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Peripheral Neuromotor Status in Convalescents after Tick-Borne Encephalitis

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Complex electromyographic examinations of 57 patients with different forms of tick-borne encephalitis were carried out during acute and delayed periods. Abnormalities of the peripheral neuromotor system were detected in patients with all forms of the disease; the most characteristic were pronounced electrogenesis disorders in the proximal part of motor nerve axons, particularly in the upper limbs, and of the spinal anterior horn motoneurons at the level of the cervical intumescence.

Key Words: *tick-borne encephalitis; peripheral neuromotor system; electromyography*

Tick-borne encephalitis (TBE) is a prevalent natural focal viral infection [5], and the problem of its diagnosis and treatment is becoming more and more pressing [2].

Two routes of TBE infection are known: transmissive (tick bite) and alimentary (drinking raw milk) [1,6]. The pathogenesis of TBE consists of two phases of infectious process: visceral and neural [8]. Propagating in the body via the blood, lymph, and neural routes, the virus infects blood cells, immune organs, other viscera, and reaches the nervous system, which serves as the place of its long multiplication and the main center of location. Three forms of TBE are distinguished: febrile, meningeal, and focal [11].

We studied electrophysiological characteristics of the peripheral nervous system in patients with various clinical forms of TBE.

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MATERIALS AND METHODS

Results of EMG studies in TBE patients treated at Neurology Department of Republican Hospital (Petrozavodsk) were analyzed. Fifty-seven patients (40 men and 17 women) aged 15-73 years (mean age 41.0±2.4 years) were examined: 46 (80.7%) with transmissive infection and 8 (14%) with alimentary infection. Three patients did not remember the fact of tick sucking, but visited the forest zone repeatedly.

The diagnosis of TBE was made on the basis of detailed clinical and epidemiological history. Specific IgM and IgG to TBE viruses in patient sera were tested by IFA (Vector-Best) for etiological verification of the diagnosis. Febrile clinical form was detected in 12 (21%) patients, meningeal in 15 (26%), and focal in 30 (53%). The studies were carried out during the acute and delayed (1-5 years) periods.

A complex of EMG methods was used for evaluation of the peripheral neuromotor system. The conduction function of various segments of the peripheral nerve motor and sensory axons was studied by stimulation EMG and organization of the skeletal muscle motor units by needle EMG (con-

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centric needle electrodes). A total of 267 motor nerves and 121 sensory nerve and 88 muscles were examined. The studies were carried out on a Nicolet Bravo electromyographer. The data were compared with the parameters in the control group (25 healthy volunteers of the same age).

The data were statistically processed using Student's *t* test (for parametric distribution of the data) and Mann—Whitney test (for nonparametric distribution). Published data [3,7,10] served as the standard parameters.

RESULTS

Injuries to the motor nerve axons of different severity were detected by EMG studies in 65% (37) patients. They manifested primarily in reduced amplitude of M-response, reduced rate of excitation propagation (particularly in the proximal segments of the upper limb nerves), and reduced proximal/distal coefficient. The most pronounced changes were detected in the accessory and subclavian nerve axons and in the median and ulnar nerve axons ($p<0.01$). These changes were detected in 50% patients with febrile TBE, 47% patients with meningeal, and 89% of patients with focal forms.

Changes in the parameters of action potentials detected in studies of sensitive fibers of the upper and lower limb nerves, were significant only in patients with focal form and concerned mainly the amplitude.

Study of the F-wave patterns in supramaximum stimulation of the median, ulnar, fibular and tibial nerves showed that the minimum latency of F-wave virtually did not differ from that in the control group, while the maximum latency was significantly higher in all clinical forms of TBE than in the controls ($p<0.01$). The most significant changes were detected in the upper limb peripheral nerves. Slight chronodispersion was observed in the control group, while in half of TBE patients it was sharply increased.

Increased maximum latency of F-waves and chronodispersion were more often observed at early stages of the disease. This suggests that the peripheral nerve axons, particularly their proximal segments, are unevenly involved in the pathological process. Due to this, the involvement of the peripheral neuromotor system can be diagnosed during the subclinical stage.

