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Original article

Paretic complications of tick-borne encephalitis and Lyme neuroborreliosis in the Czech Republic: Characteristics and clinical outcome

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ABSTRACT

Tick-borne encephalitis (TBE) and Lyme neuroborreliosis (LNB), the most common tick-borne diseases of the central nervous system in Central Europe, are frequently associated with pareses. The aim of this study was to characterise paretic complications in patients with TBE and LNB, including their severity, persistence and impact on the patients' quality of life. Our retrospective observational study included patients with aseptic CNS infection due to TBE virus or *Borrelia burgdorferi* sensu lato. Paretic complications were evaluated in the acute phase and the patients were followed up until complete regression or long-term stabilisation of any neurological deficit. The severity of the neurological deficit was graded according to the modified Rankin Scale (mRS).

A total of 823 patients (582 with TBE, 241 with LNB) was included. Paretic complications were diagnosed in 63 TBE patients (10.8 %) and in 147 LNB patients (61.0 %). In TBE, the most common neurological deficit was brachial plexus paresis in 21 patients (33 %) and bulbar symptoms in 18 patients (29 %). In LNB patients, facial nerve palsy was the most frequent neurological deficit (117patients; 79.6 %), followed by lower limb paresis in 23 patients (15.6 %). Forty-nine TBE patients and 134 LNB paretic patients completed follow-up. Paresis resolved within 3 weeks in 16 TBE patients (33 %) and 53 LNB patients (39.5 %), but the proportion of patients with paresis persisting for more than 12 months was significantly higher in TBE (34.7 vs. 3.7 %, $p < 0.001$). The mean mRS was significantly higher in TBE paretic patients compared to LNB ($p < 0.001$).

Paretic complications are significantly more common in LNB than in TBE but pareses associated with TBE last longer than in LNB and considerably reduce the quality of life of patients. Prevention remains the only way to influence the long-term motor deficits of TBE.

1. Introduction

Tick-borne encephalitis (TBE) virus and *Borrelia burgdorferi* s.l. are the most common causative agents of central nervous system (CNS) inflammation transmitted by ticks in Central Europe. Both have medical and economic impacts and pose a risk to local populations and travellers. The incidence of TBE in the Czech Republic is one of the highest in Europe, oscillating between 3.4 and 8.1/100,000 inhabitants in the last decade. The incidence of Lyme borreliosis is 27.6–46.1/100,000, and Lyme neuroborreliosis (LNB) accounts for about a quarter of the reported cases (Kříž et al., 2017). The two agents have the same vector (*Ixodes ricinus*), but in the case of TBE, alimentary infection, though rare, may also occur (Lickova et al., 2021). Due to the ability to affect the central and peripheral nervous system, both diseases can cause paresis which may result in long-term or permanent impairment of the quality of life. In the Czech Republic, acute flaccid paresis (AFP) surveillance is carried out in children up to 15 years of age according to the recommendations of the World Health Organization (WHO) as a critical component of the global polio eradication campaign. Paretic complications of other neurotropic infections and in other age groups are not reported to the central registry.

In TBE, paretic complications occur with brain or spinal cord involvement, i.e., encephalitis and myelitis (Kohlmaier et al., 2021). Neuronal damage occurs due to either perivascular inflammation and subsequent oedema, or direct destruction of spinal anterior horn neurons (myelitis) with subsequent gliosis (Gelpi et al., 2006; Love and Wiley, 2002). In the first mechanism, the paresis is usually transient and resolves early with resolution of cerebral oedema in the acute phase of the disease. However, direct destruction of motor neurons causes permanent flaccid paralysis of the neck, upper or lower limb muscles and,

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rarely, respiratory muscles (Dobler et al., 2019). Histopathological changes in the spinal cord are difficult to distinguish from poliomyelitis (Günther et al., 1997). The most serious is damage to the brainstem, particularly the medulla oblongata, resulting in impaired function of the lower cranial nerves IX, X, XI, XII (bulbar symptoms). These patients usually require ventilatory support because of the high risk of respiratory failure or aspiration. Pareses in the acute stage of TBE are reported in 4.5–17.6 % of patients (Günther et al., 1997; Haglund et al., 1996; Kohlmaier et al., 2021; Smíšková et al., 2010).

