

ORIGINAL ARTICLE

Prognosis in Sudden Hearing Loss:

Is it the Disease or the Treatment that Determines the Prognosis?

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Objective: To compare the various treatment modalities for Sudden Hearing Loss (SHL) and to determine whether the prognosis depends upon the treatment or upon the disease itself.

Materials and Methods: A total of 160 patients with SHL that were examined retrospectively between January 1995 and December 2006 were reviewed. Out of these, 115 patients, who a) presented within the first 15 days, b) completed monthly audiometric controls in the follow-up period and received c1) classical medical treatment (plasma volume expanders, vasodilators, diuretics, anti-aggregates, sedative agents and vitamin-B complex), c2) plus carbogen inhalation and/or c3) corticosteroid (systemic) therapy, c4) and/or intratympanic steroid therapy, were included into the study. Audiograms were received on the 5th 10th and 30th day of the treatment and hearing is compared based on "Pure Tone Averages" (PTA) at 500, 1000, 2000 and 4000 Hz.

Results: Patients who received treatment within the first 5 days showed 35.2% improvement at PTA while others showed only 20.5% improvement ($p=0.022$). Patients with vertigo showed 18.2% mean percentile improvement in PTAs, whereas this recovery was 32.9% in the audiograms of the patients without vertigo ($p=0.018$). The percentile of improvement in PTAs was 49.7% for ascending type audiogram group which was significantly better than other groups ($p=0.001$). According to severity of hearing loss, recovery of mild hearing losses was higher, compared to other groups ($p=0.018$). A statistically significant difference was not detected between treatment modalities.

Conclusions: All treatment methods used for the SHL provided certain degree of improvement in the audiometric measurements. But, the only statistically significant factor was the beginning of the therapy with in the first five days. Associated vertigo may have a negative effect on the outcome. Main prognostic factors were time of presentation, and presence of additional factors such as vertigo, severity of hearing loss and audiogram configurations, rather than the therapeutical agents used.

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Sudden Hearing Loss (SHL) is described as sensorineural hearing loss of 30 dB or higher at minimum three consecutive speech frequencies that develops within 3 days or less.^[1] Although its incidence is reported as 5-20/100.000 per year, it is believed to be higher as patients with SHL do not seek medical care because of spontaneous recovery. It is more common in young and middle aged people without a predilection for any gender. SHL is unilateral in more than 90% of the cases.^[2]

Inner ear has a tenuous blood supply and perfusion of cochlea could easily be compromised.^[3-6] Endocochlear

potential may be reversed after 10 to 20 minutes of cochlear ischemia but it is irreversibly lost after 30 minutes of ischemia.^[4,7] Various diseases and factors have been accused as the cause of SHL; ^[4-11] some of them can be diagnosed by history, physical examination and with certain tests; but in majority of cases it is not possible to elucidate the cause despite extensive evaluation.

There is no consensus on treatment of idiopathic cases; different forms of antiviral agents, vasodilators, volume expanders, defibrinating agents, calcium antagonists, anti-inflammatory drugs, have been used. Because of its

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anti-inflammatory effect, corticosteroids are the most widely accepted treatment modality for idiopathic cases.^[4,12-15] But as 65% of the cases show spontaneous recovery, the effect of medical treatment on the prognosis is a subject of controversy.^[16]

In this study, we aimed to compare the effect of treatment modalities on the outcome and to define the impact of the prognostic factors on the course of the disease.

Materials and Methods

A total of 160 patients who were hospitalized and treated because of SHL, in Department of Otorhinolaryngology-Head and Neck Surgery of Medical School of Uludag University between January 1995 and December 2006 were retrospectively evaluated for the study. Out of these, 115 patients who included the criteria: a) presentation within the first 15 days, b) completed monthly audiometric controls in the follow-up period and received c1) classical medical treatment (plasma volume expanders, vasodilators, diuretics, anti-aggregates, sedative agents and vitamin-B complex) c2) plus carbogen inhalation and/or c3) corticosteroid (systemic) therapy, and/or c4) intratympanic steroid therapy, were included into the study.

