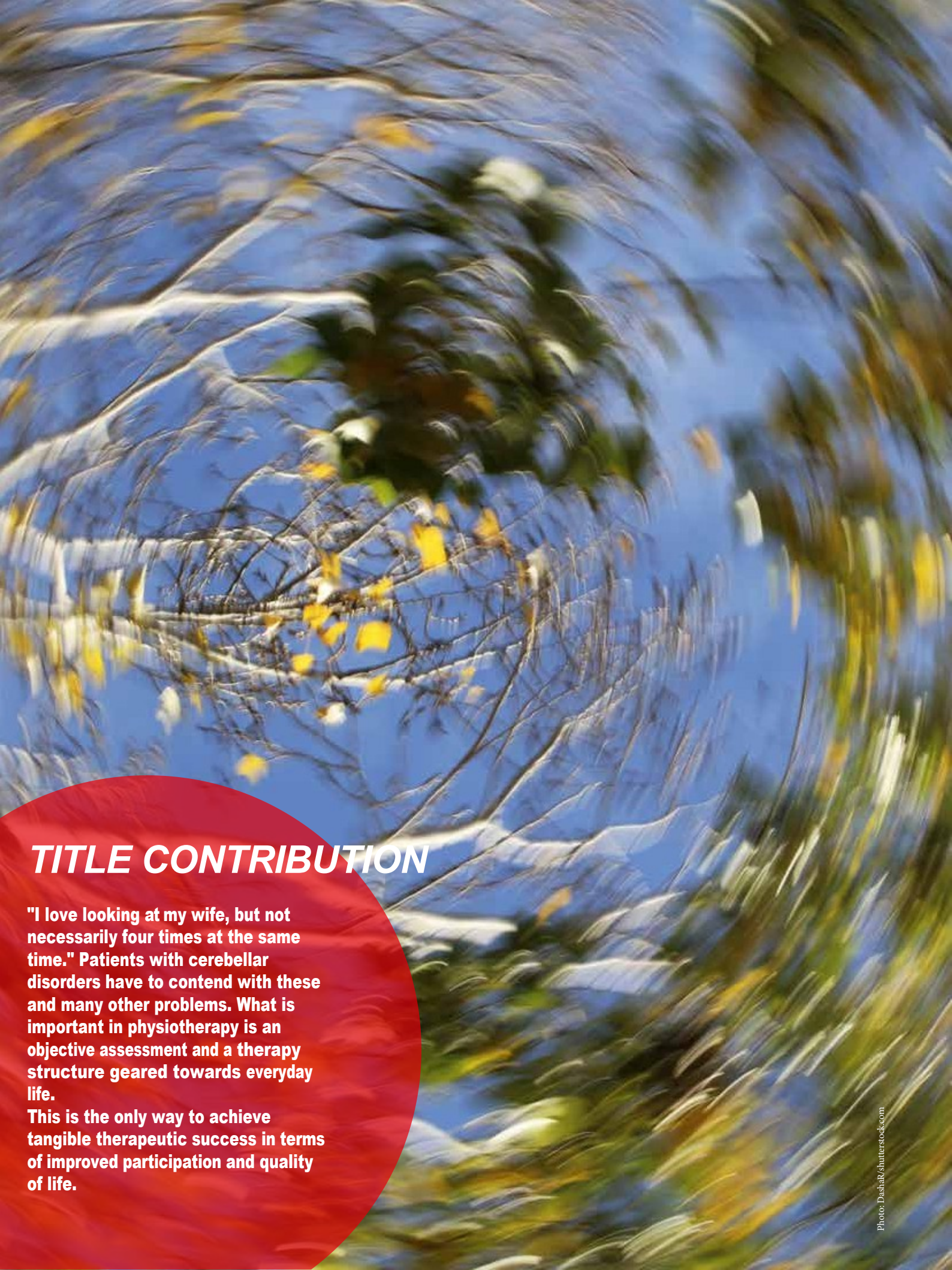
pt
ZEITSCHRIFT FÜR PHYSIO THERAPEUTEN
73rd year
February
2021

STABILITY: STEADFAST IN LIFE

AUTHOR IMPRINT

physiotherapists.com



TITLE CONTRIBUTION

"I love looking at my wife, but not necessarily four times at the same time." Patients with cerebellar disorders have to contend with these and many other problems. What is important in physiotherapy is an objective assessment and a therapy structure geared towards everyday life.

