2023

Research on CT patterns of clinically suspected stroke at Tikur Anbessa Specialized Hospital, A retrospective study.

Declaration

I, **Dr. Zerihun Gelashe Hailu** with the registration number of **GSR/5397/13**; do hereby declare that this thesis entitled **'CT Patterns of clinically suspected Stroke Patients, a retrospective descriptive study, from January of 2023 up to December of 2023 in Tikur-Anbessa Specialized Hospital, Addis Ababa, Ethiopia'** is my original work and that it has not been submitted partially; or in full, by any other person for an award of degree in any other university/institution.

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Submission date: 22-Feb-2024 04:47PM (UTC+0300)
Submission ID: 2301546621
File name: Zerihun_Gelashe_Research_FINAL_DRAFT.docx (232.94K)
Word count: 10608
Character count: 62265

ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES
DEPARTMENT OF RADIOLOGY

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A research thesis submitted to the Post-Graduate Program of Addis Ababa University, Department of Radiology, and School of Health Sciences for Partial Fulfillment for the Post-graduate degree in Radiology.

DECEMBER, 2023

ADDIS ABABA, ETHIOPIA

Acknowledgment

I would first like to express my gratitude to Almighty God for His guidance and support throughout this endeavor. I am also deeply thankful to my advisors, Dr. Abebe Woldeyohannes, Dr. Amal Saleh, Dr. Tewodros Endale and Dr. Tesfaye Gizaw, for their unwavering support from the inception of this research project to its completion. I would also like to extend my heartfelt appreciation to my brother, Dr. Tariku Gelashe, for his invaluable advice and support, particularly during the data processing stage.

Acronyms and Abbreviations

- AAU: ----------Addis Ababa University
- ABM ----------Abnormal body movement
- ACA ----------Anterior cerebral artery
- AKI ----------Acute Kidney Injury
- CD ----------Communicable Disease
- CHF ----------Congestive Heart Failure
- CKD ----------chronic kidney disease
- CLD ----------Chronic liver disease
- CT: ----------Computed Tomography
- CTA ----------Computed Tomography Angiography
- CVD ----------Cardiovascular Disease
- DM ----------Diabetes Mellitus
- DSF ---------- Depressed skull fracture
- HHD ----------Hypertensive heart disease
- HTN ----------Hypertension
- IHD ----------Ischemic Heart Disease
- LOC ----------Loss of consciousness
- MCA ----------Middle cerebral artery
- MRA ----------Magnetic Resonance Angiography
- MRI ----------Magnetic Resonance Imaging
- NCCT: ----------Non contrast computed tomography
- NCD ----------Non-Communicable Disease
- NPH ----------Normal pressure hydrocephalus
- PCA ----------Posterior cerebral artery
- PRES ----------Posterior Reversible encephalopathy syndrome
- TASH: ----------Tikur-Anbessa Specialized Hospital
- TB ----------Tuberculosis
- WHO: ----------World Health Organization

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Abstract

Introduction: Stroke, as defined by the World Health Organization (WHO), is a sudden neurological event that results from a vascular cause. Despite a downward trend in stroke incidence in developed countries, the burden of stroke is increasing in developing nations, underscoring the need for more research in this area. Timely diagnosis and treatment can improve clinical outcomes and reduce mortality. This study aims to identify the imaging patterns of clinically suspected stroke patients, determine the frequency of stroke mimics, and characterize the imaging patterns of CT-confirmed strokes. Additionally, the study investigates the recurrence rate of stroke and the factors associated with it. The findings from this type of research are essential for improving patient functional outcomes and reducing stroke recurrence rates. However, there is a dearth of data on this topic in Ethiopia, particularly regarding stroke recurrence rates and clinical stroke mimics.

Method: A retrospective cross-sectional study was conducted, utilizing medical records that had complete patient information, imaging reports for clinically suspected stroke patients and confirmed diagnoses verified by academic rank of Neuroradiology Consultants and Neuroradiology Fellows. The data was subsequently compiled and analyzed using SPSS version 27.0.

Results: In this study of 322 participants, CT revealed that 223 had strokes, while 28 had other alternative diagnoses. Hemiplegia and change in mentation were the two commonest clinical features used for clinical suspicion of stroke. These same symptoms were also the commonest in those with clinical stroke mimic diagnosis. Hypertension and cardiac disease were the two commonest comorbidities seen with cardiac illness more frequently documented in those with ischemic stroke. Ischemic stroke was found in 63% of stroke patients in our study, with the majority occurring in the MCA territory (75%). Among the remaining hemorrhagic stroke patients, basal ganglia, thalamus, and lobar hemorrhages were the most frequent locations. This study found a 15% recurrence rate for stroke, with a higher prevalence of recurrence seen among patients with hypertension, cardiac illness, older age (beyond 56 years), and in those with ischemic stroke as the initial diagnosis. Clinical stroke mimics were also studied and can come from a wide range of disease categories, including primary and secondary brain tumors, brain infections, extra-axial collections, and non-stroke vascular causes.

Conclusion: The findings of this study demonstrate the importance of accurate stroke diagnosis and the potential impact of stroke mimics on clinical decision-making. Hemiplegia and change in mentation were identified as the most prevalent clinical features for both stroke and stroke mimics, highlighting the difficulty in clinical differentiation of stroke from its mimics. Hypertension and cardiac disease were the most common comorbidities associated with stroke, with cardiac illness being more prevalent in ischemic stroke patients. Ischemic stroke accounted for the majority of stroke cases, with the MCA territory being the most common location. The study also found a notable recurrence rate of 15% for stroke, with a higher risk among patients with hypertension, cardiac disease, older age, and a history of ischemic stroke. These findings underscore the crucial role of early diagnosis, effective management of risk factors, and in improving patient outcomes and reducing stroke recurrence

Contents

1. INTRODUCTION

1.1. Background

The prevalence of stroke is already epidemic. In the world, 1 in 4 persons over the age of 25 will experience a stroke during their lifetime. Each Year, 12.2 million people will experience their first stroke, and 6.5 million of them will pass away. The number of stroke victims worldwide exceeds 110 million. (1). While the rate of stroke occurrence in developed countries has reduced by 42% over the past 40 years, it has more than doubled in low- and middle-income countries. (2). Additionally, stroke mortality rates in low- and middle-income nations are among the highest in the world, accounting for 0.8 million to 5 million annual deaths. (3)

Despite making progress toward national health care, Ethiopia nevertheless confronts a triple burden of diseases including infections, Non-Communicable Diseases (NCDs), and injuries (4) (5). The adoption of a Western lifestyle, dietary changes, urbanization, and a demographic shift with rising life expectancy and population increase are all thought to be contributing factors to this epidemiologic transition. (6) Among all the NCDs cardiovascular diseases are increasing in incidence and are leading cause of mortality in Ethiopia. In descending order, the most common three CVDs in Ethiopia were ischemic heart disease, rheumatic heart disease, and stroke. The volume of research on the epidemiology of stroke in Ethiopia is expanding, and it has revealed significant variations in the clinical and demographic traits of patients when compared to developed countries. Particularly, compared to ischemic stroke, hemorrhagic stroke occurs more frequently in Ethiopian hospitals (7) (8)

Non-contrast computed tomography (NCCT) of the head is the first line imaging study and it is quick, widely accessible, and reasonably priced modality in suspected stroke. It is used to rule out acute bleeding in patients with suspected acute ischemic stroke (AIS). The Alberta Stroke Program Early CT Score is frequently used with NCCT scans to determine the location and severity of AIS (ASPECTS). (9)In addition to "first-line" imaging, the most cutting-edge diagnostic technologies are employed to provide additional, crucial details regarding the location and complexity of stroke and other neurovascular disorders. These advanced technologies are used tools for imaging of blood vessels and blood flow and they include: CT angiography, CT perfusion, magnetic resonance imaging (MRI), magnetic resonance angiography (MRA) (10).

