

Role of Computerized Tomography Scan in Seizure Disorders

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ABSTRACT

Background: Neuroimaging can help to determine whether a seizure in a patient results from a structural abnormality of the brain or its surroundings. It is useful in a variety of clinical settings. The present study was undertaken to find the role of computed tomography (CT) scan in patients of seizure disorders. **Materials and Methods:** This was a prospective study of 2 years duration. The sample size was 100. Nonenhanced CT (NECT) scan was performed in all patients on single slice helical CT scanner. All patients with history of seizures were included in the study. Any patient with evidence of biochemical or metabolic abnormality was excluded. **Results:** The mean age of patients was 27.47 ± 19.82 years. The sensitivity of NECT was 49%. Following contrast-enhanced CT (CECT) study, the overall sensitivity came to be 51%. Also, the scans in which NECT was unable to provide a conclusive diagnosis, CECT provided a confirmatory diagnosis in most of them (34 patients, 69.38% of 49 patients). Space-occupying lesions were the most common finding and were more commonly associated with simple seizures with or without generalization. **Conclusion:** CT scan plays a very important role as a preliminary tool in radiological assessment of patients presenting with seizure. In about half of the seizure patients, it is able to diagnose or suggest the abnormality. It is valuable in making a diagnosis particularly in Indian subcontinent, where infective causes in form of space occupying lesions and infections are most important cause of seizure.

Key words: Computed tomography scan; computed tomography scan in seizures; neuroimaging in seizures; seizures

Introduction

The term seizure refers to an abrupt but transient interruption in normal brain function that comes as the result of an unregulated discharge of neurons.^[1] Common causes of seizures may vary by age of onset^[1,2] developmental defects, birth injuries, and metabolic disorders are common before the age of 2 years, whereas in the age group of 2-14 years idiopathic seizures are common. In adults, trauma, alcohol withdrawal, tumors, strokes, and unknown cause (in 50%) are frequently encountered etiologies, whereas tumor and strokes are common causes in elderly population.

Although a variety of factors influence the incidence and prevalence of seizures, about 5%-10% of the population will have at least one seizure, with the highest incidence occurring

in early childhood and late adulthood. Seizures are a frequent reason for attendance to the emergency department (ED). It has been reported that 0.24%-0.3% of adults who present to the ED do so because of a first seizure.^[3,4] Around 5% of the population will experience at least one nonfebrile seizure during their lifetime.^[5,6]

Neuroimaging can help to determine whether a patient's symptom (i.e. seizure) results from a structural abnormality of the brain or its surroundings, and it is useful in a variety of clinical settings. The use of neuroimaging requires prioritizing patients according to the available scan time. The decision to perform neuroimaging is first to make a diagnosis, plan for treatment and then for follow-up after treatment.

The present study was undertaken to find the role of computed tomography (CT) scan in patients with seizure disorders in a developing country.

Materials and Methods

This was a prospective study conducted in the department of radiodiagnosis in collaboration with the departments of neurology and pediatrics of the hospital. Written and

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DOI:

10.4103/1115-1474.128077

informed consent was obtained from all patients or their attendants. In radiology department, data sheets were completed for every patient including name, age, gender, socioeconomic status, and type of seizure.

CT scan protocol

Nonenhanced CT (NECT) scan was performed in all patients on single slice helical CT scanner (Siemens Somatom Espirit, Munich, Germany) in supine position. Above the tentorium 10 mm slice thickness were obtained, whereas 5 mm thick slices were taken below the tentorium, thin sections were taken in the region of interest. Contrast was given to the selected patients depending upon indication.

All patients with history of seizures were included in the study. Any patient with evidence of biochemical or metabolic abnormality was excluded. The data were entered into the Microsoft Excel sheet and the results were analyzed using SPSS 10.0 version for Windows (SPSS Inc. Chicago, IL, USA).

In this study, we have used the criteria of classifying space-occupying lesions into neurocysticercosis (NCC) and tuberculoma as per Rajshekhar *et al.*^[7]

Results

The study period ranged from May 2010 to May 2012, that is, for 2 years. The demographic details of this study are presented in Table 1. Maximum number of patients in our study (25, 25%) presented with the complaint of seizure in their second decade, followed by 19 patients (19%) in first decade of life. The bulk of the patients were below 30 years of age (65, 65%). Minimum number of patients in our study belonged to 8th decade (3, 3%).

