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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

The impact of cycling exercise on motor and functional recovery of patients in acute and subacute stroke phase

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SUMMARY

Introduction/Objective Neurological impairment and immobility in stroke patients can lead to numerous complications. This study aimed to evaluate the effect of cycling exercises with visual feedback combined with conventional rehabilitation on neurological and motor recovery, balance, walking speed and endurance, and activities of daily living (ADL) in patients after acute and subacute stroke.

Methods A randomized prospective controlled trial was applied to this research. One hundred and twenty-seven hemiplegic stroke patients who received in-hospital rehabilitation were randomly assigned into two groups. Both groups received conventional rehabilitation treatment. The experimental group had an extra 30 minutes of cycling exercises for the upper and lower extremities on a stationary ergocycle MOTOmed muvi. Both groups' neurological status, upper and lower limb function, independence in ADL, balance, walking speed, and endurance were observed before and after the rehabilitation treatment. Outcome measures used were the National Institute of Health Stroke Scale (NIHSS), the modified Ashworth scale (MAS), the Brunnstrom Motor Evaluation Scale (BMES), upper and lower Fugl-Meyer assessment (FMA), the Barthel index (BI), the Berg Balance Scale (BBS), the six-minute walk test (6MWT) and the Timed Up and Go test (TUG).

Results The neurological recovery on the NIHSS scale, spasticity of the knee extensor measured by the MAS, the BMES and FMA-LE subscale for the affected leg, and the 6MWT presented more significant improvement in the experimental group than in the control group after the treatment ($p < 0.05$ for all three analyses).

Conclusion Cycling exercises with visual feedback combined with conventional rehabilitation could promote neurological recovery and improve the motor function of the affected leg and walking speed in patients recuperating after acute and subacute stroke.

Keywords: rehabilitation; stroke; hemiplegia; recovery of function; lower extremity

INTRODUCTION

Stroke represents the most frequent source of acquired disability in the adult population, which leads to reduced cognitive and motor functions and a decrease in patients' autonomy in activities of daily living (ADL). Stroke usually affects older adults and results from brain tissue injury caused by insufficient cerebral blood supply [1]. Hemiplegia is a prevalent symptom after acute stroke and the focus of rehabilitation. Additionally, many stroke survivors have impaired balance and mobility. Rehabilitation treatment after stroke is more effective if it is timely, intensive, and if it includes multisensory stimulation. Various rehabilitation approaches have been proposed, but few have been confirmed as effective in clinical research. The underlying mechanism of neurological deficit recovery after stroke is still not fully explained because more than one process is involved in recovery, and cerebral plasticity plays a significant role [2]. Stationary ergocycle is uncomplicated and provides inexpensive exercise that improves muscle strength, stamina, and balance [3]. MOTOmed muvi is a new stationary ergocycle with different exercise modes. It allows recording and provides essential information on the patient's improvement in real time. That way, it can assist the clinician and therapist determine optimal training intensity and frequency to promote recovery [4]. However, there has been an insignificant number of clinical studies that examined the impact of cycling exercises on the recovery of hemiplegic patients during the acute and subacute stroke phases.

This study aimed to determine the effect of the cycling exercises performed on stationary ergocycle as an addition to conventional rehabilitation on neurological and motor recovery, balance, ADL, and walking speed and endurance in patients after acute and subacute stroke.

METHODS

Our research was devised as a prospective randomized controlled trial. The participants were

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stroke patients receiving in-hospital rehabilitation at the Medical Rehabilitation Clinic, Clinical Centre of Vojvodina from 01. March 2022 to 31. April 2023. The study was approved by the ethics committee of the Clinical Centre of Vojvodina (Ref. No. 2022-600-184). All study participants gave their written informed consent. The inclusion criteria were as follows: first stroke; stroke onset less than three months; diagnosis of ischemic or hemorrhagic stroke based on neurological examination, brain computed tomography (CT), or magnetic resonance imaging (MRI); unilateral hemiplegia; initial National Institute of Health Stroke Scale (NIHSS) score ranging 6–20; age of more than 18 years; cognitive ability to participate in rehabilitation treatment; minimal ability to actively perform movements in the shoulder and elbow with compensatory trunk movement. The exclusion criteria were recurrent stroke, stroke accompanied by severe mental disorder, patients with aphasia who could not comply with directions, and heart, liver, or renal failure. The calculation of the test power was carried out for the research. The sample size was calculated using the software G*power 3.0.10 [5]. We used an alpha level of $p \leq 0.05$, a study power of 0.8, and an effect level of 0.15 (small effect size). The sample size amounted to 90 subjects (45 each in each group)f or the combined analysis of variance [6].

