Acute Aerobic Exercise Does Not Alter the Pressor Response to the Cold Pressor Test

Elizabeth A. Gideon, Molly M. Ploof, Yi Zhang, Morgan C. O’Leary, James R. Sackett, & Blair D. Johnson

Center for Research and Education in Special Environments, Department of Exercise and Nutrition Sciences, University at Buffalo, Buffalo, NY

Abstract

Introduction: circulating vasodilator compounds are elevated after acute aerobic exercise, which contribute to post-exercise hypotension and orthostatic intolerance. This suggests that the pressor response during sympathoexcitation is blunted following acute aerobic exercise. The cold pressor test (CPT) is a sympathoexcitatory maneuver that increases heart rate and blood pressure. However, it is not known if cardiovascular dynamics during 2 minutes of the CPT are altered following acute aerobic treadmill exercise.

Purpose: Test the hypothesis that cardiovascular responses to the CPT following acute aerobic treadmill exercise are blunted.

Methods: Twelve healthy participants (23 ± 4 years, 6 females) completed a CPT before and 10 minutes after treadmill exercise (20 minutes at 65-70% of age predicted maximum heart rate). During the CPT, a hand was submerged up to the wrist in ice water (0°C) for 120 seconds. Heart rate (ECG) and blood pressure (photoplethysmography) were continuously recorded. Stroke volume was determined using Modelflow. Cardiac output was calculated as the product of heart rate and stroke volume. Total peripheral resistance was determined by dividing mean arterial pressure by cardiac output. Data were analyzed in 30 second increments. Perceived pain (0 = no pain, 10 = most severe pain) was obtained after each CPT. Data during the CPT are presented as a change from baseline and analyzed using repeated measures ANOVA.

Results: Baseline heart rate was higher post exercise (84 ± 8 vs. 86 ± 13 bpm, P < 0.01). Baseline mean arterial pressure (85 ± 10 vs. 80 ± 8 mmHg, P = 0.05) and systolic blood pressure (122 ± 14 vs. 114 ± 12 mmHg, P < 0.01) were lower post exercise. Baseline diastolic blood pressure (63 ± 8 vs. 61 ± 6 mmHg, P = 0.25), stroke volume (59 ± 14 vs. 56 ± 16 mmHg, P = 0.35), cardiac output (6.2 ± 0.8 vs. 6.6 ± 0.8 L/min, P = 0.16), and total peripheral resistance (13.9 ± 2.8 vs. 12.3 ± 1.8 mmHg/L/min, P = 0.10) were not different between pre- and post-exercise. During the CPT, the increase in heart rate was greater pre- vs. post-exercise at 30 seconds (22 ± 16 vs. 17 ± 13 bpm, P = 0.02) and 60 seconds (18 ± 16 vs. 12 ± 9 bpm, P < 0.01). Pre- and post-exercise mean arterial pressure increased while heart rate increased during the CPT and peaked at 90 seconds for pre (26 ± 10 bpm, P < 0.01) and post-exercise (27 ± 9 bpm, P < 0.01). There were no differences in the mean arterial pressure responses to the CPT between pre- and post-exercise (P = 0.99). Pre- and post-exercise total peripheral resistance increased throughout the CPT and peaked at 120 seconds for pre (5.7 ± 4.7 mmHg/L/min, P < 0.01) and post-exercise (5.9 ± 3.8 mmHg/L/min, P < 0.01). There were no differences in the total peripheral resistance responses during the CPT between pre- and post-exercise (P > 0.13 for all). Perceived pain of the CPT was not different between pre- and post-exercise (P = 2.2 vs. 6.2 ± 2.0 u, P = 0.13).

Conclusion: Post-exercise heart rate to the CPT were blunted while mean arterial pressure and total peripheral resistance responses were not different between pre- and post-exercise. These data indicate that the pressor responses to the CPT are not influenced by acute aerobic exercise whereas the heart rate response is attenuated.

Background

• Following acute aerobic exercise, postexercise hyperaemia can last for up to 20 minutes.
• The sustained rise in circulating vasodilators post exercise may blunt the rise in blood pressure during sympathoexcitation.
• The cold pressor test (CPT) is a sympathoexcitatory maneuver that increases heart rate and blood pressure.

Purpose

Test the hypothesis that the cardiovascular responses to the CPT would be blunted following acute aerobic treadmill exercise.

Methods

Subjects
• Twelve healthy subjects completed the protocol (age: 23 ± 4 years, BMI: 24 kg/m², 6 women)

Measurements
• Continuous measurements
  • Heart rate (ECG)
  • Blood Pressure (photoplethysmography)
  • Stroke volume was determined using Modelflow
  • Cardiac output was calculated as the product of heart rate and stroke volume
  • Total peripheral resistance was determined by dividing mean arterial pressure by cardiac output
  • Pain Scale (0 = no pain, 10 = most severe pain) was obtained after each CPT

Protocol
• Subjects rested quietly in the supine position 5 minutes prior to the pre-exercise CPT
• Data was collected during a 5 minute baseline period
• Subjects hand was submerged in the ice slurry (1°C) bath up to their wrist while agitating the mixture for two minutes
• Following the pre-exercise CPT, subjects performed twenty minutes of aerobic exercise (65-70% of age predicted maximum heart rate)
• Post exercise CPT was conducted 10 minutes following the exercise bout

Data Analysis
• Cardiovascular data were analyzed in 30 second increments. Data during the CPT are presented as a change from baseline and analyzed using repeated measures ANOVA. If a significant interaction or main effect was found, the Holm-Sidak post hoc procedure was used to determine where differences existed.

Results

Table 1. Baseline values

<table>
<thead>
<tr>
<th></th>
<th>Pre exercise</th>
<th>Post exercise</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Arterial Pressure (mmHg)</td>
<td>85 ± 10</td>
<td>80 ± 8</td>
<td>0.05</td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg)</td>
<td>122 ± 14</td>
<td>114 ± 12</td>
<td>0.01</td>
</tr>
<tr>
<td>Diastolic Blood Pressure (mmHg)</td>
<td>63 ± 8</td>
<td>61 ± 6</td>
<td>0.25</td>
</tr>
<tr>
<td>Total Peripheral Resistance (mmHg/L/min)</td>
<td>14 ±</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Rate (bpm)</td>
<td>64 ± 2</td>
<td>69 ± 6</td>
<td>0.00</td>
</tr>
<tr>
<td>Stroke Volume (mL)</td>
<td>100 ± 14</td>
<td>99 ± 16</td>
<td>0.39</td>
</tr>
<tr>
<td>Cardiac Output (L/min)</td>
<td>6 ± 1</td>
<td>7 ± 1</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Values are presented as mean ± SD

Conclusion

• Post-exercise heart rate responses to the CPT were blunted while mean arterial pressure and total peripheral resistance responses were not different between pre- and post-exercise.
• These data indicate that the pressor responses to the CPT are not influenced by acute aerobic exercise whereas the heart rate response is attenuated.