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Original Article

The effects of meteorological factors and air pollution on prognosis of idiopathic sudden sensorineural hearing loss

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ABSTRACT

Aim: To evaluate the effect of air pollution parameters and meteorological factors on the prognosis of idiopathic sudden sensorineural hearing loss (ISSNHL).

Methods: 40 patients diagnosed with ISSNHL who were treated in our clinic between 2015 and 2018 were examined retrospectively. Meteorological data including average temperature (T_{mean}), maximum and minimum temperature (T_{max} *and* T_{min}), relative humidity, and air pollution parameters including sulfur dioxide (SO2) and particulate matter (PM 10). Data of 10 days prior to the disease and 14 days after the treatment were analyzed.

Results: When the distribution of patients according to the seasons were examined, it was found that 12 (30%) of the patients were seen in autumn, 11 (27.5%) in spring, 9 (22.5%) in winter, and 8 (20%) in summer. When the T_{max}, T_{min}, T_{mean} values obtained as of the initiation of the treatment were compared, it was found that the values of the group without recovery were significantly lower. Relative humidity values were significantly lower in the group without recovery in pre-treatment and post-treatment measurements. No significant difference was found between the recovery groups in SO2 and PM10 values in pre-treatment and post-treatment measurements.

Conclusion: It was observed that relative humidity, T_{max}, T_{min}, T_{mean} values may affect prognosis in ISSNHL patients in our study. In addition, SO2 and PM10 were not associated with ISSNHL recovery rates. Our study is the first in the literature in terms of evaluating the relationship between air pollution parameters and ISSNHL prognosis.

Keywords: Sudden sensorineural hearing loss, meteorological factors, air pollution, particulate matter.

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Introduction

Sudden hearing loss (SHL) which is an emergency case developing within 72 hours is defined as at least 30dB sensorineural hearing loss at three consecutive frequencies. Although there are many hypotheses for its etiology such as viral, vascular and autoimmune pathologies, etiopathogenesis of SHL remains unclear [1,2].

Since viral infections are considered one of the important etiological factors of idiopathic sudden sensorineural hearing loss (ISSHL), it is believed that meteorological conditions may affect the initiation and prognosis of ISSHL. Weather changes have been shown to be involved in the pathogenesis of various diseases by suppressing the immune system [3,4]. The results of the studies in the literature investigating the relationship between weather conditions and the development of ISSHL are different [5–8].

The increasing air pollution around the world in parallel with global urbanization and industrialization reveals concerns about its negative effects on health. Particulate matter (PM) is a common air pollutant consisting of a mixture of solid and liquid particles suspended in the air. Particulate matter with a diameter of ≤10 μm (PM10) is the most harmful to human health among all air pollutants [9–11]. It has been reported that inhaled endotoxins in PM can contribute significantly to the induction of respiratory inflammation and dysfunction [12]. Epidemiological studies have shown a relationship between cardiovascular and respiratory diseases and atmospheric PM10 and SO2 levels [13,14]. Vascular disorders are also considered to have an important role in the pathogenesis of SSNHL. ISSHNL has been shown to be associated with an increased incidence of cardiovascular disease [15,16]. This relationship suggests that air pollutants may play a role in the pathogenesis of ISSNHL. Studies evaluating the effect of meteorological factors on the prognosis of ISSNHL are limited and their results are controversial. There are no previous studies investigating the effects of air pollution parameters on the prognosis of ISSNHL. The aim of this study is to evaluate the effect of air pollution parameters and meteorological factors on the prognosis of idiopathic sudden sensorineural hearing loss (ISSNHL).

Materials and Methods

In this retrospective study, the files of patients diagnosed with idiopathic sudden sensorineural hearing loss in our clinic between 2015 and 2018 were examined. Patients who received a single treatment protocol, who started the treatment within 1 week of the disease and who did not start the treatment at another center were included in the study. Patients having an unclear specific initiation date, previous autological surgery, cerebellopontine angle pathology, chronic otitis media, Meniere's disease, hypertension and diabetes were excluded from the study. A standard treatment protocol was applied to all patients. (250mg i.v. methylprednisolone on the first day followed by 1mg/kg/day i.v. methylprednisolone for a total of 14 days, decreasing the dose by 20 mg every 3 days).

The study protocol was approved by the local ethics committee (Number: 2019/136) and the study was conducted in accordance with the principles of the Helsinki Declaration.

Audiological evaluation

Standard audiometric evaluation including 250 Hz, 500 Hz, 1 kHz, 2 kHz, 4 kHz and 6 kHz thresholds was performed on all patients. ISSNHL patients were divided into groups according to the Siegel's criteria recommended by the American Academy of Otolaryngology-Head and Neck Surgery (3). Complete recovery was classified as having a final pure tone average (PTA) of less than 25 dB. Partial recovery was classified as recovery of more than 15 db in PTA and having a final PTA of 25-45 dB. Mild recovery was classified as recovery of more than 15 db in PTA and having a final PTA of >45 dB. No recovery was

classified as recovery of less than 15 db in PTA and having a final PTA of >75 dB.

