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Original Article

The Efficacy of Varied Oral Steroid Doses on the Treatment of Sudden Sensorineural Hearing Loss

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OBJECTIVE: This study aimed to compare the efficacy of oral prednisolone prescribed to admitted patients in two ways: full-dose prednisolone (continuous maximum tolerable doses of prednisolone) and tapering doses of prednisolone (steadily reduced doses of prednisolone).

MATERIALS and METHODS: Fifty-four sudden sensorineural hearing loss (SSNHL) patients, admitted to our hospital between January 2012 and April 2013, were enrolled as the study subjects. Based on the specialists' clinical experience, 27 patients received full-dose prednisolone (Group I). The other 27 received a tapering dose of prednisolone (Group II). We analyzed the efficacy of the two management groups by assessing the patients' hearing recovery after 6 months of treatment.

RESULTS: After 6 months, the average absolute hearing gain and recovery rate in Group I were 23.94 dB and 74% respectively, which was better than the 19.83 dB and 63% in Group II. However, there was no statistically significant difference in the efficacy of treatment between the groups. One patient in Group I developed the side effect of acute closed-angle glaucoma. The other 53 patients were free from severe side effects.

CONCLUSION: Prescription of a tapering dose of prednisolone is highly recommended as routine management for patients with sudden sensorineural hearing loss. Compared with full-dose treatment, it has equivalent efficacy while reducing the risk of severe side effects.

KEY WORDS: Sudden sensorineural hearing loss, steroid, side effect

INTRODUCTION

Hearing impairment is a familiar complaint in otolaryngological clinical practice. An emergency visit to a physician is often arranged when the impairment occurs overnight, whereas patients with slowly progressive hearing loss caused by aging or chronic diseases usually postpone their visit to the hospital.

A common type of urgent hearing impairment that is frequently experienced in otolaryngology is sudden sensorineural hearing loss (SSNHL). A wide range of causes have been postulated, and various types of management have been reported for SSNHL. However, systemic steroid therapy remains the initial treatment option of choice [1-3]. Nevertheless, there is currently no consensus on dosage or route of administration. In addition, many cases of side effects after treatment have been reported, and in severe cases, the side effects have been reported to cause morbidity or even mortality [4, 5].

Prescription of a tapering dose of oral prednisolone is routine management for sudden sensorineural hearing loss (SSNHL) in our hospital. However, we wanted to know whether a higher dosage would advance the treatment and result in a better prognosis. The objective of the current study was therefore to investigate whether a better prognosis could be achieved with a higher dosage of prednisolone (full-dose oral prednisolone) in dealing with SSNHL.

MATERIALS and METHODS

Data on 115 SSNHL patients admitted to our hospital between January 2012 and April 2013 were collected. Among these patients, we excluded those without records of at least 6 months of follow-up and those with severe chronic diseases, such as diabetes, cancer, and liver cirrhosis. In total, 54 patients were enrolled as the study subjects. All of the patients received routine auditory brainstem response and magnetic resonance imaging (MRI) examinations, and no evidence of brain tumors was noted. The treatments were intrinsically empiric. Based on the specialists' clinical experience, 27 patients received full-dose prednisolone (continuous maximum tolerable doses of oral prednisolone) (Group I, Day 1-7: prednisolone: 1 mg/kg/day; max: 60 mg/day), and the other 27 patients received tapering doses of prednisolone (steadily reduced doses of oral prednisolone) (Group II, Day 1-3: max; Day 4-7: 2/3 max). On admission, all of the patients in both groups were prescribed a plasma expander to assist with treatment (Day 1-3: dextran 1000 mL/day; Day 4-7: dextran

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500 mL/day). On discharge, all patients were further prescribed a maintenance dose of oral steroids (prednisolone: 20 mg/day × 7 days). The data were then analyzed using student's t-test and x^2 test to demonstrate variations in hearing improvement 6 months after the treatment in both groups. To measure improvements, we used the evaluation of hearing impairment according to the average hearing thresholds of the five frequencies in pure-tone audiometry: 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz [6]. The analysis also took into consideration the variables and suspected factors that may have influenced the prognosis or efficacy of treatment, including age, sex, body mass index, hypertension, ear fullness, otalgia, tinnitus, vertigo, dizziness, and interval between onset of hearing loss and start of treatment.

