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Role of MRI in Evaluating Seizure Etiology: Spectrum of Neuroimaging Findings

Dr. Bhumare Shubham Madanrao [1*], Dr. Subhash Chand Sylonia [2], Dr. Umesh Chandra Garga [3], Dr. Sumit Kumar Ghosh [4]

[1] Junior Resident, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India
[2] Professor, Head of Department, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India
[3] Professor, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India
[4] Assistant Professor, Saraswathi Institute of Medical Sciences, Hapur, Uttar Pradesh, India

* Corresponding Author: **Dr. Bhumare Shubham Madanrao**

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Abstract

Seizures and epilepsy constitute one of the most prevalent neurological disorders encountered in clinical practice, affecting approximately 50 million individuals globally and representing a significant cause of neurological morbidity across all age groups. The clinical management of patients presenting with new-onset seizures requires accurate characterization of the underlying etiology, since the identification of a structural or pathological substrate guides treatment planning, surgical candidacy assessment, and prognostic counseling. Among the neuroimaging modalities available for seizure evaluation, magnetic resonance imaging at 1.5 Tesla has emerged as the superior investigation of choice, offering unparalleled soft tissue contrast, multiplanar capability, and sensitivity for detecting subtle cortical, subcortical, and infratentorial lesions that may be occult on computed tomography. The present prospective study was conducted at a single tertiary institution and enrolled 100 consecutive patients presenting with seizures who underwent 1.5 Tesla MRI brain examination, with the aim of characterizing the spectrum of neuroimaging findings and correlating MRI diagnoses with clinical seizure types and patient demographics. A male predominance was observed in the study population, and generalized tonic-clonic seizures constituted the most frequent clinical seizure type, accounting for 80 percent of all cases. MRI identified pathological findings in 65 of 100 patients (65 percent), with the principal diagnoses comprising infective granuloma including neurocysticercosis and tuberculoma in 17 percent of cases, cerebral infarction with gliosis in 16 percent, glioma in 9 percent, meningioma in 3 percent, developmental malformations in 2 percent, and venous sinus thrombosis among the miscellaneous group accounting for 17 percent collectively. These findings affirm MRI as the investigation of choice for seizure disorder evaluation, capable of detecting a broad spectrum of structural and pathological abnormalities with implications for patient management.

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1. Introduction

Seizures are paroxysmal episodes of abnormal, hypersynchronous neuronal activity that may manifest as motor, sensory, autonomic, or psychic phenomena, with or without alteration of consciousness [1]. Epilepsy, defined as the tendency to experience recurrent unprovoked seizures, is estimated to affect approximately 50 million people worldwide, with an annual incidence of 50 new cases per 100,000 population in developed countries and considerably higher rates in resource-limited settings [1, 2].

The conditions collectively represent one of the most common serious neurological disorders encountered in tertiary hospital practice and are associated with substantial psychological, social, and economic burden for affected individuals and their families.

The clinical evaluation of a patient presenting with a first seizure or a newly diagnosed epilepsy syndrome requires a systematic investigation aimed at identifying any underlying structural or metabolic etiology, since the presence or absence of a lesion determines treatment strategy, surgical eligibility, and long-term prognosis [1, 2]. Etiologies of seizures encompass a wide spectrum including vascular lesions such as cerebral infarction with secondary gliosis, infective conditions such as neurocysticercosis and cerebral tuberculoma, neoplastic lesions such as glioma and meningioma, developmental malformations, mesial temporal sclerosis, venous sinus thrombosis, and metabolic or autoimmune encephalopathies [1, 2, 3, 7]. The relative frequency of these etiologies differs substantially across geographic regions, with infective granulomas representing a disproportionately high burden in tropical and subtropical countries where neurocysticercosis and tuberculosis are endemic [3, 5, 6].

Conventional computed tomography, while widely available and well-suited to detecting acute haemorrhage and gross structural abnormalities, has limited sensitivity for detecting subtle cortical dysplasias, small hippocampal volume loss, low-grade neoplasms, cavernous malformations, and posterior fossa lesions that are frequently the underlying substrate of seizures [1, 2]. High-resolution magnetic resonance imaging, by contrast, provides superior soft tissue contrast resolution, freedom from ionizing radiation, and the capacity for multiplanar and multispectral acquisition, including T1-weighted, T2-weighted, fluid-attenuated inversion recovery, diffusion-weighted, and contrast-enhanced sequences that collectively allow precise characterization of lesion morphology, signal characteristics, and enhancement patterns [1, 2, 10].

The 1.5 Tesla MRI platform has become the institutional standard in most tertiary neuroimaging centers, offering a robust combination of field strength, signal-to-noise ratio, and availability of advanced pulse sequences suited to comprehensive epilepsy protocol imaging [1, 2]. Standardized seizure MRI protocols typically include axial and coronal T1, T2, and FLAIR sequences, high-resolution coronal sequences through the hippocampi for mesial temporal assessment, diffusion-weighted imaging, and post-gadolinium T1 sequences for evaluation of blood-brain barrier disruption and leptomeningeal enhancement [1, 2, 7]. These sequences, when applied systematically, enable the detection of the full spectrum of lesions associated with seizure presentation, from small cysticercal granulomas and cavernomas to high-grade gliomas and cortical malformations of development.

In the Indian subcontinent, where tuberculosis and cysticercosis remain endemic, the contribution of infective granulomas to the burden of seizure disorders is particularly significant, with several series reporting granulomas as the most common identifiable MRI finding in patients presenting with new-onset seizures [3, 5, 6]. Against this epidemiological background, the present study was undertaken at a tertiary institution to prospectively evaluate the spectrum of MRI findings in 100 consecutive patients presenting with seizures, to correlate the neuroimaging findings with clinical seizure types and patient demographics, and to assess the diagnostic contribution of 1.5 Tesla MRI across the full range of etiological categories encountered in this patient population.

2. Aims and Objectives

The primary aim of this study was to prospectively evaluate the spectrum of MRI findings in patients presenting with seizures at a tertiary neuroimaging center and to determine the frequency of various neuroimaging diagnoses in a cohort of 100 patients examined on a 1.5 Tesla MRI system. The secondary objectives were to characterize the demographic profile of the study population including age and sex distribution, to document the distribution of clinical seizure types at presentation, to describe the MRI signal characteristics and morphological features of each diagnostic category including infective granuloma, cerebral infarction with gliosis, cerebral atrophy, developmental malformations, glioma, meningioma, and venous sinus thrombosis, to analyze the age-wise distribution of MRI abnormalities across diagnostic categories, and to assess the overall diagnostic yield of MRI in patients presenting with seizures. The findings were intended to provide prospective evidence supporting the systematic use of MRI as the primary neuroimaging investigation in the evaluation of seizure etiology.

