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A STUDY OF EXECUTIVE FUNCTIONS IN RIGHT HEMISPHERIC STROKES

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ABSTRACT

Introduction: Stroke is a leading cause of disability worldwide. Cognitive functions and, in particular, executive function is commonly affected after stroke, leading to impairment in daily activities. Previous studies have shown conflicting evidence regarding the incidence of executive dysfunction in patients with right or left hemispheric strokes. Few studies have shown that executive dysfunction is more prevalent in right hemispheric strokes.

Aims and Objectives:

1. To study the executive dysfunction in patients with Right Hemispheric strokes.
2. To compare the impairment of executive functions with the Vascular territory involved

Methods:

This was a prospective observational study which included 100 patients admitted to a tertiary care center from January 2021 to August 2021. After Institutional EC clearance, patients with Right-Hemispheric ischemic stroke on neuro-imaging (CT or MRI) were included in the study. Demographic data, clinical history, neurological examination and etiological workup like echocardiography, carotid and vertebral artery doppler, CT/MR angiography were performed. Executive function was tested clinically using go-no-go test, digit-span test, trail making test, N-back test, Rey-osterreith complex figure test and clock drawing test. Data was entered to a pre-formatted data sheet and analysed. Results: The mean age of the included patients was 58.76years, 54 patients were male, Sixty-nine patients had anterior circulation stroke, 31 had posterior circulation stroke. Forty three patients had executive dysfunction as evidenced by abnormal go-no-go test (n=22), digit-span test(n=35), trail making test(n=10), N-back test(n=23), Rey-osterreith complex figure test(n=38) and clock drawing test(n=29). Executive dysfunction was more prevalent in anterior circulation strokes (n=37) as compared to posterior circulation strokes (n=6) (p=0.001) **Conclusion:** Executive dysfunction was a common finding in patients with right hemispheric stroke and was significantly higher in patients with anterior circulation strokes.

KEYWORDS :

1. INTRODUCTION

Stroke is a common cause of disability leading to significant morbidity. Cognitive functions, in particular, executive function, is commonly affected after stroke, leading to decline in performance of daily activities, social participation and quality of life. Appropriate assessment and understanding of executive dysfunction are important to design strategies for rehabilitation. More than two-thirds of patients with stroke have limitations to live independently. Stroke can cause a catastrophic impact in patients' lives, due to impairments in physical and psychological functions, as well as in cognitive, perceptual and communication skills.[1] The prevalence of executive dysfunction after stroke ranges from 18.5% to 39%, depending on definitions and instruments used for its evaluation.[1,2,3] Executive function involves planning, problem solving, dealing with new situations, decision-making and performing complex tasks.[4] One case series by Jean Marie Annoni et al reported executive dysfunctions were more prominent in right hemisphere stroke, specifically lateral thalamic infract.[5] Many studies have outlined the physical impairments after stroke, but studies examining cognitive deficits leading to functional impairments are few. Cognitive recovery after stroke in various cognitive domains including executive dysfunction are not well reported from an Indian perspective. This study was done as there is very limited data available on correlation between executive dysfunction and right hemispheric strokes and the mechanisms leading to executive dysfunction.

Objectives:

1. To assess executive functions in patients with right hemispheric strokes.
2. To compare the impairment of executive functions with the vascular territory involved.

Material and methods: This was a cross-sectional study conducted following ethical approval from the Institution and a written informed consent from the participants. A total of 100 consecutive patients diagnosed with right hemispheric strokes from January 2021 to August 2021 were included in the study. Patients with pre-existing dementia, traumatic brain injury, psychiatric illness, terminal ill patients, patients in delirium, uncooperative patients and pregnant patients were excluded. Patients with acute stroke within the last 3 months were also excluded. Standard demographic data was collected from all participants including level of education. Illiterate patients were also excluded from the study. Details of previous neuroimaging (Computed Tomography (CT) or Magnetic Resonance Imaging (MRI)) were collected and tabulated. Patients were categorized into anterior circulation strokes (Anterior Cerebral Artery (ACA) / Middle Cerebral Artery (MCA)/ Internal Carotid Artery (ICA) Territory) and Posterior Circulation strokes (Vertebral/Basilar/Posterior Cerebral (PCA) Territory). Executive function was tested clinically using Go-no-go test, Backward Digit-span test, Trail making test B, N-back test, Rey-osterreith complex figure test and clock drawing test. The abnormalities in each of the tests were tabulated and data was analysed using SPSS v23.0.

