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A Study of Magnetic Resonance Imaging in Stroke

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Abstract **Original Research Article**

Globally, stroke is the 2nd leading cause of death and 3rd leading cause of disability. Stroke on an average occurs 15 years earlier among the population in low and middle income countries. This study was done to assess the role of Magnetic Resonance Imaging in the evaluation of stroke with MRI by just doing a few sequences- T1WI, T2WI,FLAIR,SWI,DWI which each takes about 5 minutes, thus saving the precious 'door to needle time' we can accurately detect the aetiology of stroke, differentiate acute, subacute and chronic ischemic strokes, salvageable tissue, intra vascular thrombus and guiding in thrombolytic therapy without increasing the risk of radiation exposure to the patient an in case of CT. In our study 100 patients underwent MRI head and majority of patients were in age group 60-69 years. Male preponderance was observed with a M: F ratio of 7:3.About 34% patients had both diabetes mellitus and hypertension. About 45.3% of patients presented clinically with hemiplegia. Infarction was the most common aetiology of stroke seen in 87% most common followed by intracerebral haemorrhage seen in 12% patients. With DWI and ADC sequence the exact age of infarct could be diagnosed and were categorized into four groups based on the time since onset of stroke. 8% cases of hyperacute, 78.1% patients with acute, 9.2% patients had subacute and 4.6% patients had chronic infract were diagnosed. Patients with hyperacute infract as aetiology of stroke showed changes in DWI sequence, whereas 80 patients with acute, subacute and chronic infract as aetiology of stroke showed changes in both T2 and DWI sequences. The results obtained from our study are well comparable with other stroke surveys.

Keywords: Stroke, clinical features, epidemiology, CT, MRI, treatment.

INTRODUCTION

Globally, stroke is the 2nd leading cause of death and 3rd leading cause of disability. The incidence of stroke is seen to be on a rise in the past few decades in the low and middle income countries with 70% of stroke and 87% of both stroke related death and disability-adjusted life year occurring in low and middle income countries. Stroke on an average occurs 15 years earlier among the population in low and middle income countries [1].

In India stroke has the incidence rate of 119-145/100,000 and prevalence rate is 84-262/100,000 in rural and 334-424/100,000 in urban area [2].

Central nervous system infarction is defined as brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury [3].

Stroke can be of two types; ischemic stroke (infarction) accounting for 80% of cases of stroke and hemorrhagic stroke (including primary spontaneous intracranial hemorrhages, subarachnoid hemorrhages and venous occlusion) accounting for 20% of cases of stroke.

Various imaging modalities such as CT, CT angiography ,CT perfusion MRI and MR perfusion Imaging techniques can be used in evaluating patients with clinical diagnosis of stroke. These imaging modalities are targeted towards detecting the etiology of stroke, differentiating between infarcted tissue from salvageable tissue, detecting intra vascular thrombus and guiding in thrombolytic therapy[4].

Although CT is still considered to be gold standard of brain imaging before thrombolysis, new reperfusion strategies in acute ischemic stroke require more extensive use of MRI. Ongoing technological advances in MRI and advent of new imaging sequences

has now made it possible to use MRI as a prognostic tool both in acute and chronic stages of cerebral ischemia[5].

With CT we can primarily differentiate between ischemic and hemorrhagic stroke. We can't exactly differentiate between acute, subacute and chronic ischemic strokes, which are essential for administering intravenous thrombolytic therapy. With MRI on the other hand by just doing a few sequences- T1WI, T2WI, FLAIR, SWI, DWI which each takes about 5 minutes, thus saving the precious 'door to needle time' we can accurately differentiate between ischemic and hemorrhagic stroke and also differentiate between acute, subacute and chronic ischemic strokes, without increasing the risk of radiation exposure to the patient an in case of CT[6]. This study was undertaken to evaluate role of Magnetic Resonance Imaging in stroke.

AIM

To assess the role of Magnetic Resonance Imaging in the evaluation of stroke

OBJECTIVES

- To assess utility of MRI to differentiate between ischemic and hemorrhagic stroke.
- To assess the duration of stroke for guiding thrombolytic therapy.

MATERIALS AND METHODS

This study "Role of Magnetic Resonance Imaging in Stroke" was conducted in the Department of Radiodiagnosis, after the approval from institutional ethical and research committee.

All patients clinically suspected to have stroke from all age groups irrespective of their gender were referred from various departments of our institute and were subjected to MRI examination after obtaining a written and informed consent. Patients in whom MRI was contraindicated due to claustrophobia or patients with metallic implants, cardiac pacemakers and metallic foreign body in-situ and patients who were not willing to undergo MRI examination or be a part of this study were excluded. All 100 patients had undergone MRI scanning and findings were recorded on pre structured proforma and analyzed.

