Clinico – diagnostic and therapeutic relevance of computed tomography scan of brain in children with partial seizures

Nehal H. Patel, Ashish R. Jain, Vivek K. Iyer, Anand G. Shah, Dipti A. Jain[1], Anjanaben A. Shah[2]

Departments of Pediatrics, [1]Physiology, GMERS Medical College Sola, [2]Department of Pediatrics, The Gujarat Cancer Society Medical College Hospital and Research Centre, Ahmedabad, Gujarat, India

Abstract

Background: Therapeutic relevance of computed tomography (CT) in children with partial seizures is reported to be remarkably low (1-2%). However, in the developing countries where infections involving the nervous system are common, routine CT scan of brain may help in finding treatable causes of seizures. **Objective:** Aim of this study was to evaluate the significance of CT scan of brain in the management of children with partial seizures. **Materials and Methods:** Children with partial epilepsy, whose predominant seizure type was focal motor seizures, were included in the study. CT scan of brain was done in all children aged between 1 month and 12 years with partial seizures of unknown etiology prospectively. The clinical findings of these children were noted along with the CT findings. **Results:** Between August 2001 and July 2002, of the 200 children with seizure disorder 50 children who satisfied the inclusion criteria were included in the study. CT scan of brain was normal in 16 children (32%) and was abnormal in 34 children (68%). Twenty children (~60% of abnormal scan) had potentially correctable lesions: Tuberculoma ($n = 13$), neurocysticercosis ($n = 3$), and brain abscess ($n = 4$). Five children had changes representing static pathology that did not influence patient management. The clinical features correlated with CT findings in 78% children. **Conclusion:** Children with partial motor seizures have high probability of having abnormal findings on CT scan of brain, especially, neuro-infections which are potentially treatable. Therefore, CT scan brain should be carried out in all children with partial motor seizures especially, in developing countries.

Key Words

Children, computed tomography scan, partial seizures

For correspondence:

Dr. Nehal H. Patel, S.V.M. School Road, 33, Paras Status Bungalows, Science City Road, Sola, Ahmedabad - 380 060, Gujarat, India. E-mail: nehal_pedia@yahoo.com

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Introduction

Partial seizures, depending on the origin from a specific part of brain, manifests in various forms, of which motor partial seizures is characterized by convulsive activity involving any part of the body (hands, face, legs, etc.,).[1] The diagnostic yield of computed tomography (CT) scan of brain in investigation of epilepsy depends to a large extent on seizure type. Patients with primary generalized epilepsy[2-4] and benign rolandic epilepsy[5] have a low incidence of abnormality on CT scan, while an abnormal finding on CT scan is common in children with infantile spasms.[6,7] Conventionally, during the evaluation of partial seizures, computed tomogram is carried out only if other neurological symptoms or signs are present. In their absence, the indication for CT has been less certain. Few data exists on the incidence of abnormal finding on CT scan of brain in children who present with partial seizures alone. Previous studies, which have reported abnormal findings on CT scan of brain in children with seizure disorder, mainly have children of mixed cohort with or without neurological signs, and children with known seizure etiologies.[8-12]

Although, partial epilepsy can produce a variety of symptoms, children with seizures having predominantly focal motor phenomena are more likely to have structural lesion than other epileptic symptoms.

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Materials and Methods

From August 2001 to July 2002, of all the children with seizure disorder who were admitted to our tertiary care center, children with partial motor seizures were prospectively enrolled into this observational study.

Inclusion criteria

- Children between ages 1 month and 12 years and
- Children having partial seizures with predominantly focal motor phenomena.

Exclusion criteria

- Neonates were excluded as having varied possible etiologies for the seizures
- Children who expired or not completed the treatment
- CT scan could not be done due to any reason.

Type of seizures based on detailed history and clinical examination, along-with findings of CT scan of brain were noted in all patients.

Routine investigations included complete hemogram with Erythrocyte sedimentation rate, basic renal and liver function tests, Mantoux test and X-ray chest, and were carried out in all patients. Cerebro Spinal Fluid (CSF) analysis by doing a Lumbar puncture and/or Electroencephalography (EEG) examination was carried out whenever clinically indicated. CT scan of brain with contrast was carried out in Siemens SOMATOM Definition AS + model scanner. The system has 128 slices per rotation and has highest rotation speed of 300 ms. Sections of 5-10 mm thickness were obtained with orbitomeatal line as reference.

