MRI STUDY OF CEREBROVASCULAR STROKE

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ABSTRACT

BACKGROUND AND OBJECTIVES

Cerebral ischemic stroke remains the leading cause of death and disability. The objective are Role of MRI in detection of cerebral ischemic stroke. Age and sex distribution of infarcts in Indian population. To determine the location and the territory of the involved blood vessels. Incidence of negative cases (Stroke mimics).

MATERIALS AND METHODS

All patients referred to the Department of Radio-Diagnosis with clinically suspected cerebral ischemic stroke in a period of 2 years from 2013 to 2015. The main source of data are patients from Basaveshwar teaching and general hospital attached to M.R. Medical College, Gulbarga. All MRI scans were performed on a 1.5T Philips Achieva.

Sequences used are T2WI axial and coronal, flair axial, gradient echo axial, T1WI axial, DWI axial and ADC maps. MRA (TOF)–circle Willis (neck) and SWI (optional).

RESULTS

One hundred and fifty patients who were clinically suspected of cerebral ischemic stroke were subjected to MRI study. Among these 150 patients, 77.33% had infarcts, 10.33% had intracerebral hemorrhage, 5.31% patients had cerebrovenous thrombosis, 4% patients had subarachnoid haemorrhage and 3.03% patients had tumours. However, 5 patients had normal scans and were excluded from our study. Main risk factors were hypertension and diabetes mellitus. Men were commonly affected. Youngest age group was 20 yrs. and oldest was 89 yrs. MCA territory (L>R) was the commonest territory involved in patients with cerebral infarction.

CONCLUSION

The present study is a prospective study. The results obtained from our study are well comparable with other stroke surveys. Differences in pattern of stroke may be related to genetic, environmental or sociocultural factors and to differences in the control of risk factors. MRI is non-invasive and there is no radiation hazard. Excellent grey–white matter resolution and multiplanar imaging capability of MRI helps in detection of subtle lesions. Our study observed that diffusion weighted imaging add sensitivity and specificity to the standard MR evaluation.

KEYWORDS

Cerebral Ischemic Stroke, Haemorrhage, Stroke Mimics, MRI.

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INTRODUCTION

Cerebral ischemic stroke remains the leading cause of death and disability in many countries.[1] Stroke specifically the type due to cerebrovascular disease is defined as a sudden, non-convulsive focal neurological deficit.

The term cerebrovascular disease designates any abnormality of the brain resulting from a pathologic process of the blood vessels. Pathologic process is given an inclusive meaning–namely, occlusion of the lumen by embolus or thrombus, rupture of a vessel, an altered permeability of the vessel wall, or increased viscosity or other change in quality of blood flowing through the cerebral vessels.

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The vascular pathologic process may be considered not only in it grosser aspects–embolism, thrombosis, dissection or rupture of vessel–but also in terms of more basic/primary disorder, i.e., atherosclerosis, hypertensive arteriosclerotic change, arteritis, aneurysmal dilatation and developmental malformation. Secondary parenchymal changes in the brain result from vascular lesion – ischemia with/without infarction and hemorrhage.[2]

MR imaging in stroke is targeted towards assessment of four P's – Parenchyma (Assess early signs of acute stroke, rule out hemorrhage), Pipes (Assess extracranial and intracranial circulation for evidence of IV thrombus), Perfusion (Assess CBV, CBF and MTT), and Penumbra (Assess tissue at risk of dying if ischemia continues without recanalization of IV thrombus) as described by Rowley.[3] This approach enables the detection of intracranial hemorrhage, differentiation of infarcted tissue from salvageable tissue, identification of intravascular thrombi, selection of the appropriate therapy, and prediction of the clinical outcome.[4]

Conventional MR sequences demonstrate most infarcts, but diffusion weighted MR imaging is more sensitive for detection of hyperacute ischemia. Diffusion–perfusion mismatch indicates penumbra. Gradient echo MR sequences

and in detecting hemorrhages. MR angiography enables to assess status of neck and intracranial vessels. MR spectroscopy provides information regarding the abundance of metabolites.[4]

Advantages of MRI over CT are, it is sensitive in the detection of edema, provides multiplanar views and lacks beam hardening artifacts.

Also with MRI there is no ionizing radiation associated, the gadolinium based contrast media has a minimal risk for toxic effects.[5]

Correlation of the MRI findings with the clinical features is very helpful in arriving the diagnosis and look for involvement of the specific sites.[4]

OBJECTIVES

- Role of MRI in detection of cerebral ischemic stroke.
- Age and sex distribution of infarcts in an Indian population.
- To determine the location and the territory of the involved blood vessels.