3. Materials and Methods

3.1. Source of Data and Study Design

This study was conducted as a prospective, observational investigation at the Department of Radiodiagnosis of a tertiary medical institution equipped with a dedicated 1.5 Tesla magnetic resonance imaging unit. All patients referred to the MRI department for brain imaging with a clinical indication of seizures or epilepsy were considered for enrollment. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, and institutional ethical committee approval was obtained prior to commencement. Written informed consent was obtained from all patients or, where appropriate, from a competent family member or guardian. The total study population comprised 100 consecutive patients enrolled over the study period.

3.2. Inclusion and Exclusion Criteria

Patients of any age presenting with a history of new-onset or recurrent seizures who were referred for MRI brain examination were included in the study. Both inpatients and outpatients were eligible for enrollment. Patients were excluded if they had a previously established MRI diagnosis explaining their seizures, if MRI was clinically contraindicated due to the presence of non-MRI-compatible metallic implants or pacemakers, if the patient was too unwell to undergo the examination safely, or if technically adequate

image quality could not be achieved due to motion artifact. Patients with contraindications to gadolinium-based contrast agent administration, including severe renal impairment or prior history of anaphylaxis to contrast, were examined without intravenous contrast where applicable.

3.3. Criteria for Patient Selection

Patients of all age groups presenting with any clinical seizure type including generalized tonic-clonic seizures, simple partial seizures, complex partial seizures, myoclonic seizures, absence seizures, motor seizures, and febrile seizures were included. Patients referred with a primary or secondary clinical diagnosis of seizures by the attending neurology, medicine, or pediatrics clinician were enrolled irrespective of the duration or frequency of seizure episodes. Patients with co-morbid systemic conditions that could independently explain seizure activity, such as severe metabolic derangement or septic encephalopathy, were also included provided they met the above clinical criteria, as the contribution of structural lesions to seizure susceptibility warranted neuroimaging evaluation regardless.

3.4. Technique of MRI Examination

All MRI examinations were performed on a 1.5 Tesla superconducting MRI system using a standard head coil. The imaging protocol included axial T1-weighted spin echo sequences, axial and coronal T2-weighted fast spin echo sequences, axial and coronal fluid-attenuated inversion recovery sequences, diffusion-weighted imaging with apparent diffusion coefficient mapping, and axial susceptibility-weighted imaging where available [1, 2, 17]. Following intravenous administration of a weight-adjusted dose of gadolinium-based contrast agent, post-contrast axial and coronal T1-weighted sequences were obtained in all patients in whom gadolinium was not contraindicated. High-resolution coronal sequences through the hippocampal formations were acquired in patients with clinical features suggesting temporal lobe epilepsy. Slice thickness ranged from 3 to 5 millimeters for routine sequences, with 1 to 2 millimeter sections used for targeted hippocampal imaging. All examinations were reviewed by experienced neuroradiologists, and a final radiological diagnosis was assigned based on the composite signal characteristics, morphology, enhancement pattern, distribution, and clinical context.

3.5. Statistical Analysis

Data were tabulated and analyzed using descriptive statistical methods. The frequency and percentage distribution of demographic characteristics, clinical seizure types, and MRI diagnoses were calculated. The age-wise distribution of MRI abnormalities across diagnostic categories was analyzed and presented in tabular form. The Fisher's exact test and chi-square test were applied as appropriate for the assessment of associations between categorical variables, with a p-value of less than 0.05 considered statistically significant. All statistical analyses were performed using standard statistical software.

4. Results

4.1. Demographic Profile and Clinical Diagnosis

Of the 100 patients enrolled in the study, 62 were male and 38 were female, yielding a male-to-female ratio of approximately 1.6:1. The age of patients ranged from less than one year to more than 60 years, with the largest proportion of patients falling in the 16 to 45 years age group, reflecting the high burden of seizure disorders in the economically active adult population. On clinical evaluation, generalized tonic-clonic seizures (GTCS) constituted the most common seizure type, accounting for 80 of 100 patients (80 percent), consistent with the well-established preponderance of GTCS in hospital-based seizure series in the Indian context [1, 3].

Table 1: Distribution of Study Patients According to Clinical Seizure Diagnosis at Presentation

Clinical Diagnosis	Number of Patients (%)
GTCS	80 (80%)
Myoclonic Seizures	3 (3%)
Absence Seizures	1 (1%)
Simple Partial Seizures	7 (7%)
Complex Partial Seizures	7 (7%)
Febrile Seizures	1 (1%)
Motor Seizures	1 (1%)
Total	100 (100%)

Simple partial seizures and complex partial seizures each accounted for 7 percent of the cohort, while myoclonic seizures were observed in 3 patients. Absence seizures, febrile seizures, and motor seizures were each present in a single patient, collectively contributing 3 percent of the study population. The distribution of clinical seizure types in this series reflects the referral patterns of a mixed age tertiary institution serving a broad community demographic.

4.2. MR Diagnosis and Distribution of Findings

MRI examination identified pathological findings in 65 of 100 patients (65 percent), while 35 patients (35 percent) had a normal MRI study. Among the 65 patients with abnormal MRI findings, the principal diagnoses were infective granuloma in 17 patients (17 percent), infarct with gliosis in 16 patients (16 percent), miscellaneous diagnoses in 17 patients (17 percent), glioma in 9 patients (9 percent),

meningioma in 3 patients (3 percent), developmental malformation in 2 patients (2 percent), and cerebral atrophy in 1 patient (1 percent).

Table 2: Distribution of Study Patients According to MRI Diagnosis on 1.5 Tesla Magnetic Resonance Imaging

MR Diagnosis	Number of Patients (%)
Normal Study	35 (35%)
Infarct with Gliosis	16 (16%)
Infective Granuloma	17 (17%)
Atrophy	1 (1%)
Developmental Malformation	2 (2%)
Glioma	9 (9%)
Meningioma	3 (3%)
Miscellaneous	17 (17%)
Total	100 (100%)

Note: Pathological findings were identified in 65 out of 100 patients (65 percent) on MRI examination.

