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COMPARISON OF THE EFFECTS OF EARLY NEUROLOGICAL REHABILITATION IN PATIENTS AFTER HAEMORRHAGIC OR ISCHEMIC STROKE

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PORÓWNANIE EFEKTÓW WCZESNEJ REHABILITACJI NEUROLOGICZNEJ U CHORYCH PO UDARACH KRWOTOCZNYM I NIEDOKRWIENNYM MÓZGU

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SUMMARY

Introduction

The early rehabilitation after ischaemic (CI) and hemorrhagic (ICH) stroke follows the same program.

Aim

We assessed the functional status and changes in the degree of disability along 16-weeks of post-stroke rehabilitation.

Material and methods

One hundred and twenty patients with hemiparesis after stroke by analyzing Barthel Index both globally and in detail were studied. The Manual Muscle test to evaluate the muscle strength was used.

Results

By analyzing the functional state, on the basis of daily activities, there were observed few differences in the performances, depending on the type of the stroke, both before and after rehabilitation. The muscular strength of paresis limbs increased ($p < 0.001$) in both groups. After CI, the magnitude of the improvement in the paretic upper limb was higher than in the lower limb ($p < 0.001$). There were positive correlations between: the increase of iliolumbar muscle's

STRESZCZENIE

Wstęp

W powszechnej praktyce klinicznej wczesna rehabilitacja neurologiczna chorych po udarze niedokrwiennym i krwotocznym jest realizowana według tego samego programu.

Cel

Celem badania było porównanie stanu funkcjonalnego chorych po udarach niedokrwiennych i krwotocznych w odniesieniu do przeprowadzonego 16-tygodniowego okresu wczesnej rehabilitacji poudarowej.

Materiał i metody

Badaniu poddano 120 chorych z niedowładem połowiczym po udarze mózgu. Analizując wskaźnik Barthel (IB) globalnie i szczegółowo oceniono stan funkcjonalny. Siłę wybranych niedowładnych mięśni oceniono manualnym testem mięśniowym.

Wyniki

Analizując stan funkcjonalny na podstawie codziennych czynności, zaobserwowano kilka różnic w wykonywaniu czynności w zależności od typu klinicznego udaru, zarówno przed jak i po rehabilitacji. W obu grupach chorych leczenie usprawniające skutkowało poprawą siły mięśni niedowładnych kończyn górnych i dolnych ($p < 0{,}001$). U pacjentów po udarze krwotocznym zaobserwowano zwiększenie siły mięśniowej niedowładnej kończyny górnej niż w kończyny dolnej

strength and walking up the stairs, also the increase of deltoid muscle's strength and the activity of eating, dressing and bathing.

Conclusions
The clinical type of stroke affects the efficiency of the rehabilitation. The various methodological methods of the early rehabilitation after CI and ICH need to be prepared.

Keywords: neurological rehabilitation, hemorrhagic stroke, ischaemic stroke, functional state

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($p < 0,001$). Ponadto występują dodatnie korelacje między przyrostem siły mięśniowej mięśnia biodorowo-lędźwiowego kończyny dolnej a czynnością poruszania się i chodzenia po schodach oraz korelacje pomiędzy przyrostem siły mięśniowej mięśnia naramiennego kończyny górnej a czynnością jedzenia, ubierania się i kąpieli.

Wnioski
Typ udaru mózgu wpływa na efektywność usprawniania. Należy opracować zróżnicowane algorytmy usprawniania chorych w zależności od typu klinicznego udaru mózgu.

Słowa kluczowe: rehabilitacja neurologiczna, udar niedokrwienny, udar krwotoczny, stan funkcjonalny

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Introduction and aim

Stroke is currently a serious health problem, being the second most common cause of death and the third most common cause of disability in the world. According to the report prepared by the Expert Panel of the National Program for the Prevention and Treatment of Stroke, the incidence of stroke in Poland remains at an average European level of 177/100 000 in men and 125/100 000 in women per year. (Writing Group Members, Heart Disease and Stroke Statistics, 2016). Post-stroke mortality depends on the type of stroke and the time-after stroke. The higher risk of death is related to hemorrhagic stroke (Krishnamurthi *et al.*, 2013).

