THE INFLUENCE OF HAND-HELD WEIGHT ON THE SCAPULOHUMERAL RHYTHM

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INTRODUCTION
Inman reported in 1944 that the ratio of glenohumeral (GH) to scapulothoracic (ST) motion was 2:1 [1], but more recent studies report varying ratios [2][3]. This ratio, the so-called scapulohumeral rhythm, provides insight to neuromuscular control mechanisms and fundamental biomechanics of the shoulder. Muscular stabilization of the scapula provides a critical platform for upper extremity dynamic activity. Thus, the scapulohumeral rhythm (SHR) is potentially one important parameter to characterize shoulder function during dynamic activity.

The goal of this study was to determine in vivo the influence of lifting 3kg hand-held weights on the SHR, which often are used as part of a shoulder rehabilitation program. It is assumed that muscular stabilization of the scapula increases while lifting greater weights, thus less scapular motion might be seen during early lifting and the SHR would decrease. The study hypothesis was that arm abduction with a hand-held 3kg weight would result in an increased SHR compared to arm abduction without a hand-held weight.

METHODS
Ten healthy shoulders in ten subjects (8 men, 2 women, 27 to 38 years old, average 31.5 years) were studied. All subjects provided informed consent to participate in this IRB approved study. CT scans of each shoulder were acquired at 0.5 mm intervals and 3D models of the scapula and proximal humerus were created. The subject was positioned in front of a fluoroscope and motions were recorded during active abduction from 0°-120° in the plane of the scapula. The subjects performed two trials: one trial holding a 3kg weight and one unloaded trial. 3D motions of the scapula and humerus were determined using model-based 3D-to-2D registration (Fig. 1). Motion data were grouped into 10° intervals of GH motion and compared from 5° to 65° using t-tests with p=0.05.

RESULTS
The ratio of glenohumeral motion to scapulothoracic motion varied over the range of glenohumeral abduction (Table 1, Fig 2). This ratio was greater (less scapular motion) for the loaded case at all motion increments (Table 1), and scapular motion was significantly less from 35°-55° of glenohumeral motion (Fig 2).

DISCUSSION
The scapulohumeral rhythm is considered important to understand shoulder and upper extremity function, and indicative of correct neuromuscular stabilization of the scapula as the basis for dynamic upper extremity activity. This study showed that this rhythm varies over the range of shoulder motion and with the addition of hand-held weight. The SHR was greatest (least scapular motion) at low glenohumeral abduction angles, suggesting that the scapula is relatively fixed to the torso early in the elevation arc, providing a stable fulcrum for the rotator cuff. This may set up the scapula for subsequent arm elevation, with the rotator cuff properly stabilizing the glenohumeral articulation. This effect was more pronounced when a 3kg weight was hand-held during arm elevation.

REFERENCES

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