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ACOUSTIC REFLEX AND HOUSE-BRACKMANN RATING SCALE AS PROGNOSTIC INDICATORS OF PERIPHERAL FACIAL PALSY IN NEUROBORRELIOSIS

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SUMMARY – Lyme borreliosis is a vector-borne infectious disease characterized by three disease stages. In the areas endemic for borreliosis, every acute facial palsy indicates serologic testing and implies specific approach to the disease. The aim of the study was to identify and confirm the value of acoustic reflex and House-Brackman (HB) grading scale as prognostic indicators of facial palsy in neuroborreliosis. The study included 176 patients with acute facial palsy divided into three groups based on serologic testing: borreliosis, Bell's palsy, and facial palsy caused by herpes simplex virus type 1 (HSV-1). Study patients underwent baseline audiometry with tympanometry and acoustic reflex, whereas current state of facial palsy was assessed by the HB scale. Subsequently, the same tests were obtained on three occasions, i.e. in week 3, 6 and 12 of presentation. The patients diagnosed with borreliosis, Bell's palsy and HSV-1 differed according to the time to acoustic reflex recovery, which took longest time in patients with borreliosis. These patients had the highest percentage of suprastapedial lesions at all time points and recovery was achieved later as compared with the other two diagnoses. The mean score on the HB scale declined with time, also at a slower rate in borreliosis patients. The prognosis of acoustic reflex and facial palsy recovery according to HB scale was not associated with the length of elapsed time. The results obtained in the present study strongly confirmed the role of acoustic reflex and HB grading scale as prognostic indicators of facial palsy in neuroborreliosis.

Key words: *Lyme neuroborreliosis; Lyme disease; Facial paralysis; Reflex, acoustic; Serologic tests; Bell palsy; Herpesvirus 1, human; Audiometry; Acoustic impedance tests; Croatia*

Introduction

Facial neuroborreliosis can hardly be observed as an independent entity relative to the idiopathic facial palsy (IFP, Bell's palsy). Thus, literature reports on facial palsy, when referring to mononeuritis caused by the microorganism *Borrelia burgdorferi*, investigate and compare facial neuroborreliosis in relation to IFP results. It is known that the absence of associated neurologic symptoms does not rule out Lyme disease as a cause of peripheral facial palsy, as recorded in as many as 16% of cases[1]. While many authors report rare tick bites in the history of patients with Lyme disease (29%), other studies consider the history of tick bite to be crucial in distinguishing patients with neuroborreliosis and those with Bell's palsy[2,3]. Anyhow, neuroborreliosis must be evaluated. According to Volk *et al.*, at least two of the following diagnostic criteria are required to confirm borreliosis: presence of erythema migrans; *Borrelia* antibodies in serum or cerebrospinal fluid (CSF); CSF pleocytosis >white blood cells (WBC)/mm^3; and CSF/serum index >1.5[4].

In endemic areas, borreliosis can also be confirmed by the following:

- stage 1 (erythema chronicum migrans) manifests in only 30%-80% of cases;

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- specific response need not develop in <25% of individuals with clinically present erythema migrans;
- a history of contact with tick reported in only 25%-30% of cases[2], and in some studies it is extremely low, i.e. 4.2%[5];
- the enzyme-linked immunosorbent assay (ELISA) results should be interpreted in the light of epidemiological data. Since serological reactions are insensitive in the first two weeks of infection, serology finding positive for IgM antibodies is obtained in only 50% of patients in the early stage of the disease[6]; in addition, cross-reactions may occur in WBC findings of patients with herpes simplex virus type 1 (HSV-1) reactivation[7]; and
- high percentage of domestic tick infection[8].

Cochleostapedial reflex is acoustic reflex produced by contraction of the stapedius muscle and used in topographical diagnosis of facial nerve pathology. Reflex arc consists of two parts, afferent and efferent ones. The reflex itself changes elasticity of the middle ear system, which can be tested by various diagnostic methods. These methods can be categorized in two groups. Some methods record changes occurring in the afferent part of the reflex arc, implying acoustic receptor, acoustic nerve and acoustic nuclei in the brainstem. Other methods are so designed to record changes that occur in the efferent part of the reflex arc, which are related to facial nerve nuclei, facial nerve trunk and stapedial nerve. The former group of diagnostic procedures includes all methods of hearing threshold objectivization, whereas the latter group includes highly relevant differential diagnosis procedures that reveal negative acoustic reflex response as a substantial finding.

Although acoustic reflex generally is involved in standard evaluation of every patient with facial palsy in neuroborreliosis, it has not been considered prognostically relevant so far. However, there are studies that suggest its role in predicting disease[9]. House and Brackmann have proposed facial nerve grading; after minor modifications, it was presented as House-Brackmann grading system (HB grading system) in 1985[10]. This scale has been adjusted to facial nerve evaluation standards set by the American Academy of Otolaryngology – Head and Neck Surgery (AAO-HNS), Board on Facial Nerve Disorders. The system is based on six grades (I-VI) evaluating basic (motor) facial nerve functions including sequels. The scale describes symmetry, excitability, stiffness and overall mobility of the face, and has been adopted as a universal measure of facial nerve disorders in the USA and Europe.

Bilateral facial palsy is as rare in neuroborreliosis as in IFP[11]. Although the cause of IFP remains unknown, i.e. not detected yet, and facial palsy in neuroborreliosis is mononeuritis as part of the underlying disease, current considerations propose therapy immediately upon palsy onset.