MR imaging was performed on all of the study patients with use of 1.5T MR system(SIEMENS Symphony 1.5 T MRI scanner) including fast spin-echo using our stroke protocol sequences - T1WI, T2WI, FLAIR, DWI (with ADC) and SWI. MR Angiography in 3D TOF sequence. Sequences were taken in axial, coronal and sagittal planes using 230mm field of view.

The results of the study will be tabulated and statistically analyzed. Descriptive statistical analysis was carried out to identify the characteristics and features of the collected data. Mean and percentage were used to represent the data. Microsoft excel was used to prepare the master charts.

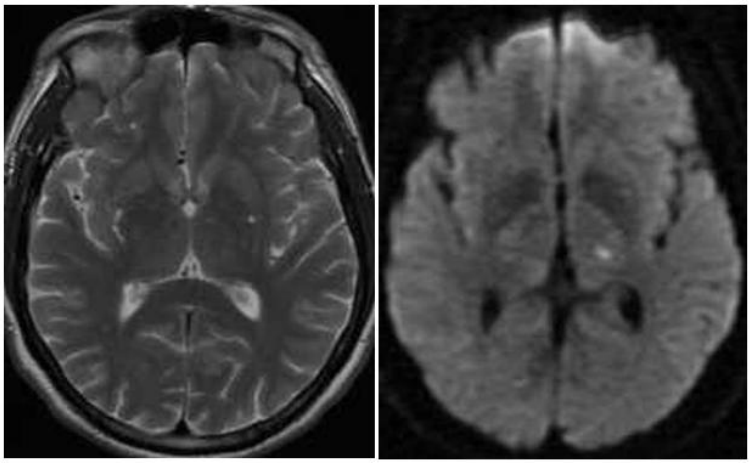


Fig-1(A-B): Axial T2WI MRI (A) and axial DWI MRI (B) images of 52 years old male with hyperacute left lacunar thalamic infarct reveals a bright spot in the left thalamic region on DWI and T2 WI is normal

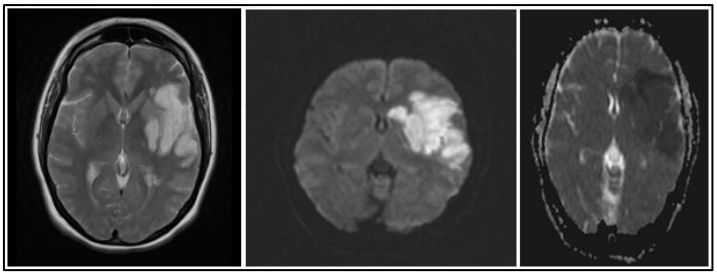


Fig-2(A-C): Axial T2WI MRI (A) and Axial DWI MRI (B) images of 68 year old man with Acute left MCA infarct shows hyperintensity on T2WI with gyral swelling and restriction on diffusion.(C) Shows hypointensity on ADC map

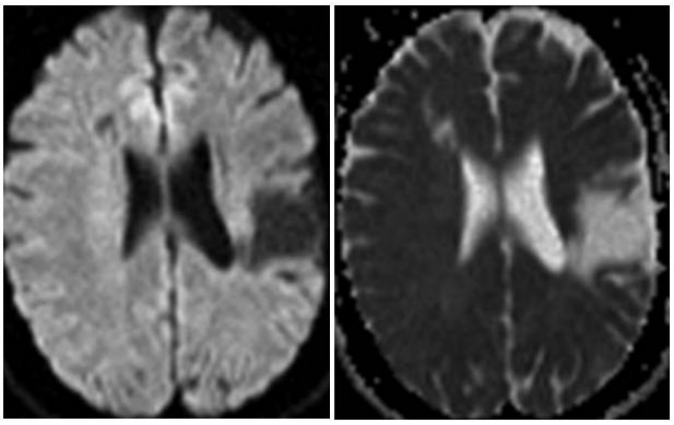


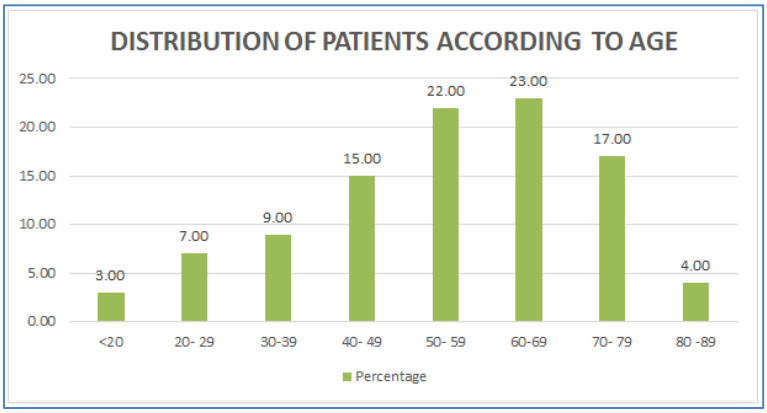
Fig-3(A-B): Axial DWI (A) and axial ADC map(B) MRI images of a Chronic infarcts in a 71-year-old man with a history of multiple strokes. Areas of decreased signal intensity on DWI and ADC map shows increased ADC values in the left parietal lobe. These features are suggestive of chronic infarction

OBSERVATIONS AND RESULTS

Following observations were made in our study. On the basis of age, patients were categorized into 8 groups [Table 1, Graph 1].

