

## Peculiarities of physical therapy for patients after traumatic brain injury

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**Key words:** traumatic brain injury, rehabilitation, physical therapy.

**Summary.** Literature review data about methods and means of physical therapy for patients after traumatic brain injury is presented in this article. Traumatic brain injury is an urgent medical and social problem all over the world. It is the most common cause of disability in Lithuania. Patient rehabilitation after traumatic brain injury is divided into two periods: acute and subacute. In the beginning of rehabilitation physical therapist evaluates patient's functional status, later he uses methods and means of treatment, and evaluates effectiveness of rehabilitation. Early verticalisation is very important for patients with coma. Physical therapy consists of prevention of complications, improvement of muscle force, and range of motions, balance, movement coordination, endurance and cognitive functions. Early rehabilitation is necessary for traumatic brain injury patients and use of physical therapy methods can help to regain lost functions and to come back to the society.

The progress of modern technologies, rush in many spheres of life, higher speed of motor vehicle, hooliganism, and alcoholism increase the number of accidents. S. T. Dawodu (1) performed research on etiology of brain injuries and concluded:

1. traumatic brain injury (TBI) is one of the most common causes of death and takes the third place in total mortality structure (after cardiovascular diseases and cancer);
2. in United States 25–35% of injuries occur during alcoholic intoxication;
3. due to TBI, about 52 000 persons die annually in the United States. The mortality rate at the hospital reaches 6 cases per 100 000 population, while outside the hospital this rate is 17 per 100 000. The incidence of mild TBI is 131 cases per 100 000 population, moderate TBI is 15 per 100 000, and severe TBI is about 14 per 100 000 population;
4. men are approximately twice as likely to sustain TBI as women. The highest risk of TBI peaks among the individuals aged 15–30 years;
5. motor vehicle accidents are the leading cause of TBI (approximately 50%), the second leading cause are falls (20 to 30% of all TBI), and the third leading cause are firearms (12%), assaults and sport injuries. Mostly brain injuries are mixed

(30 to 70%), most common of which – facial, extremities, thoracic and abdominal injuries.

6. During the last two years in the United States a number of persons injured due to car accidents decreased, however a number of firearm injuries increased.

According to E. Jaržemskas, annual incidence of traumatic brain injury in Lithuania is 3 per 1000 population for children and 4 per 1000 for adults (2).

A. Kriščiūnas and A. Juocevičius (3) conclude, that in Lithuania one of the most common causes of disability are movement disorders due to diseases and injuries. They indicate: in incidence structure of disabilities among able-bodied population for the year 2000, injuries, poisonings and other negative outcomes due to external causes amounted of 10.9%. Total incidence was 2069 cases. Unemployment due to long-lasting injuries in 2000 was recognized for 1945 persons (and that is more than 25%), most of them – young- and middle-aged people. Authors point out these problems, emerging while carrying rehabilitation for patients after injuries:

1. too small number of patients after injuries profit rehabilitation at available rehabilitation institutions: patients after injury counted only for 2.2% of all patients who received rehabilitation, al-

though usually it should count for more than 10%;

2. insufficient rehabilitation of patients after injury;
3. development of rehabilitation services for patients after injury is restricted due to small number of qualified rehabilitation specialists. This issue is most relevant for outpatient rehabilitation;
4. insufficient production and equipment of orthopaedic tools;
5. insufficient social and vocational rehabilitation for patients after severe injuries.

C. Boake, E. Francisco and S. Kothari (4) classify the rehabilitation of patients after traumatic brain injury into two groups: acute (until patient's condition gets stable) and subacute. In physical therapy for patients after traumatic brain injury they emphasize: more attention for separate activities; tasks facilitation in order to succeed; adjustment of setting for better movement and communication of patient; routinisation of practice for separate activities; focus on specific goals; control of patient's daily activities; planning the goals for next stages; setting feedback; using illustrations; and evaluation of physical therapy effectiveness.

Authors mention (4), that most natural physical therapy procedures are walking in the floor, going in and out of elevator, upstairs and downstairs, and also – adaptation of environment (setting). This source emphasizes the following needs: to analyze environmental factors having positive or negative influence on patient's daily activities; to eliminate negative factors; and to evaluate the effectiveness of environment changes.

