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ORIGINAL RESEARCH

Cognitive dysfunctions long-term after stroke occurrence: a study in patients from register of Ignace Deen teaching hospital Conakry-Guinea

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Abstract

BACKGROUND: Despite stroke risk factors are prominent and considered as significant cause of physical disabilities or dementia in Sub-Saharan African western countries, very litle investigations have focused on various post-stroke Cognitive disorders.
OBJECTIVES: Here, the aim was to assess cognitive outcomes among patients 6 month after stroke occurrence, recruited through Ignace Deen teaching hospital register, Conakry, Guinea.
PATIENTS AND METHODS: In this retrospective cross sectional study, 25 post-stroke patients were assessed for cognitive abilities using Bells test, Osterrieth Rey Complex Figure (ORFC) and Standard Progressive Matrices of RAVEN (PM 38), and matched with 25 cognitive healthy control persons. Participants were administered questionnaires in order to collect sociodemographic and clinical data.
RESULTS: The mean of age (± ESM) of stroke patients and control subjects was 57.6 (±11.05) and 40.32 (± 9.7) years respectively. Most of stroke patients presented high educational level when compared to control subjects (χ^2= 9.609, p = 0.008), but no significant differences for the distribution of occupation status (p>0.05). Regarding the type of stroke occurred, the majority was diagnosed as hemorrhagic type (80%). Among the 25 post-stroke patients, 52% showed significant visual attention ability alterations (assessed with Bells test). We reported also visual spatial (including visual perception and construction) impairment as well as working memory in post-stroke patient trough significant difficult to solve ORCF test, when compared to cognitive healthy control (p<0.001). The analysis with PM 38 showed a lessening of general intelligence among 76% of post-stroke patients (Raven score under fifth percentile rank).

CONCLUSION: Various cognitive disorders were diagnosed using different neuropsychological tests in present study. Interestingly, educational status should not be a predictive factor of cognitive disorders reported among post-stroke patients. Otherwise, current study could help to the management of post-stroke issues related to cognitive rehabilitation, healthcare and improvement of quality of life based on local specificities in SSA context.

Introduction

Stroke is one of the leading causes of adult chronic disability acquired and second factor of death worldwide (Thrift *et al.* 2000; Lopez *et al.* 2006). It was estimated that about 3 million of women and 2.5 millions of men who died from stroke (WHO 2004). Even if the incidence is declining in developed countries due to effort of risk factors reduction, stroke represents in low-level income countries around 80% of all stroke-related deaths through the world (WHO 2014). In Sub-Sahara African (SSA) countries, the clinical and epidemiological data remain incompletely documented. However, in various hospitalized-based studies, stroke is considered as one of the three leading cause of disability, lead to dementia disorders and death in SSA (Jenkins *et al.* 2018; Osuntokun 1993). In SSA francophone countries, it has been found somewhere that 45% of hospitalization at Neurology unit of Fann teaching hospital in Dakar suffered from stroke (Thiam *et al.* 2000), 32.9% at the neurology unit of Lomé Campus teaching Hospital in Togo (Balogou *et al.* 2004), and 9.3% of stroke patients aged 45 to 69 years died yearly in Ivorian public hospital (Cowppli-bony *et al.* 2007). On other hand, cognitive impairments are considered as the common stroke consequence (Patel *et al.* 2003), and post-stroke dementia disorders are seen in approximately 50% of patients (Gnonlonfoun *et al.* 2014). Cognitive impairments associated with stroke compromise functional recovery, home support, and increases risk of death (Garcia *et al.* 2013). Likewise, about 15 to 20% of patients die at the end of the first month after stroke, and functional sequels observed in 60 to 75% of survivors are motor and locomotor disorders, anxio-depressive syndromes associated to cognitive and behavioral disturbances (Godefroy 2013). One of major problems in SSA context is the suitable diagnosis of dementia-related stroke which remaining an important public health challenge. Despite, some progress, more efforts are required for the implementation-adapted strategies of diagnosis and effective management of post-stroke patients in order to help them for cognitive recovery. In developed countries dementia disorders-related stroke affect about 7% of people over 65 years of age, and 30% of aging persons (O'Brien *et al.* 2003). However, in SSA francophone context, clinical diagnoses are limited to sometime inappropriate medical neuroimaging tools, but a paucity studies have focused on cognitive outcomes consecutive to stroke event. Therefore, in present study, we assess among various aspect cognitive abilities and some of socioeconomic characteristics, and clinical data in post stroke patients previously admitted at the University teaching hospital Ignace Deen Conakry. That could help later to develop some rehabilitation processes and better care approaches based on local specificities considerations.

