ORIGINAL ARTICLE

# Pattern of computerized tomography findings of the brain in cerebrovascular accidents.

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## ABSTRACT

**Introduction:** Semi-industrialized countries like Nepal have high mortality and disability rates due to cerebrovascular accident, representing for more than 80% of all stroke deaths globally. Stroke is the most common neurological disorder requiring prolonged hospital stay. Aims of our study was to evaluate the role of computerized tomography in evaluation of cerebrovascular accident by differentiating ischemia from hemorrhage and proper identification of negative cases.

**Methods:** A descriptive cross sectional study of total 155 patients, clinically diagnosed as stroke, referred to our department of radiology for computerised tomography evaluation during six month period, were enrolled into study. The clinical information, proper history, computerised tomography findings were properly documented and analysed in SPSS version 20 software.

**Results:** Out of total 155 patients, 85 cases (55 %) were males and 70 cases (45 %) were females with male: female ratio of 1.2:1. The mean age of the patients was 63±15 years. There was significant correlation between clinical with neuroradiological findings as evidenced by p value of 0.000. Sensitivity, specificity, positive predictive value, negative predictive value of clinical findings when correlated to CT in diagnosing ischemic infarction were 84.3%, 67.3%,82.6%,70%. Similarly, sensitivity, specificity, positive predictive value, negative predictive value in diagnosing hemorrhagic infarction were 67.3%,84.3%,70%,82.6% respectively.

**Conclusions:** Computerised tomography is the first line reliable imaging modality for diagnosis, management of cerebrovascular accident and exclusion of stroke mimicker lesions. Education regarding prevention and control of modifiable risk factors can minimize the incidence of stroke.

***Key words***: *Cerebrovascular accident; hemorrhage; infarction; tomography; X-ray computed.*

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## INTRODUCTION

Cerebrovascular accident or stroke is defined as an acute loss of focal and at times global (applied to patients in deep coma and those with subarachnoid haemorrhage) cerebral function, the symptoms lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin (WHO).[1] Among 15 million stroke patients, five-million are dying and another five-million are becoming permanently disabled which is adversely affecting the economy of the country, society and family members.[2] The Jaya Stroke Foundation formed by local nepalese doctors and family members of patient evaluates that 50,000 people are suffering with stroke and 15,000 people dying from stroke annually. Stroke has ranked among the top five diseases in Nepal and is one of the major causes of death on the basis of disability-adjusted life years.[3,4] After heart disease and cancer, cerebrovascular accidents (CVA) are the leading causes of death in developed countries.[5] Arterial ischemia/ infarction accounting for the majority of cases (80%) globally. Though onset of symptoms may be sudden, especially in the hemorrhagic type compared to ischemic type, there is difficulty in differentiating ischemic versus haemorrhagic stroke clinically.[6] Non enhanced computerised tomography(CT) is one of the most accurate diagnostic modality available for differentiating ischemic infarction from haemorrhagic infarction, helpful in localization of vascular territory of infarct, for exclusion of stroke mimics like brain tumors, subdural haematoma, abscess and knowing stages of infarct according to the duration and correlation of CT findings with history and neurological deficit.[7] Early diagnosis helps in proper management and can reduce the mortality and morbidity rates. In addition, CT is easily accessible, non invasive and affordable mode of imaging.[8,9].

## METHODS

This was a descriptive cross sectional study, carried out on 155 patients who presented with features of CVA (including hemiparesis, hemiplegia, numbness, ataxia, reduced consciousness, aphasia) at the department of Radiodiagnosis, Kathmandu Medical College Teaching Hospital, Sinhamangal in six month duration between May 2019 till October 2019. A written consent was obtained from the patients before the start of the study and details about their condition including age, gender, duration of symptoms, potential risk factors like diabetes, hypertension, smoking, cardiovascular disease were documented in a questionnaire. Axial head scanning were performed using 64 slice Aquilion multidetector CT with angulation of gantry parallel to orbitomeatal line. To reduce radiation to eyes, 15-20 degree angulation of the gantry to canthomeatal line was kept. Factors of 120 kV and 200 mA was used along with slice thickness 3-5mm sections of the brain and window settings of window width : 120 and window level: 40 to decrease the artifacts from beam hardening from the petrous bone across the posterior fossa. The collected data was statistically analyzed.

