Proposal of a New Weighted Prognostic Factor Scoring System (WPFSS) in Bell's Palsy

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－ ABSTRACT －

Background and Objectives : To analyze various parameters that influence Bell's palsy prognosis at an early disease stage. **Material and Methods**：In total, 384 patients at Dong-Eui Medical Center in Busan, Korea, were retrospectively assessed from January 2004 to December 2006. The following clinical aspects were analyzed: gender, age, hypertension, postauriclular pain, vertigo, number of days from onset of facial weakness to the commencing treatment, electroneurography (ENoG) results, initial facial palsy grading, and the degree of facial palsy after 3 months. Statistical analyses of the total sum score were performed for patients with different recoveries 3 months post-onset. To accomplish this, a weighted prognostic factor scoring system (WPFSS) that served as an integrated system to analyze multiple predictive factors of Bell's palsy prognosis was created. **Results**：Results from the univariate analysis of recovery indicated that only age, ENoG response, and initial grading of facial palsy were directly correlated with recovery rate in patients with Bell's palsy 3 months post-onset. Using the WPFSS, a distinct gap was observed, which allowed for the factors to be grouped into four distinct sections that were dependent on the recovery rate. Groups with scores below 11 and above 15 points were considered to have a satisfactory recovery rate of greater than 70% and less than 9.1%, respectively. **Conclusions**：The WPFSS may provide an objective criterion for prognostic assessment and implementation of risk-adapted treatment strategies in Bell's palsy patients. **(J Clinical Otolaryngol 2016;27:67-75)**

KEY WORDS：Bell's palsy · Prognosis · Scoring method.

Introduction

Idiopathic facial palsy, also known as Bell's palsy, is the most common cause of palsy resulting from deterioration of facial nerve function. Bell's palsy typically has a favorable prognosis regardless of whether treatment is administered.[1-3] Nevertheless, the majority of patients seek physician care for information regarding prognosis and convalescence.

Several studies have focused on predicting the prognosis of Bell's palsy patients. Such studies have identified the following predictive factors: age,[3-6] hypertension,[3] otalgia or postauricular pain,[7] vertigo,[8] commencement of therapy,[9] severity of palsy 1 month after onset,[9] electrophysiological test results [e.g., electroneurography (ENoG), nerve excitability test (NET), and maximal stimulation test (MST)],[10-14] previous ipsilateral palsy,[11] initial facial palsy grading,[10,15] early beginning of remission,[16] steroid therapy,[3,12,34] topodiagnostic test restuls (e.g., Schirmer test, stapedial re-

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flex test, and electrogustometry),[9,10] diabetes mellitus,[17] Sunnybrook grading at 1 month,[18] and magnetic resonance imaging (MRI) data.[19] Some studies have analyzed the degree of correlation between prognostic factors and Bell's palsy outcome.[7,9,20] However, to date, there are no reports of an integrated scoring system in which a number of clinical factors can be studied to predict Bell's palsy prognosis.

In light of these findings, the goal of this study was to analyze various parameters that influence Bell's palsy prognosis at an early disease stage. To accomplish this, we created a weighted prognostic factor scoring system (WPFSS) that served as an integrated system to analyze multiple predictive factors. We weighted specific factors according to their degree of correlation with a favorable outcome of Bell's palsy.

Materials and Methods

This study was conducted in Dong-Eui medical center in Busan, Korea, from January 2004 to December 2006 and included 384 patients who visited within 21 days of facial weakness onset and had been clinically diagnosed with Bell's palsy if no other cause of facial palsy could be identified. This study was performed by retrospective review of patients' medical records. The patients comprised 188 males and 196 females between 16 and 80 years old (mean 46.5 ± 14.7 years). Recurrent or bilateral cases were excluded.

The severity of the facial nerve paralysis was evaluated on the House-Brackmann grading system (HBGS) proposed by House and Brackmann in 1985.[21] ENoG was performed on all the patients from 3 days to 3 weeks after onset during the acute phase of facial palsy. All patients were treated with oral prednisolone (1 mg/day/Kg) for 10 days: full dosages for first five days, in gradually decreasing dosages for next five days. The patients were simultaneously treated with famcyclovir 750 mg/day for 7 days. For adjunct treatment, all patients were administered vitamin B complex. For eye protection, intensive lubrication was performed with artificial tears and eye ointments in the early phase of treatment. Eye protection with plastic shielding or taping of the eyelids at night prevents trauma while sleeping. Facial massage and acupuncture were added. No patient was treated operatively.

