ADDIS ABABA UNIVERSITY
COLLEGE OF HEALTH SCIENCES SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF RADIOLOGY

TITLE- RETROSPECTIVE ANALYSIS OF COMPUTED TOMOGRAPHY PATTERNS OF HEMORRHAGIC STROKE AND THEIR ASSOCIATED RISK FACTORS

INVESTIGATOR: Dr. Hermella Berhanu, Radiology resident

ADVISORS:

Dr. Tesfaye Gizaw, MD, Radiologists, fellow in Nueroradiology,Assistant professor of radiology in AAU College of Health Sciences,TASH,Department of Radiology,AAU,Ethiopia

Dr. Abebe Mekonen, MD, senior consultant radiologists, subspecialty in Nueroradiology,Assistant professor of radiology in AAU College of Health Sciences,TASH,Department of Radiology,AAU,Ethiopia

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Abbreviation and Acronyms

AHA/ASA- American Heart Association/American Stroke Association

CT- Computed Tomography

HS-Hemorrhagic Stroke

ICH- Intracerebral Hemorrhage

IS- Ischemic Stroke

IVH- Intraventricular Hemorrhage

GBD- Global Burden of Disease

MRI- Magnetic Resonance Imaging

SAH- Subarachnoid Hemorrhage

TASH- Tikur Anbessa Specialized Hospital

WHO-World Health Organization

1. Introduction

1.1 Background

Worldwide Stroke is the second leading cause of death and third leading cause of disabilities (1). Overall, the GBD 2013 stroke burden estimates that there is significant increase in stroke burden in the world over the last two and half decades especially in the developing countries (2)

Stroke or "brain attack" is a clinical term that describes a sudden loss of neurological function persisting for more than 24 hours, which is caused by an interruption of the blood supply to the brain (3).

Stroke a is a broad term which encompasses intracerebral and SAH hemorrhage, ischemic stroke as well as silent ischemic and silent hemorrhagic strokes.

Stroke caused by intracerebral hemorrhage or hemorrhagic stroke is a rapidly developing clinical signs of neurological dysfunction, attributable to a focal collection of blood within the brain parenchyma or ventricular system, which is not caused by trauma (4).

In intracerebral hemorrhage, bleeding occurs directly into the brain parenchyma. Its mechanism is thought to be leakage from small intracerebral arteries damaged by chronic hypertension. Other mechanisms include bleeding diastasis, iatrogenic anticoagulation, cerebral amyloidosis and cocaine abuse. In addition to the area of the brain injured by the hemorrhage, the surrounding brain can be damaged by mass effect of the hematoma and a general increase in intracranial pressure may occur (3).

Ischemic stroke is an episode of neurologic dysfunction caused by focal cerebral, spinal or retinal infraction. Infraction is cell death attributable to focal ischemia in a defined vascular distribution or clinical evidence of focal ischemic injury based on symptoms persisting for greater than or equal to 24 hours or until death.

Stroke caused by SAH is a rapidly developing signs of neurologic dysfunction&/or headache because of bleeding into the subarachnoid space which is not caused by trauma (4)

Patients with stroke may present with various signs and symptoms such as headache, altered mentation, nausea, vomiting, seizures, focal neurologic deficits (such as right/left hemiparesis, sensory loss, visual field cut off, and aphasia). However, none of these clinical findings reliably distinguishes between hemorrhagic and ischemic stroke (3)

Confirmation that the patient had a stroke relies heavily on brain imaging such as Computed Tomography (CT) scanning and Magnetic Resonance Imaging (MRI). These imaging modalities

are also usually able to exclude stroke mimics such as brain tumors and subdural hematomas and separate brain ischemia from hemorrhage (4)

CT is more readily available and faster than MRI. Hence, CT is recommend as the initial screening procedure to differentiate ischemic stroke from intracranial hemorrhage by the most recent American Heart Association/American Stroke Association (AHA/ASA) guidelines (5)

Differentiating between ischemic vs hemorrhagic stroke is essential for the management of patients.

Hemorrhagic stroke may be classified according to its causes into primary and secondary.

Primary hemorrhagic stroke is not caused by any type of underlying deformity or coagulation disorder. The vast majority of these is directly correlated with hypertension as a risk factor, and cerebral amyloid angiopathy is also associated.

Secondary HS is caused by an underlying problem with the blood vessels. These may include hemorrhagic conversion of IS, vascular malformations (aneurysms, arteriovenous malformation, cavernoma), coagulopathy (hereditary, acquired, induced by anticoagulants or antiplatelets), neoplasms, trauma, vasculitis (6)

Hypertension is the most common etiology of primary hemorrhagic stroke. At least two third of HS patients are reported to have preexisting or newly diagnosed hypertension (3).

Most bleeding in hypertension related intracerebral hemorrhage is at or near the bifurcation of small penetrating arteries that originate from basilar arteries or the anterior, middle, or posterior cerebral arteries. (7) These hypertensive small vessel diseases result from tiny lipohyalinotic aneurysms (3).

Coagulopathy, which is among the secondary causes of HS, may be acquired or inherited resulting in a bleeding diathesis, with resulting secondary intracranial hemorrhage. Anticoagulant therapy is especially likely to increase hemorrhage risk in patients who metabolize warfarin inefficiently (4)

Risk factors for hemorrhagic stroke can be categorized into modifiable and non-modifiable factors.

