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Original Research Article

Role of Magnetic Resonance Imaging in evaluation of patients with new onset seizures

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Abstract

Introduction: Seizures are a common neurological emergency with diverse etiologies that vary across age groups. Accurate diagnosis and identification of underlying structural abnormalities are crucial for guiding management and prognostication. Magnetic Resonance Imaging (MRI) has emerged as the modality of choice for evaluating patients with new-onset seizures due to its high sensitivity in detecting structural lesions. This study was undertaken to assess the role of MRI in identifying etiological factors in patients presenting with first-onset seizures.

Materials and Method: This prospective study was conducted in the Department of Radiodiagnosis at a tertiary care centre in Chennai over two years. Seventy patients of all age groups presenting within seven days of first seizure onset and meeting International League against Epilepsy (ILAE) criteria were included. MRI brain was performed on a 3T GE Signa HDX scanner using a standardized epilepsy protocol. In selected cases, MR spectroscopy was added for lesion characterization. Data were analyzed and represented using descriptive statistics.

Results: Of the 70 patients, 41 (58.6%) were males and 29 (41.4%) females, with the majority belonging to the 46–60 years age group. Generalized tonic–clonic seizures were the most common clinical presentation (80%), followed by focal seizures (12.9%). MRI revealed abnormalities in 40 patients (57.1%), while 30 (42.9%) had normal scans. The most frequent abnormalities were infarct with gliosis (18.57%), mesial temporal sclerosis (14.29%), infections such as tuberculoma (5.71%) and neurocysticercosis (4.29%), and neoplasms (7.15%). The temporal and frontal lobes were the most commonly affected regions.

Conclusion: MRI proved invaluable in detecting structural abnormalities associated with new-onset seizures. More than half of the patients showed identifiable causes, highlighting the importance of high-resolution epilepsy protocols in early diagnosis, treatment planning, and prognostication.

Keywords: Seizures, Epilepsy, Magnetic Resonance Imaging, Mesial Temporal Sclerosis, Neurocysticercosis, Tuberculoma.

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Introduction

A seizure is defined as a paroxysmal event caused by abnormal, excessive, or synchronous neuronal activity in the brain. The clinical manifestations vary depending on the distribution of the abnormal discharges, ranging from dramatic convulsive episodes to subtle experiential phenomena not easily perceived by an observer [1]. It is important to distinguish between seizures and epilepsy: epilepsy is a clinical condition characterized by recurrent unprovoked seizures due to an underlying chronic process, whereas a single seizure or recurrent seizures due to correctable causes do not necessarily constitute epilepsy [1]. The global incidence of epilepsy is estimated at 0.3–0.5%, while its prevalence ranges between 5 and 30 per 1000 individuals [1].Approximately 10% of the population experience at least one seizure during their lifetime, and nearly two-thirds of these represent new-onset, non-recurrent seizures. However, the etiology of seizures varies significantly with age at presentation [2]. Based on the 2016 classification by the International League

against Epilepsy (ILAE), seizures are broadly categorized into focal onset, generalized onset, and unknown onset seizures [3]. Focal seizures arise from networks limited to one cerebral hemisphere and are often linked with structural brain abnormalities, while generalized seizures originate in bilaterally distributed networks and may be due to widespread cellular, biochemical, or structural dysfunction [1]. Accurate classification of seizure type is essential for diagnostic evaluation, therapeutic selection, and prognostication [3].The clinical manifestations of seizures are influenced by the lobe of origin, emphasizing the role of neuroimaging in localizing epileptogenic foci [4]. Magnetic Resonance Imaging (MRI) has emerged as the modality of choice for investigating patients with seizures, offering superior sensitivity in identifying structural abnormalities. Precise localization of epileptogenic zones is crucial not only for neurologists but also for neurosurgeons, as it guides both medical management and surgical interventions. With advancements in MRI technology, high-resolution epilepsy protocols have significantly improved the detection of morphologic and functional abnormalities. Furthermore, advanced functional imaging techniques such as MR spectroscopy, perfusion imaging, functional MRI (fMRI), and complementary modalities including PET and SPECT provide valuable information regarding metabolism and physiology of epileptogenic regions [5].In patients presenting with a first seizure, high-resolution MRI with an epilepsy protocol is recommended, except in clinically evident idiopathic generalized epilepsies such as childhood absence epilepsy or juvenile myoclonic epilepsy, where MRI may be unnecessary [5]. Physiologic imaging with PET and SPECT complements MRI findings, though these modalities often demonstrate widespread and less specific changes compared to the localized abnormalities identified by MRI and EEG [5].Given the burden of epilepsy and the critical role of timely and accurate diagnosis, this study was designed to evaluate the role of MRI in detecting structural abnormalities in patients presenting with new-onset seizures.