RESULTS

A comparison of the two study groups (Table 1) showed that the average initial hearing loss was 60.65 dB in Group I and 64.80 dB in

Table 1. Comparison of the full-dose and tapering dose prednisone groups

	Full-dose oral prednisolone	Tapering dose oral prednisolone
Evaluation period	January 2012 ~ April 2013	January 2012 ~ April 2013
Dosage scheme	Day 1-7: Prednisolone 60 mg/day	Day 1-3: Prednisolone 60 mg/day
	MBD: Prednisolone 20 mg/day x 7 day	Day 4-7: Prednisolone 40 mg/day
Assisted treatment	Day 1-3: Dextran 1000 mL/day	Day 1-3: Dextran 1000 mL/day
	Day 4-7: Dextran 500 mL/day	Day 4-7: Dextran 500 mL/day
No. of patients (n)	27 (17 women, 10 men)	27 (16 women, 11 men)
Average age (years)	46 (range 21-77)	46 (range 23-74)
Average body mass index	23.48	22.93
Average initial hearing loss (dB)	60.65	64.80
Average time for start of treatment (day)	8.11 (range 1-30)	4.44 (range 1-21)
No. of patients (n (%)) with start of treatment within 7 days	19 (70%)	24 (89%)
No. of patients (n (%)) with start of treatment within 7-14 days	4 (15%)	2 (7%)
No. of patients (n (%)) with start of treatment after 14 days	4 (15%)	1 (4%)
Hypertension (n (%))	2 (7%)	4 (15%)
Ear fullness (n (%))	11 (41%)	12 (44%)
Tinnitus (n (%))	22 (81%)	25 (93%)
Dizziness (n (%))	6 (22%)	13 (48%)
Vertigo (n (%))	3 (11%)	9 (33%)
Six months after treatment:		
Average absolute hearing gain (dB)	23.94	19.83
Cured (n (%))	9 (33%)	8 (30%)
Marked recovery (n (%))	4 (15%)	2 (7%)
Slight recovery (n (%))	7 (26%)	7 (26%)
Unchanged (n (%))	7 (26%)	10 (37%)
Side effect of prednisolone treatment:		
Closed-angle glaucoma (n (%))	1 (3.7%)	0 (0%)
Slight facial edema (n (%))	6 (22.2%)	3 (11.1%)
Abdominal discomfort (n (%))	3 (11.1%)	2 (7.4%)

1. We used the evaluation of hearing impairment according to the average hearing thresholds of the five frequencies in pure-tone audiometry (PTA): 250Hz, 500Hz, 1000Hz, 2000Hz, and 4000Hz [6].
2. We then divided the patients into 4 levels according to different degrees of recovery, verified with PTA [6]:
(1) Cured: All five frequencies were within normal levels, had recovered to the same hearing level before the episode of SSNHL, or had recovered to the same level as the other ear.
(2) Marked Recovery: An improvement in the average hearing level of the five frequencies >30dB.
(3) Slight Recovery: An improvement in the average hearing level of the five frequencies >10 dB but ≤30 dB.
(4) Unchanged: An improvement in the average hearing level of the five frequencies ≤10 dB.
MBD: maybe discharge; dB: decibel; N: number

Group II. After 6 months of treatment, the average absolute hearing gain in Group I was 23.94 dB, which was better than the 19.83 dB in Group II. However, further statistical analysis suggested no significant difference in prognosis between Group I and Group II (p=0.423).