Modifiable risk factors include hypertension, diabetes mellitus, dyslipidemia and smoking, physical inactivity, obesity, alcohol and drugs such as sympathomimetic such as cocaine as well as anticoagulant and antithrombotic agents.

The non-modifiable risk factors also called risk markers include age, sex, race-ethnicity and genetics. In general stroke is a disease of the aging, with the incidence of stroke increasing with age. At a younger age, women have high or higher risk of stroke, although at older ages the relative risk is slightly higher in men. The higher risk of stroke among women at a younger age reflects risks related to pregnancy, postpartum state as well as hormonal factors such as use of oral contraceptive pills. Blacks are at twice the risk of incidence of stroke than their white counterparts and have higher mortality associated with stroke. The risk of SAH and ICH in younger black adults is substantially higher than white counterparts. Hispanic/ latino patients also have increased risk of stroke. Genetic factors for hemorrhagic stroke with parental history and family history also increase the risk factors for hemorrhagic stroke (8)

Hemorrhagic stroke on brain CTs shows patterns of intracerebral hemorrhage which may be classified according to location into deep and lobar ICH. Deep ICHs are located in the basal ganglia, internal capsule, cerebellum or brainstem and are generally related to hypertension. In lobar ICH, hematoma is located in one of the cerebral lobes (frontal, parietal, temporal or occipital), and is caused by a wide range of causes. (6)

Brain CT scan, the imaging modality of choice in patients presenting with acute stroke, can detect ICH within few minutes of onset of stroke. It is a non-invasive diagnostic modality that demonstrates location of the hemorrhage, allows measurement of the hematoma size, and the presence of intraventricular, subarachnoid or subdural blood, or to identify any mass effect in primary on-traumatic ICH. This information are extremely useful in assessing the clinical and functional outcome in acute ICH, which cannot be obtained by clinical examination itself.

1.2 STATEMENT OF THE PROBLEM AND SIGNIFICANCE OF THE STUDY

Although, ischemic stroke accounts for the majority of strokes, the actual proportion of strokes depends on the population. Data has shown that in higher income countries ischemic stroke accounts for 91% and hemorrhagic stroke accounts for 9%, while in African countries there is a higher incidence of hemorrhagic stroke accounting for 34% (9)

The largest proportion of ICH incident cases (80%) and deaths (63%) occurred in low- and middle-income countries such as sub-Saharan Africa, central and Southeast Asia (10). However, there is limited data on incidence of stroke subtypes in sub Saharan countries such as Ethiopia. Hemorrhagic strokes are also generally more severe with a considerable higher mortality compared to ischemic stroke (10). Hence knowledge of the prevalence is critical in formulating targeted public health policies important for reduction of the disease.

The key to reducing the burden of hemorrhagic stroke are intervention strategies aimed at targeting modifiable risk factors, such as hypertension and smoking. Therefore, early detection and modification of risk factors is imperative. In high income countries such preventive strategies have proved effective. However, in developing countries there is inadequate data on the risk factors associated with HS (1).

The definition of hemorrhagic stroke is largely based on brain imaging and the diagnosis cannot be established only on clinical grounds (4). Patients with stroke are managed with a treatment course based on the diagnosis of ischemic vs hemorrhagic stroke, made with CT scanners.

In addition, CT scan findings including; hematoma volume, location of stroke, midline shift, intraventricular extension of bleed, ventricle compression, etc., influence the clinical outcome in patients with acute stroke.

This study aims to identify the possibly unique local risk factors for the occurrence of hemorrhagic stroke, which will ultimately help in increasing stroke prevention. It also intends to study the common CT patterns of hemorrhage and how it can help predict the clinical outcome of the patient.

1.3 Literature Review

Global estimates of stroke burden suggest that sub-Saharan Africa has the highest incidence, prevalence and case fatality (11) In general ischemic stroke is thought to account for the majority of stroke cases (80%). However worldwide estimates indicate that primary hemorrhage constitute a higher percentage of all strokes, compared to the caucasian population. Data from the Interstroke study involving 22 countries showed higher proportions of hemorrhagic stroke in Africa, 34% (9).

A local study done in Ethiopia found the hemorrhagic stroke accounted for more than half of stroke cases, 55.3% (12). This was also demonstrated in a study done in Gondor which showed prevalence of hemorrhagic stroke of 42.3% (13)

The incidence of strokes increases with increasing age, and the risk of stroke doubles every decade above age 55(14).

In high income countries the majority of strokes occur in older patients for instance in the US nearly three quarters of stroke occur in patients older than 65 (15). Similarly, a study done in Europe demonstrated the median age of strokes was 73 years (16).

However, in low- and middle-income countries strokes have been reported more commonly occurring in patients with a younger age. According to the WHO on average stroke occurs 15 years earlier in-and causes more deaths of people living in low- and middle-income countries when compared to those living in high income countries (1). A study done in Tikur Anbessa hospital demonstrated a quarter of strokes occurs in patients below 34 years of age (12). Another study done in the same hospital found that Hemorrhagic stroke was highly prevalent in ages between 31-45- and 46-60-years accounting for 33.1% and 37.4% respectfully with median age of 52 years (17).

In developing nations compared to developed countries, stroke occurs earlier and affects younger people in the peak of their life resulting in significant socioeconomic impact.

The male sex was identified as a risk factor for hemorrhagic stroke in one systematic review conducted by Ariesen.M and colleagues (18).Another study conducted in Qatar also showed similar results(19).