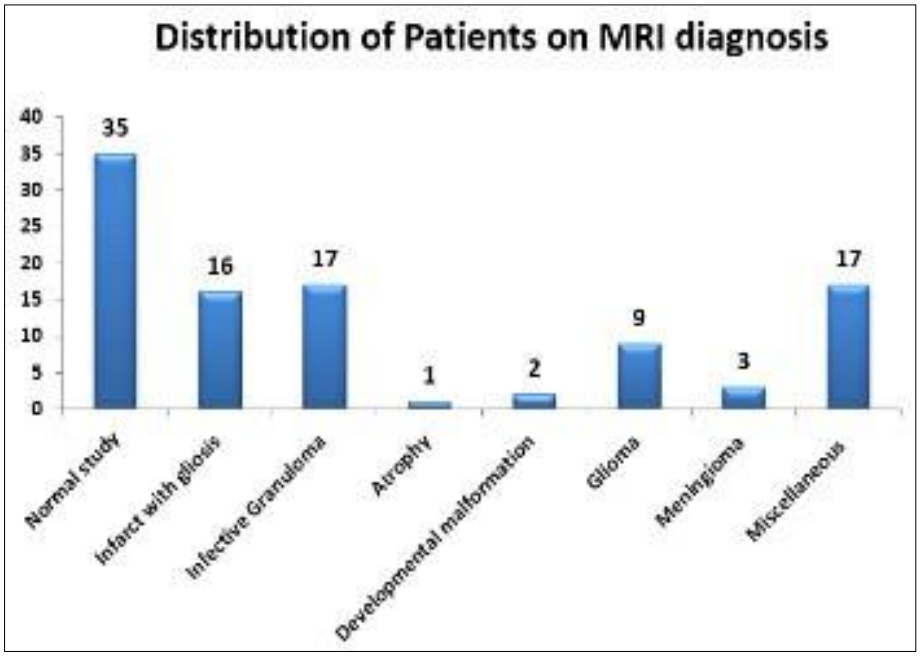


Fig 1: Bar graph showing the distribution of patients based on MRI diagnosis, including normal study (35), infarct with gliosis (16), infective granuloma (17), atrophy (1), developmental malformation (2), glioma (9), meningioma (3), and miscellaneous (17).

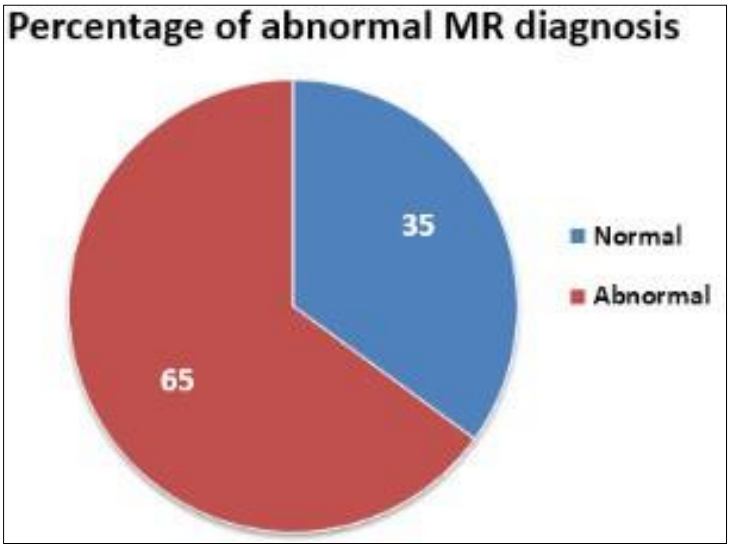


Fig 2: Pie chart showing the percentage of normal (35%) versus abnormal (65%) MRI diagnoses among the 100 study patients.

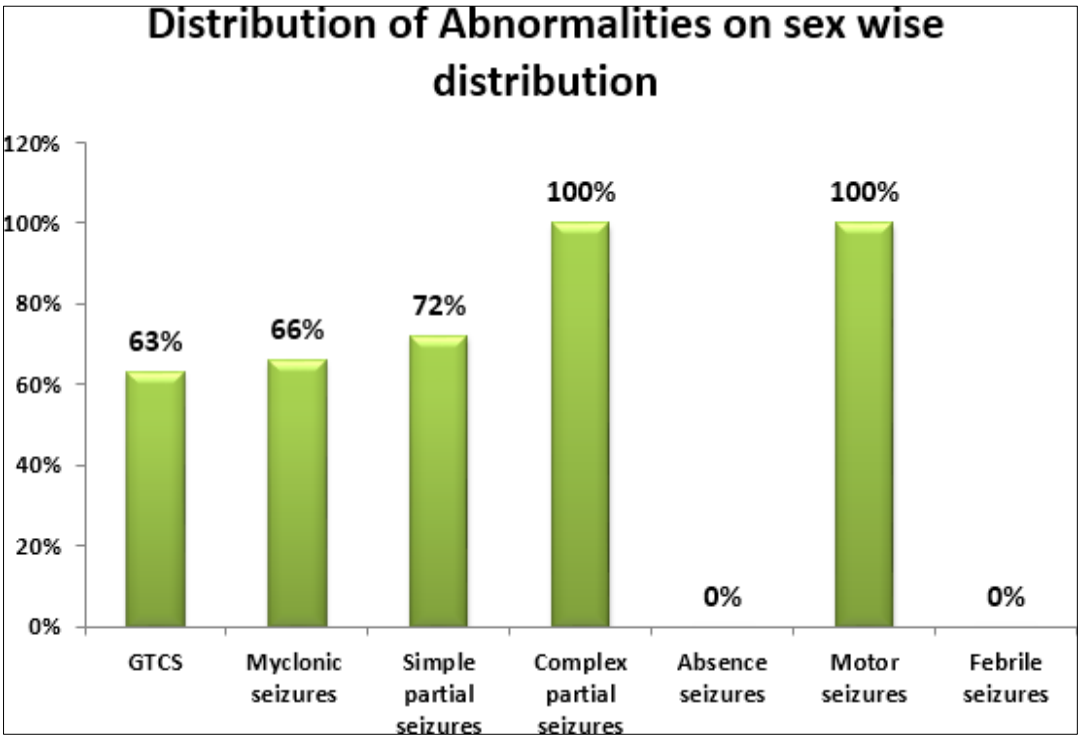


Fig 3: Bar graph showing the sex-wise distribution of abnormalities across clinical seizure types including GTCS (63%), myoclonic seizures (66%), simple partial seizures (72%), complex partial seizures (100%), absence seizures (0%), motor seizures (100%), and febrile seizures (0%).

