

40. Parkinson's disease

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Summary

Parkinson's disease is characterised by a general impairment of motor skills. Physical activity is of utmost importance and ought to be introduced in the early stages of the disease. Patients are recommended general physical activities such as hiking, walking, etc. combined with physiotherapy and home exercise programmes. Scientific studies indicate that fitness training and specific endurance training may have beneficial effects and can be recommended in certain cases. Strength training also appears to have beneficial effects, but there is currently not enough scientific evidence to recommend such training. In addition, physical activity is likely to prevent inactivity and a fear of exercise and reduces the risk of fall related injuries. Training on a stepper machine or walking on a treadmill with supports is a preferred form of exercise to cycling for patients with Parkinson's disease as spinal extension is needed to avoid kyphoscoliosis (stooped spine).

Definition

Symptoms

Parkinson's disease is characterised by increased rigidity (stiffness), hypokinesia (diminished muscle movement) and tremors (shaking) (1–3). These characteristics usually develop gradually and slowly. A common initial symptom of the disease is tremors, usually starting in one part of the body until eventually all body extremities are affected. Hypokinesia affects the entire locomotion of the patient. Patients also find it difficult to

start walking, change directions and turn. The stride is short. Parkinson's disease also leads to a change in posture including kyphoscoliosis and flexion of the hips, moving the centre of gravity forward. Patients develop a specific way of walking with the arms hanging motionless at the sides. The head is pushed forward, the spine curves and there is a lateral (sideways) movement in the shoulder blades with the shoulders being pushed forward and the upper arms turned inwards. This tendency for propulsion, i.e. forward movement, increases the risk of falling. The effect on the scalene, sternocleido mastoideus and pectoralis muscles may also lead to a deterioration in the oxygen exchange and respiration function with an increased feeling of tiredness.

In the later stages of the disease, it is not unusual for an on-off phenomenon to take place, especially during treatment with L-dopa, when the patient loses all forms of motor ability for a short period of time. The tremor is characteristic and often referred to as pill-rolling tremor. Mental health problems such as depression are not uncommon among persons suffering from Parkinson's disease nor is the onset of dementia.

Prevalence/Incidence

The overall prevalence estimate of Parkinson's disease is 15 per 10,000 residents (1, 2). The average age at onset is 55–60 years.

Diagnosis/pathophysiology

The diagnosis is an evidence-based clinical diagnosis. A number of possible pathophysiological causes of Parkinson's disease have been identified. The principal cause is a lack of dopamine in the basal ganglia. However, the background to the disease is unclear although genetic factors incorporating various mutations have been reported in families with Parkinson's disease (4). Epidemiological studies have also shown that environmental factors, such as exposure to pesticides (chemical products against fungi, insects and worms) constitute a risk factor (5, 6). A trend towards a lower risk of developing Parkinson's disease has been reported with a high level of physical activity (7, 8).

Current treatment principles

Parkinson's disease is usually treated with a combination of pharmacology and physiotherapy (1–3). In exceptional cases, neurological surgery with deep brain stimulation is carried out for the purpose of alleviating tremor and rigidity. The pharmacological treatment focuses on replacing low levels of dopamine in the basal ganglia. L-dopa is administered orally. Current preparations also contain a peripheral decarboxylase inhibitor that prevents the breakdown of dopamine. Hypokinesia is a dose-related side-effect of L-dopa. In addition, orthostatic hypertension (fall in blood pressure when standing up) and psychological side-effects such as confusion (perplexity) are relatively common, especially among elderly patients. Patients may also experience delusions and hallucinations. Sleeping difficulties and nightmares are not uncommon. The therapeutic arsenal

also includes other preparations which enhance dopaminergic activity. Dopamine agonists such as Bromocriptine and Apomorphine as well as COMT and MAO-B inhibitors that reduce the breakdown of levodopa and prolong the treatment effects of L-dopa are also used. Possible side-effects of these preparations are related to the enhanced dopaminergic activity with hypokinesia, postural hypotension and psychological side-effects.

