Original paper

Prevention and Rehabilitation, Volume 27, Issue 4/2015, p. 141-147

Neurorehabilitation in traumatic brain deficit syndrome

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Key words
traumatic brain deficit syndrome
- neurorehabilitation
- Barthel index
- proprioceptive system
- bedrest syndrome

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This report provides information about the results of the neurorehabilitation therapy programme for 122 patients with traumatic brain deficit syndrome. The treatment took place at the Adeli Medical Centre and used a special therapeutic programme developed by the Centre. The results were recorded and analysed by the Barthel index. The specialty in application of the therapeutic programme is the duration of the therapy, which runs for up to 6 hours 6 times a week. The treatment was performed by a specially trained team using modern methods of stimulation of the proprioceptive system. By using a training suit developed for astronauts, a permanent stimulation of the proprioceptive system during training is achieved as is induction of the neuroplastic processes in the area of the sensorimotor network (rete) in the brain. Induction of the neuroplasticity together with its processes of short-term and long-term areas may lead in the end to recovery and revitalisation of the motoric functions of the brain, which were lost as a result of a trauma or neurologic disease (e.g. stroke, inflammation). The Barthel index was used to determine the therapy effect. During evaluation of the therapy results, improvement was found in all treated patients, as worsening was not observed. The categories of dependencies in the basic activities of everyday life used in the Barthel index shifted generally in a positive direction. The objective of the presented report was to find out the effects of the applied special therapeutic programme and demonstrate its efficiency. The negative effect of the immobilisation syndrome (bedrest syndrome), which occurs in the case of long-term reduced physical activity, was mentioned only briefly.

In this report, an effect of the neurorehabilitation treatment in traumatic brain deficit disorders is reported as using the Barthel index.

122 patients with chronic traumatic brain injury were treated at the Adeli Medical Centre (AMC-P) with their established therapy program. The specialty is the duration of the treatment, which is carried out up to 6 hours daily 6 times a week, performed by a specially trained team with modern methods, with stimulation of the proprioceptive system. As a result, in all treated patients an improvement was to be found, while no worsening was observed.

Using the Barthel index, it was demonstrated that many patients shifted into a better dependence group. The negative impacts of the bedrest syndrome are primary muscular atrophy, polyneuropathy, and the symptoms of the posterior column, as well as joint disease and spinal defects. The effect of stimulation of the proprioceptive system is caused by the influence on the feedback system of the motor and adjustment of motor networks, with simultaneous activation of several other major areas of the brain including the thalamus and the cerebellum.

Introduction

The requirements concerning rehabilitation after acute diseases could be derived from the Hippocratic principles laid down in the categorical edict: “Doctors must do everything in order to relieve the patient's pain and restore his/her health”. This appeal results in a clear requirement, which has to be understood in line with the current medical opinion, as well as an obligation to provide rehabilitation.

ISSN 0937-552X

DOI 10.5414/PRX00483

In the case of early neurological rehabilitation after acute damage to the central nervous system, the earliest possible start of the treatment programme is indisputable, yet the relevant institutions have not so far developed detailed recommendations for the further rehabilitation process [3]. What is certain is that, whatever the neurological deficits are, there are no time limits [8]. The presence of a positive rehabilitation potential is decisive. The repetitive neurorehabilitation system represents the organisational basis for the following treatment procedures, the aim of which is to alleviate or, in the best case, remove the residual deficits persisting even several years after the onset of the acute damage. Patients who were admitted to the repetitive rehabilitation programme mostly had serious acute brain damage and a longer timely rehabilitation phase, or their rehabilitation results were accompanied by some complications. Moreover, in those patients, mostly regardless of the cause of their acute injury, symptoms of an immobilisation syndrome developed during the previous therapeutic phase, which is an additional problem for the planned course after treatment.

Patients and methodology

The following report details 122 patients with traumatic brain deficit syndrome caused by injuries of the skull and brain.

Despite early rehabilitation being provided in different neurorehabilitation centres, which the patients had undergone 6 month to 2 years ago, in all 122 patients more or less significant residual deficits persisted. The Barthel index was used as a measure of restriction to determine the scope and restriction of mobility as well as to assess the effect of the treatment achieved by the therapeutic programme used [3]. Cerebral deficits, as well as disorders caused by disturbances of higher brain functions, such as perceptive aphasia or a syndrome of the frontal lobe, manifested by apathy and impaired acceptance of the required activities, are included, in addition to motoric disorders in the form of spastic and flaccid paresis in the physical deficits.

The severity of an acute brain injury, nor the possible after-acute complications or possible secondary injuries of the brain due to the bedrest syndrome, are not taken into account in classification of the existing deficits and their negative impact on the Barthel index. [1].

