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Comparison of Cognitive Function in Patients with Stroke Based on the Location of Lesion

Anshruta Chandgothia[1], Dr. Sukhada Prabhu[2]

[1]Intern, School of Physiotherapy, DY Patil University, Nerul, Navi Mumbai, India
anshrutaa[at]gmail.com

[2]PhD Scholar, MPTh., Associate Professor, Department of Kinesiotherapy and Physical Diagnosis, School of Physiotherapy, DY Patil University, Nerul, India
sukhada.prabhu[at]dypatil.edu

Abstract: ***Loss of cognitive function seen in patients after stroke varies greatly depending on a variety of factors such as the size of the infarct, its location, number of arteries affected, etc. This study was done to assess and compare the cognitive function in patients with stroke based on the location of the lesion using the MoCA and FAB scale. Following which the results were analyzed and it was concluded that the left hemispheric infarction shows a higher degree of loss in cognition.***

Keywords: Stroke, Cognitive Impairments, MOCA, FAB, Cerebrovascular Accident (CVA)

1. Introduction

A Cerebrovascular Accident (CVA) or stroke is defined as the sudden loss of neurological function caused due to vascular interruption to the brain. The interruption may not have any apparent cause but the loss of neurological function may be severe. Stroke can vary greatly in severity; from recovery occurring in less than 24 hrs to having complete loss of motor, sensory, perceptual, language and/or cognitive function. The location of the lesion along with the extent of injury determines the severity of deficits seen in the patient.

CVA can be classified into a few types, with Ischemic Stroke being the most common of all. It occurs due to impaired blood flow to the brain caused by clot blocks, which deprive the brain of oxygen and nutrients. Other than this Hemorrhagic Stroke is also prevalent; it occurs due to rupturing of the blood vessels in or around the brain.

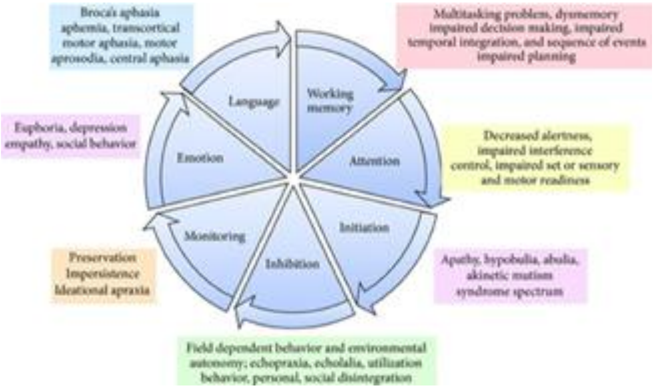
CVA is not only classified by the etiological characteristics but can also be done based on the vascular involvement. The Middle Cerebral Artery (MCA) is one of the branches of the Internal Carotid Artery which supplies the entire lateral aspect of the cerebral hemispheres. It is also the most common site for CVA's (50.8%). [1]

CVA patients with perceptual and/or cognitive deficits are thought to have localized or focal damage to the brain. Cognition can be assumed as the method used by the Central Nervous System to process information. Cognitive processes include 5 main domains, that are, Attention, Memory, Executive Function, Visuo-spatial Relations and Language. Area of the lesion greatly affects the level of cognitive dysfunction; such as speech and language impairments will predominantly be seen in patients with a left hemisphere lesion whereas visuo-spatial impairments are predominant in patients with a right hemispheric lesion.

Other than this, hemiparesis/hemiplegia, sensory deficits and ataxia may also occur with right or left hemispheric lesion and will affect the contralateral side. This is called lateralisation; the tendency for some cognitive processes to be specialized to one hemisphere of the brain. Not only do the cognitive functions vary based on the hemisphere but also the specific location of lesion. Lateralisation is important in rehabilitation due to the compartmentalized functional differences between the hemispheres[2]. Hence there is a need to compare the cognitive function in patients with stroke using some cognitive battery.

A third of stroke survivors may be troubled by post-stroke Cognitive Impairments (PSCI) or post-stroke dementia [3]. The Mini–Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) have been the most reasonable instruments for identifying PSCI [4]. Past research has shown that MoCA has a higher sensitivity than MMSE in detecting PSCI [5]. The Montreal Cognitive Assessment (MoCA) is a brief screening instrument originally designed to identify mild cognitive impairments (MCI) in elderly patients attending a memory clinic [6]. MoCA is a 1-page, 30-point test, administrable in ≈10 minutes, which evaluates different domains: visuospatial abilities, executive functions, short-term memory recall, attention, concentration, working memory, language, and orientation to time and space [7].

