

Original Research Article

Role of MRI in evaluation of seizures

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Abstract

Introduction: Assessment of the patient presenting with seizure disorder is a common problem in clinical practice. MR imaging plays a pivotal role in the evaluation of patients with seizures. Accurate diagnosis of the cause of seizure is crucial for finding an effective treatment.

Materials and methods: A prospective study was conducted on 110 patients who presented with clinical impression of seizures from August 2013 to August 2015 who were subjected to MRI scanning. This study was carried out in 110 patients with clinical presentation of seizures by subjecting them to magnetic resonance imaging to evaluate the spectrum of findings, various etiologic factors for seizures, and the most common imaging abnormality. Depending on the radiological features a provisional diagnosis was made correlating the clinical features.

Results: In our study, 110 patients who were clinically diagnosed of seizure disorder were undergone MRI examination of the brain. In our study, cerebral infarct 20%, NCC 7.27%, atrophy 5.45%, cortical malformation 3.64%, tuberculoma 3.64%, venous thrombosis 3.64% constitute the main etiological factors other being neoplasm, tuberous sclerosis, SWS and abscess. The most common abnormality was cerebral chronic infarct. The MRI findings were normal in 53 (48.1%) cases and revealed spectrum of abnormalities in 57 (51.9%) cases. The common abnormalities were cerebral infarction with gliosis (20%), infections – NCC (7.2%) and tuberculoma (3.6%), cerebral atrophy (5.45%), developmental cortical malformations (3.6%), venous thrombosis (3.6%), tuberous sclerosis (1.82%), developmental vascular malformations (1.82%), low grade glioma (1.82%), SWS (0.91%), meningioma (0.91%), cerebral abscess (0.91%) were among the abnormal findings.

Conclusion: This study observed that MRI with appropriate imaging protocols adds sensitivity and specificity in evaluation of seizures.

Key words

Seizure, MRI, Cerebral chronic infarct.

Introduction

Seizure is a paroxysmal alteration in neurologic function resulting from abnormal excessive neuronal electrical activity [1]. Epilepsy is a chronic condition characterized by recurrent seizures unprovoked by an acute systemic or neurologic insult [1]. An epileptic seizure is a clinical manifestation of abnormal, excessive neuronal activity arising in the grey matter of the cerebral cortex [2]. The incidence of epilepsy is approximately 0.3 to 0.5% and prevalence of epilepsy estimated as 5 to 10 persons per 1000 [3]. It is age dependant and higher in children and elderly persons than in young adults.

An estimated 2.5% of the population will have at least one non-febrile seizure during their lifetime. Most of the patients suffering from this disease infact majority of them have good control of this disease with the use of antiepileptic drugs. However up to 20% of patients continue to have seizures despite the best medical treatment. The good news is that most of these patients with intractable epilepsy have seizures that are focal and which can be potentially treated [3, 4].

In clinical practice the assessment of patients presenting with seizures is a problem that the physician faces quite regularly. In order to diagnose and find out the etiology of the lesion, there are many neuro radiological investigations that can be utilized. These include x-ray of skull, pneumocephalography, CSF examination, carotid angiography, EEG, CT and MRI [5].

Although the treatment of an isolated seizure is directed toward the immediate underlying metabolic or neurologic derangement, epilepsy usually requires long term pharmacotherapy or in selected cases neurosurgical intervention to eliminate or reduce recurrent seizures. Neurosurgery is most often considered in medically refractory epilepsy when removal or isolation of epileptogenic foci is possible without unacceptable neurologic deficit. In this context, the revolutionary introduction of MRI for evaluation of seizures has been a great boon,

both for the diagnosis of cerebral lesions as well as clinical management of patients with neurologic disorders.

MR imaging has emerged as the more diagnostically valuable and most valuable tool for preoperative localization of epileptogenic focus because of its excellent soft tissue contrast, allowing for detailed depiction of anatomy, freedom from beam – hardening artifact in basal brain that occur with CT and capacity for multi planar imaging [1]. A number of studies have been reported with MR abnormality 32% to 90% and in temporal lobe epilepsy 75% to 100%.

