Poststroke Cognitive Decline: A Longitudinal Study from a Tertiary Care Center

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Abstract

Objectives Poststroke cognitive decline (PSCD) is a serious disabling consequence of stroke. The purpose of this study is to find the prevalence of PSCD and sociodemographic and clinical determinants of risk factors of PSCD.

Materials and Methods This study was a prospective, hospital-based study conducted on 200 stroke patients from stroke registry during October 2015 to April 2017. Detailed clinical evaluation was done. Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) scores were used to determine PSCD after 3 and 6 months as per the *Diagnostic and Statistical Manual of Mental Disorders* V. Chi-squared test was used to find the association between two variables. The Wilcoxon signed-rank test was used to compare the difference in cognitive impairment between two follow-ups at 3 and 6 months, respectively. A p-value < 0.05 was considered statistically significant.

Results The prevalence of PSCD measured by MoCA scale at 3 and 6 months was 67 and 31.6%, respectively. By MMSE scale, cognitive decline prevalence at 3 months was found to be 87 (46.3%), which reduced to 22 (17.1%) at 6 months. The association between MMSE scale and type of stroke was significant at 3 months.

Conclusion One-third of the stroke patients developed PSCD within 3 months of onset of stroke, with different levels of severity. The major predictors of new-onset poststroke cognitive impairment were diabetes and hypertension. The prevalence of PSCD reduced significantly at 6 months of stroke on follow-up.

Keywords
► Mini-Mental State Examination
► Montreal Cognitive Assessment
► poststroke cognitive decline
► prevalence

Introduction

Stroke or cerebrovascular accident is the dysfunction of brain due to a disturbance in the cerebral blood flow. It is a global health problem and a major cause of disability.[1] Cognitive decline is an important but less studied consequence of stroke. It can be either due to aging or due to stroke. Cognitive decline associated with normal aging does not lead to impairment in daily routine activities. However, decline in cognition due to stroke may cause mild-to-severe impairment of the same. A recent study among elderly people living in slum-urban areas of Asia's largest slum at Dharavi, Mumbai, showed confirmed stroke prevalence to be 44%, and among

these, poststroke cognitive decline (PSCD) was found to be 66.6%.[2] According to Nys et al, a large number of stroke survivors developed cognitive impairment within 3 months after stroke.[3] Another study by Sundar and Adwani used Mini-Mental State Examination (MMSE) score to measure cognitive decline and found its prevalence to be 31.7% among 164 patients.[4] The few other prospective studies in India showed that the prevalence of cognitive impairment was ~20% among total stroke survivors.[5] In a recent study in India of 50 stroke patients, it was observed that 72% patients have some form of cognitive decline.[6]

There is a lack of research on cognitive decline in Indian context. Since India is a developing country with a rapid

increase in older population every year, there would be a large number of stroke survivors with cognitive decline. Therefore, it is very important to study about the prevalence and risk factors of PSCD.

Materials and Methods

This study was a prospective tertiary hospital-based study conducted from October 2015 to April 2017 in the Department of Neurology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, India. A total of 200 consecutive patients were included in the study from stroke registry. A valid informed consent was obtained from each patient. All the patients were subjected to a detailed clinical history and physical, neurological, and radiological examination as per the standard protocol prepared by us. The history of any illness, history of chronic illness, personal history of addiction, occupational history, dietary habits, and family history were taken in detail.

Stroke Registration

By definition, stroke is considered as rapidly developing clinical signs of local or global loss of cerebral function that last for more than 24 hours or lead to death within 24 hours. The *International Classification of Diseases* (*ICD*), *10th Revision*, was used to classify the types of stroke. Events were classified as cerebral infarction (ischemic; *ICD 163*), intracerebral hemorrhage (*ICD 161*), and subarachnoid hemorrhage (*ICD 160*). Subtypes of ischemic stroke were coded according to the TOAST classification. Patients with transient ischemic attacks were excluded. The subtype of stroke was verified by computed tomography and MRI of brain.

Inclusion Criteria

1. All patients with first-ever acute stroke (<1 week) admitted in the neurology ward of Sir Sunderlal Hospital from October 2015 to April 2017 were included.
2. The Folstein MMSE and Montreal Cognitive Assessment (MoCA) scores were used to determine cognitive decline after 3 and 6 months as per the Diagnostic and Statistical Manual of Mental Disorders *V*. MMSE grade score was categorized as per the standardized protocol, which if comes to ≥24—normal, 20–23—mild cognitive decline, 10–19—moderate cognitive decline, and ≤9—severe. MoCA score <26 indicates cognitive decline.
3. The World Health Organization guidelines were used to measure all blood parameters.
4. Hypertension was classified as per the Joint National Committee 8.

