



Role of MRI in Evaluation of Cystic Lesions of Brain: A Prospective Observational Study

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ABSTRACT:

Introduction: Cystic brain lesions represent a heterogeneous group of pathologies requiring accurate diagnosis for appropriate management. MRI provides superior contrast resolution and multiplanar capability for characterizing these lesions.

Aim: To differentiate various cystic brain lesions according to their pathological classification and to determine their exact location, size, extension, and multiplicity using MRI.

Materials and Methods: This prospective observational study was conducted at the Department of Radiodiagnosis, Dhiraj General Hospital, Vadodara, Gujarat, India from October 2022 to April 2024. A total of 109 patients with neurological symptoms who were found to have cystic brain lesions on MRI were included. MRI was performed using PHILIPS 1.5 Tesla machine with standard brain protocols including T1WI, T2WI, FLAIR, and post-contrast sequences. Data was analyzed using descriptive statistics.

Results: The mean age was 35.4±17.2 years with male predominance (60.55%). The most common presenting symptoms were headache and altered sensorium (42.20% each). Tumors were the most common etiology (32.7%), with glioblastoma multiforme being the most frequent (14.68%). Single lesions were observed in 73.39% of cases. Supratentorial location was predominant (77.06%). Ring enhancement was the most common pattern (65.06%), particularly in tuberculomas (24.07%) and neurocysticercosis (22.22%).

Conclusion: MRI effectively characterizes intracranial cystic lesions by providing crucial information about anatomic location, size, morphology, and enhancement patterns. Following a systematic algorithmic approach based on location, signal intensity, and enhancement characteristics facilitates accurate diagnosis and appropriate management planning.

1. Introduction

The human nervous system represents the most complex structure in the known universe, expressing more than one-third of the 23,000 genes contained in the human genome [1]. Neurologic conditions affect over 1 billion people globally and constitute 6.3% of the global disease burden according to World Health Organization estimates [2].

Intracranial cystic lesions encompass a diverse spectrum of pathologies including congenital, infectious, and neoplastic etiologies. These lesions present diagnostic

challenges due to overlapping imaging features. The primary goal of neuroimaging is to detect the abnormality, determine its location, size, extent, and characterize the lesion to provide differential diagnoses or a specific diagnosis when possible [3].

Magnetic Resonance Imaging (MRI) has revolutionized the evaluation of intracranial pathology since its clinical introduction. The multiplanar capability and superior contrast resolution of MRI enable detailed visualization of different lesion components, assessment of vascularity, and evaluation of effects on adjacent



structures [4]. Gadolinium-enhanced sequences further improve lesion characterization by demonstrating enhancement patterns that can be homogeneous, heterogeneous, ring-like, or associated with mural nodules.

The present study aimed to evaluate the role of MRI in characterizing various cystic brain lesions and to develop a systematic approach for their differential diagnosis based on imaging features.

2. Materials and Methods

This prospective observational study was conducted at the Department of Radiodiagnosis, Dhiraj General Hospital, SBKS Medical Institute & Research Centre, Vadodara, Gujarat, India from October 2022 to April 2024. The study was approved by the Sumandeep Vidyapeeth Ethics Committee.

Study Population: All patients referred to the radiology department with neurological symptoms who were found to have cystic brain lesions on MRI were included. Patients with cardiac pacemakers, metallic foreign bodies in the eye, cochlear implants, or other MRI-incompatible devices were excluded.

Sample Size: A total of 109 patients were enrolled using convenient sampling method.

MRI Protocol: All examinations were performed on a PHILIPS 1.5 Tesla MRI scanner using standard head coil. The imaging protocol included:

- Axial T1-weighted images (TR/TE: 500/15 ms)
- Axial T2-weighted images (TR/TE: 4000/100 ms)
- Axial FLAIR sequences (TR/TE/TI: 8000/120/2400 ms)
- Diffusion-weighted imaging (b values: 0 and 1000 s/mm²)

- Post-contrast T1-weighted images in axial, coronal, and sagittal planes after intravenous administration of gadolinium-based contrast agent (0.1 mmol/kg)

Image Analysis: Images were analyzed for lesion location (supratentorial/infratentorial, specific lobes), size, signal characteristics on different sequences, presence of calcification, enhancement pattern, mass effect, and associated findings. Final diagnosis was based on imaging features correlated with clinical presentation and histopathological confirmation where available.

