How Can Aerobic Exercise Improve Parkinson’s Disease Symptoms?

Aerobic Exercise, Neuroplasticity, and Neuroprotection in Parkinson’s Disease.

By Rebecca Comeau

Introduction

What is PD?
- Progressive neurodegenerative disease affecting the DA-ergic cells of the SNc
- Symptoms are motor and cognitive
- Deficits proportional to disease progression

Why Does It Matter?
- 2nd most common neurodegenerative disorder after Alzheimer’s Disease
- Severe impairments to quality of life and morbidity
- Current drug treatment (levodopa) has limited benefit

Why AEx?
- Epidemiological studies show AEx is protective against developing PD
- Treats motor and cognitive symptoms
- No detrimental side effects; found to be safe for PD patients
- Potential for sustained effect and progression prevention in animal models

Pathophysiology and Neuroanatomy

What’s affected?
- basal ganglia-thalamic-cortical loop
- motor learning capacity, automatic movement control, automatic activity on BG

How does healthy brain function change?
- BG: motor learning capacity, automatic movement control, automatic activity on BG
- SMA: movement initiation, bimanual and antiphasic movements, posture; cognitive impairments to mental flexibility and inhibition
- Cortex: GLU-ergic activity on BG

Is Aerobic Exercise Effective?

Motor and Cognitive
- Tanaka et al. (2009): improved PD cognitive function post-intervention; fMRI data suggests improved PD frontal efficiency
- Duschene et al. (2015): 3 week AEx program, improved cognition, automaticity, motor learning

Vs. Medication
- Alberts et al. (2016): effects of acute forced exercise (FE) (30% greater than voluntary) — See Figure 2.
- Forced exercise ensures optimal AEx benefits

Pathophysiology and Neuroanatomy

What’s affected?
- basal ganglia-thalamic-cortical loop — see Figure 1.
- Precise etiology not known
- Oxidative stress and neuroinflammation implicated

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Why does Aerobic Exercise Improve PD?

Neuroplasticity
- automaticity and motor learning

Neuroprotection
- BDNF release protects surviving SNc neurons

Neurorestoration
- Petzinger et al. (2010): changes to DA and GLU neurotransmission (availability, reception) improve motor and cognitive symptoms

Inflammatory Response
- Kawashishi et al. (2010): pathogenic immune response cells and cytokines change to anti-inflammatory activity

Improved Brain Health
- blood flow, angiogenesis, vascularization

References


Conclusion

Summary
- PD affects many people, current treatments do not show sustained improvement or treat cognitive symptoms.
- Growing evidence supports that AEx, particularly FE, has the potential to provide benefits drugs alone cannot.
- Acute response to AEx is as good or better than medication.
- AEx-induced benefits to PD include neuroplastic, neuroprotective, neurorestorative, and global anti-inflammatory processes.

Recommendations
- Watch for studies currently underway on FX of chronic / long-term exercise.
- FE at 60-85% HRmax; 3x/week is a promising treatment option.

Figure 1. The basal ganglia-thalamic-cortical loops (cognitive and automatic) impaired in PD. From Petzinger et al. (2013).

Figure 2. Response of PD patients to FE. From Alberts et al. (2016).

Figure 3. Exercise-induced benefits to PD. Adapted from Petzinger et al. (2013).

Goal-based aerobic exercise
- Increased synaptic strength
- Neurotransmitters
- Receptor Density
- Metabolism
- Trophic factors
- Blood flow
- Immune system

Strengthened circuitry
- Basal ganglia
- Cortex
- Thalamus
- Cerebellum
- Brainstem

Improved behaviour
- Motor (conscious and automatic)
- Cognition (executive function)
- Mood and motivation