ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.31609/jpmrs.2022-88639

Predictors of Cognitive Impairments in Patients with First-Ever and Recurrent Stroke

İlk ve Tekrarlayan İnmeli Hastalarda Bilişsel Bozuklukların Prediktörleri

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ABSTRACT Objective: Cognitive impairments usually occur after stroke. The primary aim of this study was to determine the predictors of cognitive impairments in patients with first-ever and recurrent stroke, and the secondary aim was to reveal and compare the improvements in physical, emotional and cognitive functions, sleep quality and quality of life after 4-week traditional and cognitive rehabilitation programs. **Material and Methods:** Patients were assigned into two groups: first-ever stroke (n=21) and recurrent stroke (n=18). Cognitive functioning was measured with a neuropsychological test battery comprising immediate and delayed memory, attention, non-verbal reasoning, and apraxia components; and Mini-Mental Status Examination (MMSE). Physical function, emotional status, sleep quality, and quality of life were evaluated by Functional Independence Measure (FIM), Beck Depression Inventory, Pittsburgh Sleep Quality Index, and Nottingham Health Profile, respectively. Patients received both conservative and cognitive rehabilitation and assessed at baseline (T0) and after the 4-week program (T1). **Results:** Age was negatively related to MMSE in both groups and verbal paired associates (VPA)-1 and Raven's Standard Progressive Matrices test in Group 2. There was a positive relationship between left-hemiplegic side and VPA-1 and VPA-2 tests in both groups. Number sequencing test, motor, total FIM scores, emotional reactions and social isolation subgroups improved better in favor of Group 1, at T1. **Conclusion:** Age and hemiplegic side are strong predictors of cognitive impairment. Young patients have better cognitive status, while patients with right hemispheric lesions have better verbal outcomes. Including attention skills in cognitive programs may increase the effectiveness of rehabilitation in patients with first-ever stroke.

Keywords: Cognitive function; predictor; stroke; recurrent; rehabilitation

ÖZET Amaç: İnme sonrası genellikle bilişsel bozukluklar ortaya çıkar. Bu çalışmanın birincil amacı, ilk ve tekrarlayan inmeli hastalarda bilişsel bozuklukların prediktörlerini belirlemek; ikincil amacı, bu hastalarda 4-haftalık geleneksel ve bilişsel rehabilitasyon programı sonrası fiziksel, emosyonel ve bilişsel fonksiyonlarda, uyku ve yaşam kalitesinde oluşan gelişmeleri ortaya koymak ve karşılaştırmaktır. **Gereç ve Yöntemler:** Hastalar, ilk inme (n=21) ve tekrarlayan inme (n=18) olarak 2 gruba ayrıldı. Bilişsel işlevsellik; anlık ve gecikmeli hatırlama, dikkat, sözel olmayan akıl yürütme, apraksi bileşenlerini kapsayan bir nöropsikolojik test bataryası ve Mini Mental Test (MMT) ile ölçüldü. Fiziksel fonksiyon, duygudurum, uyku kalitesi ve yaşam kalitesi sırasıyla Fonksiyonel Bağımsızlık Ölçeği (FBÖ), Beck Depresyon Ölçeği, Pittsburgh Uyku Kalitesi İndeksi ve Nottingham Sağlık Profili ile değerlendirildi. Hastalara, hem geleneksel hem de bilişsel rehabilitasyon programı uygulandı. Başlangıçta (T0) ve 4 haftalık programdan sonra (T1) değerlendirildi. **Bulgular:** Yaş, MMT ile her iki grupta, sözel çağrışım çiftleri-1 ve Raven Standart Progresif Matrisler Testi ile sadece Grup-2'de negatif ilişkili idi. Her iki grupta da sol hemiplejik taraf ile sözel çağrışım çiftleri-1 ve sözel çağrışım çiftleri-2 arasında pozitif bir ilişki vardı. Sayı dizisi testi, motor, toplam FBÖ puanları, duygusal reaksiyonlar ve sosyal izolasyon alt grupları T1'de Grup 1 lehine daha iyi gelişti. **Sonuç:** Yaş ve hemiplejik taraf kognitif bozuklukların güçlü prediktörleridir. Genç hastalarda kognitif durum daha iyiyken, sağ hemisferik lezyonu olan hastalar daha iyi sözel sonuçlara sahiptir. Bilişsel programların dikkat becerilerini içermesi, ilk inmeli hastalarda rehabilitasyonun etkinliğini artırabilir.