Study of the motor unit potentials (MUP) in the skeletal muscles and spontaneous activity of muscle fibers (fibrillation potentials, positive acute waves, indicating denervation in the muscle) detected signs of denervation/reinnervation process in 29 (80%) patients. These signs manifested in the appearance of fibrillation potentials and positive acute waves, and in some patients, decreased parameters

TABLE 1. Mean Parameters of MUP in the Muscles of TBE Patients

Parameter	Normal value	TBE form		
		febrile	meningeal	focal
Musculus deltoideus				
Mean duration, msec	9-11	11.2±1.0	11.6±0.4	13.2±2.1**
Mean amplitude, μV	400-500	553.5±73.3	592.8±53.3*	859.0±580.9*
Maximum amplitude, μV	1000-1200	1249.0±370.9	1323.8±343.2	2265.2±1802.8**
Short extensor of the thumb				
Mean duration, msec	8.5-10.0	10.0±0.8	10.7±1.3	13.2±2.6**
Mean amplitude, μV	500-700	571.7±191.9	567.7±68.8	1118.0±544.9*
Maximum amplitude, μV	1000-1200	947.0±299.0	968.3±250.2	2986.0±1901.3*
Lateral femoral muscle				
Mean duration, msec	10-12	12.3±1.7	—	13.0±3.9*
Mean amplitude, μV	500-600	661.5±276.0	—	795.0±442.7**
Maximum amplitude, μV	1000-1300	1199.3±356.0	—	2090.0±1789.6*
Anterior tibial muscle				
Mean duration, msec	9.0-11.5	12.8	12.8±0.6	12.7±3.4*
Mean amplitude, μV	500-700	610.0	722.0±127.3	738.4±290.3
Maximum amplitude, μV	1000-1500	1640.0	1345.3±686.3	1577.5±601.3*

Note. *$p<0.05$, **$p<0.01$ compared to normal.

of some MUP were detected during the acute period of the disease, which indicated shrinkage of motor units, caused by the decrease in the number of muscle fibers as a result of denervation. Spontaneous activity of motor units, fasciculation potentials indicating involvement of the spinal motoneurons into the pathological process, were detected in 23 (64%) patients with pronounced reinnervation.

Our data indicate that signs of muscle fiber denervation were present in all patients with focal TBE, the denervation/reinnervation process in these patients being more pronounced than in patients with febrile and meningeal TBE (Table 1).

Signs of reinnervation manifesting in the increase in MUP parameters (amplitude and duration) appeared with the development of the pathological process and triggering of the compensatory mechanisms. MUP parameters gradually increased and after 2-3 years several-fold surpassed the normal values. Then the reserve potentials of motoneurons were exhausted and compensatory innervation failed, this failure manifested in gradual reduction of MUP parameters, which acquired a different shape: the MUP peaks were smoothed and the time of potential increase was prolonged (potentials of motor unit in the course of their destruction). This process was in all cases paralleled by increasing manifestations of fibrillation potentials and positive acute waves (EMG signs of denervation). If the disease outcome was unfavorable, the process in most damaged muscles eventuated in motor unit death and replacement of the muscle by the connective tissue, and no MUP could be recorded any more. Clinically it manifested by coarse pareses or paralyses of the muscles and their degeneration.

The so-called giant MUP predominated during the delayed period, indicating a history of reinnervation processes, observed in involved and clinically intact muscles. Signs of reinnervation were most pronounced in patients with the focal form, particularly in the upper limb muscles. The analysis of EMG picture in these patients was particularly interesting, because the involvement of the peripheral neuromotor system was diagnosed in all examined patients. Moreover, the process characteristic of the spinal motoneuron involvement was observed in 14 (70%) patients of this group: involvement of cervical intumescence motoneurons in 10 (71%) and of cervical and lumbar intumescence neurons in 4 (29%) patients.

The maximum MUP amplitude reflecting the degree of reinnervation in the muscle was increased in all upper limb muscles and in proximal muscle of the lower limbs, in some patients also in distal muscles of the lower limb.

Hence, electrophysiological studies showed that in addition to the CNS, spinal motoneurons, spinal radices, and peripheral nerves can be involved in the pathological process. The tropism of TBE virus to cells of the anterior spinal horn of the cervical intumescence and to nerve cells of the upper limbs was detected. This hypothesis is also confirmed by the fact that our observations revealed no relationship between the site of tick bite and location of the most pronounced changes in the nervous system.

Alimentary infection most often led to the development of focal TBE with severe course. All patients with alimentary infection developed focal TBE with meningoencephalitis in 3 cases and with multilevel involvement of the nervous system in 5, their EMG picture exhibiting more pronounced MUP changes than in patients with transmissive infection. This contradicts the opinion on a more benign course of the disease in alimentary infection [9]. Further studies on more patients are needed for final conclusions.

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