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Preserving tissue in the ischemic penumbra, where perfusion is reduced but still adequate to prevent infarction, is the main objective of treatment for acute ischemic stroke. By improving collateral flow and restoring blood flow to the damaged area, tissue in this area of oligemia can be maintained. Recanalization techniques, such as intra-arterial and intravenous delivery of recombinant tissue-type plasminogen activator (rt-PA), try to create revascularization in order to save cells in the penumbra before permanent damage happens. Only a speedy restoration of blood flow will be able to lessen the effects of ischemia. (11)

Age, the severity of the stroke, and the existence of comorbidities are only a few of the variables that affect the prognosis after a stroke. In general, the sooner a stroke is treated once it occurs, the better the chance of a full recovery. Yet, some people may have long-lasting difficulties like speech impairment, memory problems, or physical impairment. (12)Although the stroke prognosis in sub-Saharan Africa is not thoroughly documented, it is thought to be worse than in other areas. The overall prognosis is impacted by limited access to diagnostic or therapeutic treatments due to inadequate health care infrastructure and resources. (13)

1.2. Statement of the Problem

Ethiopia is transitioning epidemiologically, as was attempted stated earlier, from communicable illnesses (CDs) including HIV/AIDS, TB, and malaria to non-communicable diseases (NCDs). A decreased fraction of deaths from CDs has been associated with a sharp rise in NCD mortality rates during the past 20 years. Cardiovascular disease (CVD), which accounts for 26% of deaths in Ethiopia, is the leading cause of mortality, followed by cancer, diabetes, and injuries and violent crime. Geographic differences in morbidity and death rates have been caused by an unequal distribution of NCD risk factors, such as cigarette use, physical inactivity, poor diets, and alcohol use. A positive health outcome has been achieved overall because to programs to control infectious diseases including HIV/AIDS, malaria, and others; nonetheless, additional emphasis is needed. (14)

The impact of stroke on people and communities is significant. The quality of life is directly impacted by the different physical, psychological, and functional deficits caused by stroke. The burden on individuals and communities is also increased by the financial implications of stroke. As a result, the burden of stroke on people and communities can be great and call for ongoing management resources due to its physical, psychological, and financial effects. (15) (16)

Stroke study hasn't been done much in Ethiopia, but it's been established that the disease is spreading throughout sub-Saharan Africa. According to a study that appeared in the journal PLOS One, the number of stroke deaths will double by 2030. This is anticipated to result from an aging population, rising risk factor rates in emerging nations like diabetes and hypertension, and insufficient access to high-quality healthcare. (17)

The above evidences make stroke an area of emerging problem in developing countries in general and in Ethiopia in particular. In depth understanding of this disease from risk factor, initial clinical presentation, diagnosis, treatment and to the level of short- and long-term outcome of stoke is of utmost importance. This study focusses more on some clinical aspect of stroke and primarily address the imaging pattern of clinically suspected stroke at Tikur-Anbessa Specialized Hospital (TASH).

1.3. Rationale of the Study

Stroke is a significant health issue worldwide, and early detection and treatment are crucial for improving outcomes. However, many patients present with late, making treatment more difficult and less effective. Cardiovascular disease (e.g., stroke) is a leading cause of death among all non-communicable diseases in Ethiopia. Every second matters in stroke management because dying neurons and neurons at risk are time sensitive. In depth understanding of stoke from start to end is crucial for rapid detection, diagnosis and treatment to decrease long term adverse events. The core to such fast-track management is imaging diagnosis and the understating of imaging patterns is quite useful in reducing unnecessary delay of management. The rationale for this study is that is has determine the imaging patterns of stroke at first-time presentation to Tikur-Anbessa Specialized Hospital (TASH).

This findings from this research will contribute to the current knowledge on the imaging patterns of clinically suspected stroke in Ethiopia. The results of this study will increase depth of understanding patterns of imaging of clinically suspected stroke and will clearly state local discrepancies of imaging pattern of stroke as compared to other studies in other parts of the world.

In conclusion, this study is timely and relevant to the current challenges faced in the management of stroke in Ethiopia and will provide valuable information to improve understating of imaging patterns of clinically suspected stroke in Ethiopia in particular and for the improvement of outcome of stroke management in general.

2. LITERATURE REVIEW

Demographic and clinical characteristics of suspected and confirmed stoke

In developed countries, the average age at which a stroke diagnosis is made is roughly 70 years old. (18) The average age at which a man is diagnosed with a stroke in industrialized nations is 72.7 years old, but the average age at which a woman is diagnosed with a stroke is 75.2 years old, according to the study "The Epidemiology of Stroke: A Review" from 2016. (19) A systematic review indicated that the average age of stroke diagnosis in developing countries was 57.6 years for men and 55.6 years for women, indicating a younger average age occurrence in developing countries compared to the average age of stroke diagnosis in developed countries. (20). A 2016 study that was published in the Journal of Stroke and Cerebrovascular Disorders found that the average age of a stroke diagnosis in Ethiopia was 59.56 years old, again confirming the younger age of stroke occurrence in developing countries. (21)

In the world as a whole, men have a 33% greater chance of developing stroke compared to women. (22) The West African SIREN study found a gender distribution of 56.3% males and 43.7% females. (23) A systematic review of previous stroke research in Ethiopia found that the pooled estimate of stroke prevalence was 45.07% among females and 54.70% among males. (21)

Depending on the nature and severity of the stroke, different stroke patients may present with a various percentage of clinical symptoms. The most frequent symptoms described by stroke patients were motor impairments (66.8%), global confusion (59.1%), expressive aphasia (44.3%), neglect (43.9%), and sensory deficits (37.6%), according to a 2019 study from Pakistan that was published in the National Institutes of Health. (24). Data on the clinical manifestation of stroke in Ethiopia is limited. In 2018, a prospective analysis of stroke patients at Tikur Anbessa Specialty Hospital (Ethiopia) found that altered mental status (48%), hemiparesis (47%), facial palsy (45%), hemiplegia (29%), and aphasia (25%) were the most prevalent presenting symptoms of stroke. (25)

The most prevalent pre-existing comorbidities were hypertension (45.4%), followed by hyperlipidemia (30.7%), and diabetes (9.0%), according to a 2021 large-scale community-based cohort study from China. (26)Similar findings were found in a 2020 cross-sectional survey on Congolese patients, where the most common comorbidities were hypertension (76.3%), dyslipidemia (71.1%), and diabetes mellitus (58.8%). (27)Hypertension (63.1%), atrial fibrillation (15.1%), and structural heart diseases (12.5%) were the frequently seen co-morbidities in stroke patients according to a 2022 hospital based retrospective study in Dessie, Ethiopia. (28)

Initial clinical diagnosis suggested cerebral infarction in 43% of patients, intracerebral hemorrhage in 25%, and an indeterminate condition in 32%. However, CT scans revealed a different picture, with 60% of patients having cerebral infarction, 27% having intracerebral hemorrhages, 9% having space-occupying lesions, and 4% having hemorrhagic infarcts. (29)

The most accurate estimate we have indicates that the likelihood of a final diagnosis of stroke in patients with suspected stroke is approximately 74%, with a 95% confidence interval ranging from 66% to 83%. (30). In another study, after a review of 411 patients who were suspected of having a stroke, 78 patients (19%) had a final diagnosis of stroke mimics, which included toxic-metabolic abnormalities, postictal states, infection, and malignancies. (31)

Overall data from study done on stroke recurrence is scarce particularly in sub-Saharan Africa. Based on study done in London on follow-up of 2744 persons for years, 153 instances of stroke recurrence were documented. Multivariate analyses revealed that diabetes mellitus and atrial fibrillation were both associated with an increased risk of stroke recurrence. (32) A 2018 study in Burkina Faso examined 266 patients who had recently experienced a stroke. Of these patients, 44 (16.4%) had a subsequent stroke. The average patient age was 66.5 years, with men accounting for the majority of cases. Hypertension was the most prevalent vascular risk factor, affecting 81.8% of patients. In 61.4% of cases, the prior stroke was ischemic; in 22.7% of cases, it was hemorrhagic; and in 15.9% of cases, the type of prior stroke was unknown. (33) In Ethiopia a study done in TASH on 114 study participants in year 2013 documented 8.8% stroke recurrence (34).

