Blood flow restriction and electric muscle stimulation during 14-day unilateral limb immobilization does not protect against macrovascular structural and functional changes

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METHODS

• Limb disuse or injury requiring immobilization cause a series of impairments to the affected macrovasculature.
• Macrovascular health is critical for athletes and patients alike, to support a quicker rate of recovery following injury.
• Shear-stress is known to modulate vascular function acutely.
• Thus, feasible shear-inducing interventions could help to maintain vascular health during immobilization.
• Blood flow restriction (BFR) and electrical muscle stimulation (EMS) are two passive modalities that can increase vascular health during immobilization.
• Purpose: To investigate the effects of BFR+EMS during immobilization on macrovascular structure and function.

RESULTS

Table 1: Participant characteristics.

<table>
<thead>
<tr>
<th>Control</th>
<th>BFR</th>
<th>BFR+EMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (M/F)</td>
<td>10 (6/4)</td>
<td>10 (6/4)</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>25.2±3.9</td>
<td>20.8±1.3</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.9±18.6</td>
<td>167.7±17.2</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.2±13.7</td>
<td>23.1±13.6</td>
</tr>
<tr>
<td>MAP (mmHg)</td>
<td>84.2±66.5</td>
<td>81.1±10.6</td>
</tr>
<tr>
<td>Resting HR (bpm)</td>
<td>63±10</td>
<td>67±13</td>
</tr>
</tbody>
</table>

Figure 1: Baseline and peak values of immobilized limb superficial femoral artery diameter (A, C) and blood flow (B, D) measured at pre- and post- 14-day intervention phase. n=30 total. Bars represent group means and lines show individual data.

MAIN FINDINGS

• SFA baseline and peak diameter following immobilization were reduced 0.46±0.36mm
• Peak, non baseline blood flow following reactive hyperemia was reduced
• Multiple FMD indices were unchanged, independent of intervention group
• Immobilization resulted in less negative blood velocity
• Control group time-to-peak diameter trended towards a reduction relative to intervention groups

CONCLUSIONS

We conclude that after a period of immobilization:
1) Alterations to structural arterial properties are not mitigated by BFR or BFR+EMS
2) Arterial reactivity, assessed by FMD, remained similar despite increased shear stimulus
3) There is evidence of reduced retrograde blood flow with disuse, but this is unaltered with BFR or BFR+EMS treatment

Figure 2: Indices of superficial femoral artery flow-mediated dilation in the immobilized limb. Flow-mediated dilation expressed in percent change diameter (A), relative to SRpeak (B), and adjusted for baseline diameter via allometric scaling (C). n=30 total. Bars represent group means and lines show individual data.

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