Magnetic Resonance Imaging Evaluation of Seizures: A Hospital-Based Cross-Sectional Study

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ABSTRACT

Background: Magnetic resonance imaging (MRI) is the modality of choice for evaluating patients with seizures, but the spectrum of findings varies markedly with geography, age and seizure semiology. Indian data, particularly from Rajasthan, remain limited.

Aim: To evaluate the spectrum of MRI findings in patients presenting with seizures and to correlate the imaging yield with clinical variables.

Methods: A hospital-based descriptive cross-sectional analytical study was conducted over 18 months in the Department of Radio-diagnosis of a tertiary care teaching hospital in Jaipur. One hundred consecutive patients of all ages presenting with new-onset or established seizures were enrolled by total enumeration after Institutional Ethics Committee approval. All patients underwent a dedicated seizure MRI protocol on 1.5 T scanners. Lesions were classified by aetiology, anatomical distribution, laterality, number and contrast enhancement. Associations between clinical variables and abnormal MRI were tested by Chi-square test ($p < 0.05$ significant).

Results: The cohort was male-predominant (69%) with a mean age of 32.92 ± 17.10 years (range 3–74). MRI was abnormal in 67 of 100 patients (67%). Infectious/inflammatory lesions were the leading aetiology (43.28%) — neurocysticercosis being the single most common diagnosis (32.84%) — followed by vascular (19.40%), mesial temporal sclerosis (10.45%), tuberculoma (10.45%) and neoplastic (7.46%) lesions. The parietal lobe was the commonest anatomical site (31.34%). Contrast enhancement was present in 49.25% of lesions, with ring enhancement predominating (90.91% of enhancing lesions). MRI yield was significantly higher in patients with focal seizures (100% vs 49.06%, $p < 0.001$), in those aged ≥50 years (100% vs lower in younger, $p < 0.001$) and in those with duration ≥1 year ($p = 0.02$); the difference by sex was not significant ($p = 0.42$).

Conclusion: MRI demonstrates a high diagnostic yield (67%) in seizure patients, with neurocysticercosis the predominant aetiology in this north-Indian cohort. MRI is most informative in patients with focal seizures, older age and longer duration of illness, and should be considered a frontline investigation in seizure evaluation.

Keywords: *Magnetic resonance imaging; Seizures; Epilepsy; Neurocysticercosis; Mesial temporal sclerosis; Diagnostic yield.*

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INTRODUCTION

A seizure is defined as the transient occurrence of signs or symptoms due to abnormal excessive or synchronous neuronal activity in the brain, and epilepsy is the disease state of recurrent unprovoked seizures.[1,2] Epilepsy is a major global public-health problem: the Global Burden of Disease 2021 estimates that approximately 52 million people worldwide live with active epilepsy, with the disorder accounting for a substantial proportion of years lived with disability among neurological conditions.[3,4] India harbours an estimated 12 million persons with epilepsy — nearly one-sixth of the global burden — with reported prevalence of 3.0–11.9 per 1,000 population and a particularly high incidence in rural settings.[5,6,7]

The aetiology of seizures varies considerably with age, geography and available diagnostic resources. In low- and middle-income countries including India, infections such as neurocysticercosis, tuberculoma and viral encephalitis remain leading causes, alongside vascular insults, mesial temporal sclerosis, neoplasms and developmental malformations.[8,9,10]

Neuroimaging is pivotal to the evaluation of seizure patients. Magnetic resonance imaging (MRI) has emerged as the modality of choice owing to its superior soft-tissue contrast, high spatial resolution, multiplanar capability and absence of ionising radiation. MRI demonstrates excellent sensitivity and specificity for the range of epileptogenic substrates, including mesial

temporal sclerosis (hippocampal atrophy with T2/FLAIR hyperintensity), focal cortical dysplasia, vascular malformations, tumours and post-infectious sequelae.[11,12,13,14,15] Identification of an epileptogenic lesion on MRI has substantial prognostic and therapeutic implications: lesional epilepsy is associated with higher rates of drug resistance, but a concordant MRI lesion in surgical candidates is also one of the strongest predictors of seizure freedom following resective surgery.[13,16,17]

