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ORIGINAL RESEARCH ARTICLE

Neuroimaging in Cerebrovascular Accidents

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ABSTRACT

Introduction: The incidence rate and the death rate from stroke increase dramatically with age. The one who survive are usually left with permanent disability. Thus, stroke has become a great medical and social problem. Accurate and early diagnosis may improve the morbidity and mortality rates in the future as newer and more effective therapies are currently being instituted. Neuroimaging in stroke patients, especially in acute ischemic stroke patients, plays an essential role. It helps to differentiate other causes of stroke (i.e., stroke mimics such as migraine headache, tumors, seizure, metabolic disturbance, and peripheral or cranial nerve disorders), early detection of hemorrhagic stroke, distinguish irreversible infarcted tissues from salvageable tissue, identify vascular malformations, treatment planning for intravenous thrombolysis and intra-arterial thrombectomy, and outcomes prediction. The aim of the study is to characterize type of stroke hemorrhagic *vs.* ischemic on neuroimaging. Radiological evaluation of stroke regarding –site, size, volume and duration. Correlation of neuroimaging findings with clinical findings and patient demographics.

Materials and Methods: In 100 patient single-center, prospective observational study was conducted in the department of radiology, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly and adult patients with suspected stroke on computed tomography (CT) and magnetic resonance imaging (MRI) and characterization and correlation with clinical findings were done from the study. Infarcts were grouped into hyperacute (0–24 hours), (acute 1–7 days), early subacute (7–10 days), late subacute (10–21 days)

Results: Out of 100 patients, the study showed male predominance. The majority of cases had a history of weakness. Comorbidities like diabetes, hypertension, and dyslipidemia increase the risk of stroke On the basis of GCS score the majority of the cases were, having GCS score greater than 10 (72.0%). Cranial nerve palsies and LOC were also common among patients of stroke. Out of a total 69 ischemic stroke cases, CT was positive in 55 patients, while MRI was positive in all the cases. Arterial infarcts (89.8%) are much more common than the venous infarcts 7 cases (10.2%). The majority of cases that reached our department were in the acute stage (56 cases, 81.2%), and the majority had MCA territory involved. The basal ganglia complex was the most common location for the hemorrhage and was seen in 15 cases (48.3%). The mean volume of bleeding was large in cases of lobar bleeding. There was a strong positive correlation between altered sensorium (Phi value .64) and vomiting (.60), while the symptoms showed a positive correlation. The correlation of cerebrovascular accidents with age was seen more in patients aged > 60 as compared to those age < 60 (Phi value .1).

Conclusion: This study depicts the predominance of the older age group (> 40 years). The ischemic stroke was more common than the hemorrhagic stroke, the commonest cause being the MCA territory infarcts. In the cases of hemorrhagic stroke, the ganglion-capsular bleed was the commonest. Stroke imaging has undergone significant advances over last decade. It remains very crucial for the management of hyperacute stroke in the first few hours, where aim is to recognize patients eligible for thrombolytic therapy and expected to have good outcomes. Both CT, and MRI are useful for a comprehensive assessment of acute stroke MRI is sensitive for ischemic infarct detection and can provide important and necessary information for therapy planning. Both clinical examination and early diagnosis of stroke by imaging can lead to better patient outcomes.

Keywords: Neuroimaging, Cerebrovascular accidents.

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INTRODUCTION

Cerebrovascular accidents (CVA) are on the leading causes of death in developed countries after heart disease and cancer and also become one of the leading causes of death in India. It accounts for about one percent of admissions to general hospitals.[1] Cerebrovascular accident or stroke is defined as an acute loss of focal and at times, global cerebral function, the symptoms lasting more than 24 hours or leading to death with no apparent cause other than of vascular origin.[2]

Although stroke is predominantly a disease of the middle-aged and the elderly, its occurrence in younger age groups is not rare. It has emerged as an important reason for morbidity and mortality in young adults, especially in developing countries. Stroke in young is predominantly tragic due to its potential to create a longstanding burden on victims, and their families, and the community. The clinical features of strokes are speech slurring, limb weakness, facial palsy, altered sensorium, seizures, vertigo, vomiting and headache.[3]

In the investigation of stroke and transient ischaemic attack (TIA), imaging is used to differentiate:

- Vascular from the non-vascular lesions, like tumors or infections.
- Ischemic from the hemorrhagic stroke.
- Arterial from the venous infarction, and to differentiate anterior and posterior circulation strokes to regulate whether the tight carotid stenosis is symptomatic.[4]