Remaining 45 patients admitted to our department later than 15 days after onset of SHL and excluded from the study to be able to standardize the early onset of treatment.

All patients who presented SHL were interrogated about the duration of the symptom, whether they had an upper respiratory tract infection, or exposed to barotrauma, acoustic trauma; for presence of vertigo or tinnitus and any systemic disease. All patients underwent complete otolaryngological and neuro-otological examination including evaluation of cranial nerves. Pure tone audiogram, SISI and Speech Discrimination tests, tympanograms and vestibular caloric tests were performed for all patients. Complete blood count, sedimentation rate, leukocyte formula, levels of folic acid and vitamin B12, serum lipid profile and thyroid function tests were performed to

reveal a systemic cause. Brainstem and other intracranial structures were evaluated by internal acoustic canal and cranial magnetic resonance imaging (MRI).

Audiograms were received during the 5th 10th and 30th (with one or two days of delay due to weekends) day of the treatment and hearing is compared based on "Pure Tone Averages" (PTA) at 500, 1,000, 2,000 and 4,000 Hz.

Hearing losses were classified as mild (20-40 dB), moderate (41-60 dB), severe (61-80 dB) and profound (81 dB and more) according to the average of pure tone hearing thresholds at 500, 1000, 2000 and 4000 Hz. Hearing losses were also classified into 4 groups as ascending type (hearing losses at 250-500 Hz), descending type (hearing losses at 4,000-8,000 Hz), flat type (less than 20 dB difference between the best and worst thresholds) and total or subtotal (over 85db) hearing losses.^[7,16]

Patients were divided into two groups: "early treatment group" receiving treatment within the first 5 days and "late treatment group" that received treatment between 5th and 15th days according to onset of the treatment.

All patients received classical medical treatment including plasma expanders (dextran %10-500 ml infusion in 3 hours, for 10 days), vasodilator agents (pentoxifylline 300 mg infusion in 3 hours, two times a day, for 10 days), sedative agents (mianserin 10 mg for 10 days), anticoagulants (acetyl salicylic acid 100 mg for two months), and vitamin complexes (B1, B6, B12 complexes, for two months) and bed rest was recommended for all.

Systemic (oral) corticosteroid therapy (40 mg methylprednisolone or 16 mg dexamethasone for adults and 1 mg per kilogram methylprednisolone for children) was used if patients had severe or profound hearing losses at the presentation or if any improvement was stated within the first 5 days. The dose of steroids was tapered and stopped during the 10th day. Intratympanic steroid (1 ml of 4 mg

dexamethasone once a week for three weeks) was administered if patients did not benefit from systemic corticosteroids.

Carbogen therapy (95% oxygen + 5% carbondioxide inhalation for 5 days) has been started in our department in year 2000 and later all patients received this therapy in addition to the classical medical treatment. Audiograms before and after treatment were compared in addition to comparison of percent changes between the treatment groups.

Twenty-seven patients (23.5%) received only classical medical treatment (Group 1); 23 patients (20%) received classical medical treatment plus systemic corticosteroid therapy (Group 2); 32 patients (27.8%) received classical medical treatment plus carbogen therapy (Group 3), 26 patients (22.7%) received both systemic corticosteroid and carbogen therapies together with classical medical treatment (Group 4) and 7 patients (6%) received classical medical treatment, systemic corticosteroid therapy, carbogen therapy and intratympanic steroid injection (Group 5).

Baseline audiograms and control PTA at 500, 1000, 2,000 and 4,000 Hz were performed on 5th day, on 10th day and first month.

Statistical analysis of all symptoms and signs were performed by Kruskal-Wallis and Mann-Whitney U Tests and $p < 0.05$ was accepted as statistically significant.

Results

Study included 69 male and 46 female patients with their ages ranging from 7 to 85 years (mean=40.9, median=40). Time to presentation ranged from 1 to 15 days. (mean=6.05, median=5).

Fifty-nine cases (51.4%) received treatment within 5 days after the onset of hearing loss, while 56 cases (48.6%) received treatment in 6th to 15th days. Patients who received treatment within the first 5 days showed 35.2% improvement at PTA while others showed only 20.5% improvement, and this difference was found to be statistically significant ($p=0.022$). Starting the treatment within the first 5 days has been found as a good prognostic factor (Table 1).

