Original Research Article

Role of Magnetic Resonance Imaging in Intractable Epilepsy

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Abstract

Background: Imaging is pivotal in the evaluation and management of patients with seizure disorders. Elegant structural neuroimaging with magnetic resonance imaging (MRI) may assist in determining the etiology of focal epilepsy and demonstrating the anatomical changes associated with seizure activity. The high diagnostic yield of MRI to identify the common pathological findings in individuals with focal seizures including mesial temporal sclerosis, vascular anomalies, low-grade glial neoplasms and malformations of cortical development has been demonstrated. **Aim and Objective:** 1. Study Role of magnetic imaging in intractable epilepsy. 2.Study causes of Intractable Epilepsy cases. **Methodology: Study design:** A Cross Sectional Study. **Study setting:** Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur. **Study duration:** from March 2022 to March 2023. **Study population:** The study population included all the cases with intractable epilepsy patients admitted at a tertiary care center **Sample size:** 50 **Results:** majority of cases found in above 50 years age group 19 (38%) followed by 31-50 years age group 17 (34%), 11-30 years 11 cases (22%) and 3 cases in 1-10 years age group. Majority of cases were males 32 (64%) and 18 females (36%). majority of cases diagnosed with Focal cortical dysplasia 12 (24%) followed by Tuberous sclerosis 9 (18%),Hemiatrophy 8 (16%), Rasmussen's encephalitis 5(10%), Temporal encephalocele 4(8%), Periventricular nodular heterotopias 3 (6%), Gangliogliomas 2, Hippocampal sclerosis 2, Hippocampal atrophy 2, Cavernomas 2 and 1 cases with Dysembryoplastic neuroepithelial tumors **Conclusions:** MRI-based surgical approaches are extremely useful for the surgeons to provide three-dimensional imaging with superimposed real-time pointer details that have proved successful for epilepsy patients.
Keywords: MRI, intractable epilepsy, Conventional MRI.

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INTRODUCTION

Epilepsy is a chronic disorder of the central nervous system which resulted due to the abnormal activities of the neurons.[1] According to the recent reports, more than 70 million individuals have been affected with this neurological disorder which led to increase the global disease burden worldwide.[2] A number of epidemiological studies reported that the epilepsy is globally common but its prevalence is more in the developing countries as compared with its reported prevalence in developed countries and the situation to handle the epilepsy patients in low-income countries day-by-day becoming worst [3] .Several epidemiologist's investigated that the prevalence rate of epilepsy has significantly increased in the rural areas as compared to the urban regions and this trend has almost the same in all over the globe.[4] Intractable epilepsy is when seizures can't be completely controlled by medicines. (Intractable means "not easily managed or relieved.") It's also called refractory, uncontrolled, or drug-resistant epilepsy. The etiologies of epilepsies are varied and multifactorial in most cases[5] Therefore, investigation of the underlying causes of seizures will depend on the clinical context, in particular, the type of syndrome, age, types of seizures, associated diseases, presence or absence of progressive or static motor and cognitive dysfunction, among other factors. Magnetic

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Resonance Imaging, are the most important tools for determining the syndromic diagnosis and possible etiology of epilepsy.

When to perform an MRI in a patient with seizures

There are two basic situations in which to perform an MRI in patients with seizures. The first applies to newly diagnosed patients and those with longstanding epilepsy who have not been properly investigated. The second applies to patients with refractory seizures and therefore candidates for surgery.[5] Even patients with long-term focal epilepsy of unknown etiology should undergo an MRI.

MRI becomes an important tool for prognostic counseling and defining treatment strategy. We can also use MRI to monitor progression of lesions. Diffusion tensor imaging (DTI), three-dimensional (3D) reconstructions, and coregistrations of different imaging modalities are important tools in surgical planning.

How to perform an MRI in patients with epilepsy:

The epileptogenic lesion may be detected using routine MRI protocols. However, routine MRIs often miss smaller or subtle lesions and are considered normal. Therefore, in these cases, an optimized epilepsy protocol with adequate spatial resolution and multiplanar reformatting is essential [6,7]

A proper MRI investigation of patients with focal epilepsy requires the use of specific protocols, selected based on identification of the region of onset by clinical and EEG findings.