After baseline assessment, eligible patients who met the inclusion criteria were randomly assigned to the experimental and control group in a 1:1 ratio. Computer-generated numbers were used for randomization. The numbers were stored in sealed envelopes, handled by a physician unaware of the study's purpose. The resident physician (T.S.) created the random allocation sequence using the EpiDat v. 4.0 software and maintained it classified so that allocation remained concealed. When patients appeared for the first rehabilitation session, the assigned therapist started the randomization within the computer program to irrevocably designate the patient to the control or experimental group prior to disclosing the procedure.

Both groups underwent regular conventional in-patient rehabilitation treatment for three weeks, six days per week (18 sessions). Conventional rehabilitation consisted of physical and occupational therapy, each lasting one hour. Physical therapy involved personalized exercises chosen by the therapist, manual mobilization, and physical agents. Occupational therapy implemented repetitious exercises to improve coordination and ADL skills using different standard equipment. The experimental group had an additional 30 minutes of cycling exercises for the upper and lower extremities with visual feedback on a stationary ergocycle (MOTOmed muvi, RECK-Technik, Betzenweiler, Germany). MOTOmed muvi ergocycle enables simultaneous leg and arm training. The ergocycle panel showed parameters of symmetry of bilateral upper and lower limb exertion, cycling extent (in kilometers), achievement (watts), resistance (kilograms), and number of revolutions per minute (rpms). The data during cycling were recorded on a computer.

The cycling exercises for the upper and lower extremities consisted of 15 minutes forward and 15 minutes backward movement. Every training began with preparation; patients were seated on a chair before the stationary ergocycle. Heart rate and arterial tension were measured at each session's beginning and end. Preparation was followed by passive warm-up: 150 seconds of passive cycling exercises so that the ergocycle moved the arms and legs of the patient at a steady pace of 25 rpm. After warm-up, the patients started active cycling exercise, which consisted of 10 minutes of active cycling for arms and legs. They were instructed to maintain a pedaling speed of 50–70 rpm. Visual feedback was used to accomplish load symmetry 50/50 on the ergocycle panel. The weight of active exercise was settled as Stage 13 of the Borg scale [7], signifying "a little strenuous" training. The session ended with passive training: 150 seconds of passive cycling exercises, the patient's limbs were moved by the ergocycle at a steady pace of 25 rpm.

The patients' neurological and functional status was assessed at the baseline (within the first 24 hours of admission to the Clinic) and after 18 therapy sessions. The assessment was carried out by the specialist of physical medicine and rehabilitation (S.P.), who was unaware whether the patients were assigned to the control or experimental group. NIHSS was used to estimate neurological impairment [8]. The Modified Ashworth Scale (MAS) was used to determine the knee extensor's spasticity level [9]. The Berg Balance Scale (BBS) was used to evaluate static balance and fall risk. It evaluates balance during activities such as standing, sitting, transfers, and rotations needed in ADL. A higher score implies better balance and reduced fall risk; the best result is 56 points [10]. Motor function was classified by the Brunnstrom Motor Evaluation Scale (BMES) [11] for the hemiparetic arm, hand, and leg. It has six stages: the first one is characterized by flaccidity and the inability for voluntary movement, and the last one is achieved when the patient performs isolated joint movement. BMES is a frequently administered stroke-specific tool for determining the post-stroke motor recovery level and gross hemiparesis severity [11, 12]. However, it is subjective, and due to rough evaluation, minor functional changes in recovery can be overlooked [12]. Because of these limitations, we also applied the Fugl-Meyer assessment (FMA) for a more detailed examination. FMA is based on BMES but has more sensitivity for subtle changes in motor recovery and is responsive and feasible [13, 14]. FMA analyses the reflex activity of the affected extremities, movements, and their relation to synergies, speed, and coordination. We used subsections of FMA for the upper (FMA-UE) and lower extremity (FMA-LE). FMA-UE incorporates 33 items for proximal and distal segments of the affected arm with a maximum motor score of 66 points. The FMA-LE subscale has 17 items; the highest score of 34 points is received for normal function [14]. Barthel index (BI) was applied to evaluate independence in ADL. The BI score estimates 10 essential activities needed for self-care and mobility [15]. The maximum result is 100, and lower results mean that the patient suffers from a more remarkable inability to perform ADL without help. The six-minute walk test (6MWT) and the Timed up and Go test (TUG) were used to analyze walking speed and endurance [16].

