

Original Research Article

Evaluation of seizure disorder on MRI brain with age wise correlation of various causes diagnosed on MRI.

**Dr. Apurva Shukla¹ (Resident), Dr. Akshara Gupta² (Professor & Head),
Dr. Dinesh Udainiya³ (Professor & Head) & Dr. Sweta Swaika⁴ (Assistant Professor)**

Department of Radio-diagnosis, GRMC and JAH Gwalior, 474009, Madhya Pradesh,
India^{1,2&4}

Department of Neurology, GRMC and JAH Gwalior, 474009, Madhya Pradesh, India³
Corresponding Author: Dr. Dinesh Udainiya

Background-The objective behind this study is to detect and study causes of seizure in patients with seizure disorder on MRI Brain and to age wise correlate most common causes found in different age groups, in a tertiary care hospital in Northern India.

Material and Methods

A total of 100 patients with clinical symptoms of seizures who were referred for MRI for diagnosis and evaluation, from the department of Neurology to the Department of Radio diagnosis, JAH Group of hospitals & G.R.M.C. Gwalior (M.P.) were included in the study. All MRI scans were performed on a 1.5 T Philips scanner with sequences of seizure protocol. Data was analyzed using SPSS version 16.0 and EPI INFO version 7.0.

Results

The mean age of presentation with seizure in our study was 20.5 years with male predominance seen. Age groups were divided into four categories ≤ 1 year, 1-18 years, 18-40 years and >40 years for the purpose of our study with 17 patients found in ≤ 1 year group, 37 patients in 1-18 year age group, 28 patients in 19-40 year age group and 18 patients in >40 year age group. Normal MRI was seen in 29 out of 100 patients (29%).

Infarct with gliosis was the most common finding in seizure patients (26%) in our study followed by HIE (hypoxic ischemic encephalopathy) (17% with most common age group being ≤ 1 year) & infection (15%). Other causes found were mesial temporal sclerosis in 10% patients, tumors in 6% patients , malformation of cortical development in 3% patients, neurocutaneous syndrome(SWS) identified in 1%, cavernoma in 2% cases, metabolic causes in 3% cases, demyelination in 3% cases and CVT was also found in 3% of cases.

Conclusion

Our prospective study suggests the importance of MRI in evaluation of underlying brain pathologies causing seizure disorder and age wise most common causes found on MRI brain study, which included cerebrovascular, HIE, infections, mesial temporal sclerosis, tumors, malformation of cortical development, neurocutaneous syndrome, metabolic, vascular malformation and demyelination. We hereby conclude that MRI plays a crucial role in diagnosis and management of patients with seizure disorder by detecting various underlying brain pathologies causing recurrent seizures in epilepsy patients.

Study Design: Prospective Study.

Keywords: seizure, MRI, brain & diagnosed.

1. INTRODUCTION

A seizure (from the Latin *scire*, “to take possession of”) is a transient occurrence of signs or symptoms due to abnormal excessive or synchronous neuronal activity in the brain.¹

Epilepsy describes a condition in which a person has a risk of recurrent seizures due to a chronic, underlying process. Epilepsy is defined by the International League Against Epilepsy (ILAE) as² at least two or more unprovoked (or reflex) seizures occurring more than 24 hours apart; or one unprovoked (or reflex) seizure and a probability of further seizures similar to the general recurrence risk after two unprovoked seizures, occurring over the next 10 years; or diagnosis of an epilepsy syndrome.

Based on the new 2017 International League Against Epilepsy classification of seizure types (RS Fisher et al: *Epilepsia* 58: 522, 2017) they are classified as focal onset, generalized onset and unknown onset.

Epilepsy syndromes are disorders in which epilepsy is a predominant feature, and there is sufficient evidence (e.g., through clinical, EEG, radiologic, or genetic observations) to suggest a common underlying mechanism. (Eg. Infantile spasms, benign rolandic epilepsy, Lennox gastaut syndrome, mesial temporal lobe epilepsy).

There are a myriad of etiologies, however, in adults with new onset of seizures ~50% will not have a determinable cause.³ The International League Against Epilepsy (ILAE) have proposed the following etiological classification.⁴

- structural etiology
- genetic etiology
- infectious etiology
- metabolic etiology
- immune etiology
- unknown etiology

NICE (National Institute of Health And Clinical Excellence) guidelines have recommended MRI of brain as the investigation of choice in epilepsy both for children and adults for the purpose of identifying structural abnormalities. The reason is the superior soft tissue contrast, multiplanar imaging capability and lack of beam hardening artefacts (in evaluation of the temporal fossa). This helps particularly in detecting focal lesions for eg. focal cortical dysplasia, mesial temporal sclerosis or hypothalamic hamartoma, which may pave the way to surgery in refractory epilepsy. This study has been conducted to study the etiology and spectrum of MRI findings in patients with seizures and age wise distribution of common underlying causes detected on MRI.

2. MATERIAL AND METHODS

- This study was conducted in Department of Radio diagnosis G R Medical College and J.A. Group of Hospitals, Gwalior in close association with Department of Neurology with a total of 100 patients were included in the study.

Sample size was calculated using the formula- Z^2pq/d^2

Where, $Z= 1.96$ at 95% C.I.

$p= 48.1\% = 0.481$

$q= 1-0.481$

D= 10% absolute error
 Therefore, $n = 1.96 \times 0.481(1-0.481)/10^2$
 $n= 95.90$

Source of Data & Method of Collection-

Patients with clinical symptoms of seizures who were referred for MRI from department of Neurology, Gajra Raja Medical College, Gwalior to the Department of Radio-Diagnosis with clinically suspected seizure disorder in a period of 1.5 years from January 2021 to June 2022 were the main source of data for the study. All MRI scans were performed on a 1.5 T Philips scanner.

Sequences used were T1WI sagittal, T1 IR coronal, T2W axial and coronal, FLAIR axial and coronal, gradient echo axial, DWI axial and ADC maps, T1W with contrast, MRA and MRS according to MR Imaging protocol of seizures.

Inclusion Criteria –

- All cases of clinically diagnosed epilepsy referred for MRI from department of neurology, GRMC Gwalior to Department of Radio diagnosis , GRMC ,Gwalior.
- Cases were included irrespective of age and sex.

Exclusion Criteria –

- Contraindications to MRI study like patients with pacemakers, metallic implants, aneurysmal clips.
- Claustrophobia or anxiety disorder aggravated by MRI.
- Inability to provide consent.

