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Understanding the Impact of Cerebral Artery Anatomy Distribution on Clinical Outcomes in Stroke Patients: A Retrospective Analysis

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ABSTRACT

Introduction: As one of the leading causes to suffer and death on a global scale, cerebral stroke is characterized by cerebrovascular blood flow failure ultimately causing central nervous function disturbances. The diagnosis and treatment of stroke is very dependent on accurately describing the cerebral artery involvement. Artery blockage or rupture causes cerebral stroke which leads to hemorrhagic brain tissue damage and ischemia. Stroke severity and clinical presentation are related to the involvement of specific areas within the cerebral arteries, hence understanding their distribution is paramount.

Objectives: This study aims to explore how a stroke affects the distribution of arteries in the brain, and thereby improving strategies for treating strokes.

Study design: a retrospective study.
Place and duration of study. Between 1-1-2022 and 31-12-2022 from Saidu Group of Hospitals.
Methods
This is a retrospective analysis of clinical records on 390 patients diagnosed as having suffered hemorrhagic or ischemic stroke. Demographics, imaging results and stroke subtype classification was extracted from medical records. Then the extent of cerebral artery injury was assessed using magnetic resonance imaging (MRI), as well as computed tomography scan (CT). Statistical analysis was employed to obtain the cerebral artery involvement and its association with clinical outcomes.
Results:
The age of the patients ranged from 20 to 99 years and a significant regional variation in stroke incidence was explained by different patterns across age categories ($p < 0.0001$). There was an almost equal sex ratio of patients (215 males vs. 175 females). The proportion of ischemic stroke (64.1%) was larger, and there were significant differences in the subtype distribution between groups; all $p < 0.05$). MCA involvement was most common in both ischemic (50.0%) and hemorrhagic (40.0%) strokes, followed by ACA and PCA alike for combined types of stroke [Table 5]. Mortalty rates were 15% for ischemic and 25 % for hemorrhagic stroke, with half the patients achieving a favorable functional outcome (modified Rankin Scale ≤2) at discharge.
Conclusion:
The broad array of cerebral arteries involved in different species of strokes underscores its impact on therapy results. Being able to identify the exact areas of arteries that are stenotic/occluded further aid in early diagnosis, course of therapy and prognosis. More research is needed on the underlying etiologies and treatment strategies for different stroke subtypes.
Keywords: ischemic stroke, hemorrhagic stroke, vertebrobasilar artery

INTRODUCTION

Throughout the world, stroke remains an important public health problem by accounting for a significant proportion of morbidity and premature death. 1 It is characterized by sudden impairment of blood flow to the brain, which may result in hemorrhagic or ischemic injury and various clinical presentations due to temporary or permanent neurological damages. 2 Accurate diagnosis, effective therapy, and prognosis might be deduced from the distribution of cerebral artery involvement in cases of stroke. 3 The pathophysiology of stroke involves several pathways; however, the clinical presentation and outcomes in patients following a stroke are largely determined by which areas have been affected due to occlusion or hemorrhage depending on cerebral artery territorial supply. 4 For this reason, the territories of the middle cerebral artery (MCA), anterior cerebral artery (ACA), posterior cerebral artery (PCA) and vertebrobasilar arteries are particularly relevant since it provides blood to distinct areas of brain with specific functional characteristics. 5 Advances in therapeutic strategies, diagnostic tools and devices have resulted in better management of stroke; yet the optimal treatment for an individual patient remains highly challenging. This novelty necessitates a detailed understanding of the cerebrovascular anatomy and its implications on stroke mechanism. 7 A critical appraisal of patterns of involvement in 390 subjects sheds light on the clinical presentation, epidemiology, and prognosis associated with vascular territory. 8Informed by a large, population-based sample of imaging and clinical data, we sought to define the rates and distributions of ischemic vs. hemorrhagic strokes specific to individual cerebral artery territories. 9 By identifying the top artery involvement and clinical symptom pairs, our work moves forward what we know about stroke pathogenesis for tailored medical management in each patient to provide better outcomes. 13 It is hoped that through extensive investigation into the regional vasculature advantageously used to model stroke in 390 patients, this study can complete our understanding of arterial anatomy and indeed represent useful clinical data for guiding treatment strategies with those who suffer from Stroke. 11

METHODOLOGY

Study design:

This was a retrospective review of the medical records from 390 individuals with ischemic or hemorrhagic stroke. Patients were enrolled consecutively between 1-1-2022 and 31-12-2022 from Saidu Group of Hospitals

Inclusion criteria:

Eligible patients were adults who had been clinically diagnosed, by a stroke specialist in the Accident and Emergency Department.

Exclusion criteria:

Nonstroke patients presenting with transient ischemic attacks and traumatic brain injury

Data Collection:

Study design: Information regarding the patients diagnosed as Ischemic or Hemorrhagic stroke was retrospectively collected from Medical records of Patients presented to Saidu Group of Teaching Hospitals during 1 year. Data collected included age, sex; clinical presentation, comorbidities and imaging findings. Neuroimaging studies and clinical narrative formed the basis of stroke subtype classification (ischemic or hemorrhagic). 16

Data analysis:

Frequency and percentage were used to describe demographic characteristics, types of stroke. The distribution of cerebral artery involvement with stroke and the associations between arterial regions and clinical outcomes were analyzed. The observed associations were tested for significance using statistical methods such as chi-square tests. 17

Ethical Considerations:

This study was approved by the Institutional Review Board and it followed all the ethical criteria required in society statement: Helsinki Declaration. Privacy and confidentiality of the patients was maintained throughout all stages dealing with data collection and analysis. 18

Limitations:

Given the retrospective nature of this study, potential selection bias inherent to collection of data retrospectively and use of medical records that were collected for purposes other than research is possible. Differences in the quality and interpretation of imaging may have affected accuracy of assessment for cerebral arteries involvement. Finally, the study is of a retrospective nature and based on an association between cerebral artery involvement with clinical outcome without being able to show any causal links.As such, retrospective studies may contribute to our understanding of stroke pathophysiology and provide valuable data on the epidemiology of stroke in general. 19

RESULTS

Patients included in this study were aged 20-99 years. Table 1: Number of Subjects in each age grouping, and Associated p-values derived from independence chi-square testing. The p-values indicate the statistical significance of any differences in stroke incidence by age. Importantly, a common assumption in statistical methods is that the predicted values were estimated based on sampling randomly from all ages of people, if we want to forecast how many strokes there are

across individuals at every age. Table comparing risk of stroke at various decades to create a age profile of the patient population under study for consideration as to possible patterns in 7th decade. Highly statistical significant correlation between the age range and number of patients($p<0.0001$)

Table-1: Age range of patients

Age Range	Number of patients
20-29	3
30-39	5
40-49	10
50-59	50
60-69	120
70-79	150
80-89	45
90-99	7

Table -2: Male and Female distribution of patients.

Gender	Number of Patients
Male	215
Female	175

Table -3: Percentage of ischemic and hemorrhagic stroke

Stroke Subtype	Number of Patients	Percentage
Ischemic Stroke	250	64.1%
Hemorrhagic Stroke	140	35.9%

Table -4: Distribution of Cerebral Artery Involvement in Ischemic Stroke Patients

Cerebral Artery Territory	Number of Patients	Percentage
Middle Cerebral Artery (MCA)	125	50.0%
Anterior Cerebral Artery (ACA)	50	20.0%
Posterior Cerebral Artery(PCA)	50	20.0%
Vertebrobasilar Artery	25	10.0%

Table -05: Distribution of Cerebral Artery Involvement in Hemorrhagic Stroke Patients

Cerebral Artery Territory	Number of Patients	Percentage
Middle Cerebral Artery (MCA)	56	40.0%

Anterior Cerebral Artery (ACA)	42	30.0%
Posterior Cerebral Artery (PCA)	21	15.0%
Vertebrobasilar Artery	21	15.0%

Table-6: Clinical Outcome

Clinical Outcome	Percentage
Mortality rate among ischemic stroke patients	15%
Mortality rate among hemorrhagic stroke patients	25%
Functional outcomes at discharge (mRS ≤ 2)	50%

DISCUSSION

Cerebral stroke remains a leading cause of morbidity and mortality worldwide-I suppose that the effect on human health is major. Ischemic or hemorrhagic strokes which lead to acute interruption of blood flow in brain can result as an extensive range of neurological impairments with bugs plethora management challenges in a clinical setting. When diagnosing, treating and assessing the prognosis of stroke; full knowledge regarding which parts of cerebral arteries are affected is very crucial. The aim of this study was to reveal the incidence and time trends in cerebral artery-specific ischemic stroke and hemorrhage, with a particular focus on their possible clinical implications. 20 The results of this retrospective study containing a large population-based cohort provide novel insights into the clinical characteristics and epidemiology of stroke. This study was conducted among 390 stroke patients of Saidu Group Teaching Hospitals. This study established unique cerebral artery involvement patterns in stroke patients by reviewing clinical presentations, imaging data and demographic variables. Four small specific areas of the vertebrobasilar, anterior cerebral (ACA), posterior cerebral (PCA) and middle cerebral artery tree have been demonstrated to be key sites in stroke pathophysiology. These are vital because these supply the blood to specific areas of brain, and hence important in stroke pathophysiology.
Even with advances in diagnostic and therapeutic strategies, stroke management remains challenging. This study has many inherent limitations due to its retrospective design (eg, data collecting biases and reliance on existing medical information). In addition, discrepancies between imaging quality and interpretation could also affect the reliability of identifying cerebral artery involvement. Therefore, the study's retrospective nature prevented researchers from establishing definitive causal relationships between artery involvement and those clinical end points.Nevertheless, backward-looking studies - such as the present one evaluating mechanisms contributing to stroke in people who have already experienced a TIA or stroke episode - continue to provide key information about just what goes wrong during and after strokes that current therapies may not address. By providing clarity on cerebral artery involvement distribution and its effect on clinical outcomes, this study provides valuable information that will help guide treatment decisions as well overall care for stroke patients. Larger cohort, prospectively done studies with standardized methods of data collection will be needed in the future to replicate our results and refine stroke prophylaxis strategies. 21

CONCLUSION

In conclusion, this study adds to our knowledge on the epidemiology of stroke and underscores that cerebral artery territories should be considered when diagnosing or treating strokes. Despite these limitations, the study offers significant advances in knowledge of stroke pathogenesis and brings us one step closer to being able to provide personalized treatment options that can improve patient outcome as well reduce the burden of stroke-related morbidity and mortality globally. 22

Future Directions

These findings also contribute to the existing understanding of rate and patterns of cerebro-vascular disease in stroke, further informing clinical practice. Understanding the clinical profile and epidemiology of different subtypes of ischemic stroke in conjunction with their location relating to territory of cerebral artery may better guide risk stratification, therapeutic decision-making and prognostication. Longitudinal studies investigating long-term outcomes, predictors of recovery among stroke patients in the different age groups and subtypes should be addressed by future work.Together our research underscores the importance for comprehensive stroke care and tailored interventions to alleviate the burden of illness and death from incident stroke. By enhancing healthcare delivery through the management of risk factors, developing acute treatment modules, and implementing evidence-based rehabilitation programs we can strive to improve patient outcomes.

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