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Original Research Article

SEIZURES: CLINICAL SPECTRUM AND THE ROLE OF RADIOLOGICAL AND ELECTROPHYSIOLOGICAL ASSESSMENT

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ABSTRACT

Background: Seizures are neurological disorders marked by abnormal electrical discharges in the brain, often with underlying structural, metabolic, or idiopathic causes. This study aimed to investigate the clinical, radiological, and electrophysiological characteristics of adult patients presenting with seizures, especially in resource-constrained settings. **Materials and Methods:** A cross-sectional study was conducted over 12 months at Teerthanker Mahaveer Medical College & Research Centre, involving 140 patients aged 18 years or older presenting with seizures. Data on demographics, seizure types, associated symptoms, EEG findings, and neuroimaging (CT/MRI) were collected and analyzed. **Result:** The majority of subjects were male (66.43%), with the 18–30 age group being most affected. Generalized seizures (56.43%) were more common in younger individuals, while focal seizures (31.43%) increased with age. Stroke emerged as the leading cause (29.29%), followed by idiopathic causes (26.43%) and CNS infections (22.86%). EEG abnormalities were noted in 41.43% of patients. MRI showed a higher diagnostic yield (65.31%) than CT (62.86%) and was more effective in detecting infarcts, gliosis, tumors, and infections like tuberculoma and neurocysticercosis. **Conclusion:** Stroke is the predominant cause of seizures in adults, with MRI outperforming CT in diagnostic accuracy for structural and infectious causes. Due to the broad range of potential etiologies, a comprehensive approach—incorporating clinical examination, EEG, and neuroimaging—is essential for accurate diagnosis and effective management of seizures in adults.

INTRODUCTION

Seizures are neurological disorders characterized by abnormal electrical discharge from the central nervous system, leading to disruption in neurological functioning. Even with the best medical care, recurring seizures are a persistent symptom of epilepsy.[1] Approximately 12 million individuals in India suffer from seizures, accounting for one-sixth of the world's total population.[2] Between 0.2 to 0.6 cases per 1000 person-years is the incidence rate. Three percent of ED visits and one percent of hospitalisations are due to epileptic seizures.[3]

Since the aetiology of seizures that start in adulthood is probably known, special attention must be paid to it. Trauma, CNS infections, space-occupying lesions, cerebrovascular accidents (CVA), metabolic abnormalities, and drugs are the main factors associated with these illnesses.[4] Childhood-onset seizures are more likely to be idiopathic. According to research, the precuneus is a part of a vast network that includes both cortical and subcortical areas.[5]

The reasons of seizures in developing countries, such as India, could vary from those in developed ones. The neurological condition known as epilepsy is characterised by frequent seizures that are not linked to a specific trigger.[6] Abnormalities in brain function, including hereditary factors, intracellular signalling mechanisms, and extensive neuronal networks, characterise this clinical illness.[7] In neuroscience, neuroimaging is important because it helps doctors identify and treat seizures based on a patient's complete medical history, EEG results, and other information.[8] Numerous factors, such as genetically defined illnesses, temporary physiological changes, and acquired and congenital anatomical abnormalities, may trigger seizures. In order to diagnose, identify side effects, and provide guidance for certain pharmaceutical or surgical treatments, neuroimaging is essential.[9]

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According to the Subcommittee for Paediatric Neuroimaging of the International League Against Epilepsy (ILAE), around 50% of children with new-onset focal seizures have abnormalities.[10] Adult neuroimaging research has mostly focused on chronic epilepsy, but new research has shown that a lesion that may cause epilepsy was present in 28% of all seizure patients and 53% of individuals whose seizures came from a specific area of the brain.[11] According to a recent research, MRI scans were able to determine the aetiology of "acute seizure" in 44% of people, 50% of whom were having their first seizure.[12] According to the most recent definition of epilepsy provided by the ILAE, a person must have two or more spontaneous seizures that are separated by more than twenty-four hours, have two spontaneous seizures and a probability of experiencing additional seizures over the next ten years, and have been diagnosed with epileptic syndrome.[13]