Data from the recent INTERSTROKE Study indicates that a list of 10 stroke risk factors including hypertension, diabetes, hyperlipoidemia, current smoking, alcohol consumption,

obesity, heart disease, poor diet, stress and depression was responsible for 90% of all strokes. These are modifiable risk factors, making stroke highly preventable (20).

Hypertension is identified as major medical risk factors, for causing hemorrhagic stroke. It is a modifiable risk factor with widespread prevalence.

In a systemic review, all 14 studies (11 case–control and 3 cohort studies) showed a positive correlation between hypertension and hemorrhagic strokes. Studies also showed the risk of developing ICH increases with increasing severity of hypertension (18).

A study on possible etiologies of ICH investigated in 439 patients found hypertension as an etiology (definite, probable, or possible) in about 80% of the patients (21).

In a local study, hypertension was identified as the most common risk factors associated with hemorrhagic stroke (74.1%) with more than a quarter of patients (27%) diagnosed to have HTN after stroke had already occurred. The study also found a majority of the known hypertensive patients (63.1%) were not taking antihypertensive medication or were irregularly taking their medications (17).

Studies show treatment of hypertension significantly reduces the risk of stroke. In Africa several surveys have demonstrated very low prevalence of hypertension control with lack of awareness and treatment. Hence, hypertension can be used as an entry point for stroke prevention and control programs in African countries with a high burden of hemorrhagic stroke (22).

Intracerebral hemorrhage due to hypertension tends to affect specific areas of brain. In a study on 100 patients with hypertensive ICH, the most common site of hemorrhage was found to be the basal ganglia (55%), followed by thalamus (26%), cerebral hemispheres (11%), brainstem (8%), and cerebellum (7%) (23).

Hypertensive ICH affects the deeper structures more because of hemodynamic injury to the perforating arteries which have thinner walls and are more prone to the effects of high BP. They provide supply to basal ganglia, thalamus, pons, and cerebellum respectively, thus explaining the propensity of these areas of brain to be affected more by severe hypertension (24).

A study done by Ariesenet identified smoking and diabetes as a weak risk factor for hemorrhagic stroke (18). Another study found that current smoking status (*vs* never or former) was associated with an increased risk of stroke with an increased number of cigarettes smoked per day increasing the risk of stroke. It also found heavy alcohol drinking is a risk factor for hemorrhagic stroke, but not light/moderate drinking (20)

A systemic review of twenty-three studies found that total cholesterol level is inversely associated with risk of HS. Higher levels of low-density lipoprotein cholesterol seem to be associated with a lower risk of HS, while high density lipoprotein cholesterol level seems to be positively associated with risk of intracerebral hemorrhage. (25)

Another study suggests that diet and socioeconomic status plays roles in predisposition of stroke among Africans. Dietary factors such as regular intake of meat, added table salt, and low consumption of green leafy vegetables as well as high income level were associated with increased incidence of stroke (11).

Regular physical activity was associated with a reduced risk of hemorrhagic stroke (20)

Another study found that obesity increases the risk of deep ICH, mostly through an indirect effect on hypertension and other intermediate obesity-related comorbidities, but obesity has no major influence on the risk of lobar ICH (26).

Studies show that psychosocial stress was associated with occurrence of HS (11). However, depression was not shown to be associated with HS (20).

Over the last four decades the incidence of stroke in low- and middle-income countries has more than doubled while it has declined by 42% in high income countries. This decline in high income countries was attributed to effective prevention strategies targeting modifiable risk factors and reducing mortality (1).

A local study further evaluated sites of hemorrhage in HS patients, and it was found that parenchymal hemorrhage accounted for 63.8%, with cerebral hemispheres being the most common sites (48.9%) the thalamus and basal ganglia accounted for 12.8%. The study found that cerebellar hemorrhage was a rare site (2.1%) while the rest of hemorrhagic stroke occurred as ventricular (27.7%) and subarachnoid hemorrhage (12.8%) while multifocal accounted for 10.6%. In the cerebral hemispheres it was found to be more common in the left (29.8%) with the parietal lobe as the most affected lobe 29%, followed by temporal lobe and frontal lobe which occurred 12.6% and 10.8% of stroke patients respectively. (13)

A study done by Nag, et al., on 150 patients, with CT scan proven acute non-traumatic ICH aimed to find out how hematoma volume, location of stroke, midline shift, intraventricular extension of bleed influences the clinical outcome in patients. The study showed that hematoma volume >30 cm3, brain stem hematoma, intraventricular extension of bleed and ventricular compression along and with midline shift are associated with early mortality in ICH. (27)

Another study done by Castellanos et al. found the cortical location of bleeding as an independent predictor of good short-term stroke outcome. (28) Conversely another study done by Molshatzki*et al*. found >6-fold higher odds of lobar location of stroke in case of severe stroke as compared to mild stroke (29)

A number of studies showed a direct relationship of hematoma volume with a clinical outcome in ICH. A study by Molshatzki*et al*. observed that patients with moderate to severe stroke had 2.3-fold higher hematoma volume as compared to mild stroke patients (29). This is also supported by Hemphill *et al.* in "The ICH score" where they have mentioned that hematoma volume >30 cm3 is an independent poor prognostic factor for 30-day mortality and morbidity (30).

