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Research Article

The Effect of Rehabilitation without Specific Cognitive Rehabilitation on the Improvement of Cognitive Functions in Stroke Patients: Evaluation with Risk Factors

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Abstract

Aim: This study aimed to evaluate if rehabilitation without specific cognitive rehabilitation improved cognitive functions in patients who had suffered a stroke more than 1 year ago, and to correlate this finding with risk factors.

Material and Methods: Thirty stroke patients were included in the study. A rehabilitation program was administered to the patients for a total of 30 sessions, 5 days a week. In addition, demographic data of the patients were collected, as well as several risk factors that may impair their cognitive function. The pre-and post-treatment cognitive function of the patients was evaluated using mini-mental state examination (MMSE) and functional independence measure (FIM)-cognitive. With the FIM cognitive evaluation, cognitive functions such as comprehension, expression, social interaction, problem solving, and memory were evaluated. With MMSE, from cognitive functions; orientation, registration, attention and calculation, recall, language, and praxis were evaluated. Pre- and post-treatment motor function was measured by the Brunnstrom motor recovery stage (BMRS). Pre- and post-treatment walking ability was assessed with Functional Ambulation Categories (FAC). Along with the general comparison of cognitive function pre- and post-treatment, additional pre- and post-treatment comparisons were made according to risk factors.

Results: According to MMSE and FIM-cognitive scores, improvement in cognitive function was detected following treatment ($p<0.001$, $p=0.001$, respectively). There was no statistical improvement in FAC and BMRS scores. According to MMSE, cognitive functions were more impaired before treatment in women, those with <5 years of education, and those with aphasia ($p=0.025$, $p=0.004$, $p=0.002$, respectively). According to FIM-cognitive, cognitive functions were lower in patients with aphasia, and those with left-sided brain damage ($p=0.002$, $p=0.045$, respectively). There was no difference in the magnitude of improvement between the risk factors.

Conclusion: This study showed that the rehabilitation program applied without a specific cognitive rehabilitation program in patients with chronic stroke can improve cognitive functions, although it does not cause a significant improvement compared to BMRS and FAC. Therefore, we believe that rehabilitation without specific cognitive rehabilitation will improve patients' daily activities and increase their participation in treatment.

Keywords: Stroke, cognitive impairment, rehabilitation

INTRODUCTION

Stroke is an important disease with a high mortality rate and long-term impairments in cases of survival (1). In addition, stroke results in not only physical disability but also post-stroke cognitive impairment (PSCI) in 1/3 of stroke survivors. The risk of developing cognitive impairment increases at least 5-8 times after stroke (2). Patients with PSCI are less likely to participate in rehabilitation programs. In addition to physical disability, people with cognitive disabilities show less improvement in physical functions. As a result, the patient's dependence on daily activities in life increases (3). Therefore, treatment of cognitive impairment is also essential.

Cognitive function is not restricted to a single domain. It encompasses a variety of domains such as attention, executive function, visuospatial ability, memory, and language (4). Cognitive rehabilitation includes compensatory, restorative, and educational interventions.

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Compensatory interventions aim to alleviate the patient's cognitive disability by facilitating their adaptation to the external environment through the use of aids and tools. Educational intervention entails informing family members about stroke and post-stroke cognitive impairment. This education provides information about the definition of a stroke, its management, and how the process will progress. Restorative interventions aim to directly restore impaired functions. These restorative interventions include domain-specific ones as well as interventions for generalized cognitive impairments. Aerobic exercises can be used to aid with generalized cognitive rehabilitation (5). However, domain-specific intervention is primarily performed by people who have received specialized education on this subject. Therefore, domain-specific interventions cannot be applied universally.

This study aims to determine whether cognitive functions improve in patients who have had a stroke over 1 year ago when only a neurologic rehabilitation program is applied without applying domain-specific cognitive rehabilitation and its relationship with certain risk factors.

MATERIAL AND METHOD

The prospective study was conducted at Giresun University Faculty of Medicine, Department of Physical Medicine and Rehabilitation between May 2019 and February 2020. The ethics approval for the study was obtained from the Ethics Committee of Giresun University with a decision number (2019/KAEK-55). All participants gave written informed consent and the study was performed following the 1964 Declaration of Helsinki.