Stroke imaging aims to assess the parenchyma, pipes (extra-cranial and intra-cranial circulation), perfusion and penumbra. This approach aids in the detection of intracranial hemorrhage, differentiating salvageable tissue from infarcted tissue, identifying intravascular thrombi, selecting appropriate therapy and predicting the clinical outcome.[5]

Non-contrast CT (NCCT) remains a commonly used modality of imaging to distinguish between hemorrhagic stroke and ischemic, to recognize early changes in CT, and to rule out stroke mimics.[6] MRI, including magnetic resonance angiography (MRA), is the most useful imaging modality for the evaluation of acute stroke; it offers information about the mechanism in addition to the vascular territory of stroke.[7]

MATERIALS AND METHODS

The present single-center, prospective observational study was conducted in the department of radiology, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly and adult patients with suspected stroke on CT and MRI and clinical correlation with clinical findings was done.

A standard protocol was adopted for performing CT brain which was done using Somatom definition flash dual source energy MDCT (Siemens medical solutions) and Somatom scope 32 slice. A non-contrast and/or contrast-enhanced CT examination was done as requested by the clinical departments. Non-contrast and or contrast-enhanced MRI was performed on 3 Tesla skyra and 1.5 Tesla sempra strength MRI scanner. Infarcts were grouped into hyperacute (0–24 hours), (acute 1–7 days), early subacute (7–10 days), late subacute (10–21 days).

Inclusion Criteria

- Patients of all age groups, irrespective of sex, clinically suspected of stroke undergoing neuroimaging.

Exclusion Criteria

- Patient not giving consent.
- Patients with stroke mimic, e.g., tumor, infection, inflammation.
- Patients with head injury, hypoxic injury or suspected substance abuse.

Statistical Analysis

Microsoft Excel was used to create the database and produce graphs, while the data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 23 for Windows. Mean and standard deviation (± SD) were used to describe quantitative data meeting normal distribution. Parametric independent student's t-test compared two continuous independent groups. The chi-square ($\chi 2$) test was used to compare the discrete (categorical) group. *p-value* less than 0.05 ($p < 0.05$) was considered statistically significant. Correlation was calculated using phi coefficient value ranging from +1 to -1 (+1 meaning strong positive correlation).

RESULTS

This observational prospective study was performed in the Department of Radiodiagnosis, in SRMSIMS College and Hospital, Bareilly, UP for a duration of 1.5 years on 100 cases with clinically suspected recent stroke referred patients (Figures 1-15). The research procedure followed was in accordance with approved ethical standards of the Department of Radiodiagnosis, SRMSIMS College and Hospital, Bareilly, UP, India Ethics Committee (Human). Out of 100 patients males were 69 (69%) and females were 31 (31%). The study showed the male predominance. The mean age was 60.1 ± 15.6 years.

The majority cases had a history of weakness (73.0%) followed by vomiting (52.0%) and altered sensorium (40.0%). Dysarthria was in 35.0%, seizures (20.0%), dysphagia (17.0%) and facial palsy (15.0%).

The majority of the patients of infarct, v 44.0%, had a weakness as the chief complaint, while the majority of the patients of hemorrhage had vomiting as the main complaint and the result was statistically significant ($p < 0.05$).

Based on comorbidities, the majority of the cases were having hypertension (68.0%), dyslipidemia was in 45.0% and diabetes mellitus was in 38.0%.

Among the various risk factors included, the commonest was smoking (32.0%), followed by a history of stroke 26 (26.0%).

Based on GCS score, the majority of the cases were a GCS score greater than 10 (72.0%) followed by 6 to 10 (20.0%) and below six scores was only in 8.0% of cases and

Table 1: Comparison among different studies with our study

Author	*Year of study*	*Infarcts (%)*	*Hemorrhage (%)*
Khan J *et al.*[21]	2005	53.0	23.0
Naik M *et al.*[22]	2006	58.0	42.0
Islam SS *et al.*[9]	2012	66.5	33.5
Pandian JD *et al.*[8]	2013	68.0	32.0
Our study	2022	69	31

Table 2: Various other studies with the location of intraparenchymal hemorrhages

Studies	*Location of intraparenchymal hemorrhage*				
	Basal ganglia (%)	*Thalamus (%)*	*Lobar (%)*	*Cerebellum (%)*	*Brainstem (%)*
Kase CS *et al.*[24] (1982)	33.0	20.0	23.0	8.0	7.0
Tatu L *et al.*[25] (2000)	33.0	15.7	36.5	8.8	2.0
Diamond PT *et al.*[26] (2003)	33.0	16.0	35.0	9.0	6.0
Aysenne AM *et al.*[27] (2013)	46.1	20.2	20.2	5.6	5.6
Tangella VR *et al.*[28] (2020)	64.0	25.0	3.5	7.5	-
Hedge A *et al.*[29] (2020)	52.8	22.3	11.7	6.74	3.42
Our study	48.3	9	35.4	6.4	-