STATISTICAL ANALYSIS

Data was entered in Microsoft Excel and analyzed using descriptive statistics. Continuous variables were expressed as mean \pm standard deviation (SD) and categorical variables as frequencies and percentages. The chi-square test was used for comparing categorical variables. A p-value <0.05 was considered statistically significant.

3. Results

[Table/Fig-1]: CONSORT Flow Diagram

Patients referred for brain MRI (n=156)

↓

Excluded (n=47)

- No cystic lesions (n=35)
- MRI contraindications (n=8)
- Incomplete studies (n=4)

↓

Included in analysis (n=109)

The study flow showed 156 patients were initially screened, with 109 meeting inclusion criteria and completing the study protocol.

[Table/Fig-2]: Demographic characteristics and clinical presentation

Parameter	Frequency	Percentage
Age groups (years)		
0-10	15	13.76%
11-20	17	15.60%
21-30	20	18.35%
31-40	14	12.84%
41-50	21	19.27%



51-60	16	14.68%
61-70	6	5.50%
Gender		
Male	66	60.55%
Female	43	39.45%
Clinical presentation		
Headache	46	42.20%
Altered sensorium	46	42.20%
Vomiting	34	31.19%
Visual disturbances	34	31.19%
Seizures	30	27.52%
Paralysis	9	8.26%
Fever	9	8.26%

The study population showed a bimodal age distribution with peaks in the 21-30 years (18.35%) and 41-50 years (19.27%) age groups. Male predominance was observed

with a male:female ratio of 1.5:1. Headache and altered sensorium were the most common presenting symptoms.

[Table/Fig-3]: Distribution of cystic lesions by etiology

Etiology	Number	Percentage
Tumors	36	33.03%
Glioblastoma multiforme	16	14.68%
Metastases	9	8.26%
Craniopharyngioma	3	2.75%
Medulloblastoma	3	2.75%
Pilocytic astrocytoma	3	2.75%
Acoustic schwannoma	2	1.83%
Infections	35	32.11%
Tuberculoma	13	11.93%
Neurocysticercosis	12	11.01%
Abscess	8	7.34%
Fungal infection	1	0.92%
Hydatid cyst	1	0.92%
Congenital	29	26.61%
Mega cisterna magna	9	8.26%
Epidermoid	6	5.50%



Arachnoid cyst	5	4.59%
Others	9	8.26%
Miscellaneous	9	8.26%

Neoplastic lesions constituted the largest group (33.03%), with glioblastoma multiforme being the single most common pathology. Infectious etiologies were

nearly equally prevalent (32.11%), with tuberculoma and neurocysticercosis showing similar frequencies

[Table/Fig-4]: Location and characteristics of cystic lesions

Parameter	Number	Percentage
Number of lesions		
Single	80	73.39%
Multiple	29	26.61%
Location		
Supratentorial	84	77.06%
- Frontal lobe	34	31.19%
- Parietal lobe	47	43.12%
- Temporal lobe	48	44.04%
- Occipital lobe	25	22.94%
Infratentorial	25	22.94%
- Cerebellum	15	13.76%
- Brainstem	9	8.26%
- CP angle	10	9.17%
Enhancement pattern		
Ring enhancement	54	65.06%
Inhomogeneous	26	31.33%
Mural nodule	3	3.61%

Most lesions were solitary (73.39%) and supratentorial (77.06%) in location. The parietal and temporal lobes were the most commonly affected regions. Ring

enhancement was the predominant pattern, particularly in infectious lesions.