Statistical Analysis

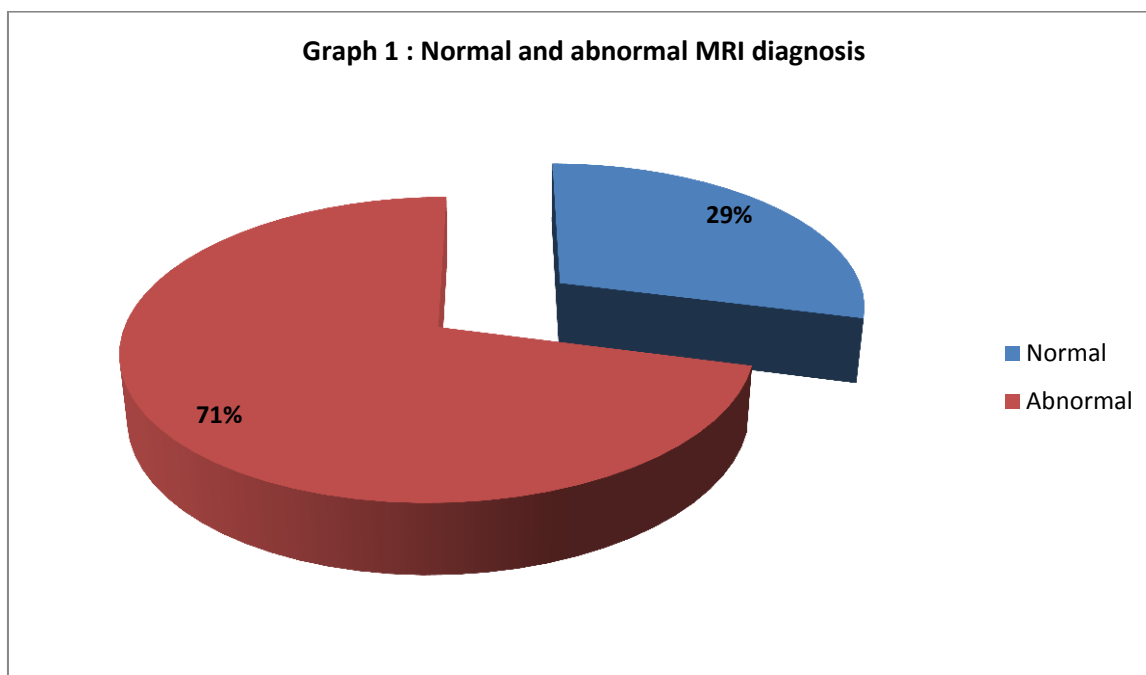
Data was entered in Microsoft Word and analyzed using SPSS version 16.0 and EPI INFO version 7.0. Appropriate statistical test were applied to analyze the data.

3. RESULTS

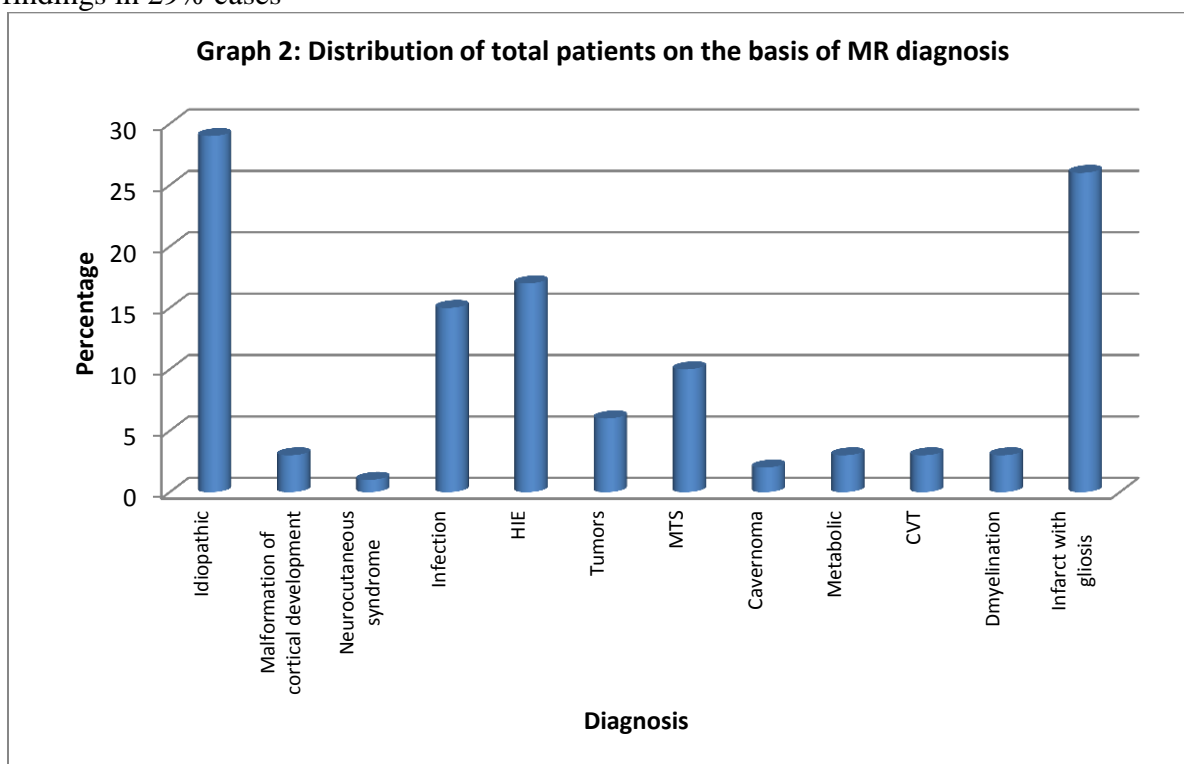
Table1 : Age and Sex wise distribution

Age group	Male	Female	Total	%
≤1 yr	10	7	17	17
1-18 yr	20	17	37	37
19-40 yr	18	10	28	28
>40 yr	15	3	18	18
Total	63	37	100	100

Out of total of 100 patients 17 patients were found in ≤ 1 year age group out of them 10 were males and 7 females, 37 patients were found in 1-18 year age group out of which 20 were males and 17 females, 28 patients in 19-40 year age group out of which 18 males and 10 females and 18 patients found in >40 year age group out of which 15 were males and 3 females. Male:Female ratio was 1.7:1. Maximum patients were found in 1-18 year age group followed by 19-40 year age group.