Patients characteristics, clinical facial function and recovery

Medical records were reviewed and analyzed with the following clinical aspects: gender, age, hypertension, accompanying symptoms (postauriclular pain, vertigo), the day of commencing treatment after palsy, ENoG results, initial facial palsy grading, and the degree of facial palsy after three months as a final result. Patients were divided into two groups according to their age: aged over 55 and under 55 years. One group included patients who were treated within 7th days after onset of palsy, while the other group began treatment between the 8th and 21th day.

Analysis of clinical factors and prognosis in Bell's Palsy

In univariate analysis, the eight independent variables included were gender (male=1, female=0), age (over 55 years=1, under 55 years=0), hypertension (present=1, absent=0) postauricular pain (present=1, absent=0), and vertigo (present=1, absent=0), number of days from onset of facial weakness to the commencing treatment (from 8 to 21 days=1, below 7 days=0), degeneration percentages on ENoG (over cutoff point=1, under cutoff point=0) and initial grading of palsy (worse than a standard grade=1, better than a standard grade=0). The response on the ENoG was compared between the normal and involved sides and is presented as the percentage degeneration. Using receiver operating characteristics (ROC) curve analysis, a cut-off point of the ENoG value was determined for the final grade of Bell's palsy at 3 months after onset. For the statistical analysis of prognosis, the ENoG values were divided into two groups based on the cut-off point. Depending on HBGS, a favorable recovery of Bell's palsy was defined as facial palsy that recovered to grade I or II at 3 months after onset of palsy.[3,9]

The grading of Bell's palsy (worse than III=1, better than II=0) at 3 months after onset was evaluated by multivariate analysis as a final result.[11,18] Poor prognosis of facial palsy was considered a dependent variable (poor recovery=1, favorable recovery=0).

Weighted Prognostic Factor Scoring System (WPFSS)

The WPFSS is a categorized system for prediction of prognosis, after weighting and scoring prognostic factors depending on the degree of their correlation with the final result in patients with Bell's palsy.

In the WPFSS, the clinical factors were the significant clinical variables in the cited literature, the prognostic factors were the significant clinical factors according to results of multivariate analysis, and the standard grade was the cut-off point of the initial palsy grade determined for poor recovery at 3 months after onset of palsy.

According to scoring steps in the WPFSS, first, no clinical factors were weighted; second, clinical factor and prognostic factor scores were weighted as the lowest rounded odds ratio of prognostic factors; third, a weighted score (y) was assigned to each prognostic factor. $(y)=X_1X_2$. X_1 is the lowest odds ratio of all prognostic factors, X_2 is the ratio of the prognostic factor regression coefficients to the lowest regression coefficients of all prognostic factors, X_1 and X_2 are rounded to the nearest integer, and finally the score for grade based on the standard grade was increased or decreased by the average lowest odds ratio of the prognostic factors per grade.

Regard to categorization in the WPFSS, after adding up a column of scores, the total sum score and the final result of Bell's palsy was analyzed in univariate analysis. As the result of the analysis, distinct gap section was divided and categorized.

Statistical analysis

For multivariate analysis, logistic regression was performed using SPSS (Version 18.0, SPSS Inc, Chicago, IL). For univariate analysis, the chi-squared test and t-test was used. Null hypotheses of no difference were rejected if p-values were less than 0.05.

Results

Patient characteristics and clinical facial function recovery

For prognostic relevance, clinical information of 384 patients and results of clinical tests are summarized in Table 1. Clinical facial nerve function according to the HBGS scale was grade II in 8 patients (2.1%), grade III in 94 patients (24.5%), grade IV in 191 patients (49.7%), and grade V in 92 patients (23.7%). The outcome at 3 months after onset, HBGS grade was I in 215 patients (56%), II in 91 (23.7%) patients, III in 61 (15.9%) patients, IV in 9 (2.3%) patients, and V in 8 (2.1%) patients. Three hundred seven (79.7%) patients showed a favorable recovery (HBGS I or II) from the palsy.

