ORIGINAL ARTICLE

The effect of cognitive impairment on functional outcome after stroke: A cross sectional study

Alia Saberi [1], Mozaffar Hosseininezhad [1], Sajjad Rezaei [2], Saeideh Salehil [1], Saeideh Aghayari Sheikh Neshin [3], Bahador Hasanzadeh [3]

[1] Neuroscience Research Center, Department of Neurology, Poursina Hospital, Guilan University of Medical Sciences, Rasht, Iran, [2] Department of Psychology, University of Guilan, Rasht, Iran. [3] Guilan University of Medical Sciences, Rasht, Iran.

Correspondence to: Sajjad Rezaei, Department of Psychology, University of Guilan, Tehran road, Rasht, Iran and Neuroscience research center, Poursina hospital, Namjoo Street, Rasht, Iran. Tel: +989113390785; email: Rezaei_Psy@hotmail.com; sajjad.rezaei@guilan.ac.ir). Fax: +981333690385

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Abstract

OBJECTIVES: Better functional prognosis of stroke after physical rehabilitation has been established following extensive investigations. However, efficacy of cognitive rehabilitation has not been clearly understood and in order to understand it, a possible association between cognitive and functional status of stroke survivors should be studied. The main objective of this study was to identify a relationship between cognitive impairment and functional outcome in chronic stroke patients.

METHODS: Stroke survivors (N=206) were recruited consecutively in a cross sectional study, at least six months after stroke. Using the Barthel Index (BI), patients were divided into two groups of functionally independent (N=146) and dependent (N=60). The Montreal Cognitive Assessment (MoCA) test was used for cognition evaluation and N=15 of patients were cognitively intact and N=191 were cognitively impaired. Statistical analysis was performed to find significant association between MoCA scores and demographic variables including age, gender, marital and job status, years of education, side of lesion and comorbidities and functional dependence.

RESULTS: The total MoCA score and all MoCA subtests were significantly related to functional dependence ($p \leq 0.05$). The total MoCA score was also an independent predictor of the BI score. It was shown that functional dependent patients were older, with lower years of education and higher numbers of females, housekeepers, and unmarried status.

CONCLUSION: The cognitive impairment had a significant impact on functional performance after stroke. Hence, more attention need to be given to cognitive status of patients after stroke in order to accomplish a more efficient rehabilitation and promote functional abilities of stroke survivors.

Introduction

Stroke is the second principal cause of death and the major cause of serious disability worldwide with significant socioeconomic burden (Benjamin *et al.* 2018). The prevalence of stroke is rising because the population ages and also the number of people surviving stroke is increasing as a result of public health promotions and improvements in medical management. The growing number of stroke survivors has attracted more attention to disabilities rather than mortalities, as many patients live with

significant sequelae including functional disability, cognitive impairment and dementia. Cognitive impairment occurs frequently in different domains, including attention, language, memory, orientation, executive function, and visual perception (Viscogliosi *et al.* 2011). Acute cognitive deficits that occur soon after stroke might persist for a longer duration in many patients and might associated with reduced functional capacity and abilities to perform activities of daily living (ADL) and can affect rehabilitation outcomes (Sally *et al.* 2005). There is not a general consensus on the impact of cognitive impairment on functional outcome. There are studies that indicated no association between them (Paker *et al.* 2010; Hajek *et al.* 1997). Significant functional improvement occurs following physical rehabilitation; However, limited evidence exists on the efficacy of cognitive or motor-cognitive rehabilitation (Maeshima *et al.* 1997; Gillespie *et al.* 2015).