Physical therapist, by evaluation of patient's functional state, must estimate disorders of biosocial functions; general clinical state; and specific state (5).

Author recommends estimating biosocial functions (orientation in environment and time, ability to perceive and to deliver information, self-care, motion, hearing, seeing etc.) by using Barthel index, functional independency test, and mini mental state examination (MMSE). These tests enable to evaluate the effectiveness of complex (integrated) rehabilitation. For clinical state estimation relevant points are: physical activity tolerance; condition of autonomic nervous system; anatomic and structural changes of heart; coronary deficiency; arrhythmia and heart conduction disorders; heart deficiency; patient's orientation, attention, cognition and perception skills; and treatment.

For specific state evaluation it is relevant to get anamnesis and to collect objective data about pa-

tient.

B. Durward (6) described the features of physical therapy for patients after traumatic brain injury at East Scotland neurosurgery hospital. He mentions two main directions of physical therapy after TBI: improvement of recovery of normal motoric activity; and prevention of complications.

Essential for patients is training of balance control, especially balance by sitting and standing. Author suggests patient's verticalisation, even if the patient after TBI is still in coma. Movement and motoric control disorders depend on severity of injury. Identification of wrong (irregular) movements is the task for physical therapist, which has to choose appropriate physical therapy in order to avoid such irregular movements and positions. Movement treatment stimulates the sensation abilities of coma patients, suffered from severe traumatic brain injury. By doing exercises patients often open their eyes. Even the speech of physical therapist during procedure could have stimulating effect. During the exercises, patient's breathing can get deeper, what positively influences respiratory system, especially if the patient has undergone long-lasting intubation.

B. Durward (6) notes, that the technique of muscle tone reduction consists of slow tension of hypertonic muscles and passive rotative waist movements. Patient being in coma is laid on verticalisation table, which gradually is verticalised and patient gets standing position. Main principle of physical therapy is, that separate body segments are moved and through it their position is changed. This way is easier for patients to hold sitting or standing position. External aid of physical therapist, which is on attendance while patient is sitting or standing, enables observing and correcting patient's balance. This technique is related with Bobath method. Patient's body segments are moved by physical therapist, which controls the positions of waist, knees, shoulders and pelvis. Together specific waist movements are performed.

F. Khan et al (7) indicate, that traumatic brain injury has influence on a rise of such factors like weakness, rigidity, reflex hyperactivity, ataxia, tremor, dyskinesia, and sense disorders. Many patients suffer from musculo-skeletal, respirative, cardiovascular system, metabolic disorders, what restricts their daily activities and abilities. Physical therapist should understand pathophysiology of injury, patient's adaptive abilities and be aware of how to compensate lost abilities for daily activities. Special interest should be devoted to the training of sit-

ting-standing, walking, reaching things and manipulating them.

Due to cardiovascular disorders, not every patient after brain injury could be actively rehabilitated. Y. Bhambhani et al (8) note, that if possible, before every physical therapy procedure one should measure maximal oxygen consumption ( $\text{VO}_2 \text{ max}$ ).

S. Sullivan (9) proposes, that patients with cardiovascular disorders should be observed during physical therapy procedure, particularly after jumping and walking. During such procedures increases patient's flexibility, force, and coordination. Later those patients turn to fitness clubs. A. Hunter et al (9) suggest increasing  $\text{VO}_2 \text{ max}$  by using treadmill, steps, and veloergometer.

E. Linan et al (10) describe the case, when a man after TBI has been hospitalized for 6 weeks with totally immobile knees (heterotopic ossification). Prescribed physical therapy lasted 4 weeks and included continuous passive movements that increase knees joints' range of motion. After treatment the patient was able to almost independent sitting on bed, and to go without compensating measures. Looking at this case it could be stated, that passive motion can lead to successive outcomes, keeping in mind that it is also safe.

