

**Original article:**

## **Study of patients referred to the department of radiodiagnosis for evaluation of seizures**

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### **ABSTRACT**

Prospective study of patients referred to the department of radiodiagnosis and imaging for evaluation of seizures/epilepsy by means of CT and MRI. The study intends to delineate the common causes and to show the strengths of one modality over the other in evaluating the patients with seizures. Epilepsy/seizures are very important cause of morbidity and require thorough investigation via cross sectional imaging. Imaging modality has to be selected based on the clinical scenario and history. Dedicated search for the epileptogenic focus should be done as the success of any surgery to alleviate the cause depends on that. MRI is deemed superior in general for patients with seizures however CT scan has a role in patients with a history of trauma and follow up cases of old inflammatory granulomas to look for calcification.

### **INTRODUCTION**

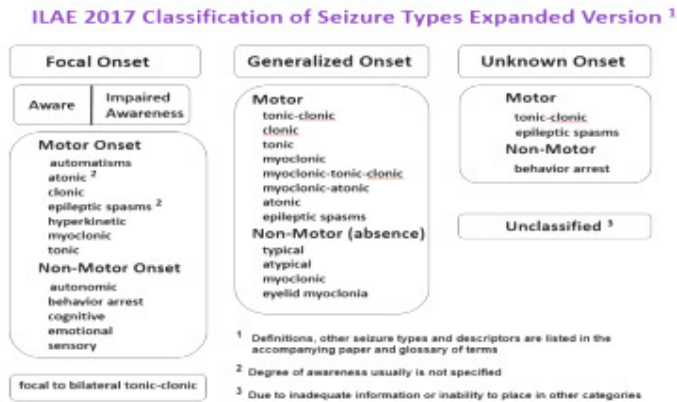
An epileptic seizure is defined as “an excessive burst of abnormally synchronized neuronal activity affecting small or large neuronal networks that results in clinical manifestations that are sudden, transient, and usually brief. Epilepsy is characterized by recurrent seizures secondary to a predisposition to generate abnormal electrical discharges from cortical grey matter, and is complicated by subsequent neurobiological, cognitive, psychosocial and occupational consequences<sup>[1]</sup> Seizures are classically defined as either generalized or partial (**Table 1**). Essentially, in generalized seizures the onset is global and with partial seizures the onset is focal<sup>[1]</sup> Neuroimaging is extremely important to delineate the focus of the seizure. While majority of epileptic patients are stable on drugs, 30-40% are refractory to treatment and require surgery.<sup>[2]</sup>

Conditions like mesial temporal sclerosis which are one of the commonest causes of partial seizures show 70-95% success rate with temporal lobectomy vs only 25-30% with medicines alone<sup>[2]</sup>. Also the success of the surgery is directly correlated with ability to define and subsequently resect the epileptogenic focus. Both CT and MRI could be used for the evaluation of the seizures. MRI is considered the superior modality as it has got greater sensitivity for detection than the CT scan. However, patients with acute seizures initially should undergo the CT because it detects the bleeding and calcified foci more accurately<sup>[3]</sup> National Institute for Clinical Excellence (NICE) guidelines for diagnosis and management of the epilepsies in adults and children recommend that an EEG should be performed to support a diagnosis of epilepsy in adults in whom the clinical history suggests the seizure is likely to be epileptic in origin. In children, EEG is recommended after the second or subsequent seizure<sup>[4]</sup>

The classification of seizures is given in **table 1**.

### **ROLE OF EEG**

Electroencephalography (EEG) is considered one of the most important tests for the seizures. The structural damage could be imaged by several other methods, however occult foci are mainly found via the EEG. EEG can tell us if the person is suffering from seizures, location of the focus of that seizure and if the person is on medications whether the medicines are working or not. Features of some of the disorders detected on the EEG investigation are listed in the **table 2** below.



EEG pattern	Epileptic syndrome/etiolo
Anterior temporal spikes	Mesial temporal lobe epilepsy
Generalized 3-Hz spike-wave complexes	Absence epilepsy
>4-Hz spike-wave complexes, generalized polyspikes	Juvenile myoclonic epileg
Generalized slow spike-wave complexes	Lennox-Gastaut syndrom
Regional (extratemporal) polyspikes	Focal cortical dysplasia
Hypsarrhythmia	West syndrome

Table-2 Taken from The role of EEG in epilepsy: A critical review <sup>[6]</sup>

Table-1. Adopted from: The New Classification of Seizures by the International League against Epilepsy 2017 <sup>[5]</sup>

## MATERIAL AND METHODS

We collected prospective data of patients referred from the various departments, Rohilkhand medical college and hospital for CT and MRI investigation due to seizures/epilepsy in the 12-month period from June 2016 to July 2017.