On NECT scan, 49 patients had an abnormal appearance, making the sensitivity of the NECT to be 49%. Despite the abnormal appearance, NECT was not able to give a conclusive diagnosis in most of the patients. Contrast was used in 90 patients. Of all the CT scans, which were normal on NECT scan, two showed enhancing lesions in the form of meningeal enhancement in one patient and an aberrant vessel in the other patient. Following contrast CT study, the overall sensitivity of CT scan in finding out an abnormality came to be 51%. Also, the scans in which NECT was unable to provide a conclusive diagnosis, CECT provided a confirmatory diagnosis in most of the patients (34 patients, 69.38%).

The contrast was not used in 10 patients, which included trauma patients, and patients who had conditions that is a contraindication to the use of contrast media such as deranged renal function or drug allergy, and so on.

Among the abnormal scans, frontal lobe was most commonly involved (16 patients), followed by the parietal lobe (8 patients). Bilateral cerebral hemisphere involvement was

noticed in nine patients. Total unilateral cerebral involvement was not seen in any patient. Temporal and occipital lobe involvement was noted in two patients each. On the basis of CT scan, space-occupying lesions were the most common finding [Table 2, Figure 1]. Of these, 22 were suspected NCC and 3 were suspected tuberculoma. On correlating the lobe of involvement to the type of seizure, all patients who presented with generalized tonic-clonic seizures (GTCS) showed pathology involving more than one lobe or bilateral hemisphere. Frontal lobe involvement was predominant in partial seizures of both simple and complex partial types. Occipital lobe involvement was least commonly noted, only in two patients with simple partial seizure [Table 3, Figure 2].

On correlating the final diagnosis to the type of seizure, space-occupying lesions were more commonly associated with simple seizures with or without generalization. This difference was statistically significant ($P < 0.05$). Vascular causes or gliosis/atrophy were present only in partial seizures. Meningoencephalitis was evenly distributed in all three groups. Trauma or tumor did not lead to simple seizures. They only led to complex seizures. The difference, however, appeared to be insignificant. Normal CT appearance was seen both in simple seizures or GTCS. However, it comprised

Table 1: Demographic details of the study

Number of patients	100
Age of patients	27.47±19.82 years (range; 3-79 years).
Male to female ratio	5:1.
Rural and urban ratio	57:43 (1.3:1)
Number of seizures	Multiple seizures-41 (41%), Single seizure-32 (32%), Two episodes-18 (18%), Three episodes-9 (9%)
Type of seizures	Simple partial seizure with or without secondary generalization-59 patients Complex simple partial seizure with or without secondary generalization-15 patients Generalized tonic-clonic seizures-26 patients

Table 2: Final diagnosis

Type	Number
Space-occupying lesions	25
Vascular	9
Gliosis/atrophy	5
Meningoencephalitis	6
Miscellaneous	2
Tumor	2
Trauma	2
Normal	49
Total	100

Space-occupying lesions included suspected tubercular granuloma or neurocysticercosis. Miscellaneous included third ventricular cyst, pachygyria, mesial temporal sclerosis, and brain abscess. Infarct was the main contributing abnormality in the vascular causes

about 73% of all GTCS patients and about 37% of all simple seizures [Table 4, Figure 3].

Discussion

To find out the seizure etiology has been a challenge for decades, which was solved to a great extent with emerging neuroimaging modalities and their advancements. In the present study, we have tried to find out the role of CT scan as a diagnostic imaging modality for seizure patients and to draw certain conclusions regarding seizure etiology, common seizure types, and so on.

In present study the mean age of patients was 27.47 ± 19.82 years. Rathi *et al.*,^[8] noted age group from 1 to 75 years in their cohort of 94 patients, of which 75% patients being children and young adults. Nair *et al.*,^[9] also noted somewhat similar findings. It suggests that mean age

of seizure occurrence in non selective group in India is more or less same.

The sensitivity in identifying an abnormality was 49% with NECT, which rose to 51% after CECT. However, NECT was not able to provide a conclusive diagnosis in most of the patients. The scans in which NECT was unable to provide a conclusive diagnosis, CECT provided a confirmatory diagnosis. It may be mistakenly assumed that use of contrast increased sensitivity by only 2%; however, it may be noticed from the results that use of contrast not only increased the sensitivity, but it also helped in arriving at proper diagnosis in about 67% of patients. The use of contrast agent has also been used if NECT

Table 3: Correlation of type of seizure to the lobe of involvement

Type→ Lobe↓	CPS with or without secondary generalization	SPS with or without secondary generalization	GTCS
Frontal	4	12	0
Parietal	0	8	0
Temporal	0	2	0
Occipital	0	2	0
B/L CH	1	5	3
>1 Lobe	5	6	3
Normal	5	24	20

B/L CH=Bilateral cerebral hemisphere, >1 Lobe=More than one lobe; CPS – Complex partial Seizures; GTCS – Generalized tonic-clonic seizure; SPS – (Simple Partial Seizures) All patients who presented with GTCS showed pathology involving more than one lobe or bilateral hemisphere. Frontal lobe involvement was predominant in partial seizures of both simple and complex partial types.

