Clinical Commentary

EEG with triphasic waves in Borrelia burgdorferi meningoencephalitis


We describe a case of encephalopathy in which the clinical picture and triphasic waves in the EEG indicated a metabolic cause. However, the illness was caused by neuroborreliosis. The occurrence of triphasic waves in the EEG is a strong evidence of metabolic encephalopathy, but triphasic waves are not specific for metabolic encephalopathy. Triphasic waves have been described in a number of non-metabolic encephalopathies and structural brain lesions. To our knowledge, this is the first report of triphasic waves in Borrelia burgdorferi meningoencephalitis.

Triphasic waves in the EEG are strongly associated to metabolic encephalopathies of various types, especially hepatic encephalopathy, but they are not entirely specific. Triphasic waves have been described in a variety of non-metabolic encephalopathies and structural brain lesions (1–3). Here, we present a case of Borrelia burgdorferi meningoencephalitis with triphasic waves in the EEG.

A case report

A 72-year-old woman with hypertension, a mild diabetes mellitus without medication, hypothyroidism, pain in both shoulders and a right total hip replacement due to coxarthrosis, came to the clinic of neurology for a sudden weakness of her left arm and hand. At examination, she had a slight paresis in the left arm and hand but no other neurological deficits. The pain in the left shoulder made the neurological evaluation somewhat difficult. Computed tomography of the brain showed no cerebral infarction but leuко arthritis. The sylvian fissures were bilaterally a bit wider than normal. A carotid duplex was normal. ECG: sinus rhythm, inferiorly a probable pathological q-wave suggesting an earlier cardiac infarction. The condition was interpreted as cerebral infarction, probably of lacunar type. After 5 days, the patient could be discharged with aspirin 160 mg daily as prophylaxis, enhanced antihypertensive medication and oxazepam 5 mg when necessary against anxiety. She was also referred to polyclinic rehabilitation.

After only one day, the patient returned to the emergency care unit with fatigue, anxiety and malaise and was admitted to a neurology ward for observation (day 1). A slight paresis remained in the left arm.

On the following day, the patient developed stupor. Her speech was limited to a few words and she fell asleep immediately after stimulation. There was suspicion of oxazepam intoxication, but the antidote flumazenil had no effect.

A new computed tomography of the brain showed no difference compared with the preceding investigation.

Electroencephalogram on day 3 revealed generalized slowing, frontal bilateral triphasic waves, a background of delta–theta waves, and no epileptiform activity (Fig. 1).

There were no signs of metabolic dysfunction, neither hepatic nor azotemic. Blood ammonium, blood glucose and electrolytes were all within normal range.

The patient recovered slowly during the following days. A slight confusion and disorientation
remained. A new EEG on day 5 showed a marked improvement. There were no triphasic waves, improved background activity but still a generalized slowing around 7 Hz, and no epileptiform activity (Fig. 2). MRI of the brain with diffusion-weighted images showed no lesions but there was an enlargement of the ventricles suggesting a normal pressure hydrocephalus. (On request, the patient complained of a very mild memory disturbance for some years but she had no other symptoms or signs of dementia or normal pressure hydrocephalus. Later a tap test and an infusion test according to Katzmann turned out normal.)

On day 6, liquor examination revealed a mononuclear pleocytosis with 300 lymphocytes per mm$^3$, no polymorphs, a highly elevated protein concentration (1.78 g/l), elevated IgG index and oligoclonal bands as signs of breakdown of the blood–brain barrier and intrathecal synthesis of immunoglobulins.

The liquor findings primarily aroused suspicion of neuroborreliosis. The patient was treated with oral doxycycline and recovered promptly. She was also treated with acyclovir for possible herpes encephalitis, but herpes simplex PCR in liquor was negative and acyclovir was withdrawn.

A week later the patient was discharged from the hospital in good health. Serology for Borrelia burgdorferi in serum and liquor confirmed the diagnosis neuroborreliosis. Serology for tick-borne encephalitis was negative. Direct microscopy for acid-fast bacilli and CSF culture showed no signs of tuberculosis.

The patient had no history of tick bite or erythema chronicum migrans, but during the summer she had often been in a tick infested area.