It is recommended that the MRI epilepsy protocols include a T1-weighted volumetric acquisition (3D) with isotropic voxel size of 1 mm or 1.5 mm in order to enable the reconstruction of images in any plane.[6,7] Multiplanar analysis is the interactive visual evaluation of brain parenchyma, acquired by volumetric MRI. These techniques allow the inspection of details of brain structure through the simultaneous analysis of brain in different planes of section, which is very important for the detection of FCDs.[7] In addition to the technical aspects of MRI acquisition, the experience of the examiner and a clinical/ encephalographic correlation are essential when searching for subtle epileptogenic lesions.[8]

MRI is the only technique able to diagnose HS in vivo, qualitative and quantitative MRI may fail to detect mild HS that is subsequently found on histopathologic examination. The hippocampal MRI abnormalities in MTLE HS can be bilaterally symmetric, but more often are unilateral or clearly asymmetric. Brain MRI also frequently shows abnormalities of volume (atrophy) and signal (T2 increase or T1 decrease) in structures outside of the hippocampus, usually ipsilateral to the sclerotic hippocampus [9] .More detailed high-resolution quantitative MRI analysis reveals a network of gray-matter atrophy that involves mesial temporal and other structures interconnected with the limbic system, including amygdala, entorhinal, perirhinal, and parahippocampal cortices, and thalamus.[10] MRI is highly sensitive and specific in detecting lesions that cause TLE and may have similar clinical manifestations as MTLE HS, such as tumors, dysplasias, vascular malformations and other lesions, such as temporal-lobe encephaloceles.[11] MRI investigation will detect most common lesions causing neocortical epilepsy, which are: low-grade tumors, malformations of cortical development, posttraumatic and postischemic lesions, inflammatory infectious scars, cavernous malformations, and arteriovenous malformations. The use of appropriate MRI protocols targeted for the study of patients with epilepsy provides the diagnosis of the majority of patients with lesional epilepsy. MRI is a basic and one of the most versatile methods in epilepsy imaging. The sensitivity of MRI in identifying epileptogenic foci in patients with medically refractory patients has been reported to be more than 80%. The sensitivity of MRI depends on the pathologic substrate, applied techniques, and last but not least, the experience of the interpreting physician.

Patients with MRI-negative epilepsy have a lower chance of having surgery than those with MRI-demonstrated lesions and, if surgery is performed, the odds of seizure freedom are two to three times lower than in the presence of a lesion on histopathology or MRI.[12] However, MRI-negative patients after successful surgery demonstrate that the process of multimodal pre surgical evaluation may lead to good outcomes.[13] In recent years many previously MRI-negative cases have been shown to demonstrate subtle changes using high-field MRI, but no significant difference in outcomes was observed between groups with and without these changes [14]. Apart from structural imaging additional postprocessing can be used for manual or automatic volumetry or voxel-based methods to identify FCDs.[15,16]

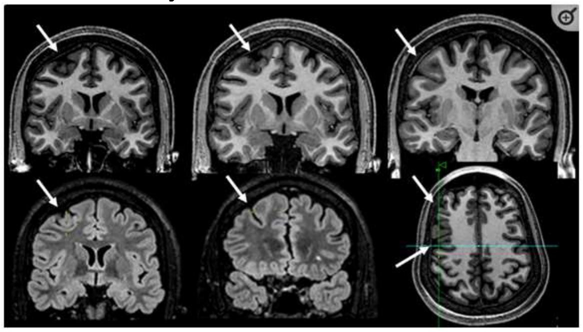

Figure 1

Above figure shows Magnetic resonance imaging (MRI) multiplanar reconstruction (MPR) in a patient with frontal-lobe seizures due to focal cortical dysplasia (FCD) who had previous MRIs considered as negative. Top row shows reconstructed volumetric coronal T1-weighted images, and bottom row shows reconstructed volumetric fluid-attenuated inversion recovery (FLAIR) images and an axial reconstructed T1-weighted image (all with 1-mm thickness). The area with FCD in the left frontal lobe presents with slightly thickened cortex associated with abnormal gyri and cortical dimple (arrows). The FLAIR images did not show a clearly abnormal signal, except for a slightly blurred cortical-subcortical transition. The postoperative histopathology showed classic signs of FCD type IIA.

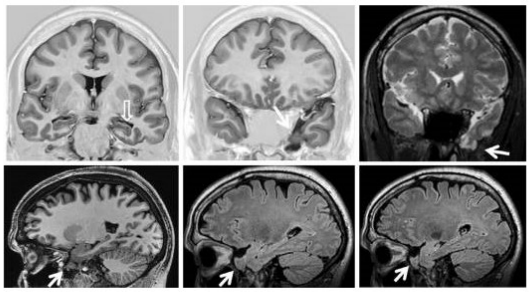

Figure 2

Above figure shows Coronal T1-weighted inversion recovery and T2-weighted images (top) and sagittal T1-weighted and fluid-attenuated inversion recovery images showing a small left anterior temporal encephalocele (arrows) and a left hippocampus with an abnormal shape and loss of internal structure (open arrow), in a patient with left temporal-lobe epilepsy.