The diagnosis of epilepsy with the help of MRI has made this diagnostic tool beyond compare to other investigations. MR is much more diagnostically valuable and there is the appropriate neuroimaging study of choice.

It has been proven beyond doubt that MRI is the most meaningful procedure in the diagnosis, treatment and follow-up of patients with inflammatory and parasitic lesions of the brain such as cysticercosis tuberculoma, brain abscess, and encephalitis. MR gives more precise localization and histological nature of lesions and subsequently, this is of immense help to both clinicians as well as neurosurgeons in their attempt to achieve a faster and more accurate method of discovering the nature of the pathologies. Coregistration of MRI with other functional imaging modalities including PET and SPECT has also been proven valuable in localization of structural and functional alteration [1].

The role of MR in epilepsy surgery in identifying the epileptogenic focus also lies in its ability to depict topographic relationships between epileptogenic lesion and the eloquent regions of brain [1]. MR is especially useful for prognosticating postoperative seizure control. The following study has been undertaken to study the etiology and spectrum of MRI findings in patients with seizures.

Materials and methods

A prospective study was conducted on 110 patients who presented with clinical impression of seizures from August 2013 to August 2015. Patients were subjected to MRI scanning and studied in Mediciti Institute of Medical Sciences, Ghanpur, Medchal.

All patients who were referred to Department of Radio-Diagnosis and Imaging Sciences with clinical symptoms and signs of seizures were studied. Study was performed with MRI machine (PHILIPS). A minimum of 30 cases were intended to be taken up for study, but the scope of increasing the number of cases also exist depending on the availability within the study period. Totally 110 cases were studied from August 2013 to August 2015.

Depending on the radiological features a provisional diagnosis was made correlating the clinical features.

Inclusion criteria

All patients presented with seizures, irrespective of age and sex was included.

Exclusion criteria

Patients with pacemakers, metallic implants, aneurysmal clips, Claustrophobia or anxiety disorders exacerbated by MRI, inability to provide consent.

Criteria for patient selection: The patients selected for the study were clinically diagnosed cases of seizures as per the criteria laid down by the ILAE 1981.

A detailed history was taken and clinical examination was done. The points noted were duration of illness, type of seizures, and any associated illness. Detailed clinical and neurological examination was done to find any neurological deficit. Based on the history and examination, a clinicoetiological diagnosis was made.

Biochemical investigations were done as per the proforma and were found to be within normal limits. All the patients underwent MRI scanning on 1.5T PHILIPS ACHIEVA. The procedure was briefly explained to the patient including the risks of contrast examination.

Routine investigations like Hb, TLC, DLC, ESR, Urine routine examination, Blood urea, Sugar, Serum creatinine, Serum calcium, Liver function tests, Fundus examination, and X-ray chest – PA view were done.

A special investigation like MRI scan brain (Plain and contrast) was done.

Materials used were Whole body MRI scanner PHILIPS 1.5Telsa, Contrast media gadolinium (Gadobenate Meglumine), and Emergency drugs like Inj. Avil, Dexamethasone, and Adrenalin, Syringes 5ml, 10ml and 20 ml.

Technique of examination: All patients were screened before entry into the MRI for ferromagnetic objects, cardiac pacemakers, and aneurysm clips etc. Patients were examined in the supine position on the MRI machine after proper positioning, and immobilization of the head was obtained. The head coil was used for the scan.

Initial topogram of the head was obtained and sequences were planned according to the MRI seizure protocol. MRI protocol at 1.5T includes the entire brain from nasion toinion; conventional routine 5mm slice thickness, T1 and T2 axial sequences, 1.5 mm slice thickness coronal oblique. T1 weighted MPRAGE or SPGR images. 1.5mm slice thickness – are acquired as a 3 dimensional (3D) volume, there by post processing and reformatting images into multiple planes.