Exclusion Criteria

1. Patients unconscious at the time of admission and uncooperative, blind, and deaf patients.
2. Patients having transient ischemic attacks and cerebral venous thrombosis.
3. Pediatric age group patients were excluded (up to 14 years).

Statistical Analysis

SPSS 16.0, IBM corporation, was used for analysis purpose. Kuppuswamy's socioeconomic scale was used to measure socioeconomic status. Univariate and bivariate analyses (number and percentage) were done for basic sociodemographic characteristics. Chi-squared test was used to see the association between two variables. The Wilcoxon signed-rank test was used to check the difference in cognitive impairment between two follow-ups at 3 and 6 months, respectively. Statistical significance was recognized when *p* < 0.05.

Results

Among the 200 patients, 12 patients died before the first follow-up at 3 months while 1 patient died between the first and second follow-up, which was done at 6 months. Basic sociodemographic and clinical characteristics of stroke patients were shown in ►Table 1. The majority (127; 65.5%) of the patients are older than 60 years, followed by 64 (32.0%) between 41 and 60 years and only 9 (4.5%) below 40 years. The mean age of patients is 64 years with a standard deviation of 12 years. Furthermore, sex-wise distribution of stroke patients shows that three-fourths of the patients, that is, 147 (73.5%), were male and 53 (26.5%) patients were female. The majority (141; 70.5%) of the patients had education up to primary level and 41 (20.5%) had more than primary education, while 18 (9.0%) patients were illiterate. In our study, the economic status of the patients was measured according to Kuppuswamy's socioeconomic scale. According to this scale, 48 (24.0%) patients belonged to lower class, 130 (65.0%) belonged to middle class, and 22 (11.0%) belonged to upper class. The majority of the strokes were ischemic 113 (56.5%), whereas 87 (43.5%) were hemorrhagic. According to the TOAST classification of Ischemic stroke, the majority of the patients had small vessel disease 65 (57.5%), large vessel disease 28 (24.7), and cardioembolic 20 (17.8%).

Poststroke cognitive disability was measured by MoCA and MMSE scales, and respective scores have been presented in ►Table 2. In this study, PSCD was seen in 126 (67%) of the cases at 3 months by MoCA scale. Later on, PSCD prevalence by MoCA scale at the second follow-up at 6 months reduced to 59 (31.6%). Of 80 cases in hemorrhagic group, 50 (62.5%) had cognitive decline at 3 months and it reduced to 20 (25.0%) at 6-month follow-up. Of 108 cases in ischemic group, 76 (70.4%) had cognitive decline at 3 months, which reduced to 39 (36.4%) at 6-month follow-up. The association between MoCA scale and type of stroke was not significant at 3 and 6 months.

By MMSE scale, cognitive decline prevalence at 3 months was found to be 87 (46.3%,) which reduced to 22 (17.1%) at 6 months. At 3 months, 32 (17.0%) had mild cognitive decline, 44 (23.4%) had moderate, and 11 (5.9%) had severe cognitive decline. Of 80 cases in hemorrhagic group, 18 (22.5%) had mild cognitive decline at 3 months, which reduced to 8 (10.0%) at 6 months. Of 108 cases in the ischemic group, 14 (13.0%) had mild cognitive decline at 3 months, which increased to 17 (15.9%) at 6 months. Further 35 (32.4%) had moderate cognitive decline, which reduced to 6 (5.6%)

Table 1 Sociodemographic and clinical characteristics of stroke patients under study (*n* = 200)

Basic characteristics	Stroke patients, frequency (%)
Age, y	
Young (up to 40)	9 (4.5)
Middle (41–60)	64 (32.0)
Old (above 60)	127 (65.5)
Mean ± SD	64.17 ± 12.23
Sex	
Male	147 (73.5)
Female	53 (26.5)
Education	
Illiterate	18 (9.0)
Primary	141 (70.5)
Above	41 (20.5)
Socioeconomic status	
Lower	48 (24.0)
Middle	130 (65.0)
Upper	22 (11.0)
Occupation	
Business	21 (10.5)
Farmer	63 (31.5)
Housewife	50 (25.0)
Retired	59 (29.5)
Other	7 (3.5)
Family history of stroke	
Yes	5 (2.5)
No	195 (97.5)
Type of stroke	
Hemorrhagic	87 (43.5)
Ischemic	113 (56.5)
Hypertension	
Yes	69 (34.5)
No	131 (65.5)
Diabetes	
Yes	77 (38.5)
No	123 (61.5)

Abbreviation: SD, standard deviation.