The mechanism of neural tissue damage in LNB is not yet fully elucidated. It may be due to direct cytotoxicity caused by borreliae adhering to nerve or glial cells but also to indirect effects of the activation of glial cells resulting in the production and release of neurotoxic cytokines such as tumour necrosis factor alpha (TNF-α) and interleukin 6 (IL-6) (Ramesh et al., 2015; Rupprecht et al., 2008). Cross-reactive antibodies against neural tissue antigens have also been considered (Fallon et al., 2010; Rupprecht et al., 2008). The cranial nerves are most commonly affected, especially the facial nerve, but also the ocular motor nerves (abducens, oculomotor and trochlear), and less commonly the trigeminal, hypoglossal and vestibulocochlear nerves. (Knudtzen et al., 2017). A typical manifestation of early neuroborreliosis in Europe is Garin-Bujadoux-Bannwarth syndrome, abbreviated to Bannwarth syndrome (BS), a painful radiculitis, with lymphocytic meningitis and with or without cranial or peripheral neuritis (Ogrinc et al., 2016; Oschmann et al., 1998; Stanek et al., 2012; Steere, 2010). The patients present with severe dermatomal pain with sensory, motor and reflex changes of the involved dermatome, occasionally with paresis of the affected limb (Halperin, 2011a). The prognosis of adequately treated BS is good; however, long-term motor deficits do occur (Ogrinc et al., 2016). In contrast to TBE, other forms of CNS involvement such as encephalitis, encephalomyelitis or bulbar symptoms are extremely rare (Baumann et al., 2009; Halperin, 2017; Hildenbrand et al., 2009; Knudtzen et al., 2017; Meurs et al., 2004). Paretic manifestations are reported in half to two thirds of LNB patients (Knudtzen et al., 2017; Ogrinc et al., 2016; Schwenkenbecher et al., 2017).

The aim of this study was to find out and compare the frequency, type, and severity of paretic complications in patients with TBE and LNB, as well as their duration and impact on patients' independence and ability to perform everyday activities.

2. Materials and methods

A retrospective observational study was carried out at the Department of Infectious Diseases at the University Hospital Bulovka in Prague from January 2007 to December 2017. Patients of all age groups except neonates are treated in this tertiary care centre.

The study group included patients with aseptic CNS infection caused by the European subtype of TBE virus or *B. burgdorferi* s.l. Aseptic CNS infection was defined as clinical symptoms of CNS disease and aseptic inflammatory CSF pattern with pleocytosis ($>5 \times 10^6$ leukocytes/L). leukocytes/μL. TBE was confirmed by presence of IgM and IgG specific antibodies or CSF IgM in previously vaccinated patients. Capture ELISA, EIA TBEV IgM and IgG kits (Test Line Brno, Czech Republic) were used. No other flaviviruses were confirmed to be endemic in the Czech Republic during the study period, and none of the patients reported recent residence in areas endemic for WNF, dengue, or other flaviviruses. Therefore, the likelihood of cross-serological reactions was very low. Lyme neuroborreliosis was confirmed by the detection of intrathecal synthesis of borrelia specific antibodies. Borrelia burgdorferi s.l.- specific antibodies were routinely detected with a commercial kit EIA *Borrelia afzelii* IgM/IgG, EIA *Borrelia garinii* IgM/IgG (Test Line Brno, Czech Republic), and confirmed by Western blot (Biowestern Diagnostika Praha, Czech Republic). Our serological tests did not include antibodies against B. miyamotoi, which is also transmitted by Ixodes ricinus. Appropriate diagnostic kits were not available in the Czech Republic during the study period. The specific antibody index (AI Bb) was determined by the method of Reiber and Lang (1991), modified by Kaiser and Lucking (1993). In two cases, the diagnosis was based on the detection of borrelia DNA in the CSF. The QI-Aamp DNA Mini Kit (QIAGEN GmbH, Germany) was used for DNA isolation.

Patients with TBE were given appropriate symptomatic and supportive therapy. Patients with confirmed LNB were treated with intravenous ceftriaxone for 21 days.