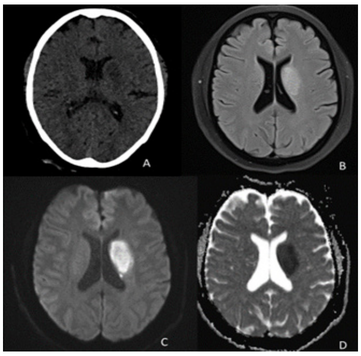

Figure 1: MCA territory infarct. Axial NCCT head (a) shows hypodensity in the left basal ganglia. the correspondng flair images (b) shows that the area is hyperintense and showing diffusion restriction on DWI (c) and ADC (d)

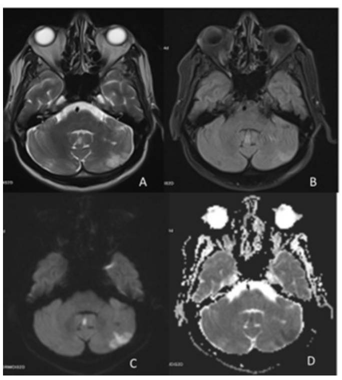

Figure 2: PICA infarct. Axial T2 (a) and flair (b) images show area of hyperintensity in the left cerebellar hemisphere showing diffusion restriction on DWI (c) and ADC (d)

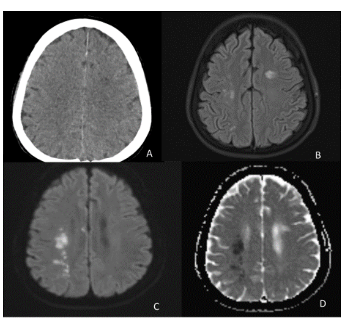

Figure 3: ACA/MCA borderzone infarct. Axial NCCT head (a) apperas normal axial flair (b) shows hyperintensity in the right centrum semiovale showing diffusion restriction on DWI (c) and ADC (d)

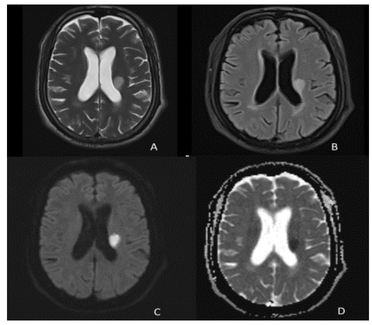

Figure 4: Thalamic infarct. (a) Axial T2; (b) flair (c) images show hyperintensity in the left thalamus, showing diffusion restriction on DWI; and (d) ADC

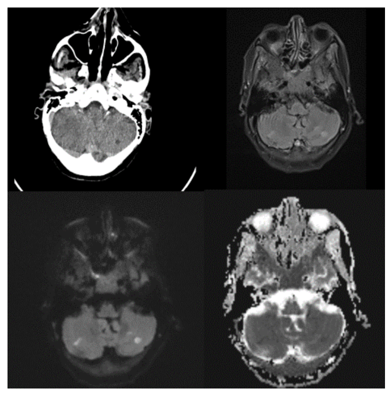

Figure 5: PICA territory infarct. Axial NCCT head (a) shows hypodensity in the left cerebellar hemisphere appearing hyperintense on flair (b) and showing diffusion restriction on DWI (c) and ADC (d)

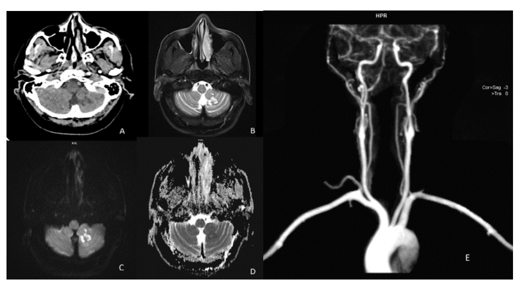

Figure 6: Vertebrobasilar artery infarct. Area of hypodensity noted in axial NCCT head (a) appearing hyperintense on T2 (b) and showing diffusion restriction on DWI (c) and ADC (d) MR angiography shows complete non-visualisation of left vertebral artery

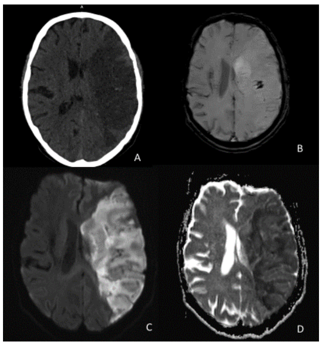

Figure 7: Hemorragic transformation in an ischemic stroke. NCCT head axial section (a) shows large area of hypodensity in the left mca territory with few hyperdensities noted within the area is showing diffusion restriction on DWI (c) and ADC (d) with few foci of susceptibility noted on SWI (b)