Subjects and Methods

<u>*Setting and type of study population*</u>

This retrospective cross sectional study was carried out among 25-post stroke ischemic or hemorrhagic patients (57.6 ±11.05 years) and matched with same number of control healthy persons (40.32 ± 9.70 years). The study took place at Ignace Deen university teaching hospital of Conakry, Guinea from August to December 2016, in collaboration with Cognitive and Behavioral sciences team of Ibn Tofail University, Kenitra, Morocco for neuropsychological expertise. Patients were recruited after obtaining free consent. Exclusion criteria concerned the cases of patients with subarachnoid hemorrhage, cerebral venous thrombosis, transient ischemic stroke, recurrent stroke, or stroke case without brain imaging.

<u>*Data collection process and tools*</u>

Questionnaire

We used an exploitation sheet to collect different anamnestic and clinical data after examination and neuroimaging analysis. Then, a questionnaire pertaining to socioeconomic and demographic characteristics was submitted to subjects.

Cognitive status assessment

Neuropsychological tools included Bells test, test of Raven Progressive Matrices (PM 38), and Rey-Osterrieth Complex Figure (ROCF-A).

Bells test

Bells test, also known as the Bell Dam test, is a test to evaluate hemineglect with its different forms as visual-spatial or visual-attentional in the patients with unilateral stroke. The principle of Bells test is to strike out as quickly as possible for two minutes 35 target stimuli (Bell figure) distributed randomly on an A4 sheet among others 280 distractor stimuli, which are familiar figures such as car, key, fish, guitar among others (Gauthier *et al.* 1989). The target stimuli are organized in seven imaginary columns, three on the left side, one middle and three on right side (Figure 1). We define different organized strategies as; **strategy A** (on top from right to left), **strategy B** (on top from left to right), **Strategy C** (on bottom from right to left), **Strategy D** (on bottom from left to right), **Strategy E** (from top to bottom right side), **Strategy F** (from top to bottom left side), **Strategy G** (from bottom to top right side),

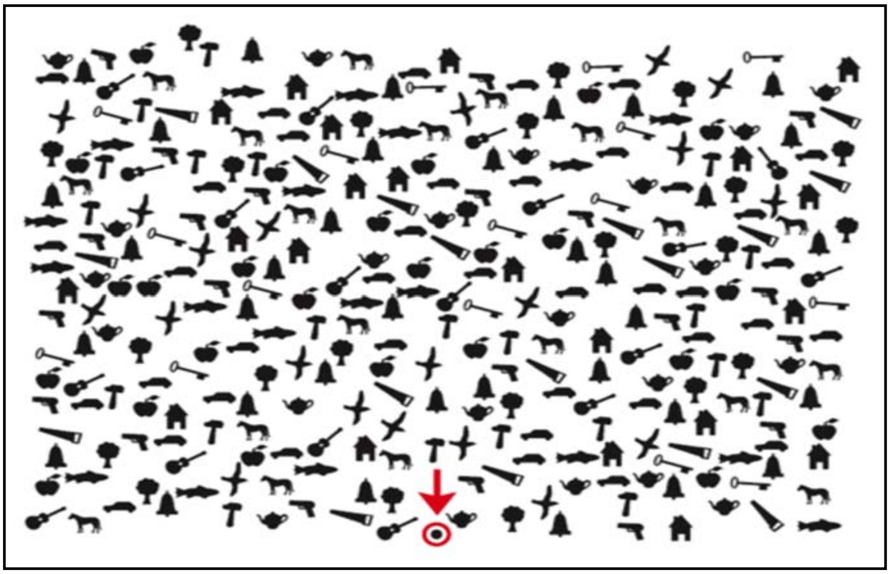

Fig. 1. Sample of the bell Test

Strategy H (from bottom to top left side), **Strategy I** (disorganized strategy).