This is the only way to achieve tangible therapeutic success in terms of improved participation and quality of life.

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Ataxia: becoming stable again

Evidence-based physiotherapy to improve motor skills

A contribution by Renata Horst and Alexander Dassel

For those in a hurry

Mild cerebellar disorders lead to dystaxia, severe disorders to dystaxia. are referred to as ataxia. In physiotherapy, the question arises as to which strategies and methods are effective. The authors use a case study to demonstrate their approach and methods. way.

The cerebellum is the secret star of human sensorimotor function. No other organ in the central nervous system performs such complex processing to ensure upright posture and movement.
to generate (1). For this to work, the systems need constant information about the positions of joints, muscles and fascia to maintain balance. This takes place via mechanoreceptors that

are distributed throughout the body. Visual information from the eyes is used to determine the position of the body in space. The semicircular canals in the inner ear determine whether and which acceleration or braking action is taking place at a given moment and in which direction. With the help of these input systems, the cerebellum generates a visual signal for each situation.
always produces the optimal motor response (2). In addition, the cerebellum is involved in emotional and neurocognitive processes as well as speech. Parts of the working memory and executive functions are localized here, which is why some scientists refer to it as a "supervised learning machine", i.e. a central nervous unit that supervises learning processes (1). Mild cerebellar disorders result in dystaxia, while severe disorders are referred to as ataxia. Typical symptoms such as dizziness, imbalance, impairment of the oculomotor system, motor speech disorder and disturbed movement sequences are the result. From a physiotherapy perspective, the question arises as to which strategy and which methods therapists can use to optimally influence the condition of those affected.

Which therapy strategy is helpful?

Traditionally, the PNF and Bobath concepts influence sensorimotor control by providing therapeutic facilitation within everyday movements. A motor training program according to Professor Heinrich Sebastian Frenkel directly exercises the patient's ability to move, grasp and balance with a focus on independently performed activities. Physiotherapists use static and dynamic exercises to train postural stability and flexibility. Strength and elasticity training, combined with vestibular stimulation, activates sensorimotor systems

at the same time. In physiotherapy, postural training refers to exercises for those muscles that work against gravity in order to organize the upright position, for example
is required for all transfers to higher or lower positions.
Resistance-increasing orthoses or weight vests are used, among other things, to reduce mechanoreceptors. The brain is stimulated to increase the intensity of affective inputs to the cerebellum. Physiotherapeutic interventions do indeed have an effect on the status of patients with cerebellar damage. In particular walking, trunk control and

any other form of activity can be demonstrably positively influenced; the evidence
However, this is only of moderate quality (3). Scientists are currently working on new approaches.

For example, transcranial brain stimulation can reduce ataxic symptoms (4). Rehabilitation exercises in virtual reality and computer programs in which the entire body has to be used to generate reactions on the screen (exergaming) are producing promising results in terms of influencing motor skills in patients with ataxia (5).

Case study

Pathology, main symptoms and primary deficit at activity/participation level

Mr. B. is a 48-year-old patient, a general practitioner by profession. In 2012, he suffered an embolic cerebellar infarction due to a dissection of the left vertebral artery. As a result, various systems were initially unspecifically disturbed, he experienced dizziness and nausea combined with gait disturbances, as well as latent headaches and uncoordinated eye movements. Fortunately, there was no brainstem compression, a feared complication with severe symptoms in the case of extensive infarcts in the cerebellum (6, 7). 

The symptoms of Wallenberg syndrome can be causally assigned to the sites of damage. allocate.

Overall, no serious sensorimotor deficits remained, so that Mr. B. was quickly able to resume his job and leisure activities, especially skiing and racing cycling. In 2016, he suffered another infarction, which was again caused by the occluded vertebral artery. This time, the medulla oblongata was affected, as a result of which Mr. B. developed Wallenberg syndrome, which was also caused by an occlusion of the posterior cerebellar artery, the
A. cerebelli inferior posterior (PICA, therefore also called PICA infarction). The symptoms of Wallenberg syndrome can be causally assigned to the sites of damage; Table 1 (8-20) provides information on some of the possible causal relationships.

During this time, Mr. B. suffered primarily from severe swallowing difficulties, which is why he had to be fed via a PEG tube for a period of almost six months. After his condition continued to improve, an attempt was made to reintegrate him into work in 2018. The remaining symptoms were too pronounced, however, so that Mr. B. eventually had to give up medical work. Neurological deficits occurred again at the beginning of 2020: Mr. B. suffered a transient ischaemic attack (TIA) with transient symptoms, including hemiplegia, speech and language disorders, but also impaired vision (21, 22). Mr. B. recovered completely after a short time.

Since the first infarction, considerable neuropathic pain has remained, mainly in the left leg, and Mr. B is also burdened by his visual disturbances in the form of multiple images (23). Stability in everyday life is particularly problematic. Whenever Mr. B. wants to cross a road, the vehicles passing at eye level upset his postural system to such an extent that there is a considerable risk of falling. In order to maintain his balance, the central nervous system generates continuous self-maintaining

Tab. 1 Causal relationship between localization of damage and symptoms in Wallenberg syndrome

Place of damage	Impact
Vestibular nuclei	Dizziness, nystagmus, vomiting
Nucleus ambiguus (with effect on vagus and glossopharyngeal nerves)	ipsilateral paralysis in the palate, pharynx and larynx regions with swallowing disorders, hoarseness, reduced gag reflex
Lateral spinothalamic tract	Contralaterally reduced pain and temperature sensation (affecting trunk and limbs)
Nucleus tractus solitarii	Weakened nausea and gag reflex
Formatio reticularis	Swallowing disorders, hiccups
Pedunculus cerebellaris inferior	ipsilateral cerebellar signs with ataxia, dysmetria and -diadochokinesia
Tractus tegmentalis centralis	palatal myoclonus
Nucleus principalis nervi trigemini	ipsilateral attenuation of pain and temperature sensation in the face
Descending sympathetic pathways	ipsilateral Horner's syndrome, typically with pupil constriction, supposedly sunken eye and reduced sweating

Table 2 N.A.P. gear classification

Digiti contact (DK)	concentric verticalization (KV)	Eccentric stabilization (ES)	Digiti-Push (DP)	Forward acceleration (VB)
first floor contact to the Excess weight take on the Forefoot (eccentric function, extensor synergy)	Pelvic rotation to dorsal (concentric Function Hip extensors and pelvitrochanteric musculature)	Plantar flexors, Knee flexors, Hip flexors, M. quadriceps and Back extensor (eccentric function)	Mm. flexor hallucis longus and peronaei (concentric function), further ongoing plantar flexors OSG and knee flexors	Benefits of the Muscle Strain-Ver-shortening cycle (Mm. rectus femoris and tibialis anterior)

Righting impulses (24, 25). Mr. B. has a disturbance of stimulus processing in the cerebellum, which he was able to compensate for to a certain extent with the remaining resources, the cerebellar reserve (26), in order to prevent postural insufficiency: He uses gaze fixation for spatial orientation. If he is deprived of this possibility, simply standing is already a challenge for him.

When asked to what extent the multiple images he constantly sees affect Mr. B., he replied: "I really like looking at my wife, but not necessarily four times at the same time." In order to get to grips with this problem, Mr.
B. consulted a functional optometrist, a specially trained optician. He diagnosed a weakness in the eye muscles and accommodation difficulties, i.e. problems adjusting between distance and near vision. Mr. B. carried out
then carried out eye exercises and was given prism glasses (27). Despite all efforts, no improvement in stability could be achieved.

Gait analysis

The gait is markedly ataxic. Mr. B. permanently tilts his upper body and especially his head to the right. The toes are pulled up in dorsiflexion over the entire gait cycle and the knees remain stiff throughout. The forefoot neither takes on weight at the beginning of the stance leg phase (digiti contact) nor does it support the push-off at the end (digiti push). Instead, the body's center of gravity is shifted from one leg to the other in the frontal plane (Table 2).

Testing the hypotheses

According to the picture of Wallenberg syndrome, Mr. B. has slight sensory disturbances in the left half of his face, his temperature and pain sensation of the contralateral half of his body is disturbed, his surface sensitivity is preserved. Depth sensitivity tests showed no pathological findings. Tests for range of motion and strength of the upper and lower extremities show physiological values. Head rotation to the right is clearly restricted.

One day Mr. B. was sitting in the surgery and said that he could see me clearly - which was not usually the case - his multiple images had suddenly disappeared. When he took off his jacket, he saw me four times again. I asked him to put his somewhat tight-fitting jacket back on, whereupon he saw me again clearly and only once. I hypothesized that despite intact depth sensitivity, the alignment between the proprioceptive and visual systems was severely delayed. The cerebellum therefore tries to obtain information via compensatory eye movements. I assumed that the tight jacket would give it additional feedback so that compensatory eye movements would no longer be necessary. To test this assumption, I wrapped two elastic bandages around his arms to test the effect of compression. The effect was the same as when wearing the tight-fitting jacket (Fig. 1).

The illustrations show selected examples of findings and therapy for the patient.

Fig. 1 Testing the effects of compression with a bandage

Fig. 2 Clinical Test for Sensory Interaction in Balance (CTSIB)

Fig. 3 Preactive stabilization while standing

Fig. 4 Action massage of the sternocleidomastoid muscle

Fig. 5 Eccentric function of the M. sternocleidomastoideus

Photos: Renata Horst

Fig. 6 The amphibian reaction initiates the transfer to the quadruped position

Clinical Test for Sensory Interaction in Balance (CTSIB)

In order to test the coordination of the systems for maintaining balance, I asked Mr. B. to stand on an unstable support surface once with his eyes open and once with his eyes closed. In both situations, he was unable to maintain his balance for longer than three seconds (Fig. 2). This means that neither his vestibulo-ocular reflexes (VOR) nor his vestibular system is intact. Mr. B. told me that he always had the urge to do a headstand. This gave me the idea that he was looking for as much proprioceptive input as possible.

Balance training

The aim of equilibrium training, or more precisely balance training, is to enable the regions responsible for organizing balance to gain "experience" of how they need to be coordinated with each other in order to ensure stability in different situations. Since life is diverse, it seems sensible to offer variability to the learning ends and their systems (28, 29). When walking in the natural environment, the head must move in space. In contrast to standing or walking, the coordination of the forefoot muscles and the vestibular system takes place on an unstable surface, such as a treadmill. In order to achieve adaptation effects, different afferent signals (proprioceptive, vestibular, visual and exteroceptive) must be coordinated with each other in relevant contexts. This requires a specific selection and evaluation process (30). When you try to maintain your balance

Fig. 7 Standing up with headstand to stimulate the vestibulospinal reflexes

on an unstable support surface, this requires a static head position. Here other requirements are placed on the visu- and vestibular systems than those that are responsible for are required for locomotion. For optimal therapeutic success, the vestibular system must be stimulated in different ways. The vestibular system adapts best when the head is moved at different speeds and experiences different positions. If you only train at a constant frequency, the patient will only have good results at this speed (31).

The vestibular system adapts best when the head is moved at different speeds.

Therapeutic approach

Exercise 1 - Preactive stabilization in standing position: The patient stands with his back in the corner and is asked to catch a barbell. This forces him to activate his foot muscles, especially the peroneal muscles, and deep trunk muscles (multifidii and transversus abdominis muscles) beforehand (32) (Fig. 3).

Exercise 2 - Action massage of the sternocleidomastoid muscle: In the supine position, the patient is asked to look at a picture hanging on the wall at the top right. This direction of gaze activates the left-sided neck muscles and leads to reciprocal innervation of the right-sided neck muscles. In the meantime, he exhales audibly in "sh". The therapist applies longitudinal traction to the muscle belly. (Fig. 4)

Exercise 3 - eccentric function of the sternocleidomastoid muscle during the transfer from sitting to lateral support: Mr. B lies down on his left elbow on the couch via the lateral support. He looks towards his right hand, which automatically leads to a lateral tilt of the head to the left and to

Gravity provides proprioceptive information for the organization of the eccentric function.

Fig. 8 The bicycle helmet provides additional proprioceptive input to the head

leads to a shift in weight on his left lower arm. Gravity provides proprioceptive information to organize the eccentric function of the sternocleidomastoid muscle (Fig. 5).

Exercise 4 - Amphibian reaction: In prone position, Mr. B. pulls his right leg towards his stomach. This movement initiates the transfer to the quadruped position. He looks under his right armpit in the direction of his free leg. He lies on his painful left cheek so that he can decide for himself how much pressure he wants to tolerate. This is intended to achieve habituation (33). This activity is ultimately intended to promote the cortical representation of the left side of his face. In addition, the head position can have a favorable influence on the sympathetic tone (34) (Fig. 6).

The head-down position can have a favorable Influence on the sympathetic tone have.

Exercise 5 - Standing up with headstand: To satisfy his desire to experience pressure on his head, Mr. B. should bend forward in a sitting position to grasp a barbell bar lying on the floor. The rapid forward acceleration of his head in space with pressure applied to his forefoot stimulates his vestibulospinal reflexes (35). This movement eccentrically activates the suboccipital muscles as well as the entire dorsal contractile and non-contractile structures. The inclination of the head promotes

also increases the swallowing reaction (36) (Fig. 7).

Course

After the last exercise, Mr. B. was spontaneously able to stand on an unstable support surface with his eyes closed for 30 seconds.

A short time later, he went on a 1,000 kilometer bike ride with his wife. The application of a Theraband through his cycling helmet served to provide him with additional proprioceptive input to his head (Fig. 8). This meant that he no longer had to compensate with increased eye movements in order to receive feedback about the position of his head in space. –

Recommendation of the pt editorial team

An interview with Renata Horst on physiotherapy for hereditary spastic paresis is available on our YouTube channel: www.youtube.com/user/ptzeitschrift

Goals

Targets must be formulated at different levels become.

Body structure/body function level

- Promote eccentric function of the suboccipital muscles
- Promote eccentric function of the sternocleidomastoid muscle
- Mobilization of the dorsal contractile and non-contractile structures of the lower extremities and trunk
- Promote elasticity of the tibialis anterior and quadriceps muscles
- Promote concentric function of the Mm. peronaei and flexor hallucis longus
- Promotion of diaphragmatic breathing and regulation of the autonomic nervous system
- Increase cardiopulmonary performance
- Automating the swallowing process, promoting breath-swallow coordination

Activity/participation level

- Safe walking with Nordic walking poles on the sidewalk
- Clear vision to be able to orientate oneself in the environment
- Reduction of neuropathic pain in the face and leg
- Being able to go on bike tours with the recumbent bike

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The complete bibliography can be requested from the authors.

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