Results

Out of 200 children who presented with seizure disorder between August 2001 and July 2002, 59 children (29.5%) had partial seizures, with well-documented focal motor phenomena and qualified for inclusion in the study. Nine children were excluded from analysis as 4 children expired after admission before investigations, 3 children were not ready for admission and investigations. CT scan could not be carried out in two patients because of financial constraints.

Of the 50 children included, simple partial seizure (SPS) was present in 25 children, complex partial seizures in 18 children while 7 children had initially partial seizures but later developed generalized seizures. There was a male preponderance in children having complex partial seizure (13 male; five female) and secondary generalized seizure (five male; two female), while sex ratio was almost equal in children with SPS (13 male: 12 female). 22% children ($n = 11$) were of 1 month 1-year-old, 40% children ($n = 20$) were 1-5 years of age, and 38% children ($n = 19$) were 5-12 years of age. Five children (10%) had history of contact to the person having tuberculosis. History of gastro intestinal worm infestation was present in 2 (4%) children and congenital heart disease in 4 (8%) children. History of febrile convulsions was present in 4 (8%) children. The family history of epilepsy was present in 2 (4%) children and febrile convulsion in 1 (2%) child. Table 1 shows the associated presenting symptoms and neurological abnormalities on examination.

The Mantoux test was positive (>10 mm) in 13 (26%) children and the findings suggestive of tuberculosis (old/active) on X-ray chest were present in 12 (24%) children. CSF fluid was examined in 22 children based on clinical suspicion, from which 15 children showed an abnormal CSF fluid analysis. Of the 17 children who had an EEG analysis, 5 children had an abnormal EEG, while in the rest 12 patients, EEG was non-diagnostic. Fundus examination detected abnormality in 18% of children (papilledema [$n = 7$] and optic atrophy [$n = 2$]). CT of brain, which was carried out in all children, [Table 2] showed abnormal findings in 68% of children ($n = 34$). Abnormal findings included infective lesions in 40% children ($n = 20$) (tuberculoma [$n = 13$] neurocysticercosis [$n = 3$], and brain abscess [$n = 4$]), focal vascular lesion in 18% children ($n = 9$) (hemorrhage [$n = 7$] and infarct [$n = 2$]) and 10% of children ($n = 5$) had a congenital static pathology (gliosis [$n = 2$], encephalomalacia [$n = 1$], subdural hygroma [$n = 2$]). The radiological diagnosis of tuberculoma is based on the presence of coalescing lesions, isodense contents, target sign, irregular margins, peripheral thick enhancement and presence of perilesional edema.[13,14] The diagnosis of neurocysticercosis is considered in the presence of multiple rings or disc lesions, non-enhancing focal hypodensities, eccentric scolex and calcified lesions.[15] Disease targeted treatment could be instituted in 20 children (40%) based on infective findings on CT scan of brain.

Table 1: Clinical findings on examination (signs and symptoms)

Presenting symptoms	Cases	Percentage
Seizures		
Focal	43	86
Generalised	07	14
Fever	25	50
Headache	21	42
Vomiting	21	42
Cyanosis	4	8
Visual disturbances	2	4
Altered sensorium	25	50
Hypertension	10	20
Papilloedema	7	14
Todd's paralysis	12	24
Cranial nerve palsy	9	18
Meningism	11	22
Optic atrophy	2	4
Normal fundus	41	82

Table 2: Findings on computed tomography in 34 children with partial seizures

Lesions	Cases	(%)
Tuberculoma	13	26
Neurocysticercosis	3	6
Vascular lesion		
Haemorrhage	2	4
Infarct	7	14
Brain abscess	4	8
Brain tumour	-	-
Congenital		
Gliosis	2	4
Encephalomalacia	1	2
Subdural hygroma	2	4

Children with SPS had significantly higher proportion of abnormal findings on CT scan [Table 3]. Correlation between the clinical diagnosis and abnormal findings on CT scan was present in most of cases [Table 4] (Spearman's Rank Correlation Coefficient was 0.973), and thus, CT scan helped in confirming the diagnosis.

