Computed Tomography Findings in Clinically Diagnosed Patients of Stroke

Medical Science

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ABSTRACT *Cerebrovascular accidents or Stroke is a neurological emergency having a large prevalence in Indian population. It important to confirm the diagnosis on imaging to differentiate ischemic and hemorrhagic stroke and to rule out stroke mimics for appropriate management. The objective of our study was to 1) Radiologically evaluate patients with clinical diagnosis of Stroke, 2) To exclude other causes that present similarly as intracranial space occupying lesions, abscesses, subdural haemorrhage etc. 3) To differentiate between ischemic and hemorrhagic stroke. 4) To determine the areas of brain involvement by stroke. 5) To look for associated complications as oedema, mass effect and herniation. 100 patients referred to our department with clinical suspicious of stroke from various other departments of our hospital as well as outside were subjected to computed tomography (CT) scan. Our study showed ischemic stroke was more common than hemorrhagic stroke. Stroke mimics also formed a sizeable population in our study. We inferred that CT scan plays an important role in patients of clinically suspected stroke.*

INTRODUCTION

Cerebrovascular accident is the second most common cause of death and fourth leading cause of disability worldwide (1). Recent study identified that 7% of medical and 45% of neurological admissions were due to stroke with a fatality rate of 9% at hospital discharge and 20% at 28 days (2). It has been reported that stroke has a prevalence of 90-222 per 100,000 population per year (3).

Patient with cerebrovascular accident presents with rapidly developing symptoms and/or clinical signs of focal/global disturbances of cerebral function, with symptoms lasting for varying duration - more than 24 hrs, at times followed by death with no apparent cause other than that of vascular origin.

Stroke is usually associated with diseases of the intracranial vascular tree. The main types include - Cerebral Infarction, Intracerebral Hemorrhage, Subarachnoid Hemorrhage and Venoocclusive Disease.

Role of imaging is to visualize the insult, evaluate the etiology, characterize the lesion and prognosticate the disease. Early diagnosis and prompt treatment accordingly in the crucial hours i.e. in the therapeutic window period, can reduce the morbidity and mortality of this life threatening disease.

In the past, imaging was possible only with conventional radiography, angiography, radio-isotope scanning, etc. The two most important drawbacks of all these modalities were:

1)Inability to demonstrate the brain parenchymal changes (especially in hyperacute and acute stage) of infarction.

2) Inability to demonstrate the brain parenchymal changes (espe- cially in hyperacute and acute stage) of infarction.

Recent advances in Computed Tomography(CT) , Magnetic Resonance Imaging(MRI), Magnetic Resonance Angiography(MRA) and Color Doppler have brought us in an era of noninvasive assessment of the brain and its vessels.

MRI is now emerging as an excellent modality of neuroimaging.

The main advantages are better resolution & tissue characterisation, multi-planar capability, no risk of ionising radiation or iodinated contrast media. However, there are problems such as pacemaker malfunctioning and displacement of surgical clips. Hence MRI is contra-indicated in such patient (with cardiac pacemaker and intracranial surgical clips).

Computed tomography is a non-invasive, quick, cost effective, easily available imaging modality which is not operator dependent. The only limitations are, it is less sensitive in detecting very early ischemic changes and posterior fossa lesions. Under these circumstances, MRI is more reliable than CT.

However CT scan is preferred over MRI in suspected cases of acute subarachnoid haemorrhage(SAH) and in the detection of inracerebral hemorrhage. CT offers the advantage of fast imaging , exact localisation and extent of the lesions, detection of small lesions with no mass effect and detection of calcification. Thus, in the sea of various imaging modalities, CT scan plays the fundamental role. It can be recommended as the first line of investigation in CVA.

In this prospective study of 100 patients clinically suspected of having stroke, CT scan was done and analysed under various headings.