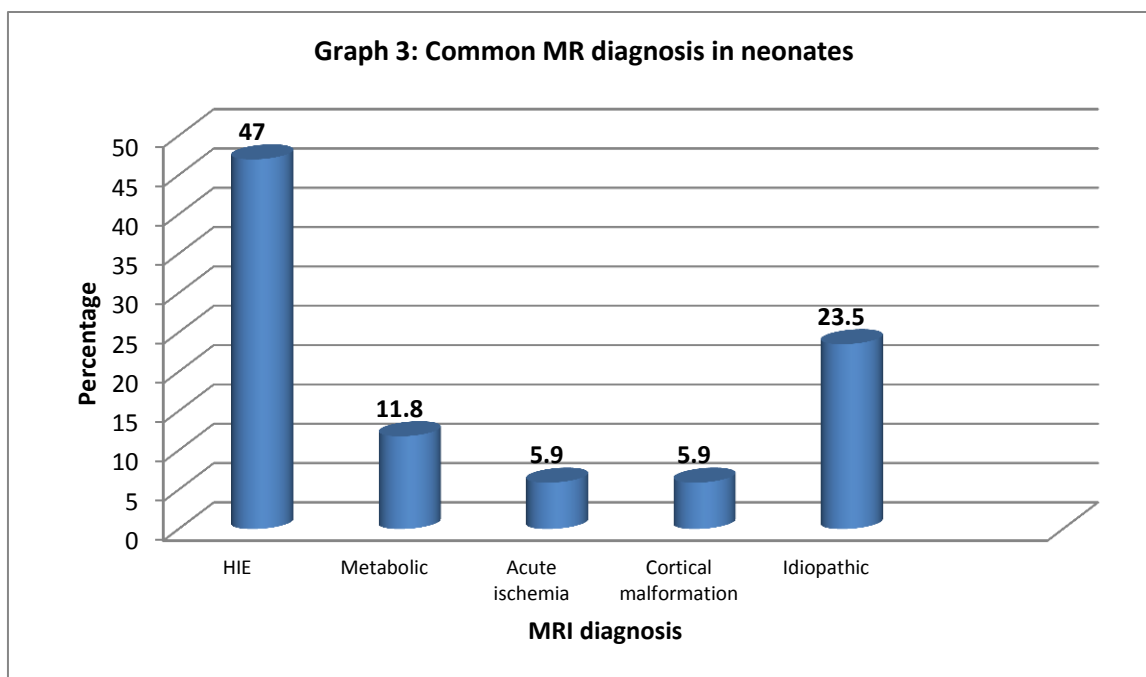


In 71% of cases the MRI showed some abnormality whereas MRI showed normal findings in 29% cases

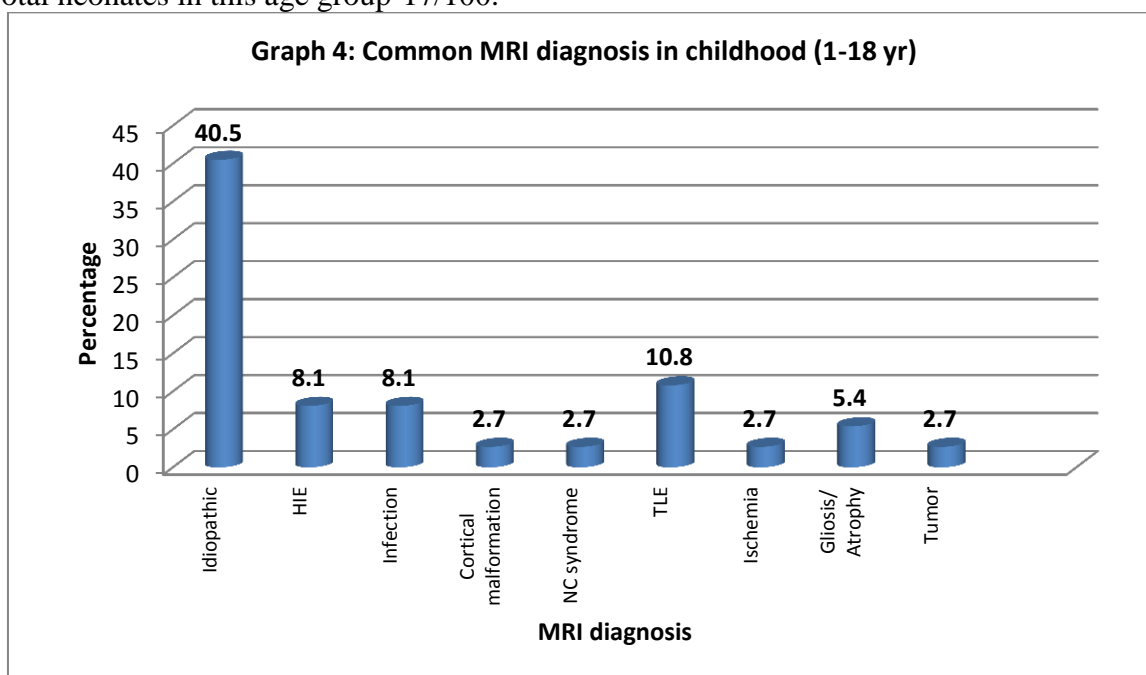


Maximum patients were in idiopathic group (29%). Overall most common cause found in our study was infarct with gliosis 26 % of cases (most common amongst the two being chronic infract with gliosis, accounting for 19% of cases and acute stroke constituting 7% of cases). It was followed by HIE 17% cases followed by infections found in 15% of cases. Mesial temporal sclerosis was found in 10% patients. Stroke was found in 7% patients and CVT in 3% cases. Less common causes detected in our study were malformation of cortical

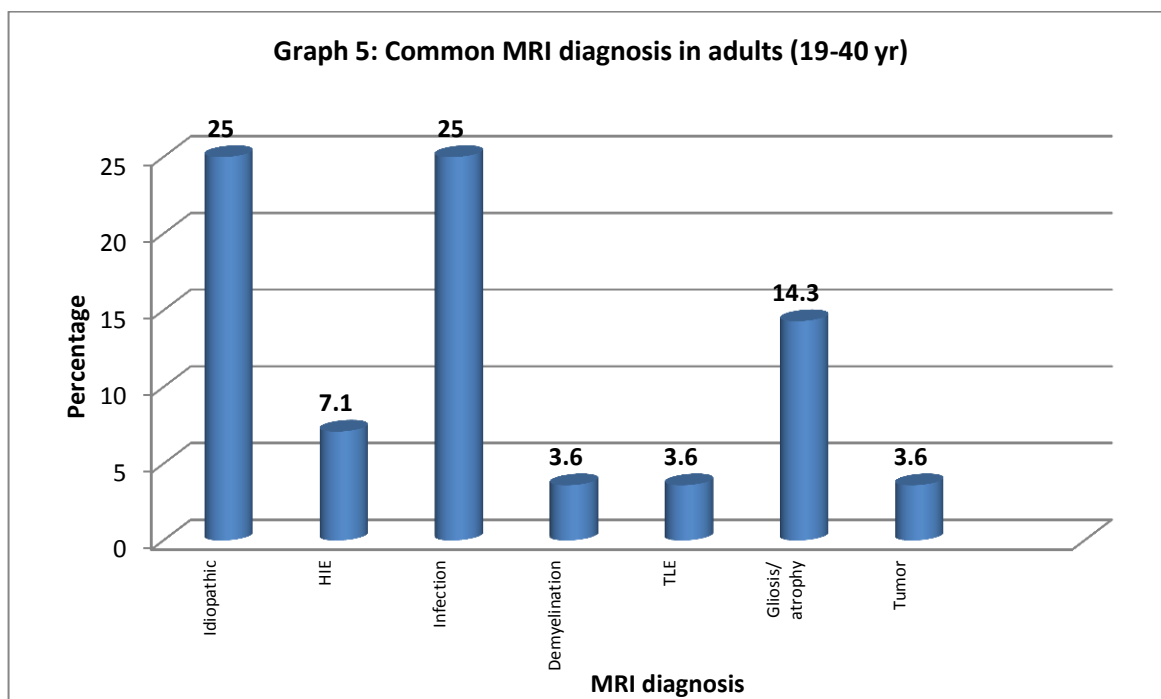
development, neurocutaneous syndrome, tumors, cavernoma, metabolic and demyelination. Some patients also showed more than one etiology.



