

Variation in Scapulohumeral Rhythm of Pathologic Shoulders on Dynamic Radiography: A Novel Diagnostic Tool

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Abstract

Background: Various pathologies decrease shoulder active motion, but there is little understanding of the specific impact on glenohumeral and scapulothoracic motion individually. Using a novel imaging modality known as Dynamic Digital Radiography (DDR), one can evaluate a patient's scapulohumeral rhythm (SHR), defined as the ratio of glenohumeral (GH) and scapulothoracic (ST) motion to arm elevation. The purpose of this study was to measure the SHR of various shoulder pathologies using DDR.

Methods: Shoulders were analyzed using DDR by obtaining a series of pulsed radiographs of the joint in motion. GH and ST motion were quantified based on DDR images during humeral abduction in the plane of the body at 0-30°, 30-60°, 60-90°, and full abduction. SHR was calculated by dividing humeral arc of motion by scapular arc of motion in each of the aforementioned ranges.

Results: 121 shoulders were analyzed. 40 healthy normal controls were compared to pathologic states, including 13 small rotator cuff tears (SRCT), 29 massive rotator cuff tears (MRCT), 16 adhesive capsulitis (AC), and 23 GH osteoarthritis. SHR for full arc of abduction differed significantly in patients with MRCT (1.91 ± 0.72), AC (1.55 ± 0.37), and GH osteoarthritis (2.31 ± 1.01) compared to controls (3.39 ± 0.79). When analyzed across 30-degree intervals of humeral abduction, there was a statistically significant lower SHR found at 0-30°, 30-60° and 60-90° of humeral abduction in MRCT, AC, and GH osteoarthritis patients across each motion range compared to controls. Control patients had an average overall humeral abduction of $103.40 \pm 31.97^\circ$ which was significantly larger compared to all included shoulder pathologies (MRCT: 75.75 ± 22.61 , SRCT: 80.93 ± 20.71 , AC: 64.49 ± 27.02 , GH osteoarthritis: 71.05 ± 34.88) and an average scapular abduction of $32.57 \pm 13.60^\circ$, which was significantly smaller than patients with a MRCT (45.57 ± 10.41) and AC (64.49 ± 27.02). Interclass correlation coefficient across all pathologies was 0.866 (0.756-0.932).

Conclusion: Although SHR varied throughout the arc of motion, it remained significantly lower (decreased GH and/or increase ST motion) in patients with MRCT (43.65% decrease), AC (54.29% decrease), and GH osteoarthritis (32.01% decrease) compared to controls. When isolating for humeral and scapular motion, all 4 pathologic conditions had decreased humeral abduction, while patients with AC and MRCT had an increased scapular compensation compared to controls. Ultimately, this study serves as a foundation for future investigation on SHR using dynamic radiography in various shoulder pathologies, potentially improving our diagnostic algorithms for these conditions.