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EEG is sensitive in early diagnosis of anti NMDAR encephalitis and useful in monitoring disease progress

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Abstract

Background& Objective: Investigation modalities, such as MRI and CSF examination, are neither sensitive nor specific in the early phase of anti-NMDAR encephalitis. Nuclear imaging may be useful to monitor the response to treatment but limited by the availability.We aimed to determine the role of EEG as a tool for early diagnosis as well as a tool to assess disease progression and response to treatment. *Methods:* A total of 99 EEGsdone in 16 patients diagnosed with anti-NMDAR encephalitis throughout the course of illness, were reviewed retrospectively. The EEG changes were correlated with the clinical presentations and response to treatment. Sixteen EEGs of patients with schizophrenia and mood disorder, and 10 EEGs of patients with infective encephalitis were included as control. *Results:* EEGs performed during the psychiatric and cognitive dysfunctionphase in patient with anti-NMDAR encephalitis, showed diffuse background slowing in the delta-theta range in all the patients. Serial EEGs showed that the dominant background frequency improved with improvement in cognitive status. Nine patients had complete recovery with normalisation of the EEG abnormalities. Eight patients had their typical clinical seizure recorded during EEG monitoring, but only 2 (25.0%) with EEG correlation. Ten patients had status epilepticus (62.5%), 5 had EEG recorded during their status epilepticus, of which only one with EEG correlation (20.0%). Eleven patients had asymmetric background (68.8%), but only 1 has correlation with focal changes in the MRI brain (9.1%). Even though the EEGs of patients with infective encephalitis also showed background slowing, their CSF analysis was supportive of an infective cause. EEGs of patients with established psychiatric disorder were within normal limits.

Conclusion: EEG abnormality has a good correlation with the degree of psychiatric and cognitive dysfunction in patient with anti-NMDAR encephalitis, and is useful in early diagnosis, monitoring the progress and the response to treatment. However, it has poor correlation with clinical seizures.

INTRODUCTION

Anti-NMDAR encephalitis was first described in 2005, initially affecting young female, with up to 56% association with ovarian teratoma.[1] As more cases being diagnosed, this paraneoplastic association reduces with the age of onset, and is also known to affect men and children.[2] Up to 2011, there have been more than 400 cases reported worldwide, with variable outcome to first-line treatments consisting of high dose parenteral steroid either independently or coupled with plasma exchange and/or intravenous immunoglobulin (IVIG).[3,4] This illness presented with sudden onset of altered cognition, with prominent psychotic features, followed by new onset seizures, with or without oro-facial dyskinesia and autonomic involvement.

Early diagnosis of anti-NMDAR encephalitis depends on clinical suspicion of the diagnosis, and limited by the availability of the anti-NMDAR antibody testing. However, the initial presentation of acute psychosis, with bizarre behaviour, confusion, paranoid delusion and visual or auditory hallucinations, especially in a young patient often leads to misdiagnosis and admission to psychiatric institution.[5] Most investigations, including blood and cerebrospinal fluid (CSF) examination, were normal or unhelpful in the early stage of disease.[6]

The MRI brain in those with anti-NMDAR encephalitis were mostly normal although focal enhancement or medial temporal lobe abnormalities can be observed.[6] Dalmau *et al*. reported that 55 of the 100 patients showed focal T2-hyperintensity in the MRI brain, mostly in the medial temporal lobes, and 14 of these patients

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had faint or transient contrast enhancement of the cerebral cortex, overlaying meninges, or basal ganglia.[1] Frontotemporal atrophy in the MRI brainis a late presentation, associated with hypoperfusion in SPECT, and was reported to be reversible in a long-term follow up study.[7]

Nuclear imaging is a potential alternative in detecting early changes in the brain as well as a tool in monitoring disease progression and response to treatment. Studies using fluoro-deoxy glucose positron emission tomography (FDG-PET) was performed during the initial phase of anti-NMDAR encephalitis showed either a global hypometabolism[8] or focal hypermetabolism[9], reversible with treatment. However, these imaging modalities were not readily available in most centres.