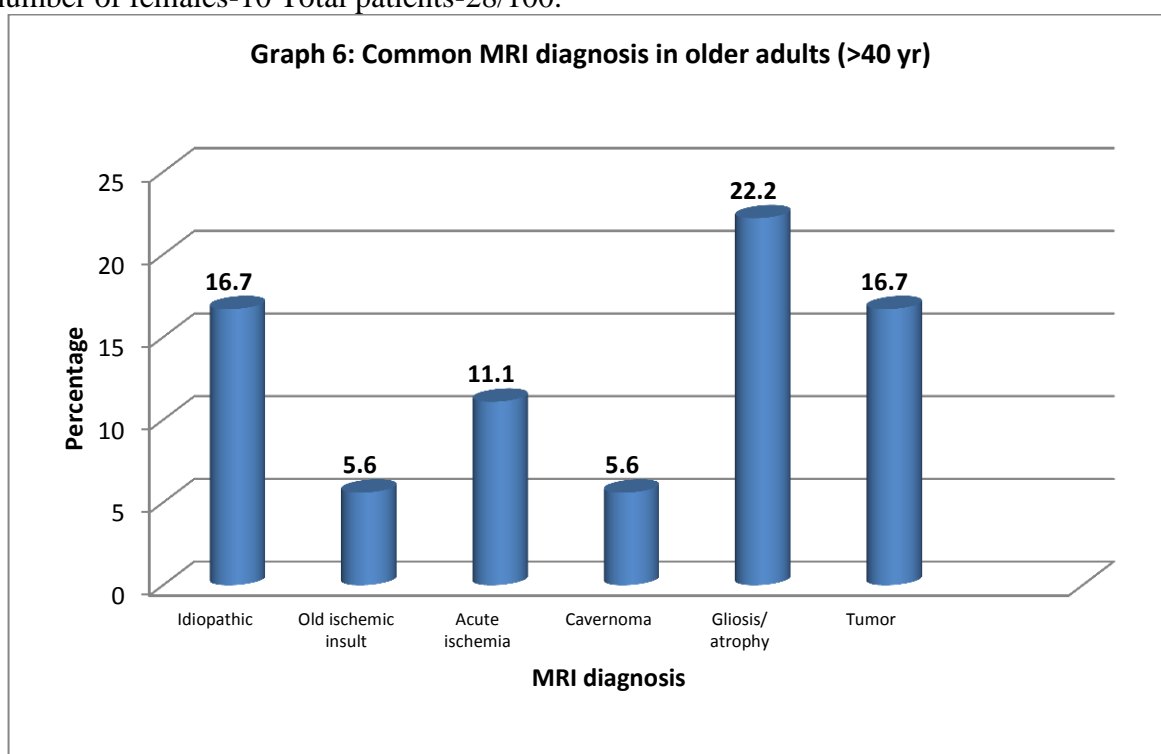
Most common cause found in this age group was HIE (47% of patients in this age group) followed by metabolic. Normal MRI was found in 23.5% patients in this age group. Total number of males in this age group-10 Total number of females in this age group-7. Total neonates in this age group-17/100.



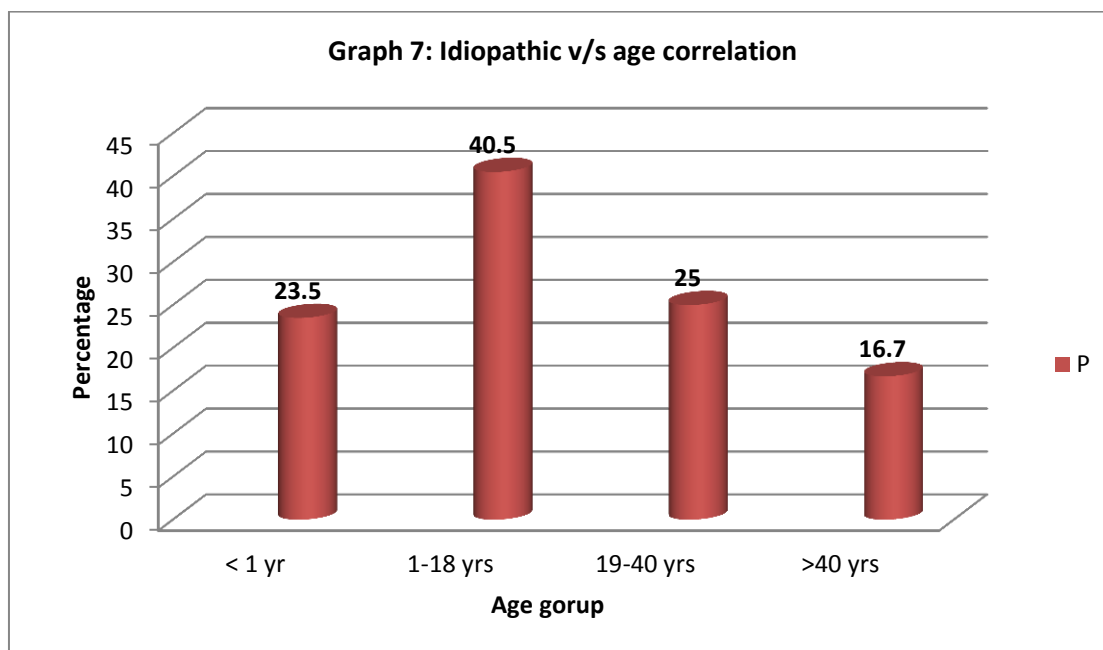
Most common cause found in this age group was mesial temporal sclerosis followed by infection and sequelae of HIE. Normal MRI was found in 40.5% patients in this age group. Total number of males in this age group-20 Total number of females in this age group-17. Total patients in this age group-37/100.



Most common cause found in this age group was infection followed by gliosis. Normal MRI was found in 25% patients in this age group. Total number of males-18 Total number of females-10 Total patients-28/100.



Most common cause found in this age group was gliosis followed by tumors then acute ischemia. Normal MRI was found in 16.7% patients in this age group. Total number of males-15 Total number of females-03 Total patients-18/100.



Normal MRI finding in a patient with seizure were found the most in 1-18 year age group. However the results were not statistically significant with p value of 0.275.