After the stroke, deterioration in the quality of life is due to central nervous system damage (Frank *et al.*, 2006). The neurological deficits after the stroke affect 40–96% of patients hospitalized at stroke or neurological rehabilitation wards (Roth *et al.*, 2001). The most common neurological deficits are hemiplegia and cognitive, emotional and intellectual dysfunctions (Duncan *et al.*, 2005). The above-mentioned consequences of a stroke which impair physical and mental fitness, hinder and repeatedly prevent a patient from living independently.

Implementation of effective rehabilitation is intended to improve impaired psychophysical functions or to compensate for the lost ones and to reduce the risk of another stroke (Diserens *et al.*, 2006). To achieve these goals it is necessary to start the rehabilitation in the treatment process as early as possible (Dobkin *et al.*, 2013). Only this concept guarantees the patients a return to active, professional and social life. Until now, the main methodological guidelines for the early post-stroke rehabilitation are common for patients after hemorrhagic and ischaemic strokes.

Considering the different pathomechanism of occurrence, the following questions seem to be very interesting: Are there any differences in the degree of disability in these two groups immediately after the stroke? Are there any differences in the dynamics

of the rehabilitation of both groups of post-stroke patients? So far, little scientific information has been devoted to this issue.

The purpose of the research was to answer the question of how the type of stroke determines disability in the assessed aspects and whether the same rehabilitation algorithm applied in the early post-stroke period is equally effective for patients after ischaemic and haemorrhagic strokes.

The following aspects have been subjected to assessment:

1. The functional state after ischaemic stroke and hemorrhagic stroke, before and after 16 weeks of the rehabilitation treatment.
2. The degree of deficiency of muscle's strength in the paretic limbs in relation to the stroke's type before and after 16 weeks of the rehabilitation treatment.
3. The correlation between the hemiparesis limb muscle's strength and the functional state, on the basis of daily activities, according to the Barthel's index parameters.

Material and methods

Participants

This was a retrospective study which utilized archival data. The treatment group consisted of patients hospitalized at the Neurological Rehabilitation Ward in Wiktor Dega's Orthopaedic and Rehabilitation Clinical Hospital in Poznan, University of Medical Sciences, between 2012–2015. The criteria for inclusion in the clinical research study was hemiparesis following the first episode of ischaemic stroke or hemorrhagic stroke. The stroke's type was determined based on head imaging examinations (MRI) performed immediately after the onset of stroke's symptoms and in the 5th day of hospitalization at the Neurology Ward. Patients with quadriplegia, patients with multiple strokes and those with hemiparesis caused by craniocerebral injury or brain tumors and those with neuropsychological deficits: aphasia, anoosognosia and previous history of dementia were excluded from the research. Since not all patients completed a full 16-weeks program, and some of those who finished it did not have a complete medical examination results in the areas of the research interest, and due to the accepted inclusion and exclusion criteria. We classified 120 patients for the further analysis. The demographic characteristics of the patients are shown in Table 1.

Clinical scales and assessments

The clinical research included the analysis of selected subjective and objective data (the location of hemiparesis, the Barthel's scale, the Jorgensen's scale, the Lovett's test) included in the individual medical records of patients. The examination was carried firstly at admission to the Neurological Rehabilitation Ward before the start of comprehensive treatment and on the day of discharge, after 16 weeks of the rehabilitation. As a matter of fact, the medical history of each patient qualified for the research included a bilateral assessment of the patient's functional state and the degree of his self-reliance in daily activities, according to the Barthel's index. The analysis involved ten daily activities (control of urination, stool, self-care, hygiene, eating, relocating from a bed to a chair and back, moving, dressing up, climbing the stairs, bathing) which were assessed every time with a point depending on whether the patient performed a given activity alone or with a help. The selected muscles' strength of upper and lower hemiplegic limbs was assessed using the Manual Muscle test: 5 – muscle contracts against full resistance, 4 – strength reduced, but contraction can still move joint against resistance, 3 – strength further reduced such that joint can be moved only against gravity with examiner's resistance completely removed, 2 – muscle can only move if resistance of gravity is removed, 1 – only a trace or flicker of movement is seen or felt, or fasciculations are observed.

