

# Dynamika powrotu utraconych funkcji u pacjentów poddanych fizjoterapii po operacyjnym leczeniu pourazowych krwiaków przymózgowych

*The dynamics of the return of lost functions in patients undergoing physiotherapy following surgical treatment of post-traumatic paracerebral hematomas*

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## Streszczenie:

Celem pracy jest określenie wpływu wczesnej fizjoterapii na dynamikę powrotu zdolności wykonywania czynności dnia codziennego, poprawę stanu funkcjonalnego i zmniejszenie ubytków neurologicznych oraz zmianę stanu świadomości u chorych po operacyjnym leczeniu pourazowych krwiaków przymózgowych.

Materiał badań stanowiła grupa 86 chorych leczonych operacyjnie z powodu pourazowego krwiaka przymózgowego. Wszystkich pacjentów podzielono na dwie grupy, gdzie podstawowym kryterium różnicującym badanych był rodzaj zastosowanej kinezyterapii.

Do oceny stopnia neurologicznego deficytu i niepełnosprawności wykorzystano Międzynarodową Skalę Niedowładów Mięśni, Zmodyfikowaną Skalę Barthel i Skalę Rankina, natomiast ocenę stanu świadomości dokonano w oparciu o skalę Glasgow Coma Scale.

Powrót utraconych funkcji u chorych usprawnianych wg wybranych wzorców koncepcji PNF i elementów Metody Bobath, w porównaniu do pacjentów poddanych kinezyterapii tradycyjnej, posiadał większą dynamikę, szczególnie w pierwszych dniach i następował w istotnie szybszym tempie. Jednak takiej zależności nie odnotowano w przypadku powrotu stanu świadomości. Największe możliwości uzyskana powrotu utraconych funkcji występują we wczesnym okresie pooperacyjnym (1-5 doba).

## Słowa kluczowe:

wczesność, pourazowe krwiaki przymózgowe, kinezyterapia

## Abstract:

*The objective of this study is to determine the impact of early physiotherapy on the dynamics of the recovery of the ability to perform daily activities, improvement in functional status, reduction in neurological deficits and change in the consciousness status in patients following surgical treatment of post-traumatic paracerebral hematomas.*

*The study material consisted of 86 patients undergoing surgical treatment of post-traumatic paracerebral hematomas. All patients were divided into two groups with the type of kinesitherapy performed as the main differentiating factor.*

*The grade of neurological deficit was assessed by the International Scale of Muscle Weakness, modified Barthel Index, and Rankin Scale, while consciousness was assessed on the basis of the Glasgow Coma Scale.*

*The return of lost function in patients undergoing rehabilitation according to selected PNF patterns and elements of Bobath therapy as compared to patients subjected to conventional kinesitherapy was characterized by better dynamics, particularly within the initial days, and progressed at a significantly higher rate. However, no relationship of this kind was observed for the recovery of consciousness. Patients have the highest potential for the return of lost functions in the early postoperative period (days 1-5).*

