Electroencephalography Findings in Adult Patients with West Nile Virus–Associated Meningitis and Meningoencephalitis

R. Gandelman-Marton,1,3 I. Kimiagar,1,3 A. Itzhaki,1,3 C. Klein,1 J. Theitler,1,3 and J. M. Rabey1,3

Departments of 1Neurology and 2Infectious Diseases, Assaf-Harofeh Medical Center, Zerifin, and 3Sackler School of Medicine, Tel-Aviv University, Tel-Aviv, Israel

Eighteen adult patients with serologically confirmed West Nile virus (WNV)–associated meningitis or meningoencephalitis were admitted to our hospital during the 2000 West Nile fever outbreak in Israel. Thirteen of the patients had a more severe and prolonged clinical course, and an electroencephalogram (EEG) was, therefore, requested. A specific EEG pattern was seen in 8 patients, consisting of generalized slowing, which was more prominent over the anterior regions. Generalized slowing that was prominent over the temporal area was seen in 2 patients, and intermittent slowing over the temporal region was seen in 1 patient. Two patients had normal EEG findings. We suggest that WNV meningoencephalitis should be considered in the differential diagnosis of meningitis or meningoencephalitis with a prolonged clinical course and anteriorly predominant slowing on an EEG.

West Nile fever (WNF) is an acute, self-limited illness caused by mosquito-transmitted West Nile virus (WNV). It presents chiefly with fever, headache, myalgia, arthralgia, fatigue, lymphadenopathy, and rash [1–3]. Meningoencephalitis occurs in ∼0.7% of all cases of WNF, especially among elderly individuals [3].

Review of the literature reveals that few case reports have referred to the electroencephalography (EEG) findings in patients with WNV-associated encephalitis or meningoencephalitis [4, 5]. None of these studies reported any abnormalities that differed from those usually described in patients with aseptic meningitis or encephalitis due to other causes [6, 7]. Furthermore, none identified a specific EEG pattern in patients with CNS involvement associated with WNF. We describe the EEG findings in 13 adult patients with serologically confirmed WNV-associated meningitis and meningoencephalitis. Patients were admitted to our hospital over the course of several months during the 2000 WNF outbreak in Israel.

Methods. EEG findings for hospitalized patients with laboratory evidence of WNV infection and clinical signs of aseptic meningitis or encephalitis were retrospectively reviewed. The diagnosis of aseptic meningitis was based on the following findings: fever, meningeal signs, and abnormal CSF findings [8]. Diagnosis of meningoencephalitis was made for patients who received an initial diagnosis of meningitis, on the basis of the criteria described above, and who developed signs of encephalitis (i.e., altered state of consciousness or signs of cortical dysfunction) during the course of illness.

Serological diagnosis of a recent WNV infection was based on detection of IgM antibodies against WNV in both CSF and serum samples using an IgM capture ELISA [9]. Patients with a probable recent WNV infection (i.e., only WNV IgM antibodies were detected in a single serum sample) were excluded. Patients for whom lumbar puncture was not performed were excluded as well. EEG was performed using 18 electrodes that were placed in accordance with the international 10–20 system and applied using standard techniques.

Results. Nineteen EEGs were performed for 13 patients admitted to our hospital with serologically confirmed WNV-associated meningoencephalitis (7 patients) or meningitis (6 patients). The mean age of patients was 55.5 years (range, 19–86 years), and there were 8 women and 5 men. EEG was performed 4–19 days (mean, 10.4 days) after the onset of clinical symptoms. One patient underwent EEG 3 times during a hospital admission, 4 patients underwent EEG twice, and 8 patients underwent EEG once. Laboratory evidence of a recent WNV infection was present in all 13 patients.

For 8 patients (62%), at least 1 EEG revealed a pattern of generalized slowing, which was more prominent over the frontotemporal areas bilaterally. For 2 patients (15%), EEG revealed generalized slowing predominantly over the temporal region, and, for 1 patient (8%), it revealed intermittent, unilateral, temporal slowing. In 2 patients (15%), all the EEG findings were normal; both of these patients had meningitis. The mean time from onset of symptoms to performance of EEG was 14.3 days for these 2 patients, compared with 9.6 days for patients with abnormal EEG findings.