Materials and Methods

This prospective descriptive study was conducted in the Department of Radiodiagnosis at a tertiary care centre in Chennai over a two-year period, and included seventy consecutive patients presenting with first-onset seizures. Eligible participants spanned all age groups—from neonates to 80 years—and were enrolled if they presented within seven days of the first seizure and fulfilled the International League against Epilepsy (ILAE) diagnostic criteria. Patients with previously diagnosed non-central nervous system disorders liable to cause seizures were excluded, as were uncooperative or severely debilitated trauma patients. Additional exclusions comprised standard contraindications to MRI—such as MRI-incompatible pacemakers, metallic implants, or aneurysmal clips—and individuals with claustrophobia or anxiety disorders exacerbated by MRI. A detailed clinical history was obtained for every patient prior to imaging.

Imaging Protocol: All participants underwent brain MRI on a whole-body 3-Tesla GE Signa HDX scanner using a dedicated head coil, with imaging performed in the supine position under a standardized epilepsy protocol. The protocol included axial T1-weighted, T2-weighted, diffusion-weighted imaging, and T2 gradient-recalled echo sequences; sagittal T1-weighted and coronal fluid-attenuated inversion recovery acquisitions; and a 3D spoiled gradient-recalled (SPGR) sequence. Post-contrast T1-weighted imaging followed intravenous administration of gadolinium-based contrast (gadobenate meglumine; 0.1 mmol/kg). Magnetic resonance spectroscopy was added in cases where lesion characterization was incomplete on conventional sequences. Ancillary materials (5 ml, 10 ml, and 20 ml syringes) and emergency medications (e.g., Avil, dexamethasone, and adrenaline) were kept readily available for contrast-related adverse event management.

Statistical Analysis and Representative Cases: Collected data were analyzed using standardized statistical methods by SPSS 21, and findings were organized into tables and depicted with bar diagrams and pie charts for clarity.

Results

A total of 70 patients presenting with new-onset seizures were included in the study. The demographic, clinical, and imaging characteristics are described below.The age of the patients ranged from infancy to 80 years. The largest group belonged to the 46–60 years age category, comprising 23 patients (32.85%), followed by the 19–30 years group with 14 patients (20%) . The mean age of the study was middle-aged, with male predominance. Out of 70 patients, 41 (58.6%) were males and 29 (41.4%) were females, yielding a male-to-female ratio of 1.4:1 (Table 1).The majority of patients presented with generalized tonic–clonic seizures (GTCS), accounting for 56 cases (80%). Focal seizures were observed in 9 patients (12.9%). One case each of absence seizure, febrile seizure, and myoclonic seizure was reported (1.43% each), while the type of seizure could not be classified in 2 patients (2.86%)(Table 2) . Out of 70 patients, 30 (42.86%) demonstrated no abnormality on MRI, whereas 40 patients (57.14%) showed identifiable abnormalities. Among the 40