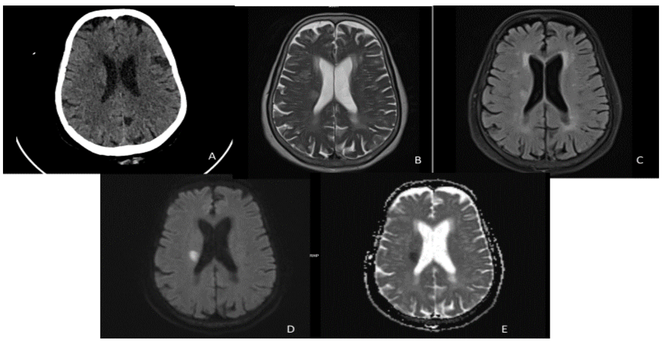

Figure 8: Lacunar infarct. Axial NCCT head shows hypodensity in the right periventricular white matter (a)appearing hyperintense on T2 (b)and flair (c) and showing diffusion restriction on DWI (d) and ADC (e)

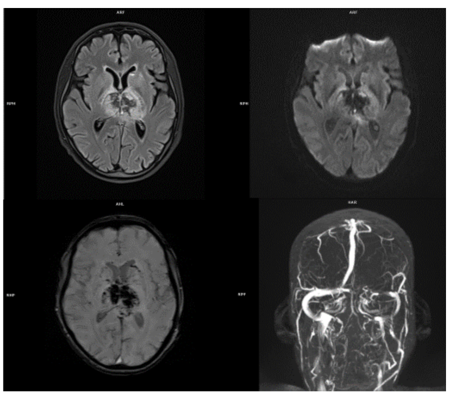

Figure 9: Venous infarct. Axial section of the brain shows diffusion restriction in bilateral thalami on DWI (a) and ADC (b) with foci of susceptibility noted within on SWI images (c) MR venography (d) shows filling defect in left transverse sinus

on clinical examination, cranial nerve palsy was seen in 14.0% cases and LOC was in 26.0% cases.

In the present study, out of 100 cases, infarcts (69 cases, 69.0%) were seen as more common than hemorrhage (31 cases 31.0%).

CT was done in all 69 cases, but it was positive in 55 cases (79.7%). About 13 cases were normal on CT, which showed evidence of ischemia on MR. MR was done in 69 cases and was positive in all 69 cases (100.0%)

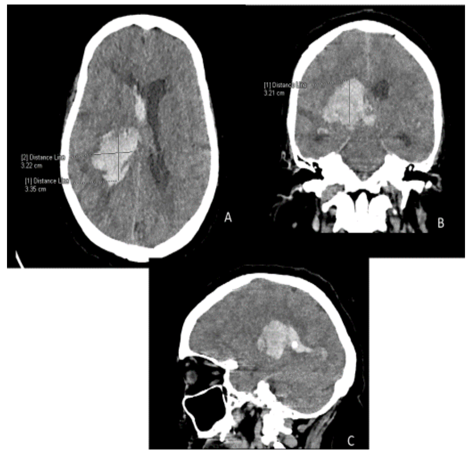

Figure 10: Thalamic bleed. Axail (a) coronal (b)and sagittal (c) section of the head shows ill-defined area of hyperdensity measuring approx 3.2x3.5x3.21(APXTRXCC)17.9 CC in the right thalamus with intraventricular extension and effacement of right lateral ventricle.

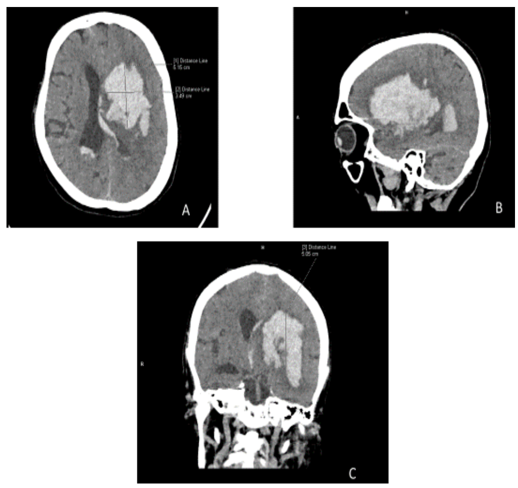

Figure 11: Gangliocapsular bleed. Axial (a) sagittal (b) and coronal (c)section of head shows ill-defined area of hyperdensity measuring approx 6.3x3.4x5.8 (APXTRXCC) 62CC in the left ganglio-capsular region with intraventricular extension and effacement of left lateral ventricle

Out of the total 69 ischemic stroke cases, arterial infarcts 62 cases (89.8%) are much more common than venous infarcts 7 cases (10.2%) but the venous infarcts were more prone to hemorrhagic transformation (71.0%). Only 22.0% of cases of arterial infarcts showed hemorrhagic transformation.