Incidence of negative cases (Stroke mimics).

METHODOLOGY

Source of Data

The main source of data for the study are patients from Basaveshwar teaching and general hospital attached to M.R. Medical College, Gulbarga.

Method of Collection Data

All patients referred to the Department of Radio-Diagnosis with clinically suspected cerebral ischemic stroke in a period of 2 years from 2013 to 2015.

All MRI scans were performed on a 1.5T Philips Achieva.

Inclusion Criteria

- All patients clinically suspected of cerebral ischemic stroke.
- Cases of all age groups irrespective of sex.

Exclusion Criteria

- Patients with history of metallic implant, foreign body, pacemaker, aneurysm clip, recently implanted prosthetic valve.
- Patients too unstable undergo MRI scan who are on ventilator support.
- Patients with history of claustrophobia.

RESULTS

One hundred and fifty patients who were clinically suspected of cerebral ischemic stroke were subjected to MRI study of the brain.

Among these 150 patients, 77.33% had infarcts, 10.33% had intracerebral hemorrhage, 5.31% patients had cerebrovenous thrombosis, 4% patients had subarachnoid hemorrhage and 3.03% patients had tumours.

However 5 patients had normal scans and was excluded from our series. In our study in a Southern Indian population based in Gulbarga it was observed that infarction and intracerebral hemorrhage were most common in the age group of 60-69 years. Men were affected commonly.

Risk factors like hypertension, diabetes mellitus, smoking and cardiac disease plays a major role in the evolution of stroke. About 52 patients had both diabetes mellitus and hypertension and the incidence of cerebral hemorrhage was more than cerebral infarction in hypertensive patients. About 45.3% of them presented clinically with hemiplegia.

The commonest territory involved in patients with cerebral infarction was middle cerebral artery (L>R) and accounted for 39.66%. 12.07 cases showed posterior cerebral artery involvement; 5.17% showed anterior cerebral artery involvement; 15.52% showed lacunar infarcts; 12.93% showed white matter ischemic changes; 7.76% shower basilar artery except PCA territory involvement; 6.03% showed multiple infarcts and 0.86% showed watershed infarct.

In cases of intracerebral hemorrhage basal ganglia was the commonly affected region, i.e. 40.0%.

The number of stroke mimics were 19 (12.34%) out of which 5.31% patients had cortical thrombosis, 4% had subarachnoid hemorrhage and 3.03% of them had tumors.

DISCUSSION

This study was directed to evaluate the role of MRI in patients presenting with cerebral ischemic stroke and also to differentiate from hemorrhage and other stroke mimics and also to study the common vascular territory involvement in ischemic stroke and to note the common age group and sex in ischemic stroke, haemorrhage and other stroke mimics.

One hundred and fifty patients clinically suspected of stroke were submitted for MRI scan of brain, among these 116 (77.33%) had cerebral infarction and 15 (10.33%) had intracerebral hemorrhage.

According to Mumbai stroke registry, 80.2% (366 out of 407) had ischemic stroke and 17.7% (81 out of 401) had hemorrhagic stroke, which is similar to our study.[6] Lausanne stroke registry also showed 82.2% infarcts.[7]

Case Distribution

Our study showed 77.33% of infarction; 10.33% of intracerebral hemorrhage; 5.31% of cortical venous thrombosis; 4% of subarachnoid hemorrhage; 3.03% of tumours. Framingham study showed 85% cases of ischemic stroke secondary to cerebral atherothrombosis and cardioembolism; 7.3% of subarachnoid hemorrhage; 6.7% of parenchymal hemorrhage; 1.70% of other types of hemorrhage.[8]

Clinical Presentation

In our study of 150 cases, 45.33% of them presented with hemiplegia, 16% of gait disturbance, 5.33% of facial palsy, 15.33% of vertigo, 12.0% of aphasia, 10.67% of vomiting, 10.67% of visual disturbances and 11.33% of headache.

Age and Sex

The age structure of the study population in this series varies from the 2nd to 9th decade. The youngest patient was 21 years old and the oldest was 89 years old. Maximum number of cases was noted in the 60-69 years of the total 116 cases of infarcts, the mean age at imaging was 64.6 years. This correlated with study of A. Shuaib et al., who had reported a similar mean age of onset of 66 years.[9] and with the study of Hideo Tohgi et al. who reported a mean age of 65.6 years.[10]

Regarding cerebral hemorrhage, the maximum incidence was found to be between 60-69 years in our series. This is

slightly higher than the study by Harrison et al., where maximum cases were between 50-59 years (33.33%).[11]

In a review of stroke epidemiology by Feigin; they concluded that the average age of patients affected by stroke is 70 years in men and 75 years in women. Our statistics show a similar age reflection.

