Exercise Training for PoTS and Syncope

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Nurse Specialists (x1)
Clinical Autonomic Scientists (x10)
Neuroendocrine Scientists (x1)
Presentation Outline

• 1a. Rationale for exercise training in PoTS/Syncope
  – Orthostatic intolerance mechanisms
  – Orthostatic intolerance treatment

• 1b. Previous research on exercise training in PoTS/Syncope
  – Orthostatic Tolerance
  – Cardiovascular responses
  – Exercise

• 2. Implementing an exercise training programme in a patient
Autonomic Nervous System Function
Orthostatic Intolerance: Risk Factors

• **Factors that induce or worsen symptoms**
• Time of day (may be worse in the morning)
• Speed of positional change
• Raised temperature
• Dehydration
• Food/Alcohol ingestion
• Physical exertion
• Menstrual period
• **Deconditioning or prolonged recumbency**
• Medications
Orthostatic Intolerance Mechanisms?
PoTS/Syncope: Treatment
Key Nonpharmacological Measures

• To be introduced
  – High salt intake (non hypertensives)
  – Water repletion
  – Small, frequent meals
  – Head-up tilt at night
  – Physical countermaneuvers
  – **Judicious regular exercise**

• To be considered
  – Elastic stockings
  – Abdominal binders
Exercise Training
Exercise Training and Orthostatic Tolerance: Healthy Populations

Experimental Physiology (1999), 84, 121-130
Printed in Great Britain

EFFECTS OF MODERATE EXERCISE TRAINING ON PLASMA VOLUME, BARORECEPTOR SENSITIVITY AND ORTHOSTATIC TOLERANCE IN HEALTHY SUBJECTS

B. L. MTINANGI AND R. HAINSWORTH*

Institute for Cardiovascular Research, University of Leeds, Leeds LS2 9JT, UK

SUMMARY

The effect of physical training on an individual’s ability to withstand an orthostatic stress is unclear. This study was undertaken to determine the effects on orthostatic tolerance in healthy volunteers of training at a level appropriate for unfit subjects and cardiorespiratory patients. In 11 asymptomatic, untrained subjects the following assessments were made: plasma volume by Evans Blue dye dilution and blood volume derived from haematocrit; carotid baroreceptor sensitivity from the slope of the regression of change in cardiac interval against pressure applied to a neck chamber; orthostatic tolerance as time to presyncope in a test of head-up tilting combined with lower body suction; exercise test relating heart rate to oxygen consumption. Subjects were then given a training schedule (5BX/XBX, Royal Canadian Air Force) involving 11-12 min of mixed exercises per day until an age/sex related ‘target’ was reached. Following training all subjects showed evidence of improved fitness, seen as decreases in heart rate at an oxygen uptake ($V_O_2$) of 1.5 l min$^{-1}$ and in the elevation of the regression line between heart rate and $V_O_2$. All also had increases in plasma and blood volumes and decreases in baroreceptor sensitivity. Seven of the subjects showed increases in orthostatic tolerance. Improvement in orthostatic tolerance was related to a low initial tolerance, and was associated with increases in plasma volume and decreases in baroreceptor sensitivity. These results show that moderate exercise training increases orthostatic tolerance in subjects who do not already have a high initial tolerance and suggest that training may be of value in the management of untrained patients with attacks of syncope due to orthostatic intolerance.
Exercise Training and Orthostatic Tolerance: Healthy Populations

- 11 participants (average age 40 yr)
- 5BX/XBX Programme (developed by Royal Canadian Air Force in 1964)
- Progressive regime; most major muscle groups
- 11-12 min per day
- Strength and Endurance Exercise
  - Stretching, sit-ups
  - Leg and shoulder raises
  - Press-ups
- Orthostatic Tolerance
  - combined head up tilt and lower body suction
## Exercise Training and Orthostatic Tolerance: Healthy Populations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before</th>
<th>After</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight (Kg)</td>
<td>74.3 ± 3.5</td>
<td>74.0 ± 2.6</td>
<td>-0.31 ± 0.3</td>
</tr>
<tr>
<td>Time to Pre-syncope (min)</td>
<td>31 ± 3</td>
<td>34 ± 2*</td>
<td>+4 ± 1</td>
</tr>
<tr>
<td>Supine HR (bpm)</td>
<td>66 ± 4</td>
<td>60 ± 3*</td>
<td>-6-5 ± 0.8</td>
</tr>
<tr>
<td>Tilted HR (bpm)</td>
<td>75 ± 4</td>
<td>69 ± 4*</td>
<td>-6-6 ± 0-8</td>
</tr>
</tbody>
</table>
Increase orthostatic tolerance following moderate exercise training in patients with unexplained syncope

B L Mtinangi, R Hainsworth

Abstract

Objective—To determine whether a programme of simple, moderate exercise training increases blood volume and improves orthostatic tolerance in patients with attacks of syncope or near syncope related to orthostatic stress.