Meteorological data

Meteorological data was obtained from the web-based national air quality monitoring network. All patients were living in the same region having the same climatic conditions. 4 meteorological parameters mean temperature *(T_{mean})*, maximum temperature *(T_{max})*, minimum temperature *(T_{min})*, average relative humidity) and 2 air pollution parameters (sulfur dioxide (SO2) and PM10) were controlled 1-7 days before ISSNHL and 14 days after ISSNHL. The relationship between the mean value of the parameters before and after onset of ISSNHL and recovery rates were examined.

Statistical analyses

For the descriptive statistics, numerical variables were expressed as mean ± standard deviation or median [minimum maximum], and categorical variables were expressed as number and percentage. The normality assumption was examined with the Shapiro-Wilks test. Kruskal-Wallis test was used for comparing groups, considering the number of observations. In case of a difference, paired comparison test was used to determine the group/groups causing the difference. Regarding the analysis of the changes over time, Paired t-test was used when parametric test assumptions were met. Wilcoxon test was used in case of it was not available. The relationship between categorical variables was examined by Chi square test. $P < 0.05$ was accepted as statistically significant in all the analyses. Analyses were performed using IBM SPSS v.21.

Results

28 were male (30%) and 12 were female of the patients in the study. The mean age was 49.5 ± 14.53 years. Hearing loss was unilateral in all patients (62.5% right and 37.5 left). Pure tone average before treatment was 57.33 ± 21.62. When the distribution of patients was examined according to the seasons, it was found that 12 (30%) of the patients were seen in autumn, 11 (27.5%) in spring, 9 (22.5%) in winter, and 8 (20%) in summer. According to the Shigel criteria, 16 (40%) patients had full recovery, 7 (17.5%) patients had partial/mild recovery, and 17 (42.5%) patients had no recovery (Table 1).

Table 1. Demographic and clinical data of the patients.

Parameters		**N**	**%**
Sex	**Female**	12	30.0
	Male	28	70.0
Seasons	**Spring**	11	27.5
	Summer	8	20.0
	Autumn	12	30.0
	Winter	9	22.5
Side	**Left**	15	37.5
	Right	25	62.5
Recovery	**Complete recovery**	16	40.0
	Partial / Might Recovery	7	17.5
	No recovery	17	42.5
Age (year) (mean ± SD)		49.5 ± 14.53	
Initial PTA (db) (mean ± SD)		57.33± 21.62	

SD: standard deviation PTA: pure tone averages

The mean age of those with full recovery was significantly lower *(P = 0.005)*. When the first PTO was evaluated, it was significantly lower in the full recovery group *(P = 0.001)* (Table 2).

Table 2. Relationship between demographic, clinical features and recovery rates in patients with ISSNHL.

Parameters		Recovery rates			
		Complete recovery	**Partial / Might Recovery**	**No recovery**	***P***
Sex	**Female** **Male**	5 (41,7%) 11 (39,3 %)	1 (8,3%) 6 (21,4%)	6 (50,0) 11 (39,3)	*0.555*
Side	**Left** **Right**	6 (40,0%) 10 (40,0%)	3 (20,0%) 4 (16,0%)	6 (40,0%) 11 (44,4%)	*0.942*
Age (year)		41.5[a] [19 - 72]	60[b] [55 - 76]	52[a,b] [23 - 71]	***0.005***
Initial PTA (db)		44.5[a] [21 - 68]	77[b] [46 - 112]	57[b] [36 - 102]	***0.001***

[a,b] indicates statistical differences of groups.

Table 3. Mean values of meteorological and air pollution parameters and difference analysis results based on Siegel's criteria.

Parameters		Recovery rate			
		Complete recovery (%)	**Partial / Might recovery (%)**	**No recovery (%)**	***P***
TMax(°C)	**Before**	16.8 [5.71 - 29]	24.85 [10.4 – 35.2]	12.28 [1.57 – 35.2]	0.083
	After	15.75 [6.46 - 25][a,b]	26.13 [9.13 - 30][a]	9.53 [1.33 – 30.4][b]	***0.034***
	p	*0.438*	*0.866*	*0.469*	
T Min(°C)	**Before**	4.71 [-3.2 – 15.25]	11.11 [0.57 – 15.7]	3.85 [-9 – 15.42]	0.164
	After	5.34 [0.33 – 10.4][a,b]	12.8 [1.4 – 13.66][a]	2.73 [-5 – 15.6][b]	***0.030***
	p	*0.959*	*0.735*	*0.653*	
Tmean(°C)	**Before**	10.55 [1.26 – 22.13]	17.98 [6.05 – 25.45]	8.07 [-1.57 – 24.7]	0.118
	After	10.61 [3.4 – 17.7][a,b]	19.89 [5.27 – 21.42][a]	5.77 [-1.84 – 22.9][b]	***0.041***
	p	*0.679*	*0.866*	*0.687*	
RH	**Before**	0.39 [0.13 – 0.77][a,b]	0.56 [0.25 – 0.75][a]	0.27 [0 – 0.72][b]	***0.018***
	After	0.36 [0.14 – 0.72][a,b]	0.66 [0.24 – 0.81][a]	0.24 [0.02 – 0.74][b]	***0.013***
	p	*0.816*	*0.128*	*0.602*	
SO2 (ppm)	**Before**	7.14 [3.5 – 42.5]	5.47 [2.4 – 15.96]	8.1 [3.6 – 29.36]	0.248
	After	6.3 [4.1 – 24.81]	6.1 [2.47 – 14.6]	7.9 [4.2 – 31.92]	0.221
	p	*0.816*	*0.310*	*0.421*	
PM 10 (µg/m^3)	**Before**	45.35 [20.3 – 100.5]	25.1 [18.5 – 74.3]	32.6 [17.3 – 100.2]	0.374
	After	57.4 [19.7 - 96]	26.6 [17.6 – 68.2]	50.2 [14.4 – 98.7]	0.110
	p	*0.918*	*0.398*	*0.124*	