Demographic data, type, frequency, and persistence of paretic complications were recorded. After discharge, patients with paresis were followed up: the first follow-up at 2–4 weeks post discharge, second at 3–6 months, third and subsequent according to the clinical status every 3–6 months, until complete regression or long-term stabilization of the neurological deficit. Clinical examination focused on signs of motoric involvement (central paresis or cranial and spinal nerve paralysis). In retrospect, patients were classified into four groups: persistence of paresis up to three weeks, three weeks to three months, 3–12 months and longer than 12 months. Inaccurate or incomplete data were completed by telephone consultation with the patient, family member or GP. Severity of neurological deficit was graded according to the modified Rankin Scale (mRS), an established clinical score to classify the grade of neurological disability and the patient́s ability to perform daily activities (Table 1) (Bruno et al., 2010). Classification of the mRS was performed at the end of each follow-up interval, i.e., at 3 weeks, 3 and 12 months, however, in patients with persistent mRS ≥ 2 at 12 months an mRS score was also determined at 24 months.

2.1. Statistical analysis

Continuous data are characterized by medians, arithmetic means and standard deviations (SD). A two-sample *t*-test was used to test for differences in means between groups. Category data are presented as counts and percentages. The differences in proportions amongst groups were analysed using Fisher's exact test and its generalization. All statistical tests were evaluated at a significance level of 0.05. Statistical analysis was performed with Stata statistical software, release 14.2 (StataCorp LP, College Station, TX, U.S.A.).

3. Results

A total of 823 patients was included, 582 with TBE and 241 with LNB. The demographic data of all patients and separately of those with pareses are shown in Table 2. All LNB paretic patients except two (145) had paresis on the day of admission, in two of them facial nerve involvement appeared on day 2 and day 5 of their hospital stay. In the TBE group, 34 patients had paresis on the day of admission, 27 patients developed paresis during their hospitalisation and one patient two days after discharge. Four patients were previously vaccinated against TBE; one had been fully vaccinated, and three patients had received only one dose administered less than four weeks before the onset of symptoms.

Table 1
Modified Rankin Scale: a clinical score to classify the grade of neurological disability and patient́s ability to perform daily activities.

Score	Symptoms
0	No symptoms
1	No significant disability. Able to carry out all usual activities, despite some symptoms.
2	Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities.
3	Moderate disability. Requires some help, but able to walk unassisted.
4	Moderately severe disability. Unable to attend to own bodily needs without assistance, and unable to walk unassisted.
5	Severe disability. Requires constant nursing care and attention, bedridden, incontinent.
6	Dead

Table 2
Demographic data of patients with tick-borne encephalitis and Lyme neuroborreliosis.

Characteristics	TBE total	TBE with paresis	LNB total	LNB with paresis
No of patients, n (%)	582	63 (10.8)	241	147 (61.0)
Men, n (%)	342 (58.9)	41 (65.0)	149 (61.8)	94 (63.9)
Children, n (%)	49 (8.5)	0 (0)	49 (20.3)	33 (22.5)
Age, mean ± SD	44.3 ± 18.3	53.9 ± 16.4	44.2 ± 23.6	42.9 ± 23.8
Age range; median	2–87; 44	22–87; 60	22–78; 49	3–86; 44
Deaths, n (%)	7 (1.2)	7 (11.1)	0 (0)	0 (0)

3.1. Pareses in tick-borne encephalitis patients

Pareses were diagnosed in 63 (10.8 %) patients, with 41 males (65 %), and no children. The gender difference was not statistically significant (Fisher's exact test =0.343). Paretic patients were significantly older than those without paresis (mean age 53.9 vs 43.2 years; $p < 0.001$). The highest rate of pareses was observed in the age groups 70–79, 60–69 and 30–39 years (23 %, 20 % and 10 %, respectively) (Fig. 1).

Overall, in the acute stage of disease the brachial plexus paresis in 21 patients (33 % of paretic cases) was the most frequent, bilateral in eight cases. Six patients with brachial plexus paresis had bulbar symptoms at the same time. Pareses of lower extremities in seven patients were less common (11 %); all but one had bilateral involvement. Thirteen patients (21 %) suffered from quadriparesis, four of them had also bulbar symptoms. Altogether, we observed bulbar symptoms in 18 patients (29 %), eleven of them progressed to respiratory distress and the need for ventilatory support. Involvement of cranial nerves III, IV, VI and VII occurred in 16 patients, five of whom had concomitant bulbar involvement or limb paresis (Table 3). Hemiparesis was observed in three patients, transient in two of them. All seven patients who died had pareses: six had quadriparesis with bulbar symptoms (four males aged 48, 65, 69, 78 years, and two females 59 years), and a 70-year-old male had a lower limb paraparesis with severely altered mental status.

