

## Comparison of Three-dimensional Scapular Kinematics in Pathologic and Non-pathologic Subjects.

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Patients with shoulder pathologies frequently display abnormal scapular kinematics. Clinical assessment of scapular motion is often performed through bilateral comparisons. Asymmetry and consistency of scapular motions however, are difficult to quantify. The purpose of this study was to compare the consistency and symmetry of three-dimensional scapular motion between pathologic and non-pathologic subjects. We hypothesized that pathologic subjects would display less consistency between trials and less symmetry when compared to non-pathologic subjects. Thirty-nine subjects (24 males and 15 females, 19 non-pathologic, 20 pathologic, age  $29.7 \pm 9.8$  years, mass  $75.5 \pm 18.25$  kg, height  $173.0 \pm 9.6$  cm) volunteered for participation. The diagnosis of an orthopedic surgeon (WBK) was used to classify subjects as pathologic. An electromagnetic tracking device was used to measure bilateral scapular kinematics. Receivers were taped to the posterior acromial angles of both scapula and a reference receiver was taped to the sternum. Investigators digitized subjects creating anatomically relevant, local coordinate axes. Participants performed five repetitions of scapular elevation up to 150 degrees of humeral elevation. A metronome controlled the rate of motion at 4 seconds per repetition. Trials were subdivided into two distinct phases, elevation and lowering. Data were analyzed using Matlab and SPSS; alpha level ( $p < .05$ , a priori). Each phase of motion was normalized to 100 data points. Inter-trial consistency and bilateral symmetry were measured through the calculation of coefficients of multiple determination (CMD). These CMD represent similarity of trials, evaluating the magnitude and rate of each scapular motion individually (upward rotation, internal rotation, and posterior tilt). CMD were also calculated to measure bilateral scapular symmetry. The measures of CMD are indicative of the percentage of variance accounted for within the data (i.e.,  $r^2$ ). We observed between trial CMD values ranging from .01 to .99 and .02 to .99 in the pathologic and non-pathologic groups respectively. We observed symmetry CMD values ranging from .01 to .99 and .26 to .99 in the pathologic and non-pathologic groups respectively. Multiple pairwise comparisons evaluated differences between groups. Statistically significant results included: 1) between trial CMD of left internal rotation during arm elevation ( $p=.004$ ), 2) between trial CMD of right internal rotation during arm elevation ( $p=.037$ ), 3) internal rotation symmetry during the lowering phase ( $p=.04$ ). Our results indicate that between trial consistency of scapular motions as

well as symmetry of scapular motions were similar between pathologic and non-pathologic groups.