Electroencephalogram (EEG) was viewed to be non-specific, revealing diffuse delta slowing without paroxysmal discharges in most cases, despite frequent bouts of seizures.[6] Continuous EEG monitoring might be more sensitive to detect epileptiform activity in non-convulsive status epilepticus (NCSE)[10] and extreme delta brush, an ictal EEG pattern, was described in association with longer hospital stay and worse clinical outcome.[11] In addition, EEG abnormalities, such as diffuse low-voltage activity, were reported to be present as early as the psychotic stage in a case report.[12]

As shown above, most investigation modalities, such as MRI or CSF are not sensitive for the early phase of the disease or limited by the availability. EEG might be a potential tool in facilitating early diagnosis despite non-specific changes and useful in monitoring disease progression and treatment response, and predict long-term outcome but this possibility was not explored systematically in the previous literature.

We aimed to determine the role of EEG for early diagnosis, assess disease progression and response to treatment, through a retrospective review of serial EEGs in our patients with anti-NMDAR encephalitis, admitted to our centres from January 2010 till August 2012. The specific objectives of this study were to describe and correlate the EEG with (1) clinical features (impaired consciousness, dysphasia, delirium, abnormal behaviour, seizure-convulsive and non-convulsive, and involuntary movements); (2) imaging; (3) timing and progress of the disease; and (4) treatment.

METHODS

Sample Recruitment

We reviewed a total of 99 EEGs from 16 cases of anti-NMDAR encephalitis throughout their course of illness retrospectively. The diagnosis of anti-NMDAR encephalitis was confirmed by the presence of positive anti-NMDAR antibody in the serum, which was tested using the anti-glutamate receptor (type NMDA) Indirect Immunofluorescence Test (IIFT) kit. Basic demographic information such as age, gender and ethnicity were included. We also included 16 EEGs of patients with established diagnosis of schizophrenia and bipolar or major depressive disorder (MDD), and 10 EEGs of patients with infective encephalitis as control.

Clinical data

The presence and timing of specific clinical features, including higher cognitive dysfunction, psychiatric, seizure and involuntary movement, were documented. The results of various investigations such as MRI brain, radiological screening for a systemic neoplasm, and serological or CSF studies to rule out other possible diagnosis, were recorded. The modalities of treatment were documented as (a) high dose parenteral steroid with or without (b) plasma exchange and/or with (c) intravenous immunoglobulin (IVIG). All patients had a slow tapering dose of oral prednisolone after the initial immunotherapy.

EEG

A mean of 6.2 EEGs per patient with confirmed diagnosis of anti-NMDAR encephalitis were performed using a standard International 10-20 system for 30-60 minutes. EEGs were performed to assess (a) the severity of psychiatric and cognitive dysfunction, during the psychotic phase and as an assessment of progression, (b) the presence of the epileptiform discharges, (c) to document the EEG correlation with seizures or involuntary movements, and (d) to determine the response to treatment. The EEG abnormalities noted were the background rhythm, presence and description of epileptiform and non-epileptiform abnormalities. A total of 16 EEGs of patients with established diagnosis of psychiatric disorders, and 10 EEGs of patients with infective encephalitis, as confirmed with clinical symptoms of fever and confusion with or without convulsion, and abnormal CSF, were also reviewed for comparison. All EEGs

were read and interpretations agreed upon by the investigators who were electroencephalographers (KSL, CTT).

Correlation with clinical manifestations and imaging

The EEG abnormalities were correlated to the clinical state of psychiatric and cognitive dysfunction, seizures and involuntary movement. EEGs were performed after a specific treatment to determine the response to treatment. EEGs were also correlated to the presence of MRI brain abnormalities.

Statistical analysis

This study employed the Statistical Package for Social Sciences version 19 (SPSS 19.0) for data analysis. All demographic data was analyzed descriptively, with nominal data presented as frequencies as well as percentages, while continuous data were presented as means and standard variations.

RESULTS

The mean age of presentation for anti NMDAR encephalitis was 20.6 years (SD, 6.9 years), ranged from 7 to 29 years. Eleven out of 16 patients were female (68.8%), with 2.2:1 female to male ratio. MRI brain was abnormal in two out of 16 patients (12.5%). Only two patients had ovarian teratoma on computed tomographic (CT) scan of the pelvis (Table 1). Three (18.8%) patients had mild pleocytosis (range from 8-12 cells/L), with otherwise normal CSF glucose and protein (Table 2).

