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Is air pollution one of the risk factors for sudden deafness? Review of the literature.

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Abstract

Introduction and objective: Sudden deafness is a serious clinical manifestation characterised by rapidly progressive hearing loss. As the duration of the disease process increases, hearing loss increases, so it is important to diagnose and begin treatment as early as possible. Determining the causative factor of sudden hearing loss is crucial for prognosis. This paper aims to summarise the current state of knowledge on the main risk factors for sudden hearing loss and treatment methods, and the impact of environmental pollution on sudden hearing loss.

Brief description of the state of knowledge: Sudden hearing loss, also known as sudden sensorineural hearing loss, refers to a sudden and significant deterioration of hearing. It appears within a few hours to a few days. It most commonly occurs for up to 72 h. It is an urgent condition requiring rapid assessment and medical intervention. According to current medical knowledge, risk factors for sudden deafness mainly include microvascular disorders, autoimmune diseases, damage to the cochlear membrane and viral infections. According to some researchers, air pollution may contribute to sudden hearing loss; however, data are still lacking and there is a need for further research. Treatment of hearing loss can include medication, hyperbaric therapy, hearing aids and, in the most difficult cases, cochlear implants. Sudden deafness is a health problem with a significant impact on patients' quality of life. Understanding the causes, diagnosis and effective treatment are key to improving quality of life and social and occupational functioning.

Methods and results: Literature review was performed using the PUBMED online database and Google Scholar. Inclusion criteria were studies published in English. Key words used in the search were: sudden deafness, sudden hearing loss, sudden sensorineural hearing loss; sudden deafness and air pollution; treatment of sudden deafness.

Summary: Hearing loss is a common condition that can have a variety of causes and dangerous consequences. This article discusses the causes of sudden hearing loss and available treatments. Articles relating to the effects of air pollution on sudden hearing loss are analysed. The need for further research into the treatment and rehabilitation of people with hearing loss to ensure the best possible quality of life and to improve social and occupational functioning is highlighted.

Key words: sudden deafness, sudden hearing loss, sudden sensorineural hearing loss; air pollution; treatment of sudden deafness.

Introduction

Sudden sensorineural hearing loss (SSHL), commonly referred to as sudden deafness, is a sudden and vague deterioration in hearing ability that develops rapidly, usually within one day or a few days. It is characterised by sensorineural damage, which means a hearing loss of at least 30 decibels at three consecutive frequencies. SSHL occurs due to a dysfunction of the inner ear and often affects only one ear. According to experts, sudden deafness is estimated to occur in between one and six people per 5,000 per year, but the actual number of new cases of SSHL may be much higher as it often goes unrecognised. SSHL can affect people of any age, but is most common in adults aged between 40 and 50 years [1,2]. According to the available literature, the aetiology of sudden sensorineural hearing loss (SSHL) has not been clarified. The onset of sudden sensorineural hearing loss is mainly considered to be microvascular disorders, autoimmune diseases, cochlear membrane damage and viral infection [3]. This article discusses the possible causes of sudden sensorineural hearing loss (SSHL) and current treatment options.

1. Possible causes of sudden sensorineural hearing loss (SSHL).

Infections

A viral infection can lead to sudden sensorineural hearing loss through several mechanisms:

1. The virus can directly infect the cochlea or cochlear nerve via the bloodstream, cerebrospinal fluid or middle ear. The virus can cause damage or inflammation within the inner ear, leading to hearing impairment [4].

2. latent virus present in the inner ear can be reactivated, leading to exacerbation of the infection and damage to the hearing organ [4].

3. Viral infection can trigger antibody cross-reactivity, which can lead to damage to inner ear tissues through autoimmunity. In addition, the virus can trigger a circulatory ligand, which activates the stress pathway, which can also contribute to sudden hearing loss, even if the inner ear itself is not directly infected with the virus [4].

The involvement of mumps virus, HSV, cytomegalovirus, as well as chickenpox and herpes viruses, including VZV and human herpes virus in sudden sensorineural hearing loss has also been demonstrated in the literature [5].