MATERIAL AND METHODS

The study was carried out in the department of Radiodiagnosis of Pad. Dr D Y Patil Medical College and Hospital using a Philips Ingenuity Core 128 slice CT. In this study patients considered were of age more than 50 years and who presented to the Medicine , Emergency Medicine department or were referred from outside for CT scan with clinical diagnosis of stroke. In this study , all 100 patients were evaluated by computed tomography. Patients considered under the heading of clinically diagnosed CVA included, transient ischemic attacks (TIA), completed stroke and stroke in evolution. Patients who had a frank history of head injury, which the referring physicians and surgeons thought to be the cause of neurological deterioration, were not included in this study. After proper positioning of the patient in supine position, helical 3 mm contiguous   CT sections were obtained. If the contrast study was required, then contrast was

injected I.V (Inj. Iopamidol 370 mg %) (Does 30 cc-adults) and then similar slices were obtained. No consent required for Plain CT study. However, consent was required, wherever contrast CT needed to be done. (As there is remote possibility of contrast re-action, emergency drugs were kept ready). Preparation was not required for plain CT. If contrast CT was indicated, then NBM for 4 hrs prior to examination was recommended.

The results were analyzed under various headings as Clinico - Radiological Correlation, occurrence and distribution of various types of stroke viz. ischemic, hemorrhagic , associated complica-tion and stroke mimmics.

Results

Clinico - Radiological Correlation - Out of 100 patients of clini-cally suspected CVA, 68 were proven to have findings of Stroke on CT, rests 23 were normal and 9 were stroke mimics. Patients with strong clinical suspicion of stroke, but who had a normal CT, were advised to undergo either, MRI or a follow up scan after 72 hours to rule out/confirm ischemic changes. Note – All the patients were presented for CT 6 to 48 hrs after onset of symp-toms and all the positive CT findings were in the acute to sub-acute stage, unless mentioned.

Incidence of various types of CT findings in Stroke (91 cases after exclusion of 9 cases of stroke mimics) - Infarction (Fig. 1) (Bland > Hemorrhagic transformation) accounted for 71.42 % of the cases and haemorrhage (Fig. 2) accounted for 28.58 %. Hence occlusive Cerebro-vascular disease was an important cause for CVA in our study.

Incidence according to etiological types of infarct (41 positive cases as detected by CT) - Majority of infarcts were in the large vessel territory (Fig 1). Veno-occlusive disease was not encoun-tered. Hemorrhagic transformation (n=2) of infarcts was includ-ed in the category of large infarcts.

Area wise Distribution of Large Infarcts - Commonly affected territory was, that supplied by MCA, followed by ACA and PCA. 3 infarcts were in the watershed region.

Distribution of Lacunar Infarcts (Small infarct) - Lacunar in-farcts (Fig. 3) were commonly noted in the basal ganglia (n=6) followed by deep white matter (internal and external capsule, n= 5) due to occlusion of deep penetrating arteries having small ca-liber. Here, the cases where lacunar infarct was associated with large infarct have also been included in calculating the distribu-tion.

Immediate complications of infarct - 9 patients of the 26 large infarcts (34.61%) cases had complication - A few patients had more than one complication. Most commonly encountered complication was mass effect (Fig. 1) (19.23%) and herniation (15.38%). Two (7.69%) patients of hemorrhagic transformation of infarct   had significant mass effect and herniation. Mass effect included perilesional edema and diffuse cerebral edema. Mini-mal local perilesional edema not causing mass effect was not included in complications.

Areawise distribution of haemorrhage (26 positive cases as de-tected by CT) - Out of 26 cases of intracerebral haemorrhage, commonly encountered location was in the basal ganglia region (Fig. 2) (15.38%). They have a better prognosis as compared to deep seated hemorrhage. (Table 7). Only a single case of brain-stem haemorrhage was encountered .

Complication of haemorrhage - Almost all cases with intracer-ebral hemorrhage had complications except 1 case of small tha-lamic bleed. 50% patients with ICB had mass effect, 46 % had intraventricular extension (Fig. 2), 46% had hydrocephalus and

23% had herniation as a complication. Many cases had more than one complication hence percentage will not add to 100.

Site predilection of haemorrhage in hypertensives (In 20 positive cases as detected on CT) - In hypertensives the most preferred site for ICB was basal ganglia (n=7) , followed by inraventricu-lar (n=5), hemispheric (n=3), thalamus (n=2) and subarachnoid space (n=2). Single patient may have more than one type of haemorrhage.

Stroke Mimmics – also formed a considerable proportions of our cases accounting for approximately 9 %. We encountered five neoplasms (Fig. 4a , 4b) which could be primary / second-ary , one neoplasm / abscess , one SDH and one AVM

Figures1 , 2 , 3 , 4a & 4b

DISCUSSION

Stroke results from thrombo-embolism causing abrupt decrease in the cerebral perfusion with cerebral infarction or from intrac-erebral haemorrhage. The abrupt onset of focal neurologic defi-cit defines a stroke or CVA. It is a frequent indication of emer-gency neuroimaging.