Design—An open study in 14 patients referred with unexplained attacks of syncope, who were shown to have a low tolerance to an orthostatic stress test.

approach to increasing orthostatic stress, by combining head up tilting with progressive lower body suction. This test is not only repeatable in individual subjects but is also able to distinguish between patients with histories of orthostatic intolerance and asymptomatic control subjects.

Using our new orthostatic stress test, we have been able to examine some of the predisposing influences leading to orthostatic intolerance and the effects of interventions which
Exercise Training and Orthostatic Tolerance: Patient Populations

- **Objective**
  - Determine whether a programme of simple, moderate exercise training improves orthostatic tolerance in patients with attacks of syncope or near syncope.

- **Design**
  - 14 patients (6/8 females/males; average age 38 yr)
  - Exercise training programme (Canadian Air Force 5BX/XBX)
  - Orthostatic tolerance test
    - combined head up tilt and lower body suction
  - Cardiovascular variables
  - Cardiorespiratory fitness (treadmill exercise test)
Exercise Training and Orthostatic Tolerance: Patient Populations

Time to presyncope (min)

Before

After

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## Exercise Training and Orthostatic Tolerance: Patient Populations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Before</th>
<th>After</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight (Kg)</td>
<td>73.2 ± 4.2</td>
<td>72.6 ± 4.1</td>
<td>−0.6 ± 0.3</td>
</tr>
<tr>
<td>Time to Pre-syncope (min)</td>
<td>24 ± 3</td>
<td>29 ± 1*</td>
<td>+5 ± 1</td>
</tr>
<tr>
<td>Supine HR (bpm)</td>
<td>71 ± 3</td>
<td>65 ± 2*</td>
<td>−7 ± 1</td>
</tr>
<tr>
<td>Tilted HR (bpm)</td>
<td>92 ± 4</td>
<td>86 ± 3*</td>
<td>−6 ± 1</td>
</tr>
</tbody>
</table>
Endurance Exercise Training in Orthostatic Intolerance
A Randomized, Controlled Trial

Robert Winker, Alfred Barth, Daniela Bidmon, Ivo Ponocny, Michael Weber, Otmar Mayr, David Robertson, André Diedrich, Richard Maier, Alex Pilger, Paul Haber, Hugo W. Rüdiger

Abstract—Orthostatic intolerance is a syndrome characterized by chronic orthostatic symptoms of light-headedness, fatigue, nausea, orthostatic tachycardia, and aggravated norepinephrine levels while standing. The aim of this study was to assess the protective effect of exercise endurance training on orthostatic symptoms and to examine its usefulness in the treatment of orthostatic intolerance. 2768 military recruits were screened for orthostatic intolerance by questionnaire. Tilt-table testing identified 36 cases of orthostatic intolerance out of the 2768 soldiers. Subsequently, 31 of these subjects with orthostatic intolerance entered a randomized, controlled trial. The patients were allocated randomly to either a “training” (3 months jogging) or a “control” group. The influence of exercise training on orthostatic intolerance was assessed by determination of questionnaire scores and tilt-table testing before and after intervention. After training, only 6 individuals of 16 still had orthostatic intolerance compared with 10 of 11 in the control group. The Fisher exact test showed a highly significant difference in diagnosis between the 2 groups (P=0.008) at the end of the study. Analysis of the questionnaire-score showed significant interaction between time and group (P=0.001). The trained subjects showed an improvement in the average symptom score from 1.79±0.4 to 1.04±0.4, whereas the control subjects showed no significant change in average symptom score (2.09±0.6 and 2.14±0.5, respectively). Our data demonstrate that endurance exercise training leads to an improvement of symptoms in the majority of patients with orthostatic intolerance. Therefore, we suggest that endurance training should be considered in the treatment of orthostatic intolerance patients. (Hypertension. 2005;45:391-398.)