4.3. Age-wise Distribution of MRI Abnormalities

The age-wise distribution of MRI abnormalities across the principal diagnostic categories is presented in Table 3. Infective granuloma was most prevalent in the 16 to 30 years age group, where 10 of the 17 cases were concentrated, reflecting the epidemiological profile of neurocysticercosis and tuberculosis affecting young adults in endemic regions [3, 5, 6]. Infarcts with gliosis were predominantly identified in the 16 to 30 and 31 to 45 years age groups, with 7 and 9 cases respectively, suggesting that cerebrovascular disease contributes to the seizure burden across middle adult life in this population. Developmental malformations were confined to patients under 15 years of age, consistent with their pathophysiological origin as congenital structural anomalies manifesting in early life [10]. Glioma and meningioma were concentrated in the 31 to 60 years age range, in keeping with the recognized age distribution of primary intracranial neoplasms [1]. Miscellaneous diagnoses, which included venous sinus thrombosis, ADEM, subdural haematoma, and encephalitis, were distributed broadly across age groups, reflecting the etiological heterogeneity of this category.

Table 3: Age-wise Distribution of MRI Abnormalities Across Diagnostic Categories in the Study Population

MR Diagnosis	<1 yr	1-15 yrs	16-30 yrs	31-45 yrs	46-60 yrs	>60 yrs	Total
Infarct with Gliosis	0	0	7	9	0	0	16
Infective Granuloma	0	1	10	4	1	1	17
Atrophy	0	0	0	0	1	0	1
Developmental Malformation	1	1	0	0	0	0	2
Glioma	0	0	1	5	4	0	10
Meningioma	0	0	0	0	3	0	3
Miscellaneous	1	5	4	2	2	1	15

Note: Infective granuloma was most prevalent in the 16 to 30 years age group, while infarcts with gliosis were most common in the 31 to 45 years age group. Developmental malformations occurred exclusively in patients under 15 years of age.

4.4 Infective Granuloma (Neurocysticercosis and Tuberculoma)

Infective granuloma was identified as the most prevalent individual MRI diagnosis in this study, accounting for 17 patients (17 percent). This category encompassed both neurocysticercosis (NCC) and intracranial tuberculoma, two of the most important infective causes of seizure disorder in the Indian subcontinent. Patients with neurocysticercosis demonstrated MRI findings characteristic of the various stages of cysticercal evolution, including the vesicular stage, with a thin-walled cyst and eccentric scolex appearing as a hyperintense nodule on T1-weighted sequences, the colloidal vesicular and granular-nodular stages, characterized by progressive ring or nodular enhancement on contrast-enhanced T1 sequences with surrounding perilesional edema on T2 and FLAIR sequences, and the calcified or inactive stage, in which lesions appear as small hypointense foci on T2-weighted and susceptibility-weighted imaging [3, 4, 5]. Tuberculomata appeared as ring-enhancing or homogeneously enhancing nodules, typically demonstrating hypointense to isointense signal on T2-weighted sequences due to their caseous composition, with surrounding T2 hyperintense edema and avid post-contrast enhancement [6]. The infective granuloma cases in this cohort were

predominantly distributed in the 16 to 30 years age group, which is consistent with the known epidemiology of both conditions in young adults in endemic settings.

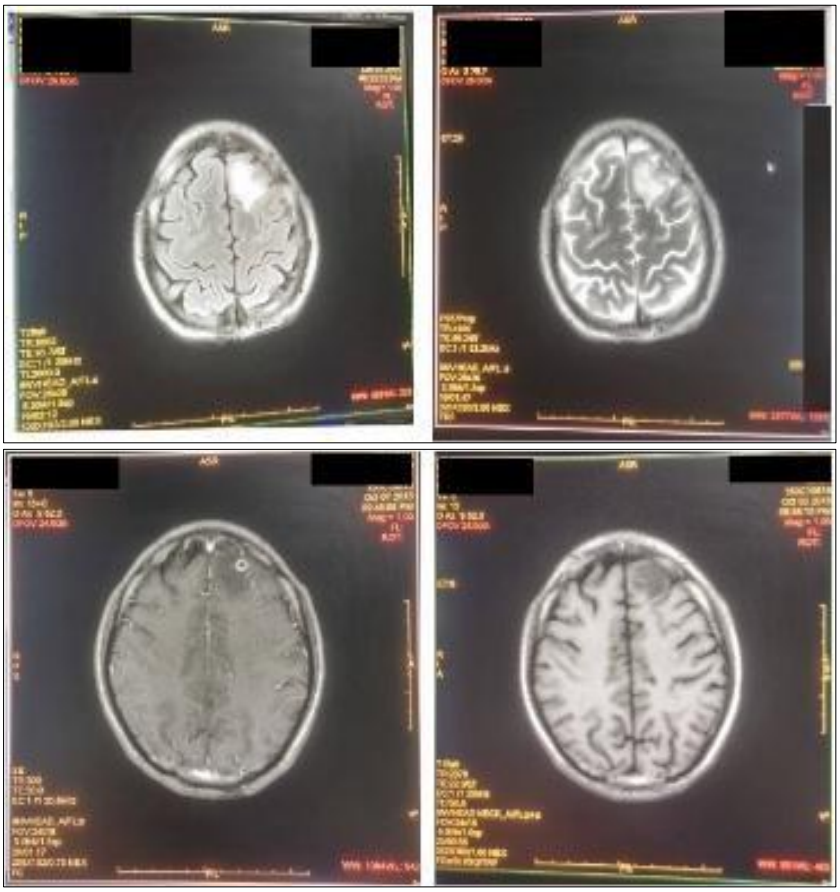


Fig 4: Inflammatory Granuloma — Axial T2 FLAIR, Axial T2, Axial T1 with contrast, and Axial T1 sequences demonstrating ring-enhancing intracranial granuloma.

4.5. Cerebral Infarcts with Gliosis

Cerebral infarction with secondary gliosis was identified in 16 patients (16 percent), representing the second most frequent MRI diagnosis in this series. Seizures arising in the context of cerebrovascular disease constitute a well-recognized clinical entity, with both acute infarcts in the early perilesional period and established gliotic scars from prior infarcts serving as epileptogenic substrates [8]. On MRI, acute and subacute infarcts appeared as areas of restricted diffusion on diffusion-weighted imaging with corresponding low apparent diffusion coefficient values, associated with T2 and FLAIR hyperintensity in a vascular territorial distribution. Established chronic infarcts were characterized by areas of encephalomalacia with surrounding gliosis, manifesting as T2 and FLAIR hyperintense signal in a cortical and subcortical distribution with volume loss and ex-vacuo dilatation of adjacent sulci and ventricles. Post-contrast enhancement was observed in subacute infarcts consistent with blood-brain barrier disruption in the subacute phase. The infarct with gliosis category was predominantly distributed in the 16 to 45 years age range, encompassing both younger patients with etiologies such as cardioembolism or vasculitis and older patients with atherosclerotic cerebrovascular disease [8].