## Key words:

early physiotherapy, post-traumatic paracerebral hematomas, kinesitherapy

### Introduction and objectives

According to many authors, brain injuries are the most common cause of death and disability in patients under the age of 25 [1, 2, 3, 4, 5, 6, 7]. According to other authors, this type of injuries is the most common cause of death and disability in patients under the age of 45 [8, 9]. Currently, about 180-220 craniocerebral injuries (CCI) are recorded annually per 100,000 population, with 10% of these injuries being fatal [9]. In the European union, more than 200 per 100,000 individuals are hospitalized following a CCI, mainly due to a road accident [10]. Every year, CCIs are experienced by about 1.4 million Americans, with 1.1 million being managed at Emergency Departments, over 235,000 being hospitalized and 50,000 dying as the result of the injury [11, 12, 13]. In Poland, 11 individuals die per 100 road accidents, and one in 13 Poles experiences a head injury. Craniocerebral injuries and the associated injuries of the central nervous system are the third most common cause of deaths following cardiovascular and cancer diseases [14, 15, 16]. Craniocerebral injuries, with their most common consequence of post-traumatic paracerebral hematomas, usually lead to severe disabilities [17]. Duration and costs of recovery are incomparably higher than in cancer or cardiovascular diseases [18]. The advancing successes of neurotraumatologists and neurosurgeons result in increasing numbers of individuals becoming patients of rehabilitation departments following head injuries [19]. In these patients, the process of recovery of lost function consists in innate mechanisms of compensation and brain plasticity which may be stimulated by therapy requiring patient's activity and cooperation [20, 21]. The PNF [22] and Bobath [23] therapeutic concepts take into account individual stimulation of natural predispositions that allow to restore the lost functions and are used in rehabilitation of patients with neurological deficits [24, 25, 26, 27], although the higher efficacy of these methods as compared to other techniques has not always been confirmed in research studies [28, 29]. From the standpoint of rehabilitation, CCIs are one of the most difficult problems as the final outcome and patient's fate largely depend on the time of initiation and rehabilitation procedures [16, 30, 31, 32, 33]. Therefore, the main objective of this study is to determine the impact of early kinesitherapy on the dynamics of the recovery of the ability to perform daily activities, improvement in functional status, reduction in neurological deficits and change in the consciousness status in patients following surgical treatment of post-traumatic paracerebral hematomas.

## Material and methods

### Characteristics of study patients

The study material consisted in a group of 86 patients undergoing surgery for post-traumatic paracerebral hematoma in the Clinic of Neurosurgery and Nervous System Trauma of the Post-Graduate Education Center at Brodno District Hospital in Warsaw. The diagnosis was made on the basis of computed tomography scans of the head and the GCS scale. Included in the study were exclusively patients with isolated head injuries who had not experienced a multi-organ injury and scored above 10 in the GCS scale after the surgical procedure.

The study group (SG) consisted of randomly selected 43 patients aged  $52.02 \pm 15.03$  years while the control group (CG) consisted of 43 patients aged  $54.71 \pm 14.40$  years. The study group consisted of 70 males and 16 females. The main differentiating factor was the type of kinesiotherapy performed.

### Study methods

In order to achieve the objectivity of the assessment of the clinical and functional condition of patients, three scales were used to assess the degree of neurological deficit and disability, namely the International Scale of Muscle Weakness, modified Bartel Index, and Rankin Scale, while consciousness was assessed on the basis of the Glasgow Coma Scale. As part of the study, patients were assessed using the above scales four times: on days 1, 3, and 5 after surgery as well as at the discharge from the hospital.

The rehabilitation program in the study group (SG) included individual kinesiotherapy based on the PNF concept and Bobath therapy. Patients in the control group (CG) were subjected to a possibly most complete kinesiotherapy including individually selected kinesitherapeutical program (passive exercise, slow active exercise, non-weight bearing exercise, vascular exercise, staged verticalization). In both groups, rehabilitation was initiated 1-2 days after surgery (2x a day, duration of 15-20 minutes at the interval of 2-3 hours).

In all cases, the moment of initiation of rehabilitation following surgical treatment of post-traumatic paracerebral hematomas and the moment of discharge were determined by the attending physician.

According to the requirements of Declaration of Helsinki, the patients were informed of the objective of the study, procedural methodology and possibility to resign of participation at any moment in the study. The study was accepted by the Senate Committee for Research Ethics at the Jozef Pilsudski University of Physical Education in Warsaw.

The results were subjected to analysis using STATISTICA™ 9.1 software package. Mean values were compared using Mann-Whitney U-test.

## Results

### Improvement and rate of recovery of upper and lower limb paresis – International Scale of Muscle Weakness (ISMW)

Reduction of paresis in both upper and lower limbs was observed in both study groups (SG and CG) during hospital rehabilitation. The most rapid improvement, i.e. the most rapid increase in the results, was observed during the first five days of kinesitherapy, between assessments 1 and 3 (Fig. 1 and 2). The improvement was slower between assessment 3 and 4 as well as between subsequent assessments.