## RESULTS

In CT-scan, maximum patients(61.9%) had ischemic infarct followed by intraparenchymal hemorrhage(25.2%), subarachnoid hemorrhage(7.1%), cerebral venous thrombosis(1.3%), normal (2.6%) and brain tumor(1.9%) as demonstrated in table 1.

**Table 1: Correlation between distribution of cases according to CT and clinical evaluation**

| Distribution of cases according to CT | Clinical distribution of cases | | Total | P value |
|---|---|---|---|---|
| | Clinically diagnosed infarct cases | Clinically diagnosed hemorrhagic cases | | |
| Infarction | 81 | 15 | 96 | |
| Intracerebral hemorrhage | 15 | 24 | 39 | |
| Subarchnoid hemorrhage | 2 | 9 | 11 | |
| Cerebral venous thrombosis | 0 | 2 | 2 | 0 .000 |
| Normal | 2 | 2 | 4 | |
| Brain tumor | 3 | 0 | 3 | |
| Total | 103 | 52 | 155 | |

Out of 155 cases, 103 cases were clinically diagnosed as ischemic infarction and 52 cases as hemorrhagic infarction. Three cases as brain malignancy and two cases as normal, reported on CT, were excluded among 103 clinically suspected infarct cases, while correlating CT with clinical diagnosis. Similarly two cases interpreted as normal on CT, were neglected among 52 clinically diagnosed hemorrhagic cases. Thus 81(82.6%) cases were diagnosed as infarction on CT among 98 clinically diagnosed infarct cases and 35 (70%) cases were proven as hemorrhage on CT among 50 clinically diagnosed hemorrhagic cases. Our study showed that the correlation between clinical findings with neuroradiological findings were statistically significant as evidenced by p value of 0.000 calculated by Pearson Chi Square Test.

**Table 2: Calculation of sensitivity, specificity, positive predictive value, negative predictive value of clinical findings when correlated to CT diagnosis**

| | Infarct | Intracerebral Hemorrhage |
|---|---|---|
| **Sensitivity** | **84.3%** | **67.3%** |
| **Specificity** | **67.3%** | **84.3%** |
| **Positive predictive value** | **82.6%** | **70%** |
| **Negative predictive value** | **70%** | **82.6%** |

Out of total 155 cases, there was male predominance comprising of 85 cases (55 %) and female constituting of 70 cases (45 %) with male: female ratio of 1.2:1. Though above data showed male predominance, gender predilection among infarct versus intracerebral hemorrhagic cases showed p value of 0.866 (calculated by Pearson chi square test),which is statististically not significant as illustrated in table 3.

**Table 3: Gender predilection among infarct and intracerebral hemorrhage in CT:**

| Gender | Infarct | Intracerebral hemorrhage | Total | P value |
|---|---|---|---|---|
| **Male** | **54(56%)** | **24(62%)** | **78** | |
| **Sex** | | | | **0.866** |
| **Female** | **42(44%)** | **15(38%)** | **57** | |
| **Total** | **96** | **39** | **135** | |

Age group ranging from 19 till 92 years were enrolled in our study. Mean age of the patients was 63±15 years. The maximum number of infarct cases were 25 between 60-69 age group and about 13 intracerebral hemorrhagic cases between 50-59 age group as demonstrated in figure one.