We then divided the patients into 4 groups according to different degrees of recovery, verified with pure-tone audiometry [6]:

1. Cured: All five frequencies were within normal levels, had recovered to the same hearing level before the episode of SSNHL, or had recovered to the same level as the other ear.
2. Marked Recovery: An improvement in the average hearing level of the five frequencies >30 dB.
3. Slight Recovery: An improvement in the average hearing level of the five frequencies >10 dB but ≤30 dB.
4. Unchanged: An improvement in the average hearing level of the five frequencies ≤10 dB.

After 6 months of treatment, the total recovery rate was 74% in Group I, in which 9 patients were cured (33%), 4 patients had a marked recovery (15%), 7 patients had a slight recovery (26%), and 7 patients were unchanged (26%). The total recovery rate was 63% in Group II, in which 8 patients were cured (30%), 2 patients had a marked recovery (7%), 7 had a slight recovery (26%), and 10 patients were unchanged (37%). There was no significant difference between the two groups (p=0.739).

In Group I, the average interval between onset of hearing loss and start of treatment was 8.11 days (range 1-30 days). After the onset of hearing loss, 19 patients received treatment within 7 days (70%), 4 patients received treatment between 7-14 days (15%), and 4 patients received treatment after 14 days (15%). In Group II, the average interval between onset of hearing loss and start of treatment was 4.44 days (range 1-21 days). After the onset of hearing loss, 24 patients received treatment within 7 days (89%), 2 patients received treatment between 7-14 days (7%), and 1 patient received treatment after 14 days (4%). Twenty-three patients (85%) in Group I received medical treatment within 14 days after the onset of symptoms, and in Group II, the percentage was even higher (26/27, 96%). However, there was no statistically significant association between the interval from onset of hearing loss to start of treatment and prognosis (p=0.218).

In addition, we further analyzed the factors that may have affected the prognosis and efficacy. The analysis showed that there were no statistically significant differences in sex (p=1.000), age (p=0.970), body mass index (p=0.633), hypertension (p=0.386), ear fullness (p=0.783), or tinnitus (p=0.224) between the two groups. However, patients with the symptoms of dizziness (p=0.046) and vertigo (p=0.049) in both groups had a statistically significantly poorer prognosis.

All of the 54 patients completed the treatment, as expected. However, one patient (3.7%) in Group I versus no patients (0%) in Group II developed the side effect of acute closed-angle glaucoma (p=1.000); 6 patients (22.2%) in Group I versus 3 patients (11.1%) in Group II experienced slight facial edema (p=0.467); and 3 patients (11.1%) in Group I versus 2 patients (7.4%) in Group II complained of abdominal discomfort (p=1.000). Accordingly, it appeared as though there was a greater incidence of side effects in Group I, although this difference did not reach statistical significance.

DISCUSSION

According to the guidelines published in 2012 by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS), SSNHL is defined as "idiopathic hearing loss in one or both ears of at least 30 dB over at least 3 consecutive frequencies occurring over a 72-hour period" [1].

It has been reported that the annual incidence of SSNHL is 5-20 per 100,000 of the population and that similar numbers of men and women are affected [1, 7]. SSNHL can occur at any age but most commonly affects those from 43-53 years of age [8]. The main causes and risk factors of SSNHL are uncertain; however, 90% of cases are presumed to be associated with vascular, viral, or multiple etiologies [1].

Aside from the typical symptom of hearing loss, other common symptoms in SSNHL include tinnitus, ear fullness, vertigo, otalgia, and ear paresthesia. More than 90% of the patients with unilateral SSNHL complain of tinnitus [7, 9], which poses the greatest difficulty in treatment and severely affects the patients' quality of life [1]. It has been reported that 33% of SSNHL patients concurrently have the symptom of dizziness and that 66% suffers from vertigo [1, 9], both of which impair the quality of life. Moreover, the results of this study showed that dizziness and vertigo were predictors of a poor prognosis in the SSNHL patients.