Inaccurate diagnosis may result from misinterpreting clinical symptoms, and seizures may extend to the frontal brain. Ultrasonography, computerised tomography (CT scan), magnetic resonance imaging (MRI), functional MRI, Positron Emission Tomography (PET), and single photon emission computed tomography (SPECT) are among the imaging modalities used to investigate seizures.[14]

EEG is a non-invasive technique for monitoring and recording the electrical impulses produced by the brain's cerebral cortex. Alpha, beta, theta, and delta are the several frequency ranges into which it is divided.[15] EEG can pinpoint the exact location of seizures, including areas affected by cortical malformation, hippocampus atrophy, certain tumours, and circumstances with two underlying causes.[16]

The goal of this study is to determine the exact type of seizure, focus the diagnostic process on particular causes, choose the best course of treatment, and gather potentially crucial data regarding the expected outcome, particularly when managing patients in resource-constrained areas.

This study explores the role of radiological imaging and electrophysiology in assessing seizures in patients, identifying common causes and risk factors. It highlights the importance of considering the unique causes of seizures in developing nations like India. The study can also identify abnormal imaging and electrophysiological changes in seizures, providing valuable insights for treatment in resource-limited areas.

MATERIALS AND METHODS

This hospital-based, cross-sectional study was carried out at Teerthanker Mahaveer Medical College & Research Centre. Following the permission of the Research Committee and the Ethical Committee, the research period lasted for 12 months. Participants in the research were patients who presented with seizures and visited the department of medicine's OPD or ICU during the study period. Using the formula $n = Z2\alpha/2\ P(100-P)/E2$, the sample size was 140. Patients who had seizures after the age of 18 and whose seizures were diagnosed using the International League Against Epilepsy Commission's categorisation and language were included in the study.[17]

The study's exclusion criteria included anybody who refused to provide their permission. Those who have recently had a traumatic brain injury, following traumatic brain damage (including neurosurgical treatments), or obstetric factors (such as eclampsia) that are causing convulsions. a patient whose medical history, barring seizures, points to a diagnosis of paroxysmal events or pseudoseizures. people with neurological conditions like movement problems or dystonia, among others.

Electroencephalography (EEG) and CT/MRI were among the extra radiological tests performed on all patients who satisfied the requirements.

Essential tests, such as haematological profile, random blood glucose, serum electrolytes (including calcium and magnesium), electrolyte levels in the blood (including calcium and magnesium), and cerebrospinal fluid analysis (if necessary), were also used to evaluate the patients. The relationship between radiological tests, electroencephalograms (EEGs), and various types of seizures was investigated.

Statistical analysis was carried out once the data was gathered.

With the help of a statistician, the gathered data was methodically arranged into a table in an Excel spreadsheet. The frequency of measurements by group was used for statistical analysis (SPSS Inc., Chicago, USA; SPSS 24.00 for Windows). The two groups' differences were assessed using the chi-square test, with a significance threshold set at $p<0.05$.

RESULTS

The current cross-sectional investigation had been performed at the Teerthanker Mahaveer Medical College & Research Centre involving 140 patients who were at least 18 years old & presented with seizures. The goal of this research endeavour was to analyze the correlation between electrophysiological, radiological, & clinical characteristics among individuals afflicted with seizures. In this study male subjects constituted 66.43% of the total, while female subjects constituted 33.57%. Therefore, males exhibited a higher prevalence of seizures in comparison to females. The age category of 18-30 years comprised the largest proportion of subjects (23.57%), followed by 31-40 years (21.43%) & 51-60 years (20.71%). At least 16.43% of the participants were 60 years of age or older.

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Table 1: Type of seizures among the study subjects

Seizure	N	%
Generalized Seizures	79	56.43
Focal Seizures	44	31.43
Without Dyscognitive Features (Simple Partial Seizures)	24	17.14
With Dyscognitive Features (Complex Partial Seizures)	16	11.43
Secondary Generalization	4	2.86
Status Epilepticus	17	12.14
Total	140	100

[Table 1] shown that 56.43 percent of the individuals had generalised seizures. 31.43% of the instances that were recorded were focal seizures, while 12.14% of the victims had status epilepticus. Of the focal seizures, 11.43% and 17.14% of the participants reported having simple and complicated partial seizures, respectively.