Table 2 : Infection v/s age correlation

Age group	A n(%)	P n(%)	Total n(%)	P value
< 1 yr	17 (100)	0 (0)	17 (100)	0.004 (Significant)
1-18 yrs	31 (83.8)	6 (16.2)	37 (100)	
19-40 yrs	19 (67.9)	9 (32.1)	28 (100)	
>40 yrs	18 (100)	0 (0)	18 (100)	
Total	85 (85)	15 (15)	100 (100)	

Infection as a cause of seizure was found the most in 19-40 year age group(32%) followed by 1-18 year (16%) group. The results were statistically significant with p value of 0.004

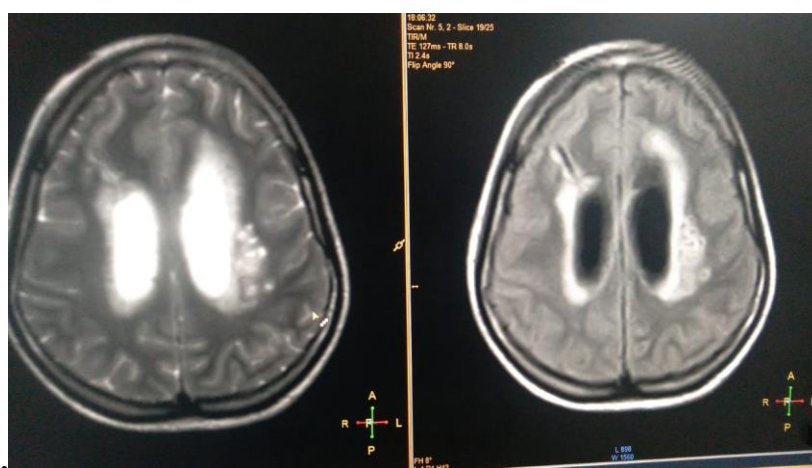


Fig.1 :a.Axial T2 and b. Axial T2/FLAIR sequences showing effacement of sulcal spaces in bilateral cerebral hemispheres with linear FLAIR hyperintensities along sulcal spaces in bilateral cerebral hemispheres with communicating hydrocephalus and periventricular ooze. Also multiple rounded, well defined T2 peripherally hyperintense

lesions seen in left periventricular region likely tuberculomas. VP shunt was seen in situ. CSF study was consistent with tubercular meningitis.

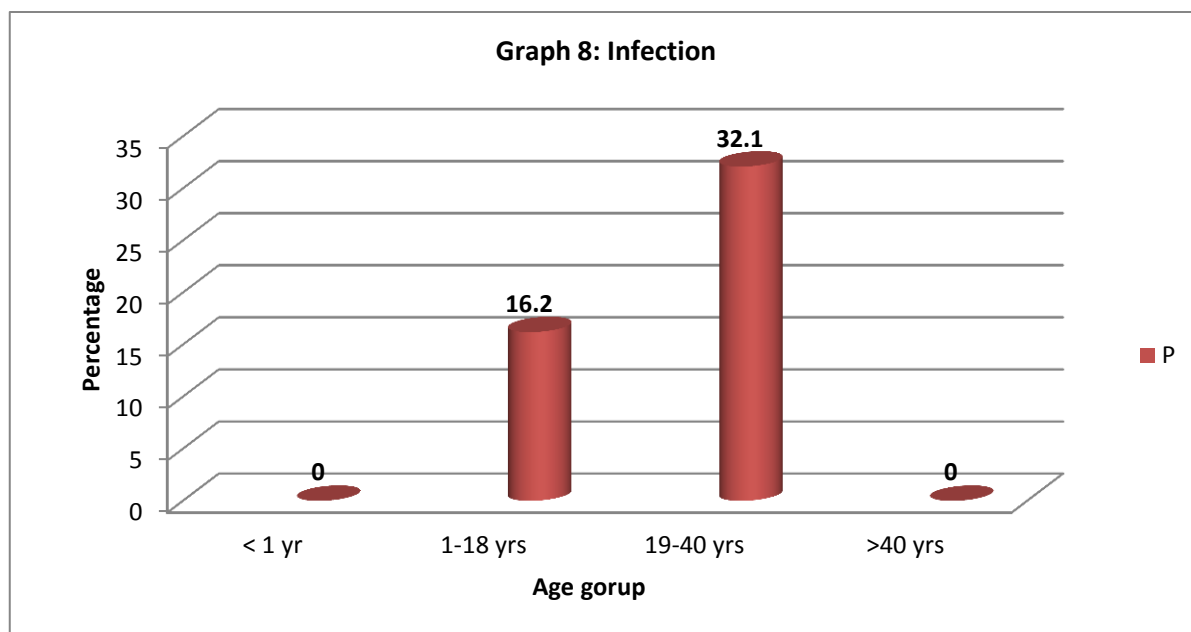


Table 3:Infarct with gliosis

Age group	A n(%)	P n(%)	Total n(%)	P value
< 1 yr	16(94.1)	1(5.8)	17 (100)	0.012 (Significant)
1-18 yrs	31(83.8)	6(16.2)	37 (100)	
19-40 yrs	19(67.9)	9(32.1)	28 (100)	
>40 yrs	8(44.4)	10(55.6)	18 (100)	
Total	74 (74)	26 (26)	100 (100)	

Infarct with gliosis was the most common finding in seizure patients in our study seen in 26% of the total patients. Amongst them, chronic infarct with gliosis was seen in majority 19% of total patients and acute-subacute infarct was found in total 7 (7%)patients which was predominant in late adult age group i.e> 40 years.

Also infarct with gliosis as a cause of seizure was found the most in >40 yrs (55.5% of patients in that age group) followed by 19-40 year age group(32.1%) followed by 1-18 year (16.2%) group and in 5.8 % patients in <1 year age group. The results were statistically significant with p value of 0.012.

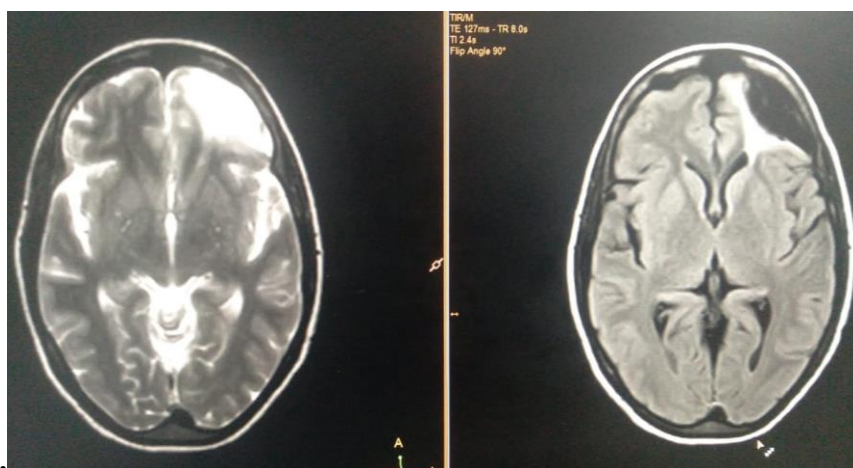


Fig.2-a.Axial T2 and **b.** Axial T2/FLAIR sequences showing area of encephalomalacia with surrounding gliosis in left frontal lobe.