Circulatory disorders

The likely genesis of sudden sensorineural hearing loss is related to circulatory disorders [6,7]. Pathogenetic factors related to circulatory disorders have been identified that are associated with sudden sensorineural hearing loss. These factors include diabetes, hypertension, dyslipidaemia and cardiovascular disease, which are also risk factors for atherosclerosis. In addition, age and a history of smoking are factors that influence the severity of SSNHL. Studies have documented associations between atherosclerosis factors and sudden sensorineural hearing loss [6]. Additionally, patients with sudden sensorineural hearing loss (SSNHL) have a higher prevalence of several cardiovascular risk factors compared to the general population [8].

Autoimmune diseases

There are several theories regarding the pathogenesis of sudden sensorineural hearing loss, which include some autoimmune causes such as temporal arteritis, systemic lupus erythematosus, Wegener's granulomatosis, Cogan's syndrome and Behçet's disease [9]. Immune-mediated sensorineural hearing loss most commonly affects women in their thirties to fifties. Although they account for less than 1% of all hearing loss cases, this is a small

percentage. Nevertheless, it is difficult to assess the real impact of this phenomenon due to the lack of studies focusing on this aetiology. Cases of sudden sensorineural hearing loss of immunological aetiology are even rarer and pose a diagnostic challenge [10]. Many authors have described in their studies a significant association of autoimmune diseases with the occurrence of sudden deafness. Junhui Jeong and co-authors investigated the risk of sudden sensorineural hearing loss (SSNHL) in patients with autoimmune diseases compared to controls in a population-based study using data from the National Health Insurance Service Korea cohort. Patients aged ≥20 years in 2006 with autoimmune diseases were included, and a control group with similar demographic characteristics was selected. Both groups were observed between 2006 and 2015 and the proportion of patients who developed sudden sensorineural hearing loss (SSNHL) was compared. Of the 13250 patients in the autoimmune disease group, 145 had an SSNHL event (1.09%). In comparison, of the 66250 people in the control group, 484 had an SSNHL event (0.73%). The risk of SSNHL was significantly higher in the autoimmune disease group compared to the control group. The incidence of SSNHL was significantly higher among patients with antiphospholipid syndrome, multiple sclerosis, rheumatoid arthritis and connective tissue diseases such as Sjögren's syndrome and Behçet's disease [11].

Air pollution

Although air pollution has been recognised as a risk factor for many diseases, its association with hearing impairment has been less studied. Many researchers hypothesise that air pollution may be one of the causes of sudden sensorineural hearing loss. This paper presents examples of studies supporting this hypothesis.

Kuang-Hsi Chang and co-authors focused on the analysis of two major traffic-related air pollutants: nitrogen dioxide (NO2) and carbon monoxide (CO). They analysed data from a long-term cohort study, using data from Taiwan's National Health Insurance (NHI), to assess the impact of these traffic-related air pollutants on SSHL. The results showed a significant increased risk of developing SSHL in people chronically exposed to air pollution. Based on long-term data, the results suggest that NO2 and CO may negatively affect SSHL. Furthermore, they showed that long-term exposure to the highest quartile of NO2 significantly increases the risk of SSHL by almost 1.63-fold, even after accounting for confounding factors. Similarly, exposure to the highest quartile of CO was also associated with an increased risk of SSHL by 1.45-fold. The mechanisms of cell damage induced by NO2 and CO are different. NO2 is a

reactive nitrogen form (RNS) that can lead to cell apoptosis, while CO prevents the efficient distribution of oxygen in the body, particularly to vital organs such as the heart and brain [12].

According to Chun-Gu Cheng and co-authors, the level of average particulate matter with a diameter of 2.5 μm or less (PM2.5) showed no association with SSHL. In contrast, maximum PM2.5 levels showed a negative association with SSHL in Korea. Additionally, exposure to nitrogen dioxide (NO2) for 2 weeks increased the risk of SSHL. The study used patient data from the electronic health records of Tri-Service General Hospital from 2011 to 2019 and an air quality dataset from Songshan station during the same period. The main outcomes were the relative risk (RR) of SSHL associated with exposure to PM2.5, O3 and NO2 over 1 month. The relationships between these factors were investigated using non-linear time series models with distributed lags [13].