Table 4: Correlation of final diagnosis with type of seizure

Type	SPS with or without generalization	CPS with or without generalization	GTCS
Space-occupying lesions	22	2	1
Vascular	5	4	0
Gliosis/atrophy	3	2	0
Meningoencephalitis	3	0	3
Miscellaneous	2	0	0
Trauma	0	1	1
Tumor	0	1	1
Normal	24	5	20

Space-occupying lesions were more commonly associated with simple seizures with or without generalization. This difference was statistically significant ($P<0.05$). Vascular causes or gliosis/atrophy were present only in partial seizures. Meningoencephalitis was evenly distributed in all three groups. Trauma or tumor did not lead to simple seizures. The difference, however, appeared to be insignificant. Normal computed tomography appearance was seen both in simple seizures or generalized tonic-clonic seizure (GTCS). However, it comprised about 73% of all GTCS patients and about 37% of all simple seizures. CPS – (Complex Partial Seizures); GTCS – Generalized tonic-clonic seizure; SPS – (Simple Partial Seizures)

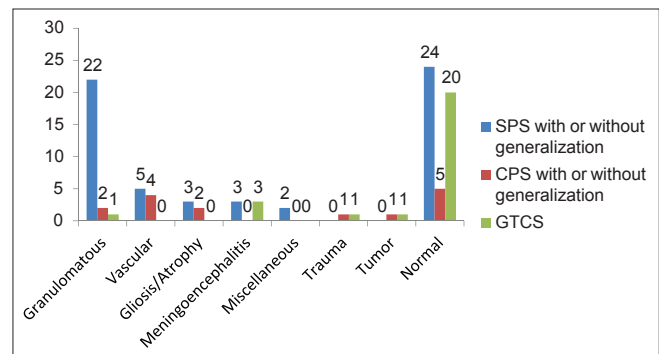


Figure 1: Graphical representation of various diagnoses

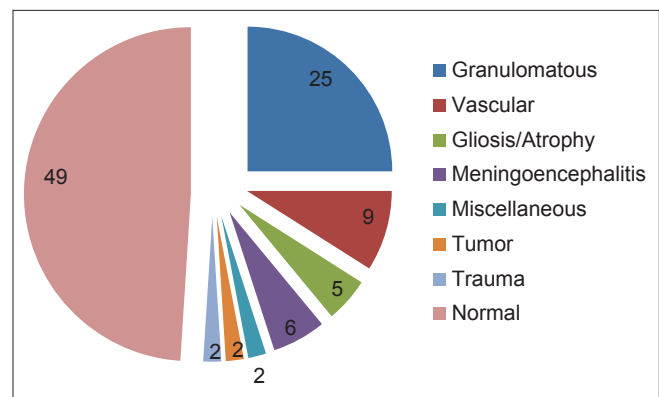


Figure 2: Graphical representation of the correlation of the lobe of involvement to the type of seizure

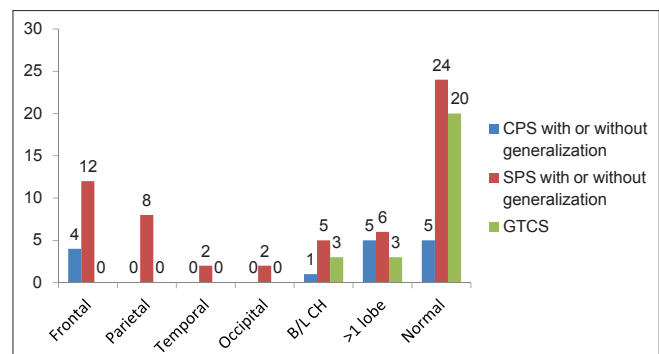


Figure 3: Graphical representation of the correlation of the final diagnosis to the type of seizure