Effects of physical activity

Due to motor impairment with hypokinesia, patients with Parkinson's disease often demonstrate muscular inactivity, which leads to a reduced working capacity. Increased physical activity leads to improved muscle function and other beneficial effects on the general state of health. In particular, there are no negative effects as a consequence of physical inactivity.

The *objectives of the physiotherapy* are to maintain and improve mobility in the torso and extremities, counteract sluggishness, improve respiration and coordination and reduce rigidity and speech impediments. In the more advanced stages of the disease, it is of utmost importance to counteract contractures (2). Fitness walking and initiation of walking are important parts of the training. A number of studies have shown that patients' ability to walk improves with physiotherapy as does their stride and walking velocity (9, 10).

Only a handful of studies have looked into the physical capacity of patients with Parkinson's disease. Patients with mild to moderate Parkinson's disease usually have a normal maximal oxygen uptake, sub-maximal heart rate and working capacity (11, 12). One of the studies carried out shows that it is possible to maintain the aerobic metabolism for a longer period of time with L-dopa treatment with a constant workload and without the formation of lactic acid. It is also an indication that treatment with Levodopa results in an increased energy efficiency during muscular work (13). Patients with Parkinson's disease also display changes in the frequency modulation of the motor units in connection with the initiation of muscle contraction (14). Motor units are normally recruited when the contraction strength increases. L-dopa treatment has been shown to facilitate the recruitment of motor units and improve frequency modulation.

In 2006, Crizzle and Newhouse (15) summarised the results of earlier studies of Parkinson's disease. They came to the conclusion that physical capacity and ADL functions (activities of daily living) benefited from physical exercise. In recent years, a growing number of studies have shown that various forms of exercise have a positive effect on the symptoms of Parkinson's disease as well as muscle function (16–24).

According to Sunvisson and colleagues (24), the motor efficiency and simultaneous capacity of patients with Parkinson's disease improved after a week of walking 4 kilometres every day in a mountainous region. A comparison between physical training and 'normal' physiotherapy showed that patients performing lower extremity exercises appeared to benefit from improved walking and ADL functions (19). Individuals with mild to moderate Parkinson's disease were also found to benefit from intensive physical training with improved motor ability and increased muscle strength, flexibility and

coordination (21). In addition, the exercise lifted the spirits, gave enhanced feelings of well-being and somewhat unexpectedly improved the ability to manage dyskinesia (21). Another study compared the effects of aerobic fitness training and Qigong with the result that aerobic fitness training gives a greater improvement in motor function (25). However, Qigong has been found to stabilize motor symptoms as well as symptoms of autonomic dysfunction (26).

According to a retrospective interview survey making comparisons between a control group and Parkinson's disease sufferers, the level of participation in sports activities is very similar until the first onset of symptoms. A striking reduction in physical exercise was noted thereafter, although it never stopped completely. The most popular activities were swimming, aerobic fitness training and nature walks, but it seemed impossible for patients with Parkinson's disease to learn new sports (27).

Indications

Physical activity is always recommended in connection with Parkinson's disease. Physical activity combined with physiotherapy should be begun in the early stages of the disease. Physical activities do not affect the progress of the disease, but improve motor skills and ADL functions and lead to a better general state of health. It is evident from a number of scientific studies that work capacity as well as other functions benefit from fitness training and certain endurance training.

Prescription

1. Daily physical activity such as trekking, walking and the like.
2. Physiotherapy once a week with a specialist physiotherapist to improve the ability to walk among other things. Self-training/home exercise programmes should be drawn up and implemented 2–3 times a week.
3. Fitness and endurance training is recommended in some cases.

Functional tests/need for health checks

Because patients with Parkinson's disease are usually of a mature age, cardiac and pulmonary functions should be assessed before any physical activity takes place in addition to general activity and the patient starts physiotherapy.