The majority of cases that reached our department were in the acute stage (56 cases, 81.2%), followed by subacute (7 cases, 10.1%) and 3 cases (4.3%) of hyperacute and late subacute each.

The maximum number of MCA territory cases involved was 34 cases (54.8%). PICA/SCA involvement was second most common with 11 cases (17.7%) followed by ACA territory 6 cases (9.7%).

Supratentorial was in the majority of the cases (93.5%), and only two cases were infratentorial.

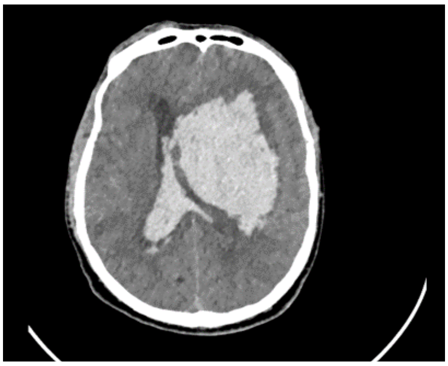

Figure 12: Lobar bleed. A large intracerebral bleed in the left frontoparietal temporal lobe measuring approximately 100CC extending into left basal ganglia with surrounding edema and mass effect with intraventricular extension

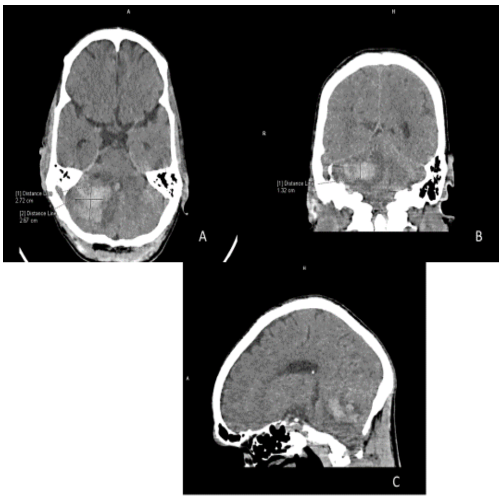

Figure 13: Cerebellar bleed. Section of head shows ill-defined area of hyperdensity measuring approx 2.8x2.6x1.4 (APXTRXCC) 5CC in the right cerebellar hemisphere: (A) Axail; (B) coronal; and, (C) sagittal

Basal ganglia complex was the most common location for the hemorrhage and was seen in 15 cases (48.3%) followed by lobar region, which was seen in 11 cases (35.4%). The thalamus was the third most common location in 3 cases (9%). Post fossa bleed were least common of all and seen in 2 cases (6.4%).

Among 31 patients of intraparenchymal bleeding, 17 patients had volume < 30 cm^3, out of which 57.3% patients had subarachnoid extension and ventricular extension while 13 patients had volume between 31 to 60 cm^3, among which 36.8% cases had subarachnoid or ventricular extension while 50.0% cases had midline shift. However, this difference was insignificant ($p = 0.703$).

The mean volume of bleed among cases of lobar bleed was 98 ± 130.1, while it was only and 5 19.3 ± 12.5 and 7 ± 2.8 among patients with thalamic bleed and cerebellum, respectively. The maximum volume of bleed observed in our study population 190 CC in a case of lobar, while the minimum volume of bleed was seen in cerebellum bleed, i.e., 5.0 CC.

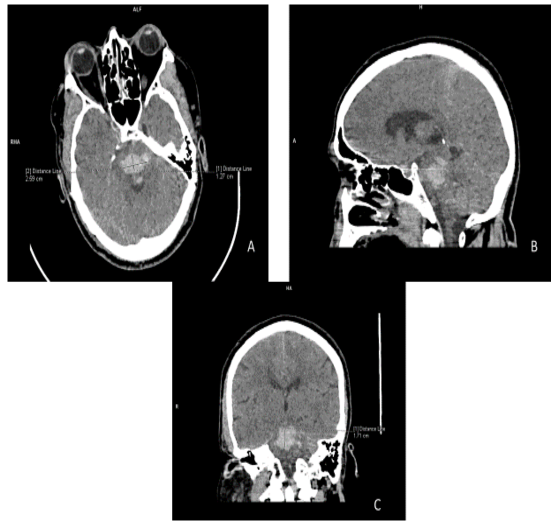

Figure 14: Brainstem bleed. (a) Axail; (b) sagittal; and (c) coronal section of head shows ill-defined area of hyperdensity measuring approx 2.9x1.2x1 (APXTRXCC) 1.7CC in the midbrain