Analysis of clinical factors and prognosis in Bell's palsy

Patients with poor recovery rates at 3 months of Bell's palsy are described with individual variables in Table 2. No statistically significant differences were found in gender ($p<0.333$) and postauricular pain ($p<0.098$). In contrast, patients aged over 55 years were significantly worse than patients who were under 55 years ($p<0.008$). Patients with hypertension ($p<0.006$) or vertigo ($p<0.025$) had higher risk of a poor recovery. The poor recovery rate in patients who started treatment late (more than 8 days after onset) was significantly higher than those starting within 7 days after onset ($p<0.001$).

Depending on the results of ROC curve analysis, the cut-off point of the ENoG value for the final grade of Bell's palsy at 3 months after onset was determined to be 50%. Based on this cut-off point, the ENoG values were divided into two groups (over 50% degeneration=1, under 50% degeneration=0). The poor recovery rate was significantly higher in patients who exhibited a poor response (over 50% degeneration)

Table 1. Summary of the clinical information and descriptive statistics in 384 Patients with Bell's palsy

Variable	Division	Patients [No. (%)]
Gender	Female	196 (51.0)
	Male	188 (48.8)
Age	<55 years old	273 (71.1)
	≥55 years old	111 (28.9)
Hypertension	Absent	328 (85.4)
	Present	56 (14.6)
Postauricular pain	Absent	134 (34.9)
	Present	250 (65.1)
Vertigo	Absent	365 (94.8)
	Present	20 (5.2)
Commencement of therapy after onset	Within 7 days	312 (81.3)
	More than 8 days	72 (18.8)
ENoG	≥50%	234 (60.9)
	<50%	150 (39.1)
Initial HBGS grading	II	8 (2.1)
	III	94 (24.5)
	IV	191 (49.7)
	V	91 (23.7)
	VI	0 (0)
HBGS grading at 3 month after onset	I	216 (56.0)
	II	91 (23.7)
	III	61 (15.9)
	IV	9 (2.3)
	V	8 (2.1)

ENoG : Electroneurography, HBGS : House-Brackmann grading system

on ENoG ($p<0.001$).

Depending on HBGS, the poor recovery rate was significantly higher in grade IV or more than in grade III or less ($p<0.001$), therefore the initial palsy grade IV was the standard grade determined for a poor recovery at 3 months after onset of palsy. Clinical findings conceivably influencing prognosis of facial palsy were analyzed by logistic regression. Age ($p<0.033$), initial grading of facial palsy ($p<0.001$), degeneration more than 50% on ENoG ($p<0.001$) were statistically significantly associated with poor prognosis of facial palsy at 3 month after onset (Table 3).

Recovery rate according to the weighted prognostic factor scoring system (WPFSS)

Table 4 shows the results of the scoring. There were ten variables: Age (over 55 y=2, under 55 y=0), hypertension (present=1, absent=0), postauricular pain (present=1, absent=0), vertigo (present=1, absent=0), degeneration percentages on ENoG (over 50%=4, under 50%=0), and five initial HBGS grades. Depending on the result of multivariate analysis in Table 3, there were no weight on hypertension, postauricular pain, and vertigo. Age had a weight of 2 (the odds ratio rounded off for age), and the ENoG value received a weight of 4 (the odds ratio for age multiplied by the regression coefficients ratio of ENoG and age). In HBGS, initial facial grade IV was a standard grade with a poor prognosis and had a weight of 6 (the odds ratio for age multiplied by the regression coefficients ratio of age and initial HBGS grading). Each initial grade was increased or decreased by the average odds

ratio for age per grade and based on a weight of 6 for HBGS grade IV; thus, HBGS grade II=2, III=4, V=8, and VI=10.

In univariate analysis, there was statistically significant between the total sum score and the final result of Bell's palsy ($p<0.001$). Distinct gap section was divided into four sections depending on a favorable recovery rate (very high, high, low, and very low). The score in each section (total sum range of score=2-20) was ≤ 8 (very high), 9−11 (high), 12−14 (low), and

Table 2. Univariate analysis of correlation between variables studied and poor prognosis at 3 months after onset in 384 patients with Bell's palsy