Anahtar Kelimeler: Bilişsel işlev; prediktör; inme; tekrarlayan; rehabilitasyon

Stroke recurrence is common and is well documented in studies with the rates ranging from 8-12 percent in the first year, 9-14 percent within two years, and to 25 percent within five years.[1-4] The type is generally the same as the initial stroke (ischemic or hemorrhagic).[1-4] Recurrent strokes have been

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Peer review under responsibility of Journal of Physical Medicine and Rehabilitation Science.

Received: 01 Feb 2022 ***Received in revised form:*** 22 Apr 2022 ***Accepted:*** 12 May 2022 ***Available online***: 23 May 2022

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shown to cause higher rates of long-term disability with more severe physical and cognitive impairments than the first-ever strokes.[3,4]

A degree of cognitive impairment usually arises in both subacute and chronic phases of stroke. It can reduce the ability to perform daily living activities, cause mood and sleep disturbances, and thereby that can lower the patient's quality of life (QoL).[5,6] To evaluate the cognitive functions of patients with objective neuropsychological tests is important.[5] Cognitive functions, which are the complex collection of mental skills, include attention, perception, comprehension, learning, memory, problem solving, and reasoning.[7] The main treatment approach to stimulate recovery after stroke is to implement an early and intensive rehabilitation program designed to limit the extent of disability and to improve functional outcomes to regain maximum independence.[8] Post-stroke restoration of physical function has been extensively researched with evidence of significant improvements following physical rehabilitation. The optimization of rehabilitation interventions and resources will be facilitated by the well-known conclusions in this regard. Functional recovery after stroke has been one of the most popular and frequently discussed topics.[9,10] However, there is scarce information about cognitive functions and rehabilitation strategies for restoration, particularly in recurrent stroke. It is difficult to predict the prevalence of post-stroke cognitive impairment, given the range of potential deficits, including memory, attention, and visuospatial ability, the reported rates range from 30-50%. In a systematic review reported by Van Rijsbergen et al., the prevalence of subjective cognitive complaints ranging from 1-54 months after stroke was reported to be 28.6-90.2%.[11] Previous studies generally used a global scale such as the Mini-Mental State Examination (MMSE) instead of a comprehensive and specific cognitive test battery and were designed without details such as the first-ever or recurrent stroke or without follow-up periods. This highlights the need to obtain more data on cognitive outcomes after first or recurrent stroke, as well as a better understanding of the potential risk factors that may affect cognitive outcomes. The requirement for follow-up studies after inpatient cognitive rehabilitation is another relatively unexplored area.

Therefore, the aims of our study were (1-) to identify the predictors of cognitive impairments in patients with first-ever and recurrent stroke (2-) to reveal and compare the improvements in physical, emotional and cognitive functions, sleep quality and QoL after a 4-week traditional and cognitive rehabilitation programs in these patients.

MATERIAL AND METHODS

SUBJECTS AND PROCEDURES

The study was designed and performed as a prospective clinical trial. Stroke patients between the ages of 18 and 75 who had stable neurological status, consecutively referred to the physical medicine and rehabilitation clinic for inpatient rehabilitation were included in this study. The patients with sensory aphasia, neglect, vasomotor instability (coagulation disorder), and drug use affecting cognitive functions were excluded from the study. Participants were totally volunteers and were informed about the nature of the study. All procedures were in consistency with the Helsinki Declarations of 1975. The study was approved by the local ethical committee of University of Health Sciences, Dışkapı Yıldırım Beyazıt Training and Research Hospital (date: November 11, 2013, no: 11/16). All participants provided informed consent in the format required by the clinical research ethics committee of University of Health Sciences, Dışkapı Yıldırım Beyazıt Training and Research Hospital.

Demographic characteristics were recorded for each patient including age, gender, people living with the patient, body mass index, duration and type of stroke, hemiplegic side, and dominancy. Patients were divided into 2 groups; the patients with the first-ever stroke (Group 1), the patients with recurrent stroke (Group 2).