In another of the research studies, Fatemeh Ranjdoost and co-authors conducted a review of studies assessing the effect of exposure to air pollution on the incidence of sudden hearing loss (SSHL). They searched current electronic databases to find studies published by 1 December 2022, using relevant keywords. A total of 1146 studies were identified, and after screening according to specific criteria, a total of eight studies were selected. The results of these studies provided the latest evidence on the association between air pollution exposure and SSHL. The mean concentrations of PM2.5, PM10, CO and NO2 in the patient group were higher than in the control group [14].

In Taiwan, Stella Chin-Shaw Tsai and co-authors conducted a nationwide study to assess the risk of sudden sensorineural hearing loss (SSNHL) in Taiwanese residents exposed to air pollution. The study included individuals aged 20 years or older with no history of SSNHL between 1998 and 2010. These individuals were followed until SSNHL occurred or until withdrawal or completion of data collection, i.e. until 31 December 2011. Annual concentrations of PM2.5, SO2, CO, NO and NO2 between 1998 and 2010 were categorised into three levels by tercile. We The results of this study showed an increased risk of SSNHL in residents with long-term exposure to air pollution [15].

As can be seen from the above examples, there is a link between air pollution and sudden hearing loss. Emerging work shows the need for further observations and research on the impact of air pollution on the risk of sudden hearing loss.

2. Treatment of sudden sensorineural hearing loss (SSHL).

Sudden hearing loss is an event with negative consequences for quality of life, social interaction and working life. Some experience dizziness and balance problems. In addition,

many people also experience bothersome tinnitus. Prompt and appropriate treatment is important so that the patient maintains the best possible quality of life [16,17]. In 2021 World Health Organisation (WHO) reported that more than 5% of the world's population, or 430 million people, required rehabilitation to correct a disabling hearing loss (432 million adults and 34 million children). By 2050, it is estimated that more than 700 million people, or 1 in 10 people, will have a disabling hearing loss [18].

Steroid treatment

Steroids, as the first-line treatment recommended in global guidelines for SSNHL, have been used for many years. However, therapeutic efficacy can be significantly dependent on various factors, such as the route of administration, dosage, duration of therapy, and frequency of use. There are many ways to administer steroids and the efficacy and safety of different routes of administration remain unclear. To date, no consensus has been reached on the optimal method of drug administration. Currently, there are two main methods of steroid therapy for SSNHL: systemic and topical. The traditional method of systemic steroid administration for SSNHL is widely used and accepted in clinical practice. However, its efficacy is not perfect and may lead to some side effects, such as electrolyte disturbances, increased blood pressure, hyperglycaemia and increased risk of infection. Therefore, it is important to explore different local delivery methods that can improve targeted drug delivery and reduce the side effects associated with steroid use. Studies provide evidence of improved hearing recovery after early treatment with steroids, which can be administered by different routes such as oral, intravenous, intratympanically or a combination of these routes [19,20,21]. In the UK, the National Institute for Health and Care Excellence (NICE) recommends steroids as first-line treatment for ISSNHL. This may include oral steroids, intratympanic steroid injections (ITSI) or a combination of both. The 2019 American Academy of Otolaryngology-Head and Neck guidelines recommend that clinicians offer patients intratympanic steroids rescue steroid therapy for incomplete recovery from sudden sensorineural hearing loss (SSHL) within 2 to 6 weeks of symptom onset [22, 23]. Studies have shown that the effect of intratympanic corticosteroid injection as first-line treatment is not statistically different from systemic administration in terms of hearing improvement in patients with SSNHL [24]. However, modified epidural steroid therapy has been shown to be a safe and effective salvage treatment for SSNHL. The findings highlight the advantages of gel foam as a strategic drug carrier placed in the recess of the round window. By minimising drug loss, prolonging the duration of action

and increasing the concentration in the lymphatic region, gel foam enhances the therapeutic effect of steroids, contributing to improved hearing outcomes in patients with SSNHL [25].