The Rey-Osterrieth Complex Figure Test (ROCF-A)
The ROCF test was dedicated to evaluation of complex cognitive functions as working memory, visual-perception and visual-construction. The Figure is divided into 18 overlapped geometric elements including rectangle, triangle, square, and circle, crosses among others (Figure 2). In current research, the former version commonly used «paper-pencil version» was replaced by the digital one. It consisted to a digital pen (Anoto system pen) with an infrared camera and an analyzer software ELIAN (Expert Line of Information Analyzer) to visualize and analyze data from pen. The test was carried out in two phases: **(1)** the copy phase assess visual-perceptive and construction abilities, in which subjects were invited to recopy faithfully possible the model in free duration, **(2)** in the second phase the model was removed, and it we asked to subjects to reproduce the figure kept in mind. There is an interphase period of 2 minutes for a distractive task (Wallon & Mesmin 2009). The total score of successful proof achievement is 72 points.

The Raven Progressive Matrices Test
Raven Progressive Matrices (PM38) were designed to assess intelligence, intellectual ability and overall mental skill through the comparison of forms and reasoning by analogy (Azzaoui *et al.* 2008). Raven's Progressive Matrix Test (1938) was created to evaluate logical inductive reasoning. It comprises 60 problems

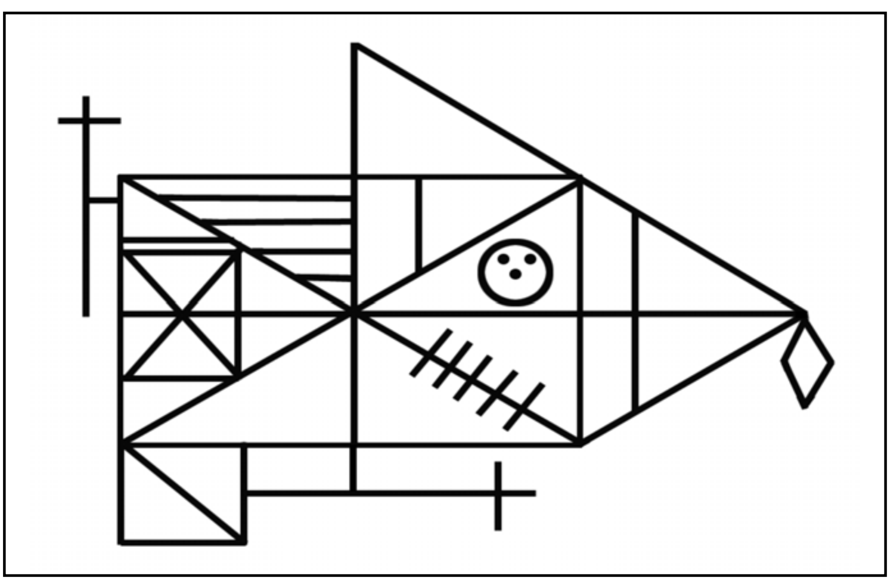

Fig. 2. Rey complex figure

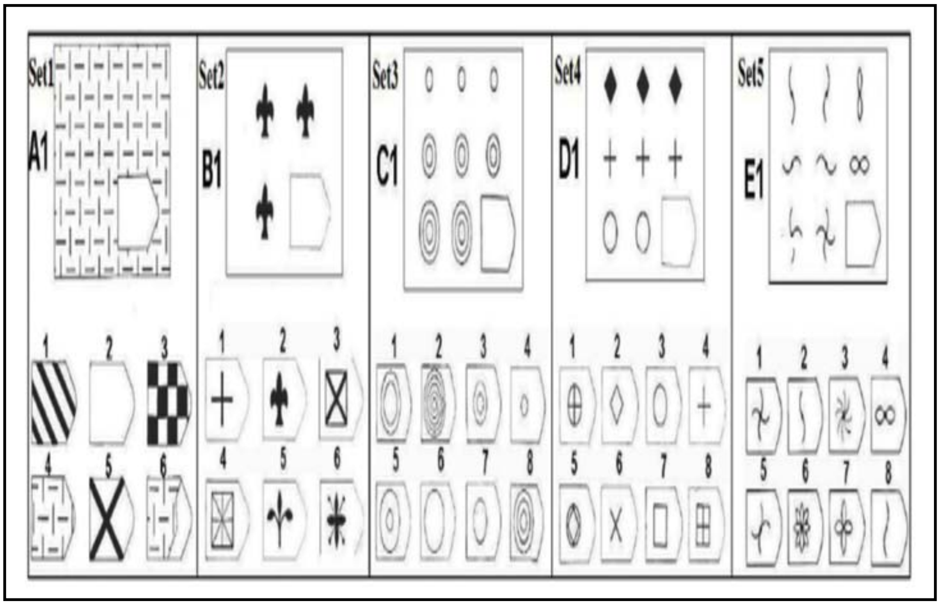

Fig. 3. Matrices Progressives de Raven (PM38)