Patients and Methods

The study included patients treated at Department of ENT and Head and Neck Surgery and Department of Infecious Diseases, Dr Josip Benčević General Hospital in Slavonski Brod, Croatia. Study protocol was approved by the Hospital Ethics Committee. Patients were explained the purpose and aims of the study and signed the informed consent form after having read it thoroughly.

Patients

The study included facial palsy patients of both sexes and all age groups divided into three groups of patients with borreliosis, Bell's palsy and HSV-1 infection. On setting study exclusion criteria, we followed the AAO-HNS Clinical Practice Guideline: Bell's Palsy from November 2013[12], which includes pregnancy, preeclampsia, diabetes mellitus and inflammatory changes of upper airways. Obese patients and those with elevated arterial pressure (<160/80 mm Hg) were not excluded, whereas patients having received palliative chemotherapy and radiotherapy of any tumor type within 12 months of the last therapeutic procedure were excluded. In addition, patients with pathologic tympanometry findings and those with known chronic ear and mastoid process inflammation, hearing amplified subjects and those with otosclerosis, tympanosclerosis and acute tinnitus persisting for up to three months, as well as facial nerve disorders of specific etiology and those associated with neurologic disorders were not considered eligible for inclusion in the study. Foresters were also excluded because they have a tenfold risk of contacting ticks and three- to fourfold risk of borreliosis as compared with the general population.

The patients included in the study were evaluated from June 2008 till April 2016.

Methods

According to the facial palsy protocol, tympanogram and acoustic reflex were determined as audiologic work-up to assess the level of facial nerve lesion on at least two occasions at 3-week interval or at the most on four occasions at 12-week interval. Acoustic reflex determination is contraindicated in the presence of tinnitus, external ear infection, recruitment, hyperacusis, and epilepsy. The reasons for repeat measurement include swallowing, speech, coughing and laughing during testing, test results inconsistent with liminar tonal audiometry findings (in this case, both tests should be repeated), and collapsible cartilaginous portions of auditory canal, which may lead to false results, in particular when the headphone is used on the contralateral ear. The method is noninvasive and crucial for therapy and prognosis. Initially, audiologic work-up was performed within three days of presentation.

Changes on the HB scale were prospectively followed-up in patients with facial palsy and prognosis of the disease was determined accordingly in subdivisions. Scale scores were set on each tympanometry and acoustic reflex determination on four visits at 3-week intervals.

At baseline, face was photographed at rest, and with forehead, eye and lip movements. After 12-week follow up, all photodocumentation was deleted or given to the patient to keep it. Patient blood (serum) samples were used to detect *Borrelia (B.) burgdorferi* and HSV-1 antibodies. Blood was sampled at Department of ENT and Head and Neck Surgery and Department of Infecious Diseases, Dr Josip Benčević General Hospital in Slavonski Brod and the samples were sent to Dr Fran Mihaljević University Hospital for Infectious Diseases in Zagreb for ELISA and Western blot testing.

Based on serology results, patients were divided into three groups as follows: borreliosis, positive for *B. burgdorferi*; HSV-1, positive for HSV-1; and Bell's palsy, negative for borreliosis and acute viral infection.

Statistics

The SPSS 21 and SAS JMP 11.0.0 software packages were used on statistical data processing. The aim of survival analysis is to determine the time needed for the patient to experience an event during the study. In the present study, this analysis included the time needed for the facial nerve suprastapedial lesion to transform to infrastapedial lesion, as assessed by the acoustic reflex determination, and the time needed for the HB scale score to reach 1, indicating recovery in the groups of patients diagnosed with borreliosis, Bell's palsy and HSV-1 infection. The length of elapsed time and therapy were considered as the factors influencing the prognosis of recovery in all three patient groups. On statistical data processing, survival analysis, one-way and two-way analysis of variance (ANOVA), χ^2-test, Fisher exact test, Kruskal-Wallis test, point-biserial correlation coefficient, and Spearman's correlation coefficient were employed.

Results

In this study, acoustic reflex and HB grading scale were estimated as predictors of facial palsy in neuroborreliosis. Out of 176 study patients, 35 patients had borreliosis, yielding the incidence of facial palsy in borreliosis of 19.88%.

Acoustic reflex

The location of lesion at four points of measurement was compared according to diagnosis. The percentage of patients with suprastapedial lesion declined continuously with time in all three diagnostic groups. As illustrated in Figure 1, patients diagnosed with borreliosis had a statistically significantly highest percentage of suprastapedial lesions at all time points, i.e. at baseline, as high as 71.4% *vs.* 51.2% in Bell's palsy group and 28.6% in HSV-1 group (χ^2=8.291; p=0.016); in week 3, 60% *vs.* 23.6% and 14.3% (χ^2=19.064; p<0.001); in week 6, 47.1% *vs.* 4.8% and 14.3% (χ^2=40.288; p=0.001); and in week 12, 20.6% *vs.* 2.4% and 7.1%, respectively (χ^2=15.005; p=0.001). All effect sizes expressed as Cramer's V were medium to large (between 0.22 and 0.48), whereby the greatest difference among diagnoses was recorded in week 6.