Key Words: autonomic nervous system ■ catecholamines ■ exercise training

Endurance Exercise Training in Orthostatic Intolerance
A Randomized, Controlled Trial

- **Aim**
  To assess the effect of exercise training on orthostatic symptoms and to examine its usefulness in the treatment of orthostatic intolerance

- **Design**
  - 2768 military recruits screened for orthostatic intolerance by questionnaire and tilt-table testing
  - 36 cases of orthostatic intolerance
  - 31 participants entered a randomized, controlled trial (~21 yr)
    - “Training” group
    - “Control” group.
  - 12 weeks training (330-350 min jogging per week)
  - Assessed by questionnaires and tilt-table testing

## Endurance Exercise Training in Orthostatic Intolerance: A Randomized, Controlled Trial

![Endurance Exercise Training in Orthostatic Intolerance: A Randomized, Controlled Trial](image)

### Variable Comparisons

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre</th>
<th>Post</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Weight (Kg)</td>
<td>73.6 (12.1)</td>
<td>71.6 (10.8)*</td>
</tr>
<tr>
<td>Aerobic Capacity (Watts)</td>
<td>199 (27)</td>
<td>250 (32)*</td>
</tr>
<tr>
<td>Supine HR (bpm)</td>
<td>66 (5)</td>
<td>66 (8)</td>
</tr>
<tr>
<td>Tilted HR (bpm)</td>
<td>107 (5)</td>
<td>93 (14)*</td>
</tr>
<tr>
<td>Tilted Change in HR (bpm)</td>
<td>41 (8)</td>
<td>27 (12)*</td>
</tr>
<tr>
<td>Supine NA (pg/ml)</td>
<td>334 (88)</td>
<td>276 (99)</td>
</tr>
<tr>
<td>Upright NA (pg/ml)</td>
<td>761 (172)</td>
<td>475 (181)*</td>
</tr>
</tbody>
</table>

# Endurance Exercise Training in Orthostatic Intolerance
## A Randomized, Controlled Trial

<table>
<thead>
<tr>
<th>Variable</th>
<th>Patients</th>
<th></th>
<th>Controls</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Dizziness</td>
<td>2.5 (1.0)</td>
<td>1.4 (0.9)*</td>
<td>3.4 (0.7)</td>
<td>2.7 (1.1)</td>
</tr>
<tr>
<td>Blurred vision</td>
<td>1.5 (1.5)</td>
<td>0.6 (0.8)*</td>
<td>2.6 (0.9)</td>
<td>2.2 (1.4)</td>
</tr>
<tr>
<td>Lightheadedness</td>
<td>1.3 (1.4)</td>
<td>0.6 (1.0)*</td>
<td>1.0 (1.4)</td>
<td>1.1 (1.3)</td>
</tr>
<tr>
<td>Headache</td>
<td>2.1 (1.0)</td>
<td>0.9 (0.8)*</td>
<td>2.1 (1.2)</td>
<td>2.7 (1.2)</td>
</tr>
<tr>
<td>Poor Concentration</td>
<td>2.5 (0.9)</td>
<td>1.3 (1.1)*</td>
<td>2.7 (1.3)</td>
<td>2.6 (1.4)</td>
</tr>
<tr>
<td>Hand tremors</td>
<td>2.3 (1.4)</td>
<td>1.3 (1.0)*</td>
<td>2.3 (1.7)</td>
<td>2.2 (1.5)</td>
</tr>
<tr>
<td>Palpitations</td>
<td>1.5 (1.2)</td>
<td>1.1 (1.1)</td>
<td>2.3 (0.9)</td>
<td>2.7 (1.0)</td>
</tr>
<tr>
<td>Nausea</td>
<td>1.7 (1.1)</td>
<td>1.1 (1.1)</td>
<td>2.1 (1.4)</td>
<td>2.4 (1.4)</td>
</tr>
<tr>
<td>Chest pain</td>
<td>0.9 (1.3)</td>
<td>0.7 (0.7)</td>
<td>1.0 (1.6)</td>
<td>1.4 (1.2)</td>
</tr>
<tr>
<td>Hyperhydrosis</td>
<td>1.9 (1.3)</td>
<td>1.4 (1.4)</td>
<td>1.5 (1.5)</td>
<td>1.6 (1.3)</td>
</tr>
</tbody>
</table>

Exercise Training and Patient Populations: Dallas Studies

Exercise Training and Patient Populations: Dallas Studies

• Target HR ~75-85% of maximum
• Initially, 2 to 4 times per week for 30 to 45 min/session using a recumbent bike, rowing, or swimming.
• As the patients became relatively fit
  – the duration of training sessions was prolonged
  – sessions of increased intensity were added (1-2 per week).
• Upright exercise was added gradually, usually month 2-3.
• By the end, patients were exercising 5-6 hr per week
• Resistance training started once weekly (15 to 20 min/session) and gradually increased to twice weekly (30 to 40 min/session).