J. Carr and R. Shepherd (11) state that estimation of movement performed in different positions enables to evaluate the force of different muscle groups and disorders of peripheral nervous system. Shortcomings can be viewed during elevating heavy weights and body, looking at personal manner of motion while person is keeping or changing positions. Endurance of muscles can be reduced by long-lasting inactivity, particularly when muscle hypotonus is present. They tried to demonstrate, that patients after traumatic brain injury or stroke suffer from lack of central motion control (warranted by cerebrum) rather than from muscle weakness. Authors note, that lower extremities are crucial in regulation of waist motion. Dysfunctional waist movement, when a person being after traumatic brain injury or stroke tries to move with upper extremities by sitting or standing, indicates that the patient, having motion control disorders in cerebrum, does not manage to change the body's center of mass, because lower extremities are not able to stabilize waist movements. There is also mentioned, that movements' starting and developing is promoted by exercise control, variety of exercises, motivation, awareness about outcomes and setting feedback.

L. Lundy-Ekman (12) states, that while patient performs different actions, ataxia gets obvious. Patient always tries to keep contact with the stable surface by moving from one point to another. Training proprioception relieves stability of position, body's turning and balance reactions. Making the motion easier or harder in such ways like establishment of cranial, truncal or extremities' position, manual control of maxilla and lips, rapid tension and resistance exercises, cryotherapy of lips and larynx muscles are performed in the way that improves motoric control during reaction to sensomotoric stimulation.

J. H. J. Allum et al (13) suppose, that essential for balance control is information from optical and vestibular systems. Additional information is delivered by proprioception and tactile senses.

S. Sullivan et al (14) state, that during upper extremity motion, foremost are activated muscle groups doing purposive movement (i.e. muscle groups of upper extremities), while proximal muscles responsible for holding position (i.e. *m. rectus abdominis*, *m. gluteus medius*, *m. quadriceps femoris*, *m. biceps femoris*) are activated later, when the balance is going to get lost. Hence, a person after traumatic brain injury loses balance quite fast, even by making simple movements.

For a patient, who is starting walking after pause, front-wheel walker helps to keep the balance. M. Wernick-Robinson et al (15) recommend using as stable walker as possible during ataxia. They also point, that ankle- and foot-orthoses for regulation of hypertonus can improve the stability of shinbone by patients with weak feet flexors.

A. Bateman et al (16) recommend for patients after brain injury aerobic training in order to improve endurance.

D. J. Wilson et al (17) examined two groups of patients: the first group consisted of patients who suffered brain injury less than 6 months ago, while in the second group were patients who suffered brain injury more than two years ago. The aim of the study was to evaluate patients' walking abilities. Physical therapy has been applied twice a week. Muscle force, reduced spasticity, and trained balance during standing and walking was improved. For evaluation it was used new scale – MAG (Missouri Assisted Gait), including evaluation of separate gait components. The results showed the improvement of gait in both groups of study.

S. Page and P. Levine (18) described the study, including 3 patients having predominant paresis of

upper extremities after traumatic brain injury. Physical activity has been trained for 4 weeks 3 times a week. One of the measures of physical therapy is position therapy. During the treatment the evaluation was performed through Action Research Arm Test (ARA), Wolf Motor Function Test (WMFT), and Motor Activity Log (MAL), and it showed the improvement of upper extremities function.

G. Shalow (19) observed 6 patients, aged from 13 to 47, who suffered traumatic brain injury 2–7 years ago. They had central nervous system (CNS) disturbance, and motoric, coordination, vegetation and perception disorders. Physical therapy has been applied for 3 months: arm function training, walking and jumping exercises. CNS function improvement reached about 69%. Author emphasizes the need of longer rehabilitation period for patients after brain injury, because the process of emerging of new connections between neurons is relatively long.

S. Blanton et al (20) described 44-years-old patient, who had paralysis of left extremities. It was diagnosed plantar-flexed contraction (31 degree from neutral position). It has been executed crural nerve blockade, adjusted orthose, which has been used 23 hours a day. During reducing of contraction the position of orthose has been set appropriately. Physical therapy lasted 27 days in order to improve mobility and perform traction of plantar flexors without orthose. After treatment the range of passive motion increased by 10 degrees. Consequently, after application of appropriate orthose and providing physical therapy (muscle traction and mobility improvement) it is possible to decrease plantar-flexed contractions.