Indian hospital-based studies have reported widely varying MRI yields in seizure patients (47–70.6%) and consistently identify a distinctive aetiological profile dominated by neuro-infections and vascular causes.[18,19,20,21,22] However, region-specific data from Rajasthan remain limited and the relative contribution of clinical predictors (seizure semiology, age and duration of illness) to MRI yield has not been systematically reported from this geography. The present study was undertaken to evaluate the spectrum of MRI findings in patients presenting with seizures at a tertiary care teaching hospital in Jaipur and to correlate the imaging yield with clinical variables.

MATERIALS AND METHODS

Study design and setting

This hospital-based descriptive cross-sectional analytical study was conducted over 18 months in the Department of Radio-diagnosis of Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India, after Institutional Ethics Committee approval. Written informed consent was obtained from every participant or guardian.

Study population and sample size

All consecutive patients of any age referred for MRI brain evaluation with new-onset or established seizures during the study period were eligible. Exclusion criteria were inability or unwillingness to provide consent, haemodynamic instability, claustrophobia, contraindications to MRI (pacemakers, cochlear implants, ferromagnetic implants) and first-trimester pregnancy. Using the single-proportion formula with an expected abnormal-MRI proportion of 60% (based on prior Indian studies), a 95% confidence level ($Z = 1.96$) and absolute precision of 12.5%, the minimum required sample size was 60 patients; this was expanded to 100 patients to improve precision of subgroup estimates.

MRI protocol and image analysis

All patients underwent imaging on a 1.5 T scanner using a dedicated seizure protocol that included axial, sagittal and coronal T1-weighted, T2-weighted, FLAIR, STIR, susceptibility-weighted imaging (SWI) and diffusion-weighted imaging (DWI) with ADC mapping, supplemented by coronal oblique sequences perpendicular to the long axis of the hippocampi for evaluation of mesial temporal structures. Post-contrast T1-weighted sequences in three orthogonal planes were obtained after intravenous gadolinium where clinically indicated.[12,23,24] All images were independently reviewed by experienced radiologists on dedicated DICOM workstations. The following parameters were systematically recorded: presence or absence of structural abnormality, lesion location (lobar distribution, laterality), number of lesions, signal characteristics, contrast-enhancement pattern, perilesional oedema, mass effect, hippocampal volume and signal, and associated findings (atrophy, calcifications, haemorrhage). Lesions were classified by aetiology into vascular, infectious/inflammatory, neoplastic, developmental/congenital, mesial temporal sclerosis, traumatic, hypoxic-ischaemic injury and cerebral atrophy categories.

Statistical analysis

All data were entered in Microsoft Excel and analysed using standard statistical software. Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Associations between categorical variables (sex, age group, seizure type, duration of illness) and abnormal MRI findings were tested using the Chi-square test. A two-tailed p-value of <0.05 was considered statistically significant; where applicable, 95% confidence intervals were calculated.

RESULTS

A total of 100 consecutive patients with seizures were studied. The cohort was male-predominant (69 males, 69%; 31 females, 31%; M:F ratio 2.23:1) with a mean age of 32.92 ± 17.10 years (range 3–74 years), the largest age band being 21–30 years (30%). Generalised tonic-clonic seizures (GTCS) were the commonest semiology (53%), followed by focal seizures (28%) and focal-to-bilateral seizures (13%). New-onset seizures comprised 38%, with the remainder presenting with established disease of varying duration (Table 1).

Table 1. Demographic and clinical profile of seizure patients (N = 100).