patients with abnormal MRI findings, 26 were males and 14 were females. This indicates a higher proportion of MRI abnormalities among males. The distribution of MRI diagnosis was most frequent abnormality detected was infarct with gliosis, seen in 13 patients (18.57%), followed by mesial temporal sclerosis in 10 patients (14.29%). Neurocysticercosis and gliomas were found in 3 patients each (4.29%), and tuberculomas in 4 patients (5.71%). Other less common findings included meningioma in 2 patients (2.86%), developmental malformations in 2 patients (2.86%), atrophy in 2 patients (2.86%), and venous thrombosis in 1 patient (1.43%).Overall, cerebrovascular etiologies accounted for approximately 20% of abnormalities, with infarct with gliosis (18.6%) and venous thrombosis (1.43%) as the underlying cause of seizures (Table 3). The age-wise distribution of MRI abnormalities- Infarct with gliosis was most commonly observed in the older age groups (46–60 years and >60 years), while mesial temporal sclerosis was predominantly seen in younger adults (19–30 years and 31–45 years). Developmental malformations were exclusively detected in children <5 years of age. Infections such as neurocysticercosis and tuberculoma were distributed across younger and middle age groups. MRI positivity varied according to seizure type .Among patients with GTCS, 29 out of 56 (52%) had abnormal MRI findings. All patients with focal seizures (9/9; 100%) demonstrated structural abnormalities. Myoclonic seizure was associated with an abnormal MRI in 1 case (100%), while absence and febrile seizures showed no corresponding abnormalities. The regional distribution of MRI abnormalities - temporal lobe was the most commonly involved region, with 17 cases, followed closely by the frontal lobe in 16 cases. Parietal lobe lesions were identified in 4 patients, occipital lobe involvement in 2, and periventricular and cisternal lesions in 2 and 1 patient, respectively.

Table 1: Age and Gender Distribution of Patients (n = 70)

Age Group (years)	Male	Female	Total	Percentage (%)
<5	1	2	3	4.29
6–18	7	6	13	18.57
19–30	7	7	14	20.00
31–45	8	2	10	14.29
46–60	14	9	23	32.85
>60	4	3	7	10.00
Total	**41 (58.6%)**	**29 (41.4%)**	**70**	**100**

Sex ratio: M:F = 1.4:1

Table 2: Clinical Diagnosis of Seizures

Clinical Diagnosis	No. of Patients	Percentage (%)
GTCS	56	80.0
Focal seizures	9	12.9
Absence seizures	1	1.43
Febrile seizures	1	1.43
Myoclonic seizures	1	1.43
Unknown	2	2.86
Total	**70**	**100**

Table 3: MRI Findings in Patients with New-Onset Seizures

MRI Diagnosis	No. of Patients	Percentage (%)
Normal study	30	42.86
Infarct with gliosis	13	18.57
Mesial temporal sclerosis	10	14.29
Neurocysticercosis	3	4.29
Tuberculoma	4	5.71
Glioma	3	4.29
Meningioma	2	2.86
Developmental malformation	2	2.86
Atrophy	2	2.86
Venous thrombosis	1	1.43
Total	**70**	**100**