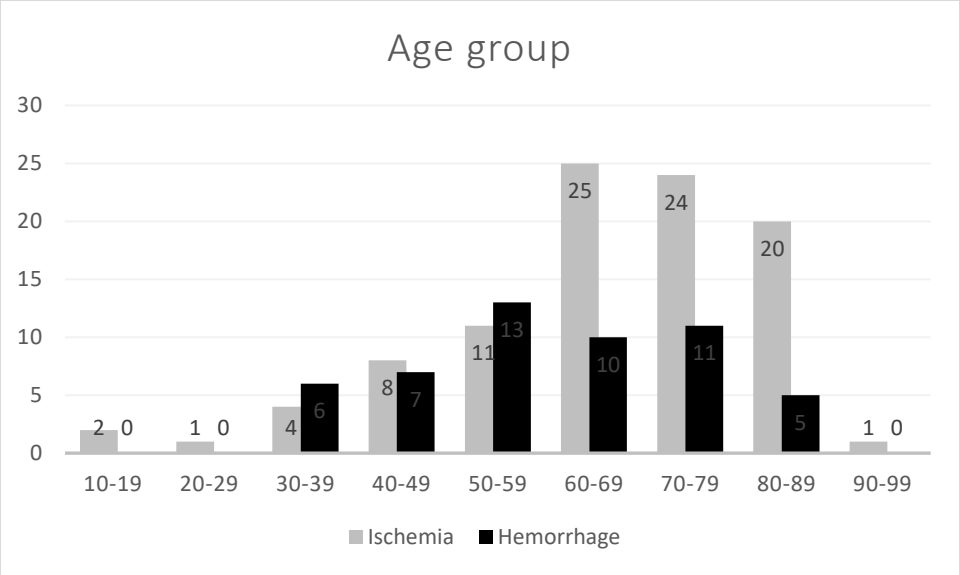


**Figure 1: Age group distribution in infarct versus hemorrhagic cases**

Among infarct versus intracerebral hemorrhagic patients, risk factor association revealed p value of 0.063 (by Pearson chi square test) which is statistically not significant as summarized in table 4.

**Table 4: Risk factors association in infarct versus intracerebral hemorrhage**

| Risk factors | Infarct | Intracerebral hemorrhage | Total | P value |
|---|---|---|---|---|
| **Diabetes** | **26** | **13** | **39(29.5%)** | |
| **Hypertension** | **24** | **23** | **47(35.6%)** | |
| **Heart disease** | **12** | **2** | **14(10.6%)** | **0 .063** |
| **Alcohol** | **23** | **9** | **32(24.2%)** | |
| **Total** | **85** | **47** | **132** | |

The commonest site of intracerebral bleed was lobar hemorrhage (13 cases). Basal ganglia(putamen), thalamus, pons , cerebellum are the commonest site of hypertensive intracerebral bleed. In case of vascular territory involvement, anterior cerebral circulation accounted for 63.1% of infarct cases and 43.1% of intracerebral hemorrhagic cases. Similarly, posterior circulation constituted about 7.9% and 17.9% of infarct and hemorrhage whereas both anterior and posterior circulation accounted for 29% of infarct and 38.4% of hemorrhagic cases

respectively. The most commonly affected side was left ( 68 cases) followed by right (60 cases) and then bilateral sides(7 cases).

## DISCUSSION

In western countries as well as in low and middle income countries, stroke accounted for approximately 85% of all deaths and is one of the leading cause of disability.[10] In a teaching hospital of Kathmandu, Devkota KC et al conducted a study and found that 68.1% of patients had ischemic stroke and 31.9% had hemorrhagic stroke.[11] In a study performed by Kumar LT etal among 100 patients of stroke, 69% patients had infarct, 21% patients had hemorrhage, 08% patients had CVT, 1% patient had subarachnoid hemorrhage and 1% patients had normal scan.[12] Our prospective study was similar to both studies which reported, 61.9 % of cases as infarct and 25.2% as hemorrhage.