G Power 3.1 software was used to calculate the required sample size. The effect size was calculated as 0.72 in the power analysis calculated according to the mean change in the FIM cognitive (6). Based on a power of 90% and a 5% level of significance, we calculated that the total sample size required was 23. Patients who had suffered a stroke more than one year ago were included in the study. The exclusion criteria were as follows: Systemic findings of conditions that may adversely affect the post-stroke rehabilitation program (such as cardiovascular, pulmonary) (n=4), psychiatric and cognitive problems before suffering a stroke (with patient records evaluated by psychiatrists and neurologists, and information obtained from patient relatives), severe communication difficulties (n=3), patients with severe communication-impairing aphasia (n=3), patients with neglect (n=0). A total of 40 patients were evaluated. Ten patients were excluded from the study due to the exclusion criteria. As a result, a total of 30 patients were assessed.

The demographic data (age, gender, duration of education), smoking status, presence of other diseases, duration from stroke onset to admission, type of stroke (hemorrhagic, ischemic), brain side affected, and presence of aphasia included in the study were recorded.

Upper extremity, hand, and lower extremity motor function measured by the Brunnstrom motor recovery stage (BMRS). Upper extremity BMRS includes 7 stages, hand, and lower extremity BMRS include 6 stages and higher stages demonstrate better recovery (7).

Walking ability was assessed with Functional Ambulation Categories (FAC). It assesses how much human support a participant requires when walking, with or without assistive devices, on a 6-point scale (0-5) (8).

The patient's cognitive functions were evaluated using a mini-mental state examination (MMSE). The MMSE has a maximum score of 30 points. With MMSE, from cognitive functions; orientation, registration, attention and calculation, recall, language, and praxis were evaluated (9).

Functional disability was assessed using the Functional Independence Measure (FIM). FIM consists of 2 parts, 13 motor items (FIM-motor) and 5 cognitive items (FIM-cognitive). Each item is assigned a point value between 1 and 7. A higher score indicates greater functional independence. With the FIM-cognitive evaluation, cognitive functions such as comprehension, expression, social interaction, problem solving, and memory were evaluated (10).

The rehabilitation program, prepared specifically for the patient by the physician, was administered by physiotherapists 5 days/per week under the physician's supervision. A total of 30 sessions of treatment were administered. The rehabilitation program includes a range of motion, neurophysiological, posture, balance-coordination, proprioceptive, stretching and relaxation, strengthening, breathing, and swallowing exercises, gait training, bladder and bowel training, and electrical stimulation. Apart from this, according to the necessity, occupational therapy was given by the occupational therapist, speech therapy was given by the speech therapist, and psychotherapy was given by the psychologists. Appropriate orthoses were prescribed to increase functionality, reduce spasticity, and maintain range of motion according to the needs of the patients.

After 30 sessions of treatment, the MMSE and FIM-cognitive tests for the patients were repeated.

Statistical Analysis

Statistical analysis was performed using SPSS version 23.0 (IBM Corporation). Continuous variables were expressed in mean ± standard deviation (SD) and median (interquartile range), while categorical variables were reported in terms of number and frequency. The assessment of normality was analyzed using the Shapiro-Wilk test. To compare quantitative data between the groups, the independent samples t-test or Mann-Whitney U test were employed according to the normality of data. To compare the pre and post-treatment data, the in-group paired sample t-test or Wilcoxon test was used according to the normality of data. The chi-square and Fisher's exact tests were used to identify the significance of the relationships between categorical variables. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 30 patients who had suffered a stroke, 13 (43.3%) female and 17 (56.7%) male were included in the study. The patients' mean age was 63.80±12.14 years and the mean disease duration was 52.20±41.71 months. The other demographic and stroke-related data of the patients are given in Table 1.

The MMSE, FIM, BMRS, and FAC values of the patients before and after the treatment are shown in Table 2. These results showed statistically significant improvement after treatment in MMSE and FIM scores to pre-treatment. There was no statistical improvement in FAC and BMRS scores after treatment.

Pre- and post-treatment MMSE and FIM-cognitive scores according to several risk factors for PSCI are presented in Table 3.

According to these results, pre-treatment MMSE scores were lower in women, those with <5 years of education, and those with aphasia (p=0.025, p=0.004, p=0.002, respectively). However, there was no statistically significant difference between pre-treatment MMSE scores according to the presence of hypertension (HT), diabetes mellitus (DM), smoking, affected brain side, and stroke type. In addition, pre-treatment FIM-cognitive scores were lower in patients with aphasia and those with an impaired left hemisphere (p=0.002, p=0.045, respectively). However, while the pre-treatment FIM-cognitive scores were relatively lower in women and those with <5 years of education, this difference was not statistically significant (p=0.050, p=0.060). There was no statistically significant difference between pre-treatment MMSE scores according to the presence of HT, DM, smoking, and stroke type.