A new independent variable was constructed to investigate whether patients with borreliosis, Bell's palsy and HSV-1 infection differed according to recovery time, as measured throughout the study period. Fisher exact test result showed the group of borreliosis patients to have longest recovery time (Fisher exact

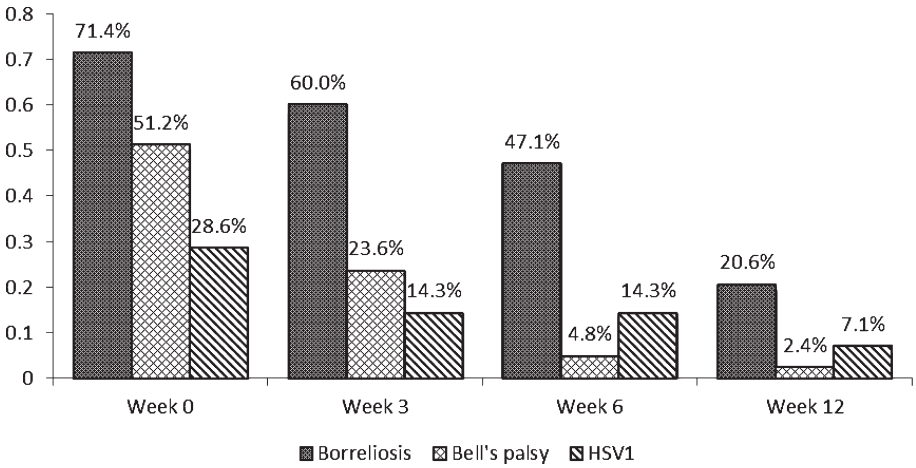

Fig. 1. Percentage of patients with suprastapedial lesion (weeks) according to diagnosis.

test=36.626; p<0.001). In this group of patients, approximately half of the patients (53%) achieved recovery by week 6, as compared with the majority of Bell's palsy patients (79%) having recovered by week 3 and the majority of HSV-1 patients (71%) being free from suprastapedial lesion on initial measurement (Table 1). As much as 47% of borreliosis patients achieved recovery only at week 12 or failed to recover at all *versus* 4.8% of Bell's palsy patients and 7.1% of HSV-1 patients. This difference was considered medium to large (Cramer's V=0.37).

Table 1. Acoustic reflex recovery time according to diagnosis

Recovery time	Borreliosis		Bell's palsy		HSV-1	
	n	%	n	%	n	%
Week 0	10	29.4	62	49.2	10	71.4
Week 3	4	11.8	38	30.2	3	21.4
Week 6	4	11.8	20	15.9	0	0
Week 12+	17	**47.1**	7	4.8	1	7.1
Total	35	100.0	127	100.0	14	100.0

HSV-1 = herpes simplex virus type 1

The importance of time for the acoustic reflex level was compared by using ANOVA. Prior to this analysis, distribution of the results on the variable of time elapsed from symptom onset to diagnostic work-up was assessed (Fig. 2). Although distribution of the results was not normal, its was asymmetric in the same direction and to approximately the same grade for the diagnoses of borreliosis and Bell's palsy. Different was

Table 2. Descriptive data on time elapsed (hours) according to diagnosis and lesion level on initial measurement (week 0)

Diagnosis	Lesion level, week 0	M	SD_M	95% Confidence interval	
				Lower limit	Upper limit
Borreliosis	IS	88.0	27.204	34.294	141.706
	SS	80.5	16.323	48.256	112.704
Bell's palsy	IS	62.0	10.365	41.570	82.494
	SS	67.9	10.202	47.766	88.046
HSV-1	IS	64.8	25.808	13.850	115.750
	SS	75.0	40.806	0	155.559
Total	IS	71.6	12.968	46.009	97.212
	SS	74.5	15.039	44.772	104.153

HSV-1 = herpes simplex virus type 1; IS = infrastapedial lesion; SS = suprastapedial lesion; M = arithmetic mean; SD_M = standard deviation of mean