OUTCOME ASSESSMENT

Patients were evaluated by the same physician in terms of all assessment parameters to minimize measurement variability. A number of assessments have been conducted to determine cognitive, physical, and emotional functions, sleep quality, and quality of life.

A privacy, well-lit room with no distractions was set up for cognitive functions. The registration form, pencil, chronometer, and a blank piece of paper were placed on a table. The neurophysiologic tests were conducted in 2 sessions and lasted approximately 2 hours. Rest periods were provided if needed. The tests were applied in the morning hours when patients were not tired. All patients were informed before each test.

- The Wechsler Memory Scale-Revised is one of the internationally well-known batteries for memory assessment.[12] The evaluation set designed in this study included immediate and delayed memory and attention components with figural memory test (FMT) (recall of geometric shapes), verbal paired associates (VPA)-1 and 2 tests (recall of words), and number-sequencing test (NST), respectively.

- Non-verbal reasoning was applied to all subjects using Raven's Standard Progressive Matrices Test (RSPMT).[13] The RSPMT consists of 60 items each showing a pattern problem with a missing piece. The subjects were instructed to select the correct part, among 6 to 8 alternatives, allowing the design to be completely accurate.

- The ideomotor apraxia test comprises 20 items, divided into 4 categories (facial, upper extremity, instrumental and complex), each containing 5 items.[14] The participants were invited to reproduce the movement with the non-paretic limb immediately after the presentation.

- MMSE was applied in order to assess global cognitive function.[15] MMSE scores range from 0 to 30 with lower scores indicating impaired performance.

The score of the Functional Independence Measure (FIM) was used to rate independence in activities of daily living and cognitive functions.[16] Items are scored on the level of assistance needed for an individual to perform daily living activities. The scale includes 18 items, scoring from 1 to 7 according to the level of independence: 1 represents total dependence and 7 indicates complete independence. Possible scores range from 18-126.

Beck Depression Inventory (BDI) was used to examine the emotional stability of patients.[17] The BDI is a 21-item questionnaire that explores depressive symptoms including sexual dysfunction, fatigue, weight problems, and sleep disorders. Each item has a list of four statements that are scored between 0-3. The score more than 9 was considered to have depression. Beck Anxiety Inventory is a self-report measure of anxiety with 21 items, demonstrating severe anxiety with higher scores.

Pittsburgh Sleep Quality Index, is a 19-item self-rated questionnaire that evaluates SQ over a 1-month time interval.[18] It includes 19 individual items generating 7 component scores: subjective SQ, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The total score ranges between 0 and 21, with higher scores (≥5) indicating poor SQ.

Nottingham Health Profile (NHP) is a generic QoL scale, of which physical, social, and emotional health status is assessed.[19] It is divided into six subscales (pain, physical mobility, emotional reactions, social isolation, sleep, and energy level) and consists of 38 items. The scores vary between 0 and 100, where 0 indicates good health and 100 indicates poor health. Each statement is scored using weighted values.

REHABILITATION PROGRAM

Patients received 1 hour of the conventional rehabilitation program for motor and functional recovery, 5 days per week, for 4 weeks. The program included occupational exercise sessions, range of movement, strengthening, stretching, balance and activities of daily living exercises according to each patient's tolerance and needs.

A cognitive rehabilitation program was conducted by a trained psychologist on a computer with RehaCom (Hasomed Inc, Magdeburg, Germany, http://www.hasomed.de) software for 4 weeks, 3 days a week. RehaCom includes activation and stimulation of various cognitive domains, such as attention, memory, and executive functions. The program includes several modules with different difficulty levels, the patient automatically increases the difficulty level after successfully performing simpler procedures. The number of errors of all patients, the time of completion of the test and the results are stored in the database.[20]

The conservative and cognitive rehabilitation programs were applied/modified according to the impairments and performance of the patients.

The relationship between cognitive functions and patients' demographic and clinical parameters was investigated to identify factors related to cognitive functions. Moreover, cognitive and clinical assessment parameters as well as changes were performed both within and between groups at baseline (T0) and after rehabilitation program (T1).