The mean age of stroke in the study done by Shrestha A etal was 58.5 years.[13] In a study conducted by Devkota KC et al[11], the mean age of stroke was 61·7 years with male predominance constituting about 58·3%. The mean age of stoke was 63 years in our study with male comprising of 85 cases (55 %) and females constituting of 70 cases (45 %) which is compatible with Devkota KC et al[11]. In our study, about 13 young patients in age group ranging from late teens till late thirtees had incidence of stroke. In Nepal, a study reported that the population of young stroke patients was significantly higher than compared to developed countries. High prevalence of rheumatic heart disease, early exposure to alcohol, smoking, stress, sedentary life style are the major contributing factors.[13] In our study, patients in age group of 60-69 years were commonly involved in ischemic cases and ranging from 50-59 years in hemorrhagic cases. Eze et al. documented that hemorrhagic CVD was significantly more common in patients between 60 and 90 years of age, whereas, the ischemic type was seen in the 50-59 year age group.[14] In a study conducted by Kumar LT et al[12], male:female ratio of 1.15:1.0 for infarction and 1.1:1.0 for hemorrhage were recorded in the study. Our study revealed that male:female ratio in ischemic cases was 1.2:1 near similar to Kumar LT et al[12] while in hemorrhagic cases, male had predominance having ratio of 1.6:1.

V. B. Kalra etal reported the most common localization in both types of stroke was parietal lobe followed by frontal lobe.[15] It was compatible with our study which also documented parietal lobe as commonly involved location followed by frontal lobe. Middle cerebral artery is the largest artery supplying the brain, thus the most involved anatomical sites could be parietal lobe and the lentiform nucleus, especially the internal capsule.[16] Kumar LT etal[12] revealed in his study that 85.5 % of cases constituting MCA territory infarct and 8.69% of cases constituting vertebro basilar artery distribution. Majority of cases (68.39%) in our study had MCA territory involvement with only 2.96 % accounting for vertebrobasilar infarct. The cause behind this could be suboptimal study of posterior fossa by CT. MRI is superior over CT for posterior fossa. In

addition to that, most cerebellar infarcts are usually small and may remain unrecognized. Left cerebral hemisphere (50.4%) was predominant side in our prospective study. Left cerebral hemisphere was also more affected than the right hemisphere in a study done by Ikpeme AA et al.[16] Kumar LT et al[12] reported that putamen was the most common site of intracerebral hemorrhage in almost 47.61% patients. In contrast, lobar hemorrhage (33.3%) followed by capsuloganglionic with thalamic hemorrhage (28.2%) were the more affected site in our study.

A study conducted by Ikpeme AA et al[16] found, four out of the 87 patients who clinically presented with a stroke was diagnosed as subdural hematoma on CT. In our study, out of 155 patients with neuoradiological features of stroke, four had normal findings and three had brain malignancy. Negative CT scan demonstrated the limitation of a clinical examination and the importance of CT scan to be present in every facility for proper management of the patients. CT scan is the first line imaging modality for the diagnosis of cerebrovascular accident and follow-up study. Clinical and CT diagnosis had significant correlation as evidenced by p value <0.001 as stated by Acharya S in their study[17]. Our study also showed significant correlation between clinical and CT findings with p value of 0.000. According to V. B. Kalra, CT was the most accurate imaging tool in haemorrhage with sensitivity of approximately 100 % and ischaemic stroke of 80%.[18] Sensitivity of ischemic infarct in our study was 84.3% similar to the above study. In contrast sensitivity of hemorrhage was only 67.3% in our study. To look for early signs of ischaemic stroke is sometimes very challenging which is not always easy and requires a great experience. In those cases, MRI with diffusion-weighted imaging is more reliable than CT.

A survey has reported that clinically diagnosed stroke patients with normal CT findings can be offered intravenous thrombolysis within three hours of onset, with excellent prognosis.[19] In our study, very few patients presented within the first six hours after the onset of stroke. There may be various reasons behind it like lack of awareness, low socioeconomic status, various superstitions including wrong beliefs and malpractices. These patients usually attend the hospital only when the condition gets deteriorated. However still CT remains the first imaging tool in cases of stroke because of being cheap, fast & wide availability in all hospitals. CT scan can be performed in patients with pacemaker, ventilator & mechanical implants where MRI is contraindicated. Thus, patients with clinical diagnosis of CVA should have CT scan evaluation for proper planning and management.

## CONCLUSION

CT scan is widely available, non invasive, affordable, speedy, reliable imaging tool for identifying the type of stroke and prompt management after accurate diagnosis. It is benefical for exclusion of stoke mimicker lesions. Knowledge about control, prevention and proper education of modifiable risk factors of stoke can improve the health care system.