Better understanding of cognitive impairment effect on physical outcomes leads to a more efficient pattern of rehabilitative care for stroke survivors, improve their quality of life, and facilitate a faster return to the community. Therefore as the main purpose of this study an independent relationship between cognitive deficit and motor impairment in stroke survivors was investigated. Furthermore, Mini-Mental State Examination (MMSE) a widely used test to assess cognitive impairment in dementia was shown to be less sensitive to mild cognitive impairment (MCI) than Montreal Cognitive Assessment (MoCA) (Pendlebury *et al.* 2010). MoCA is also shown to be an accurate tool in assessment of executive function deficits which are more prominent in cognitive impairment after vascular events even in chronic post-stroke phase (Trzepacz *et al.* 2015). Considering the mentioned strengthens of MoCA, few studies have applied this test in chronic stroke patients to screen for MCI. In order to accomplish a more accurate cognitive evaluation our patients were assessed using MoCA.

Material and methods

Patients

Out of all subjects with a first-ever ischemic stroke admitted to the outpatient stroke clinic of our university hospital from June to September 2017, 206 patients were consecutively recruited to the study. Stroke diagnosis was made by a neurologist based on the standard clinical and magnetic resonance imaging (MRI) characteristics.

Patients who had the following criteria were excluded from the study; hemorrhagic stroke or prior ischemic stroke confirmed by MRI, history of seizure, functional disability prior to stroke, aphasia, neglect, dementia, psychiatric disorders (patients who had prior diagnosis and were under treatment and when necessary, the diagnosis was confirmed by a psychiatrist), chronic alcoholism, chronic comorbidities including liver, kidney and heart failure.

All the subjects signed informed consent prior to inclusion to the study. The study was approved by the Ethics Committee of Guilan University of Medical Sciences.

Measurements

Cognitive Assessment

MoCA was proposed in order to screen mild cognitive impairment and early Alzheimer's dementia. It is a rapid administrable test which evaluates different cognitive domains; attention and concentration, working memory, executive functions, short term and delayed verbal memory, language, visuo/constructional skills, conceptual thinking, calculations, and orientation to time and place. Comparison between different screening tests available for cognitive impairment showed that MoCA is the most valuable and clinically applicable test in stroke survivors which can identify a wide variety of cognitive domains. It can be administered in 10 minutes and the total score is the summation of all the scores from subtests. The maximum possible score is 30 points and patients who score ≥26 are considered cognitively normal. In order to adjust the effect of education on the MoCA, the original validation study suggested adding one extra score for individuals with ≤12 years of education (Nasreddine *et al.* 2005).

Functional Performance

Barthel index is a useful instrument to evaluate patient's independence and designed to assess the ADLs, and is a valid and reliable method for stroke patients. It quantifies ADL by evaluating ten items with different weights related to self-care and mobility. The items include feeding, moving from wheelchair to bed and return, grooming, transferring to and from a toilet, bathing, walking on level surface, going up and down stairs, dressing, continence of bowels and bladder. Cumulating of all scores for the ten items gives the total BI score. The maximum possible score is 100 which is considered functional independence and the lower scores demonstrate some degree of dependence. It can be scored by family members or anyone who knows the patient and it is not necessary to directly examine the patient (Mahoney & Barthel 1965). In the present study, the cut-off point for BI is 90 with sensitivity and specificity as 90.7 and 88.1, respectively (Uyttenboogaart *et al.* 2005). Any scores below 90 are considered dependent.

Both cognition and functional dependence evaluation were performed at least six months after the first stroke attack.

Data Analysis

Statistical analysis was made using Statistical Package for Social Sciences (SPSS v.18). The Pearson's chi-square test was used to find any significant differences

Tab. 1. Demographic characteristics of the subjects (n=206)