Table 1. Mean percentile improvements on 10th day audiograms in Pure Tone Averages (PTA) , according to some predisposing factors.

		(n)	Pre-treatment PTA (dB) \pm sd	Mean Percentile improvement \pm sd	p
Gender	Male	69	61.4 \pm 22.9*	-0.298 \pm 0.351	0.447
	Female	46	61.0 \pm 26.4*	-0.253 \pm 0.383	
Age	≤ 50	82	59.3 \pm 24.8*	-0.287 \pm 0.383	0.807
	≥ 51	33	66.1 \pm 22.3*	-0.265 \pm 0.315	
Alcohol	User	6	45.3 \pm 23.7*	-0.215 \pm 0.478	0.975
	Not user	109	62.1 \pm 24.1*	-0.284 \pm 0.359	
Smoker	no	80	62.4 \pm 23.8*	-0.300 \pm 0.337	0.418
	yes	35	58.5 \pm 25.3*	-0.236 \pm 0.420	
Effected ear	Right	42	64.0 \pm 24.2*	-0.253 \pm 0.364	0.864
	Left	67	59.8 \pm 24.6*	-0.290 \pm 0.372	
	Bilateral	6	57.5 \pm 21.4*	-0.367 \pm 0.293	
Time Lag	1-5 days	59	60.8 \pm 25.0*	-0.352 \pm 0.399	0.022
	6-15 days	56	61.7 \pm 23.6*	-0.205 \pm 0.308	
Vertigo	no	77	58.8 \pm 24.5*	-0.329 \pm 0.361	0.018
	yes	38	66.1 \pm 23.3*	-0.182 \pm 0.352	
Tinnitus	no	20	66.5 \pm 27.2*	-0.225 \pm 0.275	0.311
	yes	95	60.1 \pm 23.6*	-0.292 \pm 0.380	
Sense of fullness	no	81	64.1 \pm 23.3*	-0.297 \pm 0.342	0.645
	yes	34	54.6 \pm 25.5*	-0.241 \pm 0.414	

* Pretreatment p value for predisposing factor $P > 0.05$; sd: standard deviation

No systemic disease that could cause SHL was determined in any patient. There were 35 smokers (30.4%) and 6 alcohol users (5.3%) among the study group. Six cases (5.3%) had symmetric involvement of both ears. Age, gender, involvement of right or left ear, smoking and alcohol had no effect on the treatment (Table 1).

Tinnitus accompanied to hearing loss in 95 cases (82.6%) whereas 38 cases (33%) complained from the presence of vertigo. Thirty-four cases (29.5%) reported sense of fullness in their ear. Hearing improvement was detected among 18.2% of patients with vertigo, whereas this improvement was present among 32.9% of the patients without vertigo ($p=0.018$). Although tinnitus and of sense of fullness in the ear did not affect the results of the treatment, response to treatment were lower if vertigo accompanied the hearing loss (Table 1).

Hearing losses were classified as mild in 28 cases (24.4%); moderate in 25 cases (21.7%), severe in 25 cases (21.7%) and profound in 37 cases (32.2%) according to pure tone audiograms. In the mild hearing loss group, recovery was higher as compared to profound group ($p=0.002$) and severe hearing loss group also had better recovery rates as compared to profound group ($p=0.034$) (Table 2).

Audiogram configurations showed ascending type hearing loss in 25 cases (21.7%); descending type hearing loss in 32 cases (27.8%); flat type hearing loss in 27 cases (23.5%) and total or subtotal hearing loss in 31 cases (27%). The percentile improvement for the

ascending group was 49.7%, which was significantly better than descending group (%20.1) and total or subtotal hearing loss group (%18.4), and the p values were 0.001, <0.001 respectively (Table 2).

No statistically significant difference was detected between treatment modalities ($p=0.283$). Better recovery rates were observed in the groups where carbogen therapy was added (group 3+group 4) as compared to other groups (group 1+group 2), however it was not statistically significant ($p=0.102$) (Table 3).