has been found to be normal.^[8,10] Sempere *et al.*,^[10] evaluated 98 patients, and noticed CT abnormalities in 33 (33.7%) patients, which is much less than present study. In another study, no specific cause for seizures was found in 65.5% of patients. Thus sensitivity came to be 34.5%.^[6] Nair *et al.*,^[9] noted abnormality in 21 out of 44 patients, thereby giving a sensitivity of 47.7%. Schoenenberger and Heim^[11] performed CT scan in 119 patients, of which 51 patients had normal scan. The sensitivity was 42.85% in this study. Most of the early studies had a low sensitivity of CT scan, probably due to early generation of the system, which has low sensitivity in detecting the intracranial lesions. The sensitivity of 40%-50% has been noted in recent studies, which is evident from above. We had a sensitivity of 51%, which is higher than the above-mentioned studies. An important reason may be the increased presence of infective lesions in developing countries, which has also been suggested by Hopkins *et al.*^[12] The presence of these lesions is easily picked up by the CT scanner due to increased incidence of calcification in these lesions.

In the present study, out of the abnormal 51 scans, frontal lobe was most commonly involved, followed by the parietal lobe. Similar locations were reported by Silverstein and Alexander.^[13] Rathi *et al.*,^[8] in their study were specific on solitary ring lesions only and they noticed that maximum number of lesions were located in the parietal lobe. These and other studies^[14,15] suggest that frontal and parietal lobes are more commonly involved than occipital or temporal in seizure disorder. However, it could be validated in another study with more number of patients.

A total of 26% patients presented with GTCS out of which 73% had a normal CT appearance, whereas patients presenting with partial seizure (74%), 61% had an abnormal CT appearance, and only 39% had normal scan, thus suggesting that partial seizures are more frequently associated with abnormal CT scan. Young *et al.*,^[16] also noted that partial seizures had abnormal scan as compared to generalized seizures. It has also been noted by other workers.^[17]

Space-occupying lesions in present study included both suspected lesions of tubercular granuloma and NCC. Out of 51 abnormal CT scans, space-occupying lesions were the most common abnormality. It was seen in 25% of patients thus comprising approximately 50% of all CT identifiable causes. From the western world, cerebrovascular causes or atrophy have been found to be more common.^[6,18,19] It may be argued that the definitive diagnosis of space occupying lesion pathology can be made only after histopathology; however, we would like to say that if the imaging parameters as described in this study^[7] point toward it, histology is seldom performed, and the treatment is started on the radiological basis. The response to the treatment further confirms the diagnosis. Tuberculosis and NCC comprise almost all space-occupying lesions. Lesions like oligodendrogliomas, meningioma, and metastasis do not exactly come in the differential diagnosis of this entity.

Puri and Gupta,^[17] in their study on seizure patients, found that tuberculoma and NCC patients presented with partial seizures more than the generalized seizures. In their assessment of ring lesions in 94 patients, Rathi *et al.*,^[8] also noticed that seizures were partial in 56% and generalized in 44% cases. Thus, present study is in agreement with the studies conducted by above authors that space-occupying lesions are more commonly associated with partial seizures and most frequently with simple partial seizure. Among the space-occupying lesions presenting with seizure etiology initially, most of these lesions were considered to be tubercular.^[20-22] However, this view was challenged by others.^[23]

Rajshekhar *et al.*,^[7] in their study on single small-enhancing CT lesion in seizure patients performed CT and used CT-guided stereotactic biopsy of these lesions as standard of reference. The histopathological examination of tissues obtained after brain biopsy revealed cysticercus granuloma in majority of patients, and only in few patients, a definite tuberculoma was demonstrated. The same has been noticed by others.^[22]

In about half of the seizure patients, it is able to diagnose or identify the type and site of the lesion as well as involvement of the surrounding structures. Contrast-enhanced images are very valuable in making a diagnosis. Although CT gives ionising radiation to the patient, but its increasing wide spread availability, patient affordability, and short scan time makes it very valuable tool in diagnostic work up of a seizure patient. Its benefit outweighs the risk.

Conclusion

CT scan plays a very important role as a preliminary tool in radiological assessment of patients presenting with seizure. It is valuable in making a diagnosis particularly in developing world, where granulomatous lesions and infections are most important cause of seizure.

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How to cite this article: Pandey J, Gujral RB. Role of computerized tomography scan in seizure disorders. *West Afr J Radiol* 2014;21:26-30.

Source of Support: Nil, **Conflict of Interest:** None declared.