Category	Number (n)	Percentage (%)
Sex		
Male	69	69.00
Female	31	31.00
Age group (years)		
0–10	5	5.00
11–20	19	19.00
21–30	30	30.00
31–40	20	20.00
41–50	7	7.00
51–60	8	8.00
>60	11	11.00
Seizure semiology		
Generalised tonic-clonic (GTCS)	53	53.00
Focal-onset	28	28.00

Focal to bilateral	13	13.00
Other / unknown	6	6.00
Duration of illness		
New-onset	38	38.00
<1 year	31	31.00
1–5 years	22	22.00
>5 years	9	9.00
MRI finding		
Abnormal	67	67.00
Normal	33	33.00

Mean age 32.92 ± 17.10 years (range 3–74). Male-to-female ratio 2.23:1.

MRI yield and correlation with clinical variables

Abnormal MRI findings were demonstrated in 67 of 100 patients (overall diagnostic yield 67%). The yield differed markedly by clinical subgroup (Table 2, Figure 1). All 28 patients (100%) with focal-onset seizures and all 13 patients (100%) with focal-to-bilateral seizures had abnormal MRI, compared with 26 of 53 patients (49.06%) presenting with GTCS — a highly significant difference ($\chi^2 = 34.23$, $p < 0.001$). MRI yield was also significantly higher in patients aged ≥50 years (100% in both 51–60 and >60 year bands) than in younger patients ($\chi^2 = 11.55$, $p < 0.001$), and in patients with duration ≥1 year (86.36% in 1–5 years; 77.78% in >5 years) compared with new-onset seizures (52.63%) ($\chi^2 = 5.78$, $p = 0.02$). The difference by sex (69.57% in males vs 61.29% in females) did not reach statistical significance ($\chi^2 = 0.66$, $p = 0.42$).

Table 2. Correlation of clinical variables with abnormal MRI findings (N = 100).

Clinical variable	Comparison	Abnormal MRI	Normal MRI	χ^2 (df)	p-value
Sex	Male vs Female	48/69 (69.57 %)	21/69 (30.43 %)	0.66 (1)	0.42 NS
		19/31 (61.29 %)	12/31 (38.71 %)		
Age (years)	≥50 vs <50	19/19 (100%)	0/19 (0%)	11.55 (1)	<0.001*
		48/81 (59.26 %)	33/81 (40.74 %)		
Seizure type	Focal vs Non-focal	26/59 (44.07 %)	33/59 (55.93 %)	34.23 (1)	
Duration	≥1 year vs <1 year	24/31 (77.42 %)	7/31 (22.58 %)	5.78 (1)	0.02*
		43/69 (62.32 %)	26/69 (37.68 %)		

*Chi-square test. *Statistically significant at $p < 0.05$. NS = not significant.*

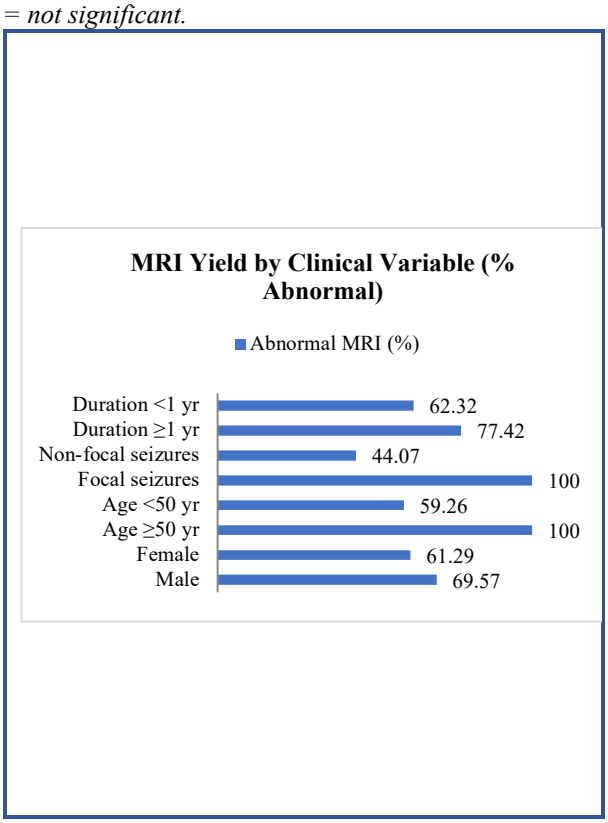

Figure 1. MRI diagnostic yield (%) stratified by sex, age group (≥50 vs <50 years), seizure semiology (focal vs non-focal) and duration of illness (≥1 year vs <1 year).