Figure 3

Above figure shows multiple cortical tubers (arrows) in a fluid-attenuated inversion recovery image in a patient with tuberous sclerosis and epilepsy.

AIM AND OBJECTIVE

OBJECTIVE:

1. Study Role of magnetic imaging in intractable epilepsy.
2. Study causes of Intractable Epilepsy cases.

MATERIAL AND METHODS

Study design: A Cross Sectional study

Study setting: Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur

Study duration: From March 2022 to March 2023

Study population: The study population included all the cases with intractable epilepsy patients admitted at a Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur

Inclusion criteria: All patients with intractable epilepsy admitted in Radio diagnosis department of Dr. D.Y Patil Medical College and Research Institute, Kolhapur

Exclusion criteria: 1. Metallic implant 2. Claustrophobia 3. Contrast 4. Not willing to participate in the study.

Approval for the study: Written approval from Institutional Ethics committee was obtained beforehand. Written approval of Radio diagnosis department was obtained. After obtaining informed verbal consent from all patients with intractable epilepsy admitted in Medicine ward and referred to radio diagnosis of Dr. D.Y Patil Medical College and Research Institute, Kolhapur such cases were included in the study.

Sample Size: 50

Sampling technique: Convenient sampling technique used for data collection.

Methods of Data Collection and Questionnaire: Predesigned and pretested questionnaire was used to record the necessary information. Questionnaires included general information, such as age, sex, religion, residential address, and date of admission. Medical history- chief complain, past history, general examination, systemic examination

Data on demographic profile of intractable epilepsy patients, investigation, personal history, medical past history data collected from patients admitted in radio diagnosis ward.

All the procedures and investigations conducted under direct guidance and supervision of pg guide. Proforma of intractable epilepsy notes maintained.

Data entry and analysis: The data were entered in Microsoft Excel and data analysis was done by using SPSS demo version no 21 for windows. The analysis was performed by using percentages in frequency tables and correlation of stroke. $p<0.05$ was considered as level of significance using the Chi-square test

RESULT AND OBSERVATION

Table 1: Distribution of Cases According To Age

Age in years	Frequency	Percentage
1-10	03	6%
11- 30	11	22%
31- 50	17	34%
Above 50	19	38%
Total	**50**	**50 (100%)**

The above table shows majority of cases found in above 50 years age group 19 (38%) followed by 31-50 years age group 17 (34%), 11-30 years 11 cases (22%) and 3 cases in 1-10 years age group.

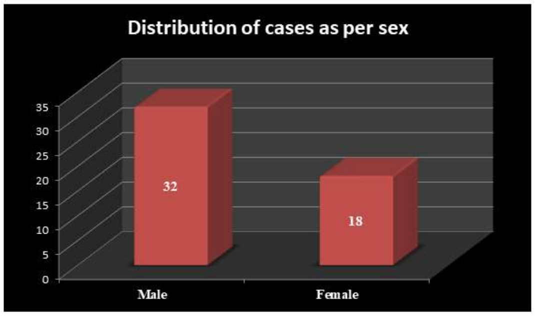

Figure 1

Majority of cases were males 32 (64%) and 18 females (36%)

Table 2: Distribution of Cases According to MRI Diagnosis

Diagnosis	Frequency	Percentage
Focal cortical dysplasia	12	24%
Tuberous sclerosis	09	18%
Gangliogliomas	02	4%
Dysembryoplastic neuroepithelial tumors	01	2%
Cavernomas	02	4%
Hemiatrophy	08	16%
Rasmussen's encephalitis	05	10%
Periventricular nodular heterotopia	03	6%
Temporal encephalocele	04	8%
Hippocampal atrophy	02	4%
Hippocampal sclerosis	02	4%
Total	**50**	**50 (100%)**

The above table shows majority of cases diagnosed with Focal cortical dysplasia 12 (24%) followed by Tuberous sclerosis 9 (18%),Hemiatrophy 8 (16%), Rasmussen's encephalitis 5(10%), Temporal encephalocele 4(8%), Periventricular nodular heterotopias 3 (6%), Gangliogliomas 2, Hippocampal sclerosis 2, Hippocampal atrophy 2, Cavernomas 2 and 1 cases with Dysembryoplastic neuroepithelial tumors