There was a statistically significant increase in MMSE scores after treatment in all risk factor groups (all p<0.05), except for patients without HT (p=0.118) (Table 3). In addition, FIM-cognitive scores were increased in all risk groups after treatment, except for those with >5 years of education, DM, and hemorrhagic SVO (p=0.060, p=0.071, p=0.072) (Table 3).

A comparison of treatment changes (Δ) of the MMSE and FIM-cognitive scores according to pre-treatment is presented in Table 4. There was no statistically significant difference between risk factors in terms of changes (Δ) in the MMSE and FIM-cognitive values after treatment (all p>0.05).

Table 1. Demographic and stroke-related data

		Stroke (n=30)		
		N (%)	Mean±SD	Median (IQR)
Age (years)			63.80±12.14	65.00 (11.00)
Gender	Female	13 (43.3)		
	Male	17 (56.7)		
BMI (kg/m²)			25.61±4.06	24.61 (4.84)
Marital status	Married	16 (53.3)		
	Single	14 (46.7)		
Duration of education	≤5 years	24 (80)		
	>5 years	6 (20)		
Smoker	Yes	6 (20)		
Diabetes mellitus	Yes	10 (33.3)		
Hypertension	Yes	24 (80)		
Aphasia	Yes	8 (26.7)		
Duration of stroke (months)			52.20±41.71	26.00 (58.00)
Type of stroke	Ischemic	24 (80)		
	Hemorrhagic	6 (20)		
Affected brain side	Left	17(56.7)		
	Right	13 (43.3)		
Lesion site	Frontal	23 (76.7)		
	Temporal	12 (40.0)		
	Parietal	26 (86.7)		
	Occipital	2 (6.7)		

BMI: Body mass index; SD: Standard deviation; IQR: Interquartile range, BMRS: Brunnstrom motor recovery stages

Table 2. Comparison of MMSE, FIM, BMRS, and FAC scores before and after treatment

	Pre-treatment		Post-treatment		P value[w]
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	
MMSE	17.17±6.38	18.00 (9.00)	19.40±6.48	21.50 (8.00)	<0.001
FIM-motor	61.73±24.87	64.00 (40.00)	65.47±24.59	69.00 (37.25)	<0.001
FIM-cognitive	27.03±6.22	29.00 (12.00)	28.27±5.44	30.00 (9.50)	0.001
FIM-total	88.67±28.70	92.00 (40.00)	93.97±27.08	96.50 (38.00)	<0.001
BMRS-upper extremity	4.30±1.82	4.00 (3.00)	4.37±1.81	4.50 (3.00)	0.157
BMRS-hand	4.07±1.64	5.00 (2.00)	4.13±1.66	5.00 (2.25)	0.157
BMRS-lower extremity	4.07±1.51	4.00 (2.25)	4.17±1.46	4.00 (2.25)	0.083
FAC	3.47±1.29	4.00 (1.25)	3.57±1.28	4.00 (2.00)	0.083

MMSE: Mini-mental state examination; FIM: Functional Independence Measure; SD: Standard deviation; IQR: Interquartile range; BMRS: Brunnstrom motor recovery stages; FAC: Functional Ambulation Classification [w]Wilcoxon test

Table 3. Pre- and post-treatment MMSE and FIM-cognitive scores according to some risk factors for PSCI