4.6. Cerebral Atrophy

Cerebral atrophy was identified as the sole MRI diagnosis in one patient (1 percent) in this cohort. Diffuse cortical and subcortical atrophy on MRI was evidenced by generalized sulcal and cisternal widening and ventricular dilatation disproportionate to the patient's age. Cerebral atrophy may serve as an epileptogenic substrate through the disruption of cortical and subcortical circuits, loss of inhibitory interneuronal networks, and the generation of abnormal epileptiform discharges within atrophic cortical regions [9]. The low prevalence of pure atrophy as the principal MRI finding in this series likely reflects the enrollment of a predominantly young and middle-aged adult cohort, among whom degenerative cerebral atrophy as an isolated cause of seizures is less common than infective or vascular etiologies.

4.7. Developmental Malformations

Developmental malformations were identified in two patients (2 percent) in this study, with both cases occurring in patients under 15 years of age. The MRI features in these patients were consistent with malformations of cortical development, including focal cortical dysplasia and polymicrogyria, which are recognized among the most common substrates of medically refractory focal epilepsy in the pediatric population [10]. Focal cortical dysplasia appeared as focal cortical thickening with blurring of the grey-white matter junction, abnormal gyral patterning, and the characteristic transmantle sign of radially oriented T2 or FLAIR hyperintensity extending from the cortex toward the lateral ventricle. Polymicrogyria was characterized by irregular cortical surface morphology with multiple small fused gyri producing a pebbled cortical surface. The exclusive occurrence of developmental malformations in patients under 15 years in

this cohort is consistent with published pediatric epilepsy series confirming that cortical malformations are a disproportionately important epilepsy etiology in childhood and early adolescence [7, 10].

4.8. Glioma

Glioma was identified in nine patients (9 percent) and constituted the most frequent neoplastic diagnosis in this series. Seizure is a common and often the presenting symptom of cerebral gliomas, particularly low-grade gliomas in which the more gradual infiltrative growth of cortical tissue results in an epileptogenic cortical irritative focus without the acute mass effect that characterizes high-grade tumors [1]. On MRI, low-grade gliomas were characterized by T1 hypointensity, T2 and FLAIR hyperintensity within the involved cortex and underlying white matter, poorly defined margins, absence of significant contrast enhancement, and absence of necrosis or haemorrhage. High-grade gliomas demonstrated irregular ring enhancement on post-contrast T1-weighted sequences with central necrosis, surrounding vasogenic edema as T2 and FLAIR hyperintensity, mass effect on adjacent structures, and sulcal effacement. Glioma cases in this cohort were predominantly distributed in the 31 to 60 years age range, consistent with the recognized bimodal distribution of low-grade and high-grade gliomas in younger and older adults respectively [1].

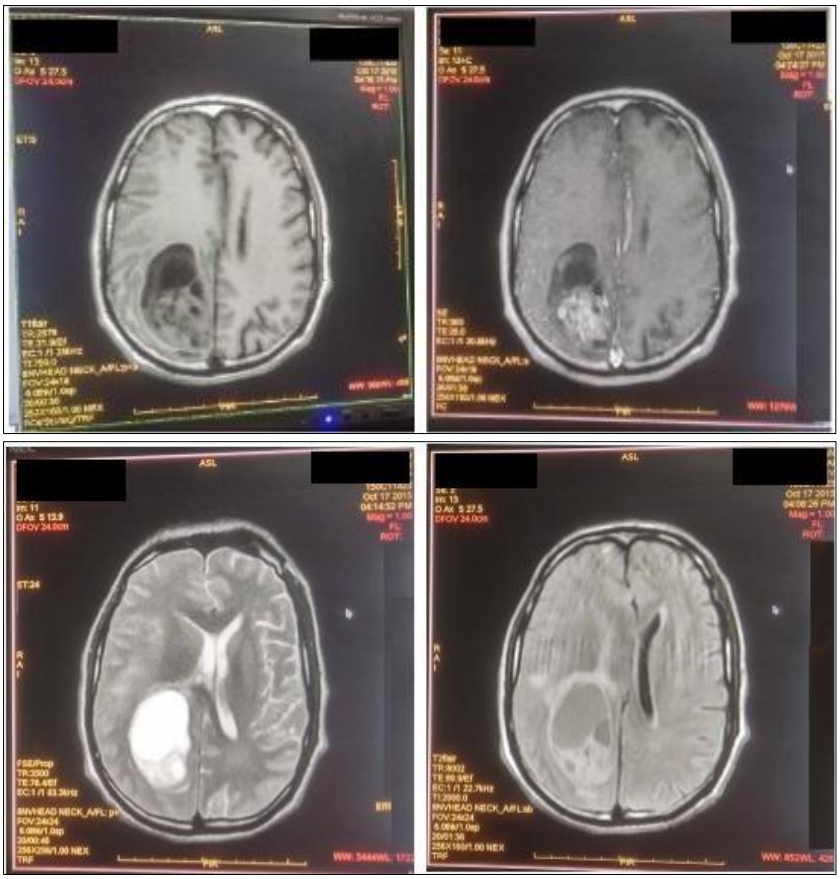


Fig 5: Glioma — Axial T1, Axial T1 with contrast, Axial T2, and Axial T2 FLAIR sequences demonstrating a temporal lobe glioma with perilesional signal changes and no contrast enhancement.

4.9. Venous Sinus Thrombosis

Venous sinus thrombosis was identified among the miscellaneous diagnostic group and represented one of the clinically significant etiologies in this category. Cerebral venous and sinus thrombosis may present with seizures as a consequence of venous infarction, cortical vein thrombosis with hemorrhagic cortical congestion, or perilesional irritation of cortex adjacent to venous hemorrhagic infarcts [11]. On MRI, the thrombosed sinus demonstrated loss of the normal flow void on T1 and T2 sequences, with intraluminal T1 hyperintensity corresponding to subacute thrombus. Post-contrast T1-weighted sequences demonstrated the characteristic empty delta sign, representing contrast enhancement of the dural walls of the sinus surrounding a non-enhancing central filling defect of thrombus. Venous infarcts appeared as wedge-shaped or irregular areas of T2 and FLAIR hyperintensity not conforming to an arterial vascular territory, frequently with evidence of haemorrhagic transformation as T1 hyperintensity and T2 or susceptibility signal dropout. Diffusion-weighted imaging demonstrated a combination of restricted and non-restricted diffusion in the infarcted territory, reflecting the mixed cytotoxic and vasogenic edema characteristic of venous ischemia [11].