In [Figure 1], study found that stroke was the most common cause of seizures, followed by idiopathic and CNS infections. Brain tumors, PRES, and Multiple Sclerosis were also prevalent. Metabolic issues were also prevalent.

[Table 2] presents the descriptive statistics (Frequency and percentage) of CNS infection, metabolic profile, associated symptoms, and EEG outcome.

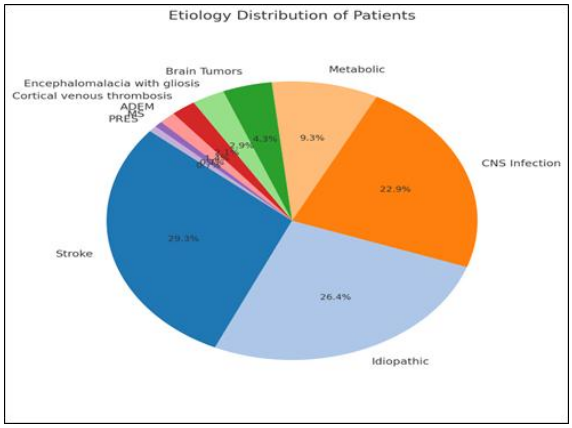

Figure 1: Etiology among the study subjects

Table 2: Descriptive statistics of CNS infection, metabolic profile, associated symptoms, and EEG outcome

		N=32	%
CNS Infection	CNS Tuberculosis	14	43.75
	NCC	11	34.38
	Viral Meningoencephalitis	3	9.38
	Pyogenic Meningitis	2	6.25
	Brain Abscess	1	3.13
	Cerebral Malaria	1	3.13
Metabolic	Alcohol Withdrawal	4	30.77
	Hyponatremia	3	23.08
	Hypocalcemia	2	15.38
	Hypoglycemia	1	7.69
	Uremic Encephalopathy	1	7.69
	Hepatic Encephalopathy	1	7.69
	Opioid Withdrawal	1	7.69
Associated Symptoms	Tongue Bite	84	60.00
	Urinary Incontinence	32	22.86
	Headache	19	13.57
EEG	Normal	82	58.57
	Abnormal	58	41.43

Table 3: Distribution of findings in neuro-imaging

		N=140	%
CT Scan	Normal	52	37.14
	Infarct	33	23.57
	Tumor	12	8.57
	Gliosis	9	6.43
	Cortical atrophy	8	5.71
	Hemorrhage	6	4.29
	Ring enhancing lesion	5	3.57
	Diffuse cerebral oedema	4	2.86
	Hydrocephalus	3	2.14
	Tuberculoma	3	2.14
	Cortical venous thrombosis	3	2.14
	Brain abscess	2	1.43
MRI Findings	Normal	34	34.69
	Infarct	16	16.33
	Tumor	9	9.18
	Gliosis	9	9.18
	Tuberculoma	7	7.14
	Neurocysticercosis	6	6.12
	Encephalitis/meningitis	6	6.12

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	Hemorrhage	5	5.10
	Diffuse Cortical atrophy	4	4.08
	Brain abscess	2	2.04

In [Table 3], CT scans revealed normal findings in 37.14% of cases, with infarcts (23.57%) being the most common abnormality, followed by tumors and gliosis. MRI, performed in 98 patients, showed a higher diagnostic yield, with only 34.69% normal findings and infarcts, tumors, gliosis, and infectious lesions such as tuberculoma and neurocysticercosis among the key abnormalities. MRI was notably more sensitive in detecting subtle or inflammatory causes of seizures compared to CT.