STATISTICAL ANALYSIS

SPSS version 15.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. The normality of continuous variables was analyzed by the Shapiro Wilks test. Descriptive statistics are given as mean±standard deviation for continuous variables, and as a percentage (%) for categorical and nominal variables. While the statistically significant difference between groups was assessed by the independent sample t-test for continuous variables, nominal and categorical variables were analyzed by χ^2 and Fisher's exact test. In addition, the statistically significant difference between recurrent measurements in the groups was assessed by the dependent sample t test and Bonferroni correction was applied to control Type I failure. Pearson's correlation test was used to establish the relationship between the cognitive function tests and the demographic and clinical parameters. Correlation coefficient was evaluated as "very weak" for 0-0.200, "weak" for 0.201-0.400, "medium" for 0.401-0.600, "strong" for 0.601-0.800 and "very strong" for 0.801-1.00. Baseline cognitive function parameters were accepted as a dependent variable and simple linear regression analysis was performed for significant correlations. The statistical significance level was set at $p<0.05$.

TABLE 1: Demographic and clinical characteristics of the patients.

	First-ever stroke n=21	Recurrent stroke n=18	p value
Age, years, mean±SD	60.33±11.03	57.5±13.6	0.602*
Gender, n (%)			
Male	15 (71.4)	17 (94.4)	0.065&
Female	6 (28.6)	1 (5.6)	
People living with patient, n (%)			
Living alone	3 (14.3)	1 (5.6)	0.484&
Partner	16 (76.2)	15 (83.3)	
Relative	2 (9.5)	2 (11.1)	
BMI, kg/m^2, mean±SD	27.2±4.91	27.7±3.37	0.515*
Stroke duration, days, mean±SD	5.9±10.69	4.6±4.23	0.633*
Stroke type, n (%)			
Ischemic	18 (85.7)	14 (77.8)	0.704&
Hemorrhagic	3 (14.3)	4 (22.2)	
Hemiplegic side, n (%)			
Right	10 (47.6)	9 (50)	0.884¥
Left	11 (52.4)	9 (50)	
Dominancy			
Dominant	10 (47.6)	10 (55.6)	0.626¥
Non-dominant	11 (52.4)	8 (44.4)	

*: Independent sample t test; &: Fisher's exact test; ¥: χ^2 test; BMI: Body mass index.

RESULTS

Twenty-one first-ever and 18 recurrent stroke patients were included in this study. The demographic and clinical characteristics of the patients are presented in Table 1. The groups were homogenous with respect to these variables.

Age was correlated negatively with MMSE (Group 1; r/p=-0.530/0.013, Group 2; r/p=-0.538/0.018) and VPA-1 (Group 1; r/p=-0.447/0.043, Group 2; r/p=-0.531/0.021) in both groups, and with RSPMT (r/p=-0.551/0.017) in Group 2. Positive correlations were found between left hemiplegic side and VPA-1 (Group 1; r/p=0.551/0.009, Group 2, r/p= 0.728/0.001) and VPA-2 (Group 1; r/p=0.618/0.003, Group 2; r/p=0.711/0.001) in both groups. According to NHP subscales, there were negative correlations between pain and FMT (r/p=-0.456/0.038) in Group 1, pain (r/p=-0.49/0.039), physical activity (r/p=-0.523/0.026), and sleep (r/p=-0.496/0.036) with RSPMT in Group 2 (Table 2, Table 3).

The variables correlated with cognitive functions were selected for simple linear regression analysis. Age and hemiplegic side remained significant for cognitive functions in regression analysis. No rela-

TABLE 2: Correlation analysis on cognitive functions of first-ever stroke patients.