Variables	Functional status		*P*-value
	Independent	Dependent	
Number of patients n(%)	146(70.9%)	60(29.1%)	
Mean age (years±SD)	62.9±11.42	68.4±11.58	0.002
Gender			
Female n(%)	60(41.1%)	39(65%)	0.002
Male n(%)	86(58.9%)	21(35%)	
Marital status			
Unmarried* n(%)	27(18.5%)	19(31.7%)	0.03
Married n(%)	119(81.5%)	41(68.3%)	
Education (years±SD)	3.5±4.43	2.3±3.7	0.053
Job status			
Professional n(%)	53(36.3%)	11(18.3%)	
Manual n(%)	68(46.6%)	26(43.3%)	
Housewife n(%)	25(17.1%)	23(38.3%)	0.002
Side of lesion			
Left n(%)	55(37.7%)	16(26.7%)	
Right n(%)	70(47.9%)	36(60%)	
Bilateral n(%)	21(14.4%)	8(13.3%)	0.25
Vascular comorbidities			
Diabetes mellitus n(%)	59(40.4%)	25(41.7%)	0.86
Hypertension n(%)	108(74%)	43(71.1%)	0.73
Ischemic heart disease n(%)	56(38%)	22(36.7%)	0.82
Hyperlipidemia n(%)	53(36.3%)	28(46.7%)	0.16

n = number of participants; % = percentage; SD = Standard Deviation.
*unmarried (including single, divorced, widowed)

between groups (independent and dependent patients according to the BI score) for discontinuous variables. The Student's t-test was applied to find differences between groups for continuous variables. Logistic regression analysis revealed the predictors of functional dependency. To find the effect of cognitive impairment on functional dependence, the Student's t-test was used for both MoCA subtests and total mean score, and the logistic regression method was used for total MoCA scores. Statistical significance was considered as a p-value ≤0.05.

Results

206 patients were prospectively included in this study. Demographic characteristics of the subjects are presented in table 1. In this table patients were divided into two groups according to their BI scores.

The frequency of patients with ischemic stroke in each arterial domains were as follows: 7 (3.4%) in anterior cerebral artery (ACA), 99 (48.1%) in middle cerebral artery (MCA), 11 (5.3%) in posterior cerebral artery (PCA). The rest of patients had stroke in other arterial territories. From all ACA strokes, 2 were in ACA trunk, 4 were in pericallosal artery, and 1 was in mixed arterial branches. MCA strokes were distributed as, 8 in MCA trunk, 18 in superior branch, 10 in inferior branch, 59 in lenticulostriate branches and 4 in mixed branches. PCA strokes were distributed as 5 in cortical, 3 in deep and 3 in mixed arterial branches.

Mean NIHSS score was 2.5±2.5 and patients were divided into two groups based on this score. 34 patients scored 5 or more and the remaining 172 scored less than 5. Mean score for Barthel Index was 85±23. Patients were subdivided into two groups based on the cutoff point for BI as independent (BI score≥90) and dependent (BI score<90). According to MoCA scores, 15 (7.3%) patients were cognitively unimpaired and 191 (92.7%) patients were impaired and showed the highest frequent cognitive dysfunction among our patients.

Chi-square analysis showed that cognitive impairment was significantly higher in dependent group. It has also revealed that functional dependence was significantly more in women than men (p=0.002) and in married than unmarried patients (p=0.04). Functional dependence was statistically related to pre-stroke job status, and patients with unskilled careers e.g., laborers were more dependent but, no association with education or vascular risk factors including hypertension, hyperlipidemia, diabetes mellitus and ischemic heart disease was observed. NIHSS score was highly associated with dependence (p<0.001). Side of the lesion and different arterial domains were not related with more dependence.

Student t-test analysis has displayed that mean value for all continued variables including age, NIHSS score,

Tab. 2. Demographic characteristics of the subjects (n=206)

Variables	Functional status		*P*-value
	Independent	Dependent	
Visuospatial-executive functions	1.28±1.56	0.55±1.06	*P*<0.001
Naming	1.88±0.9	1.36±0.9	*P*<0.001
Memory	1.08 ±0.68	1.07±0.81	*P*<0.001
Attention	2.71±1.69	1.68±1.46	*P*<0.001
Language	1.67±0.87	1.2±0.8	*P*=0.003
Abstraction	0.84±0.75	0.36±0.51	*P*<0.001
Delayed recall	1.6±1.73	1.01±1.43	*P*=0.01
Orientation	4.91±1.22	3.75±1.73	*P*<0.001
Total score	15.97±6.71	10.98±6.08	*P*<0.001

MoCA = Montreal Cognitive Assessment.

years of education, and duration from stroke onset were higher in dependent group. Additionally, it showed that total MoCA score and all MoCA subtests scores were related with functional dependence. Table 2 showed the MoCA subtests and total score in dependent and independent patients.

