

Developing Parkinson's-specific



*Muhammad Ali,
diagnosed with
Parkinson's disease
in 1982*

**Regular physical activity
may slow the
progression of
Parkinson's disease,
thereby protecting the
health and function of
older adults with this
condition**

by Becky Farley, Ph.D., P.T.

exercise programs

Parkinson's disease affects approximately 3% of adults ages 65 years and older. In the United States, more than one million people live with PD, making it the most common neurodegenerative disease after Alzheimer's. In Canada, individuals with PD number nearly 100,000, with more than half these men and women diagnosed before age 65.

PD diagnosis occurs when 70–80% of the neurons (or nerve cells) in the *substantia nigra* are gone. This part of the midbrain belongs to the *basal ganglia*, a group of nuclei associated with the ability to control movement. The substantia nigra neurons produce *dopamine*, a chemical that carries signals between nerve cells. Why these neurons are vulnerable to an early death is much debated, but most scientists agree the probable cause is exposure to an environmental toxin(s) combined with a genetic vulnerability. As these cells die, dopamine levels in the basal ganglia drop. Symptoms of PD appear once these levels reach a critical threshold.

Pharmaceutical treatments that increase dopamine levels in the brain begin with diagnosis. These therapies relieve most symptoms early in the disease, but lose their effectiveness over time. Motor and psychiatric side effects develop. Physicians often employ neurosurgery at this point, especially for people with medication side effects of involuntary movements. Even with surgery, however, most PD symptoms inevitably become more severe.

Newer neurosurgical techniques aimed at replacing or protecting dopamine cells are under investigation. *In the meantime, exercise is emerging as a neuroprotective add-on to current PD therapies—that is, it may slow or halt the disease progression by helping the brain to produce its own protective chemicals.*

Exercise and Parkinson's

A growing body of evidence indicates that physical activity can help protect dopamine cells from early death. Studies reveal that an exercise-related increase in the production of a specific growth factor, *glial cell line derived neurotrophic factor (GDNF)*, takes place in the basal ganglia (Cohen et al., 2003).

Parkinsonian rats or monkeys that run on a treadmill avoid motor impairments and maintain dopamine levels in the brain (Jankowec et al., 2003; Tillerson et al., 2001; Tillerson et al., 2003). When these animals stop exercising, symptoms reappear and dopamine decreases. These findings suggest regular physical activity is needed to prevent PD symptoms from developing (Tillerson et al., 2002).

To protect dopamine cells, exercise should start as early as possible, while there are still a lot of these neurons. Once cell loss becomes too great, medications become less effective and side effects more problematic. Functional impairments also develop that interfere with quality of life and affect economic self-sufficiency. At this stage, individuals most frequently complain of gait and balance problems. Yet they receive referrals to physical or speech therapy only 12–16% of the time, despite evidence that people treated with drug therapy *and* exercise have much less disability than those treated with medication alone (Formisano et al., 1992).

Studies also show that adults with even severe PD symptoms can maintain exercise capacity with regular aerobic activity (Canning, 1997). In addition, brief, intermittent bouts of aerobic training can enhance mood, decrease motor impairments, lessen fatigue, and improve sleep, quality of life, and speech in people with PD (Cadet et al., 2003).

Individuals reap benefits from general exercise approaches, i.e. conditioning or water programs, tai chi, sports. But disease-specific approaches may prove more effective for influencing function and increasing retention (or learning) in the long term.

How Parkinson's disease affects people

To develop PD-specific exercise approaches, health and fitness practitioners must understand what happens in the brain of an older adult with PD. They also must grasp how these changes affect a person's ability to move, think and feel (see Table 1 on page 24 for a list of motor deficits).

Dopamine appears to regulate the level of neural activity needed to start or end a movement. When dopamine levels drop to some threshold, inadequate muscle activation results, leading to movements that are slow (*bradykinesia*), incomplete (*hypokinesia*), or not terminated (*festination*). This breakdown in execution is particularly true for extensor muscles, which straighten joints, and for well-learned movement sequences (e.g. getting out of a car, walking).

Importantly, people with PD retain the ability to increase muscle activation, so they can learn to perform larger, faster movements using more conscious effort and attentional strategies (Behrman et al., 1998; Bond and Morris, 2000; Farley et al., 2004). However, they may need more practice (Behrman et al., 2000), especially for complex sequential movements (Soliveri et al., 1992).

Lower dopamine levels also interfere with the ability to maintain upright stance and to prepare the body for movement or environmental changes. The resulting balance and postural problems place people at great risk for

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Table 1. Description of major motor deficits in Parkinson's disease.

