

# Successful treatment of sudden sensorineural hearing loss by means of pharmacotherapy combined with early hyperbaric oxygen therapy

## Case report

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### Abstract

**Rationale:** According to the World Health Organization reports, adult-onset hearing loss is the 15th leading cause of burden of disease, and is projected to move up to 7th by the year 2030, especially in high-income countries. Sudden sensorineural hearing loss is considered by otologists as a true otologic emergency. The current standard treatment for sudden hearing loss is a tapered course of oral high-dose corticosteroids. The described clinical case points to the validity of undertaking early hyperbaric oxygenation (HBO) therapy together with corticosteroids for full recovery of adult onset idiopathic sudden sensorineural hearing loss.

**Patient concerns:** A 44-year-old woman complained of an abrupt hearing deterioration in the left ear with the sensation of aural fullness and loud tinnitus presented for 48 hours. The patient was admitted to the Department of Otolaryngology of Public Hospital for diagnosis and treatment.

**Diagnoses:** The patient was diagnosed with unilateral sudden idiopathic sensorineural hearing loss, assessed by measuring the tonal audiograms.

**Interventions:** The patient received treatment including oral high-dose corticosteroids combined with HBO protocol including 15 daily 1-hour exposures to 100% oxygen at 2.5 atmosphere absolute.

**Outcomes:** A pharmacotherapy combined with early HBO resulted in full recovery of hearing.

**Lessons:** Early implementation of HBO to the pharmacotherapy in sudden sensorineural hearing loss may lead to full recovery of hearing. There is a need for systematic research to establish guidelines for optimal number of HBO sessions in relation to the timeframe from hearing loss symptoms onset to implementation of HBO therapy.

**Abbreviations:** ATA = atmosphere absolute, ECHM = European Committee for Hyperbaric Medicine, HBO = hyperbaric oxygenation.

**Keywords:** corticotherapy, hyperbaric oxygenation, sudden sensorineural hearing loss

## 1. Introduction

According to the World Health Organization reports, adult-onset hearing loss is the 15th leading cause of burden of disease, and is foreseen to move up to 7th by the year 2030, especially in high-income countries. Therefore, sudden hearing loss seems to become a serious social health problem.<sup>[1]</sup> Idiopathic sudden deafness is defined as sensorineural hearing loss of unknown

aetiology, exceeding 30 dB, occurring in at least 3 neighboring frequencies and appearing abruptly within a period of 72 hours.<sup>[2]</sup> In some cases there are accompanying symptoms as tinnitus or vomiting (20%–60%). The incidence reaches 5 to 20/100,000 cases with probability of occurrence increasing with age. Adult-onset sudden sensorineural hearing loss typically occurs between 43 and 53 years of age, with equal sex distribution. The majority of cases are idiopathic and almost exclusively unilateral.<sup>[3]</sup> It appears to be characterized by hypoxia in the perilymph and, therefore, in the scala tympani and the organ of Corti. Several pathophysiological mechanisms of idiopathic sudden sensorineural hearing loss have been described so far including: viral infections, labyrinth thin membrane breaks, immune-associated disease, vascular occlusion, abnormal cochlear stress response, trauma, abnormal tissue growth, toxins, ototoxic drugs, and cochlear membrane damage or trauma.<sup>[4]</sup> There is also a theory based on an immunologically mediated vasculitis resulting in cochlear hypoperfusion. The basis for this theory is that during viral vasculitis circulating immunoglobulins are deposited perivascularly which may lead to local decrease in perfusion and tissue hypoxia.<sup>[5]</sup> In many cases, the cause of sudden deafness remains unknown. Sudden sensorineural hearing loss is considered by otologists as a true otologic emergency. The current standard treatment for sudden hearing loss is a tapered course of oral high-dose corticosteroids to

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increase circulation to the inner ear.<sup>[6]</sup> The hyperbaric oxygenation (HBO) therapy is recommended for use in sensorineural hearing loss by *European Committee for Hyperbaric Medicine* (ECHM), but *Undersea and Hyperbaric Medical Society* has not listed that illness for HBO therapy so far.

This case study report highlights the effectiveness of early implementation of HBO therapy in the treatment protocol of sudden idiopathic hearing loss. The described clinical case points to the validity of undertaking early HBO therapy together with corticosteroids for full recovery of adult-onset idiopathic sensorineural hearing loss.