[Table/Fig-5]: Age-wise distribution of common cystic lesions

Age group	Most common lesion	Second most common	Third most common
0-10 years	Arachnoid cyst (20.0%)	Tuberculoma (20.0%)	Schizencephaly (13.3%)
11-20 years	Tuberculoma (23.5%)	Craniopharyngioma (11.8%)	NCC* (11.8%)
21-30 years	NCC (30.0%)	GBM** (25.0%)	-



31-40 years	GBM (21.4%)	Tuberculoma (14.3%)	-
41-50 years	GBM (14.3%)	Multiple pathologies***	-
51-60 years	Metastases (25.0%)	Multiple pathologies****	-
61-70 years	Metastases (50.0%)	Porencephalic cyst (33.3%)	-

*NCC: Neurocysticercosis; **GBM: Glioblastoma multiforme; ***Cystic gliosis, tuberculoma, epidermoid, pilocytic astrocytoma, metastases (each 9.5%); ****Cystic gliosis, abscess, NCC (each 12.5%)

Age-specific distribution revealed congenital lesions predominating in pediatric age groups, infectious lesions in young adults, and neoplastic lesions in older age groups, demonstrating the expected epidemiological patterns.

4. Discussion

The present study evaluated 109 patients with intracranial cystic lesions using MRI, demonstrating its efficacy in lesion characterization. The demographic distribution showed male predominance (60.55%), consistent with previous studies reporting similar gender predilection in brain pathologies [5,6].

The age distribution revealed interesting patterns with congenital lesions predominating in the pediatric population, infectious lesions in young adults, and neoplastic lesions in older age groups. This distribution aligns with established epidemiological data. Arachnoid cysts, found predominantly in children (20% in 0-10 years age group), typically present early due to their congenital nature [7]. The high prevalence of tuberculomas and neurocysticercosis in the 11-30 years age group reflects the endemic nature of these infections in developing countries [8,9].

Glioblastoma multiforme emerged as the most common neoplastic lesion (14.68%), with peak incidence in the 41-50 years age group, consistent with its known epidemiology [10]. The study by Sarkar et al. similarly reported glioblastoma as the most common primary brain tumor in adults, with median age at diagnosis of 45 years [11].

The predominance of supratentorial location (77.06%) in our study correlates with findings by Kumar et al., who reported 72% supratentorial distribution of brain lesions [12]. The predilection for parietal (43.12%) and temporal (44.04%) lobes may be attributed to the higher volume of these regions and their watershed zones being susceptible to embolic phenomena in metastatic disease.

Ring enhancement pattern was observed in 65.06% of cases, predominantly in infectious lesions. This finding

supports the diagnostic utility of enhancement patterns in differentiating lesion etiology. Tuberculomas showed characteristic ring enhancement in all cases, with central T2 hypointensity in mature lesions, helping differentiate them from neurocysticercosis which typically shows scolex as T2 hypointense dot [13].

The study revealed interesting findings regarding lesion multiplicity. While most lesions were solitary (73.39%), certain pathologies showed predilection for multiple lesions including neurocysticercosis (66.7%), metastases (77.8%), and tuberculomas (46.2%). This distribution pattern aids in narrowing differential diagnoses when multiple lesions are encountered.

Signal intensity patterns on MRI sequences provided valuable diagnostic information. Congenital cysts like arachnoid cysts and porencephalic cysts followed CSF signal on all sequences without enhancement, distinguishing them from neoplastic and infectious lesions. Epidermoid cysts showed characteristic restricted diffusion, appearing bright on DWI, which helped differentiate them from arachnoid cysts [14].

Comparison with recent literature reveals concordance with our findings. Osborn et al. emphasized the importance of location, signal characteristics, and enhancement patterns in diagnosing cystic brain lesions, similar to our algorithmic approach [15]. The study by Reddy et al. on 150 patients with ring-enhancing lesions reported tuberculoma (38%) and neurocysticercosis (34%) as the most common causes in endemic areas, closely matching our results [16].

Limitations: The study had certain limitations including lack of histopathological confirmation in all cases, particularly for lesions managed conservatively. The single-center design may limit generalizability to other populations. Advanced MRI techniques like MR spectroscopy and perfusion imaging, which could provide additional diagnostic information, were not routinely performed.

5. Conclusion

MRI demonstrates excellent capability in characterizing intracranial cystic lesions through detailed evaluation of location, signal characteristics, and enhancement patterns. The systematic algorithmic approach based on



patient age, lesion location, multiplicity, and imaging features facilitates accurate diagnosis. Understanding age-specific prevalence patterns aids in prioritizing differential diagnoses. Ring enhancement remains a crucial finding, particularly in infectious lesions. Integration of clinical presentation with MRI features optimizes diagnostic accuracy and guides appropriate management strategies for patients with cystic brain lesions.

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