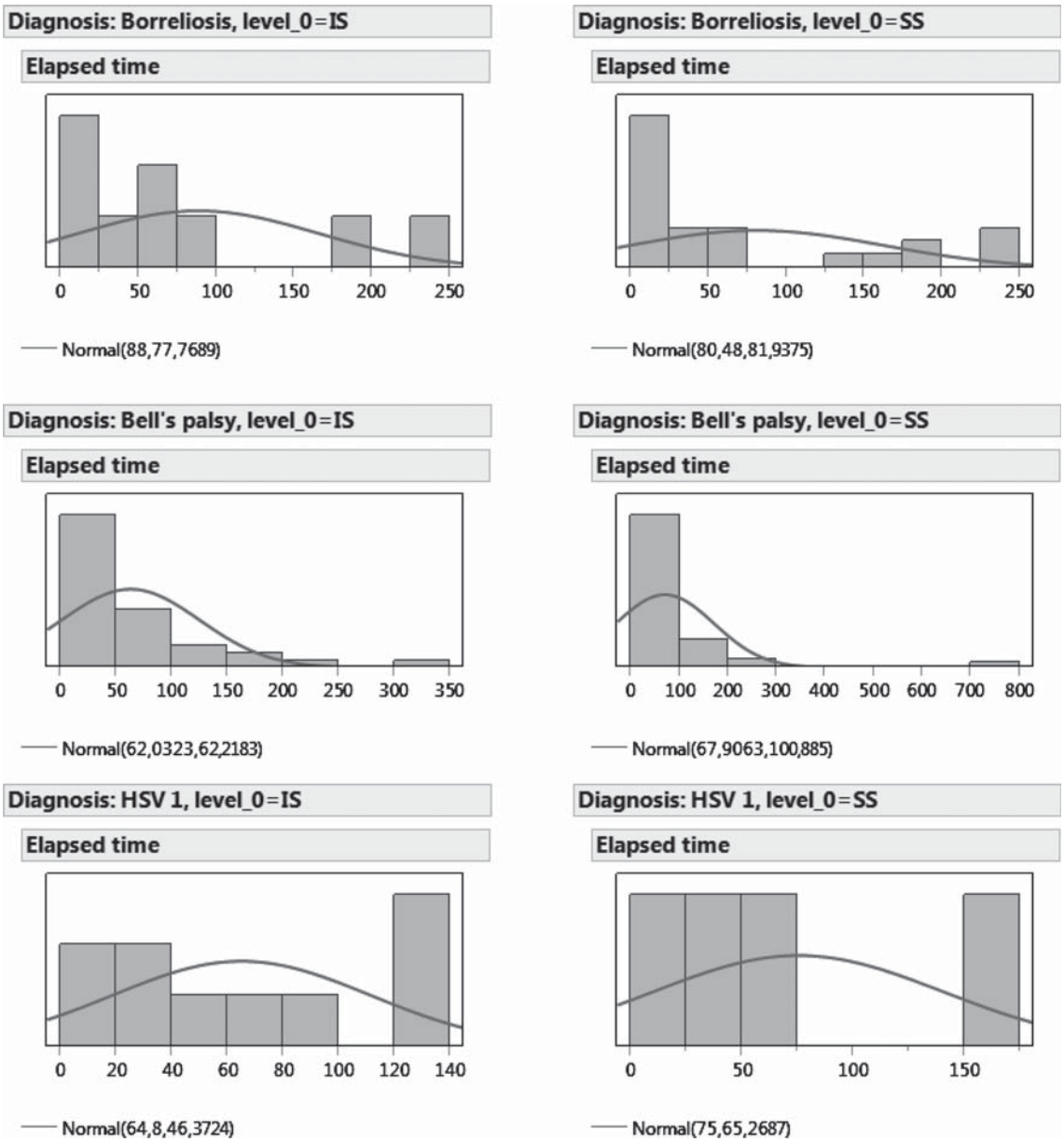

Fig. 2. Distribution of time elapsed according to diagnosis and lesion level on initial measurement (week 0).

only distribution of the time elapsed from symptom onset to diagnostic work-up in the diagnosis of HSV-1; however, ANOVA was employed since there is no alternative statistical procedure to identify interaction of two variables.

Table 2 shows descriptive data on the time elapsed from facial palsy onset according to diagnosis and lesion level at baseline (week 0). Results produced by ANOVA revealed that the time elapsed from facial palsy onset did not differ according to diagnosis ($F(2/168)=0.612$; $p=0.544$; partial $\eta 2=0.007$), lesion level at initial measurement ($F(1/168)=0.021$; $p=0.886$; partial $\eta 2<0.001$) or interaction of diagnosis and lesion level ($F(2/168)=0.082$; $p=0.921$; partial $\eta 2=0.001$).

House-Brackmann grading scale

Comparison of results obtained on the HB scale at four points of measurement according to diagnosis is shown in Table 3. Results on the HB scale were recorded in two categories (1 = recovery, HB score 1; and

Table 3. House-Brackmann (HB) scale score (in two categories) at four points of measurement according to diagnosis

Time point	HB scale score	Borreliosis		Bell's palsy		HSV-1		χ^2-test, p (Cramer's V)
		n	%	n	%	n	%	
Week 0	1	0	0	0	0	0	0	-
	>1	35	100.0	127	100.0	14	100.0	
	Total	35	100.0	127	100.0	14	100.0	
Week 3	1	9	25.7	60	47.2	7	50.0	5.472; 0.065
	>1	26	74.3	67	52.8	7	50.0	(0.18)
	Total	35	100.0	127	100.0	14	100.0	
Week 6	1	12	34.3	82	64.6	8	57.1	10.329; 0.006
	>1	23	65.7	45	35.4	6	42.9	(0.24)
	Total	35	100.0	127	100.0	14	100.0	
Week 12	1	21	60.0	88	69.3	9	64.3	1.125; 0.518
	>1	14	40.0	39	30.7	5	35.7	(0.08)
	Total	35	100.0	127	100.0	14	100.0	