All patients had significant cognitive impairment, with acute psychosis and dysphasia being the most prominent features at presentation. All 16 patients had at least 1 episode of clinical seizure, of which10 had status epilepticus (62.5%).

All patients had EEG performed during the psychotic phase with cognitive dysfunction, 8 with EEG performed during a convulsive seizure and 5 during status epilepticus. Table 1 shows the clinical features, treatment and outcome of the study patients. Table 3 shows the EEG abnormalities and the seizure manifestations.

For patients with schizophrenia and bipolar disorder/ MDD, EEGs were performed during acute exacerbation of psychotic symptoms. All the EEGs were within normal limits (Table 4). As for the patients with infective encephalitis, EEGs were performed during period of cognitive impairment (Table 5).

EEG correlation with cognitive dysfunction and other clinical presentation

All patients' EEGs performed during the psychotic phase with cognitive dysfunction showed diffuse background slowing in the delta-theta range. Four had left dominant slowing associated with dysphasia. One patient had asymmetric slowing associated with contralateral hemiparesis.

All patients with established psychiatric disorder had normal EEG during acute exacerbation of psychotic symptoms.

In patients with infective encephalitis, 9(90%) had diffuse polymorphic slowing, with 1 patient exhibiting focal slowing on the background of diffuse polymorphic slow waves. 1(10%) had focal temporal slowing with otherwise normal EEG background supportive of focal cortical dysfunction.

EEG correlation with seizures

Three patients had inter-ictal spikes (18.8%), of which one had 3Hz spike-and-slow complexes. Two patients (12.5%) had periodic complexes during the course of the illness but no anatomical correlation with clinical seizure or MRI findings.

Eight patients had their typical convulsive seizure recorded during EEG monitoring, but only 2 (12.5%) with EEG correlation. Of the 6 patients without EEG correlates, 5 manifested clinically as focal facial and limb convulsions, and one as atypical seizure with asymmetric tonic posturing (figure of four), simulating a frontal lobe seizure. The lack of EEG correlation is illustrated by Figure 1 showing a 28 years old man (Case 16) with focal seizures manifesting as eye and head deviation and dystonic left upper limb, where EEG do not show any new changes during the seizure. Interestingly, during the same recording, the patient had 4 episodes of electrographic seizure, up to 3.5 minutes in duration. Four patients (25%) developed electrographic seizure during the EEG recording, 3 during the acute phase of illness and the other 8 months after the onset of illness. Ten patients were diagnosed clinically as status epilepticus (62.5%). Five had EEG monitoring during their status epilepticus, of which only one with EEG correlation (20.0%). Of the 4 patients without EEG correlates, 3 were focal convulsive seizures, and one atypical seizure with asymmetric tonic posturing.