Table 1. Patient characteristics at baseline.

Stroke type	**Ischaemic (CI)**	**Hemorrhagic (ICH)**
Mean age years (± SD)	70 ± 11	65.5 ± 11,5
Sex M/F (N)	25/35	32/28
Comorbidities		
Diabetes mellitus N (%)	14 (23)	7(12)
Hypertension N (%)	55 (90)	46 (76)
Heart disease N (%)	24 (40)	20 (33)
Artirial fibrillation N (%)	13 (22)	16 (26)
Hypercholesterolemia N (%)	18 (30)	17 (28)
Current smoking N (%)	9 (15)	8 (13)
Stroke releted characteristis		
Patients (N)	60	60
Lesion side		
Left hemishere N (%)	36 (60)	22 (36.7)
Right hemishere N (%)	24 (40)	38 (63,3)
Time since stroke (days ± SD)	12 ± 2	14 ± 3

Rehabilitation programme

All the treatment group underwent a comprehensive, early neurological rehabilitation program, very similar methodologically and normally used at a ward. The rehabilitation process was coordinated by a medical rehabilitation physician and his recommendations were implemented by the interdisciplinary team of a physiotherapist, a speech therapists, a psychologist, an occupational therapist and a nursing staff. Individual differences, mainly in time duration, the number of therapeutic sessions and the extent to which the patient is a subject to the type of a given therapeutic procedure were the result of differences in functional state of patients. Kinesiotherapy with neurophysiological methods of facilitation (PNF), complemented by the occupational therapy and assisted by orthopedic supplies, was the basis of the therapy treatment, improving the movement abilities. The rehabilitation continued for 16 weeks, five hours a day and was implemented in a cycle from Monday to Saturday.

Statistical analysis

Descriptive statistics were made using the STATISTICA package. The descriptive statistics of the measurable parameters concerned the minimum, maximum, arithmetic means, medians and standard deviation values. Compliance of parameters with normal distribution was checked with the Shapiro-Wilk's test. Wilcoxon's non-parametric test was used to compare the effectiveness of treatments in both types of strokes, before and after rehabilitation, with global and detailed values of Barthel Index, Lovett's muscular strength scale, and the results of treatment for upper and lower paresis limbs. Non-parametric Mann-Whitney's test was used to compare the results of the Barthel's index and the results of the muscle strength, according to the Lovett's scale, before and after the rehabilitation, and muscle's strength increase as a result of the treatment for ischaemic and hemorrhagic strokes. The chi^2 test for related variables was used to compare percentage of patients assigned to individual categories of Barthel scale parameters and degree of disability the results of

before and after the rehabilitation, for both types of strokes. To test the relationship between limbs' muscular power and functional activities, according to the Barthel scale, before and after rehabilitation in both patient groups, Spearman's rank correlation coefficient was calculated. Statistical hypotheses were verified at $P < 0.01$

Ethical considerations

The study was approved by the Ethics Commission of the Karol Marcinkowski University of Poznań, Poland (project number 810/17). It was performed in accordance with the Declaration of Helsinki. All participants of the study signed a written informed consent.