Aetiological spectrum of MRI abnormalities

Among the 67 patients with abnormal MRI, infectious/inflammatory lesions were the leading aetiology (29 patients, 43.28%), with neurocysticercosis the single most common diagnosis (22 patients, 32.84% of abnormal MRI). Vascular causes (infarct with gliosis) accounted for 13 patients (19.40%), mesial temporal sclerosis and tuberculoma for 7 each (10.45%), cerebral atrophy for 5 (7.46%), hypoxic-ischaemic injury for 3 (4.48%), neoplastic lesions for 5 (7.46%) and developmental malformations for 4 (5.97%) (Table 3, Figure 2). All 22 NCC patients showed enhancement; ring enhancement predominated (90.91% of enhancing lesions overall).

Table 3. Aetiological distribution of MRI abnormalities (n = 67).

Aetiological category	Specific lesion	n	Percentage (%)
Infectious / inflammatory	Neurocysticercosis (NCC)	22	32.84
	Tuberculoma	7	10.45
Vascular	Infarct with gliosis	13	19.40
Mesial temporal sclerosis	Hippocampal atrophy / T2-FLAIR hyperintensity	7	10.45
Neoplastic	Glioma / oligodendroglioma / meningioma / DNET	5	7.46
Developmental / congenital	FCD, heterotopia, polymicrogyria, schizencephaly	4	5.97
Cerebral atrophy	Generalised / focal atrophy	5	7.46
Hypoxic-ischaemic	HIE / perinatal asphyxia sequelae	3	4.48
Other	Miscellaneous	1	1.49
Total	—	**67**	**100.00**

NCC = neurocysticercosis; FCD = focal cortical dysplasia; DNET = dysembryoplastic neuroepithelial tumour; HIE = hypoxic-ischaemic encephalopathy.

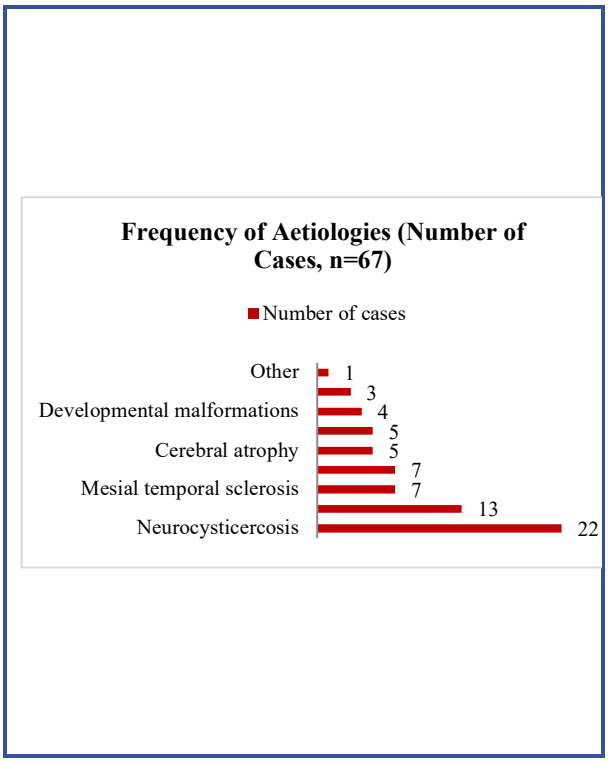

Figure 2. Frequency distribution of major aetiologies of abnormal MRI findings in seizure patients (n = 67).