**Discussion**

In 1950, Foley, Watson and Adams described bilateral synchronous slow activity with frontal dominance in EEG in hepatic coma, ‘blunt spike and wave’ (4). The term triphasic waves was introduced in 1955 by Bickford and Butt in a study which only concerned patients with hepatic disease. Triphasic waves were defined as waves with three phases, a dominant positive turn of the scale, with a slow negative turn before and after the positive wave. The triphasic waves occurred synchronously and bilaterally with frontal dominance, sometimes only frontally, sometimes over the whole cortical surface, with latency, ‘anterior–posterior lag’. The presence of triphasic waves could be linked to the patient’s degree of unresponsiveness to external stimulation. Triphasic waves dominated in stupor (‘semicoma’), when patient could be awakened only by strong stimuli, theta waves dominated in slight confusion, and delta waves dominated in coma. In a control group of patients with liver disease without encephalopathy normal alpha rhythm was recorded (5).
Bickford and Butt’s description of triphasic wave morphology is still valid with small modifications. The second positive phase is usually dominant in amplitude. Sometimes the first negative phase or the third negative phase can be dominant together with the second phase. Occasionally, the first phase is preceded by a low-amplitude positive wave (‘wave 0’). Just like the anterior–posterior lag, a posterior–anterior lag can be seen (6).

Bickford and Butt proposed the mechanism behind the triphasic waves to be either a travelling wave of positivity along the cortex or a subcortical disturbance at thalamocortical level (5). The pathogenesis of the triphasic waves is still unknown.

Bickford and Butt concluded that triphasic waves probably were specific for hepatic encephalopathy (5). Later triphasic waves have been described in a number of other metabolic and toxic encephalopathies, e.g. uremia, hypernatremia, hyponatremia, hyperglycemia, hypoglycemia, hyperthyroidism, hypothyroidism, side effects of drugs and anoxic encephalopathy (2) but also structural lesions like stroke, dementia, tumors and carcinomatosis (3). In non-metabolic conditions, the triphasic waves can also be seen in alert patients (3, 6).

Among inflammatory and infectious encephalopathies, the occurrence of triphasic waves in the diffuse encephalopathy of sepsis is well known (7). There are also single case reports of triphasic waves in Mollaret’s meningitis (8), i.e. recurrent episodes of aseptic meningitis, now attributed to herpes simplex infection, and carcinomatous meningitis (9).

However, triphasic waves according to Bickford and Butt’s definition are still considered to be highly specific for metabolic encephalopathy, with hepatic encephalopathy as the most common cause (1). No morphologic characteristics of the triphasic waves or their background activity can reliably distinguish between different metabolic-toxic causes of the triphasic waves (10) nor between metabolic or non-metabolic causes (6).

Epileptiform discharges in non-convulsive status epilepticus (generalized non-convulsive status epilepticus, also known as absence status epilepticus, and partial non-convulsive status epilepticus) can resemble triphasic waves. Generalized epileptic activity is and partial epileptic activity can be bilateral and synchronous with frontal predominance but never has the triphasic anterior–posterior (or posterior–anterior) lag. The amplitude predominance of phase II is not seen. Phase I duration of epileptic activity is shorter than phase I duration of triphasic waves, i.e. more spike than sharp transient. Epileptic activity can have extra spikes which triphasic waves never have (11).

Meningoencephalitis is a well-known but rather rare manifestation of acute neuroborreliosis. Encephalitic signs can be reduced alertness and focal neurologic deficits like hemiparesis, ataxia and cranial nerve deficits. The meningoencephalitis

Figure 2. Day 5. The patient is fully awake but slightly confused and disoriented. EEG shows marked improvement. Continuous theta activity around 7 Hz. No triphasic wave complexes. Bipolar montage.
is often combined with radiculitis or myelitis. The patient is often afebrile (12, 13).

The stuporous patient’s EEG clearly showed triphasic waves. There were frontal triphasic waves with phase I as a sharp transient and a predominant phase II, giving no indication of the differential diagnosis partial generalized status epilepticus.

The clinical picture which primarily aroused suspicion of metabolic encephalopathy was also well compatible with a Borrelia burgdorferi meningoencephalitis. The patient had a short duration of symptoms and the MRI gave no indication of cerebrovascular neuroborreliosis which is usually seen in late stages of neuroborreliosis. The first manifestation of the illness, paresis of the left arm, could possibly have been a radiculitis, although the pain in the left shoulder was not new.

Our case is a further confirmation that triphasic waves are not entirely specific for metabolic encephalopathy. To our knowledge this is the first report of triphasic waves in Borrelia burgdorferi meningoencephalitis.

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References