HSV-1 = herpes simplex virus type 1; p = level of statistical significance

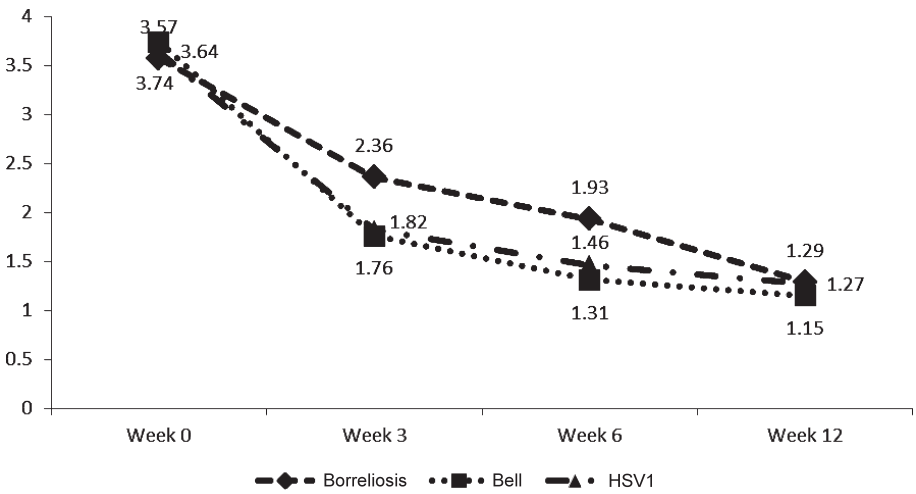

Fig. 3. Mean result on House-Brackmann scale over time according to diagnosis.

>2 = no recovery, HB score >1), thus facilitating comparison with results of acoustic reflex recovery.

Comparable to the results of acoustic reflex recovery, the percentage of patients with HB score >1 decreased with time. On initial measurement (week 0), all patients (100%) had a HB score >1 irrespective of diagnosis. During the study period, this percentage decreased to 40%, 30.7% and 35.7% in the groups of patients with borreliosis, Bell's palsy and HSV-1 infection, respectively. Comparison of these figures with those on acoustic reflex recovery revealed that the percentage of patients considered to have reached recovery was lower on HB scale. Comparison of results recorded at particular time points according to diagnosis showed some differences in the rate of acoustic reflex recovery. At baseline (week 0), all patients had HB score >1 irrespective of diagnosis; in week 3, HB score >1 was recorded in 74.3% of borreliosis patients *vs.* 52.8% of Bell's palsy patients and 50% of HSV-1 patients, yielding a difference of borderline statistical significance (χ^2=5.472; p=0.065) and small to moderate sizes (Cramer's V=0.18). In week 6, HB score >1 was recorded in 65.7% of borreliosis patients *vs.* 35.4% of Bell's palsy patients and 42.9% of HSV-1 patients

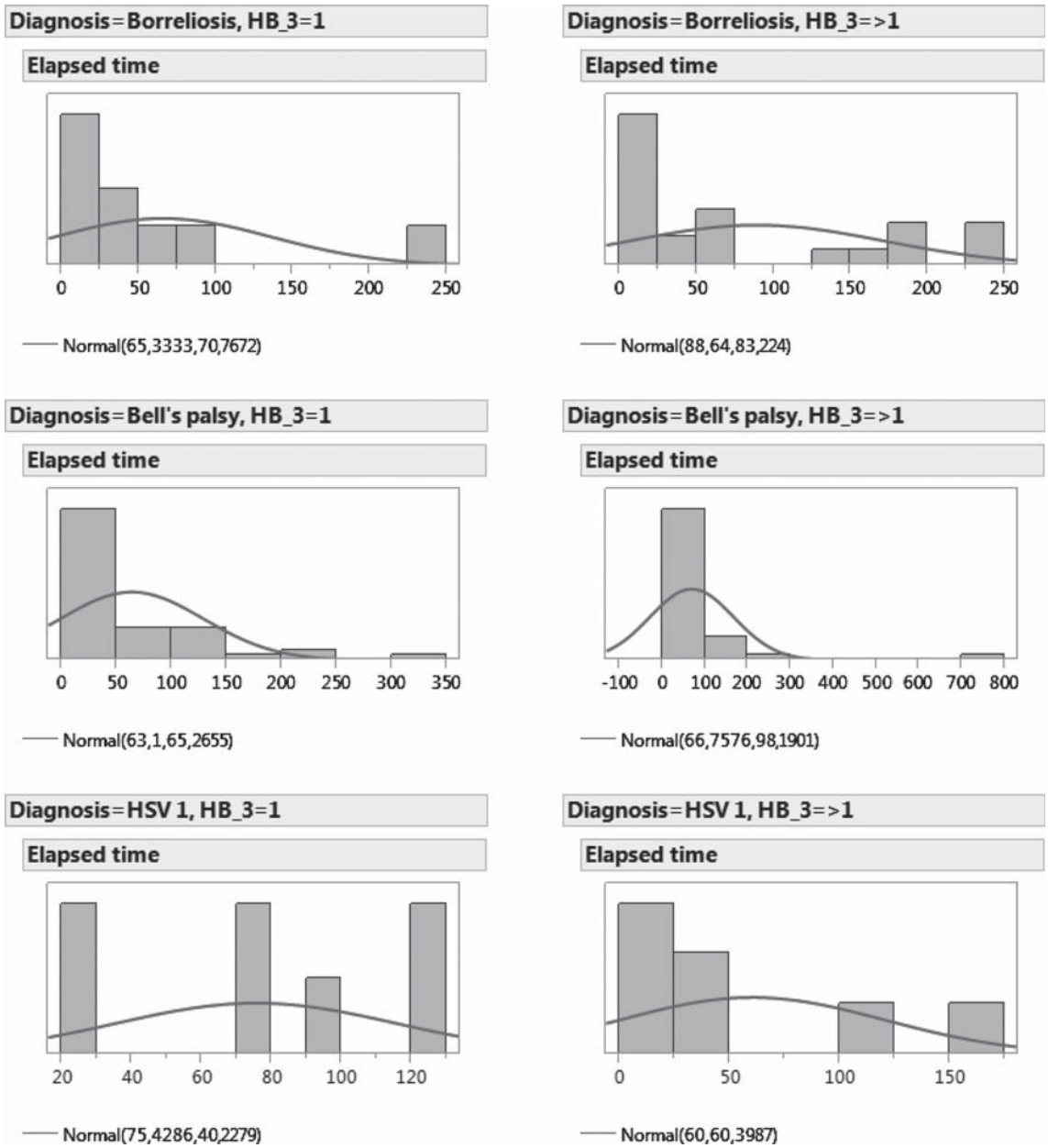

Fig. 4. Distribution of time elapsed according to diagnosis and House-Brackmann scale on second measurement (week 3).