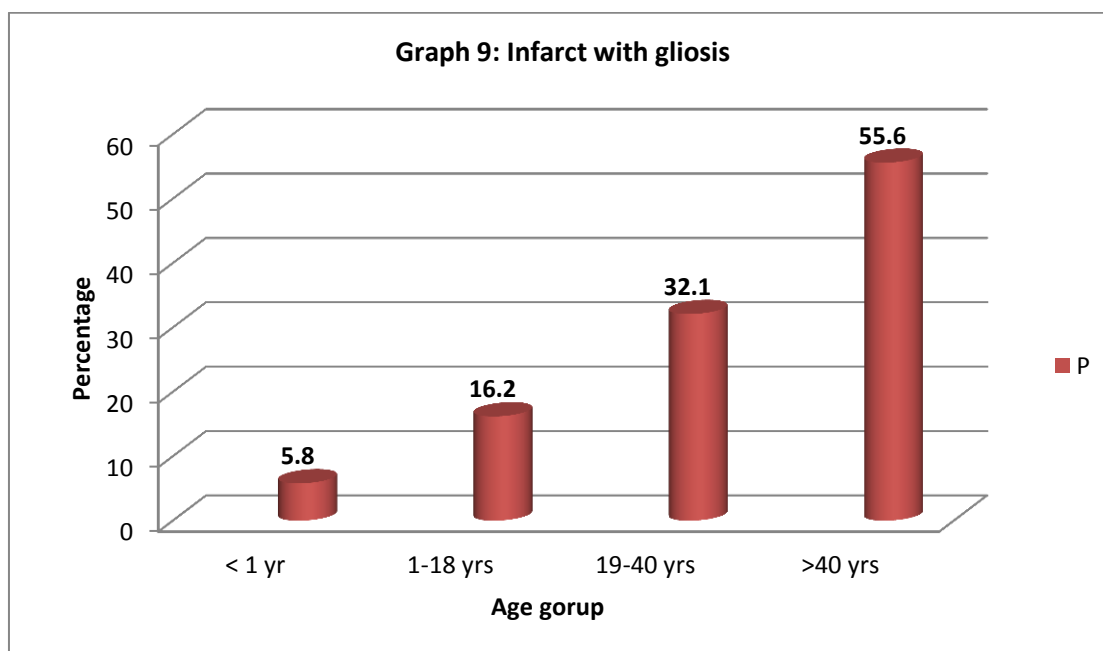
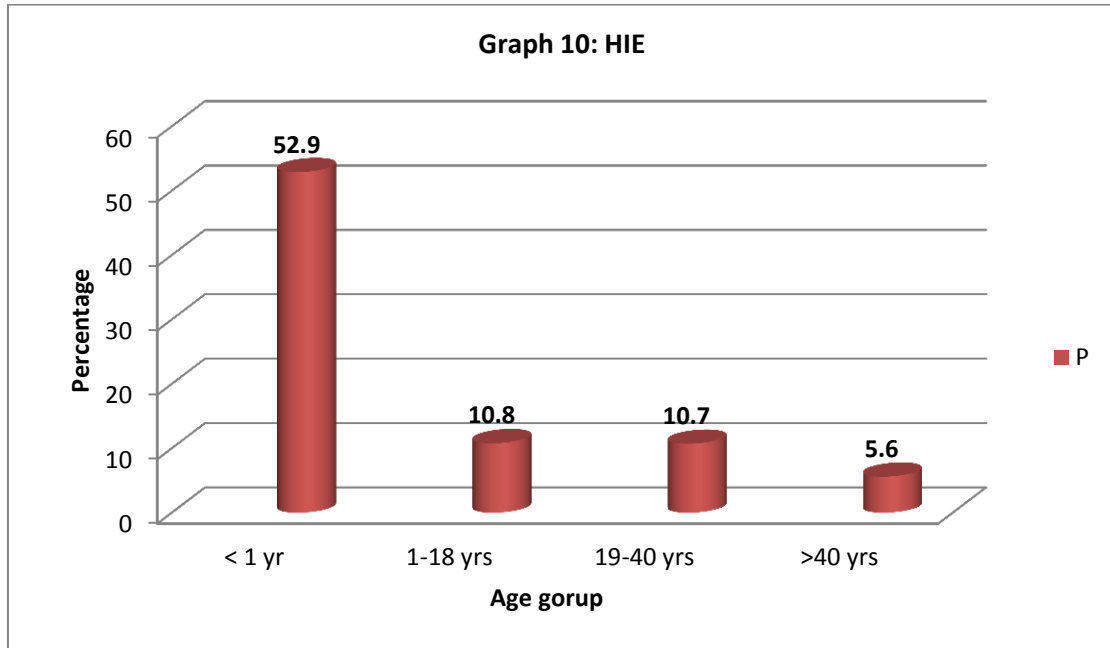


Table 4 :HIE

Age group	A n(%)	P n(%)	Total n(%)	P value
< 1 yr	8 (47.1)	9 (52.9)	17 (100)	0.001 (Significant)
1-18 yrs	33 (89.2)	4 (10.8)	37 (100)	
19-40 yrs	25 (89.3)	3 (10.7)	28 (100)	
>40 yrs	17 (94.4)	1 (5.6)	18 (100)	
Total	83 (83)	17 (17)	100 (100)	



HIE as a cause of seizure was found the most in < 1 yr age group (52.9%) followed by 1-18 year age group (10.8%). The results were statistically significant with p value of 0.001.