T min: minimum temperature; T mean: mean temperature; T max: maximum temperature RH: Relative humidity. SO2: sulfur dioxide PM: particulate matter. [a,b] indicates statistical differences of groups.

There was no difference in T_{mean}, T_{max} *and* T_{min} values between the recovery groups in terms of data before the onset of the disease. When the data after initiation of the treatment were compared, it was found that the values of the group without recovery were significantly lower *($P < 0.005$).* Relative humidity values among the recovery groups were significantly lower in the group without recovery in pre-measurements and post-measurements *($P < 0.005$)* (Table 3). There was no significant difference between the recovery groups in terms of SO2 and PM10 values both in pre-measurement and post-measurements *($P > 0.005$)* (Table 3).

Discussion

It has been revealed that the mean values of meteorological values T_{max}, T_{min} *and* T_{mean} and relative humidity before the onset of the disease and during the 14 day period after the initiation of treatment had an effect on the recovery rates. There was no relationship found between air pollution parameters SO2 and PM10 and ISSNHL recovery rates.

Various prognostic factors such as age, degree of hearing loss and time between hearing loss and the initiation of treatment, hypertension, and diabetes have been reported in the literature in patients with ISSNHL [17]. In the present study, patients who started the treatment within 1 week from the onset of the disease and who did not have hypertension and diabetes were included. The mean age and baseline pure tone average of those who fully recovered according to Shigel's criteria was significantly lower. These results were in consistency with the data in the literature.

The effects of weather conditions on the onset of ISSNHL have been investigated in previous studies [8,18–21]. Some researchers reported a significant relationship between the onset of ISSHL and weather conditions [5,6,19], while others reported no relationship between weather conditions and the development of ISSHL [7,8]. There are limited studies investigating the relationship between ISSNHL prognosis and meteorological factors [7,22]. The relationship between the daily temperature range and the recovery rates of sudden hearing loss remains unclear. Narozny et al. [17] reported the occurrence of this disease in spring as a positive prognostic factor. Durmuş et al. [22] reported a relationship between the average temperature and rainfall before the onset of ISSNHL and the prognosis of ISSNHL. In their study, Ryu et al. [7] evaluated the average temperatures from meteorological parameters and reported that the average temperatures at the onset of ISSNHL were not associated with the recovery rates. It was observed that the mean relative humidity values before and after the onset of ISSNHL and the average temperatures after the initiation of treatment were associated with the prognosis of ISSNHL. This is the first study to present that relative humidity before and after treatment is effective on prognosis.

There are various studies in the literature investigating the relationship between air pollution parameters (especially PM) and various diseases in recent years. It is reported that the increase in PM and decrease in humidity have increased hospitalization rates due to respiratory diseases in children and the elderly [23,24].

There are limited studies in the literature evaluating the relationship between air pollution parameters and ISSNHL [25,26]. Lee et al. [25] reported that there is a statistically significant but weak correlation between the number of patients hospitalized with the diagnosis of ISSNHL and the average daily PM value. Choi et al. [26] investigated the

relationship between air pollution parameters and ISSNHL and found that only concentrations of NO2 were associated with ISSNHL. The present study is the first study evaluating the relationship between air pollution parameters and prognosis of ISSNHL. In the present study, there was no significant difference in the air pollution parameters examined (SO2 and PM10 values) between the ISSNHL recovery groups.

This study has certain limitations. The most important of these is the low number of patients and investigation of a single region. Meteorological conditions and air pollution show regional differences. In addition, different statistical analyses are required excluding the interaction between meteorological factors. Multicenter studies with large case series involving several regions and different climatic conditions are needed to clarify the relationship between meteorological factors and air pollution parameters and the prognosis of ISSNHL.

Conclusion

It was found in the study that relative humidity, T_{max}, T_{min}, and T_{mean} values may affect prognosis in ISSNHL patients. In addition, SO2 and PM10, two air pollution parameters, were not associated with ISSNHL recovery rates.

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Ethical statement: *The study was conducted in accordance with the ethical approval of the University Ethics Committee (Number: 2019/136).*

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