Inclusion Criteria

1. Patients diagnosed to have Right Hemispheric Stroke with a minimum of 3 months since the stroke and within 1 year of diagnosis.

Exclusion Criteria

1. Unconscious/Uncooperative patients

2. Patients with known underlying dementia/delirium/metabolic or septic encephalopathy/ pregnancy/ terminally-ill patients.

3. Patients with multiple bilateral infarcts in multiple arterial territories.

Statistical Analysis

Statistical Analysis

Statistical Analysis was performed using SPSS v23. Using this software, basic cross-tabulation and frequency distributions will be prepared. Chi-square (χ^2) test was used to test the association between different study variables. Corrected χ^2 test (Fisher's Exact test) was used in case of any cell frequency less than 5 in the bivariate frequency distribution.

RESULTS

The study included 54 male patients and 46 female patients diagnosed with Right Hemispheric Strokes. The baseline characteristics are summarized in Table 1. Sixty-nine patients had Anterior Circulation strokes and 31 patients had posterior circulation strokes. Smoking, Hypertension, Diabetes Mellitus and Dyslipidemia were common pre-morbid conditions in both the groups.

Table 1 Baseline Characteristics of patients with Right Hemispheric stroke

Character	Anterior Circulation Stroke (n=69)	Posterior Circulation Stroke (n=31)
Males/Females	38 (55.07%) /31 (44.93%)	16 (51.61%) / 15 (48.39%)
Smoking	36 (52%)	17 (54.8%)
Hypertension	35 (50.7%)	17 (54.8%)
Diabetes	32 (46.3%)	16 (51.6%)
Dyslipidemia	26 (37.6%)	12 (38.7%)
Atrial Fibrillation	5 (7.2%)	3 (9.6%)
Valvular Heart Disease	2 (2.8%)	1 (3.2%)
Mean NIHSS	10.9 ± 3.2	9.3 ± 3.9

Executive dysfunction was seen in 43 patients with Right hemispheric stroke with most of the patients unable to perform the Rey-osterreith complex figure test(38 patients) and Backward digit span test(35 patients). Clock drawing test was abnormal in 29 patients. Most Patients were able to fare well in Trail making test B with only 10 patients showing inability to perform this test. The findings are summarized in Table 2

Table 2 Findings of tests of executive function (number (%) of patients unable to perform the test)

Character	Anterior Circulation Stroke (n=69)	Posterior Circulation Stroke (n=31)
Go-no-go test	20 (28.9%)	2(6.5%)
Digit-span test	32 (46.3%)	3 (9.7%)
Trail making test B	8 (11.6%)	2 (6.5%)
N-back Test	19 (27.5%)	4 (12.9%)
Rey-osterreith complex figure test	32 (46.3%)	6 (19.35%)
Clock Drawing test	26 (37.7%)	3 (9.7%)

Patients with anterior circulation strokes had a significantly higher incidence of executive dysfunction as compared to patients with Posterior Circulation strokes (Table 3)

Table 3 Comparison of executive function in patients with anterior vs posterior circulation strokes

Character	Anterior Circulation Stroke (n=69)	Posterior Circulation Stroke (n=31)	p = 0.001
Executive Dysfunction	37	6	
Normal Executive Function	32	25	
Total	69	31	

DISCUSSION

Cognitive impairment can severely affect day to day functioning, especially after stroke. This burden adds on to the physical impairment due to stroke. Executive functions are part of the cognitive process of acquiring, keeping and applying knowledge to behavior. [6] Executive function roles can also be divided into: (1) shifting: the capacity to initiate different tasks at the same time and return to each one;(2) updating: to monitor information and organize it according to a different objective, and retrieve it when necessary; and (3) inhibition: to inhibit one stimulus and focus on a task or problem. [7] These three functions are connected and can interfere with one another. Moreover, they contribute to performance of more complex executive functions and influence rehabilitation outcomes. [8,9]