	Δ MMSE					Δ FIM-Cognitive				
	Pre-Treatment		Post-Treatment		P_2 Value^{m}	Pre-Treatment		Post-Treatment		P_2 Value^{m}
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)		Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	
Gender										
Female (n=13)	14.23±7.14	13.00 (15.50)	16.77±7.89	18.00 (16.00)	**0.009^{p}**	24.31±6.59	23.00 (11.50)	25.85±5.93	27.00 (11.00)	**0.006^{p}**
Male (n=17)	19.41±4.81	20.00 (5.50)	21.41±4.42	22.00 (7.50)	**<0.00^{p}**	29.12±5.18	31.00 (10.00)	30.12±4.34	31.00 (13.00)	**0.028^{w}**
P_1 value	**0.025^{i}**					*0.050^{m}*				
Education										
≤5 years (n=24)	15.58±5.90	16.50 (7.00)	17.88±6.27	18.00 (9.00)	**<0.001^{w}**	26.04±6.25	26.00 (11.00)	27.21±5.39	28.50 (10.50)	**0.004^{w}**
>5 years (n=6)	23.50±3.99	23.00 (5.25)	25.50±2.59	25.00 (2.75)	**0.033^{p}**	31.00±4.56	32.00 (7.50)	32.50±3.33	34.00 (5.75)	*0.060^{p}*
P_1 value	**0.004^{i}**					*0.060^{m}*				
Smoker										
Yes (n=6)	19.33±6.41	19.00 (6.50)	21.67±5.75	22.00 (6.00)	**0.017^{p}**	27.00±5.93	27.00 (12.00)	29.00±5.40	30.00 (10.00)	**0.042^{w}**
No (n=24)	16.63±6.39	17.00 (9.00)	18.83±6.64	19.00 (8.00)	**<0.00^{w}**	27.04±6.41	29.00 (11.75)	28.03±5.55	30.00 (10.50)	**0.006^{w}**
P_1 value	*0.361^{i}*					*0.938^{i}*				
Hypertension										
Yes (n=24)	17.50±6.09	18.00 (8.25)	19.50±6.09	20.50 (7.50)	**<0.001^{p}**	27.54±5.88	29.00 (11.50)	28.71±4.97	30.00 (8.25)	**0.004^{w}**
No (n=6)	15.83±7.94	15.50 (15.50)	19.00±8.53	23.00 (15.00)	*0.118^{p}*	25.00±7.69	25.00 (15.00)	26.50±7.29	27.00 (14.25)	**0.045^{w}**
P_1 value	*0.536^{i}*					*0.360^{m}*				
Diabetes Mellitus										
Yes (n=10)	19.10±3.45	19.00 (5.25)	20.70±3.65	21.50 (5.50)	**0.006^{p}**	29.50±5.25	31.50 (11.00)	30.70±3.62	32.00 (6.25)	*0.071^{w}*
No (n=20)	16.20±7.32	16.50 (11.25)	18.75±7.51	20.00 (11.75)	**<0.001^{p}**	25.80±6.41	26.00 (10.75)	27.05±5.85	28.50 (10.50)	**0.003^{p}**
P_1 value	*0.151^{i}*					*0.126^{i}*				
Aphasia										
Yes (n=8)	11.50±6.44	11.50 (12.75)	13.25±7.03	14.50 (13.75)	**0.017^{p}**	21.25±4.71	21.00 (4.50)	23.13±4.16	22.00 (6.00)	**0.011^{p}**
No (n=22)	19.23±5.07	20.00 (6.00)	21.64±4.68	22.50 (7.00)	**<0.001^{p}**	29.14±5.35	31.00 (10.25)	30.14±4.62	30.50 (6.25)	**0.011^{w}**
P_1 value	**0.002^{i}**					**0.002^{m}**				
Affected brain side										
Left (n=17)	15.94±7.55	17.00 (12.00)	18.06±7.66	20.00 (12.50)	**0.004^{p}**	24.94±6.58	23.00 (11.00)	26.24±5.76	27.00 (9.00)	**0.012^{p}**
Right (n=13)	18.77±4.17	20.00 (7.50)	21.15±4.16	22.00 (7.50)	**<0.001^{p}**	29.77±4.62	31.00 (7.50)	30.92±3.71	33.00 (5.00)	**0.010^{w}**
P_1 value	*0.235^{i}*					**0.045^{m}**				
Stroke type										
Ischemic (n=24)	17.96±5.84	18.00 (8.25)	20.21±5.99	22.00 (6.75)	**<0.001^{w}**	27.21±6.37	29.00 (11.50)	28.50±5.47	30.00 (8.25)	**0.004^{w}**
Hemorrhagic (n=6)	15.00±8.00	13.00 (15.50)	16.17±7.94	14.50 (16.00)	**0.001^{p}**	26.33±6.06	25.00 (11.50)	27.33±5.72	27.00 (11.50)	*0.072^{p}*
P_1 value	*0.178^{i}*					*0.620^{m}*				

MMSE: Mini-mental state examination; FIM: Functional Independence Measure; SD: Standard deviation; IQR: Interquartile range; [i]independent samples t-test; [p]paired sample t test; [w]Wilcoxon test; [m]Mann Whitney U test; P_1 Value=Pretreatment comparison between groups, P_2 Value=Intra-group comparison of pre and post-treatment

Table 4. Comparison of treatment changes (Δ) of the MMSE and FIM-cognitive scores according to pre-treatment

