Is the decrease in maximal voluntary contraction following tibialis anterior tendon vibration accompanied by a disruption in excitation contraction coupling?

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Introduction

- Individuals utilizing equipment with vibratory elements demonstrate increased musculoskeletal and neurovascular impairments related to reduced strength and muscle fatigue (1).
- However, the reduced MVC may also be due to the disruption in E-C coupling (2).
- E-C coupling is ascertained in human subjects during functional activities (10 Hz) whereas maximal exercise (50 Hz) increases calcium in muscle beyond typical functional activation levels accounting for decreased E-C coupling (3).

Objective

- The purpose of this study was to investigate the extent to which E-C coupling plays a role in force attenuation following vibration.

Methods

- Subjects: 9 female and 1 male, age 33 (10.6)
- Individuals sat in a Biodex chair with 90° of hip and knee flexion.

Figure 1: Equipment set-up. The dominant foot and leg were immobilized while ankle dorsiflexion was measured.

- Stimulating electrodes were placed on the common peroneal nerve (CPN) just distal to the fibular head. For stimulation trials (7 singlet pulses, doublet, 10 Hz and 50 Hz), a dorsiflexion twitch was evoked via constant voltage stimulator.
- E-C coupling was determined by evaluating the ratio of 10 Hz to 50 Hz peak torque.
- For vibration trials, a vibrator was secured to the distal musculotendinous junction of the tibialis anterior muscle.

Results

Figure 2: Subjects were exposed to a combination of 4 conditions that included 10 minutes of vibration or no vibration bracketed by MVC or electrical stimulation (ABCD, CDAB, ACBD, BDAC).

Figure 3: Torque trace during MVC. Black arrow denotes timing of interpolated twitch used to assess % voluntary activation. Interpolated twitch was elicited with doublet stimulation during and after MVC.

Figure 4: 10 Hz / 50 Hz ratio for peak torque. A significant decrease (p<0.007) following vibration and no vibration was observed; however, no significant difference was found across conditions.

Figure 5: Peak torque during MVCs. No significant difference was found across the conditions.

Table 1: There was a significant drop in peak torque generated for pre to post comparisons for 10Hz stimulation. For the singlet stimulation, time to peak torque (mean ± SD) was significantly different between pre and post measurements in both conditions. For doublet stimulations, time to peak torque exhibited a trend towards difference in pre and post measurements.

<table>
<thead>
<tr>
<th>Single</th>
<th>Vibration</th>
<th>No Vibration</th>
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<tbody>
<tr>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
</tr>
<tr>
<td>Peak Torque (Nm)</td>
<td>2.4 ± 1.0</td>
<td>5.2 ± 10.8</td>
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<tr>
<td>Time to Peak Torque (ms)</td>
<td>110 ± 15.9</td>
<td>113 ± 13.4†</td>
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<tr>
<td>Doublet</td>
<td>Peak Torque (Nm)</td>
<td>8.9 ± 2.8</td>
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<tr>
<td>Time to Peak Torque (ms)</td>
<td>113 ± 41.2</td>
<td>117 ± 43.6†</td>
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<tr>
<td>10 Hz</td>
<td>Peak Torque (Nm)</td>
<td>8.4 ± 3.8</td>
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<tr>
<td>50 Hz</td>
<td>Peak Torque (Nm)</td>
<td>27.2 ± 11.5</td>
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<tr>
<td>Time to Peak Torque (ms)</td>
<td>205 ± 38.1</td>
<td>217 ± 16.4</td>
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References