Parkinson's disease

Part II - Motor strategy training according to the N.A.P.® concept

from Renata Horst

Summary: In the next 25 years, twice as many people will develop Parkinson's disease than in the past. It is therefore the most common neurodegenerative disease in old age. Medication helps to some extent, although many different drugs have to be taken at precise times of the day. It is often difficult to take medication precisely in old age and can only be ensured by an assistant. Side effects are also not uncommon. They even occur in 100% of cases where medication has to be taken before the age of 40. In patients between the ages of 60 and 69, side effects occur in 26% of cases after 5 years of taking medication (Melamed, 1998). Surgical procedures can also be helpful, although these are associated with certain risks (Alesch et al., 1995). Training remains essential. Motor strategy training according to the N.A.P.® concept utilizes the plasticity of the brain to promote the greatest possible independence in everyday life and participation in socio-cultural life.
Keywords: Parkinson's disease / plasticity / motor learning

Introduction

Parksinson's disease is one of the most common neurodegenerative diseases in old age. In the next 25 years, the disease will be twice as common in people over 50. Interdisciplinary teams of therapists are therefore called upon to develop modern treatment methods specifically for this patient group (Jellinger, 2005, Dorsey et al., 2007).

Clinical symptoms

Basically, the main symptoms of Parkinson's disease can be divided into positive and negative symptoms. Positive symptoms are manifestations that were not previously present and are therefore new. Negative symptoms are deficits or losses of performance that were already present before.

Positive symptoms
1. Motor rigidity
2. Resting tremor

Negative symptoms
1. Loss of postural control
2. Bradykinesia, hypokinesia (akinesia)
3. Cognitive deficits
4. Limbic and autonomic deficits

Above all, the loss of postural control causes a considerable restriction of the patient's participation in socio-cultural life. Falls due to postural instability and gait disturbances are the main factor in emergency admissions and cause the greatest costs in the healthcare system (Bloem et al, 2010). If the person concerned is afraid of falling, they avoid leaving their own four walls. As a result, they are dependent on outside help to do the shopping, go to the bank, visit the doctor, meet friends and relatives, etc. - they lose quality of life!

Negative symptoms

1. Postural control

Postural control can be defined as the ability to align body segments against gravity under both static and dynamic conditions (Horst, 2005, 2007). To achieve this, the coordination of muscle synergies must be variable - depending on the environmental conditions (support surface) - and actions must be organized. Muscle synergies cannot be modified if postural control is lost. Their activation sequence is stereotypical (Horak et al., 1992) (Fig. 1).

For the organization of corrective (balance reactions) and protective (support reactions and protective steps) strategies, the ability to follow muscle activation sequences must be available depending on the situation. They must be adapted to the requirements of the environment.

In Parkinson's disease, not only the basal ganglia are affected, but according to recent findings, pathways that run between the limbic system, basal ganglia and the brain stem are also disturbed (pedinculopontine pathways). These pathways are involved in the initiation, acceleration, deceleration and stopping of walking (Lee et al., 2000). This is why affected patients are often unable to start walking, they feel as if they are "frozen." They describe the feeling as if their feet are on the ground.
would "stick". Or they can't stop. Here they describe the feeling of being "scaled from behind". L-dopa therapy does not help to change these symptoms, so training is essential (Bartels et al, 2003).

In a multiple baseline study with 14 Parkinson's patients, Jöbges et al. (2004) were able to achieve faster step initiation, greater step length and above all - although walking was not practiced - greater gait speed. They practiced protective steps twice a day for 14 days. It is possible that the improvement
The walking speed of healthy people can be explained by the fact that they are less afraid of falling. Healthy people learn more effectively through repetition in different contexts, so-called "random practice". This involves practising the characteristics of motor control in different contexts by choosing different starting positions and exercise sequences (Horst, 2005). Parkinson's patients, on the other hand, seem to learn better by repeating the same exercise in the same context; so-called "random practice".
"blocked practice," (Lin et al., 2007).