	MMSE	FMT	VPA 1	VPA2	NST	RSPMT	IAT
	r/p	r/p	r/p	r/p	r/p	r/p	r/p
Age	**-0.530/0.013**	-0.399/0.073	**-0.447/0.043**	-0.200/0.385	-0.101/0.664	-0.365/0.104	0/1.000
Gender	-0.053/0.820	-0.224/0.330	-0.114/0.622	-0.284/0.213	-0.288/0.205	-0.166/0.473	0/1.000
Living with people	0.296/0.193	-0.338/0.134	-0.270/0.237	-0.402/0.070	0.020/0.933	0.343/0.128	0/1.000
BMI	-0.302/0.184	-0.266/0.244	0.170/0.460	0.262/0.251	-0.409/0.065	-0.266/0.243	0/1.000
Stroke duration	-0.018/0.940	0.222/0.334	0.292/0.199	0.193/0.403	0.246/0.282	0.161/0.485	0/1.000
Stroke type	-0.273/0.232	-0.139/0.549	-0.182/0.431	-0.129/0.578	-0.134/0.563	0.282/0.216	0/1.000
Affected body part	-0.081/0.239	-0.032/889	**0.551/0.009**	**0.618/0.003**	0.045/0.846	-0.308/0.175	0/1.000
FIM-total	0.082/0.722	0.024/0.918	0.210/0.260	0.283/0.214	0.262/0.252	-0.081/0.726	0/1.000
Motor	0.128/0.181	0.342/0.215	0.031/0.732	0.242/0.291	0.518/0.435	0.312/0.185	0/1.000
Cognitive	0.367/0.060	0.071/0.054	0.315/0.052	0.373/0.095	0.071/0.051	0.128/0.057	0/1.000
BDI	0.056/0.811	0.134/0.561	0.267/0.243	0.112/0.629	0.089/0.700	0.376/0.093	0/1.000
BAI	-0.056/0.811	-0.254/0.266	0.227/0.322	0.151/0.514	-0.097/0.675	-0.136/0.558	0/1.000
PSQI	-0.344/0.827	0.254/0.267	0.197/0.392	0.080/0.730	0.195/0.396	0.275/0.228	0/1.000
NHP							
Pain	-0.149/0.519	**-0.456/0.038**	0.016/0.947	-0.086/0.712	-0.073/0.753	-0.170/0.461	0/1.000
Physical activity	-0.052/0.823	-0.128/0.580	0.086/0.712	-0.083/0.721	0.051/0.826	-0.012/0.959	0/1.000
Emotional reaction	-0.015/948	-0.129/0.579	0.047/0.840	-0.125/0.588	0.106/0.646	-0.090/0.697	0/1.000
Social isolation	-0.120/0.604	-0.203/0.378	0.059/0.799	-0.137/0.555	0.081/0.728	-0.087/0.707	0/1.000
Sleep	-0.175/0.447	0.120/0.603	0.179/0.437	-0.070/0.763	0.253/0.269	0.348/0.122	0/1.000
Energy	-0.055/0.812	-0.163/0.481	0.165/0.475	0.098/0.672	0.035/0.879	-0.078/0.737	0/1.000

r: Correlation coefficient; MMSE: Mini Mental State Examination; FMT; Figural memory test; VPA: Verbal paired associates; NST: Number-sequencing test, RSPMT: Raven's Standard Progressive Matrices Test; IAT: Ideomotor apraxia test; BMI: Body mass index; FIM: Functional Independence Measure; BDI: Beck Depression Inventory; BAI: Beck Anxiety Inventory; PSQI: Pittsburgh Sleep Quality Index; NHP: Nottingham Health Profile. A value of p<0.05 was considered to be statistically significant. Pearson's correlation test was used.

tionship was found between NHP subscales and cognitive functions in both groups (Table 4, Table 5).

The outcomes of the groups regarding cognitive, physical, and emotional functions, sleep quality, and QoL at T0 and T1 are illustrated in Table 6. In terms of cognitive evaluations, the improvement in NST was better in favor of Group 1 patients (p=0.002). Functionally, both groups improved in motor and total scores, while Group 1 was superior (p=0.001, p=0.001). Emotional reactions and social isolation scores increased statistically more in Group 1 compared to Group 2 (p=0.022, p=0.012, respectively).

DISCUSSION

Age was associated negatively with MMSE for both groups, VPA-1 and RSPMT for recurrent stroke patients. Additionally, there was a positive relationship between the left-hemiplegic side and VPA-1 and VPA-2 tests in both groups. NST, motor and total FIM scores, emotional reactions and social isolation subgroups improved better in favor of Group 1 after the rehabilitation program.