Table 2 Poststroke cognitive disability scores

Disability scores	*n* (%)
MoCA (3 mo)	188
Normal	62 (33.0)
Cognitive decline	126 (67.0)
Mean ± SD	23.23 ± 3.03
MoCA (6 mo)	187
Normal	128 (68.4)
Cognitive decline	59 (31.6)
Mean ± SD	25.74 ± 2.28
MMSE (3 mo)	188
Normal	101 (53.7)
Mild	32 (17.0)
Moderate	44 (23.4)
Severe	11 (5.9)
Mean ± SD	22.62 ± 2.94
MMSE (6 mo)	187
Normal	155 (82.9)
Mild	25 (13.4)
Moderate	7 (3.7)
Severe	0 (0.0)
Mean ± SD	24.89 ± 2.03

Abbreviations: MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; SD, standard deviation.

Table 3 Comparison of types of stroke with different cognitive scales

Scale	Type of stroke		*p*-Value
	Ischemic	Hemorrhagic	
MoCA at 3 mo			
Normal	32	30	0.525
Cognitive decline	76	50	
MoCA at 6 mo			
Normal	68	60	0.181
Cognitive decline	39	20	
MMSE at 3 mo			
Normal	48	53	0.000[a]
Mild	14	18	
Moderate	35	9	
Severe	11	0	
MMSE at 6 mo			
Normal	84	71	0.295
Mild	17	8	
Moderate	6	1	
Severe	0	0	

Abbreviations: MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment.
[a]Significant at 95%.

at 6 months. At 3-month follow-up, 11 (10.2%) patients had severe cognitive decline but at 6-month follow-up, there were no cases of cognitive decline (►**Table 3**).

The association between cognitive decline measured by MoCA scale at 3 months with different predictors such as age, sex, education, occupation, socioeconomic status, type of stroke, hypertension, and diabetes is shown in ►**Table 4**. We used chi-squared test to see the association between cognitive decline and its predictors, and we found hypertension

Table 4 Comparison of cognitive decline measure by Montreal Cognitive Assessment at 3 months with its various predictors

Basic characteristics	Poststroke cognitive decline		p-Value
	No	Yes	
Age, y			
Young (Up to 40)	5	3	0.142
Middle (41–60)	21	38	
Old (above 60)	36	85	
Sex			
Male	45	92	0.541
Female	17	34	
Education			
Illiterate	6	12	0.621
Primary	47	86	
Above	9	28	
Socioeconomic status			
Lower	11	34	0.308
Middle	43	78	
Upper	8	14	
Occupation			
Business	8	13	0.568
Farmer	21	37	
Housewife	16	33	
Retired	14	41	
Other	1	3	
Type of stroke			
Hemorrhagic	31	50	0.525
Ischemic	32	76	
Hypertension			
Yes	23	38	0.039[a]
No	63	64	
Diabetes			
Yes	21	56	0.031[a]
No	62	49	

[a]Significant at 95%.

and diabetes as significant predictors. To compare the change in cognitive decline by MMSE scale at 3 and 6 months, we used the Wilcoxon signed-rank test and found significant improvement in prevalence. Similarly, we tested for MoCA scale and found significant improvement in cognitive decline from 3 months to 6 months (►Table 5).

Discussion

In most of the previous studies, cognitive decline was measured by MMSE and neuropsychological test batteries. In the Netherlands, the Maastricht CODAS, which examined first-ever poststroke cognitive impairment after 6 months by MMSE, has suggested the prevalence up to 70%.[7] The studies in Australia have shown that cognitive impairment prevalence at 3 months after stroke is 50 to 58% and were based on a series of neuropsychological tests.[8,9]

The various studies measured poststroke cognitive impairment at 3 months and found its prevalence between 30 and 69.3%.[10-12] In a Caribbean study on 293 stroke patients at 5 years after first-ever stroke, it showed that 58.9% patients suffered from the cognitive impairment.[13] Zhou et al examined the cognitive function of 434 patients with stroke on 1-year follow-up in Chongqing and found a prevalence of 37.1% at 3 months.[14] The study on 252 Singaporean patients within 6 months of poststroke showed that 44% patients suffered from the cognitive decline, while the prevalence declined to 34% in 1-year follow-up.[15]

