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POSSIBILITIES FOR REHABILITATION AFTER STROKE

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SUMMARY – The patient's own attitude, activity and social interaction influence functional outcome and quality of life after stroke. Rehabilitation of stroke patients should start as soon as the patient is in a medically stable condition. The concept of early rehabilitation should be provided by an interdisciplinary team, preferably in stroke units. The key of successful rehabilitation is teamwork of the specialist, patient and patient's family. Stroke, within the fixed limits of the brain vascular architecture, is a privileged field of research for the brain-mind correlations and the mechanisms of brain plasticity. Future studies may investigate aspects of cognitive recovery after stroke in individual patients and will relate them to the aspects of brain plasticity where synapses are sprouting. With this in mind, research will tend to elucidate whether cortical maps are enlarging, whether homologous or non-homologous areas are activated, in which hemisphere the lesions do occur, whether they are integrated into cognitive and behavioral models of recovery and if so, should this clarify the restoration or compensation of the normal functions of the brain.

Key words: *Cerebrovascular disorders – rehabilitation; Brain damage, chronic; Brain damage – physiopathology; Brain damage – rehabilitation; Physical therapy modalities*

Introduction

Stroke, or brain damage caused by disturbance in cerebral circulation, is one of the most common causes of mortality and disability in the adult population in contemporary society. In developed countries, there was a drop of mortality from stroke by about half from the seventies and eighties of the last century, mainly due to the suppression of stroke risk factors (e.g., high blood pressure, diabetes, cigarette smoking, etc.), or improvement of therapy for the acute stage of stroke.

Despite modern therapy, stroke results in lethal outcome in 20%, dependence on other people's help in 30%, need of additional treatment and care at specialized institutions in 25%, and bed-ridden condition in 10% of patients, whereas the rest achieve good recovery or remain mildly disabled, within a month after stroke[1].

Stroke sequels are difficult for patients and their families. In many patients, stroke entails paralysis, speech difficulties, memory loss, emotional instability and other disorders. Stroke is definitely not just the respective individual's problem, but also poses great public health burden[2-6].

Principles of Post-Stroke Recovery

For good recovery it is necessary to include biological mechanisms, and also therapeutic use of good rehabilitation that acts on plasticity of the brain and leads to restitution, substitution or compensation, all of these effecting motor control and cognitive functioning.

Restitution is relatively independent of external factors such as physical or cognitive stimulation; it includes biochemical factors with reduction of edema, absorption of blood or restoration of axonal transport.

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Substitution depends on external stimulation, i.e. practical activity of the paretic arm or leg during rehabilitation. Substitution involves functional adaptation to the deficit, through partially restoring neural networks and compensation for the lost or broken connections after injury. Substitution can be a process of partial reorganization of cortical representation for movement and changes in activity in components of the motor network.

Compensation aims to improve the mismatch between the patient's disability and expectations, as well as demands of the patient's environment. Compensation acts upon the locomotor system, and in particular it has an impact on increasing the time, effort and amount of training of the damaged skill[7-9].

Rehabilitation of stroke patients should start as soon as possible, precisely immediately in stroke care units, when the patient is medically stable. Early rehabilitation should be interdisciplinary, it should last at least three hours. It has been previously shown that successful rehabilitation is the result of coordinated teamwork of medical specialist, patients and their families. Previous knowledge of the pathophysiology of stroke recovery suggested that the positive effect of rehabilitation was coming from teaching the patients compensating techniques (for example, usage of the healthy hand in achieving independence) and avoiding intensive therapy of the weakened limb. Current knowledge tells us that the favorable effect of rehabilitation is achieved by repeated participation of patients in the active program of physical therapy, which brings direct impact on the process on functional reorganization in the brain and improves neurologic recovery[10].

Currently, there are two main theories on stroke recovery: theory of collateral branching from intact cells in denervated area and theory of neural pathway activation.

It is considered that there are two mechanisms of recovery of neurologic function:

- termination of the harmful effect of local factors (resolution of local edema, resorption of local toxins, improving local circulation, recovery of partially damaged neurons), which leads to early spontaneous recovery within the first three to six months after stroke; and
- the principle of neuroplasticity of the brain and nervous system, its ability of structural and functional reorganization, which is based on the collateral spread of new synaptic connections and activation of latent functional pathways, taking over functions through alternative neural pathways, reversibility of diaschisis, denervation supersensitivity and expansion of broken proximal axons.