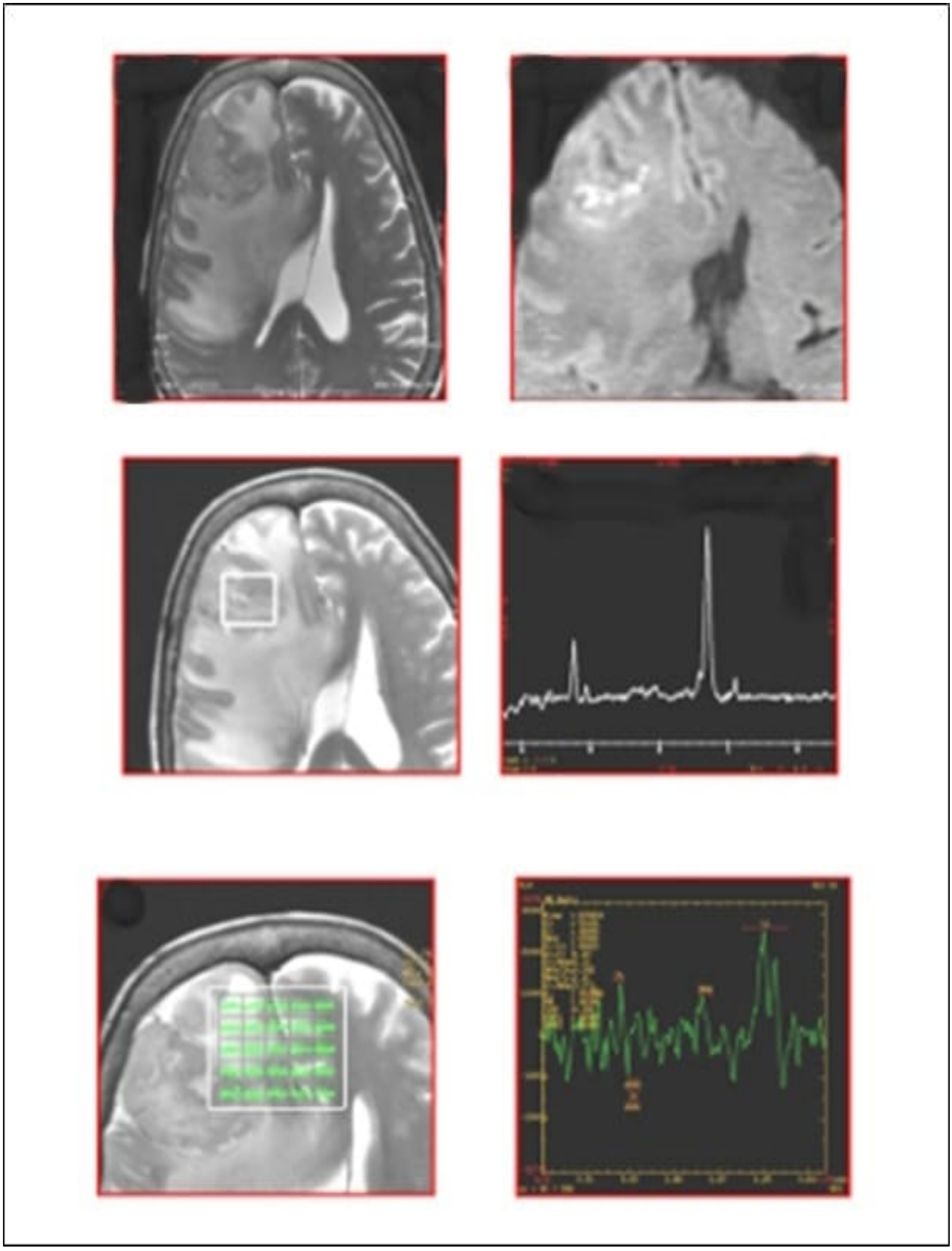

Figure 1: 35 year old female presented with fever, new onset seizure, with imaging showing findings suggestive of tuberculoma. -Lobulated right frontal lesion with thick T2 hypointense rim (a) showing diffusion restriction (b) with heterogeneous central area appearing T1 hypointense and predominantly T2 hyperintense & with surrounding frontoparietal edema extending upto to the corpus callosum (b). Spectroscopy shows increase lactate peak in the rim of the lesion (c and d) and mild decrease in NAA in the perilesional edema (e and f)- Image starting from top a to e bottom