Imaging pattern of clinically suspected stroke and CT confirmed stroke

The incidence rates of ischemic and hemorrhagic stroke subtypes are approximately 87% and 13%, respectively, according to the classification of the American Heart Association report (35). Ischemic stroke is again the most common kind of stroke in Africa, accounting for up to 73% of stroke hospitalizations. Nonetheless, the burden of hemorrhagic stroke was larger in Indigenous Africans than in Black Americans or Americans of European origin (36). To put this in perspective the proportion of hemorrhagic stroke 34% in Africa and 9% in high-income countries. This suggests a higher burden of uncontrolled hypertension in Africa, as the prevalence and severity of hypertension is associated with the proportion of stroke in a population (37) (38) (39) (36).

In a retrospective study conducted by Getachew et al at Tikur Anbessa Specialized Hospital (TASH) between 2000 and 2005, 54.8% of patients experienced an ischemic stroke, while 34.6% experienced a hemorrhagic stroke (40). In a 2016 retrospective hospital-based study at Felege Hiwot Referral Hospital in Bahir Dar, Ethiopia, 59.4% of the studied cases were ischemic, while hemorrhagic stroke accounted for 40.6% (41). Similar results were obtained from a cross-sectional study in 2019 at Yirgalem General Hospital in Sidama Regional State, Southern Ethiopia: 62.1% of the stroke patients experienced an ischemic stroke, whereas 37.9% experienced a hemorrhagic stroke (42). But according to certain studies, hemorrhagic stroke is the predominant subtype of the disease in other regions of Ethiopia. According to a prospective study conducted between 2015 and 2016 at TASH by Ayalew et al, the majority of strokes (56%) had hemorrhagic causes (43). Another hospital-based retrospective study conducted between 2015 and 2016 by Gedefa et al found that hemorrhagic stroke was the most common type of stroke, accounting for 61.3% of cases (44).

According to a 1994 study by Amarenco et al. on 115 patient's 64 percent of cerebellar infarcts were territorial, and 31 percent were non-territorial, according to a 1994 study by Amarenco et al. on 115 patients (45). A study on the distribution of 2213 individuals with ischemic stroke in various vascular territories revealed that MCA stroke (50.8%), small-vessel stroke (12.8%), and P stroke (11.4%) were the most prevalent subtypes (ACA = 5%, PCA = 7%, >1 territory, cerebellar = 4%) (46). According to a study conducted at Dessie Hospital in Ethiopia, the MCA (50%) was the most frequent site of arterial territory infarctions in ischemic stroke, followed by ACA (9%), PCA (4%), and vertebrobasilar regions (2%) in decreasing order of frequency (47).

A 2022 study from Bangladesh discovered 45% hemorrhage in the capsule-ganglionic region, 23% in the thalamus, 14% in the cerebral cortex, 7% in the pons, 4% in the cerebellum, and 4% in the subarachnoid region (48). Hussein et al. discovered in multiple sites to be the most common type of hemorrhagic stroke (7%) with parietal lobe 5%, basal ganglia 5%, internal capsule 4%, cerebellum 3%, thalamus 2%, frontal lobe 2%, temporal lobe 2%, occipital lobe 1.5%, pons 1%, midbrain 1% (47). Subarachnoid hemorrhage was found in 8% of patients in a study from Riga East University Hospital, while intraventricular hemorrhage was found in 14% of patients. The most common locations for ICH were subcortical (40%), lobar (19%), and brainstem (9%). As expected, subcortical hemorrhage was more frequently associated with hypertension than the other groups, whereas lobar hemorrhage was more frequently caused by vascular abnormalities and other causes (49)

3. RESEARCH QUESTIONS AND OBJECTIVES

3.1. Research questions

The purpose of this study is to study CT patterns of clinically suspected stroke in Tikur-Anbessa Specialized Hospital analysis to be done over the specified time frame. Specifically, it seeks to answer the following questions: What is the prevalence of ischemic versus hemorrhagic stroke? What factors are associated with stroke subtypes? How do demographic characteristics, medical history, and risk factors of stroke patients impact CT patterns of stroke at first diagnosis? What are patterns of intracerebral hemorrhage based on location within the brain? What are predominant arterial territories of brain infarction? What are clinical stroke mimics? What is the rate of stroke recurrence? What factors associated with stroke recurrence?

3.2. Objectives

General objectives

- To evaluate the imaging pattern of clinically suspected stroke.
- To determine the location of brain lesion based on non-contrast CT
- To determine pattern of clinical stroke mimics
- To determine rate of stroke recurrence

Specific objectives

- To gather and analyze data on demographic characteristics, clinical presentation, and risk factors of stroke patients.
- To determine pattern of ischemic stroke by location and/or territory.
- To determine pattern of hemorrhagic stroke by location
- To determine rate and factors associated with stroke recurrence

4. METHODS

4.1. Study Design

Descriptive retrospective cross-sectional study was used to analyze the data collected from the medical records (I-CARE) and MedWeb (Signed CT reports) of clinically suspected stroke patients with CT for confirmation of the clinical diagnosis at the Black Lion Hospital, Addis Ababa.

4.2. Study Area and Period

The study was be conducted at Tikur-Anbessa Specialized Hospital, Addis Ababa, Ethiopia, from January 2023 to December 2023.

4.3. Source and Study Population

Source population is all patients who undergo CT scan of the head at the radiology department of at Tikur-Anbessa Specialized Hospital, Addis Ababa, Ethiopia.

Study Population: Patients who underwent head CT at the Radiology department of at Tikur-Anbessa Specialized Hospital, Addis Ababa, Ethiopia with a clinical diagnosis of stroke.

4.4. Eligibility Criteria

Inclusion Criteria

- Patients with clinical diagnosis of stroke.
- Patients who have been diagnosed with ischemic stroke (brain infarction) and suspected to have recurrent stoke
- Patients who have been diagnosed with hemorrhagic stroke (intracranial hemorrhage) and suspected to have recurrent stoke
- Patients who have further follow-up at the institution.
- Patients with complete medical records, including information on clinical presentation, comorbidity and stroke diagnosis.

Exclusion Criteria

- Patient with incomplete clinical data.
- Patients with CT reports not confirmed/signed by with an academic rank below neuroradiology fellows including reports by general Radiologists and Radiology Residents.
- Patients with another initial confirmed diagnosis other than stroke with regard to brain (e.g., brain tumor, head trauma, metastases).

