Stationary Bike Riding for the Management of Parkinson's Disease:

The Surprising Effect of Unpredictable Tempo-Driven Training

By Tom Michaud, DC

Parkinson's disease (PD) is a progressive neurodegenerative movement disorder affecting nearly 1 million Americans. A recent study found the direct and indirect costs for managing Parkinson's disease in the US is in excess of $50 billion annually (1), and these costs are expected to surge as our population gets older. Parkinson's disease results from a complex interplay of genetic and environmental risk factors, which produce a gradual loss of neurons in the substantia nigra of the midbrain. The neuronal loss affects dopaminergic pathways to the basal ganglia (Fig. 1), producing the classic signs of PD: tremors, rigidity, postural instability, and slowness of movement (bradykinesia). Other diagnostic clues of early Parkinson's include pill rolling, in which the thumb and index fingers reflexively rub against each other; micrographia, in which handwriting gets smaller; and hypomimia, in which the facial muscles stiffen causing a gradual flattening of facial expressions. In late stage Parkinson's, a freezing pattern of gait becomes common, in which the person is unable to initiate the first step to begin walking.

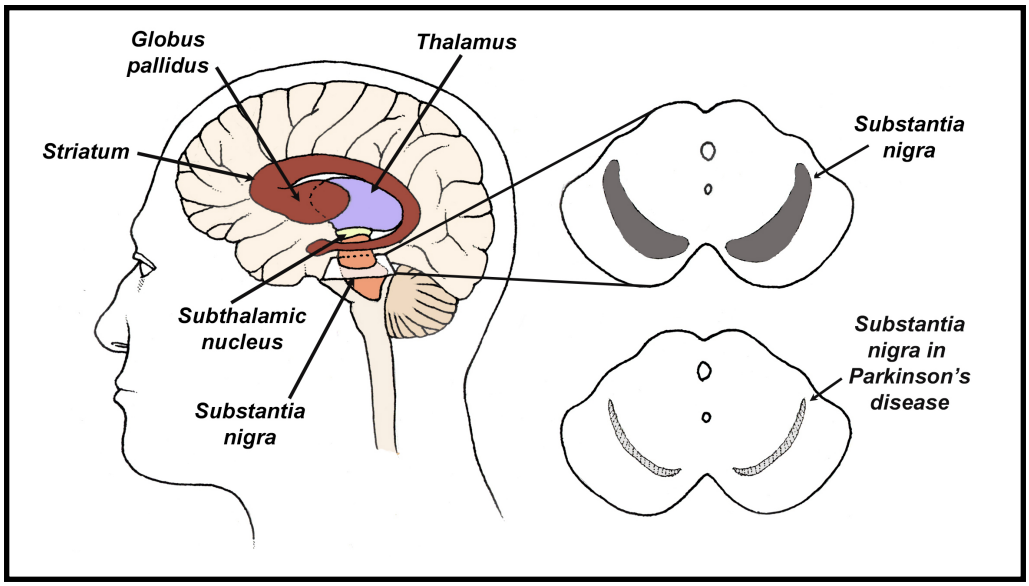

Fig. 1. The substantia nigra is a part of the basal ganglia, which consists of the striatum, globus pallidus, and the subthalamic nuclei. In addition to playing a key role in the production of smooth voluntary movements, the basal ganglia is also important with procedural learning, habit formation, cognition and even emotion. Because the substantia nigra supplies the striatum with the neurotransmitter dopamine, it is essential for proper basal ganglia function.

Conventional medical approaches for managing PD include medications, such as levodopa and other dopamine agonists, and surgical interventions, often in the form of deep brain stimulation. Unfortunately, while these treatments can reduce symptoms, they do not alter the natural progression of the disease (2). Additionally, because dopamine affects emotions as well as movement, the dopamine agonists have the horrible side effect of producing vivid and often terrifying dreams, known as night terrors, which can make it difficult to get adequate rest.

Because of the suboptimal effect of pharmacological and surgical interventions for managing PD, *The Movement Disorder Society* completed an evidence-based review of alternate treatments for the management of Parkinson's and concluded that exercise and physical rehabilitation are efficacious adjuncts to levodopa (3). A 2017 literature review on the long-term effects of exercise on people with PD concluded that balance exercises such as Tai Chi, dance therapy such as Tango and/or Irish dancing, and progressive strengthening/aerobic training programs can favorably modify symptoms and reduce fall risks for up to 12 months after completion of treatment (4). The authors of this study state that exercise interventions "have the potential to increase the efficacy of pharmacological treatment and delay disease progression in individuals with PD."