Table 1: Clinical features, treatment and outcome of the study patients

Cases/ gender/ Age/ Ethnic	Neuro-psychiatric symptoms	Abnormal movement	MRI brain	Treatment	Outcome
1. F/ 15 y/ C	Withdrawn, agitation, hand apraxia, emotional lability, echolalia, seizure, autonomic instability	Orofascial dyskinesia, abnormal gait	Normal	IVIG, IV methylprednisolone, oral prednisolone	Substantial
2. F/ 21 y/ C	Tactile, audio and visual hallucination, forgetfulness, agitation, seizure, autonomic instability	Nil	Normal	IV methylprednisolone, oral prednisolone	Full
3. F/ 9 y/ C	Withdrawn, leg apraxia, aphasic, seizure, autonomic instability	Orofascial dyskinesia, upperlimb dystonia-	Normal	IV methylprednisolone, IVIG, thymectomy	Substantial
4. F/ 19 y/ C	Withdrawn, inappropriate laughing, mutism, catatonic, seizure, autonomic instability	Orofascial dyskinesia	Normal	IV methylprednisolone	Full
5. F/ 24 y/ M	Withdrawn, aggressive, psychosis, mutism, seizure, autonomic instability	Orofascial dyskinesia	Normal	IV methylprednisolone, oral prednisolone, plasma exchange	Substantial
6. F/ 24y/C	Withdrawn, aphasic, seizure, autonomic instability	Orofascial dyskinesia	Bilateral mesial temporal sclerosis	IV methylprednisolone, plasma exchange	Substantial
7. M*/ 7y/ M	Withdrawn, aphasic, left hemiparesis, seizure, autonomic instability	Orofascial dyskinesia	R hemisphere T2 hyperintensities	IV methylprednisolone, IVIG	Substantial
8. M*/ 29 y/ M	Withdrawn, aggressive behavior, psychosis, seizure, autonomic instability	Orofascial dyskinesia	Normal	IV methylprednisolone, oral prednisolone	Full
9. M*/ 22 y/ M	Withdrawn, dysphasic-mutism, seizure, autonomic instability	Orofascial dyskinesia	Normal	IV methylprednisolone, oral prednisolone	Full
10. F/ 16y/ C	Audio and visual hallucination, forgetfulness, withdrawn, dysphasic, seizure, autonomic instability	Nil	Normal	IV methylprednisolone, oral prednisolone	Full
11. M*/ 29 y/ M	Withdrawn, aggressive, psychosis, dysphasic, seizure, autonomic instability	Orofascial dyskinesia, upper limb dystonia	Normal	IV methylprednisolone, oral prednisolone,	Full
12. F/ 24 y/ C	Withdrawn, tactile hallucination, labile emotion, delusion of presecution, seizure, autonomic instability	Nil	Normal[1]	IV methylprednisolone, oral prednisolone, Removal of immature benign ovarian teratoma	Full
13. F/ 28 y/ C	Withdrawn, confusion, seizure, autonomic instability	Nil	Normal	IV methylprednisolone, oral prednisolone	Full
14. F/ 20 y/ C	Withdrawn, audio and visual hallucination, mutism, seizure, autonomic instability	Orofascial dyskinesia, upperlimb dystonia	Normal[1]	IV methylprednisolone, oral prednisolone, Removal of mature benign ovarian teratoma	Full
15. F/ 14 y/ C	Withdrawn, aphasic, seizure, autonomic instability	Orofascial dyskinesia, upper and lower limb dystonia,	Normal	IV methylprednisolone, oral prednisolone	Partial
16. M*/ 28 y/ C	Withdrawn, aphasic, seizure, autonomic instability	Upper and lower limb dystonia	Normal	IV methylprednisolone	Pending

Ovarian teratoma on CT Abdomen; M= Malay, C= Chinese, y= years old, F= Female, M*= Male, IVIG = intravenous immunoglobulin

Table 2: CSF of the study patients with anti-NMDAR encephalitis

WBC (cells/ μL)	Normal Pleocytosis	13/16 (81.2%) 3/16 (18.8%); 8-12 lymphocytes
Protein (g/L)	Normal	16/16 (100%)
Glucose (mmol/L)	Normal	16/16 (100%)

Normal value: WBC 0-5 cells/ μL, protein 0.15-0.45 g/L, glucose 2.5-5.0 mmol/L

Two (12.5%) of the patients with psychiatric disorders presented with abnormal posturing (extra-pyramidal symptom) and involuntary movement (mouth twitching). The EEG did not support an ictal phenomenon. In patients with infective encephalitis, only 1(10%) had epileptiform discharges without clinical correlation.

EEG correlation with clinical progression and response to treatment

Serial EEGs showed that the dominant background frequency improved with improvement in cognitive status. All patients were treated with high dose parenteral steroid, with plasma exchange in 2 patients and IVIG in 3 patients, followed by slow tapering dose of oral prednisolone. Two patients had ovarian teratoma resection. There was significant EEG improvement after treatment,which correlated with the improvement in cognitive function. Nine patients (56. 3%) had complete recovery with normalisation of the EEG abnormalities.

EEG correlation with neuroimaging

Eleven patients had asymmetric background (68.8%), but only 1 had correlation with focal changes in the MRI brain (9.1%).

One patient had bilateral mesial temporal sclerosis and one patient with T2 hyperintensity of the right cerebral cortex on MRI brain, the later correlated with location of the EEG abnormalities. Others have normal brain MRI despite severe cognitive impairment and diffusely abnormal EEG.

