SCAPULOHUMERAL KINEMATICS IN INDIVIDUALS WITH UPPER EXTREMITY IMPAIRMENT FROM STROKE

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INTRODUCTION

The mobility of the shoulder girdle is a complex interaction of arthrology and neuromotor control[1]. Over 780,000 persons in the United States have a new or recurrent stroke each year. Residual, motor impairments such as weakness and incoordination can lead to changes in shoulder function and mobility. Alterations in shoulder elevation and scapular upward rotation are related to shoulder pain in persons with hemiparesis from subacute stroke[2,3]. Despite therapeutic efforts, as many as 80% of persons with stroke continue to have residual deficits, particularly within the paretic, affected limb. Additionally, it has been suggested that in individuals with stroke the upper extremity ipsilateral (“less affected”) to the lesion may also exhibit deficits. However, there is little literature that examines the scapulohumeral kinematics of the paretic and less affected limbs in persons with chronic stroke and that compares the less affected limb kinematics to individuals without upper extremity impairment.

METHODS

Fifteen individuals (63.8±17.5 yrs) with impairment from chronic stroke and 15 healthy, aged matched individuals (62.1±8.4yrs.) were evaluated. Motor impairment in those with stroke was measured with the Fugl-Myer Upper Extremity Motor Assessment (FM_UE). The FM_UE is a valid and reliable tool with a maximal score of 66. Three-dimensional kinematic data of the upper extremities was collected as participants performed three repetitions of arm elevation at a self-selected velocity and in their plane of choice. Participants were instructed to “lift your arm overhead in the most comfortable manner.” Kinematics were collected with the Motion Monitor™ short range transmitter system (Innsport, Chicago, IL) with use of “mini-bird” sensors (Ascension Technology, Burlington, VT). This system has a reported position accuracy of 0.07 inches/0.5 degrees at a 36 inch range with a resolution of .03 inch/0.1 degrees (Ascension Technology, Burlington, VT). The standardized shoulder protocol for the description of shoulder motions and global coordinate system (GCS) as recommended by the International Shoulder Group (ISG) of the International Society of Biomechanics was followed[4]. The scapula was defined in respect to the thorax (scapulothoracic) and the humerus with to respect to the thorax (humerothoracic). Three repetitions from each extremity were collected with order of extremity randomized. Humerothoracic (HT), scapulothoracic (ST) and glenohumeral (GH) kinematics were determined from the final repetition. Scapulohumeral rhythm (SHR) was calculated as the ratio of the change in glenohumeral elevation to change in scapulothoracic upward rotation. Independent t-tests (p≤0.05) compared the between group differences of the control and the less affected limb while paired t-tests assessed differences with participants less affected limb vs. paretic limb. Three participants with stroke were unable to elevate about 70°, therefore, were not included in the paretic limb analysis. Given the small sample, Cohen’s d was calculated to determine the strength of the comparative relationships with effect size defined as small (d≥0.2), medium (d≥0.5) or large (d ≥ 0.8).

RESULTS AND DISCUSSION

The scapulohumeral kinematics of participants with stroke were highly variable across all motions. Plane of elevation was significantly different between the control group and the less affected limb of the stroke group throughout the elevation motion, with the less affected limb elevation occurring more in the scapular plane and the control limb in the
frontal plane (Figure 1). No difference was found between the less affected and paretic limb plane of elevation.

**Figure 1: Plane of humerothoracic elevation**

![Diagram showing plane of elevation](image)

* = p≤ 0.05 control vs. less affected limb

Although not statistically different (p=0.07), a medium effect size (δ = 0.70) was found in mean peak HT elevation with reduced elevation in the less affected limb, compared to the control. As with previous research, greater mean peak HT elevation (p=0.03) was achieved by the less affected limb (118°) than the paretic limb (104°) within the stroke group.[2] At peak elevation, compared to the control group, the less affected limb demonstrated increased scapular internal rotation (IR) as indicated by a large effect size (δ = 0.93). Medium effect sizes were also found for reduced posterior scapular tipping (PT) of the less affected limb compared to control at HT elevation of 60° (δ=0.70), 80° (δ = 0.72) and 100° (δ = 0.73). Compared with the control group and the paretic limb, SHR was increased (p=0.01) in the less affected limb. (Figure 2) Given the large variability in impairment and movement patterns no other statistically significant differences between limbs were revealed among the kinematics within the group with stroke.

**CONCLUSIONS**

The majority of shoulder complaints involve frequent use of the arm at, or above shoulder level. There is growing evidence associating abnormal scapulothoracic kinematics with a variety of shoulder pathologies. During HT elevation the scapula should upwardly rotate and posteriorly tilt with external rotation occurring at end range of elevation. [5] Given anatomical relationships, it is believed that reductions in scapular upward rotation and posterior tilt during arm elevation could reduce the available subacromial space, potentially contributing to development of impingement as well as providing a poorer environment for tissue healing. The lack of scapular ER with decreased posterior scapular tipping found in this pilot study may be a precursor to the development of shoulder pathology in the less affected limb of persons with stroke. Given the limited elevation range of the paretic limb, the less affected limb in persons with stroke often must accomplish the majority of overhead activities. Therefore, assessment of scapulothoracic kinematics is important in understanding potential mechanisms of injury.

**REFERENCES**