In one of the most interesting papers on exercise intervention for managing Parkinson's, Alberts et al. (5) recommends incorporating "forced exercise," in which people with PD are encouraged to ride recumbent bicycles at a cadence that fluctuates between a comfortable pace and a more rapid variable pace, which borders on the highest cadence they can possibly maintain. Apparently, maintaining an uncomfortably high cadence while riding a bike improves motor function by strengthening existing neural pathways and may potentially lead to the formation of new connections (6). Other authors suggest that forced exercise triggers the release of neurotrophic factors within areas of the basal ganglia, which has been suggested to protect against cell loss (5). Regardless of the exact mechanism, several studies have shown that tempo-driven recumbent bicycle training is a safe and effective way to improve motor function in people with PD (5,7).

The discovery that variable tempo-driven bike riding could produce favorable outcomes when managing PD was serendipitous (5). In 2003, the Parkinson's researcher Jay Alberts went on a week-long tandem bike ride with a middle-aged woman who had been recently diagnosed with PD. The goal of the long-distance bike ride was to promote awareness of PD and demonstrate that PD "does not have to be a life-altering disease and that an active lifestyle can, and should, be maintained after diagnosis." Because they had not trained together, they were unfamiliar with each other's pedaling rate. Apparently, Dr. Alberts was a skilled cyclist who routinely exercised with a cadence of approximately 85 repetitions per minute. The patient with Parkinson's had less experience with tandem bike riding, and her preferred cadence was 60 revolutions per minute. After just 2 days of tandem bike riding, the patient with PD noticed significant improvement in her symptoms, including noticeable improvements in her handwriting. Given the success of that first bike ride, Alberts teamed with Ridgel et al. (7) to evaluate the effect forced exercise cycling would have on a larger group of PD patients. After just 8 weeks of performing a high-tempo cycling protocol on specially designed bikes, the subjects in the forced exercise program had a 35% reduction in PD motor symptoms, while individuals who exercised at the self-selected cadence showed no improvement. This study was repeated in 2015 with equally impressive outcomes (8).

The beneficial effects of high-cadence bike riding are not limited to Parkinson's patients. Bellumori et al. (9) demonstrated that healthy older adults could improve their reaction times and agility by performing a cycling routine in which they did intervals where they cycled at a high cadence for 20 seconds and immediately followed this with 40 seconds of comfortable low cadence cycling, which averaged 50-60 RPM. The 20 seconds on, 40 seconds off routine was continued for 20 minutes, with a five-minute pre- and post-warm-up and cooldown. In just 6 weeks, this routine produced a 34% improvement in the rate of force development in their quads, and a 47% improvement in the speed they could extend their elbows.

Given these results, this specific program would likely benefit people recently diagnosed with PD. In contrast, because of their limited ability to generate force, people with advanced Parkinson's would benefit from the modified recumbent exercise bikes used in the studies by Ridgel et al. (7,8). Unfortunately, these bikes are not yet commercially available. As a result, an alternate exercise for these individuals would be to perform tandem recumbent bike riding with a trainer cycling at a variable high cadence, while the person with PD attempts to match the cadence while peddling with light force. This could be done for 30 minutes, 3 times per week. Since people with early PD can generate significant force on their own, they do not need a tandem bicycle. They can do the routine described by Bellumori et al. (9) and perform interval training on a recumbent bike in which they cycle with a high cadence for 20 seconds, and then at a comfortable cadence for 40 seconds. This would be repeated for 20 minutes, with a 5 minute warm-up at the start, and a 5 minute cool down at the completion of the exercise routine.

Because the best outcomes occur when the high cadence is randomly varied (8,10), I've made a 20-minute audio file that alternates the cadence between 75 and 90 revolutions per minute during the 20-second on cycle and drops the cadence to between 50 and 60 for the 40-second rest cycle. This free audio file is available at humanlocomotion.com. At the start and end of this routine, you should perform a 5-minute warm-up and cooldown at a comfortable peddling cadence. Given the overall ease of use and safety associated with recumbent bike riding, variable tempo cycling should be a consideration for everyone dealing with Parkinson's disease, regardless of the severity. In fact, one study found that even in advanced cases of Parkinson's in which freezing during the initiation of gait was prevalent, forced tandem cycling improved function even though the people were so weak they were unable to push down on the pedals (11). Apparently, just moving your legs at a frequency that matches those occurring during the gait cycle stimulates sensory nerves in your lower limbs, which somehow improves motor function regardless of the lack of motor output while training. Current research confirms that PD is an incredibly complicated condition, and while researchers attempt to unravel the best pharmacological and surgical interventions for PD, there is strong evidence that a well-designed exercise program would be of benefit to almost everyone affected with this frustrating condition.

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