Discussion

SHL is a matter of utmost urgency; but its pathogenesis and treatment is still controversial. Many factors are supposed to play role in the etiology of SHL; however no etiology can be elucidated in the majority of the cases. SHL is usually unilateral and each ear is equally involved.^[17] In a series of 1220 cases by Shaia and Sheehy,^[18] bilateral SHL incidence was reported as 4%. In our group of patients, incidence of bilateral SHL was similar (5,3%). Hughes and colleagues,^[7] recommends eliminating syphilis and autoimmune inner ear diseases in cases of bilateral SHL.

Known etiologic causes are studied in detail to determine an appropriate treatment modality. Patients should be inquired about use of ototoxic drugs and endocrine, metabolic and other systemic examinations should be performed. It should be remembered that 10% of patients with vestibular schwannoma present themselves with SHL and 1 to 2% of patients with

Table 2. Mean percentile improvements according to severity of hearing loss and audiogram configurations.

		n	Pre-treatment PTA (dB) \pm sd	Mean percentile improvements \pm sd	P(Kruskal Wallis)	P(Mann Whitney U)
Severity of Hearing loss	1.mild	28	27.5 \pm 1.5	-0.389 \pm 0.328	0.026	0.002 ₍₁₋₄₎
	2.moderate	25	51.1 \pm 1.2	-0.191 \pm 0.462		
	3.severe	25	69.4 \pm 1.3	-0.380 \pm 0.389		0.034 ₍₃₋₄₎
	4.profound	37	88.6 \pm 0.5	-0.191 \pm 0.255		
Audiogram configurations	1.ascending	25	43.4 \pm 3.9	-0.497 \pm 0.306	0.02	
	2.descending	32	60.2 \pm 3.2	-0.201 \pm 0.309		0.001 ₍₁₋₂₎
	3.flat	27	46.2 \pm 3.5	-0.284 \pm 0.490		
	4.total or subtotal	31	89.8 \pm 0.2	-0.184 \pm 0.256		<0.001 ₍₁₋₄₎

sd: standard deviation

PTA: Pure Tone Average (dB)

Table 3. Comparison of results of the treatment modalities according to mean percentile improvements on 10th day audiograms in Pure Tone Averages (PTA)

Treatment modalities	1	2	3	4	5
n =	27	23	32	26	7
Pre-treatment PTA (dB)	58.6±25.1*	67.2±19.5*	51.3±25.7*	66.9±22.3*	67.7±23.6*
Percentile improvements ±sd	-0.189±0.344	-0.269±0.374	-0.365±0.407	-0.287±0.349	-0.192±0.136
p =	0.283				

Treatment modalities

1: Medical

2: Medical+Systemic corticosteroid

3: Medical +Carbogen

4: Medical+Systemic corticosteroid +Carbogen

5: Medical+Systemic corticosteroid +Carbogen+Intratympanic Steroid

PTA: Pure Tone Average (dB)

* Pretreatment p value of PTAs $p > 0.05$

sd: standard deviation

SHL have vestibular schwannoma.^[8,19] Patients who referred to our department were evaluated with cranial and internal acoustic canal MRI imaging; to exclude vestibular schwannoma, large vestibular aqueduct syndrome and other possible retrocochlear lesions. In some series of SHL, certain cases were diagnosed as Meniere's disease by later arising symptoms.^[8,20]

Patients without a known etiology of SHL, have been defined as idiopathic and they received one of the treatment modalities directed to possible causes. Patients are suggested to have bed rest, and to refrain from stress, alcohol, smoking and use of ototoxic drugs.^[21] There are numerous treatment modalities for this disorder, thus various results have been reported. The goal of combined therapy is to benefit from synergic effects. The medical agents that are used for SHL in many centers are usually directed to suppress inflammation and autoimmune injury, to decrease the edema and to regulate the microcirculation.^[21]

It has been supposed that individual response to treatment of SHL is influenced by many factors. Severity of the hearing loss at the beginning, presence of vertigo, configuration of the audiogram and time-lag between the onset of SHL and the beginning of the treatment are the most common factors.^[14,17,22-24] A generally shared opinion is that patients receiving treatment within 7-10 days after the onset of SHL show better prognosis.^[3,17,25] In a study by Tran Ba Huy

and Sauvage,^[26] on 326 patients, no difference was observed between 1st and 6th day of the treatment if the treatment has been started within the first week. In our study, comparison of time-lags within first 5 days and within 6th to 15th days, confirmed the need to start the treatment as early as possible. In our study, 59 cases received treatment within 5 days after the onset of hearing loss and improvement found to be statistically significant ($p=0.022$) in this group.