Of the 56 surviving patients with paretic complications, six were referred to neurological clinics at their places of residence, and one did not come for follow-up. Forty-nine patients completed the follow-up. In 16 patients (33 %) the paresis resolved within three weeks of onset. The most favourable outcome was observed in nine patients with involvement of cranial nerves III, IV, VI and VII and two hemiparetic patients, with early and complete improvement after resolution of cerebral oedema. On the other hand, 17 patients (35 %) had sequelae persisting for longer than a year. All of them had severe limb pareses: seven quadriparesis, five bilateral brachial plexus paresis, four unilateral brachial plexus paresis, and one lower extremities paraparesis.

Table 3
Pareses in patients with tick-borne encephalitis ($n = 63$).

Clinical form of paresis	No of patients (%)*
Paresis of upper extremities total	**21 (33.3)**
unilateral involvement	13
bilateral involvement	8
Paresis of lower extremities total	**7 (11.1)**
unilateral involvement	1
bilateral involvement	6
Quadriparesis	**13 (20.6)**
Hemiparesis	**3 (4.8)**
Bulbar symptoms	**18 (28.6)**
Involvement of ocular motor nerves (III, IV, VI)	**11 (17.4)**
Involvement of facial nerve	**5 (7.9)**

* Multiple paretic involvement was recorded in 14 patients.

3.2. Pareses in patients with Lyme neuroborreliosis

One hundred and forty-seven (61.0 %) LNB patients, consisting of 94 males (63.9 %) and 33 children (22.5 %), had paresis. As for TBE, the gender difference was not statistically significant (Fisher's exact test =0.417). The highest frequency of paretic cases was in the age groups 0–9, 10–19 and 70–79 years (70 %, 67 % and 65 %, respectively). The mean age difference of patients with and without paresis was statistically not significant (42.9 and 46.1, respectively; $p = 0.33$).

A spectrum and frequency of pareses is shown in Table 4. Facial

Table 4
Pareses in patients with Lyme neuroborreliosis ($n = 147$).

Clinical form of paresis	Number (%)		
	Adults * (114 patients)	Children (33 patients)	Total * (147 patients)
Facial nerve involvement	85 (74.5)	32 (97.0)	117 (79.6)
unilateral	60	30	90
bilateral	25	2	27
Cranial nerves III, IV, VI involvement	7 (6.1)	0	7 (4.8)
Paresis of upper extremities	8 (7.0)	0	8 (5.4)
Paresis of lower extremities	22 (19.3)	1 (3.0)	23 (15.6)
bilateral	11	0	11
Quadriparesis	1 (0.9)	0	1 (0.68)
Hemiparesis	1 (0.9)	0	1 (0.68)
Paresis of abdominal muscles	2 (1.8)	0	2 (1.4)

* Multiple paretic involvement was recorded in 12 adult patients.

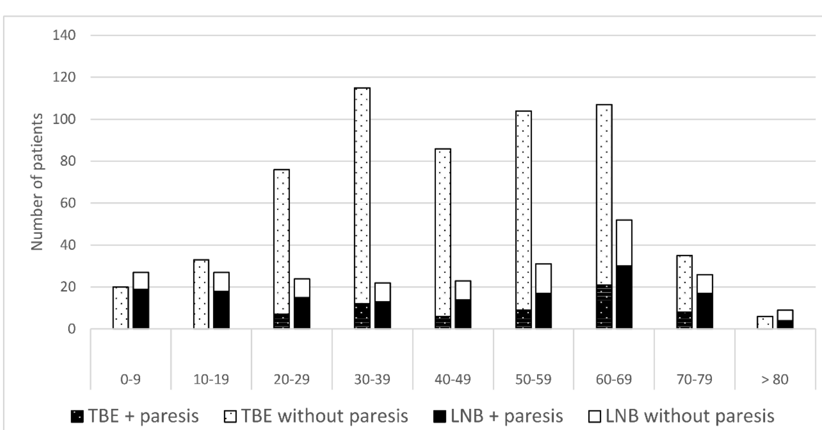

Fig. 1. Age distribution of patients with tick-borne encephalitis and Lyme neuroborreliosis, including the number of paretic cases.