Anatomical distribution and lesion characteristics

The parietal lobe was the commonest anatomical site of involvement (21 lesions, 31.34%), followed by the frontal (16, 23.88%), temporal (13, 19.40%) and occipital (3) lobes; 10 patients (14.93%) had multi-lobar involvement (Table 4, Figure 3). Right-sided involvement was observed in 27 patients (40.30%), left-sided in 24 (35.82%) and bilateral in 16 (23.88%). Single lesions predominated (47 patients, 70.15%); multiple lesions were present in 15 (22.39%). Contrast enhancement was demonstrated in 33 of 67 patients (49.25%); ring enhancement was overwhelmingly the commonest pattern (30 of 33 enhancing lesions, 90.91%), in keeping with the high prevalence of NCC and tuberculoma. All 29 patients with infectious/inflammatory pathology demonstrated contrast enhancement, compared with only 4 of 38 non-infectious cases (10.53%) — a highly significant difference ($\chi^2 = 52.68$, $p < 0.001$).

Table 4. Lesion characteristics in patients with abnormal MRI (n = 67).

Lesion characteristic	n	Percentage (%)
Lobar location		
Parietal	21	31.34
Frontal	16	23.88
Temporal	13	19.40
Multi-lobar	10	14.93
Occipital / other	7	10.45

Laterality		
Right	27	40.30
Left	24	35.82
Bilateral	16	23.88
Number of lesions		
Single	47	70.15
Multiple	15	22.39
Not applicable (atrophy)	5	7.46
Contrast enhancement		
Ring	30	90.91 of enhancing
Heterogeneous	2	6.06 of enhancing
Homogeneous	1	3.03 of enhancing
Absent	34	50.75

All 29 infectious/inflammatory lesions enhanced (100%) vs 4/38 (10.53%) non-infectious (χ^2 = 52.68, $p < 0.001$).

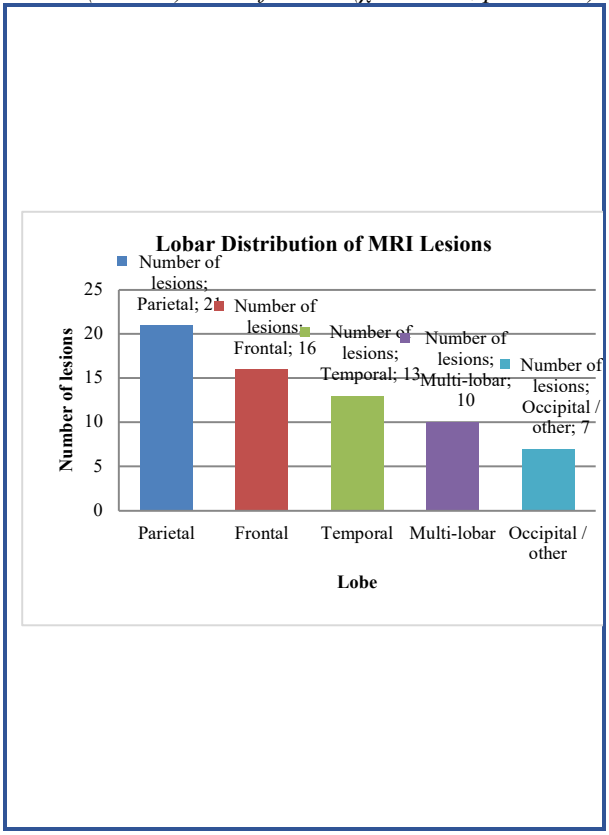

Figure 3. Anatomical distribution of MRI lesions by lobar involvement (n = 67).