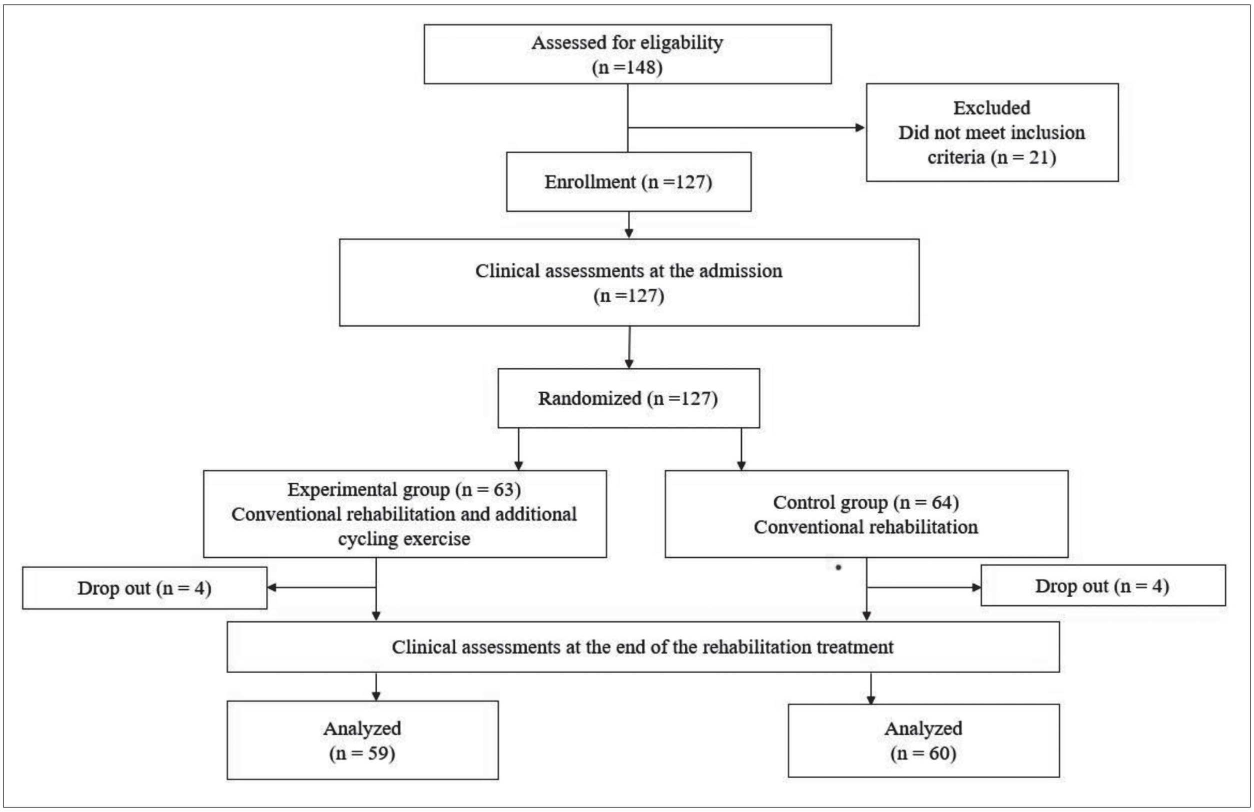

Figure 1. Flowchart of the design and conduct of the study

Statistical analysis

In our study, IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA) statistical software was applied for data processing and analysis. Frequency and percentage were used to describe the sample structure. Descriptive statistics methods were used to determine measures of central tendency (arithmetic mean) and measures of variability (standard deviation) of observed clinical data. The patients' demographic and clinical baseline characteristics in the two groups were compared using the χ^2 test for categorical variables, the independent t-test for continuous variables, and the Mann–Whitney U test for ordinal variables. The assessments at the beginning and end of each group's rehabilitation treatment were compared to determine if there were changes after the administered therapy. A Student's t-test analyzed quantitative variables. To estimate the treatment effect and differences between the control and experimental groups in two-time intervals (the beginning and the end of treatment), a split-plot analysis of variance (SPANOVA) was used. The significance level was set at $p < 0.05$.

RESULTS

The recruitment interval for this study lasted from March 1, 2022 to April 31, 2023. The participant flow is described in Figure 1. A total of 127 patients were recruited. Eight patients left the protocol for several reasons, such as illness unrelated to the study, personal reasons, and loss of desire to participate in the prescribed treatment due to the development of severe depression. The rehabilitation treatment was completed by 119 patients (Figure 1). Table 1 summarizes participant demographics. Participants in this study had moderate neurological deficits, evaluated by the NIHSS scale. Demographic and clinical data of the two groups were compared at initial evaluation, and no substantial differences were detected between groups (Table 1).

Table 1. Demographic and clinical characteristics of patients

Variables	Experimental group (n = 59)	Control group (n = 60)	p
Sex (male/female)	31/28	29/31	0.71
Age (years)	65 ± 11.98	67.34 ± 10.86	0.84
Type of stroke (I/H)	49/10	53/7	0.67
Side of hemiplegia (left/right)	24/35	28/32	0.41
Time since stroke (days)	33 ± 17.2	36 ± 19.7	0.89