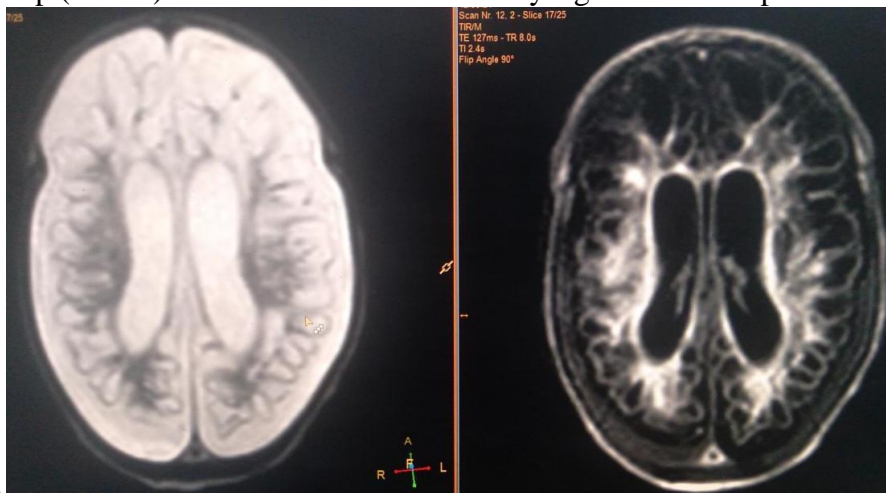
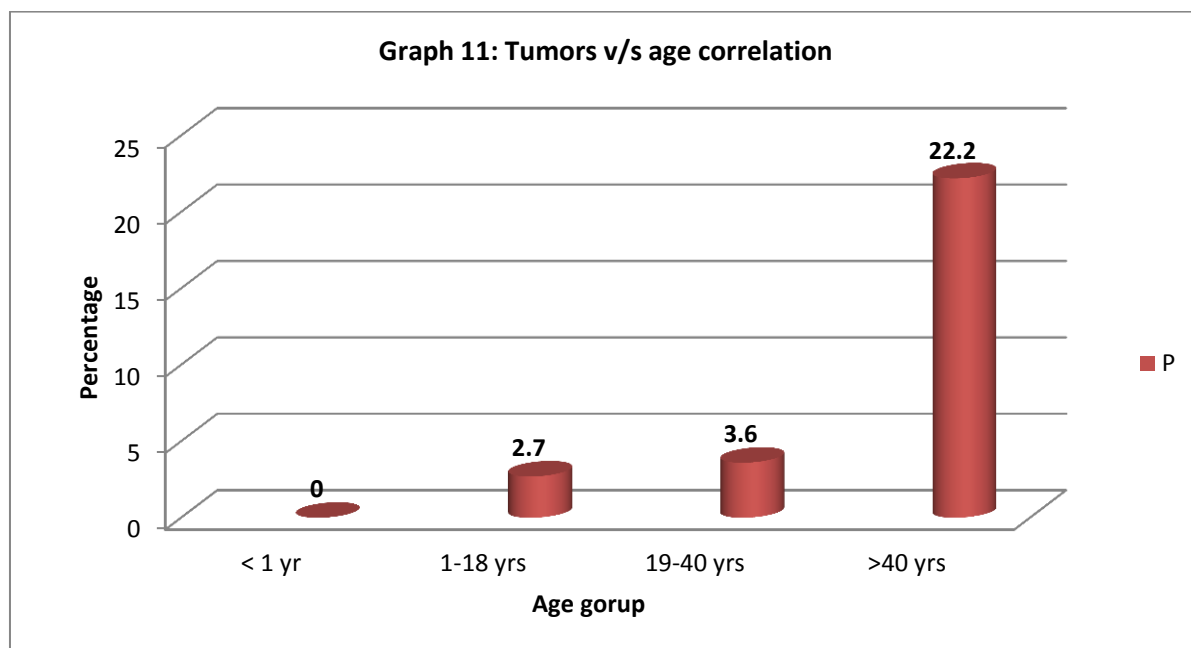


Fig.3 : Cystic encephalomalacia as a sequelae of HIE. Cerebral cortex replaced by multiple cystic lesions showing CSF signal intensity on all sequences with loss of brain volume and dilated ventricular system.



Tumors as a cause of seizure was found the most in > 40 yr age group (22.2%) followed by 19-40 year age group (3.6%). The results were statistically significant with p value of 0.036

Temporal lobe epilepsy (referring to mesial temporal sclerosis in our study) as a cause of seizure was found the most in 1-18 yr age group (16.2%). The results were not statistically significant with p value of 0.325. Metabolic causes were found in total 3 patients which was predominant in childhood age group. However the results were not statistically significant with p value of 0.142.

CVT was found in total 3 patients which was almost equally distributed. However the results were not statistically significant with p value of 0.360. Demyelination was found in total 3 patients which was predominant in 19-40 year age group. However the results were not statistically significant with p value of 0.660.

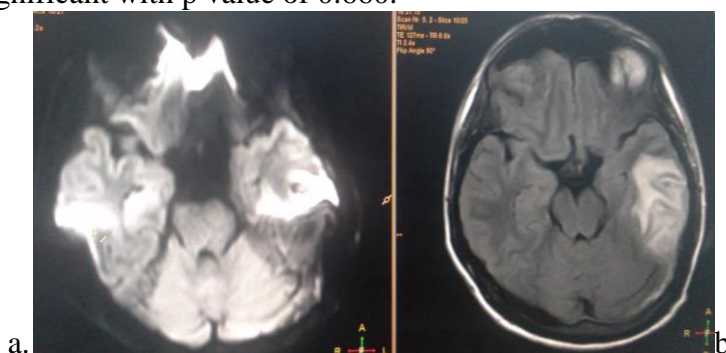


Fig.4- a.Axial DWI and B. Axial T2/ FLAIR sequences- T2/FLAIR hyperintensity showing DWI restriction in left parietal and left temporal lobe s/o infarct.

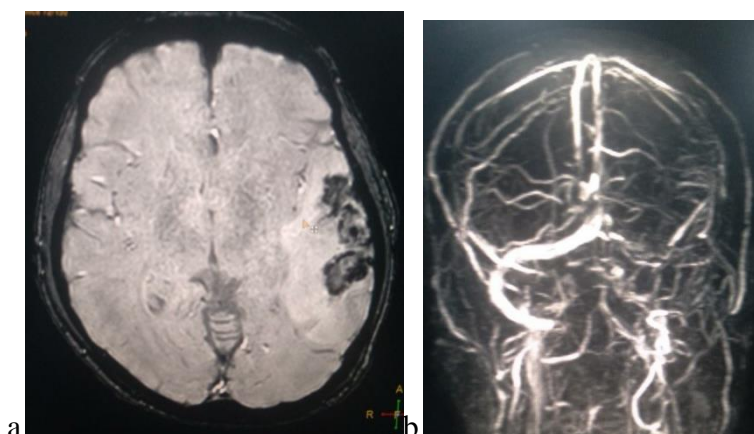


Fig.5 : a.Axial SWI and MR Venogram 3D image- The same patient showing multiple foci of SWI blooming in the area of infarct in left parital and temporal lobe- hemorrhagic transformation of infarct. Venogram showing loss of signal in left transverse and left sigmoid sinus consistent with Cerebral Venous Sinus thrombosis.

Only 1 patient with neurocutaneous syndrome was found in 1-18 year age group. However the results were not statistically significant with p value of 1.000. Cortical malformation was found in <1year and 1-18 year. However the results were not statistically significant with p value of 0.500

4. DISCUSSION

In our study of 100 patients with clinical presentation of seizure disorder who were referred for MRI from the department of Neurology, JAH Gwalior were included. Clinical history with appropriate investigations were taken from the patients as per the proforma and MRI scan was performed with Philips 1.5T MRI scanner. GTCS was the predominant pattern of presentation in our study. Age group in our study ranged from 5 day old infant to 75 year old person. Mean age of presentation with seizure in our study was 20.5 years (SD=19.28). In our study out of 100 patients with seizures 63% were males and 37% were females (M : F=1.7:1)(male predominance). In a study conducted by Ramakrishna Narra et al⁵ out of total 60 patients, 57% patients were male and 43% were females (male predominance seen), which correlates with our study.