IVH was reported as important finding by Hallevi*et al*., they found that patients with IVH were twice as likely to have a poor outcome when compared to patients without IVH. (31)A study on Japanese stroke patients also found that IVH along with hemorrhage size is related to high mortality (32).

Ina study by Fogelholm et al., a midline shift >6 mm was a strong predictor of poor outcome (33) however the study by nag et al. failed proved to that it was an independent predictor of poor outcome. (27)

2. Objectives

2.1 General Objective

- For retrospective review of CT pattern of hemorrhagic stroke and associated risk factors

2.2 Specific Objective

- Review of imaging features, as well as the distribution of hemorrhage on the non contrast head CT
- To assess the associated risk factors of HS
- To evaluate how CT imaging features can help predict the short-term clinical outcome of the patients

3.Methods and Materials

3.1 Study area and period

The study was conducted in Tikur Anbessa Specialized Hospital, located in Addis Ababa, and is one of the largest hospitals in Ethiopia. It is a tertiary level referral center which provides service to a large number of patients, both from the capital and rural areas. TASH is also a teaching hospital and under the Collage of Medical and Health Sciences.

The study was a retrospective study, data from radiology registry(PACS) to identify cases of hemorrhagic stroke patients imaged with head CT scan during a time period of March 2018 to February 2020

3.2 Study Design

Retrospective Cross-Sectional Hospital based study was employed

3.3 Population

3.3.1 Source Population

The source population were patients who had undergone CT scan of the brain, during the study period in TASH

3.3.2 Study population

The study population were patients with CT findings consistent with hemorrhagic stroke, & meeting the inclusion criteria

3.3.3 Eligibility Criteria

3.3.3.1 Inclusion Criteria

Patients with a non- contrast CT scan of the head with findings of focal hyper density in the range of 40 to 80 Hounsfield Unit, consistent with hemorrhagic stroke

3.3.3.2 Exclusion Criteria

The following patients were excluded from the study:

- Patients with incomplete medical records
- Patients with a head CT scan finding not suggestive of hemorrhagic stroke
- Patients with traumatic intracerebral hemorrhage

3.3.4 Sampling Technique and Sample Size

Non probability convenience sampling technique was employed

Variables

Dependant variable

Patient short term outcome in 30 days-Dead or A**live**

Independent variable

Imaging features- Hematoma volume,midline shif, intraventricular extension of hematoma, ventricular compression

Clinical findings- GCS, sex, address

3.5 Data Collection Plan

All the patients included in the study were investigated with CT scan of the head based on clinical suspicion of stroke or its differential diagnoses. CT scan findings consistent with hemorrhagic stroke, considered as focal hyper density in the range of 40 to 80 Hounsfield Unit, were recorded by the radiologists. The patients were identified from the PACS (radiology registry) and their medical charts and CT images and reports were used for data collection, using the structured questionnaires if meeting the eligibility criteria.

3.6 Data Analysis and Interpretation

The collected data was checked for completeness and clarity. Following this the data was entered and analyzed on SPSS version 25.0 computer Software. Then presence of an association between variables was investigated using the Chi-square test and those with p value<0.05 were considered to be statistically significant.

3.7 Ethical Consideration

Prior to data collection formal letters were obtained from the concerned authorities as well as the Research Ethics Committee of department of radiology

4. Results

4.1. Socio-Demographic data

- 82 patients were included in the study and 50 (61%) of the participants were males while 32(39%) were females. 33(40.7%) of the patients were urban dwellers while 48 (59.3 %) of the patient's came from the rural regions of the country. The age of the participant's ranged from 15-84 years of age with a mean age of 49 years and a standard deviation of 16.9 years. (Table 1)

Risk factors

- Some of the risk factors of hemorrhagic stroke that were assessed during the study include hypertension, diabetes mellitus, heart disease, prior history of stroke, smoking, heavy alcohol consumption and history of use of anti platelet/ anti coagulant drugs. (Table 2)
- Hypertension is the most commonly identified risk factor in this study with 65(79.3%) of the patient's having a history of elevated blood pressure. With 56(68.3%) of the cases having a stage II hypertension while 9(11%) of the cases had stage I hypertension and only 17(20.7%) of the patient's had no hypertension. And from the hypertensive patients only 16(24.6%) of the patients were on anti-hypertensive medication, while the rest 49(75.4%) of the patients were not on medication. The patients with a finding of hypertension and hemorrhagic stroke also had hypertensive heart disease with left ventricular hypertrophy which was seen in 7(8.5%).
- Diabetes mellitus was identified in 5(6.1%) of the patients. And 5(6.1%) other patients had a prior history of stroke. 2 patients had history anti platelet/ anti-coagulant drugs use, with one of the patients taking both anti-platelet and anti-coagulants.
- From the behavioral risk factors assessed in this study a total of 9 people were found to have a history of smoking and heavy alcohol consumption. 4 of the patient's had both heavy alcohol consumption and smoking, while 2 of the patient's only smoked and 3 of the patient's only had heavy alcohol consumption.