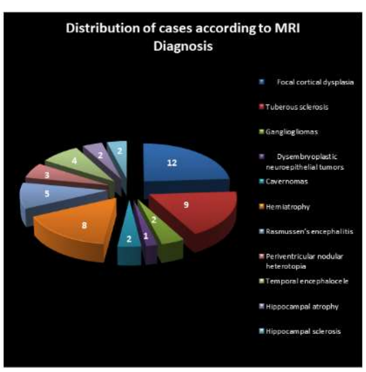

Figure 2

DISCUSSION

Study the role of the MRI in the screening of structural abnormalities of the neural lesions in patients with epilepsy. The MRI examination plays a key role for the screening of epileptogenic lesions in patients with epilepsy, this may be conducted either through MRI technique alone or in combination with some other imaging techniques such as MRI, MR spectroscopy, PET, and ictal SPECT[17] The performance of medical examination of epileptogenic lesions with these additional approaches provides an extremely valuable information about the epileptogenic lesions and its exact location in the brain, these additional approaches with MRI not only help the surgeons to perform epileptogenic lesional surgery but also help the radiologists to make their outstanding reports[18,19] In spite of the availability of these extraordinary functional imaging approaches but still the applicability of these approaches are limited[18] .There have been several reasons but the most valid reason is the involvement cost in these techniques while applying for the analysis of anatomic epileptogenic lesions[18,19] .Several investigators have reviewed all these additional techniques with MRI and all have concluded that these additional techniques are highly sensitive, more powerful, and accurate when performed with MRI[19] In 2021, a study conducted by Abdelgawad *et al.*[20] on children with non-lesional epilepsy in Minya, Egypt, reported that volumetric MRI is extremely useful in the analysis of non-lesional pharmacoresistant childhood epilepsy. In another study, Samia *et al.* from Nairobi, Kenya, reported that the conventional MRI has potential to detect multiple clinical comorbidity in childhood epilepsy.[21] Furthermore, Bernasconi *et al.* from Quebec, Canada, in 2019 reported that the structural MRI is very useful for the detection of non-invasive lesions in patients with epilepsy[22] Importantly, a study by Maqsood *et al.* from Jammu Kashmir, India, pointed out that the conventional MRI is highly sensitive for the detection of epileptogenic materials, dysfunctionality in soft tissues and they reported that MRI is the best technique for the screening of pre-operative intractable epilepsy.[23] Moreover, Ponnatapura *et al.* from Karnataka, India, in 2018 reported that MRI with dedicated seizure protocol is best for the detection of epileptogenic lesions in one half of the new-onset seizures in epilepsy patients.[24] Furthermore, Zhao *et al.* from Hubei, China, reported that Magic TVs approach through conventional MRI improves the diagnosis of epilepsy by reducing negative outcomes.[25] In another study, functional MRI found to be an important technique for the detection of hemodynamic and microstructural alterations in epileptogenic lesions.[26]

CONCLUSIONS

The applicability of magnetic resonance imaging for the diagnosis of epilepsy is highly accessible in all over the globe. With the advancement in the MRI technique, this can be also applying with additional approaches. MRI is a choice technique for the evaluation of epileptogenic lesions. The pooling of selected studies clearly indicating that the MRI-based surgical approaches provide three-dimensional pictorial details with superimposed real-time surgeons pointer information for the epilepsy patients, which already been proved successful in epilepsy surgery.