Results

Evaluation of the functional state

Through analyzing global Barthel Index values we observed that the patients after the ischaemic stroke, prior to their rehabilitation, had a higher mean BI with value 42.5 than the patients after the hemorrhagic stroke with value 35.9, however the difference was not statistically significant. Comparing BI values before and after the rehabilitation in both groups we found a statistically significant increase of BI – in patients after the ischaemic stroke the mean value was 24 while among patients who suffered a hemorrhagic stroke the mean value was 34. Comparing the BI rise in both groups reveals that there is a significant difference in treatment effectiveness for both types of strokes. The data presented in Table 2 show that the treatment is more effective in case of the hemorrhagic stroke ($p = 0.025$ test Mann-Whitney).

However these values show only the changes in the global functionality and do not inform us of the changes in individual categories. Analyzing the rehabilitation effects in more detail we noted a significant improvement in both patient groups in all studied Barthel scale parameters. In the case of the hemorrhagic stroke was observed that for activities: control of external anal sphincter, control of sphincter muscle of bladder, transferring and moving we see a significant improvement in rehabilitation effects when compared with patients after the ischaemic stroke.

The analysis of the proportion of patients assigned to given IB category among patients who suffered the ischaemic stroke and the hemorrhagic stroke, before and after rehabilitation, revealed several important insights into functional activities. A significant proportion of patients after the ischaemic stroke before rehabilitation required a significant support in eating (83.3%). The same patients in 50% of cases required assistance when walking ($p < 0.02$ chi^2 test). Among patients after the hemorrhagic stroke before rehabilitation the research revealed a significant difficulties in independent eating among 63% of patients and in mobility as 70% of them were immobilized ($p < 0.007$ chi^2 test). After 16 weeks of rehabilitation 70% of patients after the ischaemic stroke needed help when dressing up while only 21.7% did it unassisted. In the hemorrhagic group 45% of patients required assistance when dressing up but as high as 40% did it independently. These results show the importance of focusing on specific categories when assessing the effectiveness of the treatment. Detailed results of the analysis are summarized in Table 3.

Evaluation of muscular strength

Since it is well-known in clinical practice that the first movements after stroke, which are the basis for functionality improvements of the patient, appear in the humeral and hip joints , we assessed the strength of the deltoid and iliopsoas muscles of the paretic limbs according to the Lovett's scale. The results presented in Table 4 proved that there are statistically significant increases of muscle's strength of hemiplegic limbs for two types of strokes. In the case of patients with ischaemic stroke, the same treatment brings significantly better results in the upper limbs than in lower ones because the magnitude of

Table 2. The effects of rehabilitation for both types of strokes.

	Ischaemic (CI)		P-value	Hemorrhagic (ICH)		P-value	Comparison ICH vs CI		P-value
	after vs before rehabilitation			after vs before rehabilitation					
Index Barthel	66.67 ± 26.4	42.58 ± 22	**P < 0.001**	70 ± 28.6	35.92 ± 26.1	**P < 0.001**	34.08 ± 24	24.08 ± 19	**P = 0.025**
Barthel's scale parameter:									
Bowel control	8.2 ± 3.4	7.0 ± 3.8	**P = 0.008**	8.2 ± 3.3	5.4 ± 4.2	**P < 0.001**	2.8 ± 1.2	1.2 ± 0.4	**P = 0.036**
Bladder control	6.9 ± 4.1	5.2 ± 4.1	**P = 0.001**	7.8 ± 3.5	4.4 ± 4.2	**P < 0.001**	3.4 ± 0.7	1.7 ± 0	**P = 0.020**
Grooming	3.3 ± 2.4	1.8 ± 2.4	**P = 0.001**	3.7 ± 2.2	1.7 ± 2.4	**P < 0.001**	2.0 ± 0.2	1.5 ± 0	**P = 0.247**
Lower toileting	6.5 ± 3.8	3.7 ± 3.2	**P < 0.001**	6.6 ± 3.6	3.3 ± 3.5	**P < 0.001**	3.3 ± 0.1	2.8 ± 0.6	**P = 0.303**
Eating	7.9 ± 4.4	5.7 ± 4.9	**P < 0.001**	8.2 ± 2.4	5.8 ± 2.9	**P < 0.001**	2.4 ± 0.5	2.2 ± 0.5	**P = 0.837**
Transfers	11.1 ± 4.4	7.3 ± 4.9	**P < 0.001**	11.5 ± 4.2	5.9 ± 4.8	**P < 0.001**	5.6 ± 0.6	3.8 ± 0.5	**P = 0.038**
Mobility	10.6 ± 4.9	6.6 ± 5.5	**P < 0.001**	10.7 ± 5.2	4.5 ± 5.9	**P < 0.001**	6.2 ± 0.6	4.0 ± 0.6	**P = 0.036**
Dressing	5.7 ± 2.7	3.8 ± 2.2	**P < 0.001**	6.2 ± 3.5	3.4 ± 2.8	**P < 0.001**	2.8 ± 0.7	1.9 ± 0.5	**P = 0.105**
Stairs	5.2 ± 3.7	1.5 ± 2.3	**P < 0.001**	5.2 ± 4.0	1.3 ± 2.6	**P < 0.001**	3.9 ± 1.4	3.7 ± 1.4	**P = 0.488**
Bathing	1.3 ± 2.2	0.1 ± 0.6	**P < 0.001**	1.8 ± 2.4	0.2 ± 0.9	**P < 0.001**	1.6 ± 1.5	1.2 ± 1.6	**P = 0.319**