In order to assess a previous brain injury caused by a violent action on the skull, we provide a brief summary of pathophysiological processes and their morphological consequences.

Traumatic injury of the brain tissue was in these cases caused by a directly violent action on the brain (gunshot wound, etc.) or by a transfer of intracranial pressure [2]. Selier and Unterharnscheidt [9] thoroughly studied the gradient of the violent action taking place in the cranial cavity on the model of a skull and evaluated if it corresponded to the relevant rules. Grcević [5] and later Jellinger [6], on the basis of the morphological examinations, developed a model of lesions in traumatic brain injury, which was caused by a violent action on the skull. According to the current state of knowledge about the effects of this violent action, the consequences of brain damage depend on the place and direction of the violent action and its intensity. The resulting injuries affect the brain tissue and the relevant meninges and vessels supplying the brain. The surface of the brain's cortex is affected primarily. The resulting injury extends in the shape of a funnel into the depth. Depending on the direction and intensity of the violent action, a lesion is formed, which is referred to as coup or contre coup brain contusion. With regard to the intensity and direction of the violent action, laceration (tearing) of the brain or direct injury of the brain stem may occur.
From the histomorphological point of view we distinguish primary traumatic brain injury, which corresponds to the irreversible lesion of the tissue and occurs together with a violent action.

The primary injury is accompanied by secondary consequences in the penumbra, the surrounding tissue, which is caused by various pathophysiological processes (accompanying oedema, congestion disorder, local bleeding). Traumatically induced secondary injury in the penumbra represents a “battle field” for the acute therapy of a brain injury.

In addition to primary and secondary brain injuries, local as well as regional lesions of the brain tissue originate as a result of indirect injuries caused by disorders of the blood supply. Another form of lesion may be demonstrated as having consequences after local or diffuse cerebral brain oedema together with an additional injury of white as well as grey matter.

A specific risk during traumatic injury of the skull and brain, however, originates due to an increase of the volume caused by brain oedema or intracerebral bleeding, sometimes in combination with an extracerebral haematoma. As a consequence, there is brain matter movement and constriction in the tentorium and foramen occipital magnum. Acute mesencephalic syndrome and in the worst case acute bulbar syndrome, which is associated with breathing trouble or ventilatory standstill, are feared and sometimes unmanageable complications often only of small violent actions on the skull followed by apallic syndrome [1].

As is clear from the overview of the health consequences, after a traumatic skull and brain injury it is possible that a series of lesions with different acute symptoms accompanied by many clinical failures may originate. One of the basic tasks of the human brain is movement and responsibility for posture, however, in the case of various symptoms of traumatic skull and brain injury, motor disorders are mostly at the forefront of a persistent deficit or these represent the most serious subsequent complications.

Treatment programme and analysis of 122 patients with traumatic brain deficit syndrome controlled by the Barthel index

This report examines an evaluation of data concerning 122 patients with traumatic brain deficit syndrome obtained by the Barthel index.

The patients completed follow-up treatment in the Adeli Medical Center in Piešťany, Slovakia (AMC-P), using the framework of the repetitive rehabilitation system. Each patient participated in a 3-week therapeutic course during which they attended a carefully prepared individual rehabilitation programme tailored to their deficit. The Barthel index was investigated upon admission and when the patient was released [7]. The type and severity of the existing deficit symptoms were not specifically taken into account, corresponding to the basic principles of the Barthel index.

A number of detailed therapies and the estimated time needed for their implementation according to the principles of the Adeli Medical Centre were included in the concrete individual rehabilitation programme for individual patients. Experiences of relatives from previous therapies are always included in the programme. The rehabilitation programme is implemented in a defined number of detailed therapies and in the planned time needed for their implementation by the multidisciplinary team, which is led by a specially trained neurologist, and 2-4 physiotherapists take care of each patient in line with the detailed requirements of the programme. In addition, the therapeutic team also includes a masseur, speech therapist and a specialist in reflex therapy. The length of the therapy for each patient is set for 4.5 to 6 hours a day. The therapy takes place 6 days per week. Each patient undergoes therapy in individual therapeutic areas for 30 minutes on average. The basic programme also includes a full body massage lasting 40 minutes daily. In addition, hot and cold compresses and sulphur mud wrappings are applied, lasting 20 minutes daily.

Each patient underwent manual therapy every second day, which lasted for 30 minutes and aimed to mobilise their joints, limbs and spine.