The mechanism of brain plasticity and its recovery depend on a dual mechanism, structural and functional. Structural mechanism involves the creation of fibers of remaining neurons by forming new functional synapses, whereas functional mechanism includes spread of the cortical map by activating alternative neuronal networks (including damaged zone) of the previously functionally inactive pathways. All of these mechanisms of recovery have previously been described in animal models, as well as in humans in experimental setting[11].

Functional neuroimaging studies have revealed that the reorganization after brain injury can be modulated by encouraging and gaining new skills for a long time after brain injury.

These studies suggest that combination therapy, with increasing therapy intensity, improves the success of rehabilitation.

The possible role in functional recovery after ischemic stroke have polypeptide growth factors (bFGF, basic fibroblast growth factor), which stimulate branching of neurons and endogenous proliferation of progenitor cells in laboratory animals. It has already been proven that bFGF dimer, used in subacute treatment (days, weeks) improves neurologic recovery[12].

In experimental conditions it has been demonstrated that some drugs change the levels of specific central neurotransmitters and therefore influence the recovery of brain function after stroke. Substances that reduce the concentration of norepinephrine (alpha 1-blockers, adrenergic receptors, agonists of alpha 2-adrenergic receptor) reduce the recovery, whereas substances that increase norepinephrine concentration (antagonists of alpha 2-adrenergic receptors), i.e. sympathomimetics, enhance post-stroke recovery[13,14].

Rehabilitation of Cognitive Function

Cognitive functions are supported by the mechanism of brain plasticity. Current research suggests that it is essential to identify the type of change and

also the process that caused cognitive dysfunction and indicate either behavioral or pharmacotherapy.

Recovery of aphasia

Aphasia is the most common early cognitive deficit after stroke, found in 20%-38% of patients, whereas in 12%-28% of patients it occurs as a late deficit. Many patients experience spontaneous recovery in the first two weeks after stroke. The most common final recovery is recorded in the first three months, after which the recovery is slow in the next six to twelve months, with a very small number of spontaneously recovering cases. The role of sex is very important and it is well known that women recover better than men in oral production and auditory perception[15,16]. It has been found that higher IQ and a higher level of education increase the recovery of speech. It has also been documented that speech recovery is better and faster in left-handed and ambidexter patients. Some general principles of organization and functioning of the system of speech apply to each aphasic syndrome and depend on the localization of lesions. Understanding and repeating often recover more quickly when the appointment of expressions and speech recovery are slower and often incomplete. Oral pronunciation and language often improve better than written language.

The efficacy of speech therapy is influenced by the usage of early and intensive daily therapy, as shown in a variety of studies. Individual approach is very efficient. New therapeutic options, such as 'constraint-induced therapy for aphasia',

transcranial magnetic stimulation and biotechnological methods for neural regeneration by transplantation of stem cells will significantly influence speech therapy. The idea of treating patients with aphasia using the computer is already twenty years old.

Visuospatial neglect

This syndrome is understood as a consequence of interference of the mechanism of directed attention. Unilateral attention is organized in one functional circuit, and the main relay is the right parietal lobe. Numerous studies indicate the possibility of rehabilitation of patients with a variety of sensory stimulations, such as vestibular and optokinetic stimulation, transcutaneous mechanical vibrations, electric vibrations, prism adaptation, etc.[17,18].

Recovery of visual disturbances

Rehabilitation of patients with visual agnosis is rare. It requires a specific program and demanding individual treatment. Functional program is a compensation for visual exploration and fixation. Rehabilitation of higher visual functions is a new area that combines areas of neuropsychology, brain neurolinguistics and neuroophthalmology[19].

Amnesia

Inability to store and repeatedly use new information as well as memory problems is very common. Pure amnesia without other cognitive damages is rare. Extremely difficult is permanent amnesia, found after bilateral temporal damage involving the hippocampus and cortex in the perihippocampal gyrus. Unilateral damages have less severe and more specific modalities, such as inability to remember names or faces. Spontaneous confabulations appear, patients have good recovery and usually adapt to everyday life, some with full neuropsychological recovery. Unfortunately, rehabilitation techniques do not improve the memory capacity in stable amnesia, so the treatment is focused on new strategies[18].