4.5. Sample Size Determination

Sample Size Determination and Sampling Procedure: Calculated sample size is 322 based on 70% sensitivity of CT for diagnosis of stroke from an initial clinical suspicion of stoke according previous research done in TASH (Getachew et al, 2011). (40)

4.6. Data Collection

Data was collected from the patients' records (Specifically the institutions database of ICARE and MEDWEB) using a structured data collecting format prepared based on previous studies by principal investigator. For those patients with unremarkable CT report despite clinical suspicion of stroke further evaluation of patient clinical data was done especially if they have undergone investigation with brain MRI. Accordingly, for those with MRI diagnosis of stoke MR diagnosis was included in the data of particular patient.

4.7. Variables

Dependent Variables

- Imaging pattern of stroke
    - Infarction and hemorrhage
    - Location of infarction
    - Pattern of infarction whether territorial or non-territorial.
    - Territory of infarction
    - Location of hemorrhage
    - Imaging classification of infarction based on duration – acute vs subacute

Independent Variables

- Patient demographics such as age and gender.
- Clinical presentation like hemiplegia, change of mentation and seizure.
- Clinical comorbidities like hypertension, diabetes, cardiac diseases, atrial fibrillation, hematologic or solid malignancy.

4.8. Operational Definitions

Stroke: as per WHO 'rapidly developed clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than of vascular origin (50)

Infarction: infarction is brain, spinal cord, or retinal cell death attributable to ischemia, based on1. pathological, imaging, or other objective evidence of cerebral, spinal cord, or retinal focal ischemic injury in a defined vascular distribution; or Clinical evidence of cerebral, spinal cord, or retinal focal ischemic injury based on symptoms persisting ≥24 hours or until death, and other etiologies excluded. (51)

Ischemic stroke: An episode of neurological dysfunction caused by focal cerebral, spinal, or retinal infarction. (51)

Territorial Infarction– Brain infarctions conforming to conventional anatomical vascular supply of ACA, MCA, PCA, SCA, PICA, AICA and BA.

Nonterritorial Infarction: Brain infarcts less than 2 cm in diameter or infarcts in a watershed (border zone) not conforming to conventional vascular territory are classified as non-territorial infarcts.

Hemorrhagic Stroke: Rapidly developing clinical signs of neurological dysfunction attributable to a focal collection of blood within the brain parenchyma or ventricular system that is not caused by trauma (51)

Stroke by subarachnoid hemorrhage: Rapidly developing signs of neurological dysfunction and/or headache because of bleeding into the subarachnoid space (the space between the arachnoid membrane and the pia mater of the brain or spinal cord), which is not caused by trauma. (51)

Stroke by cerebral venous thrombosis: Infarction or hemorrhage in the brain, spinal cord, or retina because of thrombosis of a cerebral venous structure. Symptoms or signs caused by reversible edema without infarction or hemorrhage do not qualify as stroke (51)

Recurrent stroke: is considered any new neurological impairment, such as an ischemic or hemorrhagic stroke, that occurs at any point following the initial stroke. (33)

4.9. Data Management

The information gathered from the study was entered to SPSS version 27. Missing values, outliers, and other inconsistencies was removed from data. The data was cleaned up using frequency, sort, and list. The cleaned data was analyzed by SPSS version 27.

4.10. Data Analysis

Cleaned data was analyzed for median and mean age of stroke, stroke occurrence based on gender and also analyzed for the determination of frequency of associated comorbidities with stroke. Data was analyzed for the details of imaging pattern of clinically suspected stroke for percentage of occurrence of infarction and hemorrhage, location of hemorrhage and infarction. Dependent and independent variables was analyzed for potential association using cross-tabulation.

4.11. Data Quality Assurance

To ensure data quality, a standardized and modified questionnaire was employed. The data collection was executed by primary investigator of the research. The questionnaire was written in English language only. To improve recollection, information accuracy and result consistency, patients' data was taken from the official I-CARE and MEDWEB of Tikur-Anbessa Specialized Hospital data base.

4.12. Ethical Consideration

Ethical clearance was taken from research ethical clearance committee of Radiology Department of College of Health Sciences, Addis Ababa University. Confidentiality was maintained by keeping information anonymous and ensuring that it will not be available to anybody other than researcher.

4.13. Dissemination of the Results

Addis Ababa University, College of Health Sciences and the Department of Radiology will receive results of the research. In addition, the research findings will be presented in a seminar presentation to Radiology Department and published in a peer-reviewed journal.

5. RESULTS

Demographic, Clinical Characteristics and CT diagnosis.

There were 322 study participants (50.6 % men and 49.4 % women). The study was conducted across all age groups with minimum age of 3 years, maximum age of 114 years, mean age 52 years. (Figure 1). Among the study participants stroke was suspected based on clinical presentation of hemiplegia (61.2%), change in mentation (18.9%), headache (9.9 %), and seizure (4.7%) in that decreasing order (table 1).

CLINICAL PRESENTATIONS								
	Hemiplegia	Change in mentation (Decreased Mentation to LOC)	Headache	ABM (Focal or GTC seizure)	Difficulty of communication (slurred speech to aphasia)	Difficulty Keeping Balance	OTHERS	Total
Frequency	197	61	32	15	12	3	2	322
Percent	61.2	18.9	9.9	4.7	3.7	0.9	0.6	100

Table 1 Clinical presentations that led to clinical suspicion of stroke

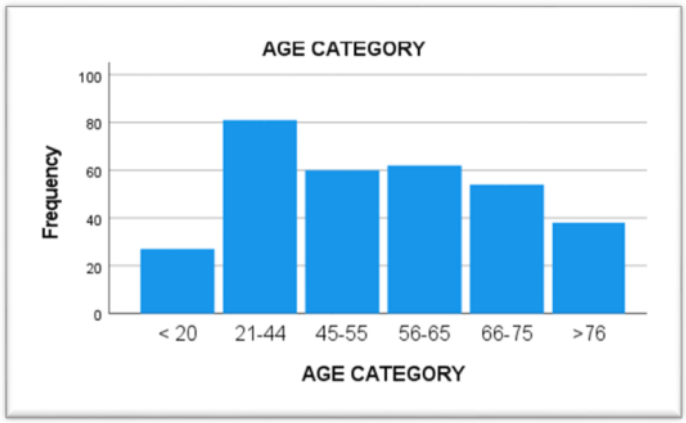

Figure- 1 Bar graph showing age category of patients who undergo head CT for clinical suspicion of stroke.

Before imaging 56% of study participants had a clinical impression of hemorrhagic stroke and the remaining had ischemic stroke as an initial clinical diagnosis before undergoing CT study. Based on CT 69.3% had received stoke diagnosis, 8.7% (28/322) received alternative diagnosis and the remaining 22 % (71/322) had unremarkable CT report. Mean age of CT confirmed stoke is 54.88 years (Male = 54.68 years and Female = 55.09 years). Majority (67%) of stroke diagnosis is made between age 20 and 65 and 85% of them between 20 and 75, thereafter stroke occurrence decreases.

Those with CT diagnosis of stroke had the following comorbidities in descending order: hypertension (38.8%), cardiac disease (48%), hypertension with diabetes (13.9%), hematologic malignancy (7.2%), HIV/AIDS (4%) and 9.4 % of study participants with stroke diagnosis had no comorbidity. (Figure 2). The mean age for the two commonest comorbidities seen in those with CT stroke diagnosis is 61.5 years for those with hypertension and 50.73 years for those with cardiac disease.