As presented in table 1, findings for 15 EEGs (79%; 5 [63%]
Table 1. Clinical characteristics of and electroencephalography (EEG) findings for 13 patients with West Nile virus–associated meningitis or meningoencephalitis.

<table>
<thead>
<tr>
<th>Patient, EEG</th>
<th>Age, years/sex</th>
<th>Diagnosis</th>
<th>Presenting signs and symptoms</th>
<th>Signs and symptoms on day EEG was performed</th>
<th>Outcome</th>
<th>EEG finding</th>
<th>Degree of slowing</th>
<th>Time EEG was performed, no. of days</th>
<th>After onset</th>
<th>After hospital admission</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>86/F</td>
<td>Meningoencephalitis</td>
<td>Fever, vomiting, drowsiness</td>
<td>Fever, coma, stiff neck</td>
<td>Died</td>
<td>Generalized slowing, maximal over anterior regions</td>
<td>Severe</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>54/F</td>
<td>Meningoencephalitis</td>
<td>Fever, malaise</td>
<td>Fever, stupor</td>
<td>Died</td>
<td>Generalized slowing, maximal over anterior regions</td>
<td>Moderate-severe</td>
<td>8</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>28/M</td>
<td>Meningoencephalitis</td>
<td>Fever, headache, drowsiness, diarrhea, stiff neck</td>
<td>Fever, headache, stiff neck</td>
<td>Recovered</td>
<td>Generalized slowing, maximal over anterior regions, with side predominance</td>
<td>Moderate</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>...</td>
<td>Meningitis</td>
<td>Fever, headache, photophobia, malaise, stiff neck</td>
<td>Fever, headache, malaise, stiff neck</td>
<td>Recovered</td>
<td>Generalized slowing and predominantly anterior intermittent slowing</td>
<td>Mild</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>19/F</td>
<td>Meningitis</td>
<td>Fever, headache, vomiting, macular eruption, stiff neck</td>
<td>Fever (which improved), headache (which improved), stiff neck</td>
<td>Recovered</td>
<td>Generalized slowing, maximal over anterior regions</td>
<td>Moderate</td>
<td>8</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>...</td>
<td>Meningoencephalitis</td>
<td>Fever, drowsiness, confusion, malaise</td>
<td>Confusion, drowsiness, malaise</td>
<td>Recovered</td>
<td>Generalized slowing, maximal over anterior regions</td>
<td>Mild</td>
<td>17</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>70M</td>
<td>Meningoencephalitis</td>
<td>Fever, drowsiness</td>
<td>Full consciousness</td>
<td>Recovered</td>
<td>Generalized slowing, maximal over anterior regions</td>
<td>Mild</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE.** Mild, 7–8.5 Hz; moderate, 4.5–6.5 Hz; severe, 2–4 Hz.
of 8 recordings for patients with meningitis and 10 [91%] of 11 recordings for patients with meningoencephalitis) were abnormal. Twelve (80%) of the 15 abnormal EEGs showed continuous, generalized slowing, which was more prominent over the anterior regions (figure 1). In 3 of these EEGs, there was a side predominance. In 2 of the recordings, there was moderate, intermittent, generalized slowing, which occurred predominantly over the anterior regions, in addition to mild, generalized, continuous slowing. Two EEGs showed mild, continuous, generalized slowing, which was more prominent over the right temporal region. One recording showed mild, intermittent slowing over the left temporal region. Findings for 4 EEGs (21%) were normal. No epileptiform discharges were present in any of the EEGs.

Discussion. WNF outbreaks in different parts of the world have been reported with increasing frequency in the past few years. However, these studies have mainly presented epidemiological and clinical data [9–17]. Only a small number of clinical studies and single case reports describe the EEG findings for patients with WNV-associated meningitis or encephalitis.

Nisenbaum and Wallis [4] reported the EEG findings for 2 children with WNV-associated meningoencephalitis. EEG revealed generalized slowing that was more prominent on the left in a 6-year-old child, and it revealed generalized slowing with repetitive poly-spikes in the right precentral and parietal regions in a 5-year-old child. Chowers et al. [5] reported the clinical characteristics of patients with WNF during the 2000 outbreak in Israel and briefly mentioned that the findings of EEGs, which were performed for 43 of 325 hospitalized patients with WNF, were consistent with encephalitis in 34 (79%).