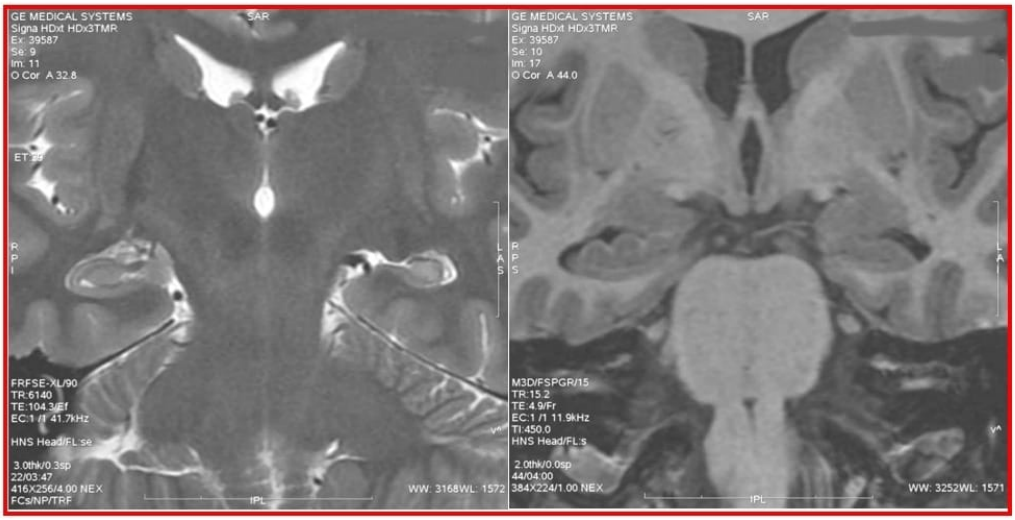

Figure 2: 16 year old male presented with new onset seizures showing findings consistent with left mesial temporal sclerosis. Coronal images through hippocampus (a- T2 WI , b –SPGR) images showing increased T2 hyperintensity of left hippocampus (a) with significant asymmetry , decreased volume and loss of internal architecture compared to right side (b)- Image left (a) to right (b)