Table-1: ***Distribution of patients on the basis of age***

S.No	Age (in years)	No. of cases	Percentage
1	**<20**	3	3.00
2	**20- 29**	7	7.00
3	**30-39**	9	9.00
4	**40- 49**	15	15.00
5	**50- 59**	22	22.00
6	**60-69**	23	23.00
7	**70- 79**	17	17.00
8	**80 -89**	4	4.00
	Total	100	100.00

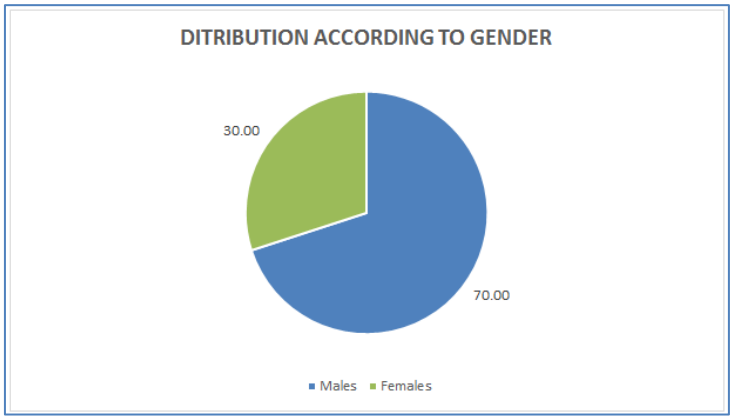


Graph-1: Graph 1. ***Majority of Patients in our study were in age group 60-69 years (23%), followed by 50-69 years (22%). Mean age of patient was 54 years***

On the basis of gender patients were categorized into 2 groups [Table 2, Graph 2].

Table-2: Distribution of patients on the basis of gender

S.No	Gender	No. of cases
1	Males	70
2	Females	30
	Total	100

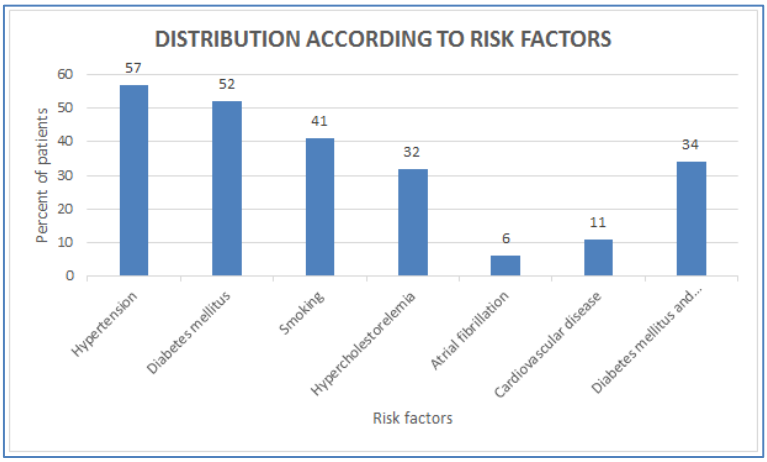


Graph-2: Male preponderance was observed in our study with 70% patients being male and 30% patients being female

On the basis of risk factors, patients were categorized into 7 groups [Table 3, Graph 3].

Table-3: *Distribution of patients on the basis of risk factors*

S.No	Risk Factors	No. of cases	Percentage
1	Hypertension	57	57
2	Diabetes mellitus	52	52
3	Smoking	41	41
4	Hypercholestorelemia	32	32
5	Atrial fibrillation	6	6
6	Cardiovascular disease	11	11
7	Diabetes mellitus and hypertension	34	34

