Cerebral Arterial Territories Most Obstructed in Ischemic Stroke: Experience of a Tropical Low Income Practice Center

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Abstract: *Background*: The cerebral arterial territory corresponds to a specific brain area irrigated by an artery. Stroke remains the leading cause of physical disability acquired wide world. We aimed to identify different arterial territories affected among patients hospitalized for ischaemic stroke.

Materials and Methods: We have conducted a retrospective study in the neurology department of our tertiary hospital. The study has carried out inpatients presenting with clinical features of ischaemic stroke from January to December 2012. Their brains CT scan have shown infarction area**s**. Patients excluded were those presented with clinical manifestations of stroke but did not perform a CT scan and those with a hemorrhagic stroke or transient ischaemic attack with normal CT scan.

Results: We have analyzed 64 cases among 408 inpatients which have given a frequency of 15.7%. The sample has included 31 (48.4%) men for 33 (51.6%) women. The mean age was 61.7 years. The clinical features were marked by motor deficit (right or left) in 98.4% followed by aphasia 35.9% and impaired consciousness, 26.6%. We have observed 31(48.4%) infarction in the right hemisphere and 36(56.3%) in the left. Two patients (3.1%) had bilateral brain infarcts. Depending on the arterial territories obstructed, the middle cerebral artery was the most affected with 76.6% followed by the anterior cerebral artery, 14.1%, the anterior choroid artery, 7.8% and the cerebellar arteries with 3.1%. The cortical and central arteries branches were affected in 82.7% and 68.8% respectively.

Conclusion: This study has highlighted the useful tools to recognize arteries areas frequently affected in ischaemic stroke. The affected brain area can easily be attached to an arterial territory with a specific anatomic and radioclinic correlation syndrome.

Keywords: Arterial territories, brain infarcts, ischaemic stroke.

INTRODUCTION

The cerebral arterial territory corresponds to a specific brain area irrigated by a cerebral artery. These arteries are responsible of brain blood flow to perfuse nerves cells [1]. It served to apply noninvasive imaging method for visualizing and quantifying whole-brain perfusion on Arterial spin label (ASL) [2]. The arterial territories have a specific clinical and anatomic correlation syndrome with the affected brain area [3-5].

Previous studies have reported the occlusion of middle cerebral artery (MCA), cortical branches arteries, putamen and thalamic nuclei respectively in 73.7%, 40.9%, 71.3% and 35.5% [6-8].

There are ischaemic and hemorrhagic stroke sub types, which represent 70-80% and 10-20% respectively in developed countries [9,10]. In Sub Saharan Africa, strokes are the leading cause of physical disabilities and death in the major departments of neurology [11,12]. The occurrence of stroke is an emergency condition that required early management. Its diagnosis is based on clinical examination and CT scan. The clinical signs are related to the specific and function of the affected vascular territories [6,14-16]. CT scan distinguishes infarction from hemorrhage area [17,18]. This differentiation is essential before being placed or not under antiplatelet, anticoagulant or fibrinolytic intravenous treatment when the patient is seen in the first three hours after the onset of clinical signs [19]. Sometimes, CT scan can be normal in the first hours of the ischaemic stroke and it is recommended to repeat it consistently 48-72 hours later or performed MRI if available. The early treatment made in an emergency stroke center improves the functional and vital prognosis of patients. The aim of this study was to identify the arterial territories affected in the setting of ischaemic stroke among inpatients.

MATERIALS AND METHODS

Setting

The neurology department of the University Hospital of the biggest town of our country had located this study. This service has 40 beds with an emergency stroke unit, an EMG and EEG laboratories, and neuromuscular histology unit. The service receives an

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average of 1,200 outpatients and hospitalized between 500-600 inpatients per year. The neurology service disposes of CT scan leading by a neuroradiologist. The whole population in the country is about 6 millions. Activities are concerned health care, teaching and research.

Selection Procedure and Assessment

The consecutive admitted patients who fulfilled the inclusion criteria (clinical signs of stroke, hypodensity on CT scan) were selected. CT scan has revealed hypo density a brain parenchyma corresponding to cerebral infarct. None of our patients had received a CT scan control. None undergo thrombolytic intravenous treatment. All patients had received medical rehabilitation and speech therapy in case of aphasia. Symptomatic treatment was established according to associated diagnostic.