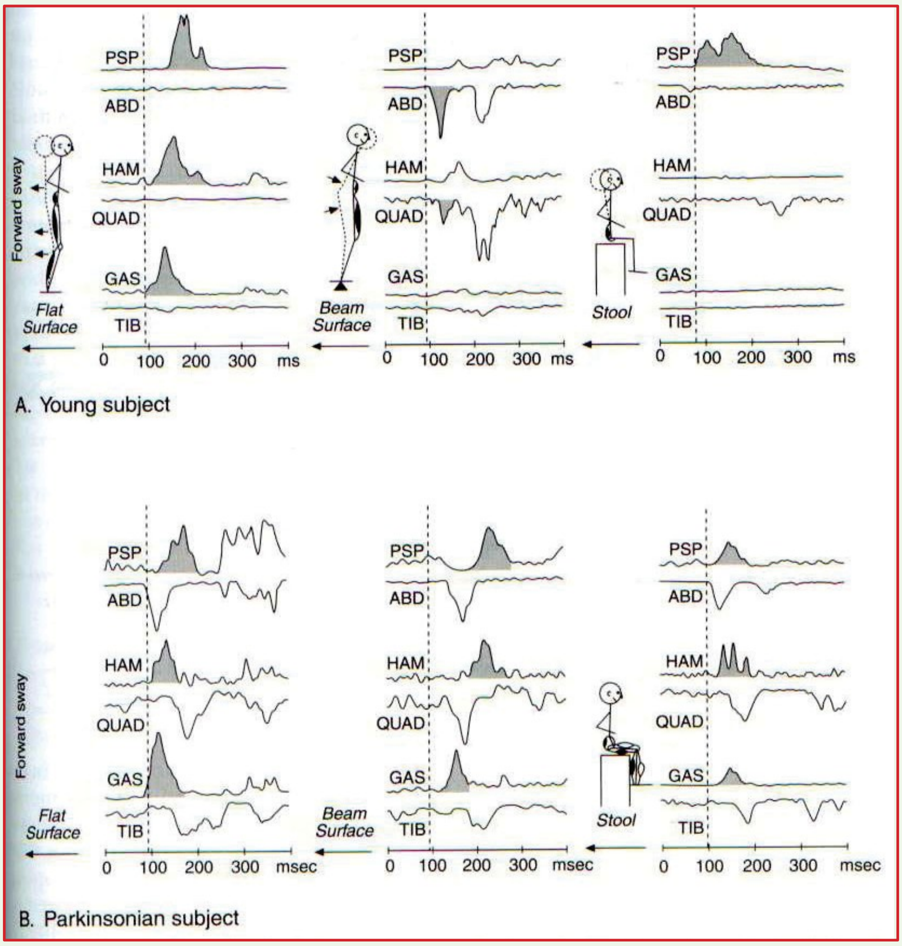
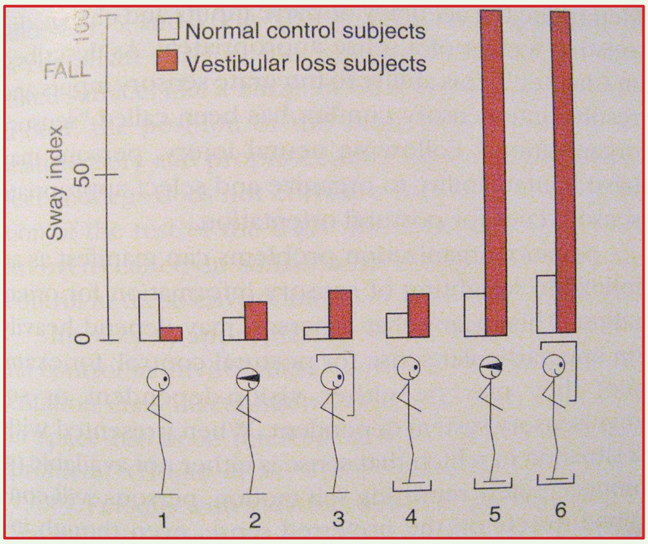


Fig. 1: A) A young, healthy person is able to organize their muscle synergies variably, depending on the support surface.
B) a patient with Parkinson's cannot adapt their muscle activation sequence to environmental demands. (From Shumway- Cook and Wooolacott, "Motor Control," 2001: adapted from Horak et al., 1992).

However, practicing protective steps should be practiced under different sensory conditions (Fig. 2). Otherwise, patients will not learn to react to the changes, e.g. walking on uneven terrain or on smooth, slippery surfaces. Changing light conditions can also lead to balance disorders. This is not only the case when walking outside in the twilight, but also when you get up at night to go to the toilet and your partner does not want to wake you up by switching on the light.

Fig. 2: Practicing protective steps under different sensory conditions. The soft foam mat and ski goggles require the patient to make greater use of his vestibular system to organize protective strategies.