Variable	No. (%) of patients with poor prognosis	Univariate p-value
Gender		
Female	36 (18.4)	0.333
Male	42 (22.3)	
Age		
Less than 54 years old	46 (16.8)	0.008*
More than 55 years old	32 (28.8)	
Hypertension		
Absent	59 (18.0)	0.006*
Present	19 (33.9)	
Postauricular pain		
Absent	21 (15.7)	0.098
Present	57 (22.8)	
Vertigo		
Absent	70 (19.2)	0.025*
Present	8 (40.0)	
Commencement of therapy after onset		
Within 7 days	53 (17.0)	0.001*
More than 8 days	25 (34.7)	
ENoG		
More than 50%	24 (10.3)	0.000*
Less than 50%	54 (36.2)	
Initial HBGS grading		
II	0 (0.0)	0.000*
III	0 (0.0)	
IV	30 (15.7)	
V	48 (52.7)	

* : statistically significant. ENoG : Electroneurography, HBGS : House-Brackmann grading system

Table 3. Multivariate analysis predicting the probability of poor prognosis for Bell's palsy from the condition 3 months after onset in 384 patients with Bell's palsy

Independent variable	Regression coefficients	Standard error	Wald s tatistics	p-value	Odds ratio (95% CI)
Age	0.681	0.318	4.57	0.033*	1.976 (1.058−3.688)
ENoG	1.091	0.312	12.233	0.000*	2.976 (1.615−5.484)
Initial HBGS grading	1.885	0.269	48.973	0.000*	6.589 (3.886−11.172)

* : Statistically significant. CI : confidential interval, ENoG : electroneurography, HBGS : House-Brackmann grading system

Table 4. Variable scoring by prognostic result in Weighted Prognostic Factor Scoring System (WPFSS)

Variable	Variable score				
	Good prognosis		Poor prognosis		
Age	≤55 aged=0		>55 aged=2		
Hypertension	Absent=0		Present=1		
Postauricular pain	Absent=0		Present=1		
Vertigo	Absent=0		Present=1		
Commencement of therapy	≤7 days=0		>8 days=1		
ENoG	≥50 %=0		<50 %=4		
Initial grading of palsy (HBGS)	2 (II)	4 (III)	6 (IV)	8 (V)	10 (VI)

ENoG : Electroneurography, HBGS : House-Brackmann grading system, weighted factor are indicated in bold ; Age score was weighted two times, ENoG score was weighted four times, Initial HBGS grading IV score of palsy was weighted six times and HBGS grade II, III, V, and VI score was increased or decreased an average of the odd ratio of age per grade based on the grade IV as a standard grade

Table 5. Relation to total sum of individual variable score and favorable recovery in weighted prognostic factor scoring system (WPFSS)

	Categorization of result			
Total sum score (Range : 2−20)	≤8	9−11	12−14	≥15
HBGS grade I or II %	87.2−100	70−78.7	42.9−59.4	0−9.1
EC of predicted result	Very high	High	Low	Very low

HBGS : House-Brackmann grading system, EC indicates enrollee category, Favorable recovery : HBGS grade I or II at 3 months after onset of Bell's palsy

≥15 (very low). The favorable recovery (HBGS grade I or II) rates was 87.2−100% (very high), 70−78.7% (high), 42.9−52.4% (low), and 0−9.1% (very low) ($p<0.001$) (Table 5).

Discussion

The author attempted to create a composite indicator using the weighted factor analysis to predict recovery at 3 months after onset in Bell's palsy patients. Although various studies have suggested a prediction analysis for Bell's palsy using individual clinical parameters or several in combination,[2-4,7,9,20,22] no single test or clinical factor has been identified to predict individual prognosis with sufficient accuracy, probably due to the involvement of multiple factors in the pathogenesis of Bell's palsy. This study is unique in that it enables prediction of the prognosis of Bell's palsy by creating a composite indicator using the degrees of correlation between various clinical factors and the final outcome.

Among factors currently known as prognostic factors, age, ENoG and the degree of initial palsy is trustworthy.[7,10,13,14] In univariate analysis of this study, age, hypertension, vertigo, commencement of therapy, ENoG, and initial grading of palsy showed significant differences with outcome at 3 months after onset of Bell's palsy. Gender and postauricular pain did not differ. Unlike the result of this study, Kasse et al has reported there was statistical significance between postauricular pain or otalgia and the final result.[8] In multivariate analysis of recovery at 3 months after onset of palsy, age, ENoG, and initial grading of facial palsy showed significant differences but hypertension, postauricular pain, vertigo, and commencement of therapy time after onset of palsy were not associated with recovery.