Patients not included in this study are those presented with clinical manifestations of stroke but did not perform a CT scan, and those with a presence of hemorrhage, lacuna or a transient ischemic attack with normal CT scan. The hemorrhagic strokes were excluded because they did not accurately permit to identify the arterial territory obstructed. Indeed, the hemorrhage of an arterial may extend to other territory making it difficult to recognize the real affected area. Hemorrhage strokes include parenchyma hemorrhage, sub arachnoid hemorrhage and hemorrhage associated to lacuna or infarction. For the brain lacunar infarct often multiple, its precise location related to affected artery is difficult. Patients with clinical signs of stroke but unable to complete the brain scan were therefore not included. The cerebral scan was normal in 68 patients who presented with a transient ischemic attack, they were also excluded.

None incident stroke and stroke relapse were included.

It was a retrospective and descriptive study made on inpatients covering a period from January 1st to December 31st, 2012. The collect sheet paper contained demographic, clinical and CT scan data. The vascular territory involved was assessed using the template proposed by Damoiso. Each CT scan was read both by a neurologist and neuroradiologist. The inpatient or his/her relatives must pay for the CT scan which price is about $100 US, and cope with other directs and indirect hospital costs. All the patients have given inform consent. The study was approved by the ethics committee of the university hospital.

Statistical Analysis

Because of the small number of cases involved, the data on clinical course according to the vascular territory affected were analyzed using descriptive statistics.

RESULTS

We have analyzed a total of 768 files. Among them, 408 had been suspected for stroke. The hemorrhagic stroke was encountered for 95(23.3%), the brain lacunar infarct, 78(19.1%), unable to complete the brain scan, 58(14.2%) and the normal cerebral scan in 68 patients.

We have retained for the study sample 64 patients including 31 men (48.4%) for 33 women (51.6%) with a

Table 1: Description of the Demographic, Clinical and Radiological Characteristics of the Study Population

Age		Sex		Admission mode	Time to realize CT scan	Clinical signs	Arterial territories
years	N	Males	Females				obstructed
36-45	11	12	1	Direct 36 (56.3%)	Average: 43H	Hemiplegia (98.4%)	MCA (76.6%)
46-55	18	9	9	Referral 28 (43.8%)	SD: 53±24H	Aphasia (35.9%)	PCA (14.1%)
56-65	14	4	10		Extreme: 6H-11 days	Uncounciousness (26.6%)	Cortcal arteries (82.9%)
66-75	10	3	7			Sensory disorders (23.4%)	Central arteries (68.8%)
76-85	8	2	6				Lenticulostriate (48.4%)
86-95	3	1	2				Right hemisphere (31;46.3%)
							Left hemisphere (36;53.7%)
	64	31	33				
		48.4%	51.6%				

Legend: SD: standard deviation; MCA: middle cerebral artery; PCA: posterior cerebral artery; CT: computer tomography; N: number; H: hour.