After controlling for other variables, total MoCA score contributed significantly to the prediction of dependence using logistic regression. Table 3 showed the detailed information on this analysis.

Discussion

The main hypothesis of our study was a significant relation between cognitive impairment and functional dependence. This aim has fulfilled by our results that showed dependent patients had significantly higher proportions in cognitively impaired group. Total MoCA score was an independent predictor of functional dependence, even after controlling for other variables. One of the practical characteristics of MoCA is that the test provides both a general and specific evaluation of cognitive status. It evaluates eight different domains of cognition. According to the current study, further to total MoCA score, all of the MoCA subtests evaluating each different cognition domain were related to functional dependence. It can be concluded that for an intact motor function all of the cognition domains are needed.

Comparing our results with previous studies on this subject is difficult mostly due to different assessment tests. Study of Lim *et al.* has suggested that modified BI (MBI) improved significantly in higher MoCA scores compared to lower MoCA scores. Initial

Tab. 3. Logistic regression of predictors for functional dependence

Variables	Coefficient B	Standard error	*P*-value	OR	95.0% C.I. OR	
					Lower	Upper
Age	.040	.025	.099	1.041	.992	1.093
Sex	-.262	.537	.625	.769	.269	2.203
Marital status	-.133	.510	.794	.875	.322	2.378
Years of education	.199	.078	.010	1.220	1.048	1.420
Pre-stroke job status; professional	-	-	.119	-	-	-
Pre-stroke job status; manual	.977	.674	.147	2.656	.709	9.953
Pre-stroke job status; housekeeping	1.548	.750	.039	4.704	1.081	20.477
NIHSS score	.619	.109	.000	1.857	1.499	2.302
Time since stroke (month)	-.003	.002	.045	.997	.994	1.000
Total MoCA scores	-.144	.055	.009	.866	.778	.965

BI = Barthel Index; OR = Odds Ratio; C.I. = Confidence Interval; NIHSS = National Institutes of Health Stroke Scale; MoCA = Montreal Cognitive Assessment.

MoCA score was positively correlated with MBI in their study (Lim *et al.* 2018). One study by Claesson *et al.* has indicated that a significant number of stroke patients with cognitive impairment were dependent in most items of Sunnaas Index of ADL (SI). They also presented a relationship between cognitive deficit and ADL using both SI and Barthel index (Claesson *et al.* 2005). Similarly Rares *et al.* obtained a statistically significant correlation between cognitive and functional disability using ADL and IADL instruments (Rares *et al.* 2016). MMSE scores were significantly lower in walking-dependent group in Hiraoka study (Hiraoka *et al.* 2017). Twenty studies were included in a review attempting to find a correlation between motor and cognitive deficits in stroke patients. They have concluded a link between the two variables although no causal relation was found. Regarding the various aspects of motor and cognition, this review has reported strong correlations between motor tasks of walking and balance and cognitive abilities of attention and executive functioning. It is worth to mention that except Lim study none of the studies discussed in this paragraph has applied MoCA as their assessment tool for cognition (Verstraeten *et al.* 2016).