DISCUSSION

Anti-NMDAR encephalitis is an immune related encephalitis, due to the circulating NMDAR antibody against the NR1-NR2 heteromers, which is abundant in the prefrontal cortex, amygdale, hypothalamus and hippocampus. The mechanism of inhibition and excitation of these receptors by the same antibody is still unclear.

EEG correlation with clinical presentations

The main finding of this study was the prominent background slowing, which was present as early as psychotic phase. This is the earliest and a reliable abnormal finding that was present in 100% of our series, and thus makes it a useful tool to guide diagnosis and differentiating anti-NMDAR encephalitis from other psychiatric disorders with normal EEG during the initial presentation, such as acute schizophrenia or manic depressive psychosis. EEG abnormality in patients with anti-NMDAR encephalitis was noted in the earlier series of 100 adult patients reported by Dalmau *et al*.[1] and in the pediatric series by Florance *et al*. in 2009[2] (77% and 100% of the cases respectively). However, the usefulness of EEG as an initial assessment tool in anti-NMDAR encephalitis has not been systematically explored. With the progress of the disease, the diagnosis of encephalitis become established, the excessive slow waves seen in anti-NMDAR encephalitis is non-specific, and cannot be used to differentiate from encephalitis of other etiologies. Nevertheless, this study has demonstrated that EEG is a highly sensitive tool in early diagnosis of anti-NMDAR encephalitis, with 100% of the cohort had abnormal EEG during the initial phase, as compared with 12.5% with abnormal MRI brain, and 18.8%% abnormal cerebrospinal fluid examination.. These findings were further supported by the normal EEG findings in 16 patients with psychiatric disorders (schizophrenia, bipolar, MDD) performed during exacerbation of psychotic symptoms. Even though patients with infective encephalitis shared the similar EEG features suggestive of encephalopathy, the CSF findings were supportive of infective origin in all patients.

Table 3: EEG abnormalities in 16 patients with anti-NMDAR encephalitis and their seizure manifestations

Case	Slow BG	Asym-metric BG	Inter ictal spike	Ictal EEG correlation with convulsive seizure	Ictal EEG correlation with atypical seizure	EEG correlation with status epilepticus	Electro graphic seizure	Periodic complex	Seizure manifestation
1.	Yes	Mild	Yes	No	-	-	No	No	Unilateral facial clonic and limb tonic seizure → GTCS, SE
2.	Yes	Marked	No	-	-	-	No	Yes	Sensory aura of "something crawling up the Right leg" followed by ipsilateral tonic clonic seizure
3.	Yes	Mild	No	No	No	No	No	No	Asymmetric tonic seizures, SE
4.	Yes	No	No	-	-	-	No	No	GTC, SE
5.	Yes	Marked	No	No	-	No	No	No	Right facial and limb clonic seizures, SE
6.	Yes	Marked	No	No	-	No	No	No	Left facial and limb clonic seizures, SE
7.	Yes	Marked	No	-	-	-	Yes*	No	Left head deviation and left tonic-clonic seizures
8.	Yes	Mild	No	Yes	-	Yes	No	No	Left head deviation and left tonic-clonic → seizures → GTCS, SE
9.	Yes	Marked	Yes**	-	-	-	No	No	Unilateral head deviation and ipsilateral limb clonic seizures → GTCS, SE
10.	Yes	Mild	No	-	-	-	No	No	Unilateral head deviation and ipsilateral tonic-clonic seizures
11.	Yes	Marked	No	-	-	-	Yes	No	Unilateral head deviation and ipsilateral tonic-clonic seizures → GTCS
12.	Yes	No	No	-	-	-	No	No	GTCS
13.	Yes	No	Yes	Yes	-	-	Yes	Yes	Unilateral head deviation → SE
14.	Yes	Marked	No	-	-	-	No	No	GTCS
15.	Yes	No	No	No	-	No	No	No	Right head deviation and rhythmic right foot tapping, right predominant generalized hypertonia, SE
16.	Yes	No	No	No	-	-	Yes	No	left eye and head deviation and left tonic seizures, SE
Total	**16/16**	**11/16**	**3/16**	**2/8**	**0/1**	**1/5**	**4/16**	**2/16**	