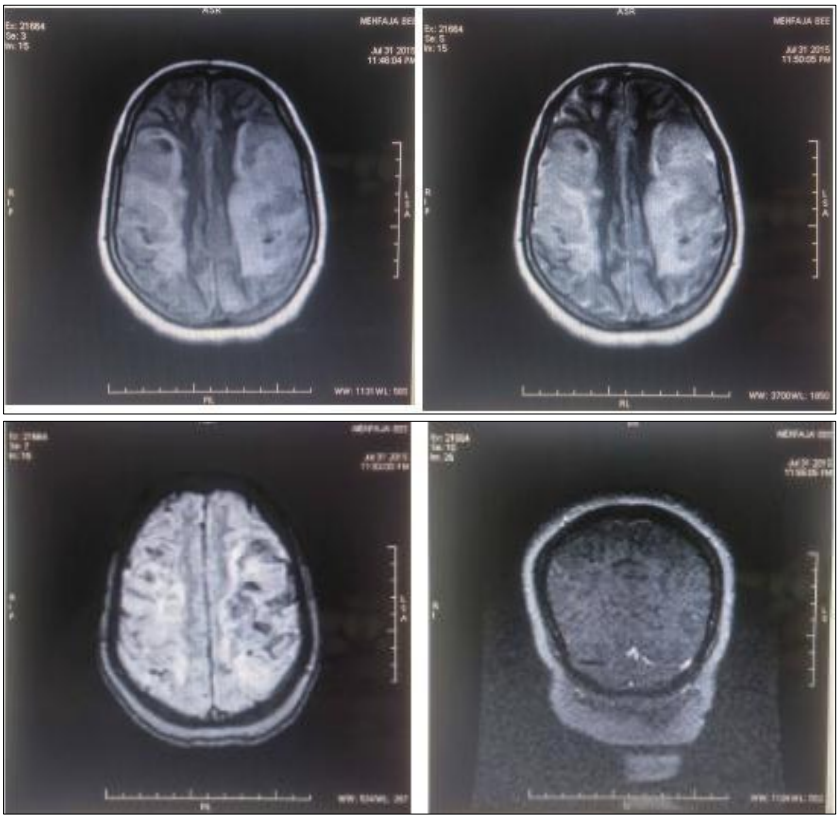
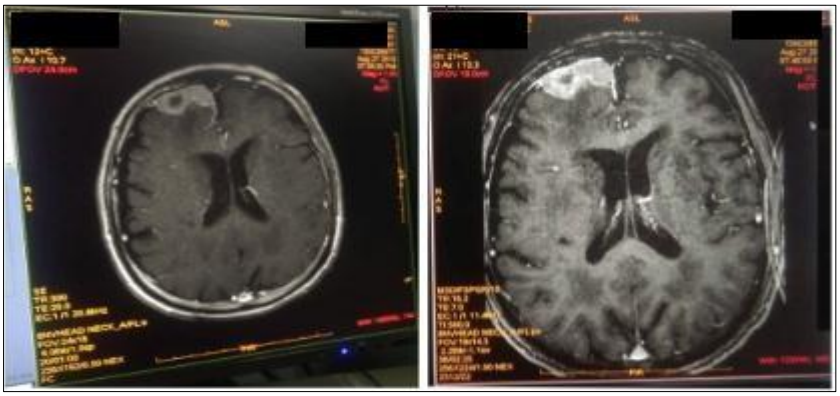


Fig 6: Venous infarct with transverse sinus thrombosis — Axial T2, Axial T2, Axial T1, and Coronal T1 with contrast sequences showing hemorrhagic venous infarct and thrombus in the transverse sinus.

4.10. Meningioma

Meningioma was identified in three patients (3 percent), all of whom were in the 46 to 60 years age group. Meningiomas are extra-axial benign neoplasms arising from the arachnoid cap cells of the meninges, and may produce seizures through direct cortical compression, perilesional edema-mediated cortical irritation, or invasion of adjacent cortex in atypical or malignant variants [1]. On MRI, meningiomas appeared as extra-axial homogeneously enhancing masses with an isointense to slightly hypointense signal relative to grey matter on T1-weighted sequences, isointense to hyperintense signal on T2-weighted sequences, and avid homogeneous enhancement on post-contrast T1 sequences with a dural tail sign. Perilesional vasogenic edema manifested as T2 and FLAIR hyperintensity in the adjacent brain parenchyma. Mass effect including sulcal effacement, midline shift, and ventricular compression was observed in proportion to the size of the lesion. The detection of meningioma as a causative lesion in seizure patients underscores the importance of contrast-enhanced MRI in the evaluation of new-onset seizures, as these lesions may be subtly isointense to cortex on non-enhanced sequences and conspicuous only on post-contrast imaging.



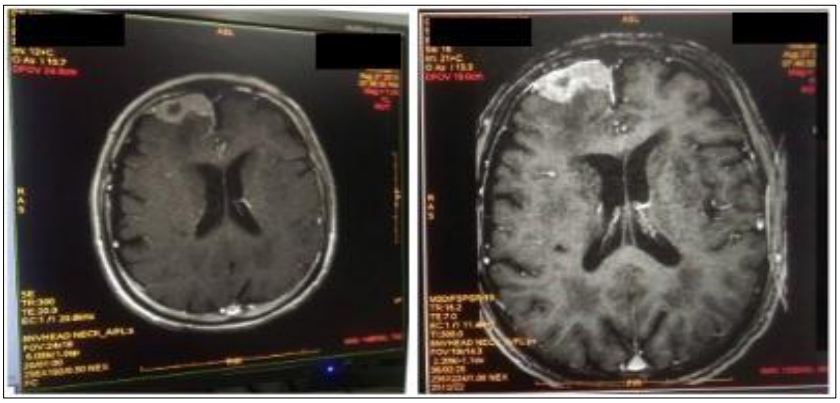


Fig 7: Meningioma — Axial T1 with contrast and Axial T1 sequences demonstrating a convexity meningioma with mass effect and homogeneous contrast enhancement.