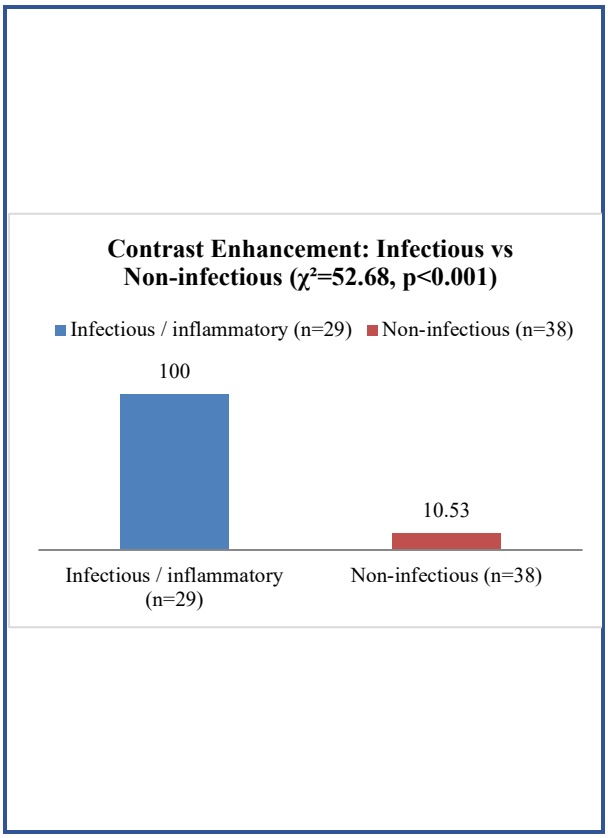

Figure 4. Contrast-enhancement pattern in infectious/inflammatory versus non-infectious lesions (n = 67).

DISCUSSION

This single-centre cross-sectional study of 100 consecutive seizure patients undergoing dedicated MRI evaluation at a tertiary care teaching hospital in Jaipur identified an overall diagnostic yield of 67%, with a distinctively north-Indian aetiological profile dominated by neuro-infections (43.28%) — neurocysticercosis alone accounting for nearly a third of all abnormal scans — followed by vascular causes (19.40%) and mesial temporal sclerosis (10.45%). MRI yield was strongly associated with focal seizure semiology, older age and longer duration of illness.

Demographic and clinical profile

The male predominance (M:F 2.23:1) and mean age of 32.92 ± 17.10 years observed in our cohort are consistent with the demographic patterns reported by other Indian and international series of seizure patients evaluated radiologically.[20,21,22,25] The high proportion of generalised tonic-clonic seizures (53%) is also concordant with previous Indian hospital-based reports.[18,19]

Diagnostic yield of MRI

The 67% overall MRI yield in our cohort lies in the middle of the published range. Comparable Indian series have reported yields between 47% in new-onset cohorts (Ponnatapura et al.)[18] and 70.6% in paediatric cohorts (Agarwal et al.).[19] International figures range from 29% in unselected first-seizure-clinic populations (Hernandez et al.)[26] to 91% in dedicated epilepsy-protocol scans in patients with refractory focal disease (Von Oertzen et

al.).[11] Our intermediate yield reflects an unselected case mix including both new-onset and established seizure patients across all ages, scanned on a dedicated seizure protocol. The strikingly higher yield in focal-seizure patients (100%) and in those aged ≥50 years (100%) mirrors international literature: focal semiology and older age are both well-established predictors of a structural lesion on neuroimaging.[12,16,17,27] Our findings reinforce the recommendation by the ILAE Neuroimaging Task Force that MRI be regarded as a frontline investigation in all patients with new-onset focal seizures and in all patients with onset after the age of 50 years.[12]