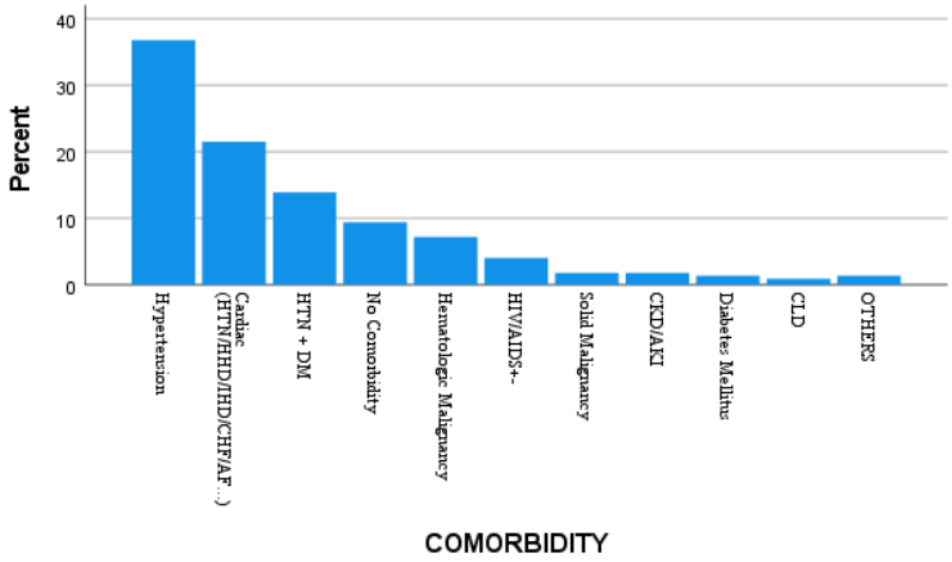

Figure-2 Comorbidities seen in patients with CT diagnosis of stroke

Hemiplegia is the most common symptom among patients with CT-diagnosed stroke, affecting 74% of individuals. The second most common symptom is a change in mentation, which occurs in 15.2% of patients. (Table 2).

CLINICAL PRESENTATIONS	Frequency	Percent
Hemiplegia	165	74
Change in mentation (Decreased Mentation to LOC)	34	15.2
Headache	9	4
Difficulty of communication (slurred speech to aphasia)	8	3.6
ABM (Focal or GTC seizure)	4	1.8
Difficulty Keeping Balance	3	1.3
Total	223	100

Table 2 Clinical Presentations of those with CT diagnosis of Stroke

Of the 322 participants in the study, 71 (22%) had unremarkable CT head, meaning that no abnormalities were detected on the scan. However, further investigation revealed that 16 of these patients had brain MRI reports available. Among these 16 patients, MRI findings showed that 7 had brain infarction (stroke), 1 had a central nervous system (CNS) infection, 1 had posterior reversible encephalopathy syndrome (PRES), and 7 had unremarkable brain MRI results.

Out of those initially diagnosed with stroke based on clinical presentation, CT revealed alternative diagnoses in 28 patients (8.7% of all study participants). Among these patients, 25%

(7/28) had extra-axial collections (epidural hematoma and subdural hematomas), 25% (7/28) had primary brain tumors, and 18% (5/28) had secondary brain tumors. (Table 3). Hemiplegia (12/28) and change in mentation (5/28) are the two commonest clinical presentation of these clinical stroke mimics.

ALTERNATIVE CT DIAGNOSIS	Frequency	Percent
Tumor (metastases)	5	17.9
Tumor primary (meningioma, oligodendroglioma, macroadenoma)	7	25
Extra-axial collections	7	25
Vascular - PRES, cavernoma	3	10.7
Infectious - tuberculoma/toxoplasmosis	1	3.6
Incidental - aneurysms, old depressed skull fracture	2	7.1
Miscellaneous – Chiari malformation, NPH	3	10.7
Total	28	100

Table 3 Alternative CT diagnosis for those patients initially presented with stroke like symptoms

Imaging pattern of CT confirmed stroke

From those with CT diagnosis of stroke 62.8% had brain infarction, 32.3% had hemorrhagic stroke and 4.5 % had both diagnosis (old with new stroke). (Table 4). Those with hemorrhagic stroke has a younger mean age (51.8 years) as compared to those with ischemic stroke (55.6 years). Among the comorbidities associated with stroke subtypes, hypertension and diabetes mellitus were prevalent in both ischemic and hemorrhagic stroke patients. In contrast, cardiac illness was more commonly associated with ischemic stroke, while hematologic malignancy was more frequently observed in hemorrhagic stroke patients.

STROKE SUBTYPE	Frequency	Percent
Infarction	141	62.8
Hemorrhage	72	32.3
Both (old Infarct with new hemorrhage)	10	4.5
Total	223	100

Table 4 Stroke imaging pattern based on CT diagnosis

COMORBIDITY	STROKE SUBTYPES		
	Infarction	Hemorrhage	Both (old Infarct with new hemorrhage)
No Comorbidity	18	3	0
Hypertension	34	41	7
Diabetes Mellitus	3	0	0
HIV/AIDS+-	9	0	0
Cardiac Illness	43	5	0
Hematologic Malignancy	3	13	0
Solid Malignancy	4	0	0
CKD/AKI	3	1	0
CLD	1	1	0
HTN + DM	22	6	3
OTHERS	1	2	0

Table 5 Stroke attack with comorbidity and stroke subtype crosstabulation

Among patients with infarction, 74% had territorial infarctions, while the remaining 26% had non-territorial (lacunar) infarctions. (Figure 3). The majority of territorial infarctions affect the MCA territory (75%), followed by PCA territory (11%), multiple territories (10%), and posterior circulation (3%). (Figure 4). The two commonest combination of multiple territory is MCA with PCA (3.5%) and MCA with ACA (2.1%).

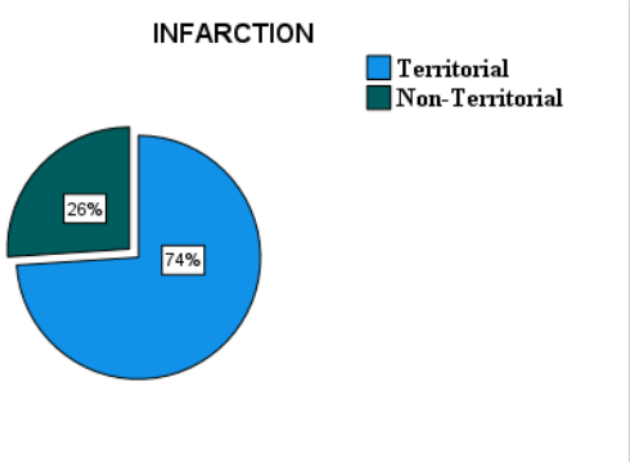

Figure-3 Territoriality of infractions based on CT diagnosis

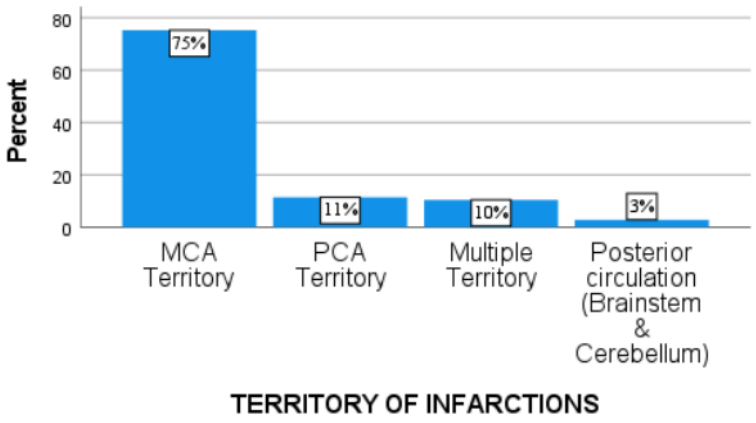

Figure-4 Percentage of territory of infarctions

In this study, the most common site of hemorrhagic stroke was the basal ganglia (32%), followed by lobar hemorrhage (25%), thalamus (22%), and subarachnoid hemorrhage (7%). Hemorrhages occurred in the pons, cerebellum, and multiple locations in 4% of cases each. Ventricular extension was documented in 1% of patients with CT-diagnosed hemorrhagic stroke. (Figure 5). Hypertension is the most common comorbidity seen those with hemorrhagic stroke accounting for 59 %, particularly seen more frequently in those with for basal ganglia and thalamic hemorrhage. This is followed by hematologic malignancy as next common comorbidity in those with hemorrhagic stroke. Among patients with lobar hemorrhage (21 patients), the frontal lobe is the most frequent site, accounting for 55.6% of cases. Multiple lobe involvement is the next most common location, occurring in 39% of cases. Temporal lobe hemorrhage is the least common, occurring in only 1% of cases. Hematologic malignancy (10/21) followed by hypertension (6/21) were the two comorbidities seen in patients with lobar hemorrhage