A meta-analysis noted that 10% of patients had dementia before the first stroke, 10% developed dementia, especially after 3 months of the first stroke, and more than 30% developed dementia after recurrent stroke.[21] The risk of recurrent stroke survivors having post-stroke cognitive impairment was 2.7 times higher than for first-ever stroke patients.[22] Similarly, in our study, it was observed that the cognitive function test scores were lower in the recurrent stroke group.

One of the variables affecting the neuropsychological performance of stroke patients was recorded as age.[23] There is evidence that the prevalence of the cognitive decline after stroke is likely to increase exponentially as age increases after 65 years old.[24] Yalıman et al. reported that cognitive function scores decrease with increasing age at both post-stroke and

TABLE 3: Correlation analysis on cognitive functions of recurrent stroke patients.

	MMT r/p	FMT r/p	VPA 1 r/p	VPA2 r/p	NST r/p	RSPMT r/p	IAT r/p
Age	**-0.538/0.018**	-0.415/0.087	**-0.531/0.021**	-0.462/0.054	-0.456/0.057	**-0.551/0.017**	0.070/0.781
Gender	-0.302/0.208	-0.098/0.698	-0.094/0.710	-0.087/0.732	-0.192/0.446	-0.095/0.708	0.059/0.817
Living with people	0.167/0.494	0.181/0.471	-0.090/0.723	0.014/0.956	0.119/0.639	0.438/0.069	0.036/0.887
BMI	0.164/0.502	-0.002/0.985	0.011/0.967	-0.137/0.588	-0.104/0.683	-0.126/0.618	0.403/0.098
Stroke duration	-0.282/0.257	-0.019/0.940	-0.06/0.808	-0.041/0.872	-0.131/0.605	-0.042/0.869	-0.436/0.071
Stroke type	-0.225/355	0.027/0.915	0.169/0.503	-0.130/0.608	-0.157/0.533	0.022/0.931	-0.454/0.059
Affected body part	0.318/0.157	0.034/0.894	**0.728/0.001**	**0.711/0.001**	0.276/0.268	0.144/0.569	0.243/0.332
FIM-total	0.449/0.054	0.259/0.299	-0.372/0.128	0.245/0.326	0.430/0.075	0.474/0.052	0.230/0.350
Motor	0.312/0.247	0.078/0.816	0.148/0.354	0.196/0.436	0.172/0.252	0.318/0.126	0.481/0.119
Cognitive	0.118/0.052	0.128/0.052	0.231/0.053	0.453/0.059	0.158/0.056	0.284/0.051	0.221/0.057
BDI	-0.294/0.221	0.024/0.925	-0.410/0.091	-0.183/0.468	-0.254/0.309	-0.213/0.365	-0.258/0.301
BAI	-0.001/0.996	0.205/0.415	0.063/0.804	-0.156/0.535	0.261/0.296	-0.082/0.746	0.281/0.259
PSQI	-0.453/0.052	-0.162/0.521	-0.117/0.644	0.262/0.293	0.008/0.975	-0.231/0.355	0.024/0.925
NHP							
Pain	-0.286/0.235	-0.162/0.521	-0.045/0.860	-0.144/0.569	-0.112/0.658	**-0.490/0.039**	-0.070/0.782
Physical activity	-0.309/0.198	-0.199/0.428	-0.204/0.417	-0.309/0.212	-0.477/0.051	**-0.523/0.026**	-0.191/0.448
Emotional reaction	-0.198/0.416	-0.046/0.855	0.091/0.719	0.033/0.898	0.042/0.869	-0.409/0.092	0.258/0.301
Social isolation	-0.197/0.418	0.064/0.802	-0.068/0.789	-0.151/0.550	-0.019/0.941	-0.350/0.155	0.096/0.706
Sleep	-0.067/0.784	0.094/0.709	0.139/0.581	0.071/0.780	-0.029/0.910	**-0.496/0.036**	0.311/0.209
Energy	-0.193/0.428	-0.365/0.136	0.092/0.718	-0.127/0.615	-0.357/0.145	-0.460/0.055	0.200/0.427

r: Correlation coefficient; MMSE: Mini Mental State Examination; FMT: Figural memory test; VPA: Verbal paired associates; NST: Number-sequencing test; RSPMT: Raven's Standard Progressive Matrices Test; IAT: Ideomotor apraxia test; BMI: Body mass index; FIM: Functional Independence Measure; BDI: Beck Depression Inventory; BAI: Beck Anxiety Inventory; PSQI: Pittsburgh Sleep Quality Index; NHP: Nottingham Health Profile. A value of p<0.05 was considered to be statistically significant Pearson's correlation test was used.