Values are presented as Mean ± SD
Comparison between gropus was perfomed with Wilcoxon test (after vs before rehabilitations) and Mann-Whitney U test (comparison ICH vs CI). P < 0.01 was considered statistically significant.

the improvement in the paretic upper limb was significantly higher than in the lower limb ($p < 0.001$ Wilcoxon test). For patients after hemorrhagic stroke, there was no difference in efficacy of the rehabilitation with respect to the upper and the lower limbs.

Validity

In the next stage of analysis we checked the dependence of the level of functionality according to IB parameters on the strength of studied hemiplegic limbs. In each case the Spearman correlation indicator was used because of the ordinal character of the variables. The analysis showed that prior to rehabilitation there were significantly moderate positive correlations between the strength of the iliopsoas muscle and the function of movement and walking up and down the stairs in both patients groups, and after the rehabilitation there were significantly strong positive correlations in the studied scope for both types of strokes (Table 5). In case of the strength of the deltoid muscle prior to rehabilitation among patients after the ischaemic stroke there was a significantly strong correlation with the function of dressing up, in the group of patients after the hemorrhagic stroke a strong correlation with action of aging and dressing up while after the rehabilitation in post-ischaemic patients we observed moderate correlations with activities of eating and dressing up, in the post-hemorrhagic patients the significantly strong correlation with the action of dressing up and moderate correlation with the activity of eating and washing up were observed (Table 5).

Discussion

The quality of life after stroke is considerably reduced compared to pre-disease period (Vesling *et al.*, 2005) Therefore all medical treatment should concentrate on minimizing the post-stroke dysfunctions as soon as possible and in effect on improving the quality of life of patients Schwamm *et al.*, (2005). As Hakkennes *et al.* (2011) argue, the initial clinical condition of a patient after the stroke is an important predictor of neurological and functional recovery. The Barthel's index is the tool most commonly used for evaluating

Table 3. Percent of patients after the ischaemic stroke and the hemorrhagic stroke matched to different daily activity categories according to Barthel Index prior and after the rehabilitation treatment.