Interactions with medical treatment

Physical activity is reported to both increase and decrease the absorption of levodopa (28). Yet, the result of another study showed no change in the plasma level, nor any variation in the effects of increased work intensity (29). Consequently, there is no reason to assume that there is any interaction between physical activity and medical treatment.

Contraindications

There are no contraindications for physical activity in general or physiotherapy treatment. There may be cardiac and pulmonary contraindications for strength training. A recently published study showed that half of the Parkinson's sufferers participating in the study had a pathologic cardiovascular reaction when subjected to a maximal load (30). If reproduced, this discovery would perhaps allow for an identification of patients without an increased risk of a cardiovascular side-effect as a consequence of physical activity.

Risks

There is an increased risk of falling, especially among patients in the later stages of the disease who may also suffer with orthostatic hypertension and physical impairment. Special consideration should be given to patients suffering from hallucinations and other similar disorders.

References

1. Aquilonius S-M. Rörelsestörningar. I: [Movement disorders] Aquilonius S-M, Fagius J, red. Neurologi. 4 uppl. [Neurology 4 issue] Stockholm: Liber AB; 2006. p. 258-76.
2. Lexell J. Multipel skleros och Parkinsons sjukdom. [Multiple sclerosis and Parkinson's disease] I: Borg J, Gerdle B, Grimby G, Stibrant-Sunnerhagen K, red. Rehabiliteringsmedicin. Teori och Praktik. [Rehabilitation medicine. Theory and Practice] Lund: Studentlitteratur; 2006. p. 288-95.
3. Midlöv P, Eriksson T, Petersson J. Parkinsons sjukdom. [Parkinson's disease] I: Läkemedelsboken 2007/2008. Stockholm: Apoteket AB; 2007. p. 786-95.
4. Valente EM, Bentivoglio AR, Dixon PH, Ferraris A, Ialongo T, Frontali M, et al. Localization of a novel locus for autosomal recessive early-onset parkinsonism, PARK6, on human chromosome 1p35-p36. *Am J Hum Genet* 2001;68:895-900.
5. Jenner P. Parkinson's disease, pesticides and mitochondrial dysfunction. *Trends Neurosci* 2001;24:245-7.
6. Kirkey KL, Johnson CC, Rybicki BA, Peterson EL, Kortsha GX, Gorell JM. Occupational categories at risk for Parkinson's disease. *Am J Ind Med* 2001;39:564-71.
7. Chen H, Zhang SM, Schwarzschild MA, Hernan MA, Ascherio A. Physical activity and the risk of Parkinson disease. *Neurology* 2005;64:664-9.
8. Sasco AJ, Paffenbarger Jr RS, Gendre I, Wing AL. The role of physical exercise in the occurrence of Parkinson's disease. *Arch Neurol* 1992;49:360-5.
9. Baatile J, Langbein WE, Weaver F, Maloney C, Jost MB. Effect of exercise on perceived quality of life of individuals with Parkinson's disease. *J Rehabil Res Dev* 2000;37:529-34.
10. de Goede CJ, Keus SH, Kwakkel G, Wagenaar RC. The effects of physical therapy in Parkinson's disease. A research synthesis. *Arch Phys Med Rehabil* 2001;82:509-15.
11. Bergen JL, Toole T, Elliott III RG, Wallace B, Robinson K, Maitland CG. Aerobic exercise intervention improves aerobic capacity and movement initiation in Parkinson's disease patients. *NeuroRehabilitation* 2002;17:161-8.
12. Canning CG, Alison JA, Allen NE, Groeller H. Parkinson's disease. An investigation of exercise capacity, respiratory function, and gait. *Arch Phys Med Rehabil* 1997; 78:199-207.
13. LeWitt PA, Bharucha A, Chitrit I, Takis C, Patil S, Schork MA, et al. Perceived exertion and muscle efficiency in Parkinson's disease. L-DOPA effects. *Clin Neuropharmacol* 1994;17:454-9.
14. Petajan JH, Jarcho LW. Motor unit control in Parkinson's disease and the influence of levodopa. *Neurology* 1975;25:866-9.
15. Crizzle AM, Newhouse IJ. Is physical exercise beneficial for persons with Parkinson's disease? *Clin J Sport Med* 2006;16:422-5.
16. Dibble LE, Hale T, Marcus RL, Gerber JP, Lastayo PC. The safety and feasibility of high-force eccentric resistance exercise in persons with Parkinson's disease. *Arch Phys Med Rehabil* 2006;87:1280-2.