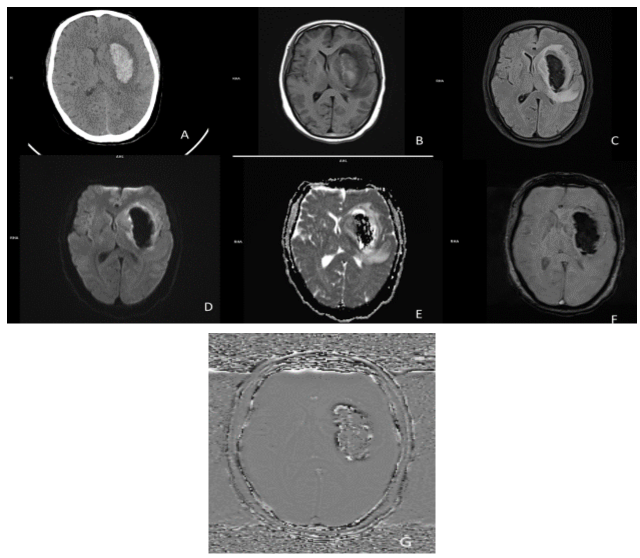

Figure 15: Gangliocapsular bleed on MRI. (a) Axial section NCCT head (b) shows hyperdensity in the left ganglio-capsular region appearing heterogeneously hyperintense on t1 (c) and hypointense on flair (d) showing no obvious diffusion restriction on DWI and (e) ADC (g) with areas of susceptibility on SWI (f) and corresponding hyperintensity on phase images

A strong positive correlation was seen in altered sensorium and vomiting, while the rest of the symptoms showed a positive correlation. The correlation of cerebrovascular accidents with age was seen more in patients age > 60.

DISCUSSION

This is a prospective observation study conducted in 100 patients with clinical features suggestive of stroke. The discussion of the result is as follows:

Age Distribution

This study included the patients across all the groups. The youngest patient was 24 a old male, while the oldest was 95 an old male. The highest number of patients was seen in the seventh decade, 32%, followed by the eighth decade (18.0%). Together they comprised 51.0% of the total patients. Mean age was 60.1 ± 15.6 years. The infarcts were much more common across all the age groups. In an epidemiological survey in stroke patients across India by Pandian JD *et al.* (2013)[8] mean age of stroke in Mumbai was 66 years, in Bangalore 54.5 years and in Trivandrum 67 years. According to Islam SS *et al.* (2012),[9] also, 58.5 years was the mean age for stroke. Another epidemiological study by Taylor FC (2012)[10] states that mean age of stroke for men is 63 to 65 years and for women 57 to 68 years. Mehta K *et al.* (2015)[11] reported that age of the patients ranged between 20 to 89 years. The youngest patient was 22 years old, and the oldest was 89. The majority of patients belonged to 6th decade (27.6%) followed by the fifth decade (22.4%). These together comprise 50.0% of total patients, with a mean age of 58.1 years.

Gender Distribution

Of these 100 cases 69 were male (69.0%) and 31 were female (31.0%). There was a male predominance in all the age groups except in the third decade, where females outnumbered males in infarcts and in the fifth decade in bleed where equal number of males and females were seen. Similarly, Shah PA *et al.* (2012)[12] in 2012 also reported male predominance in their study across all age groups except the second and seventh decades. Taylor FC (2012)[10] also reported male predominance. In contrast to our findings, Pandian JD *et al.* (2013)[8] reported female predominance in all age groups exception being the fifth and sixth decades. Mehta K *et al.* (2015)[11] reported that of 250 cases, males were 148 (59.0%) and females were 102 (41.0%). Males predominated over females in all groups except in the second and the eighth decades.

Chief Complaints

The patients were distributed based on medical history. The majority of cases had a history of weakness (73.0%) followed by headache and vomiting (52.0%) and altered sensorium (40.0%). The majority of the patients of infarct 44%, had a weakness as the chief complaint, while the majority of the patients of hemorrhage had headache and vomiting as the main complaints and the result was statistically significant.