divided into five series (A, B, C, D and E) each with12 problems, of increasing complexity each, being realized in two phases; the first phase comprising the A, B and C series (in 30 minutes) and the second phase comprising the D and E series (in 20 minutes) (Azzaoui *et al.* 2010). The task of the subject is to find the missing figure and before that, it is necessary to deduce the rules that organize the progression of the figures in line and in column in the matrix. The items are of increasing difficulty, the degree of difficulty being determined largely by the number of rules that organize the matrix and the number of attributes (shape, orientation, type of filling, etc.) by which the figures can be characterized.

Statistical analysis

The various parameters collected from the exploitation sheet were entered on an Excel sheet and the statistical analyzes were carried out using the SPSS software. We presented the mean and standard deviation values for some variables, and the one-factor ANOVA test showed the significance level. A probability threshold $p < 0.05$ is chosen for the significance of the analysis.

Tab. 1. Distribution of socio-economic and demographic data

Socio-demographic Characteristics	Stroke patients (n=25)	Healthy Controls (n=25)	χ^2	*p*-value
Sex				
Male	84%	76%		
Female	16%	24%	–	–
Marital status				
Married	96%	48%		
Single	4%	52%	–	–
Education level				
Illiteracy	40%	64%		
Elementary	24%	32%	9.609	p=0.008
Secondary/ University	36%	4%		
Occupation status				
Employed	24%	48%		
Unemployed	76%	52%	3.125	p>0.05

Tab. 2. Clinical Data on Stroke Patients

Clinical Data	Stroke patients (N=25)	Healthy controls (N=25)
Factors of occurrence		
Brutal stroke	20%	
Stroke at rest	80%	
Glasgow score		
3<GCS<8	12%	None
9<GCS<12	28%	
13<GCS<15	60%	
Diagnostic		
Subdural Hematoma	0%	
Ischemic stroke	20%	None
Hemorragic stroke	80%	
Surgical Intervention		
Yes	0%	None
No	100%	

Results

Socio-economic determinants

Educational level

Table 1 indicates that 36% of stroke patients are illiterate, 24% with primary school level, and 40% have reached secondary or higher level. In control subjects, the distribution shows that 60% of the subjects are illiterate, 32% have a primary level, and only 4% have reached a secondary or university level. The statistical analysis shows a difference in the distribution of educational attainment among the two study groups ($\chi^2 = 9.609$, $p = 0.008$).

Occupational status

The occupational status analysis shows that 76% of stroke patients are unemployed compared to 24% with stable employment. On the other hand, among healthy subjects, 48% were employed, with regular income compared to 52% unemployed (Table 1). However, Khi2 test showed a no significant difference for the distribution of this parameters among the studied populations ($\chi^2 = 3.125$, $p > 0.05$).

Clinical data and patient diagnosis

Circumstances of occurrence of the disease: the occurrence of stroke is when the subjects were resting in 80% of cases (Table 2).

States of subjects at the onset and diagnosis of the disease: the state of consciousness highlighted by the Glasgow score showed that 60% of stroke subjects were in a state of consciousness against 28% unconscious, and 12% had disorders of consciousness.

Diagnosis: Medical diagnosis after admission of stroke subjects revealed 80% cases of haemorrhagic type and 20% of cases of ischemic type (Table 2).

Surgical intervention: 44% of TC patients underwent surgery compared to 56% without intervention. In contrast, no cases of postponed surgery in stroke subjects (Table 2).

Neuropsychological tests scores

Bell test

Gross total score

The three parameters relating to the score of the bell test are the number of left omission, right omission, central omission and total omission. The number of these omissions differs between population types. Respectively, 1.28 ± 0.255; 2.00 ± 0.392; 2.92 ± 0.516; 6.56 ± 1.181 in stroke subjects versus 0.08 ± 0.055; 0.24 ± 0.105; 0.20 ± 0.82; 0.52 ± 0.174 in healthy subjects. The observed differences between the two groups are statistically significant (Table 3).

In addition, the results indicate that 13 stroke patients or 48% missed less than 6 bells versus 12 patients, or 52% had an omission rate of more than 6 bells. In contrast, none of the controls omitted bells (Table 3).