Patients subjected to kinesitherapy using selected PNF patterns and elements of Bobath therapy (SG) showed a much higher improvement in the results between assessments 1 and 2 than patients rehabilitated using conventional kinesitherapy (CG) ( $P < 0.05$ ). Inter-group differences between assessments 2 and 3, i.e. between days 3 and 5 were not statistically significant. The slowest resolution of the paresis of both upper and lower limbs and minute inter-group differences were observed in the last period of rehabilitation.

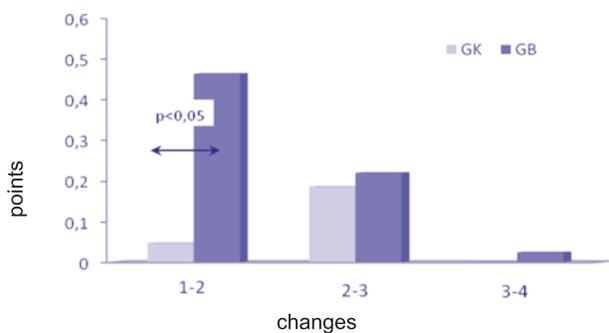


Fig. 1. Improvement in patient condition – the rate of resolution of upper limb paresis as measured by IMWS

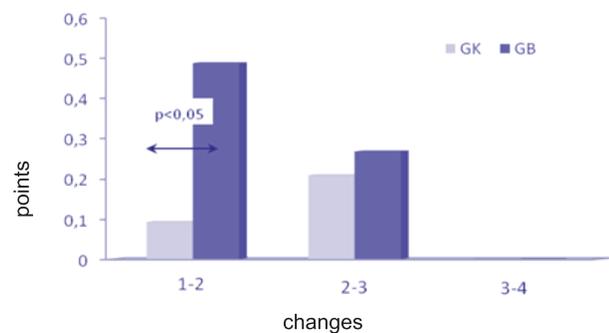


Fig. 2. Improvement in patient condition – the rate of resolution of lower limb paresis as measured by IMWS

### Improvement in the ability to perform daily activities – modified Barthel Index (MBI)

The fastest recovery and the highest improvement in the ability to perform daily activities was observed in both groups over the first three days of rehabilitation (Fig. 3). In that period, the recovery of the capabilities of interest was much faster in SG as compared to CG ( $P < 0.05$ ). In the subsequent measurements, between days 3 and 5, the improvement in the ability to perform daily activities was slower while the inter-group differences were reduced to the lack of statistical significance. The last days of inpatient rehabilitation brought about the least significant improvements.

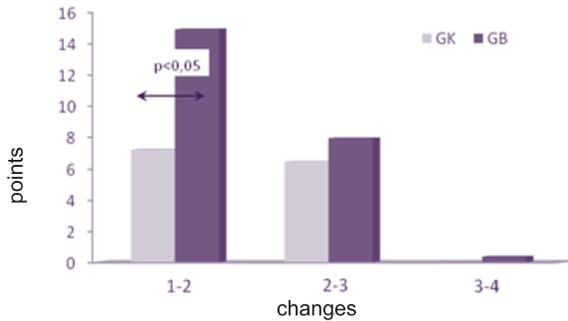


Fig. 3. Improvement in the ability to perform daily activities – modified Barthel Index

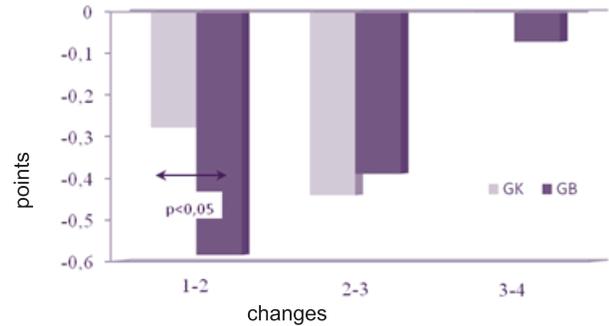


Fig. 4. Improvement in functional abilities – Rankin Scale

**Improvement in functional abilities – Rankin Scale (RS)**

Functional abilities of patients as assessed by Rankin scale are the better, the lower the score obtained by the patient. In a manner similar to the previous two tests, the highest improvements in functional abilities in both groups were observed over the first 5 days of postoperative rehabilitation (Fig. 4). Patients subjected to kinesitherapy involving selected PNF patterns and elements of Bobath therapy (SG) obtained much better results over the first 3 days of rehabilitation as compared to patients rehabilitated using conventional kinesitherapy (P<0.05). Over the following days, the inter-group difference was reduced, as was the rate of recovery of lost functional abilities in both groups.