(Fig. 3). At the last point of measurement in week 12, however, the between-group difference did not reach statistical significance (χ^2=1.125; p=0.518), unlike the previous points of measurement and acoustic reflex results. Recovery was slower in patients diagnosed with borreliosis as compared with Bell's palsy and HSV-1 patients; more than half of borreliosis patients did not reach recovery before week 12 or failed to recover throughout the study, as compared with 63.2% of Bell's palsy patients and 53.3% of HSV-1 patients having achieved recovery as early as week 3; 57.1% of borreliosis patients achieved recovery only in week 12 or not at all, as compared with 13.7% of Bell's palsy patients and 33.3% of HSV-1 patients with the same outcome. This difference was of moderate size (Cramer's V= 0.29).

Table 4. Descriptive data on time elapsed (hours) according to diagnosis and recovery time on House-Brackmann scale

Diagnosis	Recovery time	M	SD_M	95% Confidence interval	
				Lower limit	Upper limit
Borreliosis	Week 3	65.3	29.996	5.922	124.745
	Week 6	88.0	51.955	0.000	190.904
	Week 12+	78.5	22.497	33.941	123.059
Bell's palsy	Week 3	63.1	11.618	40.090	86.110
	Week 6	65.9	19.637	26.963	104.751
	Week 12+	104.0	24.959	54.566	153.434
Total	Week 3	64.22	16.084	32.361	96.073
	Week 6	76.93	27.771	21.924	131.933
	Week 12+	91.25	16.801	57.974	124.526

M = arithmetic mean; SD_M = standard deviation of mean

Table 5. Descriptive data (arithmetic mean (M), standard deviation (SD) and median) on acoustic reflex recovery time and results on House-Brackmann (HB) scale according to therapy

	M	SD	Median	N
Acyclovir				
Acoustic reflex recovery time	2.88	4.106	0	25
HB scale recovery time	4.86	3.21	3	21
Prednisolone				
Acoustic reflex recovery time	2.79	3.259	3	28
HB scale recovery time	6	3.838	3	23
Acyclovir + prednisolone				
Acoustic reflex recovery time	3.24	4.108	3	102
HB scale recovery time	5.72	3.729	3	75

Kruskal-Wallis test = difference in recovery time according to therapy (no difference among three therapy categories)

The mean time elapsed from facial palsy onset was compared according to diagnosis and time to recovery using ANOVA. Distributions of the time elapsed from facial palsy onset were compared according to groups (Fig. 4), which justified analysis since these distributions were asymmetric in the same direction and to approximately the same extent.

Table 4 shows descriptive data on the time elapsed from facial palsy onset according to diagnosis (results on patients diagnosed with HSV-1 infection were not included in the analysis because of the small number of patients according to categories) and time to recovery on the HB grading system. ANOVA results indicated that the mean time elapsed from facial palsy onset did not differ according to recovery time ($F(2/116)=0.077$; $p=0.511$; partial $\eta 2=0.01$) or interaction of diagnosis and recovery time ($F(2/116)=0.330$; $p=0.720$; partial $\eta 2=0.01$). The two measures were also compared according to recovery time determination. Spearman's correlation coefficient yielded significant and moderately high correlation of the time to recovery as defined by acoustic reflex and HB grading system ($Rho=0.61$; $p<0.001$).

Comparison of acoustic reflex and House-Brackmann grading system

On comparison analysis, finding all patients (100%) in corresponding boxes (week 3 for HB scale and week 3 for cochleostapedial lesion) would indicate perfect correlation. The greater the decrease in the number (and percentage) of patients, the lower is the degree of correlation. In week 3, week 6 and week 12, 36%, 53.8% and even 63.6% of the patients having achieved recovery according to HB scale score also showed recovery according to the acoustic reflex level, respectively. Again, greatest differences in patient classification referred to the fact that the HB grading system showed more gradual and later recovery than acoustic reflex.

Comparison of time to recovery according to therapy

Table 5 shows descriptive data (arithmetic mean ± standard deviation and median) on time to acoustic reflex recovery and results recorded on the HB scale according to therapy. For comparison of time to recovery according to therapy, the following new variables were formed: acyclovir monotherapy (patients prescribed acyclovir alone); prednisolone monotherapy (patients prescribed prednisolone alone); and acyclovir + prednisolone combined therapy (patients prescribed both acyclovir and prednisolone). Time to acoustic reflex recovery and time to recovery according to the HB scale was analyzed in separate for the above therapeutic options, yielding no statistically significant differences in the time to recovery according to therapy (time to acoustic reflex recovery: Kruskal-Wallis test=0.313; p=0.855; Cramer's V=0.14; and time to recovery on HB scale: Kruskal-Wallis test=1.170; p=0.557; Cramer's V=0.08).