Tab. 3. Distribution of the study population according to the number of omissions on each side of the test sheet

Bell 's Test Score (Mean±ESM)	Stroke patients (n=25)	Helathy controls (n=25)	t-Student	*p*-value
Left Omission	1.28±0.255	0.08±0.055	0.00	<0.001
Right Omission	2.00±0.392	0.24± 0.105	0.83	<0.001
Central omission	2.92±0.516	0.24± 0.105	1.77	<0.001
Total omission	6.56±1.181	0.52±0.174	3.86	<0.001
% of subjects omitting less than6 bells *(pathology score)*	13 (52%)	25 (100%)		
% of people omitting more than 6 bells *(non-pathology score)*	12 (48%)	0 (0%)		

The results are represented by the Mean ± ESM

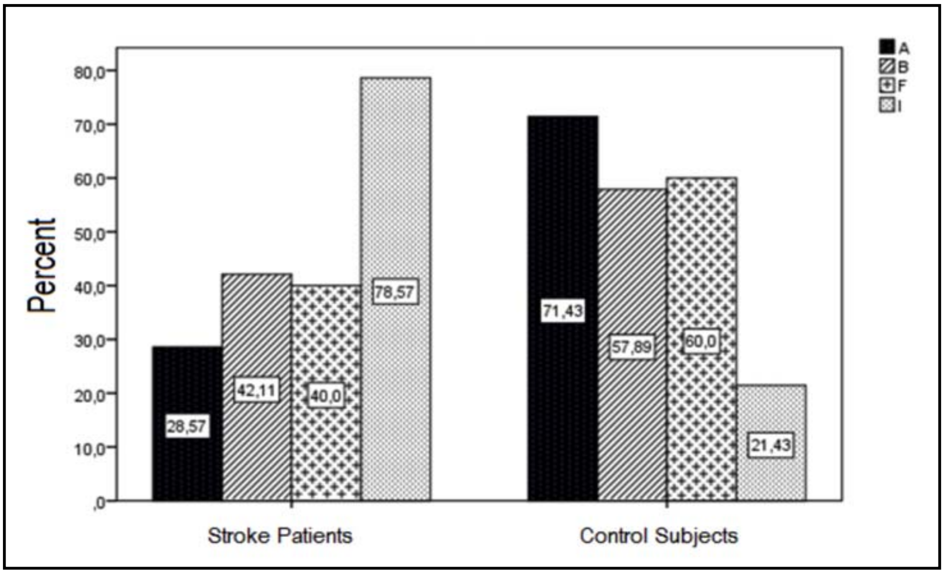

Fig. 4. Distribution of the two populations according to the cross out strategy

<u>Distribution of strategy type</u>
The strategy types was different from post-stroke patients and healthy persons. As depicted **figure 4**, 78.57% of patients use D Strategy I (disorganized strategy) against 21.43% of healthy persons. Indeed, the strategy F was performed by 40.0% of post-stroke patient versus 60.0% of control persons, and 42.11% of patients use strategy B versus 57.89% of control group. Finally, the strategy A (better strategy) was represented in 71.43% of healthy persons relative to 28.57% of post-stroke patients.

Test of Raven's Progressive Matrices
The transformation of Raven scores to percentile rank revealed that the general intelligence was affected in stroke patients **(table 4)**. In fact, 76% of stroke patients suffered from a deficiency of general intelligence (Raven score under 5th percentile rank), 24% of patients were classed below the threshold of general intelligence and the ability to solve rational problems, but with preserved intelligence according Raven score. However, most of the control group (84%) had normal intelligence (Raven score above 25th percentile rank).

Rey-Osterrieth Complex Figure test
During the copying phase, stroke subjects showed significant deficits in visuospatial and constructive perception with a relatively low score compared to healthy control subjects. A similar observation was made during the recall phase of the ORCF test, the stroke patients showed many difficulties in recalling the figures compared to the control subjects (Table 4).

