

# EFFECT OF SHOULDER IMPINGEMENT ON SCAPULAR KINEMATICS DURING SELECTED TASKS IN WHEELCHAIR USERS

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## INTRODUCTION

Manual wheelchair users (MWCU) depend on their upper extremities for mobility, transfers, pressure relief and a variety of other daily functional activities. As many as 78% of MWCU report experiencing shoulder pain since the onset of wheelchair use, with shoulder impingement diagnosed as the most commonly occurring pathology (Bayley, '87 Curtis, '99). While scapular movement patterns and scapulothoracic muscle function have been reported in open chain (non-weight bearing) humeral elevation in groups with and without shoulder impingement pathology, to date, no one has assessed the scapula during upper extremity loaded tasks that individuals who use a wheelchair must perform on a daily basis. Therefore, the **purpose** of this research was compare scapular kinematics and muscle function during selected activities of daily living (ADL) in groups of MWCU with and without shoulder impingement.

## METHODS

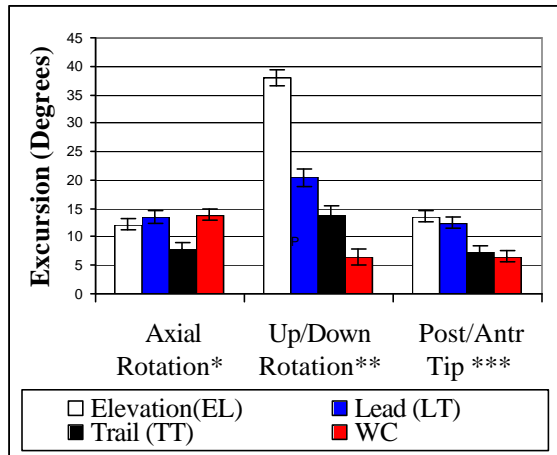
Twenty- six MWCU (mean age=42 ± 11yrs; wheelchair use = 16 ± 8yrs) participated. Twelve subjects showed signs and symptoms of shoulder impingement. Disabilities of the subjects in the sample included spinal cord injury, multiple trauma, congenital birth injuries, cerebral palsy, and spina bifida. Kinematics of the thorax, humerus and scapula were measured

(100Hz) during transfers, propulsion and scapular plane elevation via the MotionMonitor™(Innsport, Chicago, IL) electromagnetic tracking system. Segmental and global coordinate system definitions and Euler rotation sequences for the description of shoulder motions (recommended by the International Shoulder Group of the International Society of Biomechanics) were used. Surface EMG (Noraxon, USA, Inc. Scottsdale, AZ) from selected upper extremity and scapular muscles was collected at 1000Hz. Kinematics and EMG were synchronized and time normalized. Tasks were divided into phases of 30<sup>0</sup> increments based on humeral elevation angle. Two-way analysis of variance ( $p \leq 0.05$ ) was used to determine if differences existed in the scapular kinematics and EMG between the groups and among the tasks of lead limb and trail limb transfers.

## RESULTS

There was no difference in age, or duration of wheelchair use between the groups. The impingement group (n=12) demonstrated reduced maximal humeral elevation angles, increased scapular medial rotation and decreased posterior tipping during the elevation task, compared to the group without shoulder pathology (n=14). No difference was found between the groups for other kinematic variables, so data was collapsed across groups for task comparisons (n=26). Significant differences were found to exist in maximal angles of

thoracic flexion, scapular axial rotation, upward rotation, and posterior tipping, among the four tasks. Joint excursion was found to be greater for scapular upward and posterior rotations during the lead limb transfer and elevation compared to trail limb transfer and propulsion. The elevation task had the greatest amplitude of all three tasks in the upper trapezius muscle, and lowest amplitude in the biceps muscle. The trail limb transfer task demonstrated greater peak amplitude than the lead limb transfer and propulsion in the anterior deltoid and the lower trapezius muscles, with greater peak serratus anterior activity compared to activity during the propulsion task. (Table 1)



**Figure 1: Scapular excursion among tasks**  
 (\*EL&LT&WC> TT \*\* EL>LT>TT>WC  
 \*\*\* EL&LT> TT&WC,  $p \leq 0.05$ .)

## DISCUSSION/CONCLUSION

Shoulder impingement does affect humeral elevation task performance in MWCU, similar to that shown in a sample of people without disabilities (Ludewig, 2000). For both groups, the scapula is placed in positions that have been associated with impingement in open chain tasks. This is particularly true in the trail limb transfer where the scapula demonstrated increased medial, downward and anterior rotation with increased thoracic flexion. These mechanics may potentially place the MWCU at risk for development of the pathology.

## REFERENCES

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**Table 1: Peak EMG Amplitude during Performance of Selected Tasks (mean %MVC, se)**  
 \* = ( $p \leq 0.05$ )

Muscle		Elevation (EL)	Lead (LT)	Trail (TT)	Propulsion (WC)
<b>Biceps</b>	*TT & LT > EL	8% (3)	22% (3)	24% (3)	15% (3)
<b>Anterior Deltoid</b>	*TT > LT & WC	32% (4)	24% (4)	40% (4)	23% (4)
<b>Upper Trapezius</b>	*EL > LT&TT&WC	28% (2)	12% (2)	8% (2)	11% (2)
<b>Serratus Anterior</b>	*TT > WC	45% (6)	35% (6)	52% (6)	24% (6)
<b>Lower Trapezius</b>	*EL&TT & LT, WC	28% (3)	13% (3)	26% (3)	15% (3)