	Δ MMSE		P Value[m]	Δ FIM-Cognitive		P Value[m]
	Δ MMSE	Δ MMSE		Mean±SD	Median (IQR)	
Gender						
Female (n=13)	2.54±2.96	2.00 (3.00)	0.932	1.54±1.66	1.00 (3.00)	0.490
Male (n=17)	2.00±1.50	2.00 (2.50)		1.00±1.70	1.00 (2.00)	
Education						
≤5 years (n=24)	2.29±2.37	2.00 (2.75)	0.979	1.17±1.74	1.00 (3.00)	0.650
>5 years (n=6)	2.00±1.67	2.50 (3.25)		1.50±1.52	1.50 (2.50)	
Smoker						
Yes (n=6)	2.33±1.63	2.50 (3.25)	0.541	2.00±1.41	2.00 (2.50)	0.165
No (n=24)	2.21±2.38	2.00 (3.00)		1.04±1.71	1.00 (2.50)	
Hypertension						
Yes (n=24)	2.00±1.50	2.00 (2.75)	0.915	1.17±1.76	1.00 (2.75)	0.689
No (n=6)	3.17±4.12	2.00 (5.75)		1.50±1.38	1.50 (3.00)	
Diabetes mellitus						
Yes (n=10)	1.60±1.43	1.50 (3.00)	0.311	1.20±1.81	0.50 (3.25)	0.602
No (n=20)	2.55±2.50	2.50 (2.75)		1.25±1.65	1.00 (2.75)	
Aphasia						
Yes (n=8)	1.75±1.58	2.00 (3.00)	0.581	1.88±1.55	2.00 (2.75)	0.246
No (n=22)	2.41±2.42	2.00 (2.25)		1.00±1.69	1.00 (2.00)	
Affected brain side						
Left (n=17)	2.12±2.64	2.00 (3.00)	0.230	1.29±1.90	1.00 (3.00)	0.730
Right (n=13)	2.39±1.61	3.00 (2.50)		1.15±1.41	1.00 (1.50)	
Stroke type						
Ischemic (n=24)	2.25±2.47	2.00 (3.00)	0.853	1.29±1.81	1.00 (3.00)	0.710
Hemorrhagic (n=6)	2.17±0.75	2.00 (1.25)		1.00±1.10	1.00 (1.50)	

MMSE: Mini-mental state examination; FIM: Functional Independence Measure; SD: Standard deviation; IQR: Interquartile range; [m]Mann-Whitney U test

DISCUSSION

This study showed that although no improvement according to BMRS and FAC staging, there was a significant improvement in cognitive functions as a result of a rehabilitation program without applying specific cognitive rehabilitation to chronic stroke patients. According to the MMSE and FIM-cognitive, cognitive impairment is higher in patients with aphasia. In addition, cognitive functions were more affected in those who had an education period of <5 years and females according to MMSE, and in those whose left side of the brain was affected according to FIM-cognitive.

Stroke is a risk factor for vascular dementia and Alzheimer's disease (11). Cognitive functions can be impacted at different levels following a stroke, and improvement of these functions is observed most rapidly during the first three months. However, studies have shown a greater improvement in these functions in patients with good cognitive functions following acute stroke (12). It is important to have good cognitive functions to improve patients' quality of life, motor levels, and functionality, and to reduce the risk of falling (13,14). In this direction, cognitive functions and their level of functioning should be incorporated into the treatment plan so that patients can return to normal life sooner.

In a meta-analysis of stroke patients who did and did not receive a cognitive rehabilitation program, it was shown that those who received a cognitive rehabilitation program experienced fewer mental problems immediately after treatment than those who did not. However, it has been reported that there is no long-term effect. This effect was found to be small to moderate in magnitude. However, there is no evidence that its impact is sustained long-term (15). Another meta-analysis published on attention, one of the cognitive functions, showed that cognitive rehabilitation did not affect subjective measures of attention in stroke patients, either in the short- or long term. Stroke patients who received cognitive rehabilitation demonstrated an improvement in measures of divided attention immediately after treatment as compared with control. However, it is not clear whether this effect persists to a long-term follow-up. Additionally, there is no evidence that cognitive rehabilitation has an immediate or permanent impact on alertness, selective attention, and sustained attention (16). In our study, subgroups of cognitive functions in stroke patients were not evaluated in detail. As in previous studies, evaluation was made through the MMSE and FIM-cognitive, which assess the subgroups of cognitions generally. Accordingly, when a rehabilitation program is applied without specific cognitive rehabilitation, a statistical improvement was detected in the cognitive functions immediately following treatment.