Protocol also includes coronal and axial FLAIR sequences with 2-3 mm slice thickness 1 mm inter slice gap. A conventional thin slice, T2 weighted axial and coronal sequence is also obtained.

Gadobenate dimeglumine paramagnetic contrast agent was used in MRI. Contrast agent was used if a known tumour or vascular malformation identified and also used in neurocutaneous syndromes. Dosage used as 0.1 mg/kg wt. (Adults 5ml, children 2 ml).

As a precautionary measure, resuscitation apparatus and emergency drugs were kept ready.

The scans were studied in detail on monitor and finally films were taken for permanent record. MRI findings were recorded in all patients as per the proforma. Every effort was made to make sure of high quality scans and to avoid artifacts. Various details of MRI findings were studied as under- any lesion present, site, signal intensity, surrounding edema, any hemorrhage, atrophy, infarction, mass effect, contrast enhancement/enhancing lesions, calcification, developmental malformations, and hydrocephalus (**Figure – 1**).

Results

Maximum number of patients was in the age group of 1-30 years (48.18%), Sex ratio - M: F 1.5: 1, Male 67 (61%) and Female 43 (39%) with Male predominance was noted (**Table - 1**).

Maximum number of patients presented with GTCS 87/110 (79.1%). More than half of the patients 76/110 (69.09%) were presented with one to three months of onset of seizures (**Table - 2**).

Two cases had both infarct and atrophic changes and other two cases had both infarct and venous thrombosis.

In 53 (48.18%) patients the study was normal. Cerebrovascular causes, (infarct with gliosis, venous thrombosis) constitute (23.64%) 26 patients the most common MR diagnosis in patients presenting with seizures.

The MR examination revealed pathological findings in 57 out of 110 patients (52%) which includes cerebral infarct with gliosis (20%), NCC

(7.27%), atrophy (5.45%), gliomas (1.82%), cortical malformations (3.64%), tuberculoma (3.64%), venous thrombosis (3.64%), cavernoma (1.82%), tuberous sclerosis (1.82%), cerebral abscess (0.91%), and SWS (0.91%) meningioma (0.91%) as per **Table – 3**.

Figure - 1: T2, COR, Axial, post contrast and MRS shows thick ring enhancing lesion in left frontal region with perilesional edema – suggestive of tuberculoma.

