Prognosis for Sudden Sensorineural Hearing Loss: A Retrospective Study Using Logistical Regression Analysis

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Abstract: Sudden sensorineural hearing loss (SSNHL) remains a controversial problem with respect to etiology and the factors that might predict prognosis. We used logistical regression analysis to determine which factors are most strongly related to outcome for patients with SSNHL. In so doing, we employed a retrospective chart-review study. The study group consisted of 296 patients (296 ears). The outcome of SSNHL was *cured* (full recovery) in 64, *recovered* (partial recovery) in 175, and *no change* in 57. We performed separate analyses on those in the no-change and partial-recovery groups and on those in the no-change and full-recovery groups. The following factors were studied as explanatory variables: age; number of days until presentation; vestibular symptom; initial mean hearing level at 0.25 kHz, 0.5 kHz, 1 kHz, 2 kHz, and 4 kHz; and treatments (steroids, satellite ganglion block). In the first analysis, for patients in the no-change and recovered groups, the factors most strongly related to outcome were the number of days until presentation and age. The second analysis, for the no-change and cured groups, revealed that the number of days until presentation, vestibular symptom, age, and initial mean hearing level were most strongly related to outcome. Our results will increase the ability to predict the outcome for SSNHL.

Key Words: logistical regression analysis; prognostic factor; sudden sensorineural hearing loss

Sudden sensorineural hearing loss (SSNHL) is a symptom of cochlear injury. It is characterized by sudden onset and, within a few hours, reaches its maximum peak. It may be accompanied by vertigo and tinnitus [1]. Many hypotheses have been advanced to explain its etiology: vascular diseases, viral inflammation, trauma, or other lesions. In most cases, the cause of SSNHL cannot be identified. The lack of understanding of the etiological mechanism of SSNHL has rendered the development of a specific treatment very difficult and, currently, empirical therapies are used. The prognosis of SSNHL is variously reported as ranging from cured to no change. Thus, determining the prognosis of this disease is difficult. In previous reports, the prognosis of SSNHL was affected by various factors, such as age, the number of days from onset until presentation, initial hearing level, the method used for treatment, and the presence of vestibular symptoms and the like [1–3].

Although previous investigations have assessed the relation of individual factors to outcome, to our knowledge, few studies have used multivariate analysis to evaluate the contributions of multiple factors. When more than one factor may affect outcome, multivariate analyses, which can adjust for the effects of other factors, are necessary. Logistical regression analysis provides a model for multivariate analyses that can examine at regular intervals the relation between several factors and disease (or all events) after adjusting for the influence of other factors [4]. We used multiple logistical regression analysis to determine which factors are most strongly related to outcome in patients with SSNHL.

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PATIENTS AND METHODS

The patients had consecutively received a diagnosis of SSNHL and had presented to Fukuoka University Hospital between January 1983 and December 2004. SSNHL was diagnosed strictly according to criteria established by Japan's Sudden Deafness Research Committee (Table 1). A total of 296 patients (296 ears) met the criteria: 144 men and 152 women, ranging in age from 6 to 84 years (mean, 50.8 years). On presentation, all patients underwent otorhinological examinations and were confirmed to be free of ear disease, such as otitis media. We performed pure-tone audiometry at 250 Hz, 500 Hz, 1 kHz, 2 kHz, and 4 kHz at regular intervals after presentation. From the day of presentation, we provided treatment with steroids (prednisolone, 60-mg taper); vasodilators (10% low-molecular-weight dextran, 500 ml); vitamin B_{12} (1,500 μg); and satellite ganglion block (1% lidocaine [Xylocaine], 4 ml). Two hundred and nine patients were admitted to the hospital for treatment, and 87 received treatment on an outpatient basis. The baseline characteristics of patients are shown in Table 2.

We evaluated the prognosis for hearing recovery, which was the fixed hearing level, using the criteria established by the Sudden Deafness Research Committee (as described later). Recovery of hearing level to 20 dB HL or less for all 5 frequencies (0.25 kHz, 0.5 kHz, 1 kHz, 2 kHz, and 4 kHz) or an improvement to a level similar to that of the healthy side was designated as *cured* (full recovery). Improvement of 10 dB HL or more (mean hearing level at five frequencies) was evaluated as *recovered* (partial recovery). Other responses to treatment were assessed as *no change*.