We divided the age groups into four categories ≤ 1 year, 1-18 years, 18-40 years and >40 years for the purpose of our study. Various causes of seizures in each age group was then evaluated. We found 17 patients in ≤ 1 year group, 37 patients in 1-18 year age group, 28 patients in 19-40 year and 18 patients in >40 year age group. In our study majority patients were found in 1-18 year age group followed by 19-40 year age group. MRI was normal in 29 out of 100 patients (29%) in our study out of which 18 were females and 11 were males (p value =0.001) which indicates that idiopathic was more common females than males. In a study conducted by Ramakrishna Narra et al⁵ maximum patients were in age group 1-30 years and normal MRI findings were seen in 28 out of 60 patients i.e. (47%). In another study by Ravindernath et al⁶, 110 seizure patients were evaluated out of which 53 cases (48.1%) patients showed normal MRI findings and showed male predominance (Male =67% and Female=33%) similar to our study.

Infarct with gliosis was the most common finding in seizure patients in our study seen in 26% of the total patients.

Amongst them, chronic infarct with gliosis was seen in majority 19% of total patients and acute-subacute infarct was found in total 7 (7%) patients which was predominant in late adult age group i.e > 40 years.

Also infarct with gliosis as a cause of seizure was found the most in >40 yrs (55.5% of patients in that age group) followed by 19-40 year age group(32.1%) followed by 1-18 year (16.2%) group and in 5.8 % patients in <1 year age group. The results were statistically significant with p value of 0.012.

Results correlated with the study by Ramakrishna Narra et al⁵ which also found cerebral infarcts with gliosis as the most common cause of seizures. Total 8 out of 60 patients (i.e. 13% patients) showed infarct with gliosis in this study. In the study by Ravindernath et al⁶ cerebrovascular causes including stroke, CVT and gliosis was the most common cause found on MRI in 23.64% patients followed by infectious etiology (including tuberculoma, similar to our study. However in our study the second most common overall cause found was HIE (hypoxic ischemic encephalopathy) in 17 patients (17% cases) and most common age group was ≤1year and showed downward trend with age.(4 patients in 1-18 year age group, 3 patients in 19-40 year age group and 1 patient in >40 year age group). The results were statistically significant with p value of 0.001. In a study by Ankita S Mundhe et al⁷ it was found that most common cause of seizures in 0-3 year age group was HIE whereas infection was the most common cause in 3-12 year age group.

Infections including pyogenic, viral, tubercular and parasitic were found in a total of 15 patients (15%). Most of them were tubercular in etiology and was found in young population (1- 18years-6 patients, constituting 16.2% of patients in that age group and 19-40 year-9 patients, constituting 32.1% patients in that age group), which was statistically significant (p value-0.004). In a study by Ravindernath et al⁶ most common abnormality seen was chronic infarct (cerebral infarct with gliosis seen in 20% patients followed by infective causes (NCC in 7.2 % and tuberculomas in 3.6%) and these infective causes was predominantly found in younger age group (1-30years) similar to our study.

Tumors as a cause of recurrent seizures was found in 6 patients (6%) which showed upward trend with increasing age with majority of patients found in >40 year age group. The results were statistically significant with p value of 0.036. In study by Ramkrishna Narra et al⁵ tumors were found in 2 patients. In a study by KiranKumar et al⁸ total of 12 cases of tumors were found with mean age of presentation being > 50 years consistent with our study.

Malformation of cortical development was found in 3 patients (3%) out of which one was in ≤1year age group and 2 were in 1-18 year age group. This was however not statistically significant. In study by RamkrishnaNarra et al⁵ malformation of cortical development were found in 2 patients (3% of total cases). In a study by KiranKumar et al⁸ total of 5 out of 150 cases (3.3%) of malformation of cortical development were found, consistent with our study.

Mesial temporal sclerosis was found in 10 patients with 6 patients in 1-18 year age group, 2 in 19-40 year age group and 2 in >40 year age group distribution of which was not statistically significant. In study by Vineet Ojha et al⁹ most temporal lobe epilepsy cases were seen in young adult age group 20-39 year with MTS being the most common etiology. The findings were not consistent with our study in which most patients were found in 1-18 year age group.

Other less frequently encountered causes found in seizure patients on MRI in our study were neurocutaneous syndrome(SWS) identified in 1 patient, cavernoma in 2 cases (similar to a study by Ramakrishna Narra et al⁵ in which 2 out of 60 (3.3%) patients showed cavernoma), metabolic causes in 3 cases (mostly in childhood age group) and demyelination in 3 cases.

CVT was also found in 3 patients (3% of cases) distributed in both infants as well as middle age-elderly group. In a study by Kaur S. et al¹⁰ cortical venous thrombosis as a cause for seizure was found in 4% cases.

5. CONCLUSION

We hereby conclude that MRI plays a crucial role in diagnosis and management of patients with seizure disorder. Various causes of epilepsy found in patients on MRI in our study were Gliosis, infections, HIE, mesial temporal sclerosis, stroke, tumors, metabolic, demyelination, Neurocutaneous syndrome and malformation of cortical development. We conclude from our study that most common age group presenting with complaints of seizure for MRI was 1-18 year followed by 19-40 years and patients with epilepsy show male predominance.

Our study suggests the importance of MRI in evaluation of underlying brain pathologies causing seizure disorder and age wise most common causes found on MRI Brain study.

6. REFERENCES:

1. Harrison's Principles of Internal Medicine, 20e Chapter 418: Seizures and Epilepsy Daniel H. Lowenstein.
2. Fisher R, Acevedo C, Arzimanoglou A et al. ILAE Official Report: A Practical Clinical Definition of Epilepsy. *Epilepsia*. 2014;55(4):475-82.
3. Chang BS, Lowenstein DH. Epilepsy. *N. Engl. J. Med.* 2003;349 (13): 1257-66.
4. Scheffer I, Berkovic S, Capovilla G et al. ILAE Classification of the Epilepsies: Position Paper of the ILAE Commission for Classification and Terminology. *Epilepsia*. 2017;58(4):512-21.
5. Narra R, Putcha A, Y, Penumatcha N. Mri Evaluation of Seizures: Study at a Tertiary Referral Center in Southern India. *Asian J. Med. Radiol. Res.* 2021;9(2):20-26.
6. Ravindernath, Vishal Singh. Role of MRI in evaluation of seizures. *IAIM*, 2016; 3(12): 127-136.
7. Ankita S Mundhe, Balaji H Kombade. Study of role of MRI in evaluation of pediatric epilepsy at a tertiary hospital. *MedPulse International Journal of Radiology*. February 2022; 21(2): 23-29.
8. Kiran Kumar M, Kushwah APS, Pande S, et al. MRI evaluation of epilepsy with clinical correlation. *J. Evid. Based Med. Healthc.* 2019; 6(21), 1519-1524.
9. Ojha V, Mani A, Basu D, et al. Association between Clinical Features and Magnetic Resonance Imaging Findings in Patients with Temporal Lobe Epilepsy. *J Assoc Physicians India* 2022;70(11):13–17.
10. Kaur S, Garg R, Aggarwal S, Chawla SPS, Pal R. Adult onset seizures: Clinical, etiological, and radiological profile. *J Family Med Prim Care*. 2018 Jan-Feb;7(1):191-197.