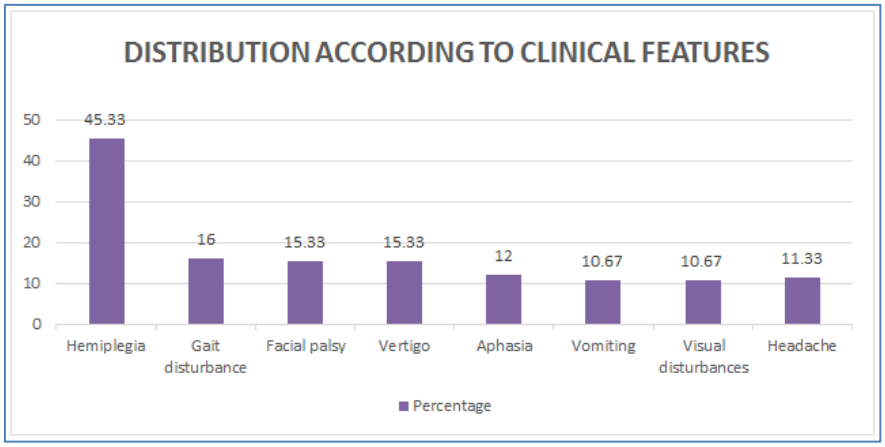


Graph-3: *Hypertension was the most common risk factor observed in our study (57% of patients) followed by diabetes mellitus (52% of patients) patient. Hypercholestorelemia was observed in 32% patients.*

On the basis of clinical features, patients were categorized into 8 groups [Table 4, Graph 4].

Table-4: Distribution of patients on the basis of clinical features

S.No	Clinical features	No. of cases	Percentage
1	Hemiplegia	68	45.33
2	Gait disturbance	24	16
3	Facial palsy	23	15.33
4	Vertigo	23	15.33
5	Aphasia	18	12
6	Vomiting	16	10.67
7	Visual disturbances	16	10.67
8	Headache	17	11.33

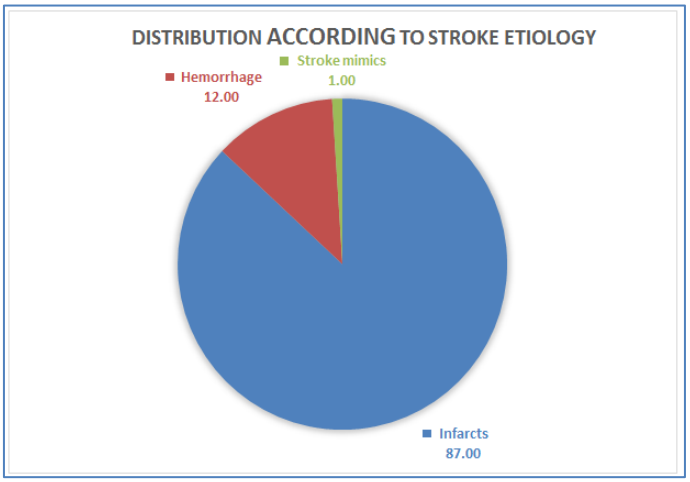


Graph-4: Hemiplegia was the most common presenting complaint in our study accounting for 45.33% of patients followed by gait disturbance seen in 16% patients

All patients were subjected to MRI Brain imaging and on the basis of stroke etiology detected were categorized into 3 groups [Table 5, Graph 5].

Table-5: Distribution of patients on the basis of stroke etiology

S.No2	Stroke type	No. of cases	Percentage
1	Infarcts	87	87.00
2	Haemorrhage	12	12.00
3	Stroke mimics	1	1.00
	Total	100	100.00



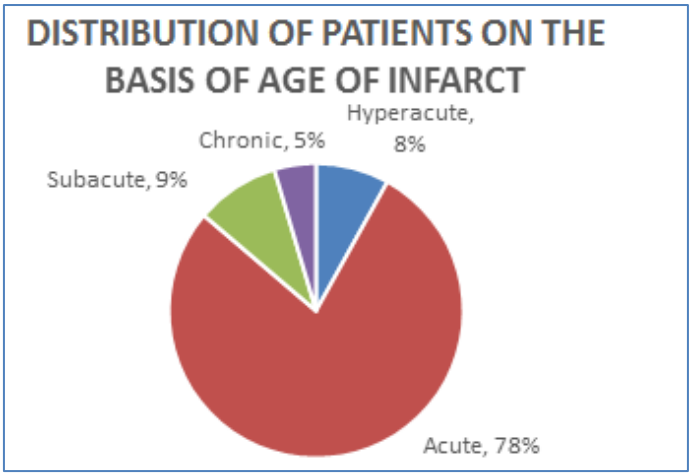
Graph-5: Infarct was the main etiology of stroke in our study (87%). Haemorrhagic stroke was observed in 12% of patients

On the basis of vascular territory involved in infarcts, patients were categorized into 7 groups [Table 7, Graph 7].