Among our 150 cases, 114 (76.0%) were males and 36 (24%) were females. In our study, out of 116 cases of infarction; 88 (75.86%) were males and 28 (24.14%) were females.

Risk Factors

The various stroke sub types have unique risk factors during to their individual pathophysiological characteristics.

In our study, the common risk factor associated was hypertension (57.33%) followed by diabetes mellitus (52%), smoking (41.33%) and hypercholesterolemia (32%). Cardiovascular disease and atrial fibrillation contributed for about 17.33%.

This observation correlated closely with Andrew Kertesz et al.[12] and Hideo Tohgi et al.[10] But the incidence of diabetes mellitus was found to be higher (52%) in our study group.

Kuller LH et al. study showed stroke was 2.5–4 times more common in diabetics.[13]

In our study both diabetes mellitus and hypertension were found in about 34.67%, which suggests a multi factorial risk etiology.

Ischemic Stroke

Out of 150 cases, we observed 116 (77.33%) cases with infarction. The percentage of infarcts reported in NEMESIS series was 72.5%.[14] stroke data bank 80.9%.[15] and oxford shire community stroke project is 81%.[16] Our study results are comparable with the various above mentioned studies.

The most common vascular territory involved in our study was the MCA, accounting for 39.66% (46 cases) of all infarcts. There was greater involvement of the left MCA. H. Naess et al. also conducted that the left MCA territory was more involved compared to right MCA territory mainly among male subjects. This could be associated with more frequent atherosclerosis in the left carotid artery, lateralization of cortical functions or both.[17]

PCA territory involvement was noted in 14 patients (12.07%) with 8 cases showing right sided involvement. 6 patients were noted to have ACA territory involvement, out of which 3 patients had right sided involvement. Involvement of basilar artery territory except posterior cerebral artery was noted in 9 patients (7.76%). Lacunar infarcts were noted in 18 patients (15.52%), which is also comparable with VSA–stroke register (R.L. Sacco et al.) 15.30%.[18] and North East China stroke (X Long et al) 15.2%.[19]

Solely white matter ischemic changes were noted in 15 (12.93%) cases. Most of these were clinically diagnosed as transient ischemic attacks. Few cases were also attributed to carotid stenosis. Out of these 15 cases, 11 cases showed periventricular hyperintensities–5 cases were classified as grade–I [Small caps (5mm or less in diameter)/thin lining (5mm or less) with regular margins]; 4 cases as grade–2 [Large caps (6-10mm in diameter)/smooth halo (6-10mm broad) with irregular margins]; and 2 cases as grade–3 [Extending cap (10mm in diameter)/irregular halo (10mm in diameter) with irregular margins]; 4 cases showed white matter hyperintensities in deep and subcortical white matter.

Also 6 cases showed foci of acute infarction within these white matter hyperintensities on diffusion weighted imaging.

Multifocal infarcts were seen in 7 (6.03%) cases. Multifocal infarcts included those infarcts in different arterial territories excluding the lacunar infarcts and white matter ischemic changes.

Only 1 case of watershed infarction were noted, which involved right middle cerebral artery–post cerebral artery territory and were attributed to embolic etiology.

Small artery occlusion includes patients with lacunar infarcts and white matter ischemic changes with no potential cardiac sources for embolism/athero-sclerotic cause. All cases under vasculitis had supportive diagnostic blood tests with correlative imaging findings. Stroke of undetermined etiology include patients with no definite cause of stroke/when this/more potential causes are attributed but unable to make a final diagnosis. Our study shows 36.21% cases of large vessel disease (Atherothrombotic); 22.41% cases of cardioembolic origin; 29.31% cases of small vessel disease; 2.59% of vasculitis and 9.48% cases of unknown origin.

Comparison of Dwi and Conventional Mr Imaging in Acute Infarcts

The total number of acute infarcts in our study is 74. Both conventional T2W and DWI sequences were positive in 42 (56.75%). Acute infarcts see only on diffusion and not visualized in conventional imaging T2W were 32 (43.25%).

Out of the 52 lesions also seen on conventional imaging, the extent of the lesions were better detected with diffusion imaging. The 42 infarcts picked up only by diffusion weighted imaging presented within 6 hours (Mean of 4.35 hours) of symptom onset to our hospital.