Patients referred for either CT or MRI from different departments for evaluation of seizures/epilepsy and fulfilling the inclusion criterion were scanned on the other modality too after taking a consent. So a patient referred for a CT scan was also scanned on the MRI and vice-versa for the sake of completion of the study. 600 patients with both CT and MRI scans were selected for the study. All the scans were done with most recent available equipment and were read by qualified radiologists.

The equipment used was

1. GE BRIGHTSPEED 16 SLICE CT SCAN.
2. HITACHI APERTO LUCENT .4 TESLA MRI (OPEN MAGNET).

## INCLUSION AND EXCLUSION CRITERION:

### Inclusion:

1. Referred patients with the seizures/epilepsy.
2. Abnormal EEG

### Exclusion:

Follow up cases with known diagnosis

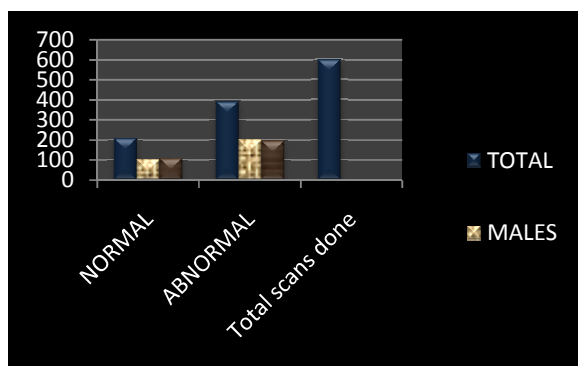
## STUDY DATA

1. CT scans: 600 CT scans were reviewed over a course of 12 months. A total of 392 scans were deemed abnormal and 208 showed no signs of abnormality as per the inclusion/exclusion criterion. The data is represented by the columns as shown in **fig-1**. As we can see in the column below, there is almost equal distribution of the abnormal scans in males and females. The CT scan showed no abnormality as defined in the inclusion criterion in almost 65% of the cases that were referred whereas the MRI was able to detect the abnormality in roughly 73% of the cases referred for the scan. The further breakup of the scans show the numbers as represented by the **fig-2**. The cases on the CT scan were divided into 4 major categories of

- 1) Calcified lesions
- 2) Subcentimetric lesions with perilesional edema
- 3) Space occupying lesions
- 4) Nonspecific lesions

It shows the bulk of the lesions detected on the CT scan were calcified lesions representing approximately 52% of the cases with the next being subcentimetric lesions with edema standing at approximately 32% of the cases. The SOL represent the rest of the lesions as shown in **fig- 2**.

Most of the space occupying lesions on the CT could not be characterized. Out of 50 lesions only 8 lesions were confidently diagnosed comprising of four acoustic schwannomas, 3 macro adenomas and 1 choroid plexus papilloma. Compared to that, MRI was able to make a diagnosis in all 50 of the space occupying lesions. The age wise distribution of the abnormalities is represented in the following table in **fig-2**.