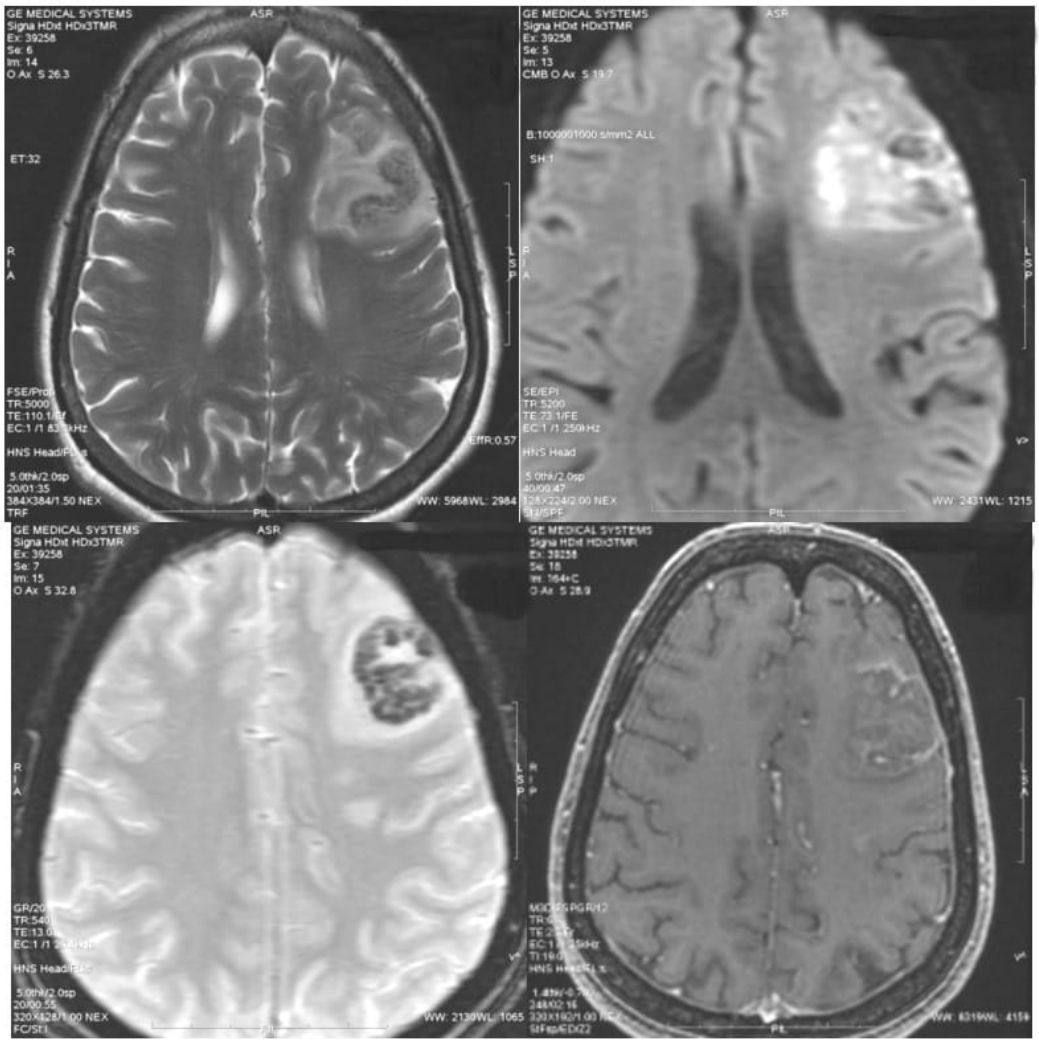

Figure 3: 53 year old female presented with new onset seizures imaging showed left frontal subacute infarct with hemorrhagic conversion, cortical laminar necrosis involving middle & inferior frontal gyri. Wedge shaped left frontal T2/FLAIR hyperintense lesion involving grey & white matter (a) with areas of diffusion restriction (b) & blooming in gradient images involving middle & inferior frontal gyri is noted (c). Linear gyral T1 hyperintensities noted. Gyral enhancement and effacement of sulci. (d)- Image number start from top a to d bottom

Discussion

This prospective study evaluated seventy patients with clinically diagnosed seizures who underwent brain MRI within seven days of onset, using a standardized epilepsy protocol. The study aimed to identify and characterize structural abnormalities associated with first-onset seizures and to correlate them with clinical findings. The age range of patients was from neonate to 80 years, with the highest incidence noted in the 46–60 years group (32.85%). Male predominance was observed, with a male-to-female ratio of 1.4:1. Similar demographic patterns have been reported in earlier studies on seizure epidemiology [6]. Generalized tonic–clonic seizures (GTCS) were the most common seizure type, accounting for 80% of cases, followed by focal seizures in 12.9%. Virendra C. Patil et al. also reported GTCS as the predominant seizure type in patients with new-onset seizures, followed by focal seizures, findings that align with the present study [6].

MRI revealed abnormal findings in 40 patients (57.1%), whereas 30 patients (42.9%) had normal scans. The most frequent abnormalities included infarct with gliosis (18.6%), mesial temporal sclerosis (14.3%), infections such as neurocysticercosis (4.3%) and tuberculoma (5.7%), neoplasms including glioma (4.3%) and meningioma (2.9%), developmental malformations (2.9%), cerebral atrophy (2.9%), and venous thrombosis (1.4%).Cerebral infarction with gliosis was observed in 13 patients (18.6%), making it the most common abnormality. These lesions included chronic infarcts, encephalomalacia with gliosis, small vessel ischemic changes, and subacute infarcts with hemorrhagic transformation. Stroke has been consistently reported as a major risk factor for late-onset seizures. Shasha Liu et al. concluded that stroke and cerebrovascular disease account for 30–50% of new-onset seizures in the elderly [7]. Similarly, Denier et al. found that watershed infarcts (23%) were more prone to cause early-onset seizures than territorial infarcts (5.3%) [8]. The findings of the present study support these observations, highlighting the contribution of vascular pathology to seizure onset in older patients. Mesial temporal sclerosis (MTS) was detected in 10 patients (14.3%), with right-sided involvement in six and left-sided in four. The typical MRI features included hippocampal atrophy, T2 hyperintensity, loss of internal architecture, and associated fornix and mammillary body atrophy in select cases. These findings were consistent with the description by Pannag Desai et al., who reported hippocampal T2 hyperintensity and atrophy as hallmark features of MTS [9]. Infective granulomas comprised neurocysticercosis (NCC) and tuberculomas.

