Effects of High Intensity Exercise on Central Neural Drive in Healthy Populations

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Effects of High Intensity Exercise on Central Neural Drive in Healthy Populations

Nicholas LeGrand, Kyra Robb, Emily Slobodian, Nicole Weaknecht, Megan Wood
Advisor: Stephanie Muth PT, PhD

Background

Current research suggests that strength gains related to central neural adaptation occur more rapidly than peripheral mechanisms1. Central neural drive (CND) is the measure of cortical output that coordinates up-regulation of agonist contraction and inhibition of antagonist muscle contractions2. Two common techniques for measuring CND are twitch interpolation and motor evoked potential from transcranial magnetic stimulation.

Results

<table>
<thead>
<tr>
<th>Citation</th>
<th>MacDermid score/Sackett rating</th>
<th>Participants</th>
<th>Training Protocol</th>
<th>Instrumentation</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carroll, 2009</td>
<td>28/48 1B</td>
<td>17 participants aged 19-35 without a significant history of neurologic disease</td>
<td>Control group- non resistance movements only</td>
<td>Electromyography and Transcranial Magnetic Stimulation</td>
<td>Training group showed a significant increase in TMS-induced twitches in both wrist extension and radial deviation at the end of 4 weeks</td>
</tr>
<tr>
<td>Ekblom, 2010</td>
<td>28/48 1B</td>
<td>20 healthy participants (12M BW) with no history of resistance training or exercise &gt;3days/week</td>
<td>Control group- no change in daily activity</td>
<td>Twitch interpolation</td>
<td>Training group demonstrated improved central neural drive and increased plantar flexor strength at the end of 5 weeks</td>
</tr>
<tr>
<td>Goodwilli, 2012</td>
<td>34/48 1B</td>
<td>14 university participants (7 men, 7 women) age range 18-35</td>
<td>Control group-no training</td>
<td>Transcranial Magnetic Stimulation</td>
<td>Training group showed significant increases in strength, decreases in SICI, and increases in cortico-motor excitability in both the trained and untrained limb at the end of 3 weeks</td>
</tr>
<tr>
<td>Kidgeli, 2010</td>
<td>32/48 1B</td>
<td>23 healthy participants (10 men, 13 women, 26.8 +/- 7.3)</td>
<td>Control group-no training</td>
<td>Electromyography and Transcranial Magnetic Stimulation</td>
<td>Training group showed significant increase in 1RM strength in absence of muscle hypertrophy, increase in MEP amplitude at and above AMT at the end of 4 weeks</td>
</tr>
<tr>
<td>Pucci, 2006</td>
<td>29/48 1B</td>
<td>20 male participants (25 +/- 5.5) from the university population</td>
<td>Control group-no training</td>
<td>Twitch interpolation</td>
<td>Training group demonstrated significant increase in knee extensor MVC and an increase in percentage maximal activation after 4-5 training days, insignificant increase in twitch amplitude by day 9</td>
</tr>
</tbody>
</table>

Summary of Key Findings

These studies demonstrated strength increases in healthy individuals as early as 10 days and within 5 weeks of high intensity strength training without muscle hypertrophy. TMS and twitch interpolation techniques provide evidence that these strength gains can be attributed to central mechanisms.

Clinical Applications

For patients with an inability to train both sides of the body, there is potential for an overflow effect into the immobilized side when the non-affected side is trained.

High intensity training may be used to capitalize on rapid cortical adaptations in patients that need strength gains in a limited time frame (e.g. preoperatively).

Additional research is needed to further explore the effects of high intensity exercise on CND, including investigation of effects in neuro-compromised individuals.

Conclusions

Current understanding of neural adaptation suggests a central component to muscle activation separate from peripheral mechanisms. Moderate evidence suggests that high intensity exercise results in rapid increases in strength through central mechanisms in the absence of muscle hypertrophy.