Discussion

Childhood seizures occur most commonly in infancy (1-24 months) with a decreasing incidence throughout the remainder of childhood.[13] The American Academy of Neurology guidelines, for evaluation of non-febrile seizures in a child recommends neuroimaging for children with post-ictal focal neurologic deficits.[16] Seizures may occur in up to 10% of population, whereas epilepsy is a chronic disease characterized by recurrent seizures which affects 2% of the population. CT scan of brain can effectively and easily diagnose and quantify cerebro-organic disturbances. Abnormal findings on CT scan of brain provide an idea about the degree of cerebral involvement in different type of epilepsies.[11] However, CT scan of brain cannot provide information on intricate changes in the fine structure of the brain as in cases of children with cerebral palsy.

The frequency of abnormal findings on CT of brain is age dependent in partial epilepsy. Angeleri *et al*. found abnormalities in 10% of childhood cases compared with 29% in patients between 19 years and 50 years and 59% in patients over 51 years.[17] The incidence of brain tumor increased when partial epilepsy has its onset in adulthood.[3] Only a few studies have addressed the radiological evaluation of children with partial seizures [Table 5]. There is higher incidence of normal CT scan of brain (50-79%) in studies from the developed countries [8,10,18] when compared to studies from India (37-76%).[1,19,20] Lagenstein *et al*. in a study of tomography

Table 3: Correlation of computed tomography scans finding and the different seizure types

Types of seizures	Abnormal tomograms (%)	Normal tomograms	Total patients
Simple partial seizures	19 (38)	6	25
Complex partial seizures	11 (22)	7	18
Secondary generalisation	4 (8)	3	7

Table 4: Correlation of computed tomography scans with the clinical findings

Clinical diagnosis		CT scan		Correlation present (*n*=39)		Correlation absent (*n*=11)	
Condition	*n*=50	Condition	*n*=50	No.	%	No.	%
Tuberculoma	16	Tuberculoma	12	12	75	4	25
		Infarct	3				
		Normal	1				
Neurocysticercosis	4	Neurocysticercosis	3	3	75	1	25
		Normal	1				
Brain abscess	4	Brain abscess	4	4	100	-	-
Congenital	6	Congenital	4	4	66	2	34
		Normal	2				
Haemorrhage	2	Haemorrhage	2	2	100	-	-
Infarct	2	Infarct	2	2	100	-	-
Idiopathic	16	Normal	12	12	75	4	25
		Tuberculoma	02				
		Infarct	01				
		Congenital	01				

CT=Computed tomography

Table 5: Computed tomography abnormalities in children with partial seizures – comparison of the studies

CT abnormalities	Present series *N*=50 (%)	Gibbs *et al*.[18] *N*=121 (%)	Jain and mangal[19] *N*=172 (%)	Kapoor *et al*.[20] *N*=100 (%)	Bachman *et al*.[8] *N*=98 (%)	Yang *et al*.[10] *N*=34 (%)	Nair *et al*.[1] *N*=198 (%)
Tumour	-	1 (0.83)	2 (1.16)	-	6 (6.12)	2 (5.55)	2 (1.01)
Infarct	7 (14)	2 (1.65)	12 (6.97)	4 (4)	-	-	12 (6.06)
Tuberculoma	13 (26)	-	22 (12.79)	5 (5)	-	-	13 (6.56)
Cysticercosis	3 (6)	-	35 (20.34)	1 (1)	-	-	20 (10.1)
Focal calcification	-	-	4 (2.32)	2 (2)	2 (2.04)	1 (2.94)	24 (12.12)
Vascular malformation	2 (4)	-	-	-	-	-	2 (1.01)
Focal atrophy	-	6 (4.96)	10 (5.81)	9 (9)	7 (7.14)	8 (23.53)	19 (9.59)
Congenital	5 (10)	2 (1.65)	18 (10.46)	3 (3)	-	1 (2.94)	5 (2.52)
Abscess	4 (8)	-	-	-	-	-	-
Others	-	15 (12.39)	5 (2.90)	-	11 (11.22)	5 (14.7)	7 (3.53)
Normal	16 (32)	95 (78.51)	65 (37.79)	76 (76)	70 (71.42)	17 (50)	81 (40.19)