A meta-analysis showed that physical exercise improved cognitive functions in people over 50 years of age independently from baseline cognitive function. In particular, it is suggested that aerobic and resistant moderate-intensity exercises should be performed several days a week (17). According to the results of this study, we think that the exercise (aerobic, balance-coordination, posture, neurophysiological, etc.) performed by stroke patients may improve their cognitive functions.

Numerous risk factors have been identified that may affect post-stroke cognitive impairment, including age, gender, education level, HT, DM, hyperlipidemia, atrial fibrillation, smoking, and the presence of aphasia (18-21).

Language is a critical component of cognition (22). In patients with aphasia, not only linguistic but also non-linguistic cognitive functions may be impaired (23-25). In our study, MMSE and FIM-cognitive scores were lower in patients with aphasia than those without. However, both the MMSE and FIM-cognitive scores improved significantly following the rehabilitation program in patients with and without aphasia. There was no difference between the two groups in terms of the level of improvement.

A study investigating risk factors for cognitive dysfunction in patients who had experienced a stroke showed that there is a decrease in global cognition as a result of both ischemic and hemorrhagic strokes. However, among ischemic strokes, thromboembolic strokes carry the highest risk in terms of global cognition disorder (18). In our study, no difference was found between patients who have suffered an ischemic or hemorrhagic stroke in terms of impaired cognitive function. However, ischemic strokes have not been compared according to their etiology.

There is evidence that people with left hemisphere involvement experience non-linguistic cognitive impairments to skills such as attention, working memory, and executive functions in addition to aphasia. In addition, those with right hemisphere involvement may exhibit a certain degree of attention and visual-spatial recognition (25). A study demonstrated that left hemisphere involvement has a greater effect on cognitive functions (26). On the other hand, our study found that FIM-cognitive scores were lower in patients with left hemisphere involvement. While MMSE scores were relatively lower in patients with left hemisphere involvement, there was no statistically significant difference. After treatment, improvement in cognitive functions was detected in both patients with left and right hemisphere involvement. However, there was no difference in the magnitude of improvement between the groups.

When other risk factors affecting cognitive functions were evaluated, the MMSE and FIM-cognitive scores were lower in female stroke patients in our study. Similar studies to ours indicate that cognitive functions are affected more in women (20,21). On the contrary, a study shows that cognitive function is more adversely affected in men (18). Considering patients' duration of education, in this study, MMSE scores were lower in those with ≤5 years of education. Although it was not statistically significant, the FIM-cognitive score was relatively lower in those with ≤5 years of education. Similar to our findings, it has been reported in the literature that cognitive functions are more affected in individuals with lower education levels (18,21,26,27). However, we believe that the test results evaluating the cognitive functions of people with low education levels before their stroke may also have been low. Some studies' data indicate that smoking (20,28), HT (18,20,28,29), and DM (21,27,29) may also be risk factors for the development of PSCI. However, our study revealed no difference between smokers and non-smokers, or between those with and without HT or DM. Although cognitive functions improved after 1 month of treatment in all groups, only the MMSE scores of those without HT and the FIM cognitive scores of those with DM and >5 years of education were statistically insignificant. There was no difference between the groups in terms of the level of improvement in any of the groups.

There were some limitations in our study. First of all, cognitive dysfunction manifests itself in various ways. We made evaluations using MMSE and FIM-cognitive, which are used frequently in other investigations. Although the patients included in the study were chronic patients for longer than 12 months, it would be better to compare this improvement with the patients who received a specific cognitive rehabilitation program to determine whether this improvement is due to the natural course of the disease or the treatment administered. However, we think that spontaneous neurological recovery is less after 12 months of ongoing chronic stroke.

CONCLUSION

As a result, domain-specific cognitive rehabilitation cannot be applied in every center, and we believe that a rehabilitation program without specific cognitive rehabilitation can improve the cognitive functions of individuals regardless of risk factors. Although there is no improvement according to BMRS and FAC staging, rehabilitation to be applied in patients with chronic stroke will improve the cognitive functions and functional independence of the patients. Improvements in these cognitive functions will encourage people to participate in treatment and carry out their daily activities.

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Conflict of Interest: *The authors declare that they have no competing interest.*

Ethical approval: *The ethics approval for the study was obtained from the Ethics Committee of Giresun University with a decision number (2019/KAEK-55). All participants gave written informed consent and the study was performed following the 1964 Declaration of Helsinki.*

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