This research uses the Frontal Assessment Battery along with MoCA to assess the cognitive function in patients with stroke. The Frontal Assessment Battery (FAB) test, which consists of six subdomains of the frontal lobe, is a simple tool for the frontal lobe function assessment at the bedside [8]. The frontal lobe functions involve the executive function, attention, initiation, disinhibition, monitoring, language, and emotion control [10-9] (figure)[10].



This research assesses the CI in acute and subacute stroke patients using the MoCA and FAB test and compares the result to the location of the lesion. This study aims to compare the loss of cognitive function and find out which lobe infarcts affect cognition more.

Aims and Objective

The aim of the study is to compare the cognitive function in patients with stroke based on location of lesion.

Objectives:

1) To assess cognitive function in patients with right hemispheric stroke.
2) To assess cognitive function in patients with left hemispheric stroke.
3) To compare cognitive impairments in patients between right and left hemispheric stroke.

2. Review of Literature

1) Title: The FAB: a Frontal Assessment Battery at bedside
   Author: B Dubois, A Slachevsky, I Litvan, B Pillon
   Review: This study was done to devise a short bedside cognitive and behavioral battery to assess frontal lobe functions. The author studied 42 normal subjects and 121 patients with varying degrees of frontal lobe dysfunction. There was good interrater reliability, internal consistency and discriminant validity. 89.1% of cases correctly identified in a discriminant analysis of patients and controls.
2) Title: A hemispheric comparison of cognitive dysfunction and sleep quality impairment in Middle Cerebral Artery infarction
   Author: Danyal Wahid, Hifza Rabbani, Ayesha Inam, and Zubaa Akhtar
   Review: This study investigates the relation between the severity of cognitive dysfunction and sleep quality impairments in patients with middle cerebral artery strokes across right and left hemisphere. A sample size of 55 patients were used, out of which 29 had Left MCA Ischemic Infarcts and 26 had Right MCA Ischemic Infarcts. They were assessed using the Neurocognitive Assessment Battery for stroke patients and the Pittsburgh Sleep Quality Index-Urdu. They found that the cognitive dysfunction and sleep quality impairment is significant between right and left hemispheres respectively. It was found that left MCA stroke patients were significantly more impaired cognitively than right MCA stroke patients and right MCA stroke patients displayed a greater degree of sleep quality impairment when compared to left MCA stroke patients.
3) Title: Comparison of the Mini-Mental State Examination and Montreal Cognitive Assessment executive subtests in detecting post-stroke cognitive impairment
   Author: Chen Fu, Xianglan Jin, Baoxin Chen, Feiran Xue, Huanmin Niu, Rongjuan Guo, Zhigang Chen, Hong Zheng, Le Wang, Yunling Zhang
   Review: This study aimed to determine how much executive abnormality was detected by the MMSE and MoCA executive subtests in a population-based cohort of Chinese post-stroke patients. A total of 1222 patients were recruited for this study. The study concluded that MoCA executive tasks are more sensitive in detecting executive dysfunction compared with the MMSE executive tasks.
4) Title: The Montreal Cognitive Assessment, MoCA: a brief screening tool for mild cognitive impairment
   Author: Ziad S Nasreddine , Natalie A Phillips , Valérie Bédirian, Simon Charbonneau, Victor Whitehead, Isabelle Collin,
   Jeffrey L Cummings, Howard Chertkow
   Review: The objective of the study was to develop a 10-minute cognitive screening tool (Montreal Cognitive Assessment, MoCA) to assist first-line physicians in detection of mild cognitive impairment (MCI). The study used 94 patients meeting MCI clinical criteria supported by psychometric measures, 93 patients with mild Alzheimer's disease and 90 healthy elderly controls. MoCA had a sensitivity of 90% to detect MCI. In the mild AD group, MoCA detected a sensitivity of 100%.
5) Title: Concurrent validity of the short version of Montreal Cognitive Assessment (MoCA) for patients with stroke
   Author: Yali Feng, Jiaqi Zhang, Yi Zhou, Bo Chen, and Ying Yin
   Review: This study aims to examine the concurrent validity of 2 Chinese versions of short version of MoCA in patients with stroke. A total of 54 patients and 27 healthy controls were recruited in this study. The Neurobehavioral Cognitive Status Examination (NCSE) was used as an external criterion of cognitive impairment. The 3 assessments demonstrated equal performance in differentiating patients with stroke from controls.
6) Title: Trajectory of Cognitive Decline After Incident Stroke
   Author: Deborah A Levine, Andrzej T Galecki, Kenneth M Langa, Frederick W Unverzagt , Mohammed U Kabeto , Bruno Giordani , Virginia G Wadley
   Review: The objective of this study was to measure the changes in cognitive function among survivors of stroke, controlling their prestroke trajectories. 23,572 participants were recruited for this study. Over a median follow-up of 6.1 years, 515 participants survived expert-adjudicated incident stroke and 23,057 remained stroke free. Among survivors, the difference in risk of cognitive impairment acutely after stroke, compared with immediately before stroke, was not statistically