Among the miscellaneous diagnostic group, which collectively comprised 17 patients (17 percent), additional diagnoses included acute demyelinating encephalomyelitis (ADEM), subdural haematoma, and encephalitis. ADEM was characterized by multifocal predominantly subcortical and deep white matter T2 and FLAIR hyperintense lesions with patchy post-contrast enhancement, consistent with the inflammatory demyelinating pathology of the condition. Subdural haematoma was identified as extra-axial crescentic collections of variable signal intensity depending on the age of haemorrhage, with associated mass effect on the underlying cortex. Encephalitis demonstrated diffuse or multifocal cortical and subcortical T2 and FLAIR signal abnormality with variable restricted diffusion and meningeal or cortical enhancement on post-contrast sequences.

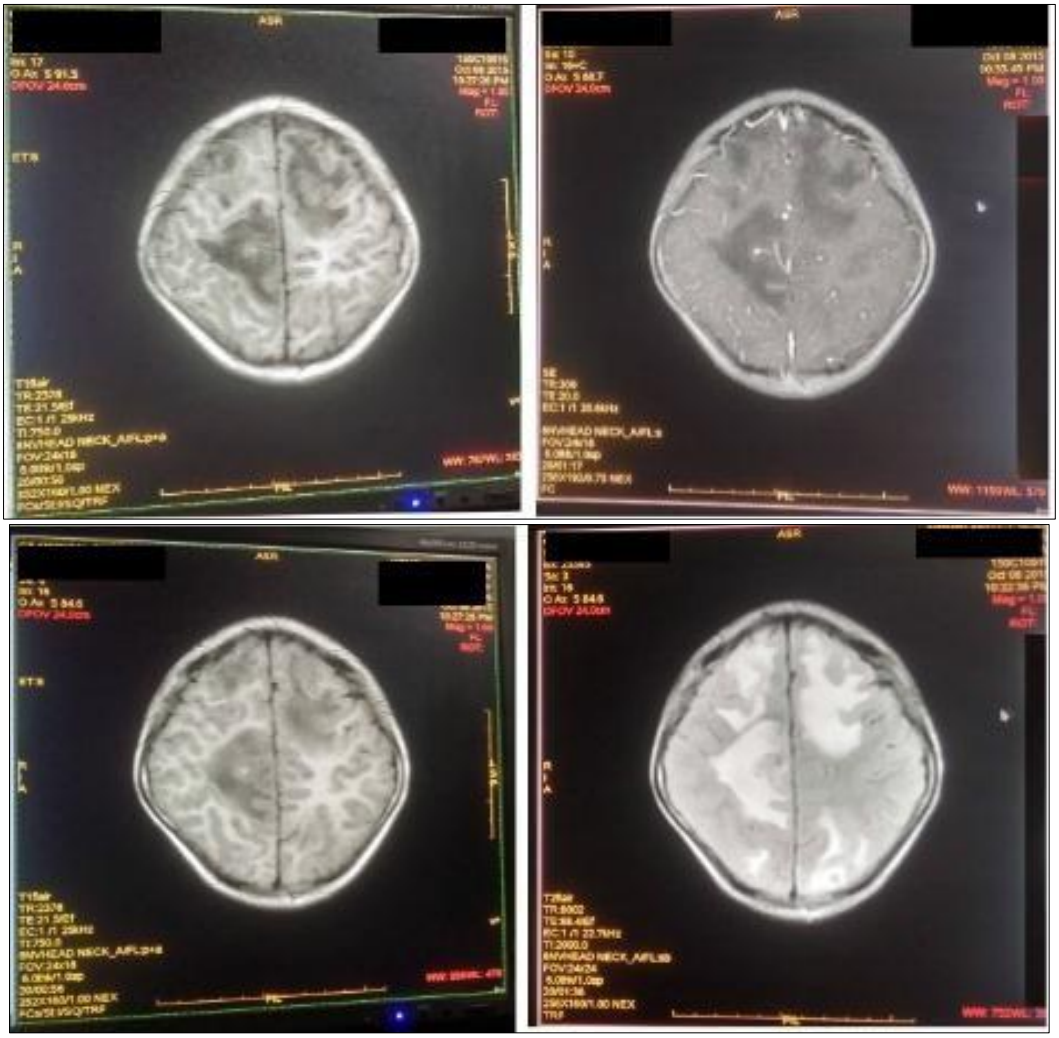


Fig 8: Acute Demyelinating Encephalomyelitis (ADEM) — Axial T1, Axial T1 with contrast, Axial T1, and Axial T2 FLAIR sequences demonstrating multifocal demyelinating lesions with patchy enhancement.

5. Discussion

The results of this prospective study of 100 patients presenting with seizures and evaluated by 1.5 Tesla MRI provide a comprehensive characterization of the neuroimaging spectrum encountered in a tertiary hospital setting and are broadly consistent with findings reported by prior investigators in comparable clinical and epidemiological contexts [1, 3, 7]. The overall MRI positivity rate of 65 percent, indicating pathological findings in 65 of 100 patients, confirms the high diagnostic yield of MRI in seizure evaluation and underscores its superiority over computed tomography for this indication [1, 2].

The male predominance observed in this study, with a male-to-female ratio of approximately 1.6:1, is consistent with patterns reported in the wider epilepsy literature, in which male sex is more commonly associated with structural etiologies including vascular lesions, traumatic brain injury, and infective conditions, possibly reflecting greater occupational and environmental exposure risks in male patients in the study region. The preponderance of generalized tonic-clonic seizures, accounting for 80 percent of the cohort, reflects the referral pattern of a mixed inpatient and outpatient tertiary center and is consistent with the clinical observation that GTCS constitutes the most common and conspicuous seizure type leading to hospital presentation in the Indian context [1, 3].

Infective granuloma emerged as the most prevalent single pathological MRI diagnosis in this series at 17 percent, a finding that is directly consistent with the epidemiological landscape of the study region where neurocysticercosis and tuberculosis are endemic. Velasco *et al*. reported NCC in a substantial proportion of patients with intractable epilepsy in their cross-sectional study of 512 patients, concluding that neurocysticercosis is a major preventable cause of seizure disorder in tropical countries [3]. Patil and Paithankar similarly reported a high prevalence of NCC in their series of 40 patients in a clinico-radiological profile study, noting that seizures were the dominant mode of clinical presentation across all stages of cysticercal evolution [4]. Sanchetee *et al*. demonstrated in their prospective series that epilepsy was the most common clinical manifestation of NCC, confirming the causal relationship between cysticercal granuloma and seizure generation [5]. The signal characteristics of cysticercal granulomas at various stages of evolution as identified in the present study, including the ring-enhancing colloidal and granular stages with perilesional edema and the end-stage calcified dot, are concordant with the MRI descriptions provided by these investigators. Naser *et al*., reporting on intracranial tuberculoma in Kuwait, described ring-enhancing and nodularly enhancing tuberculomata with T2 hypointensity due to caseous necrosis, features that correspond closely to the tuberculomatous granulomas identified in the present series [6].