17. Dibble LE, Hale TF, Marcus RL, Droge J, Gerber JP, LaStayo PC. High-intensity resistance training amplifies muscle hypertrophy and functional gains in persons with Parkinson's disease. *Mov Disord* 2006;21:1444-52.
18. Hirsch MA, Toole T, Maitland CG, Rider RA. The effects of balance training and high-intensity resistance training on persons with idiopathic Parkinson's disease. *Arch Phys Med Rehabil* 2003;84:1109-17.
19. Miyai I, Fujimoto Y, Ueda Y, Yamamoto H, Nozaki S, Saito T, et al. Treadmill training with body weight support. Its effect on Parkinson's disease. *Arch Phys Med Rehabil* 2000;81:849-52.
20. Protas EJ, Mitchell K, Williams A, Qureshy H, Caroline K, Lai EC. Gait and step training to reduce falls in Parkinson's disease. *NeuroRehabilitation* 2005;20:183-90.
21. Reuter I, Engelhardt M, Stecker K, Baas H. Therapeutic value of exercise training in Parkinson's disease. *Med Sci Sports Exerc* 1999;31:1544-9.
22. Scandalis TA, Bosak A, Berliner JC, Helman LL, Wells MR. Resistance training and gait function in patients with Parkinson's disease. *Am J Phys Med Rehabil* 2001;80:38-43, quiz 4-6.
23. Schenkman M, Cutson TM, Kuchibhatla M, Chandler J, Pieper CF, Ray L, et al. Exercise to improve spinal flexibility and function for people with Parkinson's disease. A randomized controlled trial. *J Am Geriatr Soc* 1998;46:1207-16.
24. Sunvisson H, Lokk J, Ericson K, Winblad B, Ekman SL. Changes in motor performance in persons with Parkinson's disease after exercise in a mountain area. *J Neurosci Nurs* 1997;29:255-60.
25. Burini D, Farabollini B, Iacucci S, Rimatori C, Riccardi G, Capecci M, et al. A randomised controlled cross-over trial of aerobic training versus Qigong in advanced Parkinson's disease. *Eura Medicophys* 2006;42:231-8.
26. Schmitz-Hubsch T, Pyfer D, Kielwein K, Fimmers R, Klockgether T, Wullner U. Qigong exercise for the symptoms of Parkinson's disease. A randomized, controlled pilot study. *Mov Disord* 2006;21:543-8.
27. Fertl E, Doppelbauer A, Auff E. Physical activity and sports in patients suffering from Parkinson's disease in comparison with healthy seniors. *J Neural Transm Park Dis Dement Sect* 1993;5:157-61.
28. Carter JH, Nutt JG, Woodward WR. The effect of exercise on levodopa absorption. *Neurology* 1992;42:2042-5.
29. Mouradian MM, Juncos JL, Serrati C, Fabbrini G, Palmeri S, Chase TN. Exercise and the antiparkinsonian response to levodopa. *Clin Neuropharmacol* 1987;10:351-5.
30. Werner WG, DiFrancisco-Donoghue J, Lamberg EM. Cardiovascular response to treadmill testing in Parkinson's disease. *J Neurol Phys Ther* 2006;30:68-73.