NIHSS (0–42)	10.3 ± 4.45	11.4 ± 5.67	0.63

Data are presented as mean ± SD;
I – ischemic; H – hemorrhagic; NIHSS – National Institute of Health Stroke Scale

The values of clinical assessments for the experimental and control groups at the initial evaluation and the end of rehabilitation treatment are shown in Table 2. No significant difference among the experimental and control groups was observed at the first assessment.

Patients in the experimental group showed considerable improvement in all parameters of the stationery ergocycle after 18 sessions. The average cycling extent (distance) progressed from 2612 ± 454 meters measured at

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Table 2. Values of outcome measures at baseline (T1) and the end of rehabilitation treatment (T2)

Outcome measures	Group	T1	T2	Change
NIHSS (0–42)	Experimental	10.3 ± 2.29	8.0 ± 2.14	-2.3 ± 0.95
	Control	11.4 ± 3.09	9.5 ± 3.26	-1.9 ± 1.26
	p-value	0.438	0.227	*0.030
MAS	Experimental	1.8 ± 0.79	0.6 ± 0.52	-1.2 ± 1.05
	Control	2.0 ± 1.10	1.8 ± 1.31	-0.2 ± 0.75
	p-value	0.826	*0.002	*0.003
BMES arm (1–6)	Experimental	4.2 ± 1.34	4.8 ± 1.25	0.6 ± 0.57
	Control	3.7 ± 1.31	4.5 ± 1.46	0.8 ± 0.50
	p-value	0.372	0.413	0.740
BMES hand (1–6)	Experimental	4.2 ± 1.41	4.7 ± 1.39	0.5 ± 0.75
	Control	3.8 ± 1.51	4.4 ± 1.64	0.6 ± 1.22
	p-value	0.286	0.425	0.820
BMES leg (1–6)	Experimental	4.3 ± 1.03	5.2 ± 1.03	0.9 ± 1.21
	Control	4.0 ±1.09	4.5 ± 1.15	0.5 ± 0.33
	p-value	0.553	*0.047	*0.049
FMA–UE (0–66)	Experimental	35.2 ± 15.72	42.0 ± 16.27	6.8 ± 2.05
	Control	33.6 ± 21.17	39.2 ± 21.80	5.6 ± 4.58
	p-value	0.641	0.429	0.073
FMA–LE (0–34)	Experimental	21.0 ± 5.42	29.5 ± 4.79	9.0 ± 2.75
	Control	20.2 ± 7.84	24.3 ± 7.86	4.1 ± 1.41
	p-value	0.556	*0.000	*0.000
BI (0–100)	Experimental	46.9 ± 19.09	64.8 ± 21.1	17.9 ± 15.71
	Control	51.1 ± 17.29	65.8 ± 17.8	14.7 ± 13.75
	p-value	0.371	0.653	0.239
BBS (0–56)	Experimental	28.6 ± 9.79	43.3 ± 8.64	14.7 ± 3.94
	Control	29.9 ± 13.82	39.2 ± 13.08	9.32 ± 2.83
	p-value	0.543	*0.048	*0.000
6MWT (meters)	Experimental	159.8 ± 78.62	241.6 ± 94.54	81.8 ± 70.96
	Control	142.4 ± 93.33	174.8 ± 87.12	32.4 ± 26.75
	p-value	0.293	*0.032	*0.035
TUG (seconds)	Experimental	96.2 ± 64.94	131.7 ± 84.43	35.5 ± 30.57
	Control	102.6 ± 72.42	121.9 ± 97.33	24.6 ± 19.21
	p-value	0.594	0.136	0.092