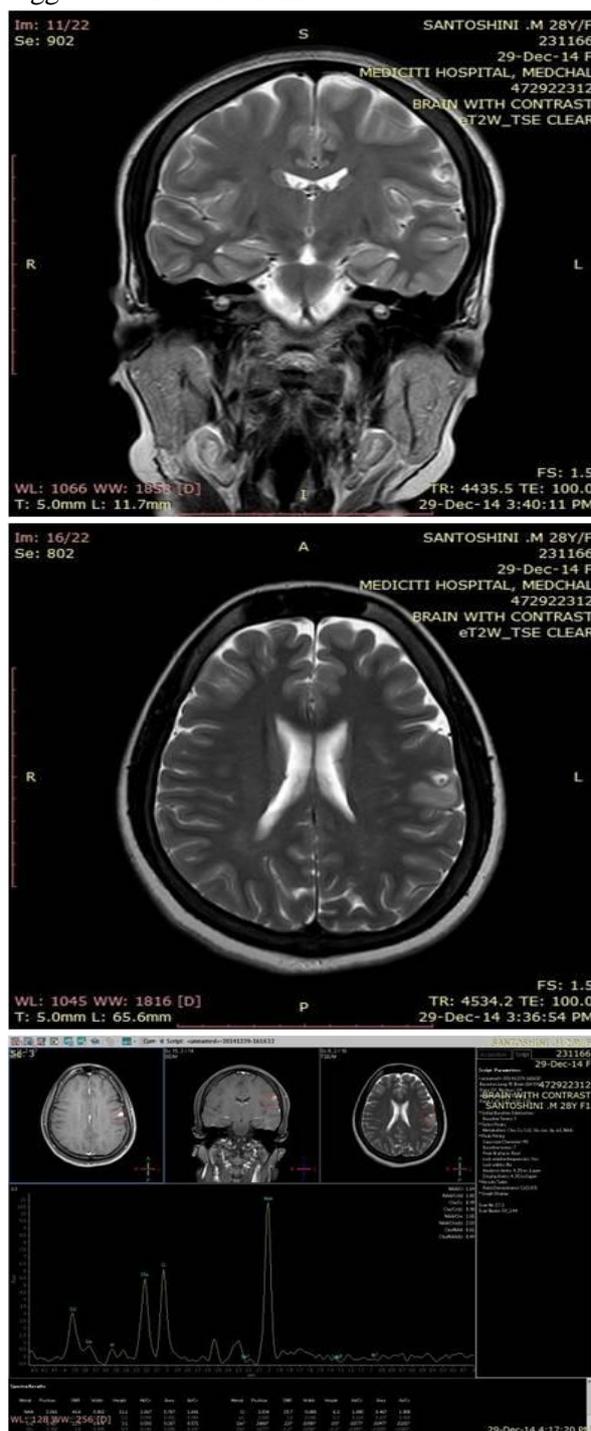


Table - 1: Age and sex wise distribution.

Age in years	Male	Female	Total	Percentage
< 1	6	13	19	17.27
1-15	18	10	28	25.45
16-30	16	9	25	22.73
31-45	9	8	17	15.45
46-60	8	3	11	10
>60	10	0	10	9.1
Total	67 (61%)	43 (39%)	110	

In the present study 57(52%) patients showed magnetic resonance imaging abnormalities (**Table - 4**). In the present study male patients (67%) showed more MR abnormalities (**Table - 5**). MR abnormality was observed maximum in patients between 1-30 years (22 patients) as per **Table - 6**. MRI was positive in all the patients presenting with temporal lobe seizures or absence seizures or motor seizures (**Table - 7**).

Table - 2: Distribution of patients on the basis of clinical diagnosis and duration of illness of seizures.

Clinical diagnosis	No. of patients	%
GTCS	87	79.1
Myoclonic seizures	10	9.1
Absence seizures	1	0.91
Simple partial seizures	4	3.64
Complex partial seizures	2	1.82
Temporal lobe seizures	2	1.82
Febrile seizures	1	0.91
Neonatal seizures	1	0.91
Motor seizures	1	0.91
Tonic seizures	1	0.91
Duration of illness	No. of patients	%
<1 month	04	03.64
1-3 months	76	69.09
>3months	30	27.27

Discussion

Patients presenting with seizures can have wide range of MR imaging abnormalities depending upon the etiology. MRI can reliably identify and

localize the intracranial abnormality so that further management can be planned accordingly. The study in southern Indian population, it was observed that most common neuroimaging abnormalities associated were cerebrovascular diseases, infections and developmental malformations. Most common age group in our study was 1-30 years with male predominance. In our study 110 patients with clinical diagnosis of seizures were selected as per the criteria laid down by ILAE 1981. The clinical history of each patient was recorded and all underwent routine biochemical investigations as per proforma. MRI scan was carried out with 1.5 T PHILIPS MRI scanners. Patients presented with seizures of varying duration ranging from few days to few months. GTCS was the most common clinical diagnosis constituting (79.1%) cases.

Table - 3: Distribution of patients on MR diagnosis.

MR diagnosis	No. of patients	%
Normal study	53	48.18
Infarct with gliosis	22	20.00
NCC	08	07.27
Atrophy	06	05.45
Tuberculoma	04	03.64
Venous thrombosis	04	03.64
Developmental malformations	04	03.64
Glioma	02	01.82
Cavernoma	02	01.82
Tuberosis sclerosis	02	01.82
Meningioma	01	00.91
Cerebral abscess	01	00.91
Sturge-weber syndrome	01	00.91

Table - 4: Percentage of abnormal MR Diagnosis.