Table 4: Percentage of positive MRI, CT & EEG findings in patients

Test	Percentage of Positive Findings
MRI	65.31%
CT	62.86%
EEG	58.57%
p-value	
MRI VS CT	0.79
MRI VS EEG	0.23
CT VS EEG	0.70

In [Table 4], MRI exhibited the highest rate of positive findings (65.31%), followed by CT (62.86%) and EEG (58.57%). However, the differences were not statistically significant (MRI vs. CT: p=0.79; MRI vs. EEG: p=0.23; CT vs. EEG: p=0.70).

DISCUSSION

A total of 140 patients aged 18 years and above, presenting with seizures, were enrolled in this cross-sectional study conducted at Teerthanker Mahaveer Medical College & Research Centre. The findings from demographic, clinical, electrophysiological, radiological, and etiological assessments are presented below.

Gender Distribution: Of the 140 individuals, 47 (33.57%) were female and 93 (66.43%) were male, suggesting that seizures are more common in men. According to the findings of Muralidhar et al., there has been a little to substantial over-representation of men in previous research.[18]

Age Distribution: 18–30 years old accounted for 23.57% of the total, followed by 31–40 years old (21.43%) and 51–60 years old (20.71%). Study participants who were over 60 made up 16.43% of the total. According to a 2012 study by Kaur et al, 47% of the patients were younger than 38, 38% were between 41 and 60, and 15% were older than 60.17 Furthermore, Hirani & Shrivastva,[19] have also observed a greater prevalence of GTCS in adults (65%, 70%, 64%, & 60%, respectively).

Types of Seizures: Generalized seizures were the most commonly observed type, occurring in 79 patients (56.43%). Focal seizures were present in 44 patients (31.43%), including 24 (17.14%) with simple partial seizures and 16 (11.43%) with complex partial seizures. Status epilepticus was documented in 17 cases (12.14%), and 4 patients (2.86%) had secondary generalized seizures.

Etiology of Seizures: Strokes accounted for 29.29% of seizures, with idiopathic aetiologies (26.43%) and central nervous system (CNS) infections (22.86%) following closely behind. Acute disseminated encephalomyelitis (ADEM; 1.43%), multiple sclerosis (0.71%), encephalomalacia with gliosis (2.86%), cortical venous thrombosis (2.14%), metabolic disorders (9.29%), brain tumours (4.29%), and posterior reversible encephalopathy syndrome (PRES; 0.71%) were among the other less common causes. 44% of seizures that happened at or after the age of 20 had idiopathic aetiology, according to Pradeep et al.[20] The most frequent causes were traumatic events (6%), neurocysticercosis (12%), TB (6%), cerebrovascular disorders (20%), and tumours (4%). According to Hirani & Shrivastva,[19] & Jiménez et al,[21] there is a notable prevalence of unexplained seizures in the adult population, with rates of 51% and 40%, respectively. According to Quraishi et al,[22] idiopathic causes (20%), stroke (30%), and infections of the central nervous system (38%), are the main causes of seizures in adults.

CNS Infections: Among the 32 patients with CNS infections, CNS tuberculosis was the most common (43.75%), followed by neurocysticercosis (34.38%), viral meningoencephalitis (9.38%), pyogenic meningitis (6.25%), brain abscess (3.13%), and cerebral malaria (3.13%). Kaur et al,17 found that CNS TB is the most common cause of seizures (42.8%), followed by neurocysticercosis (28.5%) and viral meningoencephalitis (14.3%). Pyogenic meningitis, cerebral malaria, and brain abscesses are infrequent cases. Quraishi et al,[22] found that Tuberculoma is the most common neuroinfection linked to seizures, accounting for 36.8% of cases. Kanitkar et al found that Neurocysticercosis causes 40% of seizure cases, while CNS TB causes 60%.[23]

Metabolic Causes: Out of the 13 patients with metabolic-related seizures, alcohol withdrawal was identified in 30.77% of cases, hyponatremia in 23.08%, and hypocalcemia in 15.38%. Other causes included hypoglycemia, uremic encephalopathy, hepatic encephalopathy, and opioid withdrawal (each 7.69%). In 31 percent of adult cases, alcohol withdrawal was the most frequent metabolic cause of seizures, according to Kanitkar et al.[23] The

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prevalence of alcoholic seizures was 11% in the study conducted by Hauser et al.[24]

Associated Symptoms: Tongue bite was the most common associated symptom, reported in 60% of patients. Urinary incontinence and headache were observed in 22.86% and 13.57% of cases, respectively.