nerve involvement was the most common. All but one paediatric patient suffered from this paresis, including two bilateral cases. A 17-year-old patient developed a lower limb paresis. Amongst adults, facial nerve involvement was found in 85 patients (74.5 %), 25 patients had bilateral palsy (21.9 %). Limb paresis occurred in 32 adults (28.1 %), of whom 11 (9.7 %) had bilateral deficit. A 52-year-old man with severe paraparesis and transient urinary retention had Th3-Th4 myelitis, determined by magnetic resonance imaging. A 37-year-old female with quadriparesis had a concomitant demyelinating disease and the contribution of LNB to the neurological symptoms could not be clearly assessed. The Bannwarth syndrome was diagnosed in 87 patients (36.1 %), 85 adults and two children.

Post discharge, 134 LNB patients with paresis (101 adults, 33 children) were followed up by our department. All but one child had complete resolution of paresis within three months, 26 (78.8 %) even within three weeks of starting antibiotic therapy. In a 10-year-old boy, facial nerve involvement persisted for five months. In adults, paresis resolved within three months in 77 patients (67.5 %), 69 (60.5 %) had facial or other cranial nerves paresis and eight (7 %) had limb or abdominal wall paresis. In five patients (4.4 %), motor deficits persisted more than a year; four had lower limb paresis and one had bilateral facial nerve palsy. The difference in outcome between children and adults is shown in Fig. 2.

3.3. Comparison of paretic complications in TBE and LNB

Patients with paresis were significantly older in the TBE group (mean 53.9, SD 16.4, median 60, min 22, max 78) than in the LNB group (mean 42.9, SD 23.8, median 44.0, min 3, max 84), ($p < 0.001$). The proportion of patients with paresis restitution within three weeks was similar in the TBE and LNB groups (32.6 vs. 39.5 %). However, there was a noticeable disproportion in the number of patients with longer persistence of paresis: in TBE, compared to LNB, the proportions of patients with paresis persisting longer than three months (57.1 vs. 18.7 %, $p < 0.001$) and longer than 12 months (34.7 vs. 3.7 %, $p < 0.001$) were significantly higher (Fig. 3).

The mean mRS was significantly higher in paretic patients with TBE compared to LNB during follow-up at all time points, $p < 0.001$ (Fig. 4). The time course of the median mRS and interquartile range (IQR) in the TBE group was as follows: 3 (IQR 2) at three weeks, 2 (IQR 4) at three months, 2 (IQR 3) at 12 months, and 0 (IQR 2) at 24 months. The corresponding values for the LNB group are 1 (IQR 1), 1 (IQR 2), 0 (IQR 0), and 0 (IQR 0). In LNB patients, the highest achieved score was 4, reflecting moderately severe disability, while in TBE patients it was 6, as the patients died. The probability of a score of 6 was significantly higher in TBE patients ($p < 0.001$).

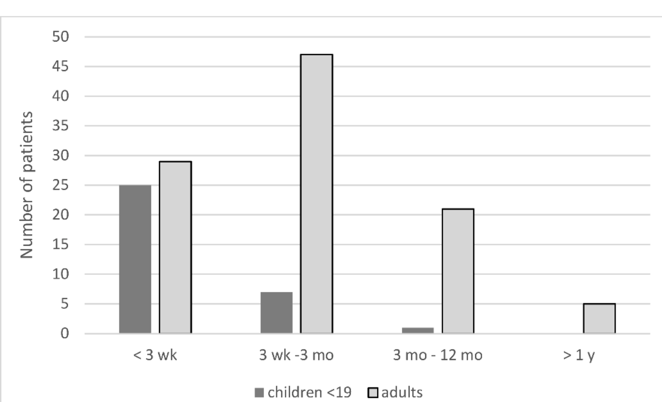

Fig. 2. Duration of paresis in children and adults with Lyme neuroborreliosis.

4. Discussion

Motor deficit was a common complication of both diseases. However, the comparison revealed differences, mainly in the age distribution of paretic patients, the number of children with paresis, and paresis duration and impact on quality of life.