The temporal classification of ischemic stroke includes- TIA (Transient Ischemic Attacks), RIND (Reversible ischemic neuro-logic deficit), Progressing stroke (gradually progressing accumu-lative neurologic deficit evolving over hours/days), and complet-ed stroke (Severe or persistent stable neurologic deficit, as end stage of prolonged ischemia) (4).

In this study, 100 patients, presenting as CVA, referred from the department of medicine and emergency medicine, over a period of 6 months, were studied. They were evaluated, for any intracra-nial pathology, with the help of computed tomography.

A stroke, or cerebrovascular accident, is defined by this abrupt onset of a neurologic deficit that is attributable to a focal vascu-lar cause (5). Although, CVA is a clinical diagnosis, neuron imag-ing plays a fundamental role. In our study all the patients had presented approximately at 6hrs to 48 hours after onset of symp-toms (acute to sub-acute). CT is a major step in neuro-radiologic workup of a patient with CVA. (6)

CT enables tissues of similar density to be separated and a pic-ture of soft tissue structures within the cranium to be built up. It provides sufficient information in respect of location, tissue ab-normality, structure displacement, and possibly the nature of the lesion for the institution of definitive treatment (7).

The purpose of this study was to demonstrate the usefulness of cerebral CT in patients who were initially diagnosed as having clinical symptoms and neurologic sings of Stroke / CVA.

Although majority of clinically diagnosed stroke patients have cerebrovascular diseases; episodes of rapid neurologic deficit may also be caused by neoplasm, abscess or subdural haema-toma (8).   In these patients, rapid clinical deterioration may be caused by sudden shifts in intracranial pressure, mechanical pressure by the mass to cause venous infarction, peri-tumoral haemorrhage and sudden paroxysmal electrical activity. There is however presence of progressive neurological deterioration and prodromal symptoms in patients with non-vascular i.e. non stroke lesions.

In our present study, out of 100 patients who presented clinically as CVA, 68 actually had stroke lesions, where as 23 were normal and 9 had stroke mimics (i.e. 5 neoplasm, 1 subdural haema-toma, 1 metastasis / primary, 1 Abscess / high grade neoplastic lesion , 1 AVM). The overall frequency of confirming CVA by CT

in our study was 68 %. The percentage of normal scans was 23 %, whereas 9 % were stroke mimics. The frequency of stroke mimics is however slightly greater than in the study by Vroom et al, who detected only 3 % non stroke lesion in patients with age more than 50 years (9).

Some authors stated that the CT has a low negative predictive value in first 6 hours, and only approximately 50% shows abnormal CT findings within 48 hour (10, 11). The patients with normal scans in our series were thus advised MRI or follow up CT after 72 hours, in order to confirm or rule out any ischemic changes in the brain.

Clinical accuracy of diagnosis of acute stroke is moderate to good, with lower reliability in less experienced or less confident examiners (12).

In our study, 36.95% of the patients belonged to the age group 50 to 60 years of age and 35.86 % were in the age group of 60 to 70 years. Sapna E. Sridharan et al in their study of 541 patients found that seventy-seven percent of patients were aged 60 years or more (13).

Brain oedema is commonly noted in patients with stroke. An early CT finding of >50% of the MCA territory, and involvement of additional vascular territories along with other risk factors help to predict the final outcome (16).

Out of the 91 patients, which were proved to have CVA on CT or were with normal CT findings but obvious neurological deficit (TIA / stroke in evolution), we found 26.37 % had Large vessel infarct , 17.58 % had small vessel / lacunar infarct , 28.57 %) had primary non-traumatic Intracerebral / subarachnoid / Intraventricular bleed and 25.27 % of the patients had normal CT who were interpreted as TIA or could be stroke in evolution (on basis of clinical findings of obvious neurological deficit) in acute stage where the CT could be normal.

A few percentage 1.09 % had both small vessel and large vessel infarcts which were considered as large vessel stroke for calculation purposes and few 2.19 % of cases had both infarction and hemorrhage i.e which were haemorrhagic transformation of infarct were considered as large vessel ischemic stroke . The patients with normal CT (thus ruling out haemorrhagic stroke and stroke mimics) were considered to have ischemic stroke for computational purposes. Thus in our study, infarctions were more than haemorrhages, 71.42 % and 28.58 % respectively.