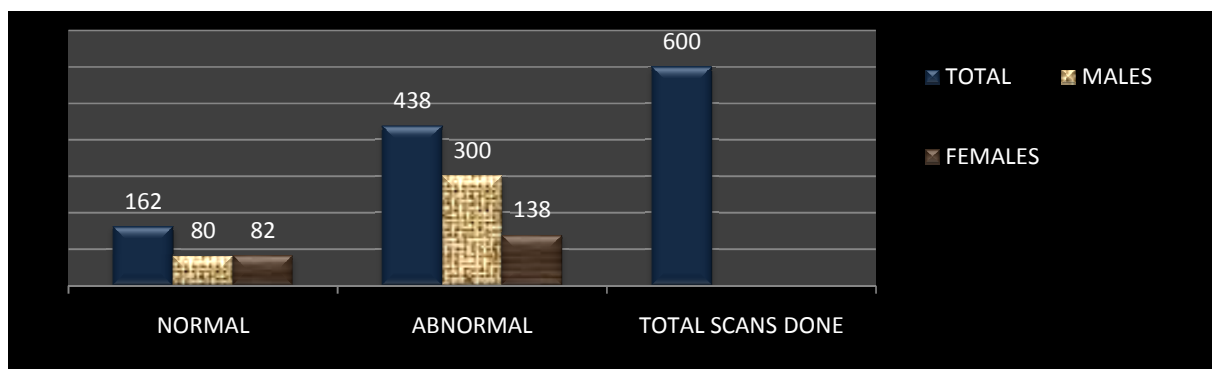


**Fig-1**

AGE	0-20	20-40	40-60	>60	TOTAL
Calcified lesions	54	80	22	06	162
Subcentimetric-lesions with edema	64	28	06	02	100
Space occupying lesions	18	22	06	04	50
Nonspecific lesions	24	16	26	14	80
<b>TOTAL</b>	<b>160</b>	<b>146</b>	<b>60</b>	<b>26</b>	<b>392</b>

**Fig-2**

**2)MRI data:** A total of 600 MRI scans were done during the period of one year and revealed the findings of 162 normal scans and 438 scans showing some abnormality. The findings are described in **fig-3**. As seen in the fig-5 below the detection of abnormalities via the MRI is approximately 73%. The further breakup of the abnormalities is shown in the **fig 4,5 and 6**. The same three categories like in CT data are made with an additional category on the specific findings. The difference is that we are able to better characterize the sub centimetric lesions. Most are diagnosed on the CT scan too but MRI can differentiate various stages and types of granulomas better than CT scan. The space occupying lesions were equal on both the CT and MRI however as previously stated MRI diagnosed 99% of the lesions correctly compared to just 16% for the CT scan.



**Fig-3**

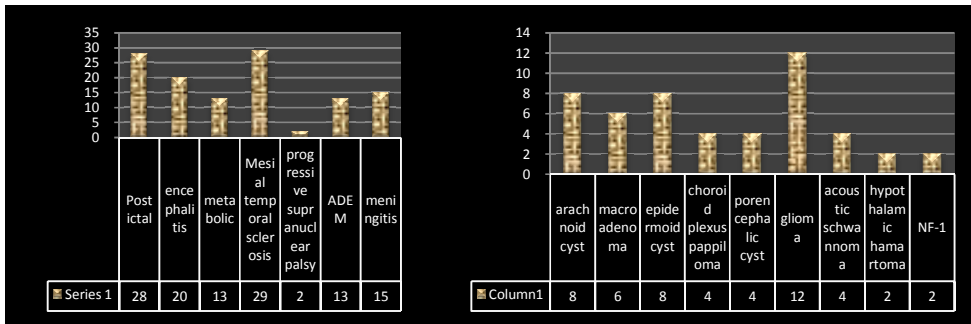


Fig-4 (specific diagnosis) Fig-5(space occupying lesions)

	0-20	20-40	40-60	>60	Total
Calcified lesions	20	60	40	0	120
Granulomas	32	84	20	08	144
SOL	08	22	16	04	50
Non specific	01	02	01	00	04
Other Specific	29	68	09	14	120
Total	90	236	86	26	438

Fig-6

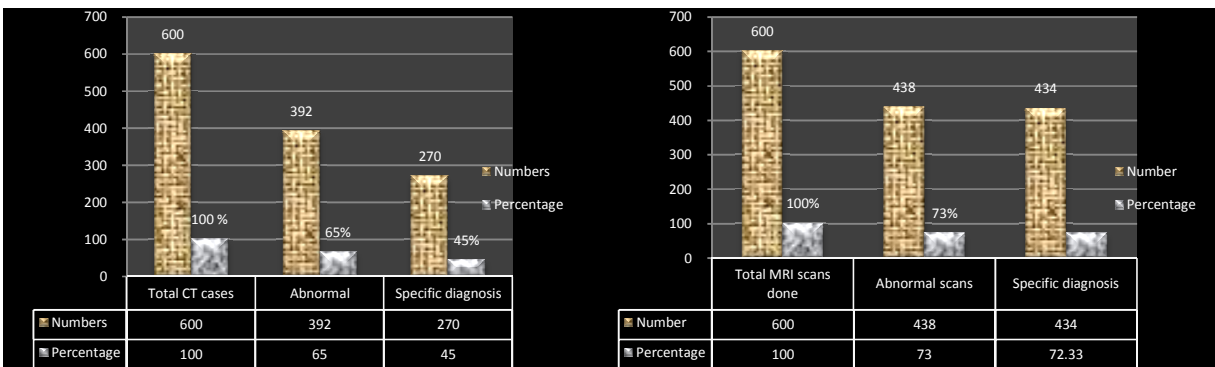


Fig-7

Fig-8

The column of specific diagnosis consists of 120 cases as shown on the **fig- 4**. Similarly the SOL(space occupying lesions) have been characterized too and shown in **fig-5**. The age wise breakup of abnormalities is shown in **fig -6**.