Variable	No. of patients	%
Normal	53	48%
Abnormal	57	52%
Total	110	100%

Table - 5: Distribution of abnormalities on sex wise distribution.

Sex distribution	No. of patients	%
Male	38	67%
Female	19	33%
Total	57	100%

Table – 6: Distribution of abnormalities in various age groups.

MR diagnosis	< 1 years	1-15 years	16-30 years	31-45 years	46-60 years	>60 years	Total
Infarct with gliosis	5	3	1	1	4	8	22
NCC	0	2	3	2	1	0	8
Atrophy	3	1	1	0	0	1	6
Tuberuloma	0	1	3	0	0	0	4
Venous thrombosis	0	0	0	4	0	0	4
Developmental malformations	3	1	0	0	0	0	4
Glioma	0	1	0	0	0	1	2
Cavernoma	0	0	1	0	0	1	2
Tuberous sclerosis	0	1	1	0	0	0	2
Meningioma	0	0	0	1	0	0	1
Cerebral abscess	0	0	1	0	0	0	1
Sturge-weber syndrome	0	1	0	0	0	0	1

Table - 7: Distribution of specific type of seizures with MR Abnormality.

Type of seizures	MR positivity	%
GTCS	42/87	48
Myclonic seizures	8/10	80
Simple partial seizures	2/4	50
Complex partial seizures	1/2	50
Absence seizures	1/1	100
Temporal lobe seizures	2/2	100
Tonic seizures	0/1	-
Motor seizures	1/1	100
Neonatal seizures	0/1	-
Febrile seizures	0/1	-

Age and sex distribution

The age range of patients was from neonate to 78 years with male predominance, male 67 (61%) and female 43 (39%).

MRI positivity

The MR examination revealed pathological findings in 57 out of 110 patients (52%) which includes, cerebral infarct with gliosis (20%), NCC (7.27%), 71 atrophy (5.45%), gliomas (1.82%), cortical malformations (3.64%), tuberculoma (3.64%), venous thrombosis (3.64%), cavernoma (1.82%), tuberous sclerosis (1.82%), cerebral abscess (0.91%), and SWS (0.91%) meningioma (0.91%).

Cerebral infarcts with gliosis

22 patients (20%) revealed cerebral infarction on MRI study. Four patients revealed acute infarct in parieto-occipital lobes characterized by diffusion restriction with mild swelling and effacement of adjacent sulci. One patient showed features of subacute hematoma in parietal lobe showing hyper intensity on T1, T2 and FLAIR sequences. The lesion shows hypointense thin rim on T2WI, FLAIR images. Perilesional edema was seen. Two patients showed MRA

abnormality like narrowing of cortical arterial branches. Chronic ischemic changes with gliosis in left fronto-parietal lobe noted in 6 patients and one patient showed cystic encephalomalacia changes in right parieto-occipital lobe. Ten patients showed tiny chronic ischemic lesions in deep white matter with bilateral periventricular hyperintense lesions on T2 and FLAIR with no restriction on diffusion sequences. One patient showed old infarct with gliosis in parietal lobe and deep gray matter nuclei. Danier C, et al. [6], conducted prospective cohort study of early onset of seizures in 661 stroke patients and concluded that infarcts involving cerebral cortex, there was a high risk of early stroke in watershed infarcts (23%) than territorial strokes (5.3%).

Neurocysticercosis

Eight patients showed evidence of neurocysticercosis (NCC). All patients had parenchymal form of NCC, with multiple ring enhancing lesions in cerebral hemispheres. Lesions showed T1 hypointense and T2 hyperintense contents. Few lesions showed perilesional edema. Most of lesions were seen in parietal lobe and some showed cystic signals with eccentric speck within the lesion. MRS showed tall choline peak in all patients. Four patients had few ring enhancing lesions with perilesional edema and four patients had multiple intra parenchymal lesions of different stages. TR Velasco, et al. [7], evaluated 512 patients of intractable epilepsy and concluded that isolated NCC was found in eight patients (1.56%). Tushar B. Patil, Madhuri M. Paithankar, et al. [8] studied 40 patients with probable diagnosis of NCC and concluded that 72% patients showed one lesion, 27% with multiple lesions and common site was parietal lobe (4%).

