

Evaluation and Characterization of Executive Function Disorders after Stroke

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Abstract

Introduction: Stroke may have a negative impact on mental health and behavior. Cognitive disorders are common after stroke. They are rarely assessed in current clinical practice, particularly in our context. They constitute a real “invisible” handicap. In sub-Saharan Africa, we are not aware of any studies specifically assessing executive functions. These functions are at the heart of all adaptation processes to new or complex situations. This prompted the authors to carry out this study at the Ibrahima Pierre Ndiaye Neuroscience Department of the Fann National University Hospital Centre (Senegal). **Objective and Methodology:** The aim of this study was to assess and characterize post-stroke alterations in executive functions in our context. We conducted a descriptive cross-sectional study. It took place over a 4-month period from April 1 to August 31, 2021. Patients were matched to controls according to age, gender and educational level. Executive functions were assessed using the Frontal Assessment Battery (FAB). **Results:** A total of 30 patients with stroke were enrolled. These patients were matched to controls. The mean age of the patients was 46.87 ± 17.65 years. For the control group, it was 39.27 ± 12.33 years. The prevalence of executive function disorders was 20% in post-stroke patients. The majority of executive functions assessed were impaired. Sensitivity to interference and environmental autonomy were the only ones preserved. **Conclusion:** Impaired executive functions are common after stroke.

They should be systematically assessed in all stroke patients to ensure optimal management.

Keywords

Post-Stroke, Mental Health, Executive Functions, Invisible Disability, Senegal

1. Introduction

Stroke is increasing in sub-Saharan Africa. It constitutes a real public health problem [1]. The physical consequences of stroke have been studied in various contexts. The rise in patient survival rates has led many teams to take an increasing interest in the psycho-behavioural and cognitive repercussions of this condition [2]. Cognitive disorders are frequently reported after stroke in Western and Asian series. However, they are rarely assessed in the Sub-Saharan African context, particularly in routine clinical practice. The few neuropsychological assessments carried out remain global and do not specifically address executive functions.

Executive functions refer to a set of high-level cognitive processes, relatively independent of each other, that enable effective, targeted behavior adapted to the environment [3]. They include inhibition, mental flexibility, planning, lexical fluency, conceptualization, programming, self-monitoring, self-regulation and initiation. In sub-Saharan Africa, we have not found any specific study of executive functions, despite the handicap associated with their impairment, which can be very severe [4]. The aim of this study was to assess executive functions in stroke survivors in Senegal.

2. Methodology

We conducted a cross-sectional, descriptive and analytical study in the Ibrahima Pierre Ndiaye Neuroscience Department. The study period ran from April 1 to August 31, 2021. Patients were matched to controls. Patients were included, and controls were recruited at the same time. We enrolled stroke survivors. They were followed as outpatients or hospitalized in the neurosciences department at Fann National HUC. Controls were recruited from the department's paramedical and administrative staff on a voluntary basis. The latter were all free of previous or current neuropsychiatric follow-ups. Matching was done according to age, gender and level of education. All stroke survivors were followed as outpatients or hospitalized at the Ibrahima Pierre Ndiaye Neuroscience Department during the inclusion period. They were conscious. They had a level of education at least equal to 3 years in a French school. Free and informed consent was obtained. Executive functions were examined using the Frontal Assessment Battery (FAB). This is a neuropsychological test developed by Dubois *et al.* in 2000 [5]. It consists of 6 subtests. Each subtest has a maximum score of 3 points. The maximum score is 18. The pathological threshold is 12 [6]. These sub-tests include similarities (con-

ceptualization), lexical fluency (mental flexibility), motor sequence (programming), contradictory instructions (sensitivity to interference), Go-No Go (inhibitory control) and grasping behavior (environmental autonomy).

3. Results

The mean age of stroke patients was 46.87 ± 17.65 years (extremes 17 and 76). It was for the control group 39.27 ± 12.33 years (extremes 22 and 66). The sex ratio was 1.7 in the patient group. There was no statistically significant difference in age or education level between the patient and control groups (see **Table 1**). All patients had performed brain CT scans.

Table 1. Socio-demographic characteristics, education level and laterality of stroke survivors and controls at the Fann National University Hospital Centre.