*This patient developed electrographic seizure 8 months after the initial presentation; **This patient had 3Hz spike-and-slow complexes; BG= background ; SE= status epilepticus; GTCS= generalised tonic-clonic seizure

Table 4: EEG findings in control patients with psychiatric disorder

No.	Gender	Race	Age (years)	Indication	EEG
1.	M	Indian	24	Bipolar disorder with positive family history. Presented with irritability and restlessness despite treatment	Normal
2.	F	Malay	49	MDD presented with altered behaviour, hallucination and depressed mood	Normal
3.	F	Malay	43	Schizophrenia with 4 years history of auditory hallucination, commanding in nature. Positive family history of schizophrenia	Normal
4.	M	Chinese	48	MDD presented with depression, agitation and abnormal behaviour.	Normal
5.	M	Chinese	22	Schizophrenia with disorganized behaviour for 4 years. Presented with visual hallucination	Normal
6.	M	Malay	24	Schizophrenia presented with extra pyramidal symptom	Normal
7.	F	Malay	37	Schizophrenia with psychosis (aggressive, hallucination and disorientation) for 1 year.	Normal
8.	M	Malay	26	Schizophrenia with paranoid, elective mutism, preference to use sign language. Positive family history of mental illness.	Normal
9.	M	Chinese	19	Schizophrenia with auditory hallucination since 3 years old	Normal
10.	M	Malay	15	Psychosis progressing to catatonic schizophrenia for 1 year. Positive family history of mental illness	Normal
11.	F	Chinese	62	MDD with psychosis. Presented with mouth twitching for 2 days.	Normal
12.	M	Indian	38	Bipolar disorder. Presented with low mood with suicidal ideation and hallucination	Normal
13.	M	Eurasian	54	Bipolar disorder. Presented with abnormal behavior for 1 year.	Normal
14.	M	Indian	21	Autism with change in behaviour for 6 years.	Normal
15.	F	Malay	38	Schizophrenia with worsening abnormal behaviour	Normal
16.	F	Chinese	44	Schizophrenia presented with mutism	Normal

M=Male, F=Female; MDD=Major depressive disorder

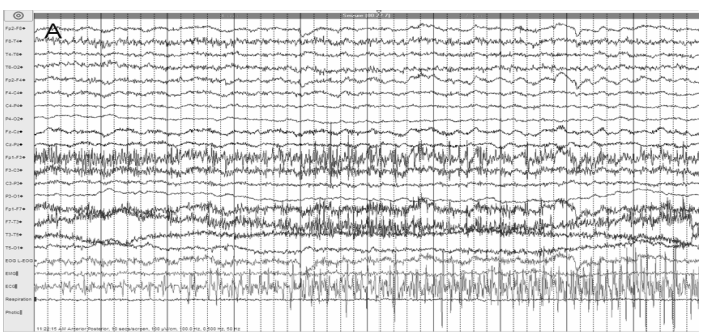
Another important finding of this study was the correlation of EEG with the clinical progression and treatment response. Besides nuclear imaging such as FDG-PET[8,9] and SPECT[7] which may be useful in monitoring clinical progress, but the facilities were not widely available, MRI brain has failed to detect clinical progression and treatment response. In fact, most MRI brain were normal in the early phase[6] and cerebral atrophy was a late presentation.[7] Hence, making EEG a cheap but yet widely available and useful tool to monitor the progress and the response to treatment in patients with anti NMDAR encephalitis.