REFERENCES

1. Devinsky O, Vezzani A, O'Brien TJ, Jette N, Scheffer IE, De Curtis M, *et al.* Epilepsy. *Nat Rev Dis Primers.* 2018;4:18024.
2. Espinosa-Jovel C, Toledano R, Aledo-Serrano Á, García-Morales I, Gil-Nagel A. Epidemiological profile of epilepsy in low income populations. *Seizure.* 2018;56:67–72.
3. Carpio A, Hauser WA. Epilepsy in the developing world. *Curr Neurol Neurosci Rep.* 2009;9:319–26.
4. Newton CR, Garcia HH. Epilepsy in poor regions of the world. *Lancet.* 2012;380:1193–201
5. Berg AT, Berkovic SF, Brodie MJ, *et al.* Revised terminology and concepts for organization of seizures and epilepsies: Report of the ILAE Commission on Classification and Terminology, 2005–2009. Epilepsia. 2010; 51:676–685.
6. Gaillard WD, Cross JH, Duncan JS, *et al.* Epilepsy imaging study guideline criteria: commentary on diagnostic testing study guidelines and practice parameters. Epilepsia. 2011; 52(9):1750–1756.
7. Cendes F. Neuroimaging in investigation of patients with epilepsy. Continuum (Minneap Minn). 623–642; 19(3 Epilepsy)
8. Von Oertzen J, Urbach H, Jungbluth S, *et al.* Standard magnetic resonance imaging is inadequate for patients with refractory focal epilepsy. J Neurol Neurosurg Psychiatry. 2002; 73(6):643–647.
9. Cendes F, Sakamoto AC, Spreafico R, *et al.* Epilepsies associated with hippocampal sclerosis. Acta Neuropathol. 2014; 128:21–37.
10. Coan AC, Campos BM, Yasuda CL, *et al.* Frequent seizures are associated with a network of gray matter atrophy in temporal lobe epilepsy with or without hippocampal sclerosis. PLoS One. 2014; 9(1):e85843.
11. Saavalainen T, Jutila L, Mervaala E, *et al.* Temporal anteroinferior encephalocele: an underrecognized etiology of temporal lobe epilepsy? Neurology. 2015; 85(17):1467–1474.
12. Téllez-Zenteno JF, Hernández Ronquillo L, Moien-Afshari F, *et al.* Surgical outcomes in lesional and nonlesional epilepsy: a systematic review and meta-analysis. Epilepsy Res. 2010; 89:310–318.
13. Bien CG, Szinay M, Wagner J, *et al.* Characteristics and surgical outcomes of patients with refractory magnetic resonance imaging-negative epilepsies. Arch Neurol. 2009; 66:1491–1499.
14. Garbelli R, Milesi G, Medici V, *et al.* Blurring in patients with temporal lobe epilepsy: clinical, high-field imaging and ultrastructural study. Brain. 2012; 135(Pt 8):2337–2349.
15. Jack CRJ, Sharbrough FW, Cascino GD, *et al.* Magnetic resonance image-based hippocampal volumetry: correlation with outcome after temporal lobectomy. Ann Neurol. 1992; 31:138–146.
16. Kassubek J, Huppertz H-J, Spreer J, *et al.* Detection and localization of focal cortical dysplasia by voxel-based 3-D MRI analysis. Epilepsia. 2002; 43:596–602.
17. Immonen A, Jutila L, Muraja-Murro A, Mervaala E, Äikiä M, Lamusuo S, *et al.* Long-term epilepsy surgery outcomes in patients with MRI-negative temporal lobe epilepsy. Epilepsia 2010;51:2260-9.
18. Castillo M. Imaging intractable epilepsy: How many tests are enough? Am J Neuroradiol 1999;20:534-5.
19. Spencer SS. The relative contributions of MRI, SPECT, and PET imaging in epilepsy. Epilepsia 1994;35:S72-89.
20. Abdelgawad EA, Mounir SM, Abdelhay MM, Ameen MA. Magnetic resonance imaging (MRI) volumetry in children with nonlesional epilepsy, does it help?. Egypt J Radiol Nucl Med 2021;52:35.
21. Samia P, Odero N, Njoroge M, Ochieng S, Mavuti J, Waa S, *et al.* tertiary hospital in Kenya. Front Neurol 2021;12:623960.
22. Bernasconi A, Cendes F, Theodore WH, Gill RS, Koepp MJ, Hogan RE, *et al.* Recommendations for the use of structural magnetic resonance imaging in the care of patients with epilepsy: A consensus report from the international league against epilepsy neuroimaging task force. Epilepsia 2019;60:1054-68.
23. Maqsood S, Ziaulhaq P, Dar IH, Ashraf S. Role of magnetic resonance imaging in evaluation of epilepsy. IAIM 2018;5:102-10.
24. Ponnatapura J, Vemanna S, Ballal S, Singla A. Utility of magnetic resonance imaging brain epilepsy protocol in new-onset seizures: How is it different in developing countries? J Clin Imaging Sci 2018;8:43.
25. Zhao X, Zhou Z, Zhu W, Xiang H. Role of conventional magnetic resonance imaging in the screening of epilepsy with structural abnormalities: A pictorial essay. Am J Nucl Med Mol Imaging 2017;7:126-37.
26. Oguz KK. Magnetic resonance imaging in epilepsy. Adv Tech Stand Neurosurg 2012;39:61-83.

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