Table-6: ***Distbution of patients with infarcts as etiology according to age of infarct***

S.NO	Infarct Age	MRI Findings					No of cases	Percentage
		T1	T2	FLAIR	DWI	ADC		
1	**Hyperacute (0-24 hours)**	Isointennse	Isointense	Hyperintense	Restriction	Hypointense	7	8.04
2	**Acute (24 hours to 1 week)**	Hypointense	Hyperintense	Hyperintense	Restriction	Hypointense	68	78.16
3	**Subacute (1 to 3 weeks)**	Iso - Hypointense	Hyperintense +/- Fogging effect	Hyperintense	Restriction to Iso - Hypo	Hypo - Hyperintense	8	9.19
4	**Chronic (>3 weeks)**	Hypointense	Hyperintense	Hypointense	Variable	Hypeintense	4	4.59
	Total						87	100.00

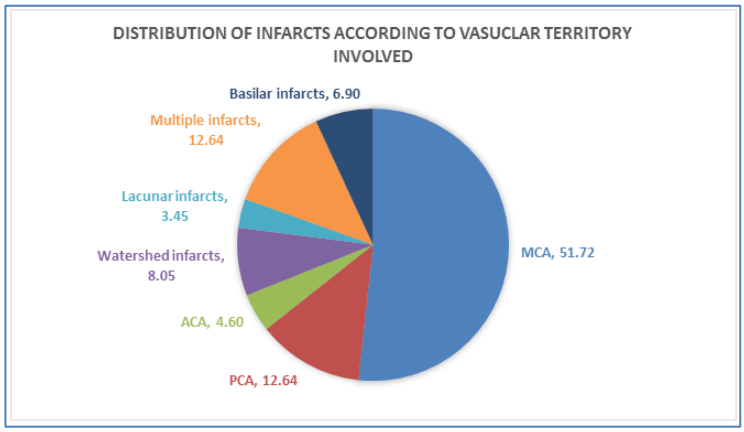
Patients with infarcts as etiology were categorized on the basis of infarct age [Table 6, Graph 6].



Graph-6: Preponderance of acute infarct 68(78.16%) was observed in our study followed by subacute 8(9.20%) and hyperacute infarct 7(8.05%)

Table-7: ***Distribution of patients on the basis of vascular territory involved***

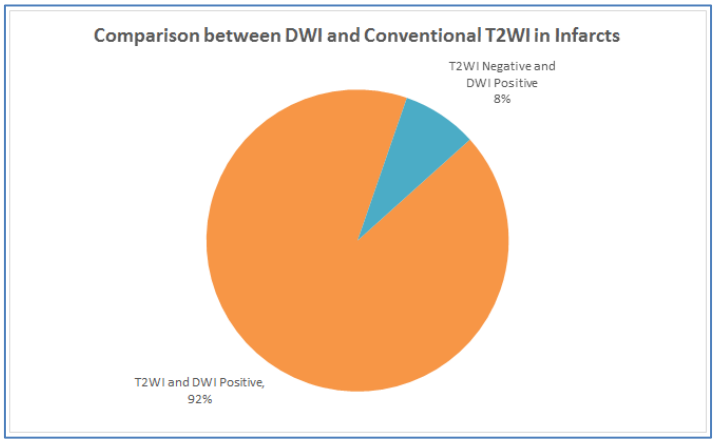
S.No	Vascular territory factors	No. of cases	Percentage
1	MCA	45	51.72
2	PCA	11	12.64
3	ACA	4	4.60
4	Watershed infarcts	7	8.05
5	Lacunar infarcts	3	3.45
6	Multiple infarcts	11	12.64
7	Basilar infarcts	6	6.90
	Total	87	100.00



Graph-7: MCA territory was the commonest territory involved in our study (51.72%) followed by PCA territory (12.64%)

Table-8: Distribution of patients on the basis of positive findings on conventional sequence and DWI [Table 8, Graph 8]

S.No	Sequence	No. of cases	Percentage
1	T2WI and DWI Positive	80	91.95
2	T2WI Negative and DWI Positive	7	8.05
	Total	87	100.00

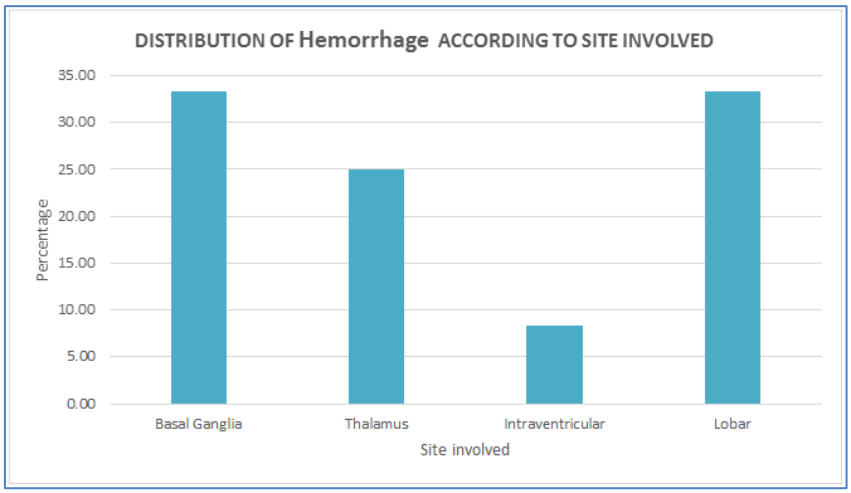


Graph-8: Patients with hyperacute infarcts as etiology of stroke showed changes only in DWI sequence whereas patients with acute, subacute, chronic infarcts as etiology of stroke showed changes in both T2WI and DWI sequences

On the basis of specific region of the brain involved patients with hemorrhagic stroke were categorized into 4 groups [Table 9, Graph 9].