significant; however, there was a significantly faster poststroke rate of incident cognitive impairment compared with the prestroke rate. Incident stroke was associated with an acute decline in cognitive function and also accelerated and persistent cognitive decline over 6 years.

3. Methodology

The current study follows a comparative study design as it studies the severity of cognitive impairments and location of lesion in patients with stroke.

Informed consent forms were taken from each of the participants before administering the scales. The patients were recruited from D. Y. Patil Hospital, Navi Mumbai over a period of 3 months between January 2022 and March 2022. Their cognitive functions were assessed using the Montreal Cognitive Assessment test and Frontal Assessment Battery test. Along with the outcome measures, demographic details were also taken including their name, gender, age, occupation, education, addictions and medical history.

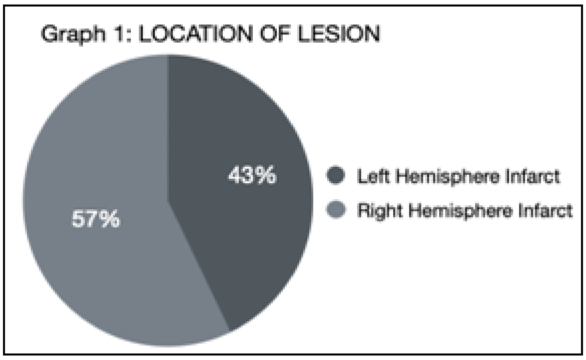
Inclusion criteria for participation in the study were patients should be diagnosed with a unilateral infarct; multiple infarcts on the same side are included; with neuro-imaging evidence from either a computed tomography (CT) or magnetic resonance imaging (MRI) scan, patients with stroke should be in the acute or subacute phase, of either gender, and should be able to communicate. Patients with a history of CVA were only included if they had no residual symptoms.

Exclusion criteria for participation in the study were patients who had prior neurological and psychiatric conditions affecting cognition like dementia, Alzheimer's, delirium, etc. Other than this, patients with severe aphasia, patients who couldn't follow one step commands and patients who refused to participate in this study were also excluded.

The MoCA scale is a 1-page, 30-point test, administrable in ≈10 minutes, which evaluates different domains: visuospatial abilities, executive functions, short-term memory recall, attention, concentration, working memory, language, and orientation to time and space [7]. These were used to assess the severity of cognitive impairment in the participant. MoCA outlines the severity as (18-25) Mild Cognitive Impairments, (10-17) Moderate Cognitive Impairments and (less than 10) Severe Cognitive Impairments, with the normal score of 25.

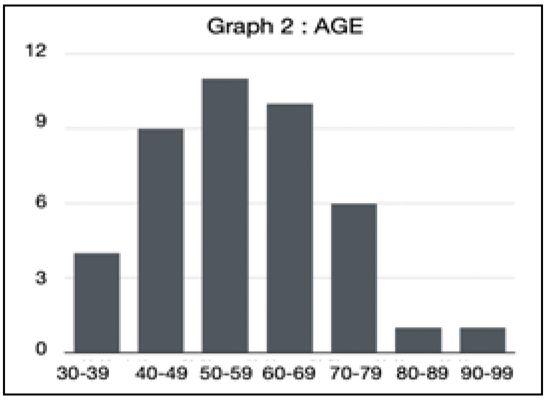
The Frontal Assessment Battery (FAB) test, which consists of six subdomains of the frontal lobe, is a simple tool for the frontal lobe function assessment at the bedside [10]. FAB has a cutoff of 12 as an indicator of cognitive impairment with a total score of 18. FAB also helps us differentiate the functional impairment in the frontal lobe as there is a separate test for each of the frontal lobe functions.