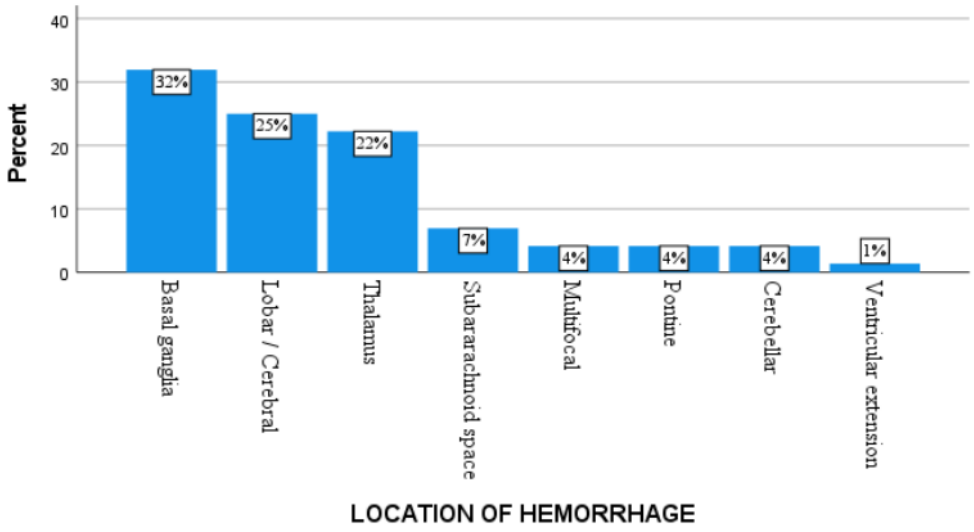

Figure 5 Location of hemorrhage in those with CT diagnosis of hemorrhagic stroke

As mentioned above the two commonest comorbidities seen in those with CT confirmed stroke are hypertension and cardiac disease. Similarly, also those with cardiac disease more frequently had ischemic stroke. But hypertension is equally prevalent in both stoke subtypes with slightly more frequent in those with hemorrhagic stroke. (See table 5 below).

Among 223 patients diagnosed with stroke based on CT scans, approximately 85% were experiencing their first stroke, while the remaining 15% had a recurrent stroke. Of those with recurrent strokes, 13.9% (31/223) had their second stroke, and 1.3% (3/223) had their third stroke. Cross-tabulation of recurrent stroke data with other study variables reveal recurrent stoke to occur in higher proportion in the age beyond 56 years, in males (56% male vs 44% female), in patients with hypertension and cardiac illness as comorbidities and in patient with brain infarction stroke subtype as a CT diagnosis. (See table 5 for more). Average age of those with recurrent stroke is higher than average age of first-time stroke (59.4 years vs 53.9 years).

	STROKE ATTACK		
Comorbidity	**First attack**	**Second attack**	**Third attack**
No Comorbidity	20	1	0
Hypertension	67	14	1
Diabetes Mellitus	2	1	0
HIV/AIDS	8	1	0
Cardiac disease	37	10	1
Hematologic Malignancy	15	1	0
Solid Malignancy	4	0	0
CKD/AKI	4	0	0
CLD	2	0	0
HTN + DM	27	3	1
OTHERS	3	0	0
Age category	**First attack**	**Second attack**	**Third attack**
< 20	9	0	0
21-44	47	6	1
45-55	42	3	1
56-65	39	10	0
66-75	32	7	1
>76	20	5	0
Stroke imaging pattern	**First attack**	**Second attack**	**Third attack**
Infarction	119	20	2
Hemorrhage	65	6	1
Both (old infarct with new hemorrhage)	5	5	0

Table 6 Stroke attack with comorbidity, age and imaging pattern crosstabulation

6. DISCUSSION

CT scans of the head play a crucial role in diagnosing and evaluating a variety of neurological disorders, with stroke being a leading indication for this imaging technique. On this study we have assessed demographic data, clinical presentation, imaging pattern of clinically suspected stoke and also imaging pattern of those with CT confirmed stroke. The study is done across all ages and the minimum and maximum age were 3 years and 114 years respectively.

The study participants were gender-balanced by CT confirmed stroke diagnosis, with nearly (163/322) 50% males and nearly (159/322) 50% females, suggesting equal occurrence of stroke in both genders. However, in the rest of the world as a whole, men have a 33% greater chance of developing stroke compared to women. (22) The West African SIREN study found a gender distribution of 56.3% males and 43.7% females. (23) A systematic review of previous stroke research in Ethiopia found that the pooled estimate of stroke prevalence was 45.07% among

females and 54.70% among males. (21). This can be explained by the fact that our study is done in wide age range from 3 years to 114 years. In comparison most of stroke studies are done in those beyond 18 years of age.

In this study mean age of CT confirmed stoke is 54.88 years (Male = 54.68 years and Female = 55.09 years). In contrast, the average age at which a stroke diagnosis is made in developed countries is around 70 years old, while in industrialized nations average age for men is 72.7 years, in females it is 75.7 years. In developing countries, the average age is 57.6 years for men and 55.6 years for women, indicating a younger average age occurrence. A 2016 study in Ethiopia confirmed average age to be 59.56. ((18) (19) (20) (21)). Our study findings substantiate the notion that stroke is diagnosed at a younger average age in developing nations compared to industrialized ones, in conjunction with previous research suggesting that females tend to be diagnosed at a later mean age than males. Younger mean at diagnosis in developing nations is related mainly to high-rate of uncontrolled hypertension.

In this study majority (67%) of stroke diagnosis is made between age 20 and 65 and 85% of them between 20 and 75, thereafter stroke occurrence decreases. It almost plateau between the age of 20 and 65. Based on research done in the US stroke risk increases with age, doubling each decade after age the of 55 years. About 75% of strokes occur in people aged >65 yrs. However, an analysis of data from the Global Burden of Disease Study found a decreased stroke incidence among U.S. adults aged 50 years and older from 1990 to 2019. In contrast, the incidence increased in individuals aged 15 to 49 years, particularly in the southern and midwestern U.S.; one reason for this may be the increased HBP and diabetes rates among younger and middle-aged adults (52).