It is difficult to diagnose SSNHL purely according to the patient's primary complaint. Physical examinations and investigations of disease progression are essential to make an accurate diagnosis, of which a detailed description of disease progression plays a very important role. Information, such as time of onset and the incidence of specific diseases or injuries, is helpful in making a diagnosis. Risk factors of hearing impairments, such as acute otitis media, acute otitis externa, a foreign body in the ear canal, ear drum perforation, and cholesteatoma, must be excluded through physical examinations. In clinical practice, all patients suspected of having SSNHL are required to undergo pure-tone audiometry. The results provide not only helpful information for the diagnosis but also information for follow-up evaluations and prognosis. In addition, MRI and auditory brainstem response are recommended in the management of patients with SSNHL, particularly when retrocochlear pathology is suspected [1, 10]. Retrocochlear pathology is a lesion developing in the vestibular cochlear nerve, brainstem, or brain. It has been reported that 2.7%-10.2% of SSNHL patients are diagnosed with a cerebellopontine angle tumor (C-P angle tumor) with the aid of MRI [1, 10]. MRI, administered with gadolinium, has been reported to have a high sensitivity in detecting retrocochlear pathology [10]. Due to poor resolution performance in the detection of C-P angle tumors and small brainstem lesions, computed tomography is recommended only for patients with contraindications to MRI [1]. In addition, routine laboratory tests are not necessary for SSNHL, and there is no need to arrange blood tests unless the patient has an unusual medical history or is highly suspected of having specific diseases, such as Lyme disease [11]. Among the 115 patients in the current study, the blood test of one patient was positive for syphilis. This case was then excluded from the study and transferred to the Department of Infectious Diseases.

Despite the fact that no single treatment option has been proven to be the most effective in the management of SSNHL, steroid treatment remains the management of choice [2, 3], of which medication includes prednisolone, methylprednisolone, and dexamethasone. The routes of administration include oral, intravenous, and intratympanic injections [2].

The guidelines published by the AAO-HNS recommend prednisone for patients with SSNHL within 2 weeks after the diagnosis, with a recommended dose of 1 mg/kg/day (max: 60 mg/day), given as a single dose for 10-14 days [1]. Another study suggested that intratympanic injections should only be considered when systemic steroids (either orally or intravenously) are proven to be ineffective or when patients have contraindications to high doses of systemic steroids (e.g., severe cases of diabetes) [1, 12].

Even though steroids are recommended as the routine treatment for SSNHL, inconsistent results regarding the efficacy have been reported [13]. In clinical practice, 32%-65% of patients with SSNHL may spontaneously recover within 2 weeks, which indicates that the actual incidence rate of SSNHL may be underestimated [13, 14]. One study pointed out that most patients treated with steroids report improvements in hearing, that those with slight hearing loss usually recover spontaneously whether treated with steroids or not, and that patients with severe hearing loss show no significant improvement after treatment [15]. However, another study came to a different conclusion by analyzing pure-tone audiometry and word recognition scores and found that severe SSNHL patients receiving steroid treatment had a better prognosis than those without treatment [16]. Analysis of patients with slight hearing loss, on the other hand, did not demonstrate any remarkable differences in prognosis whether or not they received treatment [16]. Another retrospective review found that compared with patients who received low doses of glucocorticoids or who were treated later in their course, a better prognosis was detected in those who received high doses of prednisone (at least 60 mg/day) within 2 weeks after diagnosis [17]. In the current study, most patients (49/54, 91%) received oral prednisolone treatment within 2 weeks after the onset of SSNHL. There was no statistical significance in the prognosis with regards to the interval between onset of hearing loss and initiation of treatment. To examine the relationship between steroid dosage and the prognosis of SSNHL, we compared full-dose (Group I) and a tapered dose (Group II) for differences in hearing gain and also found that there was no significant difference in the prognosis between full-dose and a tapered dose of steroid treatment.