4.2 Imaging Findings

-Isolated lobar hemorrhage was seen in 14(17%) of the cases while isolated deep bleeds involving the deep brain nuclei, brainstem and cerebellum was seen in 51(62.2%) of the cases and in the rest 17(20.7%) of the cases there were both lobar and deep brain bleeds. (Table 3)

- The basal ganglia was the most common site for the deep intracranial bleeds with 51(62.2%) of the bleeds followed by the thalamus with 11(13.4%),while the posterior fossa bleeds accounted for 6(8.8%) involving the brainstem with 4(5.9%), cerebellum with 2(2.9%) of the cases. (Fig 1)
- The most commonly involved lobe was the temporal lobe which accounted for 16(51.6%) of the lobar hemorrhages, followed by the frontal and the parietal lobes which have 7(8.5%) cases each. (Fig 2)
- The hematoma volume was greater than 30cm^3 in 29(35.4%) of the patients while on the rest 53(64.6%) the volume of the hematoma was less than 30cm3. Ventricular compression was seen in 63(76.8%) of the with a midline shift of greater than 5mm was detected in 25(30.5%) of the cases. There was intra- ventricular extension of hematoma in 21(25.6%) of the cases. (Table 4)

4.3 Clinical presentation and outcome

- At the time of presentation only 11(13.6%) of the patients had a GCS of 15/15. And 45(55.6%) of the patients had a GCS of 13-14/15, 23(28.4%) of the patients had a GCS ranging from 5-12/15 and 2(2.5%) of the patients had a GCS ranging from 3-4/15.
- And from the study participants survival beyond the initial 30 days after the hemorrhagic stroke was only seen in 56(68.3%) while the rest 26(31.7%) of the cases succumbed within the first 30 days. (Table 5)
- There were statistically significant association with poor outcome within the first 30 days with certain imaging features including the presence of midline shift of greater than 5mm, a hematoma volume of greater than 30cm3 as well as clinical features such GCS at time of presentation and (Table 6)

Table 1. Socio demographic data

Variables	Categories	Number	Percentage
Sex	Male	50	61%
	Female	32	39%
	Total	82	100%
Residence	Rural	48	58.5%
	Urban	34	41.5%
	Total	82	100 %
Age- Range	< 20 years	4	4.9%
	20 -40 years	20	24.4%
	40-60 years	34	41.5%
	>60 years	24	29.3%
	Total	82	100 %

Table 2: Identified Risk factors

Risk factors	Number(n)	Percentage (%)
Hypertension	65	79.3%
Diabetes Mellitus	5	6.1%
Use of antiplatelet or anticoagulant drugs	2	2.4%
Smoking	6	7.5%
Alcohol	7	8.5%
Previous History of Stroke	5	6.1%