THRIEEMPOTSRegistry@TexasHealth.org.
## Exercise Training and Orthostatic Tolerance: Patient Populations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pre</th>
<th>Post</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic Fitness (ml/kg/min)</td>
<td>26.8 [24.1, 29.0]</td>
<td>28.9 [26.7, 32.7]*</td>
<td>36.3 ± 0.9</td>
</tr>
</tbody>
</table>

Exercise Training and Orthostatic Tolerance: Patient Populations

Exercise Training and Orthostatic Tolerance: Patient Populations

Symptoms?
Exercise Training and Patient Populations: Exercise Responses?
Exercise Training and Patient Populations: Exercise Responses?

- Heart Rate (bpm) vs. Recovery from Exercise
- Standing and Sitting conditions
- Pre-training vs. Post-training POTS
- Statistical significance: $P < 0.01$ for stage, $P = 0.036$ for training, $P = 0.009$ for interaction
Exercise Training and Orthostatic Tolerance: Patient Populations

**Exercise Training**

- P = 0.66 for pre and 0.13 for post-intervention between groups in POTS
- P < 0.01 for training

**Propranolol**

- P < 0.01 for treatment

**Placebo**

- P = 0.26 for treatment
Exercise Training and Orthostatic Tolerance: Patient Populations/Dallas Study

**Exercise Training**

- Physical Functioning Score
  - Pre: P < 0.01
  - Post: P = 0.63

- Social Functioning Score
  - Pre: P < 0.01
  - Post: P = 0.73

**Propranolol**

- Physical Functioning Score
  - Pre: P = 0.58
  - Post: < 0.01

- Social Functioning Score
  - Pre: P = 0.29
  - Post: P = 0.58

**Placebo**

- Physical Functioning Score
  - Pre: P = 0.21
  - Post: < 0.01

- Social Functioning Score
  - Pre: P = 0.29
  - Post: P = 0.58

*P = 0.58 for pre and <0.01 for post-intervention between groups in POTS*
Conclusions

• Exercise training programmes can be successfully used in PoTS/Syncope
  – If appropriately designed/monitored

• Positive effects of exercise training are mediated by a range of factors:
  – Increased aerobic fitness
  – Increased blood volume
  – Increased heart size
  – Increased quality of life
Treatment: Multidisciplinary Approach

Deconditioning
Fatigue

Cardiovascular

Urinary/Bladder

Pain

Muscle and joints

Gastrointestinal
Thank you for your attention
Postural Tachycardia Syndrome

Postural tachycardia syndrome — current experience and concepts

Christopher J. Mathias, David A. Low, Valeria Iodice, Andrew P. Owens, Mojca Kirbis and Rodney Grahame

Abstract | Postural tachycardia syndrome (PoTS) is a poorly understood but important cause of orthostatic intolerance resulting from cardiovascular autonomic dysfunction. PoTS is distinct from the syndromes of autonomic failure usually associated with orthostatic hypotension, such as pure autonomic failure and multiple system atrophy. Individuals affected by PoTS are mainly young (aged between 15 years and 40 years) and predominantly female. The symptoms — palpitations, dizziness and occasionally syncope — mainly occur when the patient is standing upright, and are often relieved by sitting or lying flat. Common stimuli in daily life, such as modest exertion, food ingestion and heat, are now recognized to be capable of exacerbating the symptoms. Onset of the syndrome can be linked to infection, trauma, surgery or stress. PoTS can be associated with various other disorders; in particular, joint hypermobility syndrome (also known as Ehlers–Danlos syndrome hypermobility type, formerly termed Ehlers–Danlos syndrome type III). This Review describes the characteristics and neuroepidemiology of PoTS, and outlines possible pathophysiological mechanisms of this syndrome, as well as current and investigational treatments.