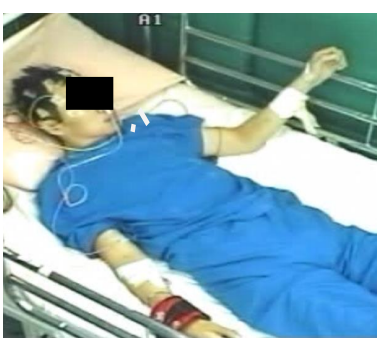
A case report suggested that rhythmic delta activity represents a form of NCSE, which resolved with felbamate but not to immunotherapies or resection of tumour.[13] This is in contrary to our series in which the EEG background slowing, of which some were rhythmic and in delta range, were more correlated with the cognitive state and response to treatment. An attempt was made to look for extreme delta brush, a rhythmic delta

Table 5: EEG findings in patients with infective encephalitis

No.	Gender	Race	Age (years)	CSF WBC	CSF Glucose	CSF Protein	EEG findings
1.	M	Malay	23	60	3.7	1.10	Diffuse polymorphic slow waves
2.	F	Malay	22	486	3.2	1.08	Diffuse polymorphic slow waves
3.	M	Chinese	50	184	2.1	1.60	Diffuse polymorphic slow waves
4.	F	Chinese	69	240	5.2	1.04	Mild focal slowing R temporal region
5.	F	Malay	52	28	8.7	1.67	Frequent burst of generalized polymorphic slow waves
6.	F	Chinese	51	48	4.0	1.23	Diffuse polymorphic slow waves intermixed with frequent sharp/spikes both posterior temporal region
7.	F	Malay	54	222	5.7	1.14	Diffuse polymorphic slow waves
8.	F	Chinese	42	78	2.4	0.84	Diffuse polymorphic slow waves
9.	M	Malay	56	186	6.0	1.24	Diffuse polymorphic slow waves
10.	M	Indian	49	66	2.4	0.84	Asymmetrical diffuse slowing (slower at R fronto-temporal region)

M=Male, F=Female





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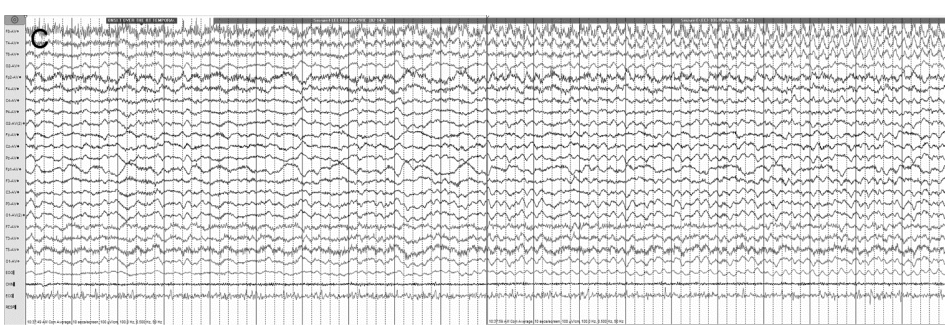

127×40 mm (300 × 300 DPI)

Figure 1. (A) EEG during a focal seizure showed persistent diffuse polymorphic slowing without any epileptiform discharges, while the patient had (B) left eye and head deviation and left upper limb dystonic posturing. (C) EEG during the same recording in average referential montage showed a right anterior temporal electrographic seizure without any clinical correlation.
72×44 mm (300 × 300 DPI)

activity with overriding beta activity as reported by Schmitt *et al.*[11], which was not found in our patients.

EEG correlation with seizure

All 16 patients in our series experienced at least one seizure, of which 10 patients developed status epilepticus and 6 patients had their convulsive seizures recorded during EEG monitoring. However, the EEG correlation with seizures was only seen in 12.5% of patients with seizure, and 16.8% of patients with status epilepticus in our patients. Most of these seizures were focal. The poor clinico-electrographical correlation in seizures occurring in this group of patients suggests that the origin of the seizures is likely in the midline structures such as medial temporal region, with limited spread of the discharges to the cortical surface. It is interesting to note that only 24% of the faciobrachial dystonic seizures in Lgi1 antibody limbic encephalitis had ictal epileptiform activity in EEG. Functional imaging showed basal ganglia and temporal lobe to be abnormal.[14] We did not manage to perform ictal SPECT in any of our patients, which might be able to highlight the area responsible for seizure production.

In conclusion, EEG abnormality has a good correlation with the degree of psychiatric and cognitive dysfunction in patient with anti-NMDAR encephalitis, and is useful in facilitating early diagnosis, monitoring the progress and the response to treatment. However, it has poor correlation with clinical seizures.

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DISCLOSURE

Conflict of interest: None

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