectional subluxation (1) and anteroinferior subluxation (1). Two patients demonstrated bilateral glenohumeral laxity, defined as excessive translation of the joint on both the symptomatic and asymptomatic sides. In the remaining patients, glenohumeral shift was subjectively within the normal range (5). In this group, quantitative analysis of motion patterns is ongoing and may reveal more subtle alterations in glenohumeral mechanics. Figure 1 shows oblique coronal images of a 26 year old woman during active abduction demonstrating (A) superior subluxation of the humerus followed by a “clunk” back into the glenoid fossa (B) with further abduction. (H = humeral head; G = glenoid fossa). Figure 2 demonstrates anterior (A) and posterior (B) subluxation of the humeral head in the axial plane in a patient with multidirectional instability. Figure 3 shows oblique coronal images of a 30 year old man with anteroinferior glenohumeral subluxation in the position of apprehension (abduction and external rotation).

Conclusions: Grossly abnormal glenohumeral translation was observed in a minority of patients, but when present, dynamic MR provided dramatic characterization of the abnormal mechanics. These functional observations may prove to be of equal or more importance than findings on static MR imaging or MR arthrography. The remainder of the patient group, with more subtle findings or normal-appearing mechanics within the constraints of our imaging protocol, represents more of a challenge both clinically and with MRI. Once our ongoing study is unblinded, we hope to discover useful correlations between detailed MR motion patterns and clinical/surgical findings that will be more broadly applicable.

References: