Tachycardia During Resistance Exercise: A Case Study

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ABSTRACT

A male weight-trained (WT) subject (A; age = 21 years, height = 193.6 cm, body weight = 113.4 kg, parallel barbell squat 10 repetition maximum [RM] = 183.7 kg) and a group of 18 similarly trained men (WT; X±SD; age = 24.7±3.0 years, height = 180.2±4.3 cm, body weight = 86.9±10.7 kg, 10 RM = 127.9±28.6 kg) were monitored during a barbell squat resistance exercise session (50% – 100% 10 RM) and a graded exercise test on a cycle ergometer. Compared with the WT group, heart rate (HR) for subject A was consistently ≥2 SD greater during resistance exercise (peak HR for 100% 10 RM = 212 b·min⁻¹ and 165.3±16.2 b·min⁻¹). The graded exercise test resulted in similar HR responses for both A and controls. Subject A’s augmented HR was present only during the pressure load of heavy resistance exercise, and not during the volume load of endurance exercise. The data suggest that subject A may be utilizing a different mechanism for heart rate regulation during resistance exercise.

Key Words: heart rate, weight training, cardiovascular, graded exercise test, anabolic androgenic steroids


Introduction

Previous research has reported the acute cardiovascular responses to heavy resistance exercise, including heart rates (HR) as high as 170 b·min⁻¹ (3, 7, 9). Unlike cardiorespiratory endurance activities, resistance exercise is not usually limited by maximal HR. Numerous factors have been reported to influence the HR response to resistance exercise, including the muscle mass activated, the muscle tension or force produced, the number of repetitions performed, the lifting cadence, the fiber type of the involved muscle, the rhythmic or static nature of the muscle action, and the presence of a Valsalva maneuver (2–7, 11, 12). Of particular interest to the present case study is a weight-trained (WT) man who participated in a previous investigation comparing cardiovascular responses to heavy resistance exercise and a discontinuous graded exercise test (3). This individual exhibited an unusually high HR response to heavy resistance exercise, and reported self-administration of anabolic androgenic steroids as an ergogenic aid for his training. The purpose of this case study is to examine the unique HR responses to heavy resistance exercise for this subject.

Methods

The subjects observed in this case study were an individual (subject A) who exhibited an unusual HR response to resistance exercise, and 18 similarly WT subjects. Subject A and the WT group (see Table 1) were subjects participating in a previously reported study designed to compare the cardiovascular responses to heavy resistance exercise and endurance exercise (3). All subjects were experienced in resistance exercise, were skilled in the parallel barbell back squat exercise, and were currently using it in their training. Before testing, each subject gave informed consent as approved by the Institutional Review Board, and completed a health status questionnaire. Ten repetition maximum (RM) loads for the squat was based on recent training sessions for each subject.

All subjects participated in 2 test sessions, during which HR was continuously monitored directly from R-R intervals from a V-5 lead. Upon arrival at both test sessions, all subjects were seated in an upright position while pre-exercise HR was recorded, followed by 5 minutes of their normal stretching and warm-up procedures. For session 1, each subject performed the parallel back squat exercise (2 × 10 at 35% 10 RM warm-up, followed by 1 × 10 at 50, 60, 70, 80, 90, and 100% 10 RM, 5-minute interset rest intervals). A weight belt was used if the subjects desired, but knee wraps were not allowed. Breathing patterns were not controlled or monitored during the squat exercise, but Valsalva maneuvers were empirically observed by the investigators during most lifting sets for all subjects.
Table 1. Characteristics of subject A and the control subjects (X ± SD; n = 18).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Subject A</th>
<th>Control subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>21</td>
<td>24.7 ± 3.0</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>193.6</td>
<td>180.2 ± 4.3</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>113.4</td>
<td>86.9 ± 10.7</td>
</tr>
<tr>
<td>Barbell squat 10 RM* (kg)</td>
<td>183.7</td>
<td>127.9 ± 28.6</td>
</tr>
</tbody>
</table>

* RM = repetition maximum.

The subjects remained seated throughout the postexercise HR recordings (15 seconds, and 1, 2, and 3 minutes), after which they were allowed to stand or move about before their next set of squats. All subjects lifted at their own preferred cadence, but the times to complete each set were similar for subject A and the WT group at all intensities.