The percentage of infarction and haemorrhage were similar to the studies in the 1970s by Kinkel W.R. et al who found 73% of the case studied were infarctions and 27% haemorrages (17). However the percentage of haemorrhages was highly less than in the similar study conducted by New Paul F.J. et al who in their study of 63 positive patients found 66.66% had infarction and 33.33 % had inracerebral haemorrhage (18). However recent studies by Shiber JR et al found that the percentage of hemorrhagic stroke is on the rise as compared to the older studies in the 1970s and 1980s. In the 757 patients studied, 49.15 were hemorrhagic stroke and 58.1% were ischemic. They hypothesized that this finding may be due to improvement of CT scan availability and implementation unmasking a previous underestimation of the actual percentage or to an increase in therapeutic use of antiplatelet agents and warfarin causing an increase in the incidence of haemorrhage (19).

CT permits visualization of brain parenchyma and many pathologic changes. It has revolutionized neurologic investigation particularly neurovascular diseases in which differentiation of haemorrhagic from ischemic disorder is critical. CT demonstrates whether the area of maximum involvement is deep or

superficial, large or small, haemorrhagic or non-haemorrhagic, whether or not associated with oedema to produce mass effect in the form of ventricular distortion and midline shift.

In our study, we classified infraction as Large vessel and Small vessel. 25 (59.52 %) cases were sequelae to large vessel disease and 16 (38.10 %) were due to small vessel disease. 1 case showed small as well as large infarct.

Lacunar infarcts are small deep cerebral infracts that are typically located in the basal ganglia and thalamus. They are small, usually less than 1 cm, often multiple and are due to embolic, atheromatous or thrombotic lesions in long, single, penetrating arterioles. In our study, lacunar infarcts were commonly encountered in the deep cerebral gray matter i.e. basal ganglia (n= 6), internal and external capsule (n=5) and in the centrum semiovale (n=2), periventricular white matter (n= 1) and multiple sites (n= 3).

Infarcts due to large artery occlusion were more in number than lacunar infarcts. This finding correlates with the study by Diagana et al.(20)

Veno-occlusive disease was not encountered as a cause of infarction in our study.

Accurate and early diagnosis of intracerebral hemorrhage has become easy with the advent of CT scan. It is also possible to study the spectrum of intracerebral hemorrhage in relation of etiology. Midline shifts, intra-ventricular extension and hydrocephalus are CT parameters of prognostic significance. Exact location, relation to deep structures, extent of oedema, displacement of related structures and IV rupture are clearly demonstrated by CT.

In our study, 28.57% of the patients had intracerebral hemorrhage. CT is very sensitive in detecting ICH. Byyny et al found the sensitivity of detection of subarachnoid haemorrhage to be 93% , thus indicating usefulness of CT for the diagnosis of hemorrhage.(21)

Hemorrhage causing stroke are usually classified as: primary intracerebral haemorrhage (ICH), subarachnoid (SAH) and intraventricular hemorrhage (IVH). The causes include hypertension, angioma, neoplasm, anticoagulants, etc. As per site, it can be classified as supra or infratentorial.

In our study, maximum patients had bleed in basal ganglia i.e. 46.15% of all bleed cases (n=12). Next in frequency was cerebral hemisphere 19.23% (n= 5), then thalamus 7.69 % (n=2) and then brainstem 3.84% (n=1) out of the total 26 cases of intracranial bleed. We also had 10 patients with intra-ventricular haemorrhage. Our findings were quite similar to the study by Pipat Chiewvit et al. In their study the most common site of intracerebral hemorrhage was also found to be the thalamus and basal ganglia. In their study, they found fifty-three cases (40.5%) with thalamic-ganglionic hemorrhage, nineteen cases (14.5%) in lobar hemorrhage, five cases (3.8%) in cerebellum, five cases (3.8%) in brainstem and eight cases (6.1%) in multiple locations. (22)

Most of the patients of ICB in our series were hypertensive 20 out of 26 (76.92 %). The commonest site in these patients was basal ganglia (n= 7). We also had a patient with brainstem haemorrhage, who was hypertensive. However, supratentorial hemorrhages were definitely more than infratentorial ones. Pipat Chiewvit et al. also found ICB to be commonly associated with hypertension (22). In our study thalamic bleed with hypertension was associated in only one case out of the two.