Data are presented as mean ± SD;
NIHSS – National Institute of Health Stroke Scale; MAS – modified Ashworth scale; BMES – Brunnstrom Motor Evaluation Scale; FMA-UE – Fugl-Meyer upper extremity subscale; FMA-LE – Fugl-Meyer lower extremity subscale; BI – Barthel index; BBS – Berg Balance Scale; 6MWT – six-minute walk test; TUG – Timed up and Go test;
*p < 0.05 is significant

Table 3. Split-plot analysis of variance (SPANOVA) for outcome variables

Variable	Wilks' λ	F	p	Partial η^2
NIHSS				
Time (beginning vs. end)	0.225	403.139	*0.000	0.775
Time* group	0.966	4.148	*0.044	0.034
Experimental vs. Control		7.045	*0.009	0.057
MAS				
Time (beginning vs. end)	0.886	312.436	*0.000	0.754
Time* group	0.019	2.369	0.086	0.031
Experimental vs. Control		5.842	*0.022	0.083
BMES arm				
Time (beginning vs. end)	0.513	110.316	*0.000	0.487
Time* group	0.976	2.889	0.092	0.024
Experimental vs. Control		2.437	0.121	0.021
BMES hand				
Time (beginning vs. end)	0.509	111.992	*0.000	0.491
Time* group	0.983	2.022	0.158	0.017
Experimental vs. Control		2.328	0.130	0.020
BMES leg				
Time (beginning vs. end)	0.494	118.75	*0.000	0.506
Time* group	0.973	3.269	0.073	0.027
Experimental vs. Control		4.634	*0.041	0.076
FMA-UE				
Time (beginning vs. end)	0.244	361.945	*0.000	0.756
Time* group	0.973	3.270	0.073	0.027
Experimental vs. Control		0.408	0.524	0.003
FMA-LE				
Time (beginning vs. end)	0.098	1071.563	*0.000	0.902
Time* group	0.438	149.923	*0.000	0.562
Experimental vs. Control		7.036	*0.009	0.047
BI				
Time (beginning vs. end)	0.772	304.326	*0.000	0.633
Time* group	0.024	2.899	0.091	0.010
Experimental vs. Control		0.548	0.446	0.005
BBS				
Time (beginning vs. end)	0.074	1466.058	*0.000	0.926
Time* group	0.612	74.272	*0.000	0.388
Experimental vs. Control		0.425	0.516	0.004
6MWT				
Time (beginning vs. end)	0.686	112.325	*0.000	0.521
Time* group	0.922	4.699	0.062	0.112
Experimental vs. Control		6.862	*0.033	0.032
TUG				
Time (beginning vs. end)	0.621	213.345	*0.000	0.578
Time* group	0.054	2.683	0.073	0.018
Experimental vs. Control		3.203	0.062	0.065