findings in 309 children with different types of epilepsy, found that 64 (39%) of 165 children with partial epilepsy had abnormal tomograms.[11] Most of these changes were atrophic and only one child had a tumor. Yang *et al*. found that 50% of 34 children with partial seizures of elementary symptomatology and 30% of 46 children with partial seizures of complex symptomatology had abnormal tomograms.[10] They found that children with partial seizures and abnormal neurological findings were a high yield group with 65% having abnormal findings. Both the series of Lagenstein and of Yang included children with abnormal neurological findings, which may explain the higher incidence of abnormality as confirmed in our study also. In these studies, focal atrophy was the most common finding, while we observed neuro-infections more frequently. Probably, the very high prevalence and incidence of neuro-infections particularly tuberculosis in our country is the reason for such striking difference. Neuro-tuberculosis is an important cause of SPS in India. Kumar *et al*.[21] noted CT evidence of tuberculosis in 14.3% of patients with partial seizures. Focal seizures were the presenting manifestation of intra cranial tuberculomas in 38% of patients.[22] In our study 26% of children had tuberculoma and were treated with antituberculous drugs. Neurocysticercosis is the most common parasitic infection of the central nervous system and 70-80% of these patients manifest with focal seizures.[23] Incidence of neurocysticercosis in patients with seizures in India varies from 2.8% to 11.8%.[21,23] In our study, 6% of children had evidence of neurocysticercosis on CT scan.

The therapeutic relevance of CT findings in children with seizures varies from 1.7% (18) to 2.7% (10). One of the main reasons for carrying out CT is to exclude a tumor or other treatable lesion such as an arteriovenous malformation. Although, these lesions are likely to present in a small minority of otherwise neurologically normal children, we had twenty children (40%) with potentially correctable lesions because of the higher incidence of tuberculomas, abscess and neurocysticercosis in our series, which enforces the view expressed by Wylie *et al*. in their recent review of partial seizures that CT is indicated in essentially all children with partial seizures.[24] However, Patel *et al*.[25] and Harwood-Nash[26] in their studies concluded that CT should be reserved for children with seizures plus abnormality on neurological examination. There have been several reports of unsuspected tumors or other structural lesions in children diagnosed by tomography.[8,27-29] Holmes *et al*. described two children, one with a glioma and the other with an arteriovenous malformation, both of whom had normal neurological examination and EEG recordings.[28] Most of the tumors described in such cases have been slow growing gliomas, so that the presence of seizures for several years does not preclude the need for neuroradiological investigation.[30] As tumors have also been found in some patients after an initially normal computed tomogram [30,31] further investigation either by repeat computed tomogram or by magnetic resonance imaging should be considered if seizures prove to be intractable.

Neuroimaging has important applications in the diagnosis and treatment of patients with seizures and epilepsy. The International League against Epilepsy guidelines for neuroimaging studies suggest that a CT can be the diagnostic imaging of choice in patients with epilepsy if an Magnetic Resonance Imaging MRI is not available.[32] As MRI is the preferred imaging technique for patients with epilepsy, advances in radionuclide-based techniques such as single-photon emission CT/positron emission tomography and electromagnetic source imaging with magneto-encephalography are providing new insights into the pathophysiology of epilepsy. In weighing choice of imaging modalities, several factors need to be considered. Accessibility and affordability of imaging modality is often a major determinant wherein CT scan is more widely available and affordable technique. CT scan involves radiation exposure, while MRI involves the risks of sedation in most infants. Both MRI and CT scan can accurately detect structural abnormalities and can be used for evaluation depending on circumstances. Thus, though MRI remains the neuroimaging modality of choice in epilepsy, CT remains valuable in resource-poor settings.

Conclusion

Our series shows that partial seizures with predominant motor manifestation have a demonstrable higher incidence of structural cause, especially in the form of neurological infections and there is a positive correlation in the clinical findings and CT scan findings. A high diagnostic yield and incremental therapeutic relevance of CT scan findings in children with partial seizure with motor manifestation makes this modality of imaging very essential and should be considered in all such children.

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