## 2. Case report

A 44-year-old woman complained of an abrupt hearing deterioration in the left ear with the sensation of aural fullness and loud tinnitus presented for 48 hours. Patient was admitted to the Department of Otolaryngology of Andrew Mielęcki Independent Public Hospital of Medical University of Silesia in Katowice for diagnosis and treatment on January 8, 2016. Symptoms were sudden in onset, with no associated pain, dizziness, or otorrhea and no history of hearing problems or medical illness. Family history was negative and physical examination was normal. Otologic examination revealed normal tympanic membranes bilaterally, with no evidence of cerumen or middle ear effusion in the left or right ear. Tuning fork examination showed positive Rinne test bilaterally but with lateralization of Weber test to the right side, indicating left ear sensorineural hearing loss. Pure tone audiometry examination confirmed a medium left-side sensorineural hearing loss up to 35 dB across the frequencies to 3 kHz and up to 60 dB across frequencies to 8 kHz, with right ear audiometry in normal ranges (Fig. 1; Photograph 1, <http://links.lww.com/MD/C37>). Computed tomography of temporal bones pneumatization, pyramids, and internal auditory canals were normal. Cause of hearing loss in that patient remained unknown. The patient was qualified to intensive pharmacological treatment with high-dose oral corticosteroid (prednisolone 60 mg; 11.4 mg/kg for a day) combined with cefuroxime 500 mg and pentoxifylline. Oral corticosteroids were tapered over a period of 17 days (60 mg of prednisone daily for 7 days, followed by a taper by 10 mg every 2 days). Together with pharmacotherapy the HBO protocol was introduced, after additional medical consultation by a specialist in hyperbaric medicine. According to ECHM guidelines, treatment series of HBO in this case consisted of 15 daily 60-minute exposures to 100% oxygen at 2.5 atmosphere absolute (ATA). All sessions took place at the same time every day (11.00 AM) and

at the same place (multisite hyperbaric chamber in the Silesian Burst Treatment Center in Siemianowice, Poland). Each session lasted 90 minutes and consisted of several phases according to ECHM recommendations. The first phase of each session lasted 10 minutes and included air compression to the pressure of 2.5 ATA (pressure equivalent to the depth of 15 m under water). This pressure value was maintained for the next 70 minutes. During this phase, the patient breathed 100% oxygen through a mask for 3 × 20 minutes, taking 5-minute air breaks with the mask off. The last 10 minutes of each session were decompression. HBO treatment as well as pharmacotherapy underwent under medical supervision without any complications. After 6 sessions of HBO combined with pharmacological treatment, the patient felt that her hearing recovered. After the end of the therapy, the patient showed complete recovery of hearing confirmed by pure tone audiometry (Fig. 2; Photograph 1, <http://links.lww.com/MD/C37>) and since then hearing levels have not changed.

About 3 days after the last exposure to hyperbaric 100% oxygen, the patient started to complain about decreasing vision in both eyes. Ophthalmologic examination confirmed bilateral near-sightedness (myopia). This effect was transient and subsided after 6 days without any intervention. It was probably a side-effect induced by HBO exposure because of oxygen toxicity or/and hyperbaric toxicity. No other side-effects of HBO therapy have occurred. The written consent was obtained from the patient for the publication of this case and accompanying content. All procedures contributing to this work comply with the ethical standards of the relevant national and institutional guidelines and with the Helsinki Declaration and its later amendments.

## 3. Discussion

The rationale for the use of HBO to treat sudden sensorineural hearing loss is supported by the fact, that the cochlea and the structures within it, particularly the stria vascularis and the organ of Corti require a high oxygen supply. However, the direct vascular supply, particularly to the organ of Corti is minimal.<sup>[7]</sup> Tissue oxygenation to the structures within the cochlea occurs via oxygen diffusion from cochlear capillary networks into the perilymph and the cortilymph.<sup>[8]</sup> The perilymph is the primary oxygen source for these intracochlear structures. Other contributory benefits of HBO may be related to its anti-inflammatory effects, as well as the blunting of ischemia reperfusion injury and reduction of edema.<sup>[4,8]</sup> Hyperbaric therapy is the only known method of increasing O<sub>2</sub> in the liquids of the inner ear. When combined with large-dose steroid therapy, overall effectiveness of

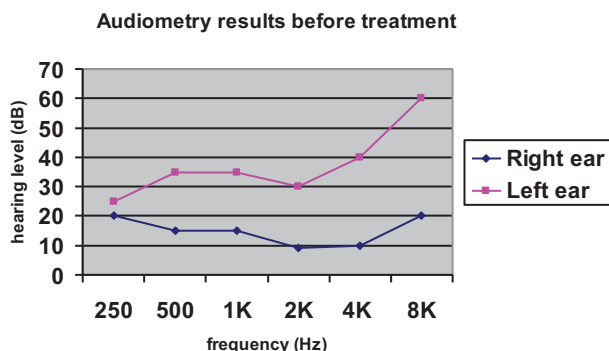


Figure 1. Audiometry results before treatment.