P. Srigiriraju and N. Rao (21) mention two cases: a man (54 years old) and a woman (48 years old), both after traumatic brain injury, with symptoms of heterotopic ossification in hip joint of paretic body side. Woman's hip flexion range reached 25 degrees, while man's range was 65 degrees. After unsuccessful treatment, which lasted for 6 months, both patients undergone operation, after which hip flexion has been improved: by man – up to 90 degrees, by woman – up to 55 degrees. Three months after operation it was applied intensive physical therapy and woman's hip flexion improved even up to 85 degrees. Thereby early surgical intervention and intensive physical therapy after surgery are useful for patients, having heterotopic ossification.

M. Mayer et al (22) suggest using three-type physical therapy for releasing spastic muscles.

The first type includes physical therapy exer-

cises, when it is performed an opposite action, which decreases the tonus of tense muscle. The movement is done towards the direction where the movement is limited. While doing such exercises it should be observed differences in motion ranges. Authors suggest, that those exercises are particularly effective for patients having spastic extensors of lower extremities. During physical therapy it is recommended to perform: internal rotation and flexion of the hip joint, maximal flexion of knee joint and dorsiflexion of ankle joint. Those positions should be held for at least 30 seconds. After such exercises spasticity of extensors usually decreases, and voluntary movements and gait pattern improve.

The second type includes physical therapy exercises, when it is accomplished short active motion in the free direction, not exceeding 0.5 second. It could be alternatively against mild resistance, followed by 3–4 seconds release and slow stretch into the restricted range.

During the third type of exercise, particular active zones of spastic muscles are stimulated by pressure.

The application of these exercises and its combinations are appropriate against severe extremities spasticity.

L. Zhang et al (23) determined the correlation between exercises performed and decrease of hypertonus. There are used specific movements after TBI for regulation of muscle tone. These motions suppress movements emerging due to wrong spastic. Patient is sitting and doing waist motions backwards and during this procedure are stimulated the muscles, which suppress the activity of waist extensors. Movements suppressing reflexes are very effective when they are concentrated to zones of head and waist and also when those movements are combined with balance-stimulating activities.

According to R. W. Bohannon (24), the mass shift (standing balance) exercises for patients are also useful. During standing, the mass shift center is feet. Such exercises are effective in keeping optimal length of Achilles tendon.

O. Keren et al (25) described the rehabilitation strategy of 22-year-old male, who suffered from very severe traumatic brain injury. On admission to the emergency room, his Glasgow Coma Scale was at the lowest (3), what means total disappearance of motor function. Motor disabilities included weakness in all four extremities, in particular left hemiplegia and right hemiparesis with severe bilateral ataxia and a marked tremor of the right arm. Range of

motion was limited in hips, patient suffered from stiff trunk and neck. Goals of physical therapy were to improve range of motion and to stimulate active movement. Physical therapy measures included orthoses, hydrotherapy, nerve block for reducing spasticity, medication etc. The motor improvement by patient, who is at the moment over 3 years post-injury, still continues and has a functional meaning. Patient is able to stand up from a chair by himself and to walk without orthoses very short distances – up to 5 steps. Marked cognitive improvement occurred as well. It is concluded, that with appropriate measures of rehabilitation and physical therapy it is feasible to recover motor functions. We suggest, that early prognosis of disability is not always meaningful. This case proves the need of occasionally continual, long-lasting and detailed observation and rehabilitation.

S. L. Hillier et al (26) from South Australia concluded, that patients even after several years after TBI have residual physical issues. The study included 67 patients, who sustained traumatic brain injury 5 years previously. It were used personal interview / questionnaire and neurophysical assessment. After brain injury only half of patients had returned to some form of paid work, though over 50% were reliant on welfare system. Considering the physical data of patients, the most frequent residual impairment were headaches, followed by balance difficulties and fatigue / weakness, while 30% had some degree of deficit in upper extremities activities, and 9% required assistance for particular transfer tasks. Overall balance was impaired by 34%, gait was altered by 24% of patients, 9% needed wheelchairs for mobility.