In clinical practice, there are many common side effects caused by systemic steroids, including central adiposity, dyslipidemia, myopathy, glucose intolerance, diabetes mellitus, glaucoma, peripheral edema, hypertension, and peptic ulcer disease (Table 2) [4, 5]. Steroids are also the most common cause of pharmacologically induced diabetes. Clinical observational studies have shown that as many as 46% of the admitted patients undergoing steroid treatment develop new-onset diabetes [18].

The incidence of side effects is closely associated with factors, such as treatment period and dosage. Nevertheless, a uniform standard for both factors still remains uncertain. Due to individual differences in susceptibility, side effects may still occur, even when the patients are prescribed with a lower dosage or treated over a shorter period of time. Attempting a lower dosage or treatment over a shorter period of time to achieve equivalent efficacy is generally agreed to be acceptable in clinical practice [19].

The findings of the current study showed that among the 27 patients in Group I, one patient developed the side effect of glaucoma. However, the other 53 patients were free from severe side effects. Despite the fact that no statistical significance was detected in the association between steroid dosage and the incidence of side effects, we suggest that steroids have both advantages and disadvantages and should therefore be administered with caution.

Numerous factors may affect the prognosis of patients with SSNHL. Among them are the interval between onset of hearing loss and start of treatment, degree of hearing loss, age, diabetes, hypertension, cancer, dosages of steroids, treatment period, and incorporation of adjuvant therapies. Since the aim of this study was to elucidate the influence of steroid dosage on prognosis, we selected patients with similar physical conditions. We found no statistical significance in the correlation between steroid dosage and prognosis. Nevertheless, as this study included only a limited number of cases, the exact difference in the efficacy of both managements can not be definitively concluded. In addition, the exclusion of patients with severe chronic

Table 2. Major side effects associated with glucocorticoid therapy

Dermatologic and soft tissue	**Neuropsychiatric**
Skin thinning and purpura	Euphoria
Cushingoid appearance	Dysphoria/depression
Alopecia	Insomnia/akathisia
Acne/Hirsutism	Mania/psychosis
Striae/Hypertrichosis	Pseudotumor cerebri
Eye	**Infectious disease**
Posterior subcapsular cataract	Heightened risk of typical infections
Elevated intraocular pressure/glaucoma	Opportunistic infections
Exophthalmos	Herpes zoster
Cardiovascular	**Gastrointestinal**
Arrhythmias	Premature atherosclerotic disease
Hypertension	Gastritis/Peptic ulcer disease
Perturbations of serum lipoproteins	Pancreatitis
Steatohepatitis	Genitourinary and reproductive
Visceral perforation	Amenorrhea/infertility
Renal	**Genitourinary and reproductive**
Hypokalemia	Amenorrhea/infertility
Fluid volume shifts	Intrauterine growth retardation
Bone	**Muscle**
Osteoporosis	Myopathy
Avascular necrosis	
Endocrine disease	
Diabetes mellitus	
Hypothalamic-pituitary-adrenal insufficiency	

diseases, such as diabetes, may have caused underestimation of the actual incidence of the side effects of the steroid treatment. Thus, the conclusions of our study still require further investigations for confirmation.

In conclusion, we recommend a tapering dose of prednisolone as routine treatment for SSNHL. Compared with full-dose treatment, it has equivalent medical efficacy, prevents over-use of medical resources, and reduces the risk of potential side effects. Furthermore, the findings of this study showed that SSNHL patients with the symptoms of dizziness or vertigo tend to suffer a poorer prognosis.

Ethics Committe Approval: Ethics committee approval was not received due to the retrospective nature of this study.

Informed Consent: Informed consent was not obtained due to the retrospective nature of this study.