As shown in the above figures MRI was able to make specific diagnosis of a structural lesion(non granulomatous,non-calcified) in 120 cases vs only 8 for the CT scan. In fact, CT scan was unable to characterize about 80 lesions.

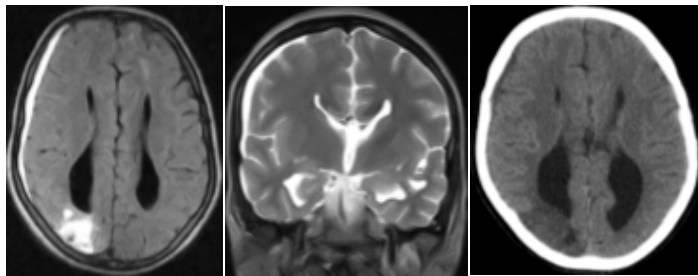
Comparing the CT with that of the MRI as illustrated in figures 7 and 8, we can clearly see the superiority of MRI in overall detection of a lesion. The MRI detected abnormalities in 73% of the cases with CT being of use in only 65% cases. Even after detection of the abnormality CT scan was unable to characterize the specific abnormality whereas the MRI had no such problems except in 4 cases where no specific diagnosis of the abnormality could be made. The CT scan made standalone diagnosis in 270 cases with a sensitivity of 45% compared to the MRI that made diagnosis in all but 4 of the 73% cases it detected. The only area where CT scan excelled was in the calcification where it detected about 42 more lesions than MRI. MRI was unable to detect small calcifications.

**DISCUSSION**

The present survey of 600 brain imaging studies comprising of both CT and MRI revealed abnormalities in approximately 69 % of the cases ranging from 65% on CT scan to 73% on the MRI. The frequency with which abnormal brain scans are found in patients with epilepsy has been highly variable in various studies. The AJNR study of 1988 puts MRI and CT sensitivity at 53 and 42% respectively<sup>[7]</sup>. Another study<sup>[8]</sup> shows MRI to be sensitive in 80% patients vs 30% patients in epilepsy.

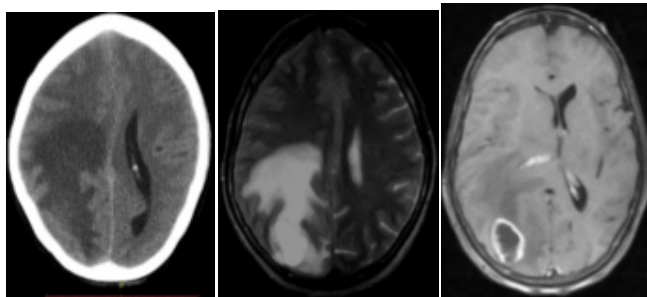
The MRI is shown to be vastly superior in finding the cause of the refractory epilepsy with a sensitivity of 95% against 32% of the CT scan.<sup>[9]</sup> The role of the MRI is further solidified with postoperative findings suggesting that MRI identified the lesion correctly in 86% of the surgical sites compared to 28% by the CT scan.<sup>[10]</sup> Contrary to the above studies, an Egyptian study done in pediatric population came to the conclusion that sensitivity of both CT and MRI stands almost equal in lesion detection at 73 and 74% respectively.<sup>[11]</sup> Another article by T ROY states that sensitivity of the CT SCAN is not higher than 30% in non-selected patient population and CT will be unable to detect abnormalities in about 50% of the patients.<sup>[12]</sup>

It is recommended by various bodies and NICE that anyone who has an unprovoked seizure should have brain MRI.<sup>[13]</sup> In one series of 600 consecutive patients with new onset seizure, an anatomic substrate was identified by the MRI in 14% of the cases. Single most common cause of seizures in resource poor countries like India is neuro-cysticercosis. In India the states of Uttar Pradesh, Bihar, Orissa and Punjab are especially endemic to NCC. Neuroimaging has improved the accuracy in diagnosis of the NCC.<sup>[14]</sup> The various CT and MRI images are anointed as **plate 1-4 below.**