Barthel's scale parameter			Before rehabilitation						After rehabilitation					
			CI		ICH		Comparison ICH vs CI	P – value	ICH		CI		Comparison ICH vs CI	P – value
			N	%	N	%			N	%	N	%		
Bowel control	0	Incontinent	10	16.70%	19	31.70%	15.00%	P = 0.103	7	11.70%	6	10.00%	−1.70%	P = 0.845
	5	occasional accident	16	26.70%	17	28.30%	1.60%		7	11.70%	9	15.00%	3.30%	
	10	Continent	34	56.70%	24	40.00%	−16.70%		46	76.70%	45	75.00%	−1.70%	
Bladder control	0	Incontinent	19	31.70%	25	41.70%	10.00%	P = 0.524	13	21.70%	7	11.70%	−10.00%	P = 0.337
	5	occasional accident	20	33.30%	17	28.30%	−5.00%		11	18.30%	13	21.70%	3.40%	
	10	Continent	21	35.00%	18	30.00%	−5.00%		36	60.00%	40	66.70%	6.70%	
Grooming	0	Dependent	38	63.30%	40	66.70%	3.40%	P = 0.702	21	35.00%	16	26.70%	−8.30%	P = 0.323
	5	independent	22	36.70%	20	33.30%	−3.40%		39	65.00%	44	73.30%	8.30%	
Toilet use	0	Dependent	22	36.70%	29	48.30%	11.60%	P = 0.257	11	18.30%	9	15.00%	−3.30%	P = 0.808
	5	needs some help	32	53.30%	23	38.30%	−15.00%		20	33.30%	23	38.30%	5.00%	
	10	independent	6	10.00%	8	13.30%	3.30%		29	48.30%	28	46.70%	−1.60%	
Eating	0	Unable	1	1.70%	6	10.00%	8.30%	**P = 0.028**	–	–	–	–	–	P = 0.575
	5	needs help	50	**83.30%**	**38**	**63.30%**	**−20.00%**		25	41.70%	22	36.70%	−5.00%	
	10	independent	9	15.00%	16	26.70%	11.70%		35	58.30%	38	63.30%	5.00%	
Transfers	0	Unable	10	16.70%	15	25.00%	8.30%	P = 0.365	1	1.70%	1	1.70%	0.00%	P = 0.933
	5	major help	23	38.30%	27	45.00%	6.70%		15	25.00%	12	20.00%	−5.00%	
	10	minor help	16	26.70%	10	16.70%	−10.00%		14	23.30%	15	25.00%	1.70%	
	15	independent	11	18.30%	8	13.30%	−5.00%		30	50.00%	32	53.30%	3.30%	
Mobility	0	Immobile	23	**38.30%**	**36**	**60.00%**	**21.70%**	**P = 0.007**	7	11.70%	7	11.70%	0.00%	P = 0.511
	5	wheelchair independent. including corners	1	1.70%	3	5.00%	3.30%		4	6.70%	7	11.70%	5.00%	
	10	walks with help of one person	30	**50.00%**	**12**	**20.00%**	**−30.00%**		24	40.00%	17	28.30%	−11.70%	
	15	independent	6	10.00%	9	15.00%	5.00%		25	41.70%	29	48.30%	6.60%	
Dressing	0	Dependent	15	25.00%	22	36.70%	11.70%	P = 0.062	5	8.30%	9	15.00%	6.70%	**P = 0.022**
	5	needs help but can do about half unaided	45	75.00%	35	58.30%	−16.70%		42	**70.00%**	**27**	**45.00%**	**−25.00%**	
	10	independent	0	0.00%	3	5.00%	5.00%		13	**21.70%**	**24**	**40.00%**	**18.30%**	
Stairs	0	Unable	42	70.00%	46	76.70%	6.70%	P = 0.184	15	25.00%	17	28.30%	3.30%	P = 0.531
	5	needs help	18	30.00%	12	20.00%	−10.00%		28	46.70%	22	36.70%	−10.00%	
	10	independent	0	0.00%	2	3.30%	3.30%		17	28.30%	21	35.00%	6.70%	
Bathing	0	Dependent	59	98.30%	58	96.70%	−1.60%	P = 0.559	44	73.30%	38	63.30%	−10.00%	P = 0.239
	5	independent	1	1.70%	2	3.30%	1.60%		16	26.70%	22	36.70%	10.00%	

Comparison between groups was performed with chi² test (comparison ICH vs CI). AP < 0.01 was considered statistically significant.