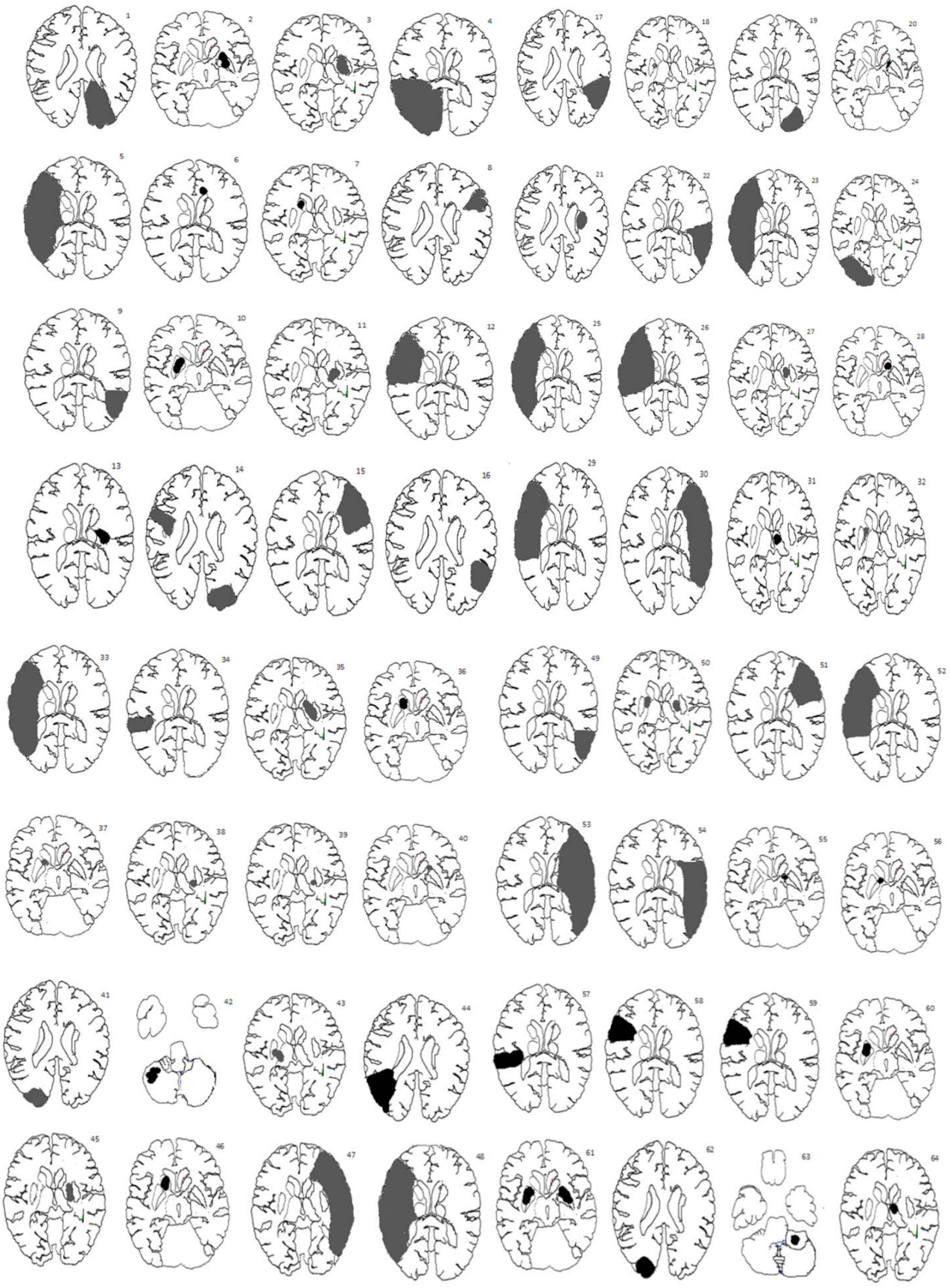

Figure 1: Arterial territories obstructed from 1st to 64th patients.

ratio sex of 0.9. The mean age was 61.7 years with extremes of 36 and 90 years old. Female age rounded about 56 and 75 years old and men, 36 to 55 years old. Eighty percent of patients accomplished their brain imaging within 72 hours. The description of the demographic, clinical and radiological characteristics of the study population was given in Table **1**.

Regarding the results of brain imaging, we have collected 67 lesions from which 31 (46.3%) pictures showed infarction in the right cerebral hemisphere and 36 (53.7%) in the left hemisphere. Two patients (3%) had presented with bilateral infarcts involved respectively the internal capsule and lenticular nuclei (pictures 50 and 61, Figure **1**), and 1 had two lesions concerning the branch of the right middle cerebral artery (MCA) and the left posterior cerebral artery (PCA) (pictures 14, Figure **1**).

In analyzing of the affected arterial territories, occlusion of MCA was predominant with 76.6% followed by the PCA, 14.1%, the anterior choroid artery, 7.8% and cerebellar arteries with 3.1%. The anterior cerebral and posterior communicating arteries were the least affected with 1.6% each. Figure **1** showed the slices of arterial territories occluded from 1st to 64th patients.

Concerning the risk factor, 43 (67.2%) had realized an electrocardiogram recording in which 31 (72.1%) were showed heart ischaemia and 5 (11.6%) atrial fibrillation. Eight patients (12.5%) had performed a Doppler of supra aortic trunks showing atherosclerosis with calcified plaques in 9.4%. According to laboratory tests performed, 32.8% (21) had homocysteinemia high level and 46.9% (30) hypercholesterolemia.

We have found as stroke complications, 5 cases (7.8%) of pneumonia, 2 cases of epilepsy and dementia in 3.1%. The average period of hospital length stay was 6 days with extremes of 1 and 81 days. In the outcome, 71.9% (46) had recovery their motor impairment after 16 weeks, 18.8% had discharge against medical advice and 9.4% had died.

DISCUSSION

The CT scan provides essential arguments in the diagnosis of stroke in limited resources setting where MRI is not available [12]. Its achievement time varied, depending on the patient financial conditions in our country. Thus in this study, the CT scan was obtained within an average of 43 hours with extremes of 6 hours and 11 days. This reflects the great difficulty to obtain brain imaging and therefore the delays in care of patients.