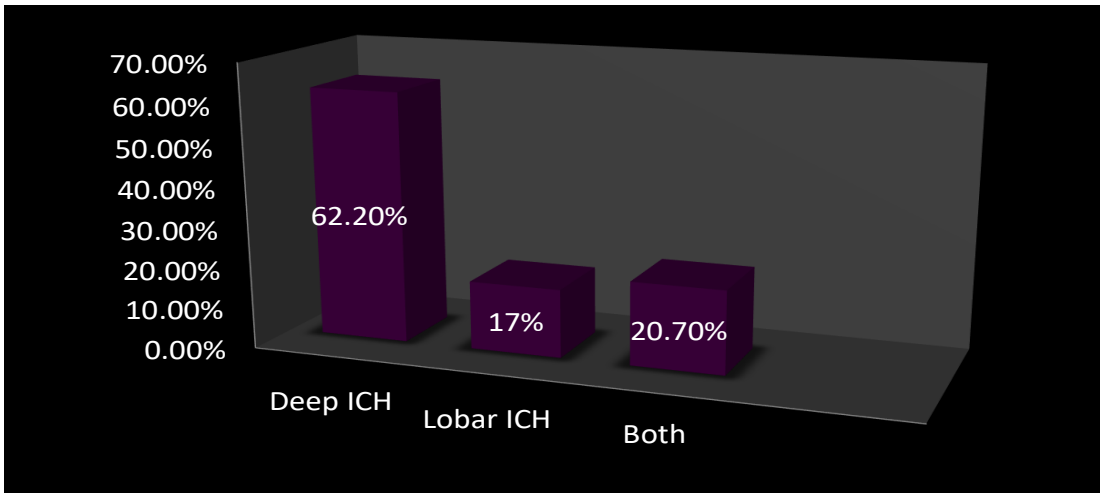

Table 3. Distribution of hematoma on Brain CT

Variables	Categories	Number(n)	Percentage (%)
	Lobar Hemorrhage	14	17%

Site of Hemorrhage	Deep ICH	51	62.2%
	Both	17	20.7%
	Total	82	100%

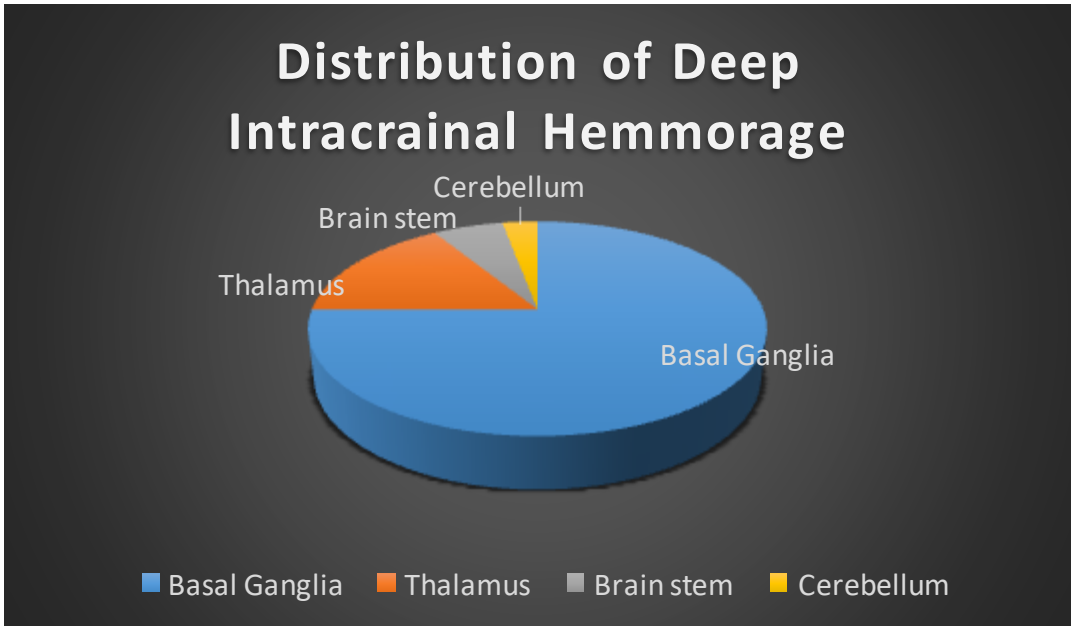

Fig 1: Distribution of Deep Intracranial Hemorrhage

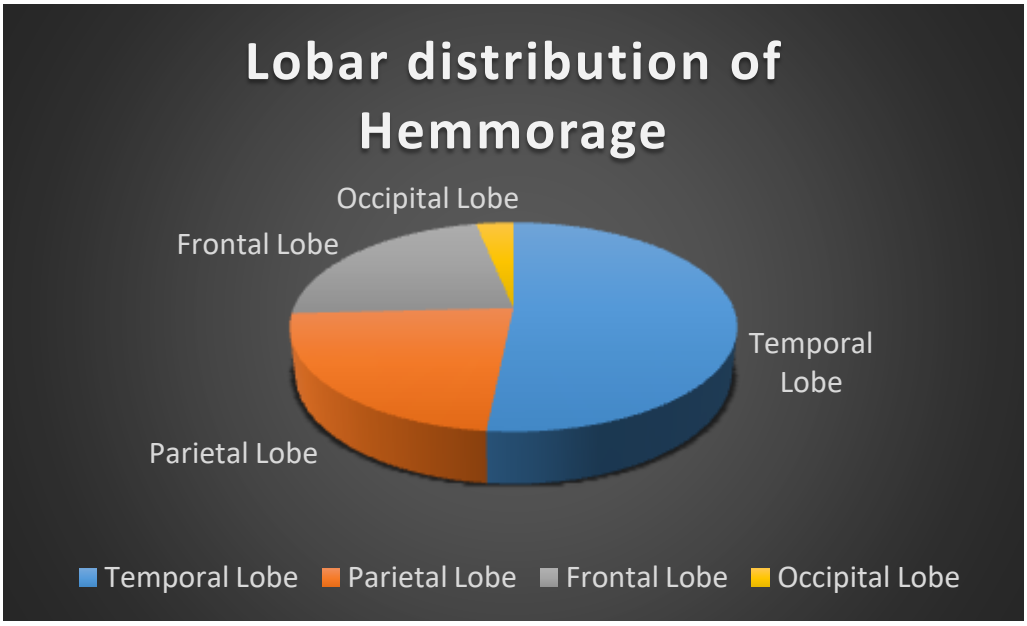

Fig 2. Lobar distribution of hemorrhage in patients with hemorrhagic stroke

Table 4: Imaging signs of severity of intracranial hemorrhage in hemorrhagic stroke

Ventricular Compression	Yes	63	76.8%
	No	19	23.2%
	Total	82	100%
Midline Shift	Yes	25	30.5%
	No	57	69.5%
	Total	82	100%
Hematoma Volume	>30 cm3	29	35.4%
	<30 cm3	53	64.6%

	Total	82	100%
Intra-ventricular Extension	Yes	21	25.6%
	No	61	74.4%
	Total	82	100%

Table 5. Association between clinical and imaging features with 30 day survival of hemorrhagic stroke patients

Variables	Categories	Outcome		
		Survived first 30 days	Died within the first 30 days	
Sex	Male	34	16	$X^2 = 0.05$ P =0.943
	Female	22	10	
Address	Urban	24	10	$X^2= 0.141$ P=0.707
	Rural	32	16	
GCS	15/15	9	2	$X^2 = 22.43$ P= 0.000
	13-14/15	38	7	
	5-12/15	8	15	

	3-4/15	0	2	
Ventricular Compression	Yes	44	19	X^2= 0.301 P = 0.583
	No	12	7	
Midline Shift	Yes	10	15	X^2= 13.295 P = 0.000
	No	46	11	
Hematoma Volume	<30 cm3	46	7	X^2= 23.689 P = 0.000
	>30cm3	10	19	
Intraventricular Extension	Yes	13	8	X^2= 0.532 P= 0.466
	No	43	18	

5. Discussion

In the sub-Saharan Africa there is a significant burden of hemorrhagic stroke, however there is sparse data on the risk factors, socio demographic distribution of patients as well as pattern of hematoma on imaging. Understanding the possible association between the patient's short-term outcome, with the CT imaging features and patient's clinical data, will help predict the prognosis of the patient.