Horak et al, (1998), have developed a test that assesses which sensory strategy can be used to better maintain balance or to find out which of the input systems is restricted (Clinical Test for Sensory Interaction in Balance, CTSIB) (Fig. 3).



Parkinson's patients often lose their balance in this test, even though they do not have a primary cerebellar disorder. Their balance organ and proprioceptive system show no deficits. However, the pedinculopontine pathways mentioned above are connected to the brain stem, which makes this disorder understandable. Since Parkinson's patients, as we have seen in Figure 1 above, cannot adapt their motor program to changing conditions, it is obvious that they experience difficulties when the sensory input suddenly changes. This can be recognized by the test when they close their eyes and initially lose their balance, but after a few seconds they "catch" it again. It is therefore important to complete t h e test and not to stop at the first sign of loss of balance. The aim of treatment is therefore not to train balance by stimulating the organ of balance or proprioceptive training, but to develop strategies with the patient that they can learn and use to solve their motor problem.

Since the automated, unconsciously controlled mechanisms are disturbed during walking and the external, cognitive mechanisms are largely intact, these can be used effectively for motor strategy training (Ni- euwboer et al., 1997, Darmon et al., 1999, Rubenstein et al., 2002).

The N.A.P.® concept describes the following treatment principles and methods (Horst, 2007):

1. Cognitive pain and anxiety management
   a) Habituation training
   b) aerobic training
2. Use of positive resources
3. The structure is only as resilient as it is loaded
   a) the structure is determined by the functional activity
   b) Facilitation of weak musculature through summation principles
   c) Promoting the elasticity of stiff muscles through biomechanical adaptation processes

Fig. 3: Body sway is assessed under 6 sensory conditions. The person should be able to maintain their balance for 30 seconds without significant fluctuations. Balance reactions are compared between the control group (white boxes) and people with vestibular deficits (red boxes). 1. visual, vestibular and proprioceptive information can be used. 2. with eyes closed, only the vestibular and proprioceptive systems are available.
3. Like 2, except that the visual input is somewhat distorted by a paper lantern that is placed over the head (here you can substitute a pair of ski goggles with gel). 4, 5, and 6: like the first three conditions, only with limited proprioceptive input, by standing on a foam mat. In the last two conditions, only the vestibular system is available for experiencing.
The motor is available to maintain equilibrium. (from: From Shumway- Cook and Wooolacott, "Motor Control," 2007, p. 249).

4. Specific application of the input systems
5. Targeted design of the therapy situation
6. Plasticity of the structures

Methods	Features
1. the patient is supported in organizing the treatment.	• His attention is drawn to the input systems required for the task at hand. • For patients with cognitive deficits, the therapist must try to create contexts in which the patient's actions can be accompanied. • In situations in which the actual action cannot be carried out, the visualization of actions should be encouraged.
2. action and treatment form a unit in that structures are specifically influenced during the execution of an arbitrary action.	• The therapist's hands are used to create the biomechanical situation required for economic execution. • The therapist's hands are only placed after it has been ensured that the target has been recognized. de.
3. starting positions are chosen specifically.	• Primarily, the starting positions are chosen that the patient needs in order to cope with activities in his everyday life and to participate in his individual socio-cultural life. • Depending on the type of muscle activation required, or depending on the structure to be influenced (contractile/non-contractile), gravitational force influences can be applied. contractile), are taken into account.

Methodical implementation of the N.A.P.® concept

In the following, practical examples of exercises are used to describe how the treatment principles can be methodically implemented within the N.A.P.® concept.

As patients with balance disorders are afraid of falling, the principle of "cognitive anxiety management" is applied.
ment" using habituation training. Methodically,
the patient is supported in organizing the action
to move. To do this, it has to move external destabilization stimuli, which only occur after its eye movements have been
therapist can cause. His attention is drawn to the input systems that are required for this task. Once the support surface is in place, the therapist must first direct his visual attention to the support surface.

The child must consciously place his foot on a specific spot, e.g. a different colored surface. Once he has learned where to place his foot to maintain his balance, the training requirements are gradually increased. In this way
For example, the visual input can be impaired by means of smeared ski goggles. Now he has to fall back on his memory system to remember where he had to place his foot to keep his balance. His proprioceptive system gives him feedback as to whether the targeted reaction has taken place or not. These methods are based, on the one hand, on the principle of "using positive resources" (visual system, proprioceptive system, memory systems) and, on the other hand, on the principles of "specific application of the input systems" and "targeted design of the therapy situation" (see Fig. 2).