Recovery of emotional changes

Emotional factors significantly affect the recovery of motor, cognitive and sensory status. Severe mood swings are very important for all neurologic diseases and especially after stroke.

Anosognosis can increase within a few hours of stroke, but the association with neglect is an indicator of weaker functional result, which increases dependence and need for institutional care.

Activation or stimulation of neural networks for emotional processing after right hemispheric stroke reduces facial expression of emotions, voice and mimics and is also less precise in vocal and facial communication. Frequent outbursts of wrath, anger and rage occur when the patient is presented with unsolvable task, especially in patients with aphasia. Post-stroke depression is very often in such patients.

Emotional incontinence, with outbursts of crying and uncontrolled laughter without stimuli, occurs in 40% of patients in the first month after stroke.

Changes in frontal lobe caused by stroke damage, with changes of the serotoninergic system lead to dis-

ruption of the regulation of emotions, with acinesis, apathy, and hypomania. In such patients, the lack of inhibition occurs, along with childish behavior and egocentricity. These disorders have serious consequences and impact on social integration, interpersonal relationships, friendships and cause difficulties in attempts to return to work. Orbital cortex is responsible for social empathy[19,20].

Classic Rehabilitation Services

For many years, rehabilitation consisted of conventional physical therapy, occupational therapy and speech therapy. Physical therapy is based on specific functional training and is conducted through traditional therapy (range of motion, muscle strengthening, mobilization), adoption of techniques and methods by Knott and Voss with proprioceptive neuromuscular facilitation, as well as encouraging specific synergies using cutaneous/proprioceptive central facilitation by Brunnstrom and training of neural development by Bobath[21,22].

Physical and occupational therapy are based on substitutional action of unaffected body parts and biological principles of brain plasticity. Forced movement increases the functioning of the undamaged hemisphere in relation to the weakened body part, whereas 'forced usage' directs patient's attention on the paretic extremity. Functional training of high intensity brings better recovery.

It seems that after staying at a specialized rehabilitation facility, the process of patient rehabilitation process, unfortunately, ends. Today, however, there is an alternative to classic rehabilitation, i.e. tele-rehabilitation, treatment and rehabilitation with the help of computers[23,24].

Rehabilitation is also possible by using so-called 'virtual reality' computer that creates the impression of a real 3D environment. 'Increased learning' is achieved by sending information on the patient's movements to the central nervous system in real time through audio-visual feedback and so individually customized rehabilitation intensity is possible.

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Sažetak

MOGUĆNOSTI ZA REHABILITACIJU POSLIJE MOŽDANOG UDARA

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Na funkcioniranje i kvalitetu života nakon moždanog udara utječu stavovi, aktivnost i socijalne interakcije bolesnika. Rehabilitaciju bolesnika nakon moždanog udara treba započeti odmah kada je u bolesnik u medicinski stabilnom stanju. Ranu rehabilitaciju treba započeti interdisciplinarno, u Jedinicama za liječenje moždanog udara. Pokazalo se da je ključ uspješne rehabilitacije u koordiniranom timskom radu liječnika, bolesnika i njegove obitelji. Najnovija saznanja govore da je oštećenje unutar arhitekture mozga novo privilegirano polje istraživanja, a odnosi se na korelaciju mehanizma moždane plastičnosti s aspekta kognitivnog oporavka u pojedinih bolesnika. Problemi vezani za kognitivni oporavak su nova područja u neurologiji, neuropsihologiji, neurofiziologiji, neurofarmakologiji te neurorehabilitaciji. Budućnost će istraživati gdje sinapse pucaju, povećavaju li se kortikalne mape, jesu li homologna i nehomologna područja aktivirana, u kojoj se hemisferi zbivaju promjene. Rezultati takvih analiza povezuju kognitivne i biheviorale modele oporavka u visoko kvalitetne oblike rehabilitacije.

Ključne riječi: *Cerebrovaskularne bolesti – rehabilitacija; Oštećenje mozga, kronično; Oštećenje mozga – patofiziologija; Oštećenje mozga – rehabilitacija; Oblici fizikalne terapije*