We performed logistical regression analyses with outcome as the dependent variable, assigning scores of 0 for *no change*, 1 for *recovered*, and 2 for *cured*. We also performed analyses for those in the no-change and recovered groups alone and for those in the no-change and cured groups alone. The following factors were studied: age; number of days until presentation; vestibular symptom (vertigo or dizziness or both); initial mean hearing level at 0.25 kHz, 0.5 kHz, 1 kHz, 2 kHz, and 4 kHz; and treatment (steroids, satellite ganglion block therapy). Age, number of days until presentation, and mean hearing level were handled as continuous variables. Absence of drug therapy was scored as 0, and the use of drug therapy was scored as 1. We statistically analyzed the data with the StatView 5.0 (SAS Institute, Cary, NC, USA). We tested statistical significance with the Wald chi-square test (two-sided), and we estimated odds ratio and 95% confidence interval by logistical regression.

Table 1. Criteria for Diagnosis of Sudden Sensorineural Hearing Loss

Main symptoms
Sudden onset of hearing loss (able to say clearly when it appeared)
Sensorineural hearing loss (usually severe)
Unknown cause
Accessory symptoms
Possibly accompanied by tinnitus
May be accompanied by vertigo, nausea, or vomiting (without recurrent episodes)
No cranial nerve symptom other than from eighth nerve

Note: Definite diagnosis involves all the foregoing criteria; probable diagnosis centers on the first two.

Table 2. Characteristics of Patients

Factors	No. of Ears
Affected side	
Right	158
Left	138
Gender	
Male	144
Female	152
Vestibular symptom	126
Therapy	
Steroids	268
Low-molecular-weight dextran	27
Vitamin B_{12}	291
Satellite ganglion block	237
Outpatient	87
Inpatient	296
Smoking	82

RESULTS

The outcome of SSNHL was cured in 64 ears (22%), recovered in 175 (59%), and no change in 57 (19%). The results of logistical regression analyses are shown in Tables 3 and 4. The odds ratio expresses the degree of change in odds associated with a 1-unit change in an explanatory variable. We performed the first analysis for those in the no-change and recovered groups. The factors most strongly related to outcome were the number of days until presentation ($p = .0001$) and age ($p = .0387$). A longer period until presentation and advanced age were associated with lower rates of recovery. We found no significant relation to outcome for other factors (see Table 3).

We performed the second analysis for those in the no-change and cured group. The number of days until presentation ($p = .0007$), vestibular symptom ($p = .0002$), age ($p = .0004$), and initial mean hearing level ($p = .0032$) were most strongly related to outcome (see Table 4). A longer period until presentation, subjective

Table 3. Prognostic Factors of Sudden Sensorineural Hearing Loss (No Change and Recovered)

Factor	Regression Coefficient	Standard Error	*p* Value (chi-square)	Odds Ratio (95% CI)
Age	−0.026	1.196	.0387	0.974 (0.951–0.999)
Days until presentation	−0.103	0.024	.0001	0.902 (0.861–0.945)
Initial mean hearing level	0.003	0.008	.7582	1.003 (0.987–1.019)
Vestibular symptom	0.008	0.362	.9820	1.008 (0.496–2.050)
Steroids	−0.832	0.661	.2079	0.435 (0.119–1.589)
Satellite ganglion block	0.034	0.437	.9372	1.035 (0.439–2.438)

CI = confidence interval.

Table 4. Prognostic Factors of Sudden Sensorineural Hearing Loss (No Change and Cured)

Factor	Regression Coefficient	Standard Error	*p* Value (chi-square)	Odds Ratio (95% CI)
Age	−0.053	0.015	.0004	0.948 (0.921–0.976)
Days until presentation	−0.136	0.040	.0007	0.873 (0.807–0.945)
Initial mean hearing level	−0.032	0.011	.0032	0.968 (0.948–0.989)
Vestibular symptom	−1.956	0.526	.0002	0.141 (0.050–0.397)
Steroids	−0.037	0.855	.9651	0.963 (0.180–5.146)
Satellite ganglion block	−0.907	0.513	.0774	0.404 (0.148–1.105)

CI = confidence interval.

Table 5. Prognostic Factors of Sudden Sensorineural Hearing Loss (No Change and Cured): Hearing Level

Factor	Regression Coefficient	Standard Error	*p* Values (chi-square)	Odds Ratios (95% CI)
250 Hz HL	−0.022	0.017	0.2040	0.978 (0.946–1.012)
500 Hz HL	0.027	0.029	0.3605	1.027 (0.970–1.087)
1 kHz HL	−0.032	0.030	0.2871	0.969 (0.914–1.027)
2 kHz HL	0.079	0.027	0.0035	1.083 (1.026–1.142)
4 kHz HL	−0.088	0.019	<0.0001	0.916 (0.883–0.950)

CI = confidence interval.

vestibular symptom, advanced age, and profound hearing loss were associated with lower rates of cure. No other factor was significantly related to the outcome.