Presence of tinnitus has been reported to positively affect the reversibility of hearing loss in various studies.^[25,27-29] Danino and colleagues, performed a study on 60 patients with SHL and found that hearing was partially or completely reversible in 80% of the cases ($n=48$) and 71% of them had accompanying tinnitus.^[30] Otherwise, in a study by Ceylan and colleagues, estimated that, SHL was unaffected by tinnitus or type of audiogram (except for midfrequencies).^[24] In our study, 95 of cases (82.6%) with SHL had accompanying tinnitus, but no statistically significant difference was observed between the cases with and without tinnitus.

Improvement of hearing in SHL patients with vertigo were found to be relatively lower in various studies.^[3,23,24,27,31] Fetterman and colleagues, proposed that vertigo had no effect on the reversibility of hearing in SHL patients.^[32] In our cases, 38 cases (33%) had accompanying vertigo and the percentage of improving

of hearing loss in these patients was 18.2% where this rate was 32.9% for the cases without vertigo. This figure may suggest that presence of vertigo can be a poorer prognostic factor. Age is another factor that affects the prognosis in hearing loss. It has negative effect on prognosis during the childhood and over the age of 50-60.^[3,17,19,32-34] But in some studies, age found to have no correlation in SHL prognosis.^[24,25] Also in our study no significant difference was found between the patients over and below the age of 50 (Table 1).

In regard to the type of hearing loss and outcomes of the treatment, ascending type of hearing loss affecting lower frequencies can be classified as a good prognostic factor.^[17,8,25,29] In our study patients with ascending type of hearing loss has also showed better recovery rates than other groups (Table 2). Twenty-five cases (21.7%) had ascending type of audiogram initially and their hearing was improved in 49.7% ($p < 0.05$). It is much more difficult to improve the hearing thresholds among patients with severe (total or subtotal) hearing loss.^[24,25,27,34] Byl,^[3] has reported 83% improvement among the patients with mild hearing loss and 22% for the patients with severe hearing loss. In contrast, Wilson and colleagues, reported recovery in 76% of their patients with hearing loss over 90 dB.^[13] Recovery is also poor in the descending type of hearing loss that demonstrates reduction at 4,000-8,000 Hz.^[23] In our study, recovery rate was 20.1% for this group of patients and only 18.4% of the patients with total or subtotal hearing loss recovered. In regard to the type of audiogram and level of thresholds cases with mild hearing loss and having ascending type of audiograms showed better response to treatment (Table 2). Cases with this type of hearing loss may present endolymphatic hydrops and/or may have the first attack of a future fluctuating hearing loss.

Wilkins and colleagues, retrospectively evaluated 132 patients and compared the 'shotgun protocol' which included most of the drugs with another group that were treated with some of these drugs included in the above protocol and found no statistically significant

difference between the improvement rates of these groups.^[19] Same study has showed no statistically significant difference between the spontaneous recovery rates and recovery rates after treatment. Intratympanic steroid injection has demonstrated positive effect on the outcomes in many studies.^[35-39] Although our study also did not demonstrate a significant difference among the treatment modalities, better recovery rates were observed in the groups when carbogen therapy was added (Table 3).

In conclusion, efficacy of the treatment is decreased with the late induction of treatment. Presence of vertigo and total or subtotal hearing loss were also unfavorable prognostic factors, whereas efficacy of treatment is higher in patients with ascending type audiograms and who admitted within the first 5 days of hearing loss. These results indicate that symptoms of the disease impacts prognosis more than the content of the treatment. We believe that there is no significant difference between the treatment modalities, thus components of the treatment should not be further increased.

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