EEG Findings: Electroencephalography (EEG) revealed abnormal findings in 58 patients (41.43%), while the remaining 82 patients (58.57%) had normal EEG results.

Neuroimaging Findings

CT Scan (n=140): CT scans were normal in 37.14% of cases. The most common abnormalities included infarcts (23.57%), tumors (8.57%), gliosis (6.43%), and cortical atrophy (5.71%). Other findings included hemorrhages, ring-enhancing lesions, diffuse cerebral edema, hydrocephalus, tuberculomas, cortical venous thrombosis, and brain abscesses. Sinha et al,25 noted that 40.7% of the subjects investigated had no abnormalities in CT head scans. The most common CT findings among patients with abnormal CT head scans were intracranial haemorrhage (9%), brain atrophy (3%), tumors (7%), neurocysticercosis (3%), & calcified granuloma (5%). Kaur et al,[17] conducted a CT head examination on all patients & found that 30% of the cases had a normal outcome. The most commonly seen abnormal CT characteristics were as follows: infarct (18%), tumor (8%), gliosis (7%), ring-enhancing lesion (5%), haemorrhage, & cortical atrophy (5% each).

MRI (n=98): MRI was more sensitive than CT in detecting underlying abnormalities, with a positive finding rate of 65.31%. Normal findings were observed in 34.69% of MRI scans. Abnormalities included infarcts (16.33%), tumors and gliosis (each 9.18%), tuberculomas (7.14%), neurocysticercosis and encephalitis/meningitis (each 6.12%), hemorrhage (5.10%), cortical atrophy (4.08%), and brain abscess (2.04%). In the research by Kaur et al,17 seventy-three percent of the patients had brain MRIs. Among these patients, 30% had a normal scan. The most common abnormality observed on MRI was infarct, which accounted for 16.3% of the cases. Gliosis & tumor were the next most prevalent abnormalities, each accounting for 8.3% of the cases. Tuberculoma, neurocysticercosis, & encephalitis/ meningitis each accounted for 6.9% of the cases. Pannag & Ravi,[26] conducted a study that showed that 46% of the participants had normal MRI brain function, which was similar to previous findings. Twenty percent of the cases had postischemia/hemorrhagic alterations, which were the most common pathological findings found on MRI. The prevalence rates of several conditions in the brain were as follows: tuberculoma (9.7%), tumors (9 percent), mesial temporal sclerosis (3 percent), neurocysticercosis (2.4 percent), encephalitis (2.4%), vascular malformation (1 percent), & progressive multifocal leukoencephalopathy (0.6 percent). With MRI showing better sensitivity than CT, the study emphasises the value of both EEG and MRI in determining the underlying causes of seizures that start in adulthood. This study's single-center design and small sample size, however, are significant limitations that might compromise the findings' generalisability. Furthermore, not every patient had an MRI because of financial and accessibility issues, which might have resulted in an underestimate of some abnormalities. It is advised that these findings be confirmed by bigger cohorts in future multi-center investigations.

CONCLUSION

This cross-sectional study concludes that stroke is the most common cause of seizures in adults, followed by idiopathic causes, CNS infections, metabolic disorders, and, less frequently, brain tumours and other neurological conditions like gliosis, CVT, ADEM, MS, and PRES. Younger people were more likely to experience generalised seizures, whereas older people were more likely to experience focal seizures. Though it may still seem normal in a sizable percentage of instances, MRI was shown to be more effective than CT in detecting underlying structural reasons, especially in situations like infarcts, neuroinfections, and demyelinating illnesses. All adult patients who come with seizures should have a comprehensive clinical assessment, EEG, adequate neuroimaging (ideally MRI), and pertinent metabolic studies to guarantee correct diagnosis due to the variety of aetiologies and possible severity.

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