In this study hemiplegia (74%) and change in mentation (15.2%) were the two commonest symptoms for both clinically suspicion of stroke and for those with CT-confirmed stroke patients, A Pakistani study shed light on the most common symptoms experienced by stroke patients. Motor impairments topped the list with a prevalence of 66.8%, followed by global confusion (59.1%), expressive aphasia (44.3%), neglect (43.9%), and sensory deficits (37.6%). (24) Similarly, a 2018 prospective study conducted at Tikur Anbessa Specialty Hospital (Ethiopia) identified altered mental status (48%), hemiparesis (47%), facial palsy (45%), hemiplegia (29%), and aphasia (25%) as the most prevalent presenting symptoms of stroke. (43) Overall, the findings from current and previous studies suggest that motor impairments, cognitive difficulties, and speech problems are major presenting symptoms of stroke and should be recognized promptly to facilitate timely diagnosis and treatment.

In our study among patients with a CT diagnosis of stroke, the most common comorbidities were hypertension (38.8%), heart disease (48%), and hypertension combined with diabetes (13.9%). A smaller percentage of patients had hematological malignancies (7.2%) or HIV/AIDS (4%). Notably, 9.4% of participants with stroke had no identified comorbidities. Studies from China, Congo, and Ethiopia consistently demonstrate that hypertension, hyperlipidemia, and diabetes are the most prevalent comorbidities among stroke patients. The prevalence of these comorbidities varies across the studies, but hypertension consistently ranks as the most common

comorbidity. (26) (27) (28). Taking it further patients diagnosed with stroke, the mean age of concomitant cardiac illness and hypertension is 50.73 years and 61.5 years, respectively. This points out cardiac disease is stroke related comorbidity more commonly at younger average age. This can be explained by the fact that the most common cardiac condition in Ethiopia, rheumatic heart disease, is seen frequently in younger patients. (53)

In this study clinical diagnosis suggested hemorrhagic stroke in 56% of patients and ischemic stroke in the remaining 44%. However, CT scans provided a different picture, with 63% of cases confirmed as ischemic infarction, 32% as hemorrhagic stroke, and 4.5% identified with a combination of both stroke types. This is in comparison to another study with which initial clinical diagnosis suggested cerebral infarction in 43% of patients, intracerebral hemorrhage in 25%, and an indeterminate condition in 32%. CT scans revealed 60% had cerebral infarction, 27% intracerebral hemorrhages, 9% space-occupying lesions, and 4% hemorrhagic infarcts. (29). As clearly stated, both in the current and previous studies, in many cases, clinical diagnosis alone is not as reliable as a CT scan for confirming a diagnosis. While clinical evaluation can provide valuable clues about a patient's condition, it is often insufficient to definitively establish a stroke subtype.

Our findings indicate that approximately 69% of patients with suspected stroke were confirmed to have stroke based on CT evaluation. Among total study participants 8.7 % had (28/322) alternative stroke mimics as a diagnosis. These stroke mimics seen in this study are from across all disease categories including both primary (Macroadenoma, meningioma and oligodendroglioma) and secondary brain malignancies, brain infections like tuberculosis and toxoplasmosis, non-stroke vascular causes like PRES and cavernoma and extra-axial collections. The likelihood of a stroke diagnosis in suspected stroke patients is 74% in other similar study, with a 95% confidence interval of 66%-83%. Another study also found 19% of suspected stroke patients had stroke mimics, including toxic-metabolic abnormalities, postictal states, infection, and malignancies. (30) (31). Our findings generally align with those of another study mentioned earlier, indicating comparable rates of stroke diagnosis. Moreover, our study has revealed a lower incidence of stroke mimics compared to the previous studies Our study also underscores the importance for CT-interpreting Radiologists and Neuroradiologists to be cognizant of the broad range of disease presentations that can appear on CT scans in patients with clinical suspicion of stroke.

In this study of 322 participants, 71 (22%) had unremarkable CT head scans, indicating no detectable abnormalities. Further examination revealed that 16 of these patients had brain MRI reports available. Among these 16 patients, MRI findings showed brain infarction (stroke) in 7 patients, brain tumors in 2 patients, a central nervous system (CNS) infection in 1 patient, posterior reversible encephalopathy syndrome (PRES) in 1 patient, and unremarkable brain MRI results in 5 patients. Eventhough it is difficult to compare our data (small number of patients having MRI), similar study showed 11.5 % of patients having had findings of acute to subacute infarct on the subsequent MRI after initial CT become unremarkable. (54) This highlights the importance of considering alternative diagnostic methods, such as MRI, when CT scans are inconclusive.

In developed nations ischemic stroke account for significant majority (87%) and in Africa despite conflicting study findings ischemic stroke is still the predominant finding but hemorrhagic stroke occurs in higher proportion in Indigenous Africans than in Black Americans or Americans of European origin. (36) (37) (38) (39). In this study from those with CT diagnosis of stroke 62.8% had brain infarction, 32.3% had hemorrhagic stroke and 4.5 % had both diagnosis (old with new stroke). This in line with a retrospective study conducted by Getachew et al at Tikur Anbessa Specialized Hospital (TASH) between 2000 and 2005, where 54.8% of patients experienced an ischemic stroke, while 34.6% experienced a hemorrhagic stroke (40). Similar studies done in Bahidar Felege Hiwot Hospital (2016) and Yirgalem Hospital (2019) showed similar proportion with ischemic stroke accounting for majority of cases. (41) (42) But according to certain studies, hemorrhagic stroke is the predominant subtype of the disease in in Ethiopia. According to a prospective study conducted between 2015 and 2016 at TASH by Ayalew et al, the majority of strokes (56%) had hemorrhagic causes (43). Another hospital-based retrospective study conducted between 2015 and 2016 by Gedefa et al found that hemorrhagic stroke was the most common type of stroke, accounting for 61.3% of cases (44).

Those with hemorrhagic stroke has a younger mean age (51.8 years) as compared to those with ischemic stroke (55.6 years) in this research. This is in line with study done in 2011 in East China in which patients with ischemic stroke were significantly older than those with hemorrhagic stroke, with a mean age of 68.37 years compared to 62.16 years ($p<0.01$). (55) Study in Dessie, Ethiopia also finds similar result in which patients with ischemic stroke had a higher mean age (63.4 ± 9.6 years) than patients with hemorrhagic stroke (53 ± 9.6 years). (47)

There is scarce research finding on whether ischemic stroke is territorial or non-territorial. In our study among patients with infarction (ischemic stroke), 74% had territorial infarctions, while the remaining 26% had non-territorial (lacunar) infarctions. According to a 1994 study by Amarenco et al. majority on 115 patient's 64% of cerebellar infarcts were territorial, and 31 % were nonterritorial, (45). An analysis of current and past research indicates that approximately two-thirds of ischemic strokes exhibit a territorial large vessel pattern, with the remaining cases presenting as lacunar infarctions. Such type of two-tier classification for ischemic stroke is quite important for treatment and prognosis. Those with large vessel territorial infarctions have worse functional outcome and cardiovascular mortality as compared to non-territorial infarctions. Treatment wise patients with territorial large vessel strokes may benefit from treatment with antiplatelet or anticoagulant medications to prevent blood clots from forming. Patients with lacunar infarctions, on the other hand, may benefit from treatment to control their blood pressure or cholesterol levels. (56) (57) (58)

The majority of territorial infarctions from this study affect the MCA territory (75%), followed by PCA territory (11%), multiple territories (10%), and posterior circulation (3%). The two commonest combination of multiple territory is MCA with PCA (3.5%) and MCA with ACA (2.1%). Our study finding is similar to previous studies with MCA territory infractions accounting for significant majority of territorial infarctions as compared to other studies listed below. A study on the distribution of 2213 individuals with ischemic stroke in various vascular territories revealed that MCA stroke (50.8%), small-vessel stroke (12.8%), and brain stem stroke (11.4%) were the most prevalent subtypes (ACA = 5%, PCA = 7%, >1 territory, cerebellum = 4%) (46). According to a study conducted at Dessie Hospital in Ethiopia, the MCA (50%) was

the most frequent site of arterial territory infarctions in ischemic stroke, followed by ACA (9%), PCA (4%), and vertebrobasilar regions (2%) in decreasing order of frequency (47).