Mullins ME, et al. in his study on 691 patients observed 97% sensitivity and 100% specificity with DWI; 58% sensitivity and 100% specificity with conventional MRI and 40% sensitivity and 92% specificity with CT.[20]

Lansberg et al. in his study to determine yield of adding DWI to conventional MRI protocol for acute stroke observed 50.60% sensitivity and 46.59% specificity using conventional MRI as compared with DWI.[21]

These results are consistent with our results and substantiate the superiority of DWI over conventional MR imaging.

Hemorrhagic Stroke

The percentage of hemorrhagic stroke in our study population was 10.33%.(15)

This is comparable with following studies: NEMESIS 14.5%.[14] LAUSANNE stroke registry 9.17%.[7] and Oxford shire community stroke project 10%.[16]

In our study 40.0% (6) cases showed intracerebral hemorrhage in basal ganglia; 20.0% showed lobar involvement; 20.0% showed in brainstem; 13.33% (2) in cerebellum and 6.67% (1) showed thalamic involvement. Lausanne registry also showed 42% of lenticulocapsular involvement; 8% cerebellum; 4% thalamus; 6% in brainstem and 40% lobar involvement.[7] These results were comparable with our study.

Stroke Mimics

Eighteen (12.34%) cases presented as stroke mimics, out of which 8 patients had cerebral venous thrombosis; 6 patients had subarachnoid hemorrhage; 5 patients had tumour 2 metastasis 3 meningioma.

Subarachnoid Hemorrhage

Subarachnoid hemorrhage incidence in our patients was 4% (6 patients), which is comparable with NEMESIS 4.3%.[14] and China stroke registry (Lin–Feng Zhang et al)–1.8%.[22]

Cortical Venous Thrombosis

In our study we had 5.31% (8) cases cortical venous thrombosis is more often in women likely due to predisposing conditions such as pregnancy or use of hormonal contraceptives in the 20-35 years age bracket.

CONCLUSION

1. The present study is a prospective study and included patients with suspected cerebral ischemic stroke.
2. This study is an analysis of the epidemiological trends (Age, sex); risk factors (Hypertension, diabetes mellitus, smoking and cardiac disease); vascular distribution of infarcts, pattern involvement of hemorrhage in a southern Indian population in Davangere based on MRI findings in 150 patients.
3. The results obtained from our study are well comparable with other stroke surveys. Differences in pattern of stroke may be related to genetic, environmental or sociocultural factors and to differences in the control of risk factors.
4. MRI is non-invasive and there is no radiation hazard. Excellent grey – white matter resolution and multiplanar imaging capability of MRI helps in detection of subtle lesions. Sensitivity of MRI to altered water content allows earlier detection of infarcts.
5. Our study observed that diffusion weighted imaging add sensitivity and specificity to the standard MR evaluation. DWI makes an important contribution to stroke management. DW imaging with restricted diffusion helped in the evaluation of acute infarcts in the setting of multifocal infarcts, lacunar infarcts and white matter ischemic changes responsible for the patients symptomatology and in distinguishing acute from subacute and chronic infarcts.
6. Though CT is considered as the imaging modality widely available at affordable cost, multimodal MRI has carved a niche as the feasible, cost effective and time saving initially 'State of the art' imaging modality in cerebral ischemic stroke and has a definite role in the diagnosis and management of the same.

The limitation of this study is its lack of systematic follow-up neuroimaging. Another constraint is a selection bias; since not all patients clinically diagnosed as cerebrovascular accident routinely undergo DW MR imaging.

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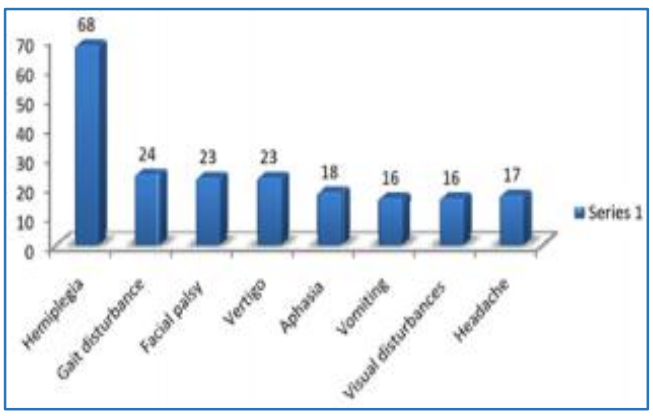
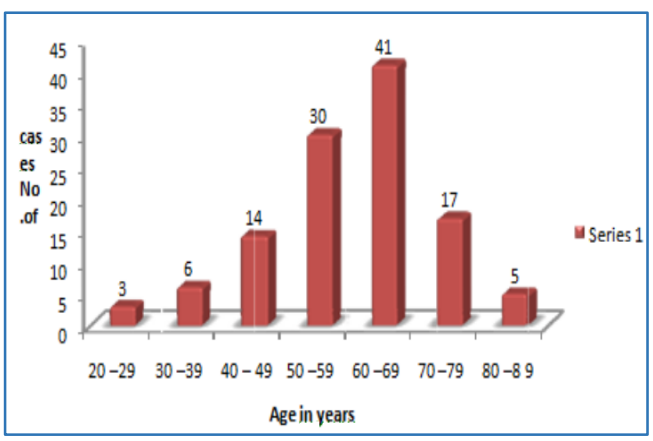
	No. of Cases	Percentage
Infarcts	116	77.33
Hemorrhage	15	10.33
Stroke mimics	18	12.34