A very important point in the therapy in the Adeli Medical Centre, in addition to various methods for simulation of the proprioceptive system, is the use of a suit created as a result of space technology, which is used by Russian astronauts on their long-term flights into space. In addition, the Galileo method and therapy on vibration platform was used in the therapeutic programme in individual patients. The scientific nature of this therapy is based on the knowledge of the effect of activating the sensorimotor areas of the upper brain through stimulation of the proprioceptive receptors, as proved by Golaszewski et al. by relying on the help of functional magnetic resonant tomography. If necessary, speech therapy of 40 minutes is possible. A biological feedback was also carried out based on an encephalogram and lasted 40 minutes.

The doctor responsible for the team decides on the course of therapy and the application of individual additional therapies, based on consultations with the team members. A neurologic check is planned for each patient once a week. Family members also participate in team meetings.

Barthel index

The Barthel index is a simple and workable evaluation process which classifies the patient's abilities to perform the basic activities of daily life [7]. It is used for the systematic recording of self-sufficiency or need for care. Originally, the Barthel index was developed by the doctor Florence I. Mahoney and the physiotherapist Dorothea W. Barthel in Baltimore, USA, in 1965 as a dependency index of patients with neuromuscular or musculoskeletal diseases in order to determine their movement restrictions. The Barthel index is used as an assessment of the need for care.

The doctor or the medical staff will assess 10 various "activities of everyday life". They award points; the minimum is 0 (needs complete care) and the maximum is 100 (self-sufficiency). The patient can be classified in an assessment of their level of dependency as highly dependent – up to 40 points, patient with moderate dependency – 45-80 points, slightly dependent – 85-95 points and independent – 100 points.

However, the informative value of the Barthel index is limited. The value of 100 points tells us that the patient is able to perform all activities listed in the scoring. However, it is not possible to deduce out of this if the patient is able to live independently and be responsible for himself/herself. More complex activities of everyday life, such as shopping, housekeeping or managing an office are not included in the Barthel index.

Evaluation results of the Barthel index in treated patients

Data on about 122 patients with traumatic brain deficit syndrome obtained through the Barthel index are graphically shown in Figure 1 and in Table 1. The analysed collective of patients may be divided according to their level of severity into three groups: high, moderate and low levels of dependency. The values of the Barthel index for individual groups are shown separately. The average value of the Barthel index at admission to the Adeli Medical Centre for the whole collective of patients was 56.6 points. The average value of the group at the time of release of the patients after completion of the therapeutic programme was 66.4 points – moderate level of dependency. In particular, it should be noted that the Barthel index did not worsen in any of the patients. The effects of the treatment programme can be assessed only as positive. While assessing the Barthel index values it was found that before the completion of the therapeutic programme there were, according to the Barthel index, 40 patients who were highly dependent, and 10 out of these patients had experienced a significant improvement when they reached the nearest high level with a difference of 10 points at the end of the therapy; these were classified as patients with a moderate level of dependency – Barthel index 45-80. After the treatment, out of 51 patients with a primarily moderate level of dependency 10 showed light dependency according to the Barthel index – value 85-95, and their dependency decreased by 10 points. In order to show the improvements in all three groups of dependency, the average Barthel index was used for each group at their admission.

The Barthel index values at the time of admission to the Centre and the therapeutic programme were compared with the average values after finishing the neurorehabilitation programme. Analysis of the results of the averaged values of the Barthel index and the change of values after the treatment programme are graphically shown in Figure 1 and completed in Table 1. The chart shows that there was a significant change in all 3 groups of dependency according to the Barthel index after the therapeutic programme was completed.

The values in the table represent the numerical evidence.