2. Bradykinesia, hypokinesia (akinesia)

The slowing of movement is one of the biggest problems for the voluntary motor skills of Parkinson's patients. Bradykinesia describes the slowing down of a movement that has already begun and involves a longer movement time, whereas "akinesia" describes the absence of movement initiation and involves a longer reaction time (Sohn and Hallett, 2005). The CNS organizes fast, goal-directed voluntary movements by means of a so-called "tri-phasic muscle activation" (Beradelli et al., 1996, Ghez, Thach, 2000). First of all, the agonists of the target movement are activated (acceleration phase). Shortly before reaching the target, the antagonists contract to decelerate the movement, whereupon the agonists are activated again to stabilize the final position. This centrally controlled movement program involves a relatively constant activation sequence and enables movements of different distances to take approximately the same amount of time. In order for the movement over the longer distance to take approximately the same amount of time as over a shorter distance, a stronger EMG magnitude must be applied. The movement program is intact in Parkinson's patients. They simply have insufficient motor energy to generate and complete the movement (Sohn and Hallett, 2005). The practical consequence of this evidence is that strength endurance and speed-strength training is extremely important for Parkinson's patients (Fig. 4).

Another characteristic of bradykinesia is that simultaneous and sequenced movements are difficult to perform. Normally, when limb and eye movements need to be coordinated for activities, the bradykinesia begins.
the movement of the eyes slightly earlier than that of the extremity (Warabi et al., 1988). Parkinson's patients begin their ex-
has taken place. It is unclear whether this deviation is due to the fact that simultaneous movements cannot be organized or because these patients first have to visually focus on their target before they can initiate the movement.

Fig. 4: The patient trains his extensor synergy eccentrically and concentrically when standing up and sitting down. The barbell reinforces the gravity information according to the N.A.P.® treatment principles: "Every structure is only as resilient as you load it", "specific use of the input systems" and "specific design of the therapy situation".

The treatment principle of "using positive resources" is used for these symptoms in the N.A.P® concept. To initiate movement, the patient's attention is directed to visual stimuli. Anatomically, the cerebellar loop and the basal ganglia loop are connected in parallel. The movement plan and the necessary motor strategy for executing the action are determined before the movement is initiated. Information from the environment is specifically selected beforehand and passed on to the cortex from the association areas. Feedback from the periphery enables corrections to be made during the execution of the movement if there is sufficient time to do so (Fig. 5).

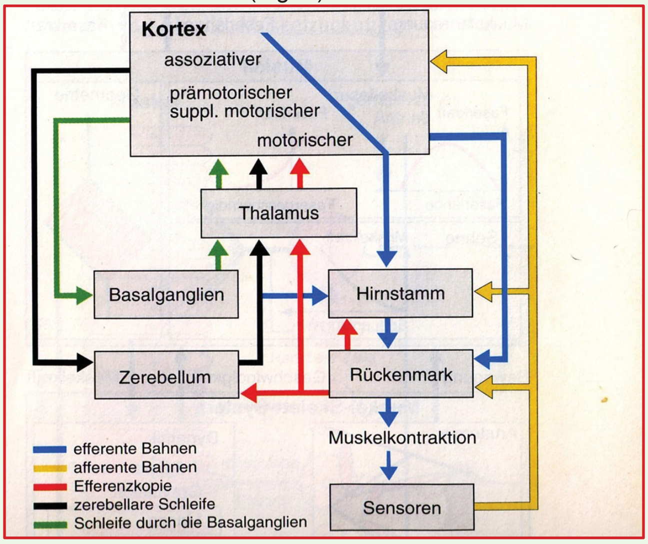


Fig. 5: Cerebellar and basal ganglia loops are connected in parallel. (From: Dudel, Menzel, Schmidt: "Neurosciences", 1996, p. 191).

External visual cues (triggers) can be used to enable the Parkinson's patient to start moving. In clinical practice, it can be observed that patients can climb stairs much more easily than walking on the level. This may be because the steps provide a visual stimulus, which requires a cognitive strategy. Climbing steps is not only an aid for initiating movement, but also fulfills other important treatment goals that have already been explained: speed strength training and strength endurance training.