Cerebral atrophy

Six patients showed features of Cerebral atrophy. Four patients revealed atrophic changes mainly involving bilateral frontal and temporal lobes with periventricular leukomalacia changes. One patient revealed chronic right frontal infarct with gliosis and diffuse cerebral atrophy and one patient showed cortical, subcortical atrophic

changes in bilateral parietal lobes. Rabecca SN Liu, et al. [9], studied 7 patients with epilepsy underwent MRI scan and revealed that significant atrophy of hippocampus, neocortex in 17% and concluded that the brain volume reduction in epilepsy is the cumulative effect of an initial precipitating injury and age related cerebral atrophy. Significant atrophy developed in individual patients particularly those with temporal lobe epilepsy. Ghayyur Khan, et al. [10], studied 100 patients with MRI associated symptoms of seizures, dementia and diabetes and found cerebral atrophy in 47% male and 43% female, concluded that cerebral atrophy is a complication of long standing diabetes well recognized by MRI.

Tuberculoma

Four patients were diagnosed as having tuberculoma on MRI scan. The lesions were well defined, rim enhancing, conglomerate with thick wall of different size. The lesions showed perilesional edema and on MRS revealed elevated lactate, lipid peak. Diagnosis of tuberculoma was based on MR appearances along with one or more following supportive evidences – History of taking ATT in past, any history of contact, and any e/o tuberculosis in X-ray chest. Three patients followed after treatment and significant resolution of the lesions found and one case not reported for follow-up imaging. Naser UAMA, Abdul Ghaffur MRCP, et al. [11], studied 925 intracranial space occupying lesions with seizures and found 1.4% intracranial tuberculoma and followed after treatment, 66.6% responded well to medical treatment and 33% failed to respond. Remarkable improvement of intracranial lesions within 6 weeks and complete resolution of the lesions within 12 weeks was found.

Cavernoma

2 patients revealed well defined focal non enhancing lesion showing hemorrhagic signal intensities in the sub cortical white matter of left frontal lobe in one patient and parietal lobe in another patient with complete hypointense rim on gradient echo sequence. Hakan Kayali, et al.

[12], studied 37 patients with cavernoma on MR imaging 30 male and 7 female patients concluded that 57% of the patients showed supratentorial location of the lesions. Rigamonti, et al. [13], studied 9 patients of proven cavernoma using both CT and MR. CT showed 11 lesions whereas MR showed 38 lesions illustrating the increased sensitivity of MR for detecting of cavernous angioma.

Tuberous sclerosis

Two patients with clinical diagnosis of tuberous sclerosis undergone MR neuroimaging and revealed multiple ill defined areas of altered signal intensity affecting the cortex and subcortical white matter of both cerebral hemispheres suggestive of cortical and subcortical tubers respectively. One patient in addition showed left frontal lobe subependymal nodules and bilateral frontal, right temporal, bilateral occipital and left parietal multifocal small white matter linear and patchy hyperintense lesions on T1WI. No mass effect or perilesional edema was present. Bilateral parietal periventricular cystic changes were noted. Barkovich, et al. [14] studied 7 patients with clinical history of tuberous sclerosis with MRI and revealed that parenchymal nodular and subependymal linear lesions hyperintense on T1 and hypointense T2 WI. Concluded that clinically suspected tuberous sclerosis in infancy the MRI should not be delayed and recognition of specific imaging characteristics of tuberous sclerosis in early infancy with MRI help in diagnosis as early possible. Thus ensuring appropriate clinical management of patients and counseling of parents.

Developmental malformations

Four patients showed the features of developmental malformations. Two patients revealed polymicrogyria of frontoparietal lobe. Another one patient revealed inferior vermian agenesis and other patient showed frontal and temporal lobe lissencephaly.