4. Results



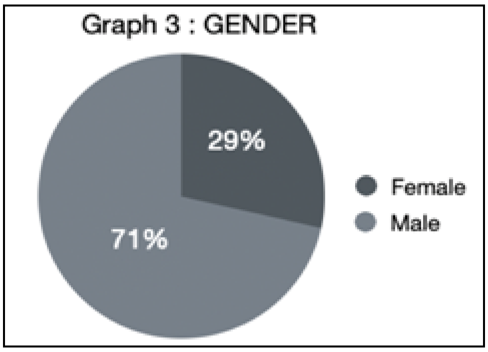
Graph 1: Distribution based on location of lesion

Inference: The total number of participants in the study was 42. 18 of which were patients with a left hemispheric cerebral infarct and 24 were patients with a right hemispheric cerebral infarct.



Graph 2: Distribution by Age

Inference: The median age of all the participants was 57.5 years.



Graph 3: Distribution by Gender

Inference: Out of the 42 participants, 12 of the participants were females and 30 were males, i.e.71% were males and 29% were females.

One Sample Test was used to determine the difference between the cognitive impairments in patients with right and left hemispheric stroke. In table 1, the cognitive impairments in patients with stroke shows that patients with a left infarct demonstrated a severe cognitive impairment compared to the right infarct. This was based on the use of the Montreal Cognitive Assessment Scale.

Table 1: Comparison of cognitive impairment between patients with left & right infarct using Montreal Cognitive Assessment Scale

	N	Mean	Std. Deviation	Std. Error Mean
Left MOCA	18	10.2222	7.50338	1.76856
Right MOCA	24	13.9167	9.38508	1.91572

One-Sample Test						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Left MOCA	5.78	17	0	10.22222	6.4909	13.9536
Right MOCA	7.264	23	0	13.91667	9.9537	17.8796

Inference: The cognitive impairment in patients with left and right infarct show a statistical significant difference with p value of 0.000

Also, based on mean scores, the patients with left infarct have demonstrated a severe cognitive impairment (mean ± SD = 10.22 ± 7.50) compared to patients with right infarct (mean ± SD = 13.916 ± 9.38).

In table 2, the cognitive impairment in patients with stroke shows that patients with a right infarct demonstrated a lesser severity of cognitive impairment as compared to the left infarct when they were evaluated using the Frontal Assessment Battery. The results from both the tables indicate that affection of the left hemisphere causes a higher degree of cognitive dysfunction as compared to a right hemisphere infarct.

Table 2: Comparison of cognitive impairment between patients with left and right infarct using Frontal Assessment Battery

	N	Mean	Std. Deviation	Std. Error Mean
Left FAB	18	8.9444	4.35852	1.02731
Right FAB	24	10.9167	5.19127	1.05966

One-Sample Test						
	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Left FAB	8.707	17	0	8.94444	6.777	11.1119
Right FAB	10.302	23	0	10.91667	8.7246	13.1087

Inference: The frontal assessment battery in patients with left and right infarct show a statistical significant difference with p value of 0.000

Also, based on mean scores, the patients with right infarct have demonstrated a higher score indicating better performance (mean ± SD = 10.91 ± 5.19) as compared to patients with left infarct (mean ± SD = 8.944 ± 4.35).

5. Discussion

In this study, the aim was to compare the cognitive dysfunction among patients with stroke based on the location of lesion. A few studies have been conducted in the past to find the hemispheric difference in stroke patients. In one of the studies they found that left hemispheric strokes are more common than the right and were usually more severe due to the higher incidence of large vessel ischemic strokes in the territory of the left middle cerebral artery.[12] One small retrospective imaging study of lacunar strokes revealed a higher event rate in the right hemispheric stroke.[17] Another retrospective study [18] showed that LHS was associated with greater neurological deficits, based on the admission NIHSS score, but a better chance of recovery. [12]

To further investigate this, our study included all types of stroke patients with neuroimaging proof like MRI or CT scan. A total of 42 subjects participated in this study; amongst the 42 subjects 43% had a left infarct and 57% had a right infarct.