A second most common complaint was dysarthria 27.0% in patients of infarct and weakness 29.0% in patients of hemorrhage. However, the result was not statistically significant. Similarly, a study done by Abdu H *et al.*[13] in 2021 reported that acute onset of headache is the most common symptom seen in HS patients compared to IS patients. However, in a study done by Fekadu G *et al.*[14] in 2019, most of ischemic stroke patients presented with headaches followed by aphasia and facial palsy. In a study done by Chugh C *et al.*[15] in 2019. Clinical presentation of stroke depends on the area of the brain affected by occlusion of the arteries. American Heart Association/ American Stroke Association (AHA/ASA) is popularising the FAST algorithm to diagnose stroke in the prehospital setting. The FAST acronym stands for facial droop, arm weakness, slurred speech, and time of onset. Pancha HN *et al.* (2015)[16] reported that patients presented with a history of acute severe headache, unconsciousness, dysarthria, weakness of limbs, and uncontrolled hypertension—suggestive of acute cerebrovascular stroke.

Risk Factors

Risk factors were present in 76 cases in our study. Multiple risk factors were seen in 40 patients. Among the various risk factors included, the commonest was hypertension in 68 cases (68.0%), followed by dyslipidemia in 45 cases (45.0%), diabetes mellitus in 38 cases (38.0%) and smoking and history of stroke in 32 and 26%, respectively. Among multiple risk factors, a combination of hypertension and diabetes mellitus and hypertension and smoking intake was the most common in 20 cases.

Hypertension was the most common associated risk factor across all age groups. Smoking was more common in younger subsets and diabetes was more common after the age of 40 years. Our findings were in with the findings of Pandian JD *et al.* (2013)[8] and Shah PA *et al.* (2012)[12] hypertension was the commonest etiology followed by smoking, whereas according to Taylor FC (2012),[10] smoking was the commonest factor followed by hypertension. Ahmad S *et al.* (2016)[17] reported that a history of hypertension was important among the risk factors. 55.55% with hypertension showed cerebral hemorrhage. About 33.33% with hypertension showed infarct. In our study, smoking has an additive effect on the stroke risk factor of a subject. According to Gordon NF *et al.* (2004),[18] smoking doubles the risk of stroke. A person smoking 20 cigarettes a day has six times the risk of stroke compared to a non-smoker. For a person with high blood pressure, the risk of having a stroke is 5 times more than a smoker with normal blood pressure and 20 times more than a non-smoker with normal blood pressure. Reports that 10.0% of deaths from stroke are due to smoking.

Ischemic Stroke *vs* Hemorrhagic Stroke

Ischemic stroke is common, accounting for about 80% of all stroke patients.[11] Similarly, in the present study, ischemic stroke was more commonly seen in 69 (69.0%) cases than hemorrhagic stroke in 31 (31.0%) cases. Ischemic stroke was more common. Various studies concluded similar findings. However, Shah PA *et al.* (2012)[12] studied a significant number of cases and concluded that hemorrhagic stroke more common in the Kashmir valley. Suman S *et al.* (2017)[19] reported that 80 patients were clinically examined and as CVA and sent for CT scan study of brain. Among total patients, 46 (57.5%) had infarction, 26 patients (32.5%) had a hemorrhage, 4 (5%) had a subarachnoid hemorrhage, three patients (3.8%) had venous thrombosis. One patient (1.2%) was normal. Ogun SA *et al.* (2000)[20] assessed the frequency of misdiagnosis of stroke using brain CT. In 156 patients admitted with clinical features suggestive of stroke were reviewed with CT brain. It was found that only 89 of them (57.0%) had neuro-radiological features suggestive of stroke, of which 59 (66.0%) had cerebral infarctions while 30 (34.0%) had a cerebral hemorrhage.

Frequency of Infarct Pattern

We had total 69 cases ischemic stroke of which the arterial infarcts found in 62 cases (62.0%) outnumbered the venous infarcts which were found in 7 (7.0%) cases. Shah PA *et al.* (2012)[12] also observed a similar pattern. Arterial infarcts (8.8%) were more commonly seen than venous infarcts (0.5 %).

In this study, hemorrhagic transformation was commonly seen in the venous infarction. A total of 4 out of 5 cases (88%) of venous infarction showed hemorrhagic transformation, whereas in arterial infarction, 16 out of 69 cases (22%) showed hemorrhagic transformation (Table 1).

Temporal Evaluation of Infarcts

Out of 69 ischemic lesions, 3 cases were hyperacute 4.3%, 7 (10.1%) were in the early subacute stage, 3 were late subacute (4.3%) and the majority were acute stage 56 (81.2%).