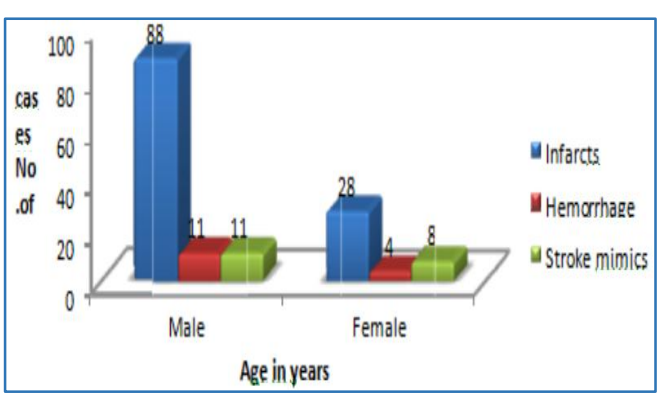
Table 1: Case distribution



Graph 1: Clinical Features



Graph 2: Age distribution (Infarcts)



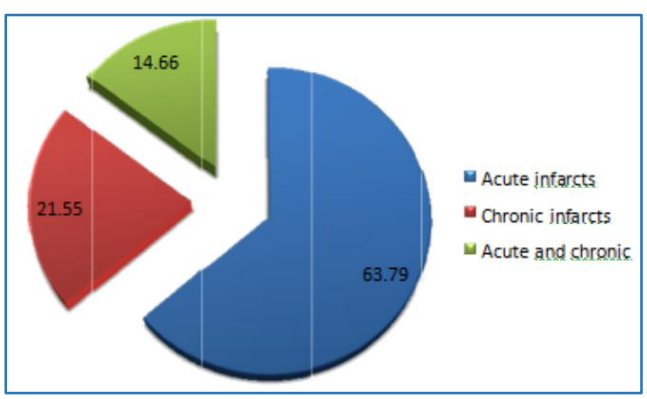
Graph 3: Sex distribution (Infarct, Hemorrhage and Stroke mimics)

Risk Factors	No. of Cases	Percentage
Hypertension	86	57.33
Diabetes mellitus	78	52.0
Smoking	62	41.33
Hypercholesterolemia	48	32.0
Atrial fibrillation	9	6.0
Cardiovascular disease	17	11.33
Diabetes mellitus and hypertension	52	34.67

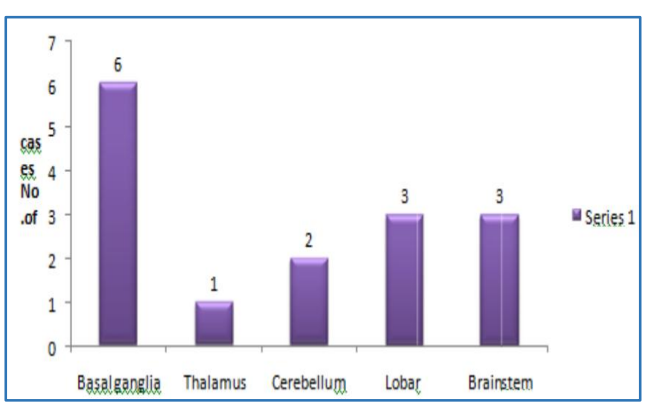
Table 2: Risk factors

Vascular Territory Factors	No. of Cases	Percentage
MCA	56	39.66
PCA	14	12.07
ACA	6	5.17
Watershed infarcts	1	0.86
Lacunar infarcts	18	15.52
Multiple infarcts	7	6.03
Basilar except PCA	9	7.76
WMIC	15	12.93

Table 3: Infarcts in Vascular Territory (n=116)



Graph 4: Type of Infarcts



Graph 5: Incidence of Hemorrhage in Different Parts of Brain