Serial scans of ICB indicated that attenuation rises from the

levels exhibited by circulating blood by approx. 7 to 14 units, in very short period of time, consistent with formation of clot and clot retraction (23).

The high density of hemorrhage is due to hemoglobin situated in the RBC. The attenuation of hemoglobin is due to its protein content, globin and its iron content. Iron contributes only 7 to 8% of its total attenuation. Calcium in both RBC and serum, contributes only to a negligible fraction to the attenuation of the whole blood and the blood clot (23).

Typical CT appearance in recent ICB is homogeneous area of increased attenuation surrounded by well demarcated narrow low attenuation ring (LAR), corresponding to zone of ischemic necrosis. Extravasated blood undergoes a variable degree of retraction which is completed within 6 hours. LAR is due to damage and development of oedema related to clot lysis, with breakdown of blood brain barrier (24).

As hematoma ages, diagnostic specificity of CT decreases because haematoma reduces in size and density and it becomes iso to hypodense. At 10 weeks, substantial atrophy is recognized, mimicking findings of infarction (25).

The increase in mass effect during 3 to 7 days is due to oedema. The cause of reduced density with aging is related to factors such as breakdown of blood products and inflow of cerebrospinal and extra cellular fluids (25).

Contrast enhancement takes place after 7 to 9 days due to loss of autoregulation with luxury perfusion, extravasation of contrast from blood vessels due to localized breakdown in blood brain barrier (26).

The commonly encountered complications of ICB are mass effect with or without herniations, intraventricular extension and hydrocephalus. In our study maximum no. of patients with ICB, developed intraventricular extension 52.17 % (n= 12). Significant number, (that is n=12) of patients developed hydrocephalus, the cause being, either mass effect over the ventricular outflow tract or intraventricular hemorrhage or SAH. Findings of IVH usually correlate with poor neurologic status and a bad prognosis (27).

Intraventricular hemorrhage may be primary or secondary. Primary occurs because of trauma or choroid plexus tumors. Secondary or extension of intraparenchymal and subarachnoid hemorrhage into the ventricles is responsible for hydrocephalus.

SAH can be diagnosed on CT by presence of hyperdense blood in interhemispheric fissure, various cisterns, sulci, etc. CT is helpful in localizing the lesion in SAH in most of the cases (21). A sufficient volume of blood has to be present in the subarachnoid space, to provide adequate spatial and contrast resolution. If the patient is anemic, the blood will be isodense and it will not be seen (28). In our study, 3 patients had SAH, where hyperintensity was clearly seen in the basal cisterns.

Unlike all previous neuroimaging techniques, CT permits direct visualization of brain parenchyma and many of its pathologic changes and thus provides neuroscientists with an investigative tool of unprecedented importance. CT scanning is important in the early evaluation of cerebrovascular diseases. CT is capable of imaging the specific morphologic appearance of infarction and haematoma early enough with sufficient accuracy to influence the further clinical work up, care and treatment of these patients.

CONCLUSION
Computed Tomography is the most useful modality in the diagnosis of cerebrovascular accident. It is helpful in confirming the

clinical diagnosis of CVA , to further diagnose patients as hemorrhagic or ischemic stroke as well as to rule out other lesions i.e. stroke mimics. The complications of stroke as edema , mass effect , midline shift , herniation and hydrocephalus were also well diagnosed on CT which are important prognostic indicators.

Figure 1. Axial plain CT brain showing a fresh infarct in the right MCA territory with mass effect and midline shift.


Figure 2. Axial plain CT brain showing right thalamo-capsular hemorrhage with mass effect and intra-ventricular extension.

Figure 3. Axial plain CT brain showing right basalganglia lacunar infarct along with age related atrophy and periventricular ischemia.

Figure 4a and b) Axial pre and post contrast CT brain showing right frontal enhancing high grade space occupying mass lesion with surrounding edema and mass effect.
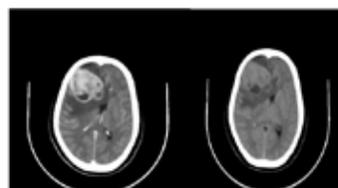
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