Inconsistent findings were also reported by some studies that makes it difficult to come to an agreement. Paker *et al.* (2010) reported no significant differences between cognitively impaired and unimpaired patients according to their Barthel index scores at discharge and after 6 months. They also reported significant improvement after rehabilitation in both groups. Analysis of correlation coefficient of three different functional tests including BI and four different cognitive tests in a study by Hajek and colleagues has shown an insignificant relationship. Regardless of the insignificant relation between functional and cognition tests, they suggested a proper cognition assessment combined with functional evaluation particularly in stroke patients to predict stroke outcome more valuable (Hajek *et al.* 1997). Another study investigating 22 hemorrhagic strokes has found that the most important predictor of ADL improvement was paresis in lower limb. None of the unilateral spatial neglect and aphasia were related with functional outcomes (Maeshima *et al.* 1997).

It seems that most of the recent studies have uncovered a significant relationship between functional dependence and cognitive impairment after stroke.

With respect to other variables evaluated in this study, patients in the functional dependent group were significantly older and more females were present among them but none of those variables had an independent predictive role in functional outcome. Age has been consistently reported as a negative predictor of functional independence (Weimar *et al.* 2002; Hofstad *et al.* 2017; Ferreira *et al.* 2015; Hirano *et al.* 2016). Sex, however, did not show such consistency in literatures. There are studies that claimed females were significantly more dependent after stroke (Weimar *et al.* 2002; Paolucci *et al.* 2006; Petrea *et al.* 2009) and female sex was an independent predictor of functional outcome assessed by modified Rankin score (Ganti *et al.* 2013). Other studies have stated no significant difference between genders (Hiraoka *et al.* 2017; Hirano *et al.* 2016). Our analysis also indicated housekeeping job status and low education level as the negative predictors of functional dependence. As an explanation these variables are associated with poor socioeconomic status that has been related to poor functional outcome (Ouyang *et al.* 2018). According to our data, NIHSS score which measures the severity of stroke, was a strong predictor of functional dependence. Many previous studies emphasized that the severity of stroke is the principle factor associated with final outcome (Weimar *et al.* 2002; Hofstad *et al.* 2017).Vascular territory and lesion side in our patients did not show any relation with functional dependence. Consistent with our findings, previous reports have shown no association between vascular territory and lesion side and functional outcome (Hiraoka *et al.* 2017; Libman *et al.* 2001). Another report, however, has shown a relation between right-sided and bilateral lesions and poor performance in functional test compared to left-sided lesions. It was also indicated that regardless of the arterial region, large vessel infarctions had poor functional outcome (Ween *et al.* 1996). Weimar *et al.* has concluded that stroke in lenticulostriate arteries was an independent predictor of functional outcome (Weimar *et al.* 2002). Diabetes has also been suggested as a negative predictor of functional dependence (Weimar *et al.* 2002).In the present study, though, comorbidities including diabetes were not related with functional dependence.

This study has some limitations. First, all subjects were recruited from a single educational hospital; hence, it is difficult to generalize the results to all stroke survivors in the community. Second, some of the patients did not participate in the rehabilitation program due to different reasons, and lack of rehabilitation might have influenced their functional outcomes after stroke. Third, patients with pre-stroke dementia were excluded from this study, but it was possible for some of our patients to have varying degrees of undiagnosed pre-stroke cognitive deficit. Fourth, according to the MoCA scores most of our cases were cognitively impaired and this might be due to relatively old and low educated patients in the study. We took 26 as the cut off value for the MoCA as it was suggested by Nasreddine *et al.* (2005). However, the original cut off value has been questioned by several studies claiming that this value might overestimate normal individuals with higher age and less education (Coen *et al.* 2011; Rossetti *et al.* 2011). Finally, number of subjects in this study is relatively low and the results might have affected. Further investigations with more patients are suggested to make more accurate conclusion.

Conclusion

Beyond all the mentioned limitations, we concluded that cognitive impairment has significant correlation with functional dependence after stroke and the MoCA scores can predict functional outcome. This finding is of great importance in post-stroke management and planning for rehabilitation to increase long-term quality of life in patients.

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Authors' contributions

A.S., M.H., S.R., S.S., S.A.S, and B.H. contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

Disclosure of interest

The authors report no conflicts of interest.

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