The number of paretic complications of **tick-borne encephalitis** clearly differed amongst age groups. None occurred in the children and adolescents in the groups we studied, although they have been reported in the literature (Krbkova et al., 2015; Lindquist and Vapalahti, 2008). The highest occurrence of pareses was in the 70–79 age group but they were relatively common also in the 30–39 age group. Motor deficits lasting longer than one year were observed in 2.9 % of all patients with TBE, which is consistent with the frequency 2.2–8.4 % described in other studies (Bogovic et al., 2018; Mickiene et al., 2002; Veje et al., 2016). Long-term motor deficits affected adult patients across a wide age spectrum, with encephalomyelitis present in all. Most central pareses resolved during hospitalization (within three weeks). They were most likely caused by oedema and inflammatory infiltration of neural structures, without severe neuronal destruction.

In **Lyme borreliosis**, neurological involvement develops in about 15 % of untreated infected persons, usually several weeks after the tick bite (Halperin, 2011b; Stanek et al., 2012; Thaisetthawatkul and Logigian, 2002). Pareses were described in 44.2–60.2 % of them (Knudtzen et al., 2017; Ogrinc et al., 2016; Schwenkenbecher et al., 2017), in accordance with our results (61 %). Pareses occurred in all age groups in our study. All children with LNB had the most common type of paresis, i.e., unilateral facial nerve involvement, except a boy with mild paresis of the left lower limb. This is consistent with other studies in children (Arnez and Ruzic-Sabljic, 2009; Broekhuijsen-van Henten et al., 2010; Henningsson et al., 2009; Oymar and Tveitnes, 2009). In adult patients with LNB, the pareses were more varied; in addition to facial nerve involvement, there were also pareses of the limbs or trunk muscles related to spinal root involvement. The reason for this difference is not clear. Some authors point to a possible link with the site of the tick bite: in children more often on the head or neck, in adults on the lower limbs (Oschmann et al., 1998; Skogman et al., 2003). We were unable to verify this hypothesis because of insufficient information on the site of tick bites. A favourable course and rapid regression were observed in children and adults with unilateral facial nerve involvement. Most studies reported similar conclusions, except for one in which nearly one-fifth of paediatric patients had residual paresis after one year (Skogman et al., 2003). In that particular study, paresis was evaluated by detailed otorhinolaryngological examination, which revealed even minor abnormalities that are usually no longer subjectively perceived by patients. Bilateral facial palsy was present in 23 % of our LNB patients with facial nerve involvement; this correlates with other studies (Hansen and Lebech, 1992; Thaisetthawatkul and Logigian, 2002), whereas Ogrinc et al. (2016) described a lower frequency of 10.7 %. Patients with bilateral facial nerve involvement had a worse prognosis; in a quarter of them the symptoms persisted for 3–12 months. It is of note, that bilateral facial nerve palsy has been described in a relatively small number of diseases: LNB, neurosarcoidosis, Miller-Fischer syndrome and primary HIV infection (Halperin, 2008). In our experience, LNB is the most common. In the study period, neurosarcoidosis was diagnosed in a single patient with bilateral facial nerve involvement, and there were no cases of Miller-Fischer syndrome and HIV primary infection. Limb and abdominal paresis required the longest rehabilitation but the residual neurological deficit was mild, not requiring walking assistance and did not substantially affect the quality of life.

A comparison of TBE and LNB groups showed that LNB patients had paresis significantly more often than TBE patients (61 % vs 10.8 %). Children were more prevalent in the LNB group, both their total number as well as the subgroup with paresis. The most likely explanation is that in children TBE virus infection is more likely to be asymptomatic or mild with nonspecific symptoms than LNB. It can be assumed that TBE virus

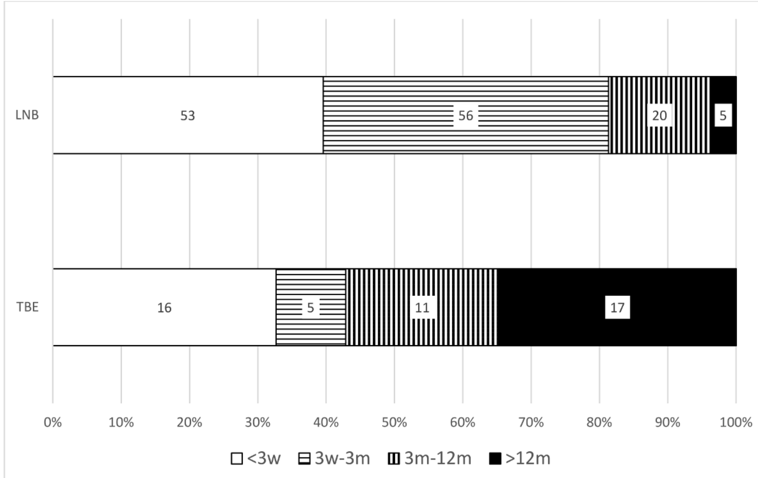

Fig. 3. Duration of pareses in the patients with tick-borne encephalitis (49 patients) and Lyme neuroborreliosis (134 patients).