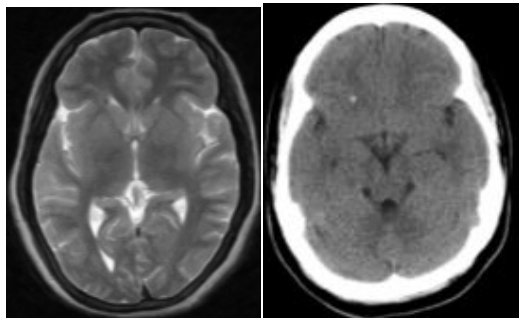
A BC

Plate-1: Axial FLAIR MRI shows colpocephaly with appearance of lateral ventricles parallel to each other (A) with similar findings on the axial non enhanced CT (C). The patient had abnormal movements and h/o fall after that. A right parieto-occipital contusion and mild right sided subdural hemorrhage could be seen as a result. B, shows coronal MRI with absence of corpus callosum showing the typical Viking helmet appearance of the lateral ventricles.



A B C

Plate-2: Axial non contrast CT scan shows edema at the right parieto-occipital region with midline shift towards the left side (A). Axial T2W MRI shows a small cystic lesion in the right parieto-occipital region with surrounding edema (B). Contrast enhanced T1W MRI shows a ring enhancing lesion in the right parieto-occipital region. The differential was an abscess or a metastatic lesion. The final diagnosis was secondary from the breast carcinoma.



A B

Plate-3: Axial T2W image shows a small hypointense focus near the frontal horn of right lateral ventricle (A). Axial NCCT shows a small calcified focus in the same location.

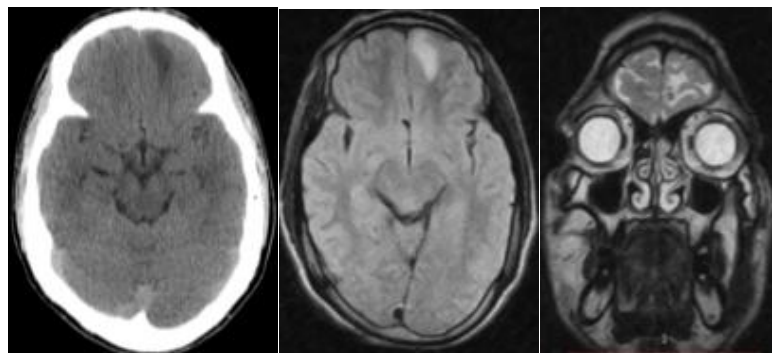


Plate4:NCCT scan shows mild focal edema in the left frontal region (A), hyperintensity is seen on FLAIR MRI images in the same region (B).Coronal MRI shows a hypointense lesion in the left frontal region with mild surrounding edema.

A B C

### Conclusion:

The discussion provides many insights on the use of CT and MRI in patients with seizures:

1. The cost and availability of the MRI necessitates the use of the CT scan. The advantages of CT scan are low cost, more availability and a very fast scanning speed. On top of that it is better than MRI in detection of the subtle and soft calcifications which is important in a country like India where bulk of the intracranial calcifications are due to infections. Cendes et al states that although CT scan can serve as a low cost emergency investigation of choice for lesions, it cannot replace MRI for the proper investigation of epilepsy.<sup>[15]</sup>
2. MRI is much superior in making a proper diagnosis of a detected lesion. It is superior to the CT in both temporal fossa and the brainstem region due to the beam hardening effects. It is able to detect subtle edema, cortical thickening and evaluation of the basal cisterns. With the use of multiple sequences it is able to differentiate various cysts of the brain where the CT scan struggles. Cendes et al states that MRI should be done in all cases of epilepsy apart from cases of primary generalized epilepsy and other syndromes with typical EEG features.<sup>[15]</sup>

Multiple publications have stated that if a lesion is identified on MRI scan at the area of abnormal EEG signals, then it correlates to better seizure control after surgery<sup>[16,17,18]</sup>

3. Therefore the first line of imaging modality in cases of seizures should be MRI, however CT scan can serve as a great screening tool especially in poor countries.

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