3. Cognitive deficits

One characteristic of bradykinesia described above is the difficulty in performing simultaneous movements. Parkinson's patients also have difficulty performing motor and cognitive tasks simultaneously or even one after the other. They cannot automatically switch their attention from one task to another. This ability to "shift" (switch) depends on the intact function of the basal ganglia and the dopamine level. Dopamine is a neurotransmitter that is required for learning new tasks and for switching attention. In particular, new tasks that have not been practiced before require the ability to abandon a habitual pattern of behavior. If you concentrate on a specific task, you have to be able to block out irrelevant information. This so-called "reciprocal in-hibition" enables selective attention. The task of the basal ganglia, through their connection with the pre-frontal cortex, is to remove this inhibition when a change of attention is required. Although the "motor" cortex is able to select the program required for the task, the basal ganglia are responsible for enabling access to the required program. As intrinsically organized access is not possible for them, patients can access externally controlled strategies to activate the required programs.

4. Autonomic and limbic deficits

The autonomic or vegetative nervous system is referred to as the brain of "physical well-being" (Gurevich and Korczyn, 2005) and is responsible for the function of all body systems, e.g. the cardiovascular and digestive systems. A good supply of oxygen is essential for the nervous tissue. The sympathetic border ganglia are located ventral to the costo-transverse joints. Mobilizing these can have a beneficial effect on the nutrition of the nervous tissue under neural prestress (see illustration on page 5).

Above all, possible existing swallowing disorders lead to a significant reduction in the quality of life of the Parkinson's patients. The mimic muscles that are used for The muscles required for chewing and grinding are emotionally controlled by the limbic system. The broca center also controls these muscles. In addition, the fine motor skills of the fingers, tongue muscles and hearing are controlled in the broca center.

sounds are organized. As Parkinson's patients have neither primary fine motor skill deficits nor hearing deficits, finger exercises and phonetic exercises can promote the activity of the mimic muscles (Fig. 6a and b). Only when sufficient tone of the supra- and infrahyoid muscles and tongue muscles can be built up does the oesophageal sphincter open for the automatic swallowing process. If this mechanism does not work, the spittle produced cannot be swallowed.

Fig. 6a (left): The patient imitates chewing movements while the therapist supports his circular lip movements. 6b: The patient is asked to moisten his upper lip while the therapist supports him.

Positive symptoms

Motor rigidity

"Tonus" is defined as resistance to passive stretch. Rigidity is a form of increased tone. In Parkinson's patients, it has been shown that there are changes in the passive, non-contractile, mechanical properties of the muscles. Studies show that the upper extremities of Parkinson's patients are significantly stiffer at rest than those of healthy subjects, even though EMG activity is not increased.

An important treatment goal is to promote structural elasticity. On the one hand, rolling exercises in low positions enable the patient to lose their fear of falling and, on the other hand, these activities promote the structural elasticity of the non-contractile structures.

tures. Since, as described above, patients are treated by ex-
visual stimuli can better initiate their movements.

As the therapist's hands are not necessarily indicated here. The patient is supported in moving their eyes first and looking after their hand or focusing on objects in the room. Nevertheless, the therapist's hands can be used during the rolling activity.

Therapists apply longitudinal traction to muscles that exhibit stiffness. In this case, the therapist's hands are used to achieve the structural goal of promoting elasticity, but not to "initiate" the activity.

Resting tremor

The so-called "resting tremor" is characterized by involuntary antagonistic contractions. The Parkinson's patient's resting tremor decreases as soon as they perform an arbitrary movement. However, the tremor can still be present in static postures. As the "tri-phasic muscle activation sequence" described above is pre-programmed in fast, targeted voluntary movements and these patients have a normal movement program, it seems important to practice everyday movements with clear visual and achievable targets. It has already been described that Parkinson's patients do not have sufficient motor energy to generate the first agonistic acceleration. Thus, after the goal has been visually defined and the patient has mentally made the start, the therapist's hands could be used to support their rapid voluntary movement.

Summary

For the treatment of patients with Parkinson's disease, it is important to understand the individual symptoms and their causes. As several symptoms can occur at the same time, treatment must be varied with clearly defined objectives. These goals must be defined jointly by the interdisciplinary team and fixed times of day must be planned for the various treatments, as the medication taken by these patients is also set for fixed times of day. The treatment principles of the N.A.P.® concept, from which the methodological procedures are derived, offer modern techniques for developing motor strategies to help these patients cope with everyday life. In the future, it would be desirable not only to demonstrate the effectiveness of the N.A.P.® concept through individual case studies, but also to prove its effectiveness for the treatment of Parkinson's patients through randomized controlled studies.

Literature available from the author

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