Aetiological spectrum

Neurocysticercosis was the single commonest aetiology in our cohort (32.84% of abnormal scans), a finding which is consistent with the established epidemiology of cysticercosis in India, where it is held to be the most common cause of acquired epilepsy.[8,9,10] Tuberculoma (10.45%) and infarct with gliosis (19.40%) reinforce the dual burden of neuro-infection and cerebrovascular disease in adult Indian seizure populations, while mesial temporal sclerosis (10.45%), neoplastic lesions (7.46%) and developmental malformations (5.97%) round out the etiological spectrum.[20,22,25] Parietal-lobe predominance (31.34%) in our cohort — contrary to the temporal-lobe predominance often seen in surgical-epilepsy series — likely reflects the lesion-driven distribution of neurocysticercosis, which preferentially involves the parietal and frontal cortex; this pattern has been previously noted in Indian seizure cohorts.[20,25] The contrast-enhancement pattern in our cohort was also strongly informative: all infectious/inflammatory lesions enhanced (100%) compared with only 10.53% of non-infectious lesions, a highly significant difference ($p < 0.001$) that recapitulates the well-established imaging signature of active neuro-infection.[10]

Strengths, limitations and clinical implications

Strengths of the present study include the use of a dedicated, standardised seizure MRI protocol, independent radiological review, prospective consecutive enrolment of unselected patients of all ages, and concurrent analysis of imaging, demographic and clinical variables. Principal limitations are the single-centre design, the modest sample size of 100, the lack of long-term clinical follow-up, the absence of histopathological correlation for selected lesions, the absence of EEG correlation, and the use of 1.5 T rather than 3 T MRI (the latter being known to incrementally improve detection of subtle epileptogenic substrates such as focal cortical dysplasia).[16,13] Despite these limitations, the magnitude of the overall yield (67%), the strength of the clinical-imaging correlations, and the distinctively north-Indian aetiological profile carry clear clinical implications: MRI — ideally with a dedicated seizure protocol — should be regarded as a frontline investigation in all patients with seizures, particularly in those with focal semiology, onset after the age of 50 years or established disease, where the probability of a structural epileptogenic lesion approaches certainty.[12,24]

Comparison with prior studies

Table 5 summarises the diagnostic yield of MRI in seizure cohorts across the published Indian and international literature, contextualising the present finding.

Table 5. Comparison of MRI diagnostic yield in seizure cohorts across published studies.

Study (Year)	Region	n	Population	MRI yield (%)
Von Oertzen et al. (2002)	Germany	123	Refractory focal epilepsy	91 (dedicated)
Ponnatapura et al. (2018)	India	129	New-onset seizures	47
Bhatia et al. (2017)	India	144	Adult-onset seizures	59.7
Hernandez et al. (2018)	Australia	1013	First seizure clinic	29
Agarwal et al. (2021)	India	160	Paediatric seizures	70.6
Alyoubi et al. (2023)	Saudi Arabia	171	Paediatric seizures	60.8
Jayalakshmi et al. (2014)	South India	–	New-onset seizures	~55–60
Modi et al. (2024)	North India	–	Late-onset seizures	High in ≥50 yr
Present study (2026)	**India (Rajasthan)**	**100**	**Mixed-age, all-seizure**	**67 (NCC 32.84%)**

NCC = neurocysticercosis. Yields vary by population (refractory vs new-onset), age band and MRI protocol intensity.

CONCLUSION

Magnetic resonance imaging demonstrates a high overall diagnostic yield (67%) in patients presenting with seizures at a tertiary care teaching hospital in north India, with neurocysticercosis the single most common aetiology (32.84%), followed by vascular and mesial-temporal causes. MRI yield was particularly high in focal seizures (100%), older patients (≥50 years: 100%) and patients with established disease (≥1 year duration), and the contrast-enhancement pattern was strongly informative in differentiating infectious from non-infectious aetiology. These findings reinforce the role of MRI — ideally with a dedicated seizure protocol — as a frontline investigation in seizure evaluation, particularly

in geographies where neurocysticercosis remains endemic, and support its early use in patients with focal semiology, late-onset disease or longer duration of illness.

DECLARATIONS

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Ethical approval: Obtained from the Institutional Ethics Committee of Mahatma Gandhi Medical College and Hospital, Jaipur, prior to commencement of the study.

Conflict of interest: None declared.

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