	Cases Number (%) N = 30	Controls Number (%) N = 15	Total N (%)	P-value
Sex				
Male	19 (63.3)	5 (33.3)	24 (53.3)	0.056
Female	11 (52.4)	10 (66.7)	21 (46.7)	
Age				
<20	1 (3.3)	0 (0.0)	1 (2.2)	0.13
[20 - 30]	5 (16.7)	4 (26.7)	9 (20)	
[30 - 40]	7 (23.3)	5 (33.3)	12 (26.7)	
[40 - 50]	2 (6.7)	4 (26.7)	6 (13.3)	
[50 - 60]	8 (26.7)	0 (0.0)	8 (17.8)	
[60 - 70]	4 (13.3)	2 (13.3)	6 (13.3)	
>70	3 (10.0)	0 (0.0)	3 (6.7)	
Education level				
Elementary school	5 (16.7)	0 (0.0)	5 (11.1)	0.077
secondary school	16 (53.3)	6 (40.0)	22 (48.9)	
higher education	9 (30.0)	9 (60.0)	18 (40)	
Number of years of education				
<12 years	18 (60)	5 (33.3)	23 (51.1)	0.084
>12 years	12 (40.0)	10 (66.7)	22 (48.9)	
Laterality				
Left-handed	1 (3.3)	0 (0)	1 (2.2)	0.68
Right-handed	28 (93.3)	14 (93.3)	42 (93.3)	
Ambidextrous	1 (3.3)	1 (6.7)	2 (4.4)	

Ischemic strokes were the most frequent. They accounted for 74% of all cases. Hemorrhagic strokes accounted for 13%. Cerebral venous thrombosis was present in 10%. A combination of ischemic and hemorrhagic stroke was observed in 3% of cases. Lesions affected the minor hemisphere in 50% of cases. The dominant hemisphere was involved in 47% of cases, and both hemispheres in 3%. 53% of patients had a moderate stroke, and 47% had a minor stroke, according to the NIHSS score. Functional autonomy was assessed using the modified Rankin score in 53% of cases. Thus, 10% of patients had a modified Rankin score of 0; 6.7% a Rankin score of 1; 26.7% a score of 2; 10% a score of 3 and 46.7% a score of 4. Controls had a Rankin score of 0.

The time taken to administer the neuropsychological examination ranged from less than a week to three months. This timeframe was longer for outpatients. They were assessed on the day of their consultation, which could be delayed by the time of their stroke. 36.7% of cases were examined in less than a week after their stroke. 23.3% were assessed between 1 and 2 weeks. 10% were examined between 2 and 3 weeks. 10% were seen between 3 and 4 weeks. 6.7% were seen between 5 and 8 weeks. 3.3% were seen between 9 and 12 weeks. 10% were seen beyond 13 weeks. The median time to complete the neuropsychological examination was 9.5 days.

This neuropsychological examination was carried out using a battery of neuropsychological tests, including the FAB. The examination was carried out at the patient's bedside for inpatients and at the outpatient clinic for outpatients. The order in which the tests were administered was as follows: Bell test—Rey figure copy—Trail Making Test A—Trail Making Test B—Rey figure memory—FAB—Senegal test—MMS—MoCA—Last test. FAB was administered to 25 patients, representing a completion rate of 83.3%. In this paper, we present only the results obtained with FAB (see [Table 2](#) and [Table 3](#)).

Table 2. Evaluation of executive functions in stroke patients followed at Fann National Hospital University Centre.

	Conceptualization	Lexical fluency	Programming	Sensitivity to interference	Inhibitory control	Environmental autonomy	FAB score
Case1	2	2	1	0	3	3	11
Case 2	3	3	3	3	3	3	18
Case 3	3	2	3	1	3	3	15
Case 4	3	3	3	3	3	3	18
Case 5	2	1	3	3	3	3	15
Case 6	2	0	0	0	0	3	5
Case 7	3	3	3	3	3	3	18
Case 8	3	2	3	3	3	3	17
Case 9	3	3	3	3	2	3	17
Case 10	3	1	3	2	0	3	12

Continued

Case 11				Not Applicable				
Case 12				Not Applicable				
Case 13	3	2	3	3	2	3	16	
Case 14	3	3	3	3	3	3	18	
Case 15	3	0	3	2	3	3	14	
Case 16	3	1	3	2	0	3	12	
Case 17	3	3	1	3	0	3	13	
Case 18	3	2	3	3	3	3	17	
Case 19				Not Applicable				
Case 20	3	1	3	2	2	3	14	
Case 21	3	3	3	3	3	3	18	
Case 22	3	3	3	3	3	3	18	
Case 23	2	0	3	2	0	3	10	
Case 24	2	2	2	2	3	3	14	
Case 25	3	0	3	0	2	3	14	
Case 26				Not Applicable				
Case 27	0	0	0	2	2	3	7	
Case 28				Not Applicable				
Case 29	3	2	3	3	2	3	16	
Case 30	3	1	3	2	3	3	15	
Mean	2.68 ± 0.69	1.72 ± 1.12	2.4615 ± 1.07	2.27 ± 1	2.15 ± 1.15	3	14.42 ± 3.43	

Table 3. Evaluation of executive functions in controls using the frontal assessment battery.