Table-9: Distribution of patients with hemorrhagic stroke on the basis of specific region involved

S.No	Site of Involvement	No. of cases	Percentage
1	Basal Ganglia	4	33.33
2	Thalamus	3	25.00
3	Intraventricular	1	8.33
4	Lobar	4	33.33
	Total	12	100.00



Graph-9: Basal ganglia were the commonest region of brain involved with hemorrhage as etiology (33.33%). Thalamic involvement was observed in 25% of patients

DISCUSSION

The goals of an imaging evaluation for acute stroke are to establish a diagnosis as early as possible and to obtain accurate information about the intracranial vasculature and brain perfusion for guidance in selecting the appropriate therapy to prevent permanent damage. Investigators showed good clinical outcomes of thrombolytic drug therapy in patients with acute stroke who were selected on the basis of imaging criteria and this study with the main aim to assess MRI findings in the evaluation of stroke.

The age structure of the study population in this series varies from the 1st to the 9th decade. Maximum number of cases was noted in 60-69 years (23% of patients) of the total 100 cases of stroke, the mean age at imaging was 54 years. This correlated with study done by Bhattacharya *et al*. Dalal *et al*. and Sridharan *et al*. in Stroke in India - Fact-sheet and study done by Nagaraja D *et al.* who reported a similar mean age of 54.5 year [7, 8].

However in developed countries people ≥65 years of age (particularly those ≥80 years of age) have a higher prevalence of stroke because the risk of stroke increases with age, as observed in a study done by Ovbiagele B *et al*. [9].

There is a concerning shift in the overall stroke burden toward younger age groups, particularly in low- and middle-income countries as in a study done by KatanM and Luft.. About 12% of strokes in India occur in the population younger than 40 years [10].

In our study a distinct male preponderance was noted among the 100 cases of stroke 70% were males and 30% females. Similar findings were observed in a study done by Sridhar Srimath Tirumala Konduru *et al*. Also globally, men continue to have a higher incidence of stroke than women was observed in a study done by Suzanne Barker-Collo *et al*. Which can be attributed to women being protected by endogenous estrogens, males are also more prone to HTN and DM than females and smoking is more common in males [11, 12].

Hypertension (57% patients), diabetes mellitus (52% patients) and hypercholesterolemia (32% patients) were the most common risk factors for stroke seen in our study. Similar observation was made by Puneet K Yadav et al and P.N. Sylaja *et al*. in their study [13,14].

In our study hemiplegia was the most common presenting sign was seen in 45.33% patients which was similar to study done by Chirayu Vijaykumar Vaidya. Also instability of gait (4.5% patients), vomiting (1.9% patients) and headache (1.1% patients) were common clinical features observed in their study and similar clinical presentations were observed in our study [15].

Of the total 100 cases in our study 87% strokes were caused due to infarct, 12% due to haemorrhage and 1% case was of stroke mimics. Similar observations were made in a study done by Sapna E. Sridharan *et al*. and Tapas Kumar Banerjee *et al*. Risk factors such as diabetes, atrial fibrillation, previous myocardial infarction, previous stroke, and intermittent arterial claudication lead to ischemic stroke and are more commonly seen in our population hence ischemic infarct is more common etiology of stroke. Whereas smoking and high alcohol intake leads to hemorrhagic stroke and are less prevalent risk factors [16].

Patients with infarct as etiology of stroke were categorized in hyperacute(8.04% patients), acute(78.16% patients), subacute (9.19% patients) and chronic (4.59% patients) based on MRI brain findings on T1,T2,FLAIR, DWI and ADC sequences which matched with MRI findings in study done by Laura M. Allen *et al*. [17].

Hyperacute stroke was within 0-24 hours of onset of stroke and showed isointensity on T1WI, isointensity on T2WI, hyperintensity on FLAIR, restriction on DWI and hypointensity on ADC sequences.

Acute stroke was from 24 hours to 1 week of stroke onset and showed hypointensity on T1WI, hyperintensity on T2WI, hyperintensity on FLAIR, restriction on DWI and hypointensity on ADC sequences.

Subacute stroke was from 1-3 weeks of stroke onset and showed iso-hypointensity on T1WI, hyperintensity +/- fogging effect on T2WI, hyperintensity on FLAIR, restriction to iso-hypointensity on DWI and hypointensity to hyperintensity on ADC sequences.