Hyperbaric therapy

Hyperbaric oxygen therapy (HBOT) is one treatment for patients with sudden sensorineural hearing loss (SSNHL). It is recommended as an elective treatment in patients undergoing steroid therapy. According to recent scientific studies, hyperbaric oxygen therapy should be introduced within two weeks of the onset of the first symptoms. Hyperbaric oxygen therapy can be used to improve the treatment of patients with sudden sensorineural hearing loss, either as an adjunct to steroid therapy or as rescue therapy. Other reputable medical societies and associations also recommend the use of HBOT. The therapy consists of exposing the patient to 100% oxygen under increased pressure of 1.5 to 2 ATA. The aim of this therapy is to increase the oxygen supply to the cochlea to improve the patient's immunity and haemodynamics, reduce hypoxia and oedema, and enhance the body's natural responses to infection and ischaemia. There are currently no clear guidelines for a specific HBOT protocol in patients with SSNHL, however, there is growing interest in this treatment modality in this area [26, 27, 28].

Ginkgo Biloba

Ginkgo biloba Linn leaf extract (GBE) is an active substance extracted from the dried leaves of the ginkgo tree. It is commonly used to treat a variety of conditions. The composition of GBE includes ginkgo flavonoids, quercetin, ginkgolides, organic acids and other constituents that exhibit a variety of pharmacological effects, including vasodilation. In addition, GBE has shown efficacy in the treatment of heart disease, cerebral thrombosis, cerebral ischaemia, cerebral dysfunction, traumatic brain injury, nervous system diseases and in neutralising oxygen free radicals. Studies by the cited authors suggest that complementary therapy with Ginkgo biloba extract (GBE) may be more beneficial than no use of this extract. Significant improvements in total therapy efficacy, cure rates and pure tone hearing threshold were demonstrated, and significant improvements in haemorheological indices were observed with treatment, with a reduction in the rate of side effects. Based on the results of the analysis and the theoretical underpinnings regarding SSHL, GBE may be an excellent complementary and alternative therapy strategy. However, the low quality of some research articles carried a risk of bias, which may have affected the reliability of this study to some extent. Therefore, the long-term efficacy and safety of GBE in the treatment of SSHL still need to be confirmed in a

large, multicentre and carefully designed RCT-type clinical trial to provide reliable evidence for the efficacy of GBE as an adjunctive treatment for SSHL [29].

Cochlear implant

A cochlear implant is a form of hearing rehabilitation used for bilateral moderate to profound sensorineural hearing loss when traditional hearing aids are unsuccessful. It works by direct electrical stimulation of the auditory nerve, so it is important that the central structures of the auditory nerve are in good condition in candidates for this type of rehabilitation. Due to the possibility of permanent ossification and fibrosis of the cochlea, prompt implantation is crucial for optimal post-operative results [30].

Conclusions

This article discusses relevant aspects of sudden sensorineural hearing loss (SSHL), including causes, treatments and the need for further research into the subject. Sudden sensorineural hearing loss (SSHL) is an urgent condition that requires prompt diagnosis and medical intervention to prevent permanent consequences on patients' quality of life. A review of the literature showed that the main risk factors for SSHL include microvascular disorders, autoimmune diseases and viral infections. An interesting issue that requires further research is the effect of air pollution on sudden hearing loss. Treatment options for SSHL include drug therapy, hyperbaric therapy, hearing aids and cochlear implants. There is also a study confirming the positive effect of Ginkgo biloba leaf extract on the effectiveness of SSHL therapy. However, further research is needed to better understand the mechanisms and optimal treatment strategies for SSHL and the impact of air pollution on the risk of this condition. These findings highlight the need to continue research on SSHL and to strive to provide patients with the best possible quality of life and improve social and occupational functioning.

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