	Conceptualization	Lexical fluency	Programming	Sensitivity to interference	Inhibitory control	Environmental autonomy	FAB score
Control 1	3	3	3	2	3	3	17
Control 2	3	3	3	3	3	3	18
Control 3	3	2	3	3	3	3	17
Control 4	3	3	3	3	3	3	18
Control 5	3	2	3	3	3	3	17
Control 6	3	3	3	3	3	3	18
Control 7	3	3	3	3	3	3	18
Control 8	3	2	3	2	2	3	15
Control 9	3	3	3	3	3	3	18

Continued

Control 10	3	3	3	3	3	3	18
Control 11	3	3	3	2	3	3	17
Control 12	3	3	3	3	3	3	18
Control 13	3	3	3	3	3	3	18
Control 14	3	2	3	3	3	3	17
Control 15	3	2	3	3	3	3	17
Mean	3	2.66 ± 0.48	3	3	2.93 ± 0.26	3	17.40 ± 0.82

Table 4. Main executive functions impaired post-stroke in patients followed at the neurosciences department of Fann National University Hospital Centre.

Executive functions assessed	Case Mean score	Control Mean score	P-value
FAB Global score	14.42	17.40	0.0021
Conceptualization	2.68	3	0.0425
Mental flexibility	1.72	2.66	0.0073
Programming	2.46	3	0.0475
Sensitivity to interference	2.27	2.80	0.0701
Inhibitory control	2.15	2.93	0.0087
Environmental autonomy	3	3	-

The dysexecutive syndrome was found in 20% of stroke survivors. The executive functions most affected were conceptualization, mental flexibility, programming and inhibitory control. The difference was statistically significant compared with the control group.

4. Discussion

The study population was young, with a mean age of 46.87 ± 17.65 . Male predominance was noted. Other studies in sub-Saharan Africa have also reported young populations. Indeed, a recent systematic review based on stroke registries in sub-Saharan Africa found a mean age of 59 years and a male predominance [7]. This might be explained in part by the youth of the general population. Added to this are the changing habits and sedentary lifestyles of the West African population. The frontal assessment battery appeared to be an appropriate tool in our context. Indeed, the completion rate in post-stroke patients was 83.3%. The only condition for patients' inclusion in this study was a minimum of three years' schooling in a French school. The Hong Kong team [2] used the same tool in its Chinese version. However, they reported an average socio-cultural level of 7 years. This difference may be explained by the low literacy rate in our context.

Regarding stroke typology, 74% of patients had an ischemic stroke, 13% a hemorrhagic stroke, and 10% a cerebral venous thrombosis. This distribution of stroke

types is similar to that found in the literature [8], with a predominance of ischemic stroke. Severe strokes were not assessed. Indeed, FAB could not be administered to them either because of the very significant global cognitive deficit or the consciousness disorders. Tang WK *et al.* [2] included only survivors of minor strokes. Consequently, the proportion of dysexecutive syndrome objectified was probably underestimated.

In the literature, some teams reported more global cognitive assessments that were not specific to executive functions. This was the case in Cameroon, where the prevalence of cognitive impairment after stroke was 41.2% [9]. It was higher in Uganda, with 63% of patients affected [10]. Specific impairments of various cognitive functions, particularly executive functions, should be carefully investigated in order to propose appropriate rehabilitation treatments. The lack of appropriate human resources (neuropsychologists) is one of the reasons limiting access to neuropsychological assessment.

The dysexecutive syndrome was found in 20% of stroke patients, with a statistically significant difference compared with the control group. In China, authors reported a similar result, with an 18% prevalence of dysexecutive syndrome [2], using the Chinese version of the FAB. Other studies have reported prevalences ranging from 10% to 50% [11] [12]. This rate tends to decrease with progression, from 6 months to 4 years post-stroke, with a recovery of 25% to 30% [13]. This underlines the importance of early and appropriate cognitive rehabilitation. Various executive functions were impaired in our study. These were conceptualization, mental flexibility, programming and inhibitory control. Assessment of social cognition and personality changes should be considered in future studies.

This study had its limitations. The FAB does not allow assessment of all executive functions [14]. As the latter has a direct impact on behavior, a behavioral assessment would provide definitely added value. We excluded severe patients, and this may contribute to underestimating the dysexecutive syndrome.

5. Conclusion

Stroke is a major public health problem worldwide, particularly in sub-Saharan Africa. In addition to physical disability, they can lead to cognitive impairment, particularly in executive functions. The dysexecutive syndrome should be systematically investigated. Early diagnosis and appropriate treatment can facilitate social and professional reintegration. This requires a multidisciplinary approach based on collaboration between stroke management teams and mental health professionals with expertise in neuropsychology. In the meantime, this remains a real challenge in our context, where human resources are scarce or even non-existent in some regions.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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