Furthermore, we considered hearing level at five frequencies separately (0.25, 0.5, 1, 2, and 4 kHz) (Table 5). In patients in the no-change and cured groups, hearing levels at 2 and 4 kHz were significantly related to the outcome. Profound hearing loss at 2 kHz and mild hearing loss at 4 kHz were associated with high rates of cure.

DISCUSSION

Logistical regression analysis provides a model for multivariate analyses that can examine at regular intervals the relation between several factors and disease (or all events) after adjusting for the influence of other factors. When more than one factor might affect outcome, multivariate analyses, which can adjust for the effects of other factors, are necessary [4]. Although previous investigations have assessed the relation of individual factors to outcome, to our knowledge, few studies have used multivariate analysis to evaluate the contributions of multiple factors. We used multiple logistical regression analysis to determine which factors are most strongly related to outcome in patients with SSNHL. The strength of this study was its use of relatively rigorous diagnostic procedures, reasonable case representation, and the large number of consecutive patients (suggesting that the reported associations might not be chance findings).

The outcome of SSNHL was related to the number of days until presentation and age. A long interval before the presentation and advanced age were associated with lower rates of recovery and cure (full recovery). Furthermore, subjective vestibular symptoms and profound hearing loss were associated with lower rates of cure. Our observation that age is a significant prognos-

ticator differs with that of Moskowitz et al. [3] and Roman et al. [5] but agrees with that in several previous reports [1,6]. According to several reports, advanced age, hypertension, diabetes, and hyperlipidemia are poor prognostic factors, suggesting that microvascular dysfunction in the cochlea gives rise to poor outcome [1,7].

Time from onset of hearing loss to presentation also appears to be significant in prognosis. Most studies have demonstrated that presentation after 7–10 days results in a poor outcome [2,3]. Some have proposed that this is owing to a self-selection process, whereby those who recover quickly do not seek medical care.

The severity of the initial hearing loss is used as an indication of more severe damage to the cochlea. A severe initial loss theoretically lowers the potential of recovery of hearing. Profound hearing loss at 2 kHz and mild hearing loss at 4 kHz were associated with high rates of cure. Up-sloping audiograms have been reported to have a better prognosis for recovery [1,3,6,8]. The correlation between high-tone SSNHL and poor prognosis was presented in a study by Linssen and Schultz-Coulon [9]. The correlation between high-tone hearing loss and vertigo was explained by the anatomical proximity of the basal turn of the cochlea and vestibule. Cochlear lesions may cause vestibular damage by endolymphatic alterations via ductus reunions. Vertigo may be an indicator of the extent and severity of the injury [8]. In our study, 68% of patients with profound hearing loss (mean hearing level > 90 dB) had vertigo, whereas 33% of patients with mild hearing loss (mean hearing level < 90 dB) had vertigo. On the basis of our results, we suggest that vertigo is an adverse prognostic sign for the outcome of hearing.

We also saw no significant relation between outcome and therapy (steroids and satellite ganglion block). This does not indicate that the outcome would have been the same without treatment, because virtually all patients in this series received some drug therapy. None of the therapeutic options has established itself as fully effective in SSNHL, even if some studies found vasodilators, anticoagulants, plasma expanders, and steroids beneficial [1].

The treatment of SSNHL is still open to debate, even after 60 years of research. The only treatment that has proven more effective than placebo is the early application of steroids. Cochlear damage seemed to be limited by the antiinflammatory properties of the steroids [1]. What has become clear is that SSNHL is not the result of a single disease process. Confounding the issue is the high spontaneous recovery rate. To prove a treatment is effective, a statistical analysis in a randomized double-blind study must be used. However, such a study is not possible in our community. The lack of a universally accepted definition for SSNHL and for its recovery limits the ability to compare and evaluate the treatment protocols.

CONCLUSION

We presented a case series of 296 patients with SSNHL and used multiple logistical regression analysis to determine which factors are most strongly related to outcome. We found the prognosis for SSNHL to be better in patients who present early and young and who have mild hearing loss and to be worse in those with vertigo.

First, immediately after onset of disease, the patient should consult a physician as soon as possible for diagnosis and treatment. Then, predicting good prognosis in younger patients with mild hearing loss and no vestibular symptom is possible. Thus, our results will increase the ability to predict the outcome for SSNHL. However, physicians must discuss with their patients the etiology and treatment options and jointly determine a treatment plan.

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