**Improvement in the consciousness status – Glasgow Coma Scale (GCS)**

The dynamics of the return to consciousness differed from that of the changes in the rates of recovery of functional abilities, ability to perform daily activities and resolution of limb paresis. No inter-group differences at the level of statistical significance were observed between both groups in the dynamics of the changes in the consciousness status of the study patients (Fig. 5). In both groups, the fastest recovery of consciousness was observed between assessments 2 and 3, while lowest rates were observed in the final period of inpatient rehabilitation.

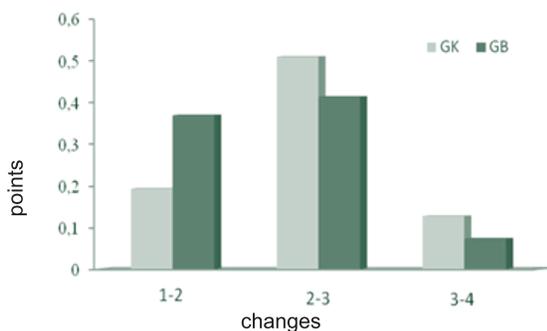


Fig. 5. Improvement in the consciousness status – Glasgow Coma Scale

## Discussion

According to the theory of compensation, areas of brain that were not damaged by the injury are capable of performing the functions of the damaged systems [34, 35, 36, 37]. Non-damaged structures may take over the functions of damaged structures to various degrees. Cortical representation areas may be modified by sensory stimuli, experience and learning as well as in response to cerebral injuries [38]. Depending on the nature of new environmental interactions as well as of the acquired abilities, the location of these areas may be shifted and the size may be either increased or reduced [39]. Cortical reorganization determines the success in the recovery of functions lost following the injury within the central nervous system (CNS), and rehabilitation may successfully exploit the natural brain plasticity [40]. Therapeutic interactions may exert beneficial effects on the brain at all ages, although the results observed in the elderly are somewhat lower [41]. Treatment may help to recover functions lost following brain surgery; however, the treatment methods should be selected with consideration to the specific nature of the injury [42, 43]. In particular, cholinergic activity is of primary importance for cortical plasticity and improvement of brain injuries [44].

The compensation ability is an innate trait; the damaged nerve tissue is capable of undergoing repair processes which may be significantly stimulated by physiotherapy [45, 46, 47]. The objective of the treatment team is to make use of these innate capabilities of the system to properly shape and fix the compensation mechanisms. The earliest possible initiation of rehabilitation of patients following head injury is considered to be a very important factor increasing the possibility for the development of compensation mechanisms [16, 19, 48, 49]. As demonstrated by Buchajczyk et al. [50], the shorter the time between the injury and physiotherapy initiation, the faster the recovery of motor functions.

In the results presented herein, the largest increases, i.e. the fastest improvement in the tested functions (functional abilities, ability to perform daily activities, resolution of paresis and improvement in the consciousness status) in patients who had undergone surgical treatment of post-traumatic paracerebral hematomas was observed in the initial postoperative period. After day 5, the increase in the respective values was markedly slower.

Appropriate choice of rehabilitation methods prove to be another and extremely important factor responsible for faster and fuller return of lost functions. The results of our study clearly demonstrate that the return of functional abilities (ability to perform daily activities, improvement in functional status and reduction in neurological deficits) in patients undergoing rehabilitation involving selected PNF patterns and elements of Bobath therapy was significantly faster as compared to conventional kinesiotherapy. However, the change in the rehabilitation method has no significant effect on the rate of the recovery of consciousness.