Jagruti P. Sanghvi, Surekha B. Rajadhyaksha and Meher Ursikar, et al. [15] studied 76 children

with seizures and CNS malformations based on MRI neuroimaging and concluded that 19 cases revealed corpus callosal dysgenesis, 9 patients with lissencephaly and 9 patients with focal cortical dysplasia, 6 patients with pachygyria, 3 patients with polymicrogyria, 15 patients with tuberous sclerosis and 3 patients with Sturge-Weber syndrome.

Glioma

Two patients revealed low grade glioma on MRI. One patient showed lesion in right frontal region and other patient in left frontal lobe.

The MR features

The lesions hypointense on T1WI and hyperintense on both T2WI and FLAIR sequences. Mild perilesional restriction with mild mass effect was seen. MRS showed elevated choline peak in both cases and the lesions showed no contrast enhancement. The above features suggestive of low grade glioma and both patient were referred to higher centers. .

Venous sinus thrombosis

Four patients showed MRI features of cerebral venous sinus thrombosis in our study. Two patients showed superior sagittal sinus thrombosis and one revealed left transverse sinus thrombosis and other patient showed thrombosis in transverse and sigmoid sinuses Out of four cases, two patients showed hemorrhagic infarct with thrombus and one patient showed extension of thrombus into superficial cortical vein with focal gyral edema. In our study two patients presented with the history of puerperium and one patient with history of oral contraceptive use. Following appropriate medical therapy, two patients follow up MR imaging showed resolution of thrombus and two cases not reported for follow up imaging. Rishi K. Gupta, et al. [16], reported a case of superior sagittal sinus (SSS) thrombosis with long history of continuous headache and MRV confirmed the presence of SSS thrombosis with small venous infarct where CT was normal.

Meningioma

One patient revealed the features of meningioma in frontal convexity. Well defined extra axial, enhancing SOL noted in left anterior frontal convexity, measuring 5x4 cm. It was dural based lesion with dural tail at its margin revealed subtle cortical hyperostosis of the roof of the left orbit and Perilesional edema extending into adjacent white matter compressing the lateral ventricle. The lesion was compressing the underlying cerebral parenchyma and causing midline shift. In our study, the neuroimaging showed features of meningioma with mass effect.

Sturge-weber syndrome

One patient revealed MR features of Sturge-weber syndrome showing focal cortical atrophy in right frontoparietal and occipital lobe with predominant involvement of occipital lobe. Intense pial enhancement noted in these regions. Morphological features suggestive of angiomatous malformations in the above mentioned regions. Schmauser I, et al. [17], showed MR is the most sensitive imaging for revealing the full extent of the lesions of Sturge-weber syndrome.

Cerebral abscess

One patient showed evidence of space occupying lesion in right posterior high parietal lobe with perilesional edema with low signal intensity on T2WI with peripheral hyper intensity on T1WI. The lesion showed rim enhancement on contrast. Restriction noted on diffusion weighted images and MRS shows high lactate, lipid peak.

IJ Cranen, et al. [18], reviewed from 2000 adult patients on MRI with localization related epilepsy in 2005 to 2011 using a standard epilepsy protocol. The study revealed 61% normal, 36% abnormal and 2% non diagnostic. In abnormal patients 53% MTS, 18.3% cortical malformations, 10.9% gliosis and infarcts, 7.1% vascular malformations and 5.1% tumors.

Conclusion

MR imaging is a superior neuroimaging modality with no radiation exposure and should be the first

investigation of choice in epileptic syndrome, cerebrovascular disease with seizure, developmental cortical malformations, and vascular malformations. Its ability in identifying subtle lesions, location, extent of the lesions and amount of findings are excellent but has moderate sensitivity in patients with GTCS.

It was observed that MR positivity was more in myoclonic seizures, temporal lobe seizures, absence seizures and motor seizures than most commonly referred GTCS cases. Our study observed that MRI with appropriate imaging protocols adds sensitivity and specificity in evaluation of seizures.

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