In this study, the most common site of hemorrhagic stroke was the basal ganglia (32%), followed by lobar hemorrhage (25%), thalamus (22%), and subarachnoid hemorrhage (7%). Hemorrhages occurred in the pons, cerebellum, and multiple locations in 4% of cases each. (Figure 5. Among patients with lobar hemorrhage, the frontal lobe is the most frequent site, accounting for 55.6% of cases. Multiple lobe involvement is the next most common location, occurring in 39% of cases. Temporal lobe hemorrhage is the least common, occurring in only 1% of cases. In our study the commonest comorbidity for basal ganglia and thalamic hemorrhage is hypertension and hematologic malignancy is the commonest in those with lobar hemorrhage.

In comparison, other studies have shown that the distribution of hemorrhagic stroke varies among different regions. A 2022 study from Bangladesh found that the most common locations for hemorrhagic stroke were the basal ganglia (45%), thalamus (23%), and cerebral cortex (14%). Other studies done in Ethiopia have reported that multiple sites (7%), parietal lobe (5%), basal ganglia (5%), and internal capsule (4%) are also common locations for hemorrhagic stroke. Additionally, subarachnoid hemorrhage and intraventricular hemorrhage have been reported in 8% and 14% of patients, respectively. The most common type of intracerebral hemorrhage (ICH) is subcortical (40%), followed by lobar (19%) and brainstem (9%). As expected, subcortical hemorrhage is more frequently associated with hypertension than lobar hemorrhage, which is more frequently caused by vascular abnormalities and other causes. (47) (48) (49).

Recurrent strokes were seen in 15 % of study participant and were more common in older patients (average age of 59 years for recurrent stroke vs 54 years for first time stroke), in males (among those with recurrent stokes 56% were male), in patients with hypertension and cardiac illness, and patients with brain infarction stroke subtype. In comparison two studies, one conducted in London and the other in Burkina Faso, investigated recurrent stroke. The London study followed 2744 individuals over several years and found that diabetes mellitus and atrial fibrillation were both significantly associated with an increased risk of recurrent stroke. They identified 153 (5.6%) patients to have recurrent stroke among the total study participants The Burkina Faso study examined 266 patients who had recently experienced a stroke and found that 16.4% of them had a subsequent stroke. The average patient age was 66.5 years, and hypertension was the most prevalent vascular risk factor. These studies as well as the current study highlight the importance of addressing modifiable risk factors, such as hypertension, diabetes mellitus and cardiac illness to reduce the risk of recurrent stroke. In addition, as compared to a lower sample size (114) study done in TASH, Ethiopia (2013), recurrent stroke is seen in higher percentage in our study (8.8 % vs 15% respectively) (32) (33) (34)

7. Limitation of the study

The study design based on retrospective data collection is the main limitation of the study causing exclusion of some study population by data incompleteness. The other limitation is reliance on analysis of CT and MRI report for data used for the research.

8. Conclusion

This study's findings suggest that stroke diagnosis occurs at a younger age in developing countries compared to developed nations. Hypertension, diabetes, and cardiac illness were consistently identified as common comorbidities among stroke patients, and optimizing these modifiable risk factors could potentially reduce the high recurrence rate observed in this study. Both stroke and stroke mimics exhibit similar initial clinical symptoms, emphasizing the need for imaging to differentiate between the two and guide appropriate management strategies. Despite conflicting data on stroke subtype prevalence both in Ethiopia and in Africa, this study has demonstrated a high proportion of ischemic strokes, primarily in the MCA territory, with a higher prevalence of cardiac illness among patients with this diagnosis. Hemorrhagic strokes are more commonly found in the basal ganglia, thalamus, and lobar regions. Moreover, this study highlights the high incidence of hematologic malignancy as an associated comorbidity in those with hemorrhagic stroke, particularly in younger individuals at diagnosis.

9. Recommendation

Further prospective studies are needed to elucidate the underlying connection between stroke and clinical symptoms, the extent of clinical and radiological mimics, and to explore more thoroughly the frequency and contributing factors of recurrent stroke. This research can be divided into three main areas: 1) Imaging patterns of stroke clinical mimics, 2) Imaging patterns of confirmed stroke using CT and/or MRI, and 3) Prevalence, imaging patterns, and factors associated with stroke recurrence. Finally, in addition to CT/MRI report analysis as we did in this research, blinding a group of neuroradiologists can provide an alternative methodology for researches areas listed above.

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Annex: Data collection tool for CT patterns of Clinically suspected Stroke

This is a tool for collection of data for research title of imaging patterns of clinically suspected stroke.

* Indicates required question

1. Sex *

Check all that apply.

- [ ] Male
- [ ] Female

2. Age (In years) *

_____

3. Clinical Presentation *

Check all that apply.

- [ ] Hemiplegia
- [ ] Change in mentation (Decreased Mentation to LOC)
- [ ] Headache
- [ ] ABM (Focal or GTC seizure,)
- [ ] Difficulty of communication (slurred speech to aphasia)
- [ ] Difficulty Keeping Balance
- [ ] Others: _____

4. Comorbidity *

Check all that apply.

- [ ] Hypertension
- [ ] Diabetes Mellitus
- [ ] HIV
- [ ] Cardiac (CHF, Rheumatic, Ischemic , Atrial Fibrillation...)
- [ ] Hematologic Malignancy
- [ ] Solid Maligncy
- [ ] CKD/AKI
- [ ] CLD
- [ ] No Comorbidity
- [ ] Other: _____

5. Clinical Diagnosis *

Check all that apply.

- [ ] Ischemic Stroke
- [ ] Hemorrhagic Stroke

6. CT Diagnosis

Check all that apply.

- [ ] Stroke (Infarction/Hemorrhage)
- [ ] Unremarkable
- [ ] Alternative Diagnosis

7. Write the diagnosis if the above question answer is Alternative Diagnosis

_____

8. MRI done for unremarkable CT if suspicion was ischemic

Mark only one oval.

- ◯ Yes
- ◯ No

9. MRI Diagnosis if Yes to above Question

_____

10. Stroke Diagnosis

Mark only one oval.

- ◯ for the 1st time
- ◯ 2nd attack
- ◯ 3rd attack
- ◯ 4th attack

11. Stroke imaging pattern

Check all that apply.

- ☐ Infarction
- ☐ Hemorrhage
- ☐ Both (old Infarct with new hemorrhage)
- ☐ Hemorrhagic transformation

12. If infarction

Check all that apply.

- ☐ Territorial
- ☐ Non-Territorial

13. If Territorial

Check all that apply.

- [ ] MCA Territory
- [ ] ACA Territory
- [ ] PCA Territory
- [ ] Posterior circulation (Brainstem and Cerebellum)
- [ ] Multiple Territory

14. If Multiple territory

_____

15. If Hemorrhagic mention location of hemorrhage

Check all that apply.

- [ ] Basal ganglia
- [ ] Thalamus
- [ ] Lobar / Cerebral
- [ ] Pontine
- [ ] Cerebellar
- [ ] Subararachnoid space
- [ ] Ventricular extension
- [ ] Multifocal

16. If lobar hemorrhage

Check all that apply.

- [ ] Frontal
- [ ] Temporal
- [ ] Parietal
- [ ] Occipital
- [ ] Multiple lobe

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