G. Williams and P. Goldie (27) analyzed the prediction of patient's running ability by four specific motor tasks. The study included 40 traumatic brain injury subjects (20 runners and 20 non-runners), who had received greater than 8 months rehabilitation. The four tasks included: bounding onto a leg, balancing on one leg, walking on toes, and stepping backwards up a step. The results showed, that all four tasks were strong predictors of running ability, and the bounding task was the strongest one. Logistic regression indicated, that patients who could execute this motor task, were 24.6 times more likely to be able to run than patients who could not. No statistically significant difference was found between runners and non-runners for group characteristics such as age, severity of injury, time post-injury.

R. S. Tappan (28) made a research in order to evaluate the influence of cognitive rehabilitation on balance training for patients after traumatic brain injury. Researcher used physical therapy for 16-year-old patient after brain injury in order to improve the balance in both quiet and distractive environments. Balance disorders intensified in distractive environment, where the patient could not keep attention and concentrate. The physical therapy included training of balance and cognitive functions. After 11 weeks the patient had fully recovered balance and returned to the school. According to Tappan, patients after brain injury need not only balance training but also cognition and perception training.

C. Boake, E. Francisco, and S. Kothari (4) state, that the purpose of rehabilitation at subacute stage is to help the patient with traumatic brain injury to return into society. Main methods, used in this stage, include technical measures. For such patients it is very useful the group therapy, when attention, memory and other cognitive functions are trained. In recovery process very helpful are family members, who participate in achieving long-lasting goals of rehabilitation. We suppose, that family members involvement in the process of rehabilitation is successful in Lithuania.

All over the world the problem of traumatic brain injury is relevant medical and social issue. Depending on the severity of injury, consequences are various – from recovery to total disability. That is why the patient after TBI needs early rehabilitation, and early physical therapy can improve regaining lost functions and turn back into society as fully-fledged member. Physical therapist works with rehabilitation team and is responsible for prevention of complications, training of muscle force, increasing range of motion, improving balance, coordination, endurance, and perception skills.

Patients after moderate or severe traumatic brain injuries in Lithuania are treated at departments of rehabilitation in neurological hospitals, though it still lacks a unique approach to the methods of rehabilitation and physical therapy for such patients. The reason for it could be the lack in research on physical therapy influence on functional activity of patients after traumatic brain injury. Foreign literature provides more research on physical therapy methods for training of muscle force, balance, range of motion, and endurance, though the data about prevention of complications, physical therapy for coma patients, and prognostic potential is still insufficient.

## Ligonių, patyrusių galvos smegenų traumą, kineziterapijos ypatybės

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**Raktažodžiai:** galvos smegenų trauma, reabilitacija, kineziterapija.

**Santrauka.** Straipsnyje pateikiami literatūros duomenys apie kineziterapijos metodų bei priemonių taikymą pacientams, patyrusiems galvos smegenų traumą. Galvos smegenų trauma visame pasaulyje yra aktuali medicininė bei socialinė problema. Lietuvoje viena dažniausių invalidumo priežasčių – po ligų bei traumų atsirandantys judėjimo sutrikimai. Reabilitacija po galvos smegenų traumų skirstoma į du etapus: ūminį ir poūmį. Reabilitacijos pradžioje kineziterapeutas turi įvertinti paciento funkcinę būklę, po to taikyti gydymo metodus, priemones bei įvertinti jų efektyvumą. Pabrėžiama komos būsenos ligonių ankstyvo vertikalizavimo svarba. Kineziterapija apima komplikacijų prevenciją, raumenų jėgos, judesių amplitudės didinimą, pusiausvyros ir judesių koordinacijos, ištvėmės, suvokimo lavinimą. Galvos smegenų traumą patyrusiam ligoniui ankstyva reabilitacija būtina, o ankstyvas kineziterapijos taikymas gali greičiau padėti atgauti prarastas funkcijas bei grįžti į visuomenę ir gyventi visavertį gyvenimą.

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