Shoulder Activation for Wheelchair Users
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Disclosures
No Disclosures

Learning Objectives
Identify the key muscles and their role in proper biomechanics of the shoulder function in wheelchair users.
Review interventions to increase efficiency for shoulder strengthening, thus preventing injury.
Identify and compare the differences between the endurance and hypertrophying muscle groups from the STOMPS program.
Background

Spinal Cord Injury (SCI) Incidence: ~12,000 cases/year
70% of manual wheelchair users have shoulder pain due to reliance on the upper extremities.
Altered muscle activity may result in detrimental kinematics and impingement.
Unopposed activity of scapular downward rotators. Anterior tilts, may contribute to superior translation of the humerus or glenohumeral internal rotation. Muscles that perform upward rotation, posterior tilting and external rotation are shown to avoid impingement pain.

Mulroy’s Study

Existing home exercise program (HEP) developed to mimic the demands of various muscles during functional activities is effective in reducing but not eliminating shoulder pain

Mulroy’s Study Cont..

Randomized control trial, 12 week home based exercise program; individuals with paraplegia with spinal cord injury
Exercise group:
- Hypertrophy exercises were selected for high force/short duration of activity
- Endurance exercises were selected for low force/long duration activities
Control Group:
- 1 hour instructional video
Pain measured with the Wheelchair User’s Shoulder Pain Index (QOL measure)
Decreases seen in shoulder strength were associated with muscle strength
Purpose: To critically evaluate muscle activation of 6 key shoulder muscles during 4 wheelchair-based home exercises designed for individuals with paraplegia.

Hypothesis:
1. We hypothesize that hypertrophying exercises will cause greater activation than endurance exercises.
2. We hypothesize that SA will have decreased muscle activation during all 4 exercises as no exercise specifically target SA.
The 6 key muscles

- Pectoralis Major (PM)
- Latissimus Dorsi (LD)
- Upper Trapezius (UT)
- Lower Trapezius (LT)
- Middle Deltoid (MD)
- Serratus Anterior (SA)

Participants

Convenience sample of 10 Individuals (7M, 3F; ages 37-60) with paraplegia, non-painful shoulders, and SCI levels ranging from T4-L2

Why use non-painful shoulders?

Methods

Randomized: Order of exercises was randomized for each participant (practice and study)

Equipment: Multi-Channel Wireless Surface EMG (Aurion) was used on the 6 key muscles: SA, UT, LT, PM, LD, and MD.

Procedure: Individuals instructed on 4 exercises; 2 hypertrophy exercises of 8-rep max (pulldown and external rotation) and two endurance exercises of 18-rep max (scaption and retraction)

Analysis: Data were normalized using muscle activation reported as a % maximal voluntary isometric contraction (MVIC). Maximal strengthening is defined as >40% MVIC.
Endurance (15-rep max)

- Rows
- Scaption

Hypertrophy (8-rep max)

- Pull-down
- External Rotation

Results (Avg. Muscle Activation)

- Pectoralis Major
- Latissimus Dorsi
- Middle Deltoid
- Upper Trapezius
- Lower Trapezius
- Serratus Anterior
Results

<table>
<thead>
<tr>
<th></th>
<th>Endurance</th>
<th>Hypertrophy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scaption</td>
<td>Retraction</td>
</tr>
<tr>
<td>Pectoralis Major</td>
<td>6±5%</td>
<td>3±2%</td>
</tr>
<tr>
<td>Latissimus Dorsi</td>
<td>8±4%</td>
<td>16±17%</td>
</tr>
<tr>
<td>Middle Deltoid</td>
<td>35±15%</td>
<td>10±6%</td>
</tr>
<tr>
<td>Upper Trapezius</td>
<td>42±14%</td>
<td>10±7%</td>
</tr>
<tr>
<td>Lower Trapezius</td>
<td>10±14%</td>
<td>9±6%</td>
</tr>
<tr>
<td>Serratus Anterior</td>
<td>28±12%</td>
<td>10±5%</td>
</tr>
</tbody>
</table>

Discussion

Hypotheses not supported: Endurance exercises displayed greater muscle activation than hypertrophy exercises and no exercises maximally activated SA defined as >40% MVIC. SA reached its highest activation during scaption. However, this exercise also targeted the UT and MD which may contribute to impingement. The exercise utilizing a dumbbell showed more overall muscle activation as compared to elastic band resistance.

Clinical Relevance

Home exercises reduce, but do not eliminate shoulder pain. Future HEPs should target key muscles necessary for function while considering biomechanics to address impingement. Current exercises may be ineffective unless key muscles are selectively targeted at the appropriate intensity. This may be achieved through the use of biofeedback, alternative forms of resistance or modified exercise positions.
So what else can we do?

SA Activation Study

Investigation of SA activation during a traditional wall slide at and above 90° of elevation, Scaption and Push up plus. Single Group Repeated Design Surface EMG Purely looked at Intensity of muscle activation.

SA Activation Study

SA had no significant difference between the 3 exercises Scaption had the highest SA and UT activation with minimal UT activation. As humeral elevation angle increases so does SA activation Wall slide allows for SA activation where people normally have impaired biomechanics.
References