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REFERENCES

1. Stachler RJ, Chandrasekhar SS, Archer SM, Rosenfeld RM, Schwartz SR, Barrs DM, et al. Clinical practice guideline: sudden hearing loss. Otolaryngol Head Neck Surg 2012; 146: 1-35. [CrossRef]
2. Rauch SD, Halpin CF, Antonelli PJ, Babu S, Carey JP, Gantz BJ, et al. Oral vs intratympanic corticosteroid therapy for idiopathic sudden sensorineural hearing loss: a randomized trial. JAMA 2011; 305: 2071-9. [CrossRef]
3. Haynes DS, O'Malley M, Cohen S, Watford K, Labadie RF. Intratympanic dexamethasone for sudden sensorineural hearing loss after failure of systemic therapy. Laryngoscope 2007; 117: 3-15. [CrossRef]
4. van Raalte DH, Quwens DM, Diamant M. Novel insights into glucocorticoid-mediated diabetogenic effect: towards expansion of therapeutic options? Eur J Clin Invest 2009; 39: 81-93. [CrossRef]
5. Hoes JN, Jacobs JWG, Boers M, Boumpas D, Buttgereit F, Caeyers N, et al. EULAR evidence-based recommendations on the management of systemic glucocorticoid therapy in rheumatic diseases. Ann Rheum Dis 2007; 66: 1560-7. [CrossRef]
6. Nomura Y. Diagnostic criteria for sudden deafness, mumps deafness and perilymphatic fistula. Acta Otolaryngol Suppl 1988; 456: 7-8. [CrossRef]
7. Fetterman BL, Luxford WM, Saunders JE. Sudden bilateral sensorineural hearing loss. Laryngoscope 1996; 106: 1347-50. [CrossRef]
8. Rauch SD. Clinical practice: Idiopathic sudden sensorineural hearing loss. N Engl J Med 2008; 359: 833-40. [CrossRef]
9. Yimtae K, Srirompotong S, Kraitrakul S. Idiopathic sudden sensorineural hearing loss. J Med Assoc Thai 2001; 84: 113-9.
10. Weber PC, Zbar RI, Gantz BJ. Appropriateness of magnetic resonance imaging in sudden sensorineural hearing loss. Otolaryngol Head Neck Surg 1997; 116: 153-6. [CrossRef]
11. Peeters N, van der Kolk BYM, Thijsen SFT, Colnot DR. Lyme disease associated with sudden sensorineural hearing loss: case report and literature review. Otol Neurotol 2013; 34: 832-7. [CrossRef]
12. Han CS, Park JR, Boo SH, Jo JM, Park KW, Lee WY, et al. Clinical efficacy of initial intratympanic steroid treatment on sudden sensorineural hearing loss with diabetes. Otolaryngol Head Neck Surg 2009; 141: 572-8. [CrossRef]
13. Conlin AE, Parnes LS. Treatment of sudden sensorineural hearing loss: II. A meta-analysis. Arch Otolaryngol Head Neck Surg 2007; 133: 582-6. [CrossRef]
14. Mattox DE, Simmons FB. Natural history of sudden sensorineural hearing loss. Ann Otol Rhinol Laryngol 1977; 86: 463-80.
15. Wilson WR, Byl FM, Laird N. The efficacy of steroid in the treatment of idiopathic sudden hearing loss: a double-blind clinical study. Arch Otolaryngol 1980; 106: 772-6. [CrossRef]
16. Chen CY, Halpin C, Rauch SD. Oral steroid treatment of sudden sensorineural hearing loss: a ten year retrospective analysis. Otol Neurotol 2003; 24: 728-33. [CrossRef]
17. Slattery WH, Fisher LM, Iqbal Z, Liu N. Oral steroid regimens for idiopathic sudden sensorineural hearing loss. Otolaryngol Head Neck Surg 2005; 132: 5-10. [CrossRef]
18. Donihi AC, Raval D, Saul M, Korytkowski MT, DeVita MA. Prevalence and predictors of corticosteroid-related hyperglycemia in hospitalized patients. Endocr Pract 2006; 12: 358-62. [CrossRef]
19. Da Silva JAP, Jacobs JWG, Kirwan JR, Boers M, Saag KG, Ines LBS, et al. Safety of low dose glucocorticoid treatment in rheumatoid arthritis: published evidence and prospective trial data. Ann Rheum Dis 2006; 65: 285-93. [CrossRef]