Scapular Muscle Activation during Push-up Exercises on Different Hands Support Surface

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Background

The push-up exercise is a common exercise as a fitness or rehabilitative program for scapular muscle strengthening on various hand supported surfaces.

The trapezius and the serratus anterior muscles are an important force couple for the scapulothoracic motion and scapular control.

The muscle activations of the scapular muscles have not been investigated for repetitive push-ups previously.

Methods

20 healthy young adults (age: 21.6±2.4y; height:174.4±6.9cm; weight: 72.3±16.3kg) volunteered for this study.

Surface electromyographic (EMG) data of upper trapezius (UT), lower trapezius (LT) and serratus anterior (SA) were collected on the dominant side during repetitive push-ups on the stable or unstable hands supported surface conditions.

Difference between two different supported surface (stable & unstable condition) and three timing phase (early, middle & late phase) during push-ups were determined by two-way repeated measured ANOVA

For the hands supported surface main effect:

The SA (F=8.442; p=0.009) showed greater activation in unstable condition during push-up plus. There was no hands supported surface main effect in UT (F=1.500; p=0.236) & LT (F=0.170; p=0.684).

For the timing phase main effect: There was an timing phase main effect for the SA (F=3.815; p=0.042). The SA activation in middle (p=0.039) & late (p=0.039) phase were greater than early phase during push-up plus.

There was no timing phase main effect in UT (F=0.164; p=0.850) & LT (F=5.130; p=0.017).

Table 1: Muscle activation results for hands supported surface main effect

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Stable</th>
<th>Unstable</th>
</tr>
</thead>
<tbody>
<tr>
<td>UT</td>
<td>3.5±0.8</td>
<td>5.4±1.1</td>
</tr>
<tr>
<td>LT</td>
<td>3.9±0.7</td>
<td>3.5±0.5</td>
</tr>
<tr>
<td>SA</td>
<td>16.9±1.7*</td>
<td>30.5±4.1*</td>
</tr>
</tbody>
</table>

Note. Values are %MVC ± SD  
* p<0.05

Table 2: Muscle activation results for timing phase main effect

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Early</th>
<th>Middle</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>UT</td>
<td>4.3±0.6</td>
<td>4.7±0.8</td>
<td>4.4±0.6</td>
</tr>
<tr>
<td>LT</td>
<td>4.0±0.5</td>
<td>3.3±0.4</td>
<td>3.9±0.4</td>
</tr>
<tr>
<td>SA</td>
<td>20.4±1.8*</td>
<td>25.2±2.5*</td>
<td>25.7±2.6*</td>
</tr>
</tbody>
</table>

Note. Values are %MVC ± SD  
* p<0.05

Conclusion

There was no hands supported surface X timing phase interaction for the UT (F=0.982; p=0.394), LT (F=0.660; p=0.529) and SA (F=0.065; p=0.938).

The SA muscle activation was significantly affected by the hands supported surface and the timing phase during the push-up plus.

References

Lear LJ, Gross MT. An EMG analysis of the scapular stabilizing synergists during a push-up progression. JOSPT 1998; 28(3):146-157
Lehman GJ et al. Shoulder muscle EMG activity during push-up variations on and off a swiss ball. Dynamic medicine 2006;5(7):139-143