The study showed that the majority of patients with hemorrhagic stroke were in the productive age group, with age 40-60 and 20- 40 years (41.5% and 24.4%) with a median age of 50. These findings are consistent with a number of studies conducted in the country, for instance a study done in Tikur Anbessa hospital demonstrated a quarter of strokes occurs in patients below 34 years of age (12). Another study done in the same hospital found that hemorrhagic stroke was highly prevalent in ages between 31-45 and 46-60 years (33.1% and 37.4%) with median age of 52 years(17).

This study also showed that older patients (> 60 years) accounted for 29.3%, which is not in accordance to studies done in high income countries. In the US nearly three quarters of stroke occur in patients older than 65 (15). Similarly, a study done in Europe demonstrated the median age of strokes was 73 years (16). According to the WHO on average stroke occurs 15 years earlier in-and causes more deaths of people living in low- and middle-income countries when compared to those living in high income countries (1).

The study observed that males were found to have a higher rate of HS compared to females (61% vs. 39%), this is similar to a systemic review conducted by Ariesen. M and colleagues (18) and study (19).

Similar to other studies conducted in Ethiopia, this study shows, the majority of patients resided in rural parts, compared to urban regions (17).

In accordance with previous researches, this study found that hypertension was the most commonly identified risk factor (79.3%) (18,20,21). Similarly, a study by Martí-Fàbregas. J and company found hypertension as an etiology in about 80% of the ICH patients (21). A positive correlation between hypertension and hemorrhagic strokes, was also demonstrated in a systemic review conducted by Ariesen M and colleagues. According to their observation, the risk of developing ICH, increases with increasing severity of hypertension (18), this is in line with our study, in which stage II hypertension is found in the majority of the cases.

Several surveys in African countries have demonstrated very low prevalence of hypertension control, with lack of awareness and treatment (22). This was also reflected in this study with three fourth of known hypertensive patients not on antihypertensive medication or irregularly taking medication. Another local study demonstrated a similar finding, with majority of the known hypertensive patients (63.1%), that were not taking medication or were irregularly taking their antihypertensive medications (17). This study also found that of the hypertensive patients with hemorrhagic stroke (8.5%) had hypertensive heart disease with left ventricular hypertrophy. Other risk factors that were evaluated include diabetes mellitus, seen in 6.1% of patients. This is lower than results of other researches, where it was demonstrated in 10% of patients with ICH (35,17).

Studies have suggested that current smoking and heavy alcohol drinking were associated with increased risk of hemorrhagic stroke (20). In this study current smoking and alcohol drinking were seen in 7.5 % and 8.5% of patients. Although this is lower than the findings of the systemic review conducted by Gretrude.N et al. (35) in the sub-Saharan Africa, it is a significantly higher rates of smoking and alcohol drinking than demonstrated by other similar local studies (17). Risk factors such as antiplatelet or anticoagulant drugs were less commonly seen in this study.

CT scan imaging findings of our study shows that the deep ICH is a more common location than lobar hemorrhage (62.2% vs.17%). The basal ganglia was the most common site for the deep intracranial bleeds with 62.2% of the bleeds, followed by the thalamus (13.4%),and posterior fossa structures accounted for 8.8% of cases with the brainstem (5.9%), and cerebellum (2.9%) of the cases. These locations are common sites for hemorrhage in patients with hypertension and the vast majority of our patients were shown to be hypertensive. Hypertensive ICH affects the deeper structures more due hemodynamic injury to the perforating arteries which have thinner walls and are prone to effects of high BP. Hence, perforating arteries supplying the basal ganglia, thalamus, pons and cerebellum are affected more by severe hypertension (24). In line with this, a study by Zafar. A et al, on a 100 patients with hypertensive ICH, demonstrated that the deeper bleeds was most common sites of hemorrhage, with majority of hematomas in the basal ganglia, followed by the thalamus, brainstem and cerebellum (55%, 26%, 8% and 7%), while cerebral hemispheres accounted for 11% of cases (23).

In contrast, one study found that the cerebral hemisphere was the most common site of hemorrhage (63.8%), with parietal lobe being the most affected, followed by temporal then

frontal lobes (13). This is quite different from our observation, in which isolated lobar hemorrhage was seen in 17% of the cases, with more than half of the cases involving the temporal lobe (51.6%), this is followed by hemorrhages involving the frontal and parietal lobes (8.5% each). Hemorrhage involving both lobar and deep brain bleeds was seen in 20.7% of cases.

Other imaging findings in this study include hemorrhage volume, in the majority of patients was found to be less than 30cm3 (64.6%), midline shift of greater than 5mm and intraventricular extension of hematoma was observed in one fourth of patients. The study also found that ventricular compression was seen in more than three fourth of patients.

This study also attempted to determine if the short-term outcome of patients with acute stroke, has an association with certain imaging as well clinical parameters.