Major motor deficits	Description of movements
Inadequate levels of muscle activation	Festination: difficulty terminating a sequence or braking a movement. Bradykinesia: slow movements. Hypokinesia: small, incomplete movements. Akinesia/freezing episodes: difficulty starting or sudden cessation of movement. Unable to maintain upright stance: stooped, flexed posture due to greater impairment in extensor muscle activation.
Rigidity	Increased resistance to passive movement that occurs in the limb and trunk muscles.
Inadequate preparation for movement	Failure to make preparatory movements with the trunk and proximal limbs (near where the limbs attach to the trunk) before a voluntary movement. Posture not adapted to changing environments. Delayed responses to disturbances caused by external factors. Creates a high risk for unexpected falls and loss of balance.
Tremor	Usually occurs while resting; can also happen during movement (action) or holding against gravity (postural).
Secondary adaptive responses	Weakness, contractures, scoliosis, cardiovascular deficits, swallowing deficits.
Dyskinesias	Side effect of dopamine replacement medications. Involuntary movements or posturing involving particular muscle groups. Can be large or small in size or cause cramping (dystonias).

falls, cardiovascular deficits and pain from skeletal deformities.

Striking similarities exist between cognitive and motor deficits in PD. Finishing a thought or shifting to a new one challenges individuals with PD; terminating a movement or starting a new one is equally taxing. Likewise, sustaining attention is as difficult as sustaining muscle activation.

Besides cognitive and motor deficits, people with PD have impaired sensory processing and rely more on vision to guide movement. *Not only do these individuals require more conscious effort to make bigger or faster movements, they also perceive normal movements as "too big or too fast." These effects suggest a*

sensory mismatch between how people move and how movements feel. To aid retention and carryover to functional movement, exercise protocols must include strategies that speak to these cognitive-sensory-motor deficits.

Two PD-specific exercise protocols have been developed and tested in controlled, randomized clinical trials. One protocol addresses *axial rigidity*, in which neck and trunk muscles resist passive stretching. This approach instructs people to perform spinal flexibility exercises in a relaxed manner (Schenkman et al., 1998). The other protocol addresses movement deficits by teaching people to *think big* to increase muscle activation (Farley et al., 2002).

According to many studies, external cues that help focus attention on the critical aspects of movement and attentional strategies that promote conscious effort can do the following:

- Improve gait;
- Reduce *freezing* episodes (during which movement stops suddenly); and
- Enhance performance of simultaneous tasks.

Yet no standardized protocol exists for teaching these strategies. (A list of cueing strategies beneficial to people with PD [Morris, 2000] appears in Table 2 on page 25.)

Table 2. Cueing strategies to simplify movement.

Strategies to simplify movement	
<p>Attentional cueing strategies</p> <p><i>Replaces loss of automaticity (or automatic processing) with conscious effort.</i></p> <ul style="list-style-type: none"> • Avoid dual tasks. • Break down complex movement into discrete sequences. • Focus on deliberate completion of each part. • Mental rehearsal—plan your path; scan the environment: <ul style="list-style-type: none"> • Estimation technique—guess the number of steps to your destination; count them aloud; accuracy is unimportant (Argue, 2000). • Verbal instructions—“swing your arms big; step high, heel down; reach and go.” 	<p>External cueing strategies</p> <p><i>Focuses attention on the critical aspects of movement.</i></p> <ul style="list-style-type: none"> • Visual: <ul style="list-style-type: none"> • Strips of white tape on the floor in doorways and areas where initiation of movement is difficult; • Colored targets at eye level; • Cue cards for functional tasks. • Auditory: <ul style="list-style-type: none"> • Metronomes, musical beats, finger tapping, clapping. • Proprioceptive: <ul style="list-style-type: none"> • Rocking side to side; rocking back to go forwards.

Exercise guidelines

Based on the above deficits, a comprehensive, PD-specific exercise program should include the following:

- Focus on extensor muscle activation—intensity and duration;
- Cueing strategies to simplify movement;
- Motor learning principles—multiple repetitions, high effort, simple cues;
- Sensory awareness training; and
- Aerobic conditioning.

The two case illustrations below show how to incorporate these guidelines into an exercise program for older adults with PD.

Case one: mild PD. In early PD, symptoms affect primarily one side of the body. These symptoms include tremor; mild gait disturbances (short steps); stooped posture; balance difficulties in crowds and unpredictable environments, or during dual tasks; and small handwriting. Athletes often report

difficulties with turning and stopping quickly during sports, as well as fatigue and less endurance.

Recommendations. Exercise programs incorporating aerobic conditioning, stretching and strengthening are appropriate. Health and fitness practitioners should encourage clients to continue sports interests, if athletic, and to practice in optimal *on medication* periods. For neuroprotective effects, individuals should participate in aerobic training for 30 minutes per day at least five times weekly. This exercise can include various modalities, i.e. treadmill, stationary bikes, swimming, hiking/walking, and aerobic classes.

Clients with endurance and fatigue issues should exercise in short, effortful, repetitive bouts. Even during aerobic and sports activities, they should focus on increasing effort, as well as performing movements deliberately and through their complete range of motion.