When a comprehensive assessment of cognition was performed in a multi-center study in Belgium and the Netherlands, cognitive dysfunction was present in 55% (89/190) of individuals after stroke. The following functions were compromised: executive function (39.1%), visual perception and construction (38.1%), neglect (31.3%), abstract reasoning (25.6%), verbal memory (25.6%), language (25.6%) and visual memory (22.0%). [1] Another study from New Zealand showed that 30–50% of 307 patients had impaired cognitive performance. [2] among which the most common deficit was executive dysfunction (30.4%). Wolf TJ et al, in a study performed on 55 participants with mild stroke (NIHSS<6), found approximately 66% of patients to have some form of executive dysfunction. [10] R. Vataja et al found executive dysfunction in approximately 34% of patients' post-stroke. In their study which included 214 patients with stroke, executive dysfunction was analysed using the stroop test, Wisconsin Card sorting test and Trail making A and B test. Executive dysfunction was present in a higher number of patients with left hemispheric strokes as compared to the right side especially involving the superior division of the ACA and MCA. They also found approximately 28% of patients with pontine infarcts to have executive dysfunction. They hypothesized that lesions of frontal-subcortical circuits (fronto-pallidal circuit, thalamo-cortical circuit are associated with higher frequency of executive dysfunction. They also found that patients with pontine strokes had a higher Fazeka's grade of white matter subcortical lesions, thereby suggesting a similar mechanism of executive dysfunction in pontine strokes. [11] Animal models have shown that lesions of the pedunculopontine tegmental nucleus which has projections via the frontal-subcortical pathways to the prefrontal cortex could lead to executive dysfunction similar to that seen in frontal lobe disorders. [12] In the Belgian and Dutch Cohort, among patients with a cortical stroke, 73% of patients with a left hemispheric stroke and 44% of patients with a right hemispheric stroke had impaired executive function. Executive dysfunction was also seen in approximately 28% of patients with either left/right subcortical strokes and 27% of patients with infratentorial strokes. [1] Annoni JM et al in a case series found that lateral thalamic infarcts, especially those involving the right side were found to be significantly associated with executive dysfunction.

The right hemisphere is known to play a major role in certain aspects of executive function, especially selective attention and verbal fluency. [5] A meta-analytic review of executive functions and frontal lobe by Alvarez AJ et al found that the right prefrontal cortices are more activated than the left pre-frontal cortices during tasks requiring color matching, phonemic verbal fluency and while performing the stroop test. [13] Another study by Rao et al, comparing executive functions in patients post stroke, Transient Ischemic Attacks (TIA) and Peripheral Vascular Disease (PVD) with that of healthy controls, did not find any significant difference between the incidence of executive dysfunction between right and left sided strokes. They also found that patients with TIA and PVD / hypertension without a stroke also had significantly higher incidence of executive dysfunction as compared to healthy controls, thereby suggesting the role of silent microvascular disease in the pathogenesis of Executive dysfunction. [14] In a study by Khedr E M et al among 81 patients with Acute ischemic Stroke, found that 21% of patients had cognitive dysfunction. Among the patients with cognitive dysfunction post stroke, majority of the patients (58.8%) were those who had a stroke in the non-dominant hemisphere which, more often than not, is the right hemisphere. [15] This study also showed higher incidence of cognitive dysfunction in patients with anterior circulation strokes (70.6%) as compared to those with posterior circulation strokes which is similar to the findings in this study. [15]

CONCLUSION

Executive dysfunction is a common occurrence in patients' post-stroke, especially those involving the right hemisphere. Involvement of the frontal-subcortical circuitry is the most likely mechanism of executive dysfunction in most strokes, hence the higher incidence of executive dysfunction in anterior circulation strokes. Executive dysfunction could lead to significant impairment in activities of daily living apart from the motor or sensory deficits and thus its recognition is paramount post-stroke and appropriate therapies be initiated for rehabilitation.

LIMITATIONS

Lack of a non-stroke control group, single-point analysis of executive function without data of executive function prior to stroke, exclusion of patients with TIA and absence of objective measures of stroke-volume and periventricular leukoarraiosis were the limitations of this study.

DISCLOSURES

The authors declare no conflict of interest. Ethical Approval for this study was taken from the institutional ethical committee in December 2020.

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