A number of studies showed a direct relationship of hematoma volume with clinical outcome in ICH. A study by Molshatzki et al. observed that patients with moderate to severe stroke had 2.3-fold higher hematoma volume, as compared to mild stroke patients (29). This is also supported by Hemphill et al. in "The ICH score" where they have mentioned that hematoma volume >30 cm3 is an independent poor prognostic factor for 30-day mortality and morbidity. A study done by Nag, et al., also found that patients with large volume hematoma (= >30 cm3) are associated with early death, in contrast patients with smaller hematoma volume are associated with prolonged survival (27). This is similar to the findings of our study, that demonstrates that mortality (poor outcome) is significantly higher in patients with larger hematoma volume (>30cm3)65% as compared to smaller hematoma volume (<30 cm3), 13% (p value<0.001)

In addition, this study also observed that patients with midline shift greater than 5mm have a significantly higher mortality (poor outcome) 60%, compared to patients without midline shift>5mm, 19.2% (p value<0.001). A similar observation was seen in study by Fogelholm et al., which demonstrated that a midline shift >6 mm was a strong predictor of poor outcome (33), however the study by nag et al. failed prove this association. (27)

IVH was reported as important finding by Hallevi et al., they found that patients with IVH were twice as likely to have a poor outcome when compared to patients without IVH. (31) A study on Japanese stroke patients also found that IVH along with hemorrhage size is related to high mortality (32). Our study, however failed to prove this association, between IVH and poor outcome.

Ventricular compression by hematoma was found by Nag,et al, to have a significant association with poor outcome in ICH patients, (27) this study however has not found ventricular compression to be statistically significant for poor outcome, probably because ventricular compression is not a sole indicator of mass effect, it's also indicated by midline shift, which is a significant factor in this study.

The study by, Hallevi et al found that patients GCS score are strongly associated with outcome. They also demonstrated an association with the patients age (31). This is also reflected in our study where the GCS score has a statistically significant association with poor outcome of the patient. We observed that patients with lower GCS scores (<=12) had a significantly higher mortality rate 68%., as opposed to patients with higher GCS scores (>13), 16%. The sex and the address of the patients in this study, however did not show statistically significant association with the outcome of patients.

5.1. Limitations of the study

Incomplete medical records was a major limitation for this retrospective study. Another major limitation for this retrospective study was missing patient medical records. An additional limitation is that only the short-term outcome of the patient, within 30 days was assessed. So long term follows up and impact of the hematoma, location and other CT parameters on a long duration functional outcome remains to be determined.

6. Conclusion

Hemorrhagic stroke remains a major public health concern, whose mortality can be reduced by targeting modifiable factors such as hypertension. This study identified that the majority of patients were male and in the productive age group with hypertension as the major risk factor. Most of these patients although aware of their diagnosis were not treatment. As shown from data from high income countries that have reduced the burden of HS, public health strategies that include screening and managing hypertension, DM as well as creating awareness of the importance of adequately managing risk factors, may significantly reduce the burden of HS in this region.

On the NNCT, the study found that the majority of hematomas were deep ICH, with most common site being the basal ganglia.

The non-contrast CT scan of the brain, not only confirms the diagnosis but can help us predict the short term outcome of the patient. Our study found that a hematoma volume>30 cm3 and a midline shift greater than 5mm is significantly associated with poor outcome. Other clinical parameters including lower GCS score is also associated with poor outcome. Using these imaging and clinical features may help to better understand the prognosis of the patient.

7. References

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Data collection format

1. Socio demographic data

1.1 Age (in years)_____

1.2 Sex

a. Male
b. Female

1.3 Address_____

a. Rural area
b. Uraban area

1.4 Monthly Income_____

Associated Risk Factors

2. Blood Pressure at admission

a. Normal <120/80
b. .Prehypertension- systolic 120-139mmHg, diastolic 80-89mm Hg
c. Stage 1- systolic 140-159mmHg, diastolic 90-99mm Hg
d. Stage 2- systolic 160mmHg, diastolic 100mm Hg or greater

2.2 If the a known hypertensive patient, is the patient on antihypertensive medication?

a. Yes
b. No If No specify the reason_____

3. Presence of Diabetes Mellitus

a. Yes
b. No If yes specify the admission RBS_____

4. Is the patient a current smoker

a. Yes
b. No If yes specify the smoke packs per year_____

5. Presence of regular alcohol consumption

a. Yes
b. No

If yes specify the amount

a. moderate -Female 20-39g Male 40-59g

b. heavy- Female->40 Male>60g alchol daily

6. Presence of known heart disease

a. Yes
b. No

If yes specify the type/ echo findings_____

7. Is the patient taking the following medications

7.1 Anticoagulant

a. Yes
a. No

7.2Antiplatelet

a. Yes
b. No

8. Previous history of stroke/TIA

a. Yes
b. No

9. Family history of stroke

a. Yes
b. No

9.Patients GCS score on admission

a. 3-4
b. 5-12
c. 13-15

10. CT scan findings

I. Anatomical location of hemorrhage

1. Site
    a. Right
    b. Left
    c. Bilateral
1. Lobar
    a. Frontal
    b. Parietal
    c. Temporal
    d. Occipital
2. Deep ICH
    a. Basal ganglia
    b. Thalamus
    c. Brain stem
3. Primary IVH
4. Cerebellum
5. If a combination of findings please specify_____

II. Other CT scan findings

1. Hematoma volume
    a. < 30 cm3
    b. >/30 cm3
2. IVH extension of hemorrhage

a. Yes
b. No

3. Midline shift >5mm
    a. Yes
    b. NO
4. Ventricular compression
    a. Yes
    b. NO

III. Evidence of vascular malformation. If yes please specify

a. AVM

b. anyerusm

c. cavernoma

d. others

11. Patient outcome following ICH

a. Patients died within 30 days
b. Patients survived beyond 30 days