The superiority of PNF and Bobath techniques as demonstrated in our results may be explained by precise (i.e. adequate to the damage) selection, interactions targeting stimulation of CNS reconstructural capabilities that are the key for successful treatment

[51]. PNF is a form of the treatment of neuromuscular dysfunctions by means of enabling and facilitating information transfer. It assumes individual optimized activation of motor organs that allows to take full advantage of the plasticity of the nervous system [22]. Bobath therapy involves stimulation of muscle tone, inhibition of improper reflexes, triggering movements possibly most similar to normal as well as the use and fixation of the acquired motor abilities in everyday activities. The treatment is based on the knowledge of the mechanisms of motor control and learning as well as of the neuroplasticity and functional movements in humans [21, 24, 25].

It is believed that although passive movement of paretic limbs stimulates the surviving cortical structures and association areas, taking advantage of patient's ability to perform active movements is the most effective way to stimulate neuroplasticity [52, 53, 54]. Neural junctions and cortical maps are continuously remodeled by human activity. If complex motor activities are preformed regularly, cortical representations of muscles involved becomes larger [55, 56]. Functional improvement is achieved as an effect of comprehensive rehabilitation programs, and therefore physiotherapy should not be limited to isolated exercises, but should rather involve functional movements adapted from everyday life. Patients with brain injuries must regain their ability to perform functional motor tasks such as getting up, walking, climbing up stairs, changing position, reaching, and holding. These abilities should constitute the main goal or physiotherapist's efforts. The evidence for clinical efficacy of physiotherapy in this area may be considered to be quite universal [57, 58, 59, 60, 61].

As could be expected, functional stimulation of patients undergoing surgical treatment following CCI should, due to its targeted character, affect cortical motor centers much faster than passive methods. However, this type of stimulation has no better effect on the recovery of consciousness as compared to passive methods. The possibility of the improvement in patient's motor activity being achievable more easily than the mental and emotional improvement was assumed by Haftek et al. [30] and Przysada et al. [62].

Inpatient rehabilitation together with surgical treatment constitute an integral process of restoring the lost functions. The earliest possible stimulation of spontaneous, biological compensation processes reduces the risk of early and delayed complications. The stability and further advancement of the process is largely affected by rehabilitation being continued after completion of hospital treatment. In addition, the role of a physiotherapist is limited in some areas where an invaluable contribution can be made by the patient's close ones and relatives [63]. Comprehensive (i.e. inpatient and environmental) rehabilitation, including particularly neuropsychological rehabilitation, beneficially affects patients' functioning in the most disturbed areas, thus improving their quality of life [64, 65, 66, 67]. The return of lost functions, return to family and professional life and ability to control the emotional domain is a goal that can be achieved by multidimensional therapy being carried out to its fullest capabilities at every stage of the process.

### Conclusions

1. All patients having undergone surgical treatment for post-traumatic paracerebral hematoma and subjected to physiotherapy experienced a significant improvement in the ability to perform everyday activities and functional status. Reduction in neurological deficits and improvement in consciousness were also observed.
2. The return of the ability to perform everyday activities, improvement in functional status and reduction in neurological deficits in patients having undergone surgical treatment for post-traumatic paracerebral hematoma and subjected to physiotherapy involving selected PNF patterns and elements of Bobath therapy was significantly faster as compared to conventional kinesiotherapy. No differences were observed between the study groups in the dynamics of improvement of the consciousness status.
3. The largest increases in the tested variables, i.e. the largest dynamics of the return of lost functions in patients having undergone surgical treatment for post-traumatic paracerebral hematoma was observed in the initial postoperative period. After day 5, the increase in the respective values was slower.
4. When carrying out rehabilitation of patients having undergone surgical treatment for post-traumatic paracerebral hematoma, one should take advantage of physiotherapeutic methods targeting this particular disorder according to selected PNF patterns and elements of Bobath therapy while paying particular attention to the initial postoperative period.

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