Neurocysticercosis (NCC): Three patients (4.3%) demonstrated NCC, with parenchymal, ventricular, and mixed forms. MR spectroscopy showed reduced NAA and elevated choline and lactate peaks. Mehta et al. emphasized that young patients with focal seizures or seizure clusters frequently demonstrate NCC on imaging [10]. Zhao et al. also described similar MRI spectra of NCC [11], while Pandit et al. highlighted the role of MR spectroscopy in differentiating NCC from other intracranial lesions [12]. Patil et al. reported solitary lesions in 72% of NCC cases and multiple lesions in 27%, corroborating the findings of our study [13].

Tuberculoma: Four patients (5.7%) had tuberculomas, presenting as ring-enhancing lesions with hypointense rims on T2, perilesional edema, and elevated lactate peaks on spectroscopy. Ahluwalia et al. [14] and Pretell et al. [15] described similar imaging features. Rajshekhar et al. emphasized the diagnostic challenge in differentiating NCC from tuberculoma in endemic regions and underscored the utility of MR spectroscopy [16]. Two patients (2.9%) showed diffuse cerebral atrophy with dilated ventricles and widened sulci, particularly involving the frontal and temporal lobes. Sinha et al. reported variable degrees of cerebral atrophy as a common MRI finding in elderly patients with new-onset seizures [17]. Khan et al. also highlighted cerebral atrophy as a complication of chronic conditions such as diabetes, detectable on MRI [18]. Two cases (2.9%) demonstrated developmental abnormalities: one with tuberous sclerosis showing cortical/subcortical tubers, subependymal hamartomas, and radial bands; and one with subcortical heterotopia. These findings were consistent with prior reports by Kalantari et al. [19] and Donkol et al. [20]. Sanghvi et al. also demonstrated a wide spectrum of malformations in pediatric patients with seizures, including tuberous sclerosis and heterotopia [21]. Three patients had gliomas (4.3%) and two had meningiomas (2.9%). The gliomas showed typical features of low-grade tumors, with one case suggestive of high-grade glioma on MR spectroscopy. Assis et al. reported that neoplasms account for 13.3% of seizure etiologies in elderly patients, second only to stroke [22]. The imaging characteristics of meningiomas in our study were in concordance with descriptions by Watts et al., including dural attachment, isointense T1 signal, and avid contrast enhancement [23]. Case reports by Shogan et al. further support these MRI features [24]. One young female patient (1.4%), an oral contraceptive user, was diagnosed with superior sagittal sinus thrombosis with venous infarct on MRI and MRV. Similar imaging findings were reported by Gupta et al., where MRV confirmed the diagnosis [25].

Conclusion

MRI identified structural etiologies in 57.1% of first-onset seizure cases, most commonly infarct-related gliosis, mesial temporal sclerosis, infective granulomas (neurocysticercosis/tuberculoma), and neoplasms. Infarct-gliosis predominated in the elderly, whereas mesial temporal sclerosis and developmental malformations were more frequent in younger patients. All focal-seizure cases had MRI abnormalities, with temporal and frontal lobes most often involved—supporting high-resolution epilepsy-protocol MRI as feasible option for diagnosis, management, and surgical planning.

Limitations of the Study

Single-centre, small sample (n=70) and hospital-based design may limit generalizability and introduce referral bias. Evaluation relied primarily on MRI; PET/SPECT and uniform EEG correlation were not consistently performed. Lack of long-term follow-up precluded prognostic assessment. Genetic/metabolic testing—especially in paediatric malformations—was constrained by resources.

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