Concerning the different arterial territories affected, we have found 76.6% (49) and 1.6% for MCA and ACA respectively. Similar results were reported in previous studies in 1998 and 2003 in Europe with respective rate of 73.7% and 1.8% [6,8,20,21]. The low rate observed with ACA may be related to its position and diameter, which probably receives less emboli from the internal carotid artery than MCA.

Cerebellar arteries were affected in 2 cases (3.1%). The cerebellar arteries have being connected to the basilar artery right angles (AICA) and vertebral artery (PICA), emboli are less commited to follow the blood flow in these arteries. Similar results were reported in China in 2004 [7].

Considering the cortical and central branches affected, we had a total of 67 lesions in which 35 (52.2%) were localized to cortical branches and 32 (47.8%) in the central branches. This predominance of cortical branches is due to their smaller diameter and position to the blood flow with the possibility of fast thrombosis [7].

Regarding the basal ganglia lesions, there were a total of 41 lesions, 24 (64.9%) in the internal capsule, 7 (18.9%) in the caudate nucleus, 6 (16.2%) in the putamen and 4 (6.3%) for the thalamus. LEE *et al.*, [8] were observed 16.7% for the internal capsule, 12% for the caudate and 71.3% for the putamen nuclei, and 35.5% of thalamic lesions. These results were different to that we have obtained due to smaller size of our sample. The study of Lee *et al.*, was solely focused on the basal ganglia nuclei.

Territories of brain arteries have specific clinical significant. It can be determined in the treatment and the prognosis of ischaemic infarction area. One cerebral artery often vascularize a large territory by its multiples branches. This territory can be involved in total, partial or focal parts by the infarction. The diameter of the artery affected determines also the therapeutic measures approaches used and its complications, and the existent of sequelae in the follow up [1,3,21]. The arterial territory has a significant radioclinic correlation [3-5,23]. Brain arterial tree mapping developed by some authors is valuable for a variety of clinical and scientific applications [1-5,23]. This is important for brain perfusion system, and provides quantitative descriptions of arterial branches, bifurcation patterns, and the estimation of the

corresponding vascular territories and the pathogenesis of infarcts. Sometimes similar vascular lesions induce different topographic patterns in some arterial (MCA, ACA) territories infarction, which are related to individual vascular variability, degree of primary and secondary collateralization, and pathogenesis of infarcts [23-26].

In case of involvement of a large arterial territory with a resuscitation status and fatal brain swelling, decompressive craniectomy is performed associated to routine symptomatic treatment [27,28]. When the obstructed territory is not so large, re-perfusion by thrombolytic treatment is observed but thus also need more requirements condition to avoid fatal hemorrhagic stroke after intra-arterial reperfusion therapy [19]. In secondary prevention, anti platelet therapy was prescribed to the outpatient in 65.6% and anti vitamin K treatment in 11.6% of cases. None of our patients had undergone thrombolytic intravenous treatment as was reported in other studies [29-31].

We have recorded 9.4% of death. The mortality rate may have a significant link to the topography, function and size of the affected artery [23,28,32].

Our mortality rate may be underestimated because we did not follow the 18.8% of patients who discharged against medical opinion. We did not also collect all patients admitted during that period in another clinic or those who cannot effort the modern care facilities and use traditional therapy. The hemorrhagic stroke was excluded because they do not accurately identify the arterial territory obstructed. Indeed, the hemorrhage of an arterial may extend to other territory making it difficult to recognize the real affected artery. For the brain lacunar infarct, often multiple, its precise location on CT scan of the affected artery is difficult. Seventy height patients with clinical signs of stroke have not been able to complete the brain scan. The scan was normal in some patients who presented with a transient ischemic attack, they were also excluded. All these exclusion constitute the bias of recruitment but the consistency of our findings with previous studies gives the validity to the data.

The mean age reported by several authors concerning ischaemic stroke varied from 60 to 64.2 years old, and is similar to that observed in our study [7,12,14-17]. We concluded that ischaemic stroke often occurs in elderly people.

Regarding the stroke risk factors, our data concord with those reported in the literature and show that hypertension is the leading risk factor followed by diabetes and embolic heart diseases in ischaemic stroke [7,19,21,33,34].

CONCLUSION

The middle cerebral artery and the cortical arteries branches were the most often obstructed in ischaemic stroke. This study provides to inexperienced neurologists and clinicians not specialized in neurology more view to recognize the different arterial territories that must frequently be affected in ischaemic stroke. It also helps to understand the anatomic and radioclinic correlation of stroke syndromes.

AUTHOR'S DECLARATION

All coauthors have read and approved the contents of the submitted manuscript. We certify that the submission is not under review at any publication elsewhere.

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