NIHSS – National Institute of Health Stroke Scale; MAS – modified Ashworth scale; BMES – Brunnstrom Motor Evaluation Scale; FMA-UE – Fugl-Meyer upper extremity subscale; FMA-LE – Fugl-Meyer lower extremity subscale; BI – Barthel index; BBS – Berg Balance Scale; 6MWT – six-minute walk test; TUG – Timed up and Go test;
*p < 0.05 is significant

the initial session to 3978 ± 868 meters at the final session ($p < 0.001$). The mean achievement (wattage) raised from 13.7 ± 6.73 watts at the first session to 26.8 ± 10.36 watts at the final session ($p < 0.001$). The average resistance at the initial session was 5.8 ± 2.45 kg, which advanced to 8.6 ± 3.89 kg at the final session ($p < 0.001$).

At the end of the treatment (discharge), the experimental group presented more pronounced neurological recovery on the NIHSS scale, reduced spasticity of the knee extensor measured by the MAS, more substantial improvement on the BMES for the affected leg, the FMA-LE subscale, the BBS, and 6MWT ($p < 0.05$).

We used SPANOVA to determine the impact of two therapeutic approaches. The results of the SPANOVA analysis confirmed a statistically significant difference in the neurological recovery measured by the NIHSS scale ($F_{1, 117} = 7.045$, $p = 0.009$), spasticity of the knee extensor measured by MAS ($F_{1, 117} = 5.842$, $p = 0.022$), the BMES for the affected leg ($F_{1, 117} = 4.634$, $p = 0.041$), FMA-LE subscale ($F_{1, 117} = 7.036$, $p = 0.009$) and 6MWT ($F_{1, 117} = 6.862$, $p = 0.033$) at the end of rehabilitation treatment in favor of the experimental group (Table 3). For all tested variables, changes between the pretest (beginning of the rehabilitation treatment) and posttest values (end of rehabilitation treatment) in both groups were highly statistically significant ($p < 0.001$). The effect size was large; thus, both groups of patients benefited from rehabilitation treatment. The interaction between the treatment type and time is shown in Table 3.

DISCUSSION

Various studies have shown that brain function is, to a degree, compensatory after stroke [17, 18]. Based on neuroplasticity, the function of the central nervous system can be improved by intensive rehabilitation. Furthermore, timely applied treatment can enhance the gene expression of nerve growth factors, improve neurotransmitter transmission, and advance motor function [19]. Current research findings imply that aerobic training can improve the strength of affected limbs, balance, and walking speed after stroke [20]. Stationary ergocycle MOTOmed muvi provides passive, assisted, and active resistance training modes for the upper and lower extremities. The used mode can be adapted for every patient based on the motor recovery stage. Cycling exercises prevent muscle atrophy, expand the range of joint motion, and help patients gain confidence to participate in the rehabilitation treatment [21]. Reports agree that most of the recovery after a stroke occurs within the first 3–6 months [22, 23]. However, there is limited research on the impact of cycling exercise on motor improvement during the acute and subacute stroke phases. In our study, we noted a more substantial neurological recovery assessed by the NIHSS in the experimental group, although the interaction between the type of treatment and time was significant. Máté et al. [22], in their meta-analysis, confirmed that cycling exercise combined with functional electrical stimulation can enhance neurological recovery and aerobic fitness in patients with central nervous system disorders. Wei et al. [23] found that early rehabilitation positively affects neurological recovery measured by the NIHSS after stroke. The results of the present study demonstrated that the experimental group displayed significantly lower spasticity at discharge, similar to some other studies [18, 20]. This might be because visual feedback cycling exercises activate the monosynaptic corticospinal inhibition pathways and reduce the transmission from neurons to muscles, reducing muscle spasticity [24]. Our findings show that after the treatment, the experimental group exhibited more prominent improvement in BMES for the affected leg, FMA-LE subscale, and 6MWT, indicating that cycling exercises can substantially improve lower limb motor and walking functions. Similar results were obtained in previous studies, which evaluated the use of cycling training in chronic stroke [24, 25]. Nindorera et al. [26], in their research, combined conventional rehabilitation and cycling training for patients with chronic stroke and discovered that applied protocol could improve lower extremity function and stamina, gait speed, and reduce muscle tone. Furthermore, the patterns of muscle activity during walking and cycling require alternate flexion and extension motion and corresponding activation of agonist and antagonist musculature. This can benefit neuromuscular regulation and muscle activation of the paretic lower extremity [27]. In our research, the upper extremity motor function (the BMES for the affected arm and hand and the Fugl-UE subscale) significantly increased after rehabilitation treatment. Nevertheless, the difference among the groups after the treatment was insignificant ($p > 0.05$). In their study, Linder et al. [24] obtained similar results. Despite the significant change in BI for both groups after the treatment, our findings imply that both treatments were equally beneficial. This is in accordance with several other trials [22, 25, 27]. Considering the effect of additional cycling exercise on balance (BBS), we found no statistically discernible difference among the groups, although the experimental group presented a higher trend of improvement. Duran et al. [27], in their research, found that different treatment approaches had a modest impact on balance in stroke patients (cycling training *vs*. underwater walking therapy *vs.* conventional rehabilitation). Our results confirm that cycling exercises as part of a post-stroke rehabilitation program can promote lower limb recovery, reduce spasticity, and improve gait recovery.