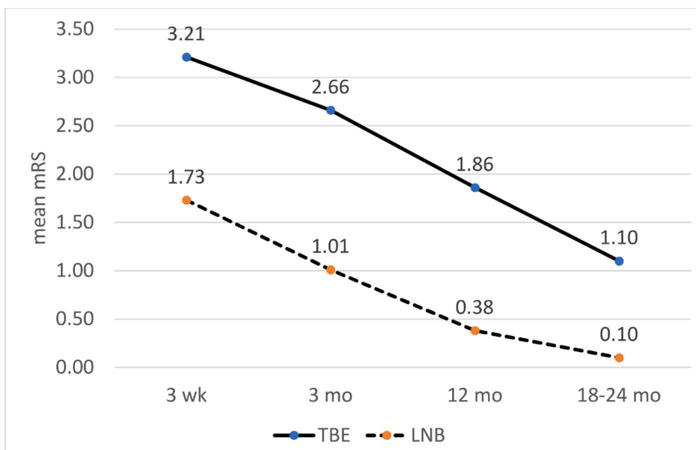

Fig. 4. Mean values of the modified Rankin score (mRS) in paretic patients with tick-borne encephalitis and Lyme neuroborreliosis in the evaluated time intervals (3 weeks, 3 months, 12 months and 18–24 months from the onset of symptoms).

infection in children is more likely to remain undiagnosed.

The proportion of long-term neurological deficit (>1 year) was similar in the TBE and LNB patients. However, there was a significant difference in the severity of paresis as classified by the mRS. Differences in outcome can be explained by two factors and their combination. The first is the different pathogenesis. In TBE, the brain and spinal cord parenchyma is affected more frequently than in LNB. The affinity of the TBE virus to the motor neurons of the spinal cord leads to their direct destruction and consequently severe motor deficits. Limb paresis in LNB is rather a result of late or inadequately treated spinal root inflammation, where probably prolonged oedema leads to mechanical compression. Damage to the brain parenchyma or spinal cord itself is rare in LNB. Interestingly, amongst our 35 LNB patients with paretic limb or abdominal involvement, only five had facial nerve palsy. It can be speculated that the concomitant involvement of facial nerves, which is typical of LNB, can lead to early diagnosis in patients with radiculitis. The therapy is thus started in the phase of radicular pain, before the development of paresis, which improves the outcome. The second factor impacting the course of disease is the available treatment. Early neuroborreliosis responds very well to antibiotic treatment in most cases. Remission of cranial nerve palsy often occurs within 2–3 weeks of antibiotics. However, there is no causal therapy for TBE, and supportive and symptomatic treatment usually neither prevents the development of paretic complications nor leads to their rapid improvement.

Our study focused mainly on the duration of motor deficit and its impact on quality of life, rather than on neurocognitive impairment (postencephalitic syndrome), which is particularly common after TBE. Previously published studies have proposed scoring systems to assess the severity of TBE in adult patients in the acute phase of the disease (Bogovic et al., 2014), or self-reporting questionnaires, assessing not only motor limitations but also, for example, cognitive or sleep impairment in the long term (Veje et al., 2016). For assessment of the CNS infection sequelae, it would be optimal to unify these classifications and develop a uniform scoring system. This would provide a consistent evaluation of the severity of sequelae and an objective assessment of the complications of CNS infections.

In conclusion, pareses in TBE are less frequent but more severe than in LNB and considerably reduce the quality of life for patients. Pareses in the LNB, although being more common, are more reversible and the prognosis is better. Disease prevention remains the only way to influence the long-term motor deficits of TBE. Although an effective and safe TBE vaccine has been available for many years, vaccination coverage remains low in many endemic countries in Europe.

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CRediT authorship contribution statement

Dita Smíšková: Conceptualization, Investigation, Writing – original draft. **Dušan Pícha:** Writing – review & editing. **Martin Slížek:** Investigation. **Olga Džupová:** Writing – review & editing.

Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

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