ADL. The Barthel's rate reliably documents, increasing under the influence of the rehabilitation, self-independence in basic daily activities (Sulter *et al.*, 1999). Nowadays it is known that stroke after affects may be partially reversible and the rehabilitation

Table 4. The muscle's strength of the deltoid muscle and the iliopsoas muscle of paresis limbs, according to the type of stroke, before and after the rehabilitation treatment.

	Ischaemic (CI) after vs before rehabilitation		P-value	Hemorrhagic (ICH) after vs before rehabilitation		P-value	Comparison ICH vs CI		P-value
The muscle's strength Lovett's scale: Paresis upper limb (deltoid muscle)	3.93 ± 1.16	2.98 ± 1.57	**P < 0.001**	3.63 ± 1.45	2.84 ± 1.74	**P < 0.001**	0.79 ± 0.29	0.95 ± 0.41	P = 0.057
Paresis lower limb (iliopsoas muscle)	4.07 ± 0.99	3.47 ± 0.92	**P < 0.001**	3.98 ± 1.05	3.21 ± 1.37	**P < 0.001**	0.78 ± 0.33	0.6 ± 0.02	P = 0.636
Comparison		Ischaemic (CI)			Hemorrhagic (ICH)				
Paresis upper vs lower limb		0.35 ± 0.39	**P < 0.001**		0.02 ± 0.04	P = 0.818			

Values are presented as Mean ± SD. Comparison between gropus was perfomed with Wilcoxon test (after vs before rehabilitations and comparison paresis upper vs lower limb) and Mann-Whitney U test (comparison ICH vs CI). P < 0.01 was considered statistically significant.

Table 5. Summary of statistically significant correlations of the muscle's strength in paresis limbs, according to the Lovett's scale, with daily activities, according to the Barthel Index.

Barthel's scale parameter		The muscle's strength according to Lovett's scale				
		Ischaemic (CI)		Hemorrhagic (ICH)		Diffrent ICH/CI
		Before rehabilitation	After rehabilitation	Before rehabilitation	After rehabilitation	
Paresis upper limb						
Eating	Correlation coefficient	0.221	**0.307**	**0.4**	**0.315**	−0.042
	P-value	P = 0.09	**P = 0.017**	**P = 0.002**	**P = 0.014**	P = 0.748
Dressing	Correlation coefficient	**0.613**	**0.322**	**0.556**	**0.512**	**−0.335**
	P-value	**P < 0.001**	**P = 0.012**	**P < 0.001**	**P < 0.001**	**P = 0.009**
Bathing	Correlation coefficient	−0.019	0.244	0.117	**0.342**	0.045
	P-value	P = 0.884	P = 0.06	P = 0.373	**P = 0.007**	P = 0.735
Paresis lower limb						
Mobility	Correlation coefficient	**0.348**	**0.536**	**0.419**	**0.636**	0.094
	P-value	**P = 0.006**	**P < 0.001**	**P = 0.001**	**P < 0.001**	P = 0.475
Stairs	Correlation coefficient	**0.29**	**0.458**	**0.423**	**0.645**	**−0.305**
	P-value	**P = 0.025**	**P < 0.001**	**P = 0.001**	**P < 0.001**	**P = 0.018**
Correlation significant at P < 0.01						

procedures must be also adapted respectively. In our research with BI (Table 2) we showed that a comprehensive, early post-stroke rehabilitation results in a functional improvement of hemiplegic limbs, and furthermore the scale of the improvement is dependent on the type of suffered stroke. In Di Moncaco *et al.* (2010) studies 90% of patients experienced improvement in day-to-day activities (self-service and independence) as measured by Barthel index. The importance of early, comprehensive, post-stroke rehabilitation was previously also noted by other researchers (Hosfstad *et al.*, 2017). This fat was also clearly underlined in Bernhardt *et. al.* (2007). As Jorgensen's (1995) research shows the greatest improvement in the condition is observed up to 6 months after the stroke and most motor functions return up to six weeks. Neurological condition returns by

approx. 2 weeks earlier than functional state. Also, Kwakkel *et al.* (2011) pointed that the most important are the first six months after the stroke to achieve significant effects of the rehabilitation. Generally the worse the neurological and functional state of the patients at the moment of starting the rehabilitation treatment and the later the treatment is applied the worse its effects which was proved by Salter *et al.* (2006).