The limitations of this study include the difference in the duration of treatment for the examined groups, which burdens the generalization of the results. More tests could be applied to monitor hand functions aside from the FMA-UE, which could be the topic of further research. Research with longer and more rigorous follow-ups is needed to examine the long-term benefits of cycling exercises for stroke patients. Furthermore, this study was carried out in a single rehabilitation clinic with patients who mostly suffered from moderate stroke, so our findings may not be suitable for all settings.

CONCLUSION

Our results imply that cycling exercises on a stationary ergocycle combined with conventional rehabilitation could improve neurological and motor recovery of hemiparetic lower extremity and walking speed in acute and subacute stroke patients. Cycling exercises with visual feedback could be part of a protocol for the in-hospital rehabilitation of acute or subacute stroke patients.

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Утицај вежби на стационарном ергоциклу на моторички и функционални опоравак болесника у акутној и субакутној фази можданог удара

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САЖЕТАК

Увод/Циљ Неуролошки дефицит и смањена покретљивост код болесника са можданим ударом могу довести до бројних компликација. Ова студија је имала за циљ да процени ефекат вежби у виду *feedback* тренинга ергоциклом у комбинацији са конвенционалном рехабилитацијом на неуролошки и моторички опоравак, баланс, брзину хода, издржљивост при ходу и активности свакодневног живота код болесника после акутног и субакутног можданог удара.

Методе Ово истраживање дизајнирано је као рандомизирана проспективна контролисана студија. Сто двадесет седам болесника са хемиплегијом после можданог удара који су били на болничкој рехабилитацији рандомизирано је у две групе. Обе групе су имале конвенционални рехабилитациони третман. Експериментална група је добила додатних 30 минута вежби за горње и доње екстремитете на стационарном ергоциклу *MOTOmed muvi*. Неуролошки статус, функција горњих и доњих екстремитета, независност у активности свакодневног живота, баланс као и брзина и издржљивост при ходу, процењени су пре и после рехабилитације код обе групе. Коришћене скале за процену исхода биле су скала Националног института за здравље за мождани удар (*NIHSS*), модификована Асхвортова скала (*MAS*), *Brunnstrom* скала (*BMES*), *Fugl-Meyer* процена за горње и доње екстремитете (*FMA*), Бартел индекс (BI), Бергова скала баланса (*BBS*), шестоминутни тест хода (6*MVT*) и тест „устани–крени“ (*TUG*).

Резултати Неуролошки статус процењен на основу скале *NIHSS*, спастичност екстензора колена мерена помоћу *MAS*, *BMES* и *FMA-LE* субскала за захваћену ногу, као и 6*MWT* показали су значајно веће побољшање у експерименталној групи у односу на контролну групу после третмана ($p < 0,05$ за све три варијабле).

Закључак Вежбе на ергоциклу са визуелним *feedback*-ом у комбинацији са конвенционалном рехабилитацијом могу унапредити неуролошки опоравак, побољшати моторичку функцију захваћеног доњег екстремитета и брзину хода код болесника после акутног и субакутног можданог удара.

Кључне речи: рехабилитација; мождани удар; хемиплегија; функционални опоравак; доњи екстремитет