***Recommendations:***

Lack of standardization of clinical methodologies by clinician can limit the diagnosis of stroke.

Especially for perfusion/penumbral imaging, unenhanced CT is not helpful. In those cases, in future other researchers can improvise the study by using more advanced and accurate imaging modalities like CT/MR perfusion and DW MRI .

Future researchers can include more number of patients for longer duration for more accuracy.

## CONFLICT OF INTEREST

None

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None

## REFERENCES

1. Hatano S. Experience from a multicenter register, Bull. WHO, 1976; 54: 541- 553.
2.World Health Organization. Global burden of stroke. 2004. Available at http://www.who.int/cardiovascular_diseases/en/cvd_ atlas_15_burden_stroke.pdf (accessed 10 October 2011).
3. Pandit A, Arjyal A, Farrar J, Basnyat B. Neuological letter from Nepal. Pract Neurol. 2006; 6:129–33.
4. Munvar Miya Shaik1,2, Keat Wei Loo2, and Siew Hua Gan. Burden of stroke in Nepal.International Journal of Stroke. Vol 7, August 2012, 517–520
5.Donnan GA, Fisher M, Macleod M, Davis SM. Stroke. Lancet. 2008;371:1612-23.
6. Rosenwasser RH, Annonde RA. Diagnostic imaging for stroke. Clinical Neurosurgery. 2000;46:237-260 .
7.Holmes JE, Mirsa RR. A - Z of emergency radiology. New York: Cambridge University Press; 2004. p. 15-7.

8.Forsting M, Dorfler A, Knauth M, Kunmer RY. Neuro radiological studies and findings in stroke. Ther- Umsch. 1996;53:535-43.
9. Allen CMC, Lueck CJ. Diseases of the central nervous system. In: Boon N, College N, Walker B, Hunter J, eds. Davidson's principles and practice of medicine 20th edition. United Kingdom: Churchill living stone. 2006:979
10.World Health Organisation. Regional framework for NCD. Cardiovascular diseases: fact sheet WHO. 2011. Available at http://www.who. int/mediacentre/factsheets/fs317/en/index.html (accessed 10 October 2011).
11.Devkota KC, Thapamagar SB,Malla S.Retrospective analysis of stroke and its risk factors at Nepal Medical College Teaching Hospital.Nepal Med Coll J2006; 8:269–75.
12. Kumar LT, Gore VN, Patil GC. The role of computed tomography in the evaluation of cerebrovascular accidents. Int J Res Med Sci 2016;4:4305-9.
13. Shrestha A, Shah DB, Koirala SR, Adhikari KR, Sapkota S, Regmi PR. Retrospective Analysis of Stroke and Its Risk Factors at Bir Hospital. PMJN Postgraduate Medical Journal of NAMS. 2011;11:2
14. Eze CU, Okaro AO, Ohagwu CC. Pattern of computed tomography findings in cerebrovascular accident patients in South-Eastern Nigeria. A retrospective study of 480 patients. Eur J Sci Res 2009;34:1049
15.V. B. Kalra, P.S.S. Kiran. Role of computed tomography in cerbrovascular accident. Journal of Evolution of Medical and Dental Sciences/ Volume 2/ Issue 6/ February 11, 2013 : 542-543.
16.Ikpeme AA, Bassey DE, Oku AO, Ephraim PE. Computerized tomography findings of cerebrovascular disease in adults in Calabar, Nigeria. West Afr J Radiol 2014;21:12-16
17. Acharya, S., & Chaturvedi, S. (2016). Significance of Computed Tomography in the Diagnosis of Cerebrovascular Accidents. *Journal of Lumbini Medical College*, *2*(1), 18-20.
18. V. B. Kalra, P.S.S. Kiran. Role of computed tomography in cerbrovascular accident. Journal of Evolution of Medical and Dental Sciences/ Volume 2/ Issue 6/ February 11, 2013 : 542-543
19.Schriger DL, Kalafut M, Starkman S, Krueger M, Saver JL, *et al*. Cranial Computed tomography interpretation in acute stroke. JAMA 1998;279:1293-7.