TABLE 4: Sample linear regression analysis results for age and hemiplegic side in both groups.

	First-ever stroke Odds ratio, 95% CI	pvalue	Recurrent stroke Odds ratio, 95% CI	p value
Age				
MMSE	-0.447 (-0.378)-(-0.007)	**0.042**	-0.484 (-0.454)-(-0.010)	**0.048**
VPA-1	-0.296 (-0.071)-(-0.327)	0.193	-0.626 (-0.443)-(-0.091)	**0.005**
RSPMT	-0.441 (-0.577)-(-0.007)	0.055	-0.549 (-0.607)-(-0.065)	**0.018**
Hemiplegic side				
VPA-1	0.557 (1.493-9.007)	**0.009**	0.670 (3.040-11.710	**0.002**
VPA-2	0.616 (0.944-3.945)	**0.003**	0.708 (1.463-4.737)	**0.001**

CI: Confidence interval; MMSE: Mini Mental State Examination; VPA: Verbal paired associates; RSPMT: Raven's Standard Progressive Matrices Test.

healthy groups.[25] Patel et al. found a relation between post-stroke cognitive disorders and age.[26] Our results showed a negative correlation between age and some cognitive components including global cognition for both groups and memory and non-verbal reasoning for patients with recurrent stroke.

Conventional studies indicate that left cerebral hemispheric lesions often cause significant impairment to language and verbal memory functioning whereas right hemispheric damage is associated with deficits in nonverbal, perceptual-motor, and spatial abilities.[27,28] This study demonstrated that the left-

TABLE 5: Sample linear regression analysis results for RSPMT in both groups.

	First-ever stroke Odds ratio, 95% CI	p value	Recurrent stroke Odds ratio, 95% CI	p value
RSPMT				
Pain	-0.085(-0.217-0.048)	0.161	-0.093 (-0.208-0.022)	0.104
Physical activity	-		-0.124 (-0.268-0.019)	0.085
Sleep	-		-0.079 (-0.215-0.078)	0.237

CI: Confidence interval; RSPMT: Raven's Standard Progressive Matrices Test.

TABLE 6: The outcomes of cognitive, physical, and emotional functions, sleep quality and quality of life at T0 and T1.

	First-ever stroke			Recurrent stroke			Inrgroup
	T0	T1	p value	T0	T1	p value	p value
MMSE	24.5±4.7	24.9±3.9	0.419	21.5±.5	22.5±.7	0.141	0.353
WMS-R							
FMT	5.05±1.68	5.29±1.73	0.393	4.56±1.54	4.50±1.65	0.918	0.716
VPA-1	10.33±4.77	10.81±4.78	0.483	8.17±5.81	9.33±5.85	0.264	0.820
VPA-2	3.95±2.01	4.14±2.08	0.645	2.78±2.23	3.11±2.37	0.190	0.093
NST	7.52±2.67	9.14±2.26	**0.002**	6.39±3.10	6.39±2.87	1.000	**0.019**
RSPMT	19.05±7.30	20.29±8.90	0.275	16.17±8.34	16.22±7.35	0.944	0.403
IAT	60±0.0	60±0.0	1.000	59.83±0.70	59.83±0.70	1.000	1.000
FIM-total	85.4±18.3	98.5±13.1	**0.001**	97.7±18.6	102.1±16.5	**0.002**	**0.001**
Motor	51.7±18.3	64.1±12.4	**0.001**	63.7±17.5	68.1±15.5	**0.002**	**0.001**
Cognitive	33.7±3.2	34.3±1.5	0.102	34.0±2.6	34.0±2.6	1.000	0.460
BDI	17.2±11.0	14.1±10.5	0.208	13.0±5.4	12.4±6.5	0.543	0.369
BAI	13.9±12.2	10.0±11.4	0.033	11.6±8.5	11.8±9.5	0.889	0.088
PSQI	7.7±6.1	7.8±5.7	0.820	5.7±3.9	4.8±2.8	0.321	0.451
NHP							
Pain	39.1±37.3	37.6±41.9	0.583	41.7±31.0	36.5±32.2	0.221	0.436
Physical mobility	75.6±23.6	66.1±20.8	0.026	64.0±25.2	55.6±31.2	0.168	0.607
Emotional reactions	54.9±29.1	44.1±35.1	**0.033**	36.4±32.6	39.7±31.0	0.450	**0.022**
Social isolation	53.8±34.2	38.5±35.2	**0.010**	34.3±35.5	32.8±33.5	0.44	**0.012**
Sleep	45.6±35.2	42.2±34.1	0.212	24.2±27.5	19.0±18.2	0.282	0.667
Energy	75.1±28.3	68.8±30.5	0.178	74.6±27.9	64.7±27.3	0.103	0.812