Stroke has been increasing in incidence recently due to the increased risk factors. Risk factors for hemorrhagic and ischemic stroke are similar, but have some differences; such as hypertension is a particularly important risk factor for hemorrhagic stroke, though it contributes to atherosclerotic disease that can lead to ischemic stroke as well.[14] Research also suggests that acute infections may work as a short term trigger for stroke in patients.[15] Another risk factor found to be associated with stroke was air pollution. [14-16]

The incidence of stroke also increases with age, with the incidence doubling for each decade after age 55. [19] Recent studies also suggested an increasing prevalence and incidence of ischemic stroke in the 20-54 years population.[20] In hemorrhagic stroke patients, the incidence increases after 45 years of age. [21] The median age of the participants in this study was found to be 57.5 years; with the majority of the participants falling between the age range of 50-59 years. Previous studies found that more strokes occur in women than men, because of the longer lifespan of women compared to men [22]; another study performed in 8 different European countries found that the risk of stroke increased by 9% per year in men, and 10% per year in women. [23] Contrary to this we found that more men (71%) suffered from stroke as compared to women (29%).

Stroke affects the cognitive domain, which includes attention, memory, language, and orientation. Based on stroke location and severity, memory disorder may occur for one or more memory types, eventually ending in memory decline and loss. [24] Therefore, using the Montreal Cognitive Assessment Scale and the Frontal Assessment Battery scores were calculated to assess the cognitive loss in these patients. The results we found after analyzing the data from the 2 scales, i.e., MoCA and FAB were similar. It stated that patients who suffered from a left hemispheric infarct showed higher signs of cognitive impairment as compared to patients with a right infarct. Studies of infants and children suggest that the LH has greater metabolic demands than the right.[27] This hemispheric difference may place the LH at greater risk for functional decrement with a reduction of blood flow.[12]

Along with the greater risk of functional loss, the left hemisphere deals with a greater number of the cognitive functions.

In one of the previous studies [12], they found a similar result which stated that left hemisphere strokes were more severe and had poorer outcomes. Another study found that in a hemispheric comparison between the left and right MCA stroke patients, it was found that left MCA stroke patients were significantly more impaired cognitively than right MCA stroke patients and right MCA stroke patients displayed a greater degree of sleep quality impairment when compared to left MCA stroke patients.[26] This is due to the lateralisation of the brain; where the left hemisphere is usually more active than the right except while performing visuo-spatial activities. [25]

We also found that patients with right infarcts scored higher on the FAB assessment compared to the left infarct patients. This may be due to the fact that left-hemisphere strokes might have hampered the capability to understand task instructions, due to the potential presence of sensory aphasia.[28] Another reason for this may be the left hemisphere dominance for language which has been consistently confirmed by research.[29] Therefore, patients with a right infarct majoritively have their language skills intact causing them to score higher on the FAB.

6. Conclusion

This study compared the cognitive function in patients with stroke using the Montreal Cognitive Assessment Scale and the Frontal Assessment Battery to find which hemispheric lesion causes a greater loss of cognition. This study concludes that left hemispheric infarcts appear to be more severe and have a worse outcome on both the scales, regardless of the type of stroke or artery affected.

7. Recommendations

Post-stroke cognitive impairment (PSCI) is defined as failure in any cognitive domain after stroke: executive function; memory; language; visuospatial ability; visuoconstructional ability; or global cognitive function. Due to the heterogeneity of PSCI, its potential treatment strategies range from preventing new strokes and preventing white matter changes, to treating hypertension as well as other underlying vascular risk factors, while preventing amyloid deposits. [30-31]

The treatment of PSCI and dementia is based on the effective treatment of vascular risk factors, including lifestyle modification when needed. Treatment of associated conditions such as depression and delirium is important in order to both prevent and manage PSCI. [32] Other than this cognitive remediation therapies can also be employed to effectively treat the condition. All the domains of cognition can be separately trained as well; such as targeting protocols for improving the working memory of the patient.

Mental practice is also speculated to be effective because of its ability to use the same motor schema as when physically practicing the same task through the activation of similar neural regions and networks during mental practice. [33] This can thus help in producing greater improvements in patients' activities of daily living.

After a stroke, the physical fitness is also vastly affected, from strength to cardiovascular fitness. Physiotherapy is the primary method of overcoming these impairments. Exercise may be beneficial for improving learning and memory, and overall cognitive abilities. [34] Research has been done on the benefits of various drugs that have proven to help improve global cognition, such as Vinpocetine, Nimodipine, etc. [34]

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