Discussion

Stroke is one of the leading cause of morbidity and mortality around the world (Beyene & Asefa 2018; Jenkins *et al.* 2018). While the incidence is lessening in some developed countries including the US, stroke is considered a major cause of death, disability or dementia in SSA (Jenkins *et al.* 2018). It has been reported that the main risk factor for stroke remains hypertension in SSA (Watila *et al.* 2012), as well as young people are affected by hemorrhagic-type strokes relatively when compared to those of developed countries. On other hand, a major problem remains the diagnosis of typical cognitive disorders subsequent to stroke, and absence of suitable policy for patient's healthcare and improvement of quality of life. In this setting, this first one study in Conakry-Guinea was dedicated to assessment of cognitive status in some post stroke patients, and the implication of sociodemographic features associated.

Sociodemographic variables including age, sex, education level and employment status were analyzed in this study. The average age of stroke patients in our study is 57.6 ± 11.05 years. This is in line with other found in developing Sub-Saharan countries; 57.2 ± 9.9 years in Cameroon (Mapoure *et al.* 2017), and 59.66 ± 13.14 years in Ethiopia (Fekadu *et al.* 2019). The high prevalence occurred at elderly could be due to hypertension, a potential risk factor of stroke at this age. However, in SSA context, more epidemiological studies could focus on the increasing others risk factors in young population as demographic transition, changes of dietary habits and its consequence on health such as obesity, early diabetes or atherosclerosis, which promote hypertension occurrence. In present study, the sex distribution of stroke patients revealed men are predominantly affected (84%). The predominance of stroke prevalence among men in SSA has been reported in a recent survey conducted in Ethiopia (Fekadu *et al.* 2019). The authors reported that the increase of risk factors could be related to some habits such as alcoholism and smoking more commonly seen in men in Africa. In addition, a plausible physiological explanation is likely the

Tab. 3. Distribution of the study population according to the number of omissions on each side of the test sheet

Age	Score Raven Stroke Patients	Percentile Ranks	Age	Score Raven Healthy controls	Percentile Ranks
62	14	4	35	32	26
52	16	4	36	40	43
65	14	4	29	45	59
62	25	15	62	19	8
45	15	4	24	42	48
58	15	4	25	27	18
42	16	4	28	45	59
43	17	5	18	43	50
63	15	4	30	42	48
77	10	2	43	43	50
70	30	22	29	51	82
75	16	4	59	50	78
57	20	9	33	54	92
38	18	7	19	34	29
68	16	4	12	28	19
59	12	2	22	37	35
48	10	2	19	38	38
66	23	13	70	23	13
57	11	2	40	37	35
50	16	4	38	43	50
72	11	2	58	45	59
53	20	9	65	42	48
65	16	4	29	50	78
53	13	3	48	39	40
40	15	4	53	38	38

absence of the vascular protective effects of endogenous estrogen in the male gender.

The educational status of stroke patients included illiteracy (unable to read or write), but also cases of primary, secondary and higher. An analysis of the distribution of education level showed that 36% of stroke patients reached secondary level or higher, compared to only 4% in control subjects. It clearly shows that the appearance of stroke seems to be independent of the level of education. However, the level of education or awareness about stroke, warning signs, its symptoms and risk factors is not well-known among the general population in SSA (Akiyama & Hasegawa 2013). Conversely, a recent survey conducted in the city of Yaoundé reported a good knowledge of stroke in general population, but suggests a more amplified communication through the media and in schools in order to reach young or under-informed populations (Nansseu *et al.* 2017). That is important for an early prevention or effective treatment strategy for dealing with complications.

In this study, the clinical data showed that hemorrhagic stroke is the common type reported (80% of cases) compared to ischemic stroke (20% of cases). In fact, hemorrhagic stroke is commonly identified SSA countries studies unlike to developed countries (Gedefa *et al.* 2017; Nyame *et al.* 1998; Matuja *et al.* 2004; Beyene & Asefa 2018). As mentioned above, arterial hypertension is a potential risk factor for hemorrhagic stroke, and it is found in many studies in SSA. Even if, a controversial studies reported that ischemic strokes predominated over hemorrhagic stroke (Fekadu *et al.* 2019; Mapoure *et al.* 2017).

Regarding the evaluation of the cognitive status of patients in the post-stroke period (1-3 months after the events), Mini Mental State Examination (MMSE) is the overall appropriate tool used to diagnose dementia disorders (Bour *et al.* 2010). In present study, beyond to the evaluation of memory abilities, we emphasized on others aspects of cognition as executive functions or general intelligence. The Neuropsychological tests encompassed the Bells test, the Raven Standard Pro-

Tab. 5. RCF test score of patient and control groups. The scores are represented by averages.