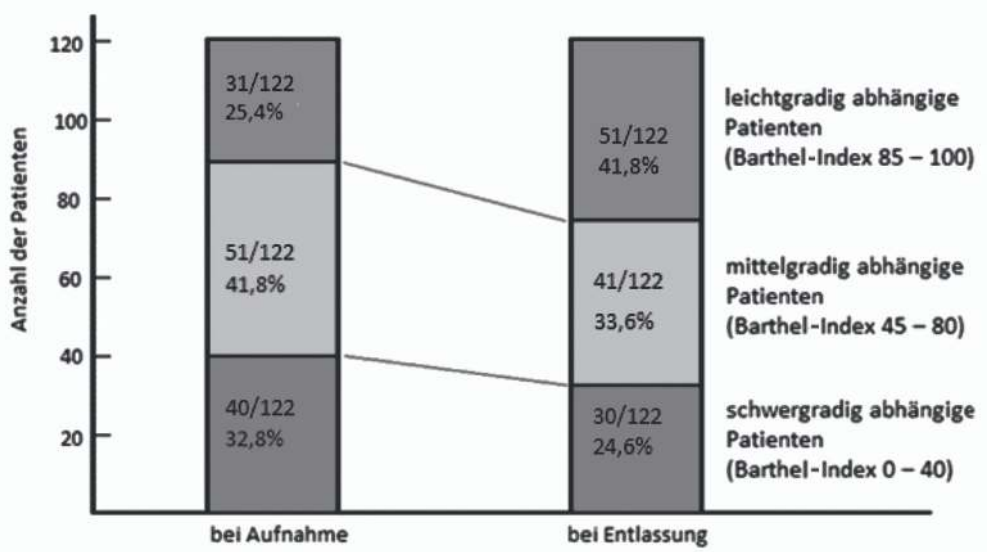

Figure 1 Barthel chart to show patients with high level of dependency (Barthel index 0-40 points, below), patients with medium level of dependency (45-80 points, in the middle) and patients with low level of dependency or independent patients (from 85 points, on the top). The left column shows division at the time of admission to the Adeli Medical Centre; the right column shows division at the time of their release. At the time of admission (the left column), 40 patients were highly dependent (below), 51 had a moderate level of dependency (middle) and 31 had a low level of dependency (at the top). At the time of their release (the right column) only 30 patients were already highly dependent (below), 48 had a moderate level of dependency (middle) and 44 had a low level of dependency (at the top).

Tab. 1. The illustration of the number of patients in table in individual groups was divided according to the level of dependency at the time of admission, which was determined by the Barthel index (group 1: highly dependent patients (Barthel index 0-40 points), group 2: patients with moderate level of dependency (Barthel index 45-80) and the group 3: patients with low level of dependency (Barthel index 85-100)). The right column shows moderate and average values of the Barthel index of those patients in individual groups at the time of admission and at the time of release from the Centre.

Barthel index		Number of patients			Barthel index	
		0 - 40	45 - 80	85 - 100	Median	Mean
Group 1	**upon admission**	40	0	0	10	16,18
Upon admission of high addiction patients	**at release**	30	10	0	15	22,84
Group 2	**upon admission**	0	51	0	65	63,30
Upon admission of patients with a moderate addiction	**at release**	0	38	13	70	74,36
Group 3	**upon admission**	0	0	31	90	91,39
Upon admission of patients with a light addiction	**at release**	0	0	31	100	98,19

Discussion of results

The assessment of the data obtained by the Barthel index generally states that in 122 patients with persisting complications after traumatic brain deficit syndrome who were treated at the Adeli Medical Centre achieved a high positive effect of the treatment. The Barthel index was used by all patients in order to assess their deficit of abilities to perform activities of everyday life, as well as to assess the positive effect of the treatment consisting of a special therapeutic programme. Various motor disorders and associated load, as well as the need for nursing care were assessed. During the assessment, attention was not paid to individual details. All patients had already gone through previous therapy during the early rehabilitation phase. Symptoms of the bedrest syndrome occurred in some of the patients.

In order to explain the positive results of the therapy at the Adeli Medical Centre, several approaches exist and will be described in detail below. The most important is a thorough treatment programme individually developed for each patient and administered by a therapeutic team consisting of therapists educated in physiotherapy, with 2-4 trained therapists working under the supervision of a neurologist who specialises in neuro-rehabilitation and is responsible for implementation of the programme.

The time devoted to the treatment is very important. Each patient underwent a treatment programme of approximately 6.5 hours per day. Individual parts of the therapeutic programme were divided during their administration and the tiredness factor was taken into account. The daily programme was administered 6 days a week.

When applying the treatment methods, it is in principle a stimulation of the proprioceptive system and these therapeutic methods are used in addition to vibration technology, which is also a direct stimulation of receptors.

A special point in providing neuro-rehabilitation in the Adeli Medical Centre is the use of an individual programme developed especially for each patient, which takes into account his/her special neurological deficits. When developing the programme, experiences from previous neurorehabilitation therapies, as well as integration of information from their family in order to harmonise the treatment effect, were deliberately included.

The permanent basic stimulation of the proprioceptive system used a suit developed for astronauts, which the patient has on during the whole treatment. Each movement, active as well as passive, goes against the basic resistance resulting from the construction of the suit. From the neurophysiological point of view it is assumed that the sensorimotor network will be activated. During each move, a mechanical tension arises in the involved joints, which causes stimulation of the Golgi receptors in the articular capsule and thus an increased input into the cortical projection areas of the Ib fibres. Another input into the projection areas I and II fibres arises by irritation of the involved system of stretch receptors when overcoming the blocked functions of the joints.

Moreover, the Ruffini receptors of joints are stimulated through the mechanical load, which re-initiates the increased proprioceptive input into the sensorimotor cortex. A permanent stimulation of the sensorimotor network in the brain during the training, produced by the training suit, may lead to reorganisation processes in the brain through the processes of short-term and long-term neuroplasticity and also to restoration and revitalisation of the motor functions of the brain that were lost due to trauma.

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