The influence of age on outcome has been reported to be highly significant. Katusic et al. observed a higher rate of incomplete recovery in the age range above 55 years.[5,7] But Yeo et al. reported there were no significant differences in age between the complete re-

covery and incomplete recovery group in the Bell's palsy.[23] In this study, patients over 55 years of age had a significantly lower recovery rate than did younger patients.

Regarding the ENoG, the literatures show that the ENoG has an important role in the early estimation of the severity and prognosis of facial palsy.[24,25,27] In agreement with the literature, this study showed that the result of ENoG has significant prognostic value. In this study, based on ROC curve analysis, 50% facial nerve degeneration was determined as the ENoG cut-off point for the prediction of poor prognosis. In multivariate analysis, the ENoG response was a significant factor for poor prognosis between the under 50% degeneration group and over 50% degeneration group. However, the author believes that the cut-off point determined by the ROC curve analysis cannot be applied universally because ENoG may include technical errors;[27] therefore, validation checks are required in each clinical trial.

For initial palsy grading, the facial palsy grade was subjectively appraised under grading system such as House-Brackmann grading system,[21] Sunnybrook,[28] and Yanagihara[29] scoring system. The former one has been used more universally and the latter two facilitate creation of a finer scoring classification.[28,29] They appear to have a high statistical correlation with each other to estimate for prognosis and assess treatment results.[28-31] In the present study, there was the most obvious statistical difference for poor prognosis between HBGS grade IV or more group and HBGS grade III or less group. The initial grade of facial palsy was divided into each grade to propose a better weighted factor analysis for creating a composite indicator. HBGS grade IV was defined as the standard grade. And each grade was given weighted score by result of multivariate analysis. In univariate analysis, total sum score of each variable and favorable recovery reached statistically significant level to predict recovery from palsy

Regarding the follow-up, Murakami et al. reported a randomized, multicenter, controlled study that mean time for recovery in prednisolone group and prednisolone-valacyclovir group was 76.4 days and 70.7 days, respectively.[32] According to Peitersen, a minimum follow-up of one year is necessary to achieve a steady state in the facial muscles.[3] In other studies, the follow-up was given as at least three months,[10] six months,[11] or one year after the onset of the facial palsy.[16] The author agrees that a minimum follow-up of 1 year is necessary in facial palsy which is worse than HBGS grade IV.

Until now, several statistical methods have been proposed to meet the necessary and sufficient conditions for prediction of the prognosis in Bell's palsy.[7,9,20] Ushio et al. suggested a formula using the correlation coefficient found by statistical methods for predicting the prognosis of patients with facial palsy.[7] Ikeda et al. classified clinical findings into three grades: low risk, moderate risk, and high risk.[9] Takemoto et al. reported a statistical formula using the relationship of the results of ENoG and the Yanagihara score for a poor prognosis.[20] However, they left something to be desired because it is extremely difficult to compare the results due to result in their relatively small cohort,[7,10] analysis in many different statistical ways,[7,15,20] and the null hypotheses of these studies.[7,9,11,14] Moreover, the high spontaneous recovery rate of the disease[3] and selection bias makes the interpretation difficult.

A detailed scoring system for the initial palsy, such as the Sunnybrook system, is required to suggest a more reliable composite indicator system.[18,28] Also, a year or more of follow up might yield better results.[3,16] In the creation of a composite indicator, the factor scores calculated from correlation coefficients may lead to creation of a faulty composite indicator because the larger factor scores corresponding to each factor are used in the composite indicator and parts of known prognostic factors are also used as factors of the composite indicator. The error between predicted and actual outcome was relatively small in cases of early maximal recovery but tended to be larger for cases with longer and poorer recoveries. To reduce bias in the

WPFSS, the author tried to encompass as many significant factors as possible depending on the result of statistical analysis. However, retrospective study has several limits to establish cause and result.[33] Therefore, a prospective study with a large controlled cohort is required to evaluate the usefulness of the WPFSS system.

Conclusion

In this study, among patients age 55 years or older, an ENoG response of less than 50% and an initial HBGS grade IV or more were especially important factors for prediction of a poor prognosis of Bell's palsy. On the basis of the WPFSS, the percentage with a favorable recovery rate (HBGS I or II) was over 70% and below 9.1% in the groups with scores below 11 points and above 15 points, respectively. The WPFSS will provide an objective criterion for prognostic assessment of risk-adapted treatment strategies in patients with Bell's palsy. However, a prospective study with a large controlled cohort is required to assess the usefulness of this system.

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