In cases of arterial infarction, MCA was the commonest involved vascular territory (54.8%) followed by PICA/SCA (17.7%), ACA territory (9.7%) followed by PCA (8.1%) and multiple territory (6.5%) whereas watershed (3.2%). According to Naik M *et al.*[22] (2006), MCA (77.0%) was the most common territory followed by PCA (11.5%), followed by ACA (7.0%) and (24.0%) lacunar infarction. In a study, Kauzi S *et al.* (1993)[23] also reported 75.0% cases MCA infarction, 13.0% ACA and 8.0% PCA and others.

Frequency of Hemorrhagic Stroke Pattern

Out of 100 stroke cases, 31 were of hemorrhagic stroke. Supratentorial hemorrhage was seen in 30 (96.8%), and infratentorial hemorrhage was seen in 1 (3.2%). Commonest affected regions was the basal ganglia, the thalamus, and the internal capsule (61.3%) followed by the temporal (19.4%), and frontal region (12.9%). Naik M *et al.*[22] also reported basal ganglia & internal capsule and thalamus in 34 cases (53.96%), the commonest location followed by temporoparietal region in 22 cases (34.4%). Posterior fossa bleed was noted in 7 cases (11.11%). According to Shah PA *et al.* (2012)[12] putamen (53.0%) was the commonest location, followed by the thalamus (29.7%), cerebellum (9.0%) and pons (2.5%), respectively.

In another study by Kase CS *et al.* (1982)[24], found that the location of intracerebral hemorrhage was seen among 33% of cases of putamina bleed, 23.0% of lobar bleeding, 20.0% of thalamic bleed, 8.0% of cerebellar bleed, 7.0% pontine bleed and miscellaneous 9.0%, the results of which are different to results of the present study (Table 2).

Clot volume is an important prognostic factor in spontaneous intracerebral hemorrhages. The mean volume of bleed in cases of ganglio-capsular, thalamus, lobar bleed, and cerebellar bleed was 31.3 ± 17.9, 19.3 ± 12.5, 98 ± 130.1, 7 ± 2.8 and it was seen the lobar bleeds are larger than ganglio-capsular and thalamus bleed. In agreement with our study Chun Chen Y *et al.* (2006),[30] Falcone GJ *et al.* (2013)[31] and Jungin H *et al.* (2015),[32] in their study stated that the mean volume of bleed in thalamic-ganglia bleed, lobar bleed and cerebellar bleed was 34.88 ± 30.0, 39 and 11.0 ± 11.5 CC, respectively. Menon G *et al.* (2019),[33] established that the mean clot volume in thalamic hemorrhages was 13 ± 9.5 mL and most (89.74%) of the patients had clots with less than 20 mL volume. In his study group, Yeon SC *et al.* (2016)[34] found the mean volume of spontaneous basal ganglia bleed to be 29.5 ± 6.9 CC. Audrey CL *et al.* (2019),[35] concluded the volume cut-off of 8 and 18 mL among patients with thalamic and basal ganglia bleed, respectively to predict poor outcomes with a sensitivity of 72.0 and 70.0%, respectively and specificity of 78.0 and 83.0%, respectively.

Patients were categorized based on volume in three groups: < 30, 31 to 60 and >60 mL. In our study it was seen that among 31 patients of intraparenchymal bleeding, 17 patients had volume <30 cm^3, out of which 57.3% patients had subarachnoid extension and ventricular extension while 13 patients had volume between 31 to 60 cm^3, among which 36.8% cases had subarachnoid or ventricular extension while 50.0% cases had midline shift. However, this difference was a statistically insignificant *p-value* (0.703). The bleeding closer to the ventricular system showed more propensity for intraventricular extension, irrespective of the volume of the bleeding. In a study conducted by Hallevi H *et al.*[36] in 2022, it was stated that thalamic ICH would likely rupture into the ventricles. This might be because of the anatomic proximity of the thalamus to third ventricle, in addition to the tendency for the blood to spread medially, and there is a unique decompression range for every location below which the range IVH is unlikely to happen.

CONCLUSION

This study depicts that stroke is more common in elderly age group. The ischemic stroke was more common than the hemorrhagic stroke, the commonest cause being the MCA territory infarcts. In the cases of hemorrhagic stroke, the ganglio-capsular bleed was the commonest; however, the volume of the lobar bleed was more than the ganglio-capsular bleed. Stroke imaging has undergone significant advances over last decade. It remains very crucial for the management of hyperacute stroke in the first few hours, where aim is to recognize patients eligible for thrombolytic therapy and expected to have good outcomes. Both CT, and MRI are useful for the comprehensive assessment of acute stroke MRI is sensitive for ischemic infarct detection and can provide important and necessary information for therapy planning. Both clinical examination and early diagnosis of stroke by imaging can lead to better patient outcome.

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