Detailed comparative analysis of the IB values in evaluated specific categories showed differences in the way activities were performed by the two studied patient groups. Significant differences before the rehabilitation were primarily related to locomotion since 60% of CHI patients were immobilized while only 38% of CI patients were immobilized. This values are concurrent with Miller's *et al.* (2008) observations who estimated the percentage of patients incapable of independent walking among patients who suffered serious stroke at 50% however without taking into consideration the type of stroke. Also Opalińska *et al.* (2012) observed an improvement in functional locomotion after the early after-stroke rehabilitation, however this study was conducted only on CI patients. The most difficult to recover, despite 16 weeks of rehabilitation, proved to be the ability to independent washing-up and bathing since only 26% of patients after CI and 36% of patients after CHI were in that regard self-sufficient (Table 3).

Our results are further backed by Kaluzny *et al.* (2016) research on the effects of early rehabilitation among CI patients which showed statistically significant improvement in self-service and other daily activities. The significance of earliest possible implementation of rehabilitation of hemiplegic upper limbs among patients who suffered a stroke in order to improve their functions was demonstrated by Turton *et al.* (2002). Rodgers *et. al.* (2003) also showed in their research a positive effect of a comprehensive, early rehabilitation on functionality of the hemiplegic upper limbs among post-stroke patients using i.a. BI. These observations are completely concurrent with our own results since the evaluated early post-stroke rehabilitation resulted in a significant improvement of functionality in specified BI categories (Table 2). Similarly to this study Kwakkel *et. al.* (1999) showed that an early post-stroke rehabilitation (from 14th day) results in significant improvement of walking functions and functionality of the hemiplegic upper limb. We observed however that among patients who suffered ischaemic stroke the difference in muscle strength increase between deltoid and iliopsoas muscles was significant. Hence the question whether the increase in strength in the studied muscles is reflected in the upper and lower hemiplegic limbs' functionality. Our results undeniably point to significant correlation between the strength of the iliopsoas muscle of the lower limb and the function of mobility and walking up and down the stairs both prior an after the rehabilitation which is concurrent with observations made by Nakayam *et. al.* (1995).

In case of patients after the ischaemic stroke we showed a significant, strong positive correlation between the strength of the deltoid muscle of the upper limb prior to rehabilitation and the activity of eating. After the treatment we got moderate correlations in cases of eating and dressing-up. In case of patients after the hemorrhagic stroke we found a significant, strong positive correlation between the strength of the deltoid muscle of the upper limb before treatment and activities of eating and dressing-up. After the treatment the studied correlations proved to be significant in each case (Table 5), yet moderate (in case of eating and washing up) or strong (in case of dressing up). These observations are concurrent with observations made by Olsen *et. al.* (1990) Similar observations were made by Huang *et. al.* (2009) who documented that among post-stroke patients with a BI value similar to ours there is a positive correlation between the function of the hemiplegic limbs and the

extent of their scope of movement measured by Barthel scale after the accident. It must be underlined however that unlike in our study this research did not distinguish between the type of stroke.

Conclusions

On the basis of the foregoing research results it can be emphasized that, the clinical type of stroke significantly differentiates, in the early stage, the degree of disability and consequently alters the effectiveness of the 16-week rehabilitation carried in the same methodology.

The correlations of functional conditions hemiparesis limbs and increase in muscle's strength in paresis limbs can indicate the program of rehabilitation.

The occurring differences in the degree of disability and in the effects of 16 weeks of rehabilitation suggest the need to prepare different methods of the early health improvement after ischaemic and hemorrhagic strokes.

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