Chronic stroke was from more than 3 week of stroke onset and showed hypointensity on T1WI, hyperintensity on T2WI, hypointensity on FLAIR, variable on DWI and hyperintensity on ADC sequences.

Majority of patients with infarct as the etiology of stroke were in the age range of 50-69 years(45.98% patients) .Similar findings were seen in a study done by Sridhar Srimath Tirumala Konduru *et al*. (60% patients). Male preponderance was observed in our study with 70.11% patients being male and 29.89% patients being female among 87% cases of infarct. The male-to-female ratio was 5:1 (83.4% patients) were males were findings in a study done by Deepa Dash and correlated closely with our study [18].

In our study distribution of patients on the basis of vascular territory involved in infarct showed MCA territory was the commonest territory involved seen in 51.72% patients. Similar finding of most common territory involved was middle cerebral artery was seen in 49.6% patients in a study done by Jong-Won Chung *et al*. [19]. An atherothrombotic infarction of the internal carotid artery invariably presents with symptoms predominantly in the MCA territory [20].

Patients with hyperacute infarcts as etiology of stroke showed changes only in DWI sequence whereas patients with acute, subacute and chronic infarct as etiology of stroke showed changes in both T2WI and DWI sequences. Similar changes on T2W and DWI MR sequences in hyperacute, acute, subacute and

chronic infarcts was also seen in a study done by Laura M. Allen *et al.* [17].

In our study 33.33%(4 patients) had haemorrhage in the basal ganglia, 25%(3 patients) in the thalamus,8.33%(1 patient) in the intraventricular region and 33.33%(4 patients) in the lobar region. Similar observations of basal ganglia–thalamic region were the most common site for intracranial hemorrhage was made by Shyamal K. Das *et al*. [21]. Long-standing poorly controlled hypertension accounts for the majority of basal ganglia hemorrhage, and leads to a variety of pathological changes in the vessels including microaneurysms of perforating arteries (Charcot-Bouchard aneurysms) small (0.3-0.9 mm) diameter aneurysms that occur on small (0.1-0.3 mm) diameter arteries. A distribution that matches incidence of hypertensive hemorrhages includes 80% lenticulostriate,10% pons,10% cerebellum found in hypertensive patients may thrombose, leak or rupture ,accelerated atherosclerosis: affects larger vessels hyaline arteriosclerosis, hyperplastic arteriosclerosis: seen in very elevated and protracted case [22].

Conventional MRI is more sensitive and more specific than CT for the detection of acute cerebral ischemia within the first few hours after the onset of stroke. Conventional MRI is less sensitive than diffusion-weighted MR imaging in hyperacute phase. Diffusion restriction with reduced ADC has been observed as early as 30 minutes after the onset of ischemia [4]. While acute infarcts may be seen early on conventional MR images, diffusion-weighted MR imaging is more sensitive for detection of hyperacute ischemia. Gradient-echo MR sequences can be helpful for detecting a hemorrhage. The status of neck and intracranial vessels can be evaluated with MR angiography, and a mismatch between findings on diffusion and perfusion MR images may be used to predict the presence of a penumbra. The information obtained by combining various imaging techniques may help differentiate patients who do not need intravenous or intraarterial therapy from those who do, and may alter clinical outcomes [7]. While diffusion-weighted MR imaging is most useful for detecting irreversibly infarcted tissue, perfusion-weighted imaging may be used to identify areas of reversible ischemia as well [6].

An unenhanced CT is widely available, can be done in patients in whom MRI is contraindicated and can be performed quickly and can help rule out hemorrhage (a contraindication to thrombolytic therapy).

CT angiography and CT perfusion imaging, respectively, can depict intravascular thrombi and penumbra. These examinations are easy to perform on most helical CT scanners and are increasingly used in stroke imaging protocols to decide whether intervention is necessary.

Now a days with a complete MRI stroke protocol is achieved in 20 minutes and detection of hyperacute infarct and increased number of lesion is achieved with MRI. No risk of ionizing radiation. Gadolinium based contrast medium has minimally increased risk for toxic effects on the kidney. With MR perfusion studies penumbra (salvageable tissue) can be identified too and also hemorrhages can be detected on GRE-SWI sequence [4].

The likelihood of stroke recurrence in the developing world is expected to be higher because compliance with treatment for control of risk factors and prophylaxis against stroke is poor.

To obtain such priority for stroke prevention awareness of stroke must be raised among health planners and governments. Another priority is education of the public and of health-care providers about the preventable nature of stroke, as well as about the warning symptoms of the disease and the need for a rapid response.

The present study is a prospective study and included patients with suspected stroke. This study is an analysis of the epidemiological trends ,risk factors, vascular distribution of infarcts, pattern involvement of hemorrhage based on MRI findings in 100 patient who were clinically suspected of stroke were subjected to MRI study of the brain.