Cerebral infarction with gliosis was the second most frequent pathological MRI finding at 16 percent, and its predominant distribution in the 16 to 45 years age group in this study suggests a significant contribution from non-atherosclerotic causes of cerebral ischemia in younger adults, including cardioembolism, hypercoagulable states, and vasculitis. Myint *et al*. reviewed the relationship between post-stroke seizures and post-stroke epilepsy and identified cortical involvement and haemorrhagic transformation as important determinants of seizure risk following cerebral infarction [8]. The present series corroborates the clinical significance of residual gliosis as an epileptogenic substrate, with gliotic scarring identified on FLAIR and T2 sequences in the distribution of prior ischemic injury serving as the principal basis for the MRI diagnosis.

Cerebral atrophy as the sole MRI finding in 1 percent of cases is consistent with the study's predominantly young adult enrollment profile. Khan *et al*. identified cerebral atrophy on MRI as a significant finding in patients with type II diabetes mellitus, suggesting a vascular and metabolic contribution to cortical volume loss in older adults [9]. While the present series did not systematically document metabolic co-morbidities, the single atrophy case likely reflects a similar multifactorial process.

Developmental malformations were identified in two pediatric patients (2 percent), exclusively in those under 15 years of age. Sanghvi *et al*. reported a spectrum of congenital central nervous system malformations in pediatric epilepsy in their series of patients studied by MRI, concluding that MRI is indispensable for the detection and characterization of cortical dysplasias, heterotopias, and polymicrogyria that underlie medically refractory focal epilepsy in children [10]. Gulati *et al*. similarly emphasized the critical contribution of MRI in identifying structural lesions including cortical malformations in childhood epilepsy, reporting abnormal MRI findings in a substantial proportion of pediatric patients in whom clinical and electroencephalographic evaluation was inconclusive [7]. The present results affirm these observations, demonstrating the exclusive pediatric occurrence of developmental malformations and highlighting the necessity of MRI in the epilepsy evaluation of children.

Glioma accounted for 9 percent of cases in this series, predominantly in the 31 to 60 years age group, consistent with the age distribution of both low-grade and high-grade gliomas described in the neuro-oncology literature. The MRI distinction between low-grade gliomas, which typically lack contrast enhancement and demonstrate infiltrative T2 signal abnormality, and high-grade gliomas, which exhibit ring enhancement, central necrosis, and surrounding vasogenic edema, is critical for treatment planning and neurosurgical decision-making [1, 2]. Seizure as a presenting symptom of glioma is particularly characteristic of low-grade tumors where prolonged cortical infiltration precedes neurological deficit, making MRI an essential tool for early tumor detection in patients presenting with new seizures.

Venous sinus thrombosis, identified among the miscellaneous group, represents a diagnostically challenging entity in which MRI including post-contrast sequences and MR venography is essential for confident diagnosis, since the variable signal characteristics of intraluminal thrombus may mimic normal flow-related signal on non-enhanced sequences [11]. Gupta *et al*. described superior sagittal sinus thrombosis presenting with headache and demonstrated the diagnostic importance of MRI and MR venography in confirming the diagnosis and characterizing the extent of thrombosis [11]. The venous thrombosis cases in the present study similarly demonstrated the characteristic combination of absent flow void, T1 hyperintense intraluminal thrombus, and empty delta sign on contrast-enhanced sequences that enabled definitive MRI diagnosis.

Meningioma in three patients (3 percent), all in the 46 to 60 years age group, reflects the well-known peak incidence of meningioma in the fifth to seventh decades, with female predominance in other series though not exclusively evident in the present small subset. The avid homogeneous

enhancement and dural tail sign on post-contrast T1 sequences are pathognomonic MRI features that allow confident radiological diagnosis without histopathological confirmation in the appropriate clinical and imaging context. The miscellaneous group, encompassing ADEM, subdural haematoma, and encephalitis, highlights the etiological breadth of structural and inflammatory conditions that must be considered in the MRI evaluation of seizures, and emphasizes the value of a comprehensive multisequence protocol including contrast-enhanced imaging for their characterization.

The findings of this study, taken in aggregate, confirm that 1.5 Tesla MRI provides a high diagnostic yield of 65 percent in patients presenting with seizures and is capable of identifying a diverse spectrum of structural, infective, vascular, neoplastic, and developmental etiologies that may not be detectable by other imaging modalities. The concordance of the present results with those of Hatipoglu *et al*., Im *et al*., and other investigators in comparable settings lends further validation to the role of MRI as the neuroimaging investigation of choice in seizure evaluation. The 35 percent rate of normal MRI in this series is consistent with published data indicating that a substantial proportion of patients with idiopathic generalized epilepsy, particularly those with primary GTCS of genetic etiology, will not have a demonstrable structural lesion on MRI, and should be evaluated further with advanced imaging techniques such as 3 Tesla MRI, voxel-based morphometry, or functional MRI where clinically indicated [1, 2].

6. Conclusion

This prospective study of 100 patients presenting with seizures evaluated on a 1.5 Tesla MRI system demonstrates that MRI achieves a high overall diagnostic positivity rate of 65 percent, identifying a broad spectrum of structural and pathological etiologies across all age groups. The most prevalent MRI diagnoses were infective granuloma including neurocysticercosis and tuberculoma, cerebral infarction with gliosis, glioma, meningioma, developmental malformations, and venous sinus thrombosis, with the miscellaneous category additionally encompassing ADEM, subdural haematoma, and encephalitis. The age-wise distribution of MRI abnormalities followed clinically expected patterns, with infective granulomas predominating in young adults, infarcts with gliosis in the middle adult age group, developmental malformations exclusively in pediatric patients, and neoplastic lesions in the fourth to sixth decades. Male sex predominated in the study population, and generalized tonic-clonic seizures were the most common clinical presentation. These findings collectively affirm that 1.5 Tesla MRI, utilizing comprehensive multisequence protocols including post-contrast sequences, is the investigation of choice for the evaluation of seizure etiology, providing diagnostically actionable information that directly influences patient management in the majority of cases. In endemic regions where infective granuloma constitutes the leading identifiable MRI finding in seizure patients, the systematic application of MRI in seizure evaluation offers the greatest potential for early diagnosis and appropriate directed therapy. Continued investment in MRI availability, protocol optimization, and radiological expertise in tertiary neuroimaging centers is essential to realizing the full diagnostic potential of this modality in seizure disorder management.

7. References

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