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Vojta Therapy in Patients with Acute Stroke – A New Approach in Stroke Rehabilitation

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Abstract

Unilateral motor weakness is one of the most common deficits resulting from stroke and one of the main causes of disability. Stroke rehabilitation is multidisciplinary and the aim of physiotherapy should be to promote activation and stabilisation of the remaining innervation and functions of the damaged central nervous system. Scientific evidence demonstrating the values of specific rehabilitation interventions after stroke is limited. It is still unclear, which physiotherapeutic approaches in stroke rehabilitation are most effective. Modern approaches follow the idea that functional improvement to a large extent relies on the use of compensatory movement strategies, enabling patients to learn to cope with their deficits. The Vojta therapy is based on a completely different approach: the reflex locomotion. Vojta described inborn movement sequences of reflex locomotion that are retrievable at all times. The therapist stimulates these innate patterns of movement by applying pressure to defined zones. The therapeutic use of reflex locomotion enables elementary patterns of movement in patients with impaired locomotor system, for example due to brain damage caused by stroke, to be restored once more, assuming that repeated stimulation of these "reflex-like" movements can lead to something like "new networking" within functionally blocked neuronal networks. After Vojta treatment, these patterns are more spontaneously available to the patient. Clinical experience shows, that Vojta therapy improves postural control, uprighting against gravity and goal-directed movements. We will discuss implementation of Votja therapy in stroke rehabilitation and introduce a first ever randomized controlled trial for this approach in stroke rehabilitation.

Keywords: Stroke rehabilitation; Physical therapy; Vojta therapy; Reflex locomotion; Recovery

Abbreviations

RCT: Randomized Controlled Trial; TCT: Trunk Control Test; CBS: Catherine de Bergego Scale; MESUPES: Motor Evaluation Scale For Upper Extremity In Stroke Patients; NIHSS: National Institute of Health Stroke Scale; mRS: Modified Rankin Scale; BI: Barthel Index; rTMS: Transcranial Magnetic Stimulation; CT: Computed Tomography; MRI: Magnetic Resonance Imaging

Introduction

Stroke is the leading cause of disability among adults [1] and hemiparesis is the most common impairment after stroke [2]. It can be estimated that there will be 23 million first ever strokes in 2030 [3]. There is still a paucity of evidence-based knowledge about recovery and rehabilitation [4], although the evidence base for stroke rehabilitation has grown exponentially over the last 20 years [5]. Acute stroke treatment was revolutionary improved in the last years by implementation of thrombectomy, as a game-changing intervention to inhibit brain damage and has let to remarkable improvement of clinical outcomes. The discovery of a breakthrough intervention in the field of neurorehabilitation improving the potential of true recovery is desirable [6]. We know that stroke rehabilitation delivered in a stroke unit is highly effective and reduces death and dependency [7]. The benefit of stroke units results not only from thrombolysis or thrombectomy, which are suitable for a smaller proportion of all stroke patients, but from the multidisciplinary stroke unit management, including dysphagia management and elements of early neurorehabilitation conducted by physicians, nursing staff, physical therapist, occupational therapist, speech therapist, psychologist and others, including the patients family or caregivers. Stroke rehabilitation is multidisciplinary and has the goal of maximizing function, minimizing impairments, and preventing poststroke complications [8,9]. Unfortunately less is known about the specific or combined interventions and care practices that contribute most to improved outcome [10]. An optimal treatment for patients who had a stroke could not be identified so far, also due to the fact, that only few studies address the question of the optimal physiotherapy in stroke rehabilitation. Furthermore the scientific evidence in stroke rehabilitation comprises of a big amount of methodical incorrect rehabilitation trials [11]. Physical therapy is a complex intervention and many factors may greatly influence outcomes [12].

Most studies on stroke recovery and neurorehabilitation have been conducted in so-called chronic patients, with stroke onset more than 6 months before, probably because these patients are easier to recruit and have a stable baseline [13]. Only few recovery trials have initiated restorative treatments within 7 days [6] after onset and can therefore be classified as acute, as proposed by experts in stroke

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Table 1: Inclusion and exclusion criteria (Vojta Stroke Trial).