MMSE: Mini Mental State Examination; WMS-R: Wechsler Memory Scale-Revised; FMT: Figural memory test; VPA: Verbal paired associates; NST: Number-sequencing test; RSPMT: Raven's Standard Progressive Matrices Test; IAT: Ideomotor apraxia test; FIM: Functional Independence Measure; BDI: Beck Depression Inventory; BAI: Beck Anxiety Inventory; PSQI: Pittsburgh Sleep Quality Index; NHP: Nottingham Health Profile. A value of p<0.05 was considered to be statistically significant. Dependent sample t-test was used.

hemiplegic side of the body was associated positively with verbal tests in all patients. Therefore, patients with right hemispheric lesions had better verbal outcomes in groups than left hemispheric involvement.

Our results suggest that after 4 weeks of rehabilitation (except for successful results of NST), a recovery in cognitive functions occurred numerically but was not shared statistically. The NST which reflects attention was the most improved parameter in the study of Hochstenbach et al. similar to our findings.[29] In conformity with the literature, supporting that cognitive involvement and recovery are more difficult in patients with multiple infarctions, no significant improvement in attention was found in the recurrent stroke group. It was thought that the leading cause of why there was no significant improvement in attention and concentration in these recurrent-stroke patients as in patients with first-stroke was that this dysfunction could be a sequel to previous strokes.[30]

Yeh et al. found that aerobic exercise combined with computerized cognitive training has better effects on the cognitive functional status of survivors of stroke than active control.[31] Studies have shown that directing students' attention to the effects of their movements may be more beneficial than learning their attention to the details of their actions.[32] Incorporation of attention focus into rehabilitation, as it affects the learning of motor skills, can potentially increase the effectiveness of rehabilitation.

After the rehabilitation program, an improvement was noted in the functional scores of all patients and in terms of some QoL components with the superiority of first-ever stroke patients. Despite short-term implementations, positive results were achieved as expected. However, any of the functional, emotional, sleep quality or QoL variables used in this study was not a predictive factor on cognitive tests.

The study had some shortcomings. It was a cohort study, with-no matched non-stroke group available in the comparison of cognitive outcomes. The findings of the study are limited to stroke cases presenting to hospital that were hospitalized, having inpatient treatment. The number of groups was relatively small. Because patients with aphasia and neglect were excluded from the study (to exclude unreliable data) in order to limit the study to a specific patient profile. In addition, patients with stroke who had difficulty continuing the RehaCom program after the first evaluation could not carry on to contribute to the study. We used mean scores of each domain without regard to cut-off points, for both cognitive and clinical outcomes, thus leading to less specificity. However, this study provided a meaningful contribution to the issue of cognitive functions, as yet scarce data, using detailed tests instead of global tests.

CONCLUSION

Age is a powerful predictor of cognitive impairments. This situation can be speculated as an impending challenge due to the aging population. The study underlines that patients with right hemispheric lesions have better verbal outcomes than left hemispheric involvement in first-ever or recurrent stroke patients. Another remarkable point is incorporating attention skills into cognitive programs can potentially increase the effectiveness of rehabilitation particularly in first-ever stroke patients. It is important to prevent recurrence of stroke since there is a vicious circle between recurrent stroke and impairment of cognitive functions.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

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