Scores	Sroke patients	Healthy controls	t-Student	*p*-valuer
Copying phase (Visual perception and construction)	39.24±2.85	64.48±1.78	8.02	<0.001
Successful rate copying phase	54.16%	89.55%		
Recall phase (Working memory)	17.64 ± 3.28	51.60 ± 2.28	4.75	<0.001
Successful rate	24.5 %	71.66%		

Data are represented by the Mean ± SEM

gressive Matrix (PM 38), and the Rey-Osterrieth Complex Figure test. Globally, our results are consistent with previous findings that reported various significant degrees of cognitive impairments in the post-stroke period (Gnonlonfoun *et al.* 2014; Mellon *et al.* 2015; Patel *et al.* 2003; Moran *et al.* 2014). According to some authors, 40 to 70% of stroke patients suffered from cognitive disorders, and almost half of them presented dementia disorders (Tatemichi *et al.* 1994; Godefroy & Stuss 2007, Godefroy *et al.* 2011). Here, based on the score of Bells test, we found that 52% of stroke patients (6 months after the event) had visual-spatial deficit, and very few cases of left unilateral hemineglect (1 in 25 cases) or right unilateral hemineglect (1 in 25 cases). Furthermore, attention disorders are some kind of cognitive dysfunctions frequently found during post-stroke period. It is estimated at a prevalence of between 24% and 51% (Hyndman *et al.* 2008). Our results with the Bells test corroborated with those of a previous one that suggested a significant total number of omissions in stroke patients with right hemisphere lesions compared to post-stroke patients with left hemisphere lesions or healthy control subjects (Oliveira *et al.* 2016). In addition, these authors have shown in these patients a high prevalence of disorganized strategy especially in the right column, as reported also in this study. In SSA countries context including Guinea with the high cost of neuroimaging analysis, the use of sensitive and valid neuropsychological tests could be considered as a credible alternative for a diagnosis of referral to methods of cognitive rehabilitation and improving the quality of life of patients. Another factor that could explain the Bell test poor performances in stroke patients is mental fatigue. We found that stroke patients spent more time to cross out the bells when compared to the healthy controls. Thus, both mental fatigability and attentions disorders could compromise cognitive reactivity and subsequently difficulties of cognitive recovery in post-stroke patients.

The intention of this study was not to study only cognitive dementia in post-stroke patients as reported elsewhere with the MMSE (Mapoure *et al.* 2017; Patel *et al.* 2003) but also examine an expanded range of cognitive post-stroke conditions. For this purpose, visual-spatial abilities including visual-perception, visual-construction and working memory were assessed with the ORCF test. We noticed significant difficulties to solve the ORCF by post-stroke patients. This performance explains dysfunction of execution function in which working memory remains important component. In fact, the central administrator sub-components named visual-spatial register and phonological loop interact continuously (Brown *et al.* 1988). Working memory is essential for managing tasks and solving problems on a daily basis. This test could be efficient for a diagnosis referral to other advanced techniques such as medical imaging or electrophysiology.

Finally, Raven's cognitive test (PM 38) was used to describe the level of general intelligence through reasoning by analogy and mental skill in post-stroke subjects. As we expected, Raven's score was ranked at the low percentile (5-25th rank) in post-stroke patients, as opposed to healthy control subjects (score above 25th rank). They also expressed great mental skill difficulties in solving the different sets of problems. Those results pertaining to general intelligence alteration in post-stroke patients. So visual-spatial and attentional disabilities (evaluated with Bells and ORCF tests) are key factors of cognition dysfunction and intelligence level alteration in post-stroke patients.

There is still no consensus about the appropriate tools for post-stroke cognitive impairments diagnosis, unless needed a broad neuropsychological assessment (Khedr *et al.* 2009). However, in SSA context with limitations in medical technology platforms, few studies have focused the use of neuropsychological tests in neurology. To our knowledge, this first present neuropsychological study in Guinea about cognitive disorders among patients 6 months after stroke could constitute a diagnosis of interest and guidance for better cognitive rehabilitation and improvements of the quality of life of patients. Moreover, high level of education in these patients when compared to healthy control subjects should limit the bias of the cognitive outcomes. However, additional studies with a wide sample size of stroke patients could reinforce the validity and reliability of cognitive test employed in comparison to other tool routinely exploited (The MMSE).

Conflicting of interest

No conflict of interest declared by authors.

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