In this study, PSCD was found in 67% of the cases at 3 months, which is within the range mentioned in previous studies. In del Ser et al's study, cognitive status at 24 months was stable in most cases (151; 78.2%), worsened in 27 (14%; 6 demented and 21 nondemented), and improved in 15 (7.8%; 7 demented and 8 nondemented).[10] While in our study, we saw significant improvement in cognition of 35.4%, that is, from 67% at 3 months to 31.6% at 6 months. The possible reasons for this improvement may be neuroplasticity during recovery phase. Another study by Mahon et al showed 84% cognitive impairment by MoCA and cognitive functioning, which significantly declined by 2.8%, 4 years after stroke.[16]

In our study, the prevalence of PSCD by MoCA was 67.0 and 46.3% by MMSE at 3 months, which was around 20% higher. During follow-up at 6 months, the prevalence of cognitive decline by MoCA was 31.6 and 18.1% by MMSE. However, the mean change in MoCA and MMSE score between 3 and 6 months was almost same (2.27 in MMSE score and 2.51 in MoCA score) and this improvement in cognition was found to be statistically significant. In previous studies also, it has been observed that MoCA scale showed early and higher prevalence of PSCD than MMSE scale.[17,18] Therefore, MoCA scale is more sensitive than MMSE scale to detect the early poststroke cognitive impairment. Many past studies have shown MoCA scale to be more efficient and more valid than MMSE for PSCD measurement.[19-21] On subgroup analysis in the ischemic group, we saw an increase in the number of cases with mild impairment in cognition because of shift of cases from severe and moderate cognitive decline group into mild cognitive decline and normal cognition groups. In a recent study on 212 patients in Korea, cognitive improvement was observed from cognition level at admission to cognition level at discharge. However, they have not mentioned the mean duration of stay of patients at hospital.[22] They used MoCA as well as MMSE to measure cognitive decline and studied the correlation between MoCA and functional outcome among subacute stroke patients with cognitive dysfunction. On investigation, they found that the group with high MoCA scores showed better functional outcome in the subacute stroke phase.

Table 5 Comparison of Mini-Mental State Examination scale and Montreal Cognitive Assessment scale at 3 and 6 months

	n	Mean ± SD	Median	IQR	Wilcoxon signed-rank test	p-Value
MMSE score (after 3-mo follow-up)	188	22.61 ± 2.94	24.00	4.00	−8.759	0.000
MMSE score (after 6-mo follow-up)	187	24.89 ± 2.03	26.00	2.00	Difference is significant	
MoCA score (after 3-mo follow-up)	188	23.22 ± 3.02	24.00	5.75	−9.656	0.000
MoCA score (after 6-mo follow-up)	187	25.74 ± 2.30	26.00	4.00	Difference is significant	

Abbreviations: IQR, interquartile range; MMSE, Mini-Mental State Examination; MoCA, Montreal Cognitive Assessment; SD, standard deviation.

There are many risk factors for stroke/recurrent strokes and cognitive impairments such as increasing age after 65 years, lower educational level, hypertension, diabetes mellitus, dyslipidemia, smoking, and atrial fibrillation. However, their association with first-ever poststroke cognitive impairment is still debatable.

There is quite discrepancy among the past studies regarding age, sex, and education as a predictor of cognitive decline. A few studies have shown education as a significant predictor of cognitive decline,[12,16,21-24] while few have shown that it is an insignificant predictor.[25] In our study, we found that age, sex, education, duration, and occupation were insignificant predictors for PSCD while diabetes and hypertension were found to be significant predictors. A study done by Mahon et al[16] showed that sex (male) and occupation (unemployed) were also significant predictors of PSCD. In a study by Mok et al,[12] age, education, and old stroke/recurrent stroke cases were found to be significant predictors of PSCD while in Korean study, age, education, and duration from onset to admission period were found to be significant predictors of poststroke cognitive impairment.[21] Both the studies by Mok and Korean group have not given any explanation why there was more cognitive impairment in uneducated and unemployed patients.

Conclusion

The prevalence of PSCD falls in the range of 20 to 80% and such a vast difference is mainly due to various factors such as difference in races, duration of study, and the diagnostic criteria applied in the studies. In this study, only hypertension and diabetes were found to be significant predictors for new-onset PSCD. Our data have shown significant improvement among patients having cognitive decline from 3 to 6 months.

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