A generalized background slowing on the EEG is generally nonspecific. It is seen in encephalopathies of various etiologies, including metabolic, hypoxic, endocrinologic, degenerative, and inflammatory encephalopathies [7]. Prominence of generalized slowing over the anterior regions has been reported to occur during the early stages of Creutzfeldt-Jakob disease (CJD), herpes simplex encephalitis, and syphilis involving the CNS. This EEG abnormality, however, is only a transient finding in the course of the unfolding EEG pathology in these 3 infectious diseases [6–7, 18–23]. In addition, generalized slowing or slowing confined to the anterior regions has been reported in patients with herpes zoster or herpes zoster–associated encephalitis [24]. A somewhat similar EEG pattern of diffuse irregular slowing, maximal frontally, may be seen in severe cases of adrenal insufficiency. However, additional findings can be seen in the EEGs for these patients [7].

The EEG for patients with CNS infections may reveal variable abnormalities consisting of generalized slowing [6, 24–36], focal slowing [6, 25, 26, 29–30, 33, 34, 36], and epileptiform dis-
charges [6, 26, 28, 31–33, 36]. Periodic complexes of symmetrical and synchronous high-voltage δ waves are typical of CJD and subacute sclerosing panencephalitis [23, 37].

Coxsackie virus, echovirus, and bacterial meningitis and tick-borne, Japanese, and St. Louis encephalitis are the CNS infections most clinically similar to WNV-associated meningitis. However, the EEG findings for these diseases are different from the pattern described in 8 of our patients. The pattern in our patients consisted of regional prominence, which has not been reported for coxackie virus and echovirus meningitis [6, 7]. The regional prominence, which consists of slower background activity, was continuous in all 8 patients. However, the frontal prominence reported in Japanese encephalitis is due to higher amplitude and not to slower activity [30], and the severe slowing that may occur over the frontal areas in patients with bacterial meningitis or viral encephalitis is intermittent [6, 7, 29–32, 34]. In addition, epileptiform discharges, which were described in the EEGs of patients with St. Louis encephalitis, were not present in the EEGs of our patients [32].

The relatively large number of EEG requisitions in our patients may seem clinically unjustified. However, in contrast to our usual patients with seasonal aseptic meningitis, patients with WNV-associated meningoencephalitis and, especially, meningitis seemed to have a more severe and prolonged clinical course [38].

Most of the abnormal EEG findings in this study involved a certain pattern of generalized, continuous slowing, which was more prominent in the anterior (frontal and temporal) regions and, at times, had a side predominance. The existence of this pattern and the degree of slowing seemed to reflect the severity of the illness. It is unclear whether it has any relation to time pattern and the degree of slowing seemed to reflect the severity and, at times, had a side predominance. The existence of this a certain pattern of generalized, continuous slowing, which was reported in Japanese encephalitis is due to higher amplitude prominence, which consists of slower background activity, was described in 8 of our patients. The pattern in our patients consisted of regional prominence, which has not been reported for coxackie virus and echovirus meningitis [6, 7]. The regional prominence, which consists of slower background activity, was continuous in all 8 patients. However, the frontal prominence reported in Japanese encephalitis is due to higher amplitude and not to slower activity [30], and the severe slowing that may occur over the frontal areas in patients with bacterial meningitis or viral encephalitis is intermittent [6, 7, 29–32, 34]. In addition, epileptiform discharges, which were described in the EEGs of patients with St. Louis encephalitis, were not present in the EEGs of our patients [32].

The relatively large number of EEG requisitions in our patients may seem clinically unjustified. However, in contrast to our usual patients with seasonal aseptic meningitis, patients with WNV-associated meningoencephalitis and, especially, meningitis seemed to have a more severe and prolonged clinical course [38].

Most of the abnormal EEG findings in this study involved a certain pattern of generalized, continuous slowing, which was more prominent in the anterior (frontal and temporal) regions and, at times, had a side predominance. The existence of this pattern and the degree of slowing seemed to reflect the severity of the illness. It is unclear whether it has any relation to time pattern and the degree of slowing seemed to reflect the severity and, at times, had a side predominance. The existence of this

**References**