Discussion

Facial palsy is a disorder that is nowadays stigmatized as an unacceptable sociologic, aesthetic and economic disease sequel. Opinions vary considering the level of facial palsy recovery. In the study by Ikeda *et al*., surgeons evaluated 20%-30% of their patients as cured, while the patients did not feel so, since they all had minimal residual facial dyskinesia[13]. Such different perception of cure, also observed in other studies, has led to a conclusion that numerous sequels of the disease have been neglected by clinicians having considered them trivial.

The etiology of facial palsy frequently remains unknown. The known causes are diverse, including facial mononeuritis in neuroborreliosis as a condition prognostically more severe than IFP, primarily because it is part of the complex clinical picture of borreliosis, thus being more difficult to control and treat as a disease sequel, in particular if persisting in post-treatment Lyme disease syndrome.

With the aim to prevent long term sequels of facial palsy, in the present study acoustic reflex values and HB scale score were assessed as prognostic indicators of facial palsy in neuroborreliosis. Borreliosis was present in 35 (19.88%) of 176 patients with facial palsy, which is consistent with literature data, where its incidence ranges from 7.1% to 41%[3,14-16]. However, the body of data on its incidence is rather scarce, the more so as a higher percentage of facial palsy in borreliosis is reported in pediatric population.

According to some reports, topographical diagnosis of acoustic reflex is performed in only 79% of patients[4], thus the real incidence of facial palsy in neuroborreliosis patients remains questionable and findings related to it should be interpreted with caution, although it appears objectively reasonable to state that in the areas endemic for borreliosis the incidence of facial palsy is about 25%.

Acoustic reflex generally is included in standard evaluation of every patient with facial palsy in neuroborreliosis but has not been considered relevant for prognosis to date, although there are literature reports suggesting its role as a predictor of the disease[9]. The more so, in some recent studies, the variable of acoustic reflex was observed together with other predictors of prognosis. The following variables were assessed: patient age, HB scale, electroneuronography (ENoG), nerve excitability test (NET), blink reflex, and acoustic reflex. Time to full recovery could have been predicted by use of the adjusted coefficient of 0.51 for HB scale, ENoG, acoustic reflex and NET. Using the Nagelkerke coefficient of determination of 0.72, complete recovery could have been predicted by patient age, HB scale, ENoG and NET. Although statistical analyses have been proclaimed a rather imprecise method, it is concluded that maximal recovery can be assessed by use of the HB grading system, ENoG and NET as recovery predictors[17].

Among few studies having used and assessed the role of acoustic reflex as a disease predictor, the study by Bjerkhoel *et al*. evaluated the incidence of *B. burgdorferi* caused facial palsy in south Sweden and aimed to identify tests to confirm and rule out the diagnosis of borreliosis in patients with peripheral facial palsy. During a 6-month study period, 43 patients with peripheral facial palsy were examined. Bell's palsy was diagnosed in 31, borreliosis in six, zoster oticus in four patients, and myeloma and melanoma metastasis in one patient each. Acoustic reflex could be induced in 15 (38.46%) of 39 patients. A higher grade of facial palsy was found in 24 patients with absent acoustic reflex (suprastapedial nerve lesion) as compared with the group with acoustic reflex preserved (infrastapedial nerve lesion) on both initial and last visit. However,

there are no data on suprastapedial nerve lesion relative to the disease, i.e. what type of acoustic reflex response prevailed in particular disorders[14].

Our study results confirmed the patients diagnosed with borreliosis to have a greater number of suprastapedial lesions and their number was higher on the last, 12-month follow up. Determining the site of lesion has not yet been explicitly mentioned in the literature as predictor of facial palsy, in particular not in relation to diseases as the etiologic cause of facial palsy. At baseline, suprastapedial lesion was present in 71.4% of borreliosis patients, 51.2% of Bell's palsy patients, and 28.6% of HSV-1 patients. At 12-week follow up, the respective percentages decreased to 20.6%, 2.4% and 7.1%. Statistically most significant improvement was recorded in week 3 of facial palsy onset ($p<0.001$).

To the best of our knowledge, there is no study report clearly distinguishing cochleostapedial lesions according to the etiology of facial palsy. The acoustic reflex lesion in acute facial palsy is mostly described in general, irrespective of its etiology. According to literature data, acoustic reflex is absent in 38%-66% of all facial palsy cases, irrespective of etiology[4,14]. Our study confirmed that recovery took longest in the group of patients with borreliosis, as previously suspected. Some recent studies investigated the role of the time elapsed from symptom onset on the disease prognosis. Volk *et al*. observed the interval from palsy onset to the initiation of treatment, i.e. <6 days *vs*. ≥6 days, and demonstrated the role of the time elapsed from palsy onset to diagnosis and treatment. The patients having presented within 5 days of facial palsy onset had a significantly shorter median recovery time than those with longer time elapsed from facial palsy onset to presenting for treatment. On the other hand, the same study indicated that etiology did not influence recovery time significantly[4]. In our patients, the time elapsed from symptom onset to presentation had no influence on facial nerve recovery time in any diagnosis.