The flexed posture associated with PD contributes to a narrow base of support, limited ability to shift weight and, eventually, weakness of the extensor and abductor muscles. This weakness further limits a person’s ability to use a wide base of support and balance. Strength training should focus on muscle extension, rotation and abduction to restore complete muscle activation, which improves posture, increases base of support, and enhances balance. (Turn to pages 30–31 for a sampling of muscle extension exercises for older adults with PD, courtesy of Thera-Band Academy.) The choice of resistance modality (i.e. machines, free weights, bands) will depend on a client’s functional level, need for postural support, and available range of motion. Traditional lower extremity strengthening improves balance and reduces falls (Hirsch et al., 2003), but people with PD must also practice using that level of effort and

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muscle activation during task-specific training, such as sit to stand.

Stretching exercises can help with rigidity, flexed posture, and the secondary changes in muscle shortening that result from inadequate extensor muscle activation. Spinal flexibility exercises that emphasize rotation and relaxation may improve trunk mobility and functional performance (Schenkman et al., 1998).

Aging clients with PD can reap benefits from mind-body classes such as yoga, feldenkrais, Alexander technique and pilates. These activities stress conscious awareness of posture and movement, placing emphasis on relaxation and breathing (Stallibrass, 1997; Taylor, 2001). The *Art of Moving™* is a highly recommended, PD-specific exercise approach with a published protocol and an exercise video that health and fitness practitioners can use to teach these types of movement strategies (Argue, 2000).

Balance activities should promote the dynamic balance needed for functional activities such as reaching and turning in the home environment, pushing or carrying objects, and negotiating unpredictable environments. Also, the time of diagnosis is ideal for clients to begin tai chi classes. This type of whole-body, large-scale and purposeful movement can reduce falls in people with PD (Marjama-Lyons et al., 2003). (See “Ezy Tai Chi” in the May/June

2004 issue of the *Journal on Active Aging* for a simpler practice for older adults.)

Case two: moderate PD. Symptoms affect both sides of the body several years after people begin medications. Freezing episodes and gait problems may occur, loss of balance happens more regularly, and functional activities such as rising from a chair become slow and difficult. The effects of medications last for shorter periods. And motor performance becomes more variable, with *on* and *off* periods noted in the medication cycle.

Recommendations. As able, clients should continue their aerobic activities, with supervision to avoid falls and monitor progression. Health and fitness practitioners may need to incorporate task-specific routines into aerobic and/or endurance activities for some people. Examples of meaningful tasks include getting out of a bed or chair; rolling and coming to sit on a bed's edge; and turning or changing directions.

Task-specific training can become a strength, balance and aerobic practice in one when practitioners include cueing and attentional strategies, multiple repetitions, and intermittent rest periods. Functional, large extension movements (e.g. big reaching movements) also simplify turning, develop balance and increase strength.

Finally, for gait and freezing problems, cueing and attentional strategies can help. For example, white lines on the floor at an appropriate step length can help clients increase and sustain longer strides. Metronome-timed steps can help initiate movement and avoid freezing episodes. A rocking motion can help start a movement sequence (e.g. walking, rolling, sit to stand), and avoiding dual tasks during gait can

increase stride length and walking speed.

Precautions and challenges

There are several safety precautions when working with older adults with PD. Exercise should occur during *on* periods, when medications work best. As part of initial client interviews, practitioners should establish typical medication cycles—when individuals take medications, how long they feel *on*, and how suddenly and frequently *off* periods occur.

Some people have abrupt *on-off* periods or *dyskinesias* during *on* periods. Dyskinesias are involuntary, excessive and abnormal movements. Some individuals develop *dystonias* (or cramping of particular muscle groups), which can cause pain and interfere with the ability to balance or bear weight.

The risk of falling is high in people with PD, and falls can occur suddenly—even while sitting. These falls may be due to orthostatic hypotension, in which blood pressure drops on standing; gait abnormalities; or inadequate preparation for movement. Also, dopamine medications worsen certain cardiovascular reflexes—orthostatic hypotension, arrhythmias (or irregular heartbeats), and exercise-induced hypotension (an abnormal blood pressure response to exercise). Clients may be screened for a fixed pulse rate, which prevents an adequate response to exercise and places a patient at higher risk for falls (Reuter and Engelhardt, 2002).

Other PD factors can reduce a client's motivation for and adherence to exercise, and even result in anxiety. These factors include such symptoms of dopamine loss as fatigue and depression. The conscious attention needed to increase muscle activation can also add to physical and mental fatigue. Health

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and fitness practitioners should use both humor and emotionally relevant tasks to help clients with learning and adherence.

Exercise: help within reach

Although the long-term effects of exercise on overall health and cognitive function are undisputed (Cotman and Berchtold, 2002), the idea that something as simple as exercise may be neuroprotective is a potential major breakthrough. Several other candidates may offer neuroprotection in PD, e.g. Coenzyme Q-10. But findings are inconclusive and require further clinical trials.

In contrast, regular physical activity is available, requires no U.S. Food and Drug Administration approval, and can be safely combined with other types of therapies for potentially greater neuroprotective effects. ☺

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Note: Dr. Farley has no connection to Hygienic Corporation, makers of Thera-Band products, or to Thera-Band Academy, which supplied the sample strength training exercises shown on pages 30–31.

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