Session 2 started with a 5-minute warm-up on an unloaded cycle ergometer after the pre-exercise HR measurement. This was followed by a discontinuous graded exercise test (GXT) on a cycle ergometer (3-minute stages, 50 r·min⁻¹, 1-minute rest intervals), with resistance starting at 100 W, and increasing in 50-W increments for each successive stage. The GXT was terminated when the 50 r·min⁻¹ cadence could not be maintained, or when the subjects attained their estimated maximum HR (220 – age in years). An audiovisual metronome was used to assist the subject in maintaining the rate of pedaling. A minimum of 2 days and a maximum of 7 days elapsed between the 2 test sessions.

Statistical Analyses

Mean ± SD HR values for the control group are reported for each repetition of each set of resistance exercise, and for maximal values during the GXT. Results for subject A were compared with the results for the control group, with values greater than 2 SD from WT group values being noted.

Results

During the 50% 10 RM set, HR responses for subject A were well within 1 SD of HR for the WT group. All subsequent sets showed a HR > 2 SD for subject A compared with the WT group. The greatest resistance exercise HR was always observed during the last 2–3 repetitions of each set (see Figure 1). During the GXT, the HR for subject A was always within 1 SD of mean values for the WT group (see Figure 2).

Discussion

Of primary interest is subject A’s extremely high HR during the resistance exercise. Despite an estimated maximum HR of 199 b·min⁻¹ (220 – age), HR reached

![Figure 1. Exercise (repetitions 1–10) and recovery (postexercise 15 seconds, 1 minute, 2 minutes, 3 minutes) heart rates (b·min⁻¹) during barbell squat resistance exercise for subject A (open circles) and control subjects (X ± SD; n = 18; closed squares). *difference > 2 SD.](image1)

![Figure 2. Exercise (last 15 seconds of each stage) and recovery (15 seconds poststage) heart rates (b·min⁻¹) for subject A and control subjects (X ± SD; n = 18) during a discontinuous graded exercise test on a cycle ergometer.](image2)
completed the exercise session because of the compromised cardiac output that accompanies such conditions.

Although contributing factors to HR during resistance exercise include the amount of muscle mass activated, muscle force development, the number of repetitions performed, the lifting cadence, and Valsalva maneuvers (2, 4, 6, 7), none of these variables was different for subject A compared to the WT group. Even though subject A was the strongest subject in the study, his strength/body weight ratio was comparable though subject A was the strongest subject in the studies, the highest HR consistently occurred during the last 2–3 repetitions (2, 9), and was associated with loads between 70–95% of 1 RM (2). It should be noted that the HR response to the GXT for subject A was similar to HR for the WT group. This suggests that the tachycardia response occurred only in the presence of a pressure load (i.e., weight training), and not with a volume load (i.e., GXT). Recovery blood pressures for subject A were not different from the WT group for either the resistance exercise or the GXT (data not shown). Examination of the electrocardiogram trace indicated normal and clearly distinguishable P, QRS, and T waves, with no indication of paroxysmal supraventricular tachycardia, or premature atrial or ventricular contractions. Supraventricular tachycardia is unlikely since no sporadic and distinct increases or decreases in HR were observed during the test session. In addition, atrial fibrillation did not appear to be present as indicated by consistent R-R intervals. If either supraventricular tachycardia or atrial fibrillation were present, it is unlikely that subject A could have completed the exercise session because of the compromised cardiac output that accompanies such conditions.

It should be noted that subject A reported self-administering AAS (personal communication; J.M. Steinacker, M.D.). Although it is not clear what effect AAS have on the autonomic nervous system, it is also possible that sympathetic/parasympathetic input may have been altered, thus influencing exercise-induced HR. Why such a possible mechanism would affect only the resistance-exercise HR response is not known. Because this is a case study, it is important to note that such contributing mechanisms are purely speculative, and subject A may have simply been an anomaly with an unusually high HR in response to a particular type of exercise (i.e., heavy resistance exercise).

**References**

9. MacDougall, J.D., D. Tuxen, and D.G. Sale. Arterial blood


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