On the other hand, the above results of acoustic reflex assessment according to diagnosis indicate that patients with borreliosis have a significantly higher number of suprastapedial lesions and longer recovery time, suggesting that etiology significantly influences facial palsy recovery. The present study confirmed recent reports on the prognostic value of the acoustic reflex. Good knowledge of the technique performance and acoustic reflex presentation is of outmost importance for detecting complex sequels of neuroborreliosis, intra- and extra-axial lesions (infiltration of facial nerve nuclei and fibrils by direct spirochete action or immune mediated processes), which mask the disease with other neurologic diagnoses, thus protracting time to therapy and worsening disease prognosis[18]. The HB scoring system has a major role in clinical routine as a method of fast assessment of the facial nerve and face condition. This scale is simple and efficient in grading nerve status in the first weeks of facial palsy onset. In addition, the study by Ushio *et al*. demonstrated HB scale to be strong predictor of the disease and cochleostapedial nerve status[17]. Many authors consider that score 3 on the HB scale is found initially in the majority of patients with acute facial palsy irrespective of diagnosis, with the exception of nerve trauma[4,19,20].

Comparison of our results revealed differences according to acoustic reflex recovery. In week 3 and even more in week 6, a statistically significant difference in HB score was found between borreliosis patients and the other two patient groups. In patients diagnosed with borreliosis, recovery time was longer as compared with patients with Bell's palsy and those with HSV-1 infection. This means that longer and slower facial nerve recovery was clearly demonstrated by use of HB scale in patients with neuroborreliosis as compared with the other two patient groups.

In the evaluation of prognostic value, acoustic reflex and HB scale were correlated in order to confirm their conformity. These results showed the HB scale to yield a more precise prognosis than acoustic reflex, which is quite understandable because the former has 6 and the latter only 2 points of measurement. However, when performed in combination, these two methods make the prognosis of facial palsy more reliable.

Finally, descriptive data on the acoustic reflex recovery time and HB scale according to therapy were used to identify as many as possible prognostic factors in the management of facial palsy in neuroborreliosis. These analyses were performed in separate. There was no statistically significant difference in recovery time according to therapy. Although one of the aims of the study was to demonstrate prognostic role of therapy, preliminary statistical data processing clearly showed it was a wrong presumption, i.e. therapy had no prognostic value.

In conclusion, it appears that HB scale and acoustic reflex can serve as a predictor tandem for facial

palsy in neuroborreliosis. Yet, comparison with electrophysiological results obtained by standard and other prognostic methods available, recommended in recent studies, should also be taken in consideration[21-23].

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Sažetak

VRIJEDNOSTI KOHLEOSTAPEDIJALNOG REFLEKSA I HOUSE BRACKMANNOVE LJESTVICE KAO PROGNOSTIČKIH POKAZATELJA KLJENUTI LIČNOGA ŽIVCA U NEUROBORELIOZI

A. Sekelj i *D. Đanić*

Lajmska borelioza je vektorom prenosiva infektivna bolest. Kljenut ličnoga živca je u velikom broju slučajeva jedini simptom i znak neuroborelioze. U endemskim krajevima borelioze svaka akutna kljenut ličnoga živca indicira serološku obradu i implicira poseban pristup bolesti. Cilj istraživanja bio je pronaći i potvrditi vrijednost kohleostapedijalnog refleksa i House-Brackmannove (HB) ocjenske ljestvice kao prognostičkih pokazatelja kljenuti ličnoga živca u neuroboreliozi. U istraživanje je bilo uključeno 176 bolesnika s akutnom kljenuti ličnoga živca koji su nakon serološke obrade podijeljeni u tri osnovne skupine: boreliozu, Bellovu kljenut i kljenut ličnoga živca uzrokovanu virusom HSV-1. Vrijeme prijma u bolnicu označeno je kao nulti tjedan, a vrijeme od nastanka kljenuti do javljanja liječniku kao izgubljeno vrijeme. Svakom bolesniku je učinjena preliminarna audiometrija s timpanometrijom i kohleostapedijalnim refleksima, a trenutno stanje kljenuti ličnoga živca ocijenilo se prema HB ocjenskoj ljestvici. Iste pretrage provedene su u još tri mjerenja ambulantno, tj. u trećem, šestom i dvanaestom tjednu od prijma u bolnicu. Bolesnici s dijagnozom borelioze, Bellove kljenuti i HSV-1 razlikuju se prema brzini oporavka kohleostapedijalnog refleksa, tj. oni s boreliozom najsporije su se oporavljali. U svim vremenskim točkama imali su najveći postotak suprastapedijalnih lezija i oporavljali su se kasnije od ostalih dijagnoza. Također, prosječan rezultat na HB ljestvici opadao je kroz vrijeme i to sporije za bolesnike s boreliozom. Prognoza oporavka akustičkog refleksa i kljenuti ličnoga živca prema HB ljestvici nije povezana s izgubljenim vremenom. Rezultati dobiveni ovim istraživanjem čvrsto potvrđuju ulogu kohleostapedijalnog refleksa i HB ljestvice kao prognostičkih pokazatelja kljenuti ličnoga živca u neuroboreliozi.

Ključne riječi: *Neuroborelioza; Lymska bolest; Lični* živac, *kljenut; Refleks, akustični; Serološka obrada; Bellova pareza; Herpesvirus 1, humani; Audiometrija; Akustički impedancijski testovi; Hrvatska*