In conclusion, although CT is considered as the imaging modality widely available at affordable cost, multimodal MRI has carved a niche as the feasible initially imaging modality in cerebral ischemic stroke and has a definite role in the diagnosis and management of the same and by performing fewer selected sequences like FLAIR, DWI and SWI we can curtail the cost and time of a MRI scan.

REFRENCES

1. Johnson W, Onuma O, Owolabi M, Sachdev S. Stroke: a global response is needed. Bulletin of the World Health Organization. 2016;94:634–634A.
2. Pandian JD, Sudhan P. Stroke epidemiology and stroke care services in India. J Stroke Cerebrovasc Dis. 2013;15:128–34.
3. Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJB, Culebras A. An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2013;44:2064–89.
4. Srinivasan A, Goyal M, Al Azri F, Lum C. State-of-the-Art Imaging of Acute Stroke. RadioGraphics. 2006;26:S75–95.
5. Lev MH. Perfusion Imaging of Acute Stroke: Its Role in Current and Future Clinical Practice. Radiology 2013;266:22–7.

6. Petkova M, Rodrigo S, Lamy C, Oppenheim G, Touzé E, Mas J-L. MR Imaging Helps Predict Time from Symptom Onset in Patients with Acute Stroke: Implications for Patients with Unknown Onset Time. Radiology. 2010;257:782–92.
7. Nagaraja D, Gururaj G, Girish N, Panda S, Roy AK, Sarma GRK. Feasibility study of stroke surveillance: data from Bangalore, India. Indian J Med Res. 2009;130:396–403.
8. Kumar S, Taylor F. Stroke in India - Fact-sheet Updated; 2012.
9. Ovbiagele B, Goldstein LB, Higashida RT, Howard VJ, Johnston SC, Khavjou OA. Forecasting the Future of Stroke in the United States: A Policy Statement From the American Heart Association and American Stroke Association. Stroke. 2013;44:2361–75.
10. Katan M, Luft A. Global Burden of Stroke. Seminars in Neurology. 2018;38:208–11.
11. Konduru SST, Ranjan A, Nallajerla JS, Gonuguntala S. Study of Symptoms, Risk Factors and Prescribing Patterns in Cerebral Stroke Patients. Indian Journal of Pharmacy Practice. 2017;10:20–6.
12. Barker-Collo S, Bennett DA, Krishnamurthi RV, Parmar P, Feigin VL, Naghavi M. Sex Differences in Stroke Incidence, Prevalence, Mortality and Disability-Adjusted Life Years: Results from the Global Burden of Disease Study 2013. Neuroepidemiology. 2015;45:203–14.
13. Yadav PK, Simerleen S, Kumar V, Joshua A, Krishnan S, Kumar SP. Survey of Knowledge and awareness about cerebro-vascular stroke, its risk factors, warning signs and immediate treatment among mangalore urban population-a cross-sectional study. Age. 2013;40:116-22.
14. Sylaja PN, Pandian JD, Kaul S, Padma Srivastava MV, Khurana D, Schwamm LH. Ischemic Stroke Profile, Risk Factors, and Outcomes in India. Stroke. 2018;49:219–22.
15. Vaidya C, Majmudar D. A clinical study of ischemic stroke from capital of Gujarat, India. Sahel Medical Journal. 2015;18:177.
16. Andersen KK, Olsen TS, Dehlendorff C, Kammersgaard LP. Hemorrhagic and ischemic strokes compared: stroke severity, mortality, and risk factors. Stroke. 2009;40:2068–72.
17. Allen LM, Hasso AN, Handwerker J, Farid H. Sequence-specific MR imaging findings that are useful in dating ischemic stroke. Radiographics. 2012;32:1285–97.
18. Dash D, Bhashin A, Pandit AK, Tripathi M, Bhatia R, Prasad K. Risk factors and etiologies of ischemic strokes in young patients: a tertiary hospital study in north India. J Stroke Cerebrovasc Dis. 2014;16:173–7.
19. Chung J-W, Park SH, Kim N, Kim W-J, Park JH, Ko Y. Trial of ORG 10172 in Acute Stroke Treatment (TOAST) classification and vascular territory of ischemic stroke lesions diagnosed by diffusion-weighted imaging. J Am Heart Assoc; 2014;3.
20. Teasell R, Viana R, BHSc SD, Madady M. Stroke Rehabilitation Clinician Handbook 2016.
21. Das SK, Banerjee TK, Biswas A, Roy T, Raut DK, Mukherjee CS. A prospective community-based study of stroke in Kolkata, India. Stroke. 2007;38:906–10.
22. Chung CS, Caplan LR, Yamamoto Y, Chang HM, Lee SJ, Song HJ. Striatocapsular haemorrhage. Brain. 2000;123.Pt 9:1850–62.