Inclusion criteria	Exclusion criteria
Adults (> 18 years)	Participation on another clinical trial
CT* or MRI** proven acute ischemic or hemorrhagic stroke within 72h after onset of symptoms	Severe cognitive impairment due to aphasia or dementia, prohibiting that physiotherapeutic challenges can be understood.
Severe hemiparesis (medical research council scale for muscle strength ≤2)	Pregnancy
premorbid modified Rankin Scale (mRS) ≤3	
maximum National Institute of Health Stroke Scale Score (NIHSS) 25	
Voluntary written consent by the patient	

CT=computed tomography; MRI=magnetic resonance imaging.*

rehabilitation [14]. There is an ongoing debate about the optimal timing of rehabilitation, although starting rehabilitation early is a widely accepted principle of care for people affected by stroke [15]. Stroke rehabilitation begins during the acute hospitalization, as soon as the diagnosis of stroke is established and lifethreatening problems are under control and there is a growing evidence indicating better outcome of neurorehabilitation in stroke with early initiation of treatment [16]. Delays to the initiation of rehabilitation seem to be associated with a poorer outcome and a longer length of stay in hospital for patients [17], furthermore motor training started around 5 days after stroke is more effective than training started at day 14 or day 30 [18].

The Bobath Concept in Stroke Rehabilitation

Another key question concerning physical therapy in stroke rehabilitation does not apply to timing and duration of therapy, but to the crucial issue of the right approach: which one to use out of the plenty currently available rehabilitation methods. Furthermore the question arises, whether an "ideal approach" is reasonable for all patients who had a stroke with manifold deficits and disabilities in a heterogeneous collective. Numerous meta-analysis and reviews have been conducted in order to evaluate different rehabilitation techniques, however the randomized controlled trials (RCT) that were considered in systematic reviews only contain a small proportion of methods that are used in routine clinical settings.

The Bobath-concept is one of the most widely used approaches in stroke rehabilitation within the western world, although several studies have failed to demonstrate superiority and showed partially even inferiority compared to other physiotherapy approaches [19-21]. In northern America and Scandinavia the Brunnstrom method is more common. Concepts, as well as the proprioceptive neuromuscular facilitation (PNF) and Vojta method have in common that they claim to have a neurophysiological basis, in which facilitation and inhibition play a basic role. The concept of neuronal reorganization aims at preventing the development of pathological movements by recognizing variations of "normal central postural control mechanism" regulations [22]. The Bobath concept was developed from the 1940s on by the physical therapist Berta Bobath and the physician Dr. Karl Bobath. The Bobath treatment aims at normalizing muscle tone and facilitate volitional movement through handling of specific points (trunk, pelvis, shoulders, hands, and feet) in order to guide patients through the initiation and completion of intended tasks [23]. Both, the patient and the therapist need to participate actively during the treatment. Several trials for rehabilitation of upper limb motor impairment in patients with an acute, subacute or chronic stroke indicated, that Bobath therapy is similar or inferior to other rehabilitation approaches (as meaningful task-specific training, constraint-induced movement therapy, motor relearning program, movement science-based physiotherapy). Therefore the Bobath concept has been criticized and at present there are insufficient arguments for integrating Bobath therapy into stroke rehabilitation [23]. As knowledge of neurophysiology has changed, it is no surprise that some of the former explanations may sound outdated. But several modern principles of plasticity and learning can be identified in the concept. Modern approaches follow the idea that functional improvement to a large extent relies on the use of compensatory movement strategies, enabling patients to learn to cope with their deficits.

Vojta Therapy

The Vojta therapy is a type of physical therapy, also called reflex locomotion or Vojta method. Václav Vojta was a Czech neurologist and pediatric neurologist and was born on the 12th July 1917 in Mokrosuky, Bohemia, the Czech Republic. He died on the 12th September 2000 in Munich. Vojta developed the bases of his diagnostics and therapy, between 1950 and 1970, while looking for a treatment for children with cerebral palsy. He observed that these children responded to certain stimuli (gentle pressure placed at specific zones) in certain body positions with recurring motor reactions in the trunk and the extremities. He could activate muscle groups and patterns of movements that were normally not available to the patient and discovered, that children with cerebral palsy treated with this method exhibited better gait, better posture and better speech after therapy [24]. He described inborn global motor patterns of reflex locomotion that are retrievable at all times and can be found in all forms of human locomotion representing the basis for human movement. He assumed that the therapeutic use of reflex locomotion enables elementary patterns of movement in patients with impaired locomotor system, for example due to brain damage by stroke, to be restored, assuming that repeated stimulation of these "reflex-like" movements can lead to something like "new networking" within functionally blocked neuronal networks.

The therapist can activate these innate patterns of movement, by applying pressure to pre-defined zones, in a patient who is in a prone, supine or side lying position. Such stimuli automatically lead to an automatically movement complex in newborns and also in adults and does not require actively willed cooperation. There are ten zones distributed over the trunk, the arms and legs [25-27]. Dependent of the stimulated zone the therapist can provoke regardless of the patient's age a type of creeping movement and rolling, the so called

Table 2: Assessment tools for the Vojta Stroke Trial.

Test	Abbr.*	Tool for…	Range/Scores	Lit.**
Trunk Control Test	TCT	Validated test to assess motor impairment and postural control after stroke	A range of 0 (patient is not able to turn around at all in lying position) to 100 (patient is able to sit for 30 seconds independently on the edge of the bed) points can be achieved	[53-56]
Motor Evaluation Scale for Upper Extremity in Stroke Patients	MESUPES	Clinical and research tool to qualitatively evaluate arm and hand function during recovery after stroke, comprising of 17 items pertaining to arm (8 items) and hand (9 items) performance.	The whole tests takes up to 30 minutes, wherefore we performed in our trial items 1 to 4 of the MESUPES-arm. Furthermore only the first 4 items are performed in lying position, so that even severe effected patients were able to perfom the task. A total score of 20 can be achieved with a range of 0 (indication no movement and no tonus adaption to a passive movement) to 20 (indicating an independing arm movement).	[57,58]
Catherine Bergego Scale	CBS	Standardised checklist consisting of 10 items to assess the presence and extent of neglect in patients with stroke and hemispatial neglect,	Uses a 4 point rating scale for each item (0 indicating no neglect and 3 indicating a severe neglect). In order to spare our patients we abbreviated the CBS and assessed only item 5 and 6. This results in a total score of 6 (0 no neglect, 6 severe neglect).	[59,60]
National Institutes of Health Stroke Scale	NIHSS	Quantitative measure of neurological deficit in stroke patients	The 15 items score ranges from 0 to 42, higher scores indicating a more severe neurological deficit and a greater stroke severity	[61-63]
Modfied Rankin Scale	mRS	Categorises level of functional independence with reference to pre-stroke activities	Ordinal scale ranging from 0 (no symptoms) to 5 (severe disability), with a score of 6 allocated to patients who died.	[64,65]
Barthel Index	BI	Validated measure of disability assessing 10 items of daily life and mobility activity	A total score ranging from 0-20 (lower scores indicating increased disability, 20 indicating all activities performed).	[66-69]

*Abbr.= Abbreviation; ** Lit.= Literature.

"reflex creeping" or the "reflex rolling". Based on the principles of ontogenetic development he defined the postural regulation as a control of body posture and uprighthing of the body against gravity as elementary components of locomotion, as well as goal-oriented movements of the limbs. Vojta believed, that every accurate movement starts from a definite posture and ends in a posture [28], conceding postural control one of the most important goals of therapeutic use of Vojta therapy.

Initially Vojta therapy was applied mostly for newborns with central coordination disorders or spastic movement disoders. Nowadays the neurokinesiological examination techniques are commonly used in pediatrics in order to recognize early motor developmental disturbances in newborns, babies and infants (some times even before they are clinically visual), because an early diagnoses of motor developmental disturbances allows early initiation of therapies, preferentially within the first 6 months of life, and an early treatment offers the best chances of recovery.

Although Vojta reflex locomotion is a sufficient therapeutic method for the promotion of normal posture control and the direct activation of respiratory muscles in children with cerebral palsy [29,30], its application in other diseases has not been studied sufficiently [31].Vojta reflex locomotion has been reported to activate trunk and the deep muscles of the spine to regulate trunk stability and increase spinal rotation force, thereby enhancing postural control [31]. It is widely-used in adults, but concerning neurological diseases there is only some evidence for patients with multiple sclerosis [32] (indicating a positive effect of Vojta therapy) and for patients with paraplegia [33,34].

Vojta in Stroke Rehabilitation: Why?

In newborns with motor developmental disturbances an early initiation of a suitable therapy is highly recommended to prevent the appearance of incorrect movement sequences. For the same reason we think that it is beneficial to start Vojta treatment early after stroke. Furthermore observations in animal models suggest that there is about a month of heightened plasticity in the brain early after stroke, when most recovery from impairment occurs [9,35]. Therefore, there seems to be a limited time window for the greatest motor recovery and increased receptivity to training regimens in stroke rehabilitation.

In 2013 we implemented Vojta therapy into the established treatment concept (predominantly Bobath concept) on our stroke unit. We observed that Vojta therapy improved efficacy of other approaches, working with repetitive exercises by activation of automatic movement patterns and lead to an improvement of postural control, uprighting against gravity and target-oriented movements. Directly after Vojta therapy stroke patients showed an improvement of the posture and movement patterns that showed definable consolidation tendency after a few days on the stroke unit. As an early effect we observed muslce fasciculation in the motoric target area -even in plegic limbs, appearance of movement sensation in neglect regions, as soon as vegetative (piloarective, vasomotoric, sudomotoric) reactions in the therapeutic area. Patients reported of sensoric effects as a heat sensation projected to the periphery, suggesting a systemic effect of Vojta therapy. These clinical observations motivated as to further investigate Vojta therapy in stroke rehabilitaton. To our knowledge Vojta therapy has never been investigated in stroke patients.

Spacial Neglect – A Common Symptom in Stroke but Difficult to Treat

Spatial neglect is a common (in 43% of right brain-lesioned patients and 20% of left brain-lesioned [36]) syndrome following stroke, most frequently of the right hemisphere, predominantly but not exclusively of the parietal lobe. Elements of spatial neglect may also be seen with infarctions of the left hemisphere; however, symptoms are clinically less consistent than in right hemispheric neglect [37]. It is a complex deficit in attention and awareness with the failure to detect, respond, or orient to the stimuli located in the portion of space contralateral to the lesion. The therapeutic process is often prolonged, because neglect patients show slower functional progress during rehabilitation and need longer hospitalization [38,39]. In addition to focal disturbances, an interhemispheric imbalance, with over-activation in the intact hemisphere, is supposed to be of predominant clinical relevance for neglect, following the concept of interhemispheric rivalry [22,39]. Some trials therefore investigated the effect of cortical stimulation addressing the contralesional hemisphere overexcitability as a cerebral pathophysiological mechanism in hemispatial neglect. Beside methodological heterogeneity the authors concluded, that there are promising results for theta-burst stimulation, suggesting that transcranial magnetic stimulation may be a powerful add-on therapy in the rehabilitation of neglect patients [39]. There is also some evidence for sub-acute and chronic stages of stroke for prism adaption as a suitable rehabilitative approach in patients with neglect [40], using prism glasses to create an optical shift of the visual field to the right [41]. Treatments for neglect are often difficult to apply in stroke rehabilitation, due to short duration of effects, patient discomfort, or the difficulty for patients to cooperate [39,42], so that there is an urgent need for a suitable therapeutic approach for neglect. We observed a positive effect of Vojta therapy on neglect, but this has not been investigated systematically yet.

TheVojta Stroke Trial

We designed an investigator-initiated, prospective parallel-group, single-center, randomized controlled clinical trial to compare Vojta therapy and conventional physiotherapy in patients with acute ischemic or hemorrhagic stroke. This RCT will be the first trial to investigate improvement of postural control due to Vojta therapy in early rehabilitation of patients who had a stroke, which is a very new approach in stroke-rehabilitation. The aim of the trial was to investigate Vojta therapy in acute stroke patients with severe hemiparesis within 72 hours after onset. We hypothesize, that Vojta therapy improves postural control and motor function in early rehabilitation of stroke patients compared to conventional physiotherapy. This trial is registered at ClinicalTrials.gov (NCT03035968) and we obtained ethical approval from the Institutional Research Ethical Review Board (the Hessian Regional Medical Board; Approval Number: FF 88/2015). All potentially eligible patients were screened on the first day after admission to the stroke unit and during the first 72h after stroke onset, in case of deterioration after admission. Eligible patient with written informed consent were enrolled and randomly assigned (1:1) to receive usual stroke unit care with conventional physiotherapy (control group) or Vojta therapy (interventional group). Inclusion and exclusion critera are summarized in table 1.

Postural control is an important prerequisite for further mobility. Early control of sitting balance as a base for regaining standing balance and afterwards gait is an important factor for the final outcome at six-months [9]. For this reason we decided to choose postural control as primary outcome parameter. The predefined primary outcome is an improvement of postural control measured with the trunk control test (TCT) on day 9 after admission to the hospital compared to baseline (difference in scores on TCT scale between baseline and day 9). The TCT is a validated test to assess motor impairment and postural control after stroke (table 2). Secondary outcomes will focus on improvement of neglect (Catherine de Bergego Scale [CBS]), motor function of the arm (motor evaluation scale for upper extremity in stroke patients [MESUPES], part 1 to 4), neurological deficits (National Institute of Health Stroke Scale [NIHSS] and modified Rankin Scale [mRS]) and daily life activity (Barthel Index [BI]) (table 2). We include the mRS andBI as a secondary outcome, although the European Stroke Organisation Outcomes Working Group [43] recommended the use of the mRS as a primary outcome measure in acute stroke trials.

The effects of the interventions will be analysed by intention-to-treat analyses. For the primary endpoint (difference of scores in trunk control test between day 9 and baseline) an increase of 12 points (=12%) on the scale of the TCT was predefiened as a meaningful difference pragmatically, due to lack of data in the literature, because an improvement of 12 points in the TCT indicates a clinical relevant improvement of self-dependence (i.e. no more need of an auxiliary person, no more need for an adjuvant as edge of bed for moving). All adverse events and serious adverse events are recorded and assessed by the investigators throughout the trial until day 90 according to standard definitions.

Spontaneous Recovery and Brain Plasticity

In clinical practice we can observe, that many patients, who survive a disabling stroke show some spontaneous recovery [9,10], but the neurophysiological basis for this is poorly understood. For a long time it was believed that in the adult brain the nerve paths are fixed and immutable, so that a regeneration of axons and dendrites seemed to be impossible. Nowadays, this paradigm is obsolete; however, the role of neurogenesis in human adult stroke recovery still remains unclear.

Cortical reorganization and brain plasticity seem to be the structural correlates for the intrinsic motor recovery of the central nervous system over the course of time after onset of stroke [44]. Mechanism described as neural plasticity or neuroplasticity have been observed and investigated by different approaches from a clinical to a neurobiological and a neuropathological point of view, including functional changes in the context of learning and recovery and structural changes in the nervous system, including changes in synaptic efficacy, modifying protein synthesis or proteinase activity in nerve cells, creation of new anatomical connections or by altering synapses morphologically, and by specific apoptosis [22,45]. During development the brain shows high plasticity as new connections are formed redundantly and removed through use-dependent processes [35]. There are parallels between motor recovery after stroke (relearning) and the acquisition of skilled movement patterns in human infants (learning) [46], so that cortical reorganization after brain injury due to stroke can be compared to those occuring during physiological development [35]. It is known that the cerebral cortex can reorganize its neural networks [47], but it is unclear how the remapping of lost function is initiated. When the normal input to a particular area of the primary somatosensory cortex is lost because of injury, rapid structural and functional reorganization results in this area being activated by sensory stimulation of the surrounding intact body regions [47]. We propose that Vojta therapy may be such an activating stimulus.

The promotion of mechanisms of neural plasticity in stroke recovery seems to be a key principle of neurorehabilitation, as possible by using stimulation techniques and creating a stimulating learning atmosphere. The latter has been showed in animal models with rats, which had a focal brain ischemia after ligation of middle cerebral artery. Interestingly the rats showed much better recovery when held in an enriched environment with free acess to physical activity and social interactions [48].

In this article we did focus on physical therapy in stroke rehabilitation, however there are numerous approaches with promising results, as non-invasive cortical stimulation techniques with the purpose of enhancing neuroplasticity and recovery. It had been assumed that suppressing the undamaged contralesional motor cortex by repetitive low-frequency transcranial magnetic stimulation (rTMS) or increasing the excitability of the damaged hemisphere cortex by high-frequency rTMS will promote function recovery after stroke [49]. The heterogeneity of trials might have led to the result of meta analysis, hence current evidence does not support the routine use of rTMS for the treatment of stroke [50]. Another approach to support neuroplasticity is a pharmacological intervention in order to influence brain neurotransmitters that have been identified to be related with motor learning.

A beneficial effect of amphetamine in recovery of function was suggested after decades of animal research, but unfortunately more recent studies in both humans and animals failed to show a benefit [13]. Furthermore glutamate, acetylcholine, 5-hydroxy tryptophan, norepinephrine and domapine have been studied but no single medication evaluated for its beneficial effect of modulating plasticity has reached Class I evidence so far [22].

Conclusion

Stroke rehabilitation is challenging and many questions remain unansewered, like the optimal timing and approach or even if an “optimal approach” does exist or is necessary at all [10]. RCTs in stroke rehabilitation are particularly complex [51], and especially early rehabilitation trials that intervene across acute and rehabilitation care settings [6]. There is an urgent need to improve stroke rehabilitation trials methodologically, as in a first step by standarization of outcome definitions and measurements, which would allow pooling data and aiding to perform meta-analyses, as recommended by the Stroke Recovery and Rehabilitation Round table task force [52], in order to improve stroke rehabilitation, because stroke survivors deserve the most effective treatments. In our opinion there will not be an individual approach for motor recovery that is suitable for every patient with stroke. One treatment may be better in the acute phase, another better for severe affected patients in the subacute phase, so that stroke rehabilitation ideally should be tailored for each individual stroke patient. Furthermore we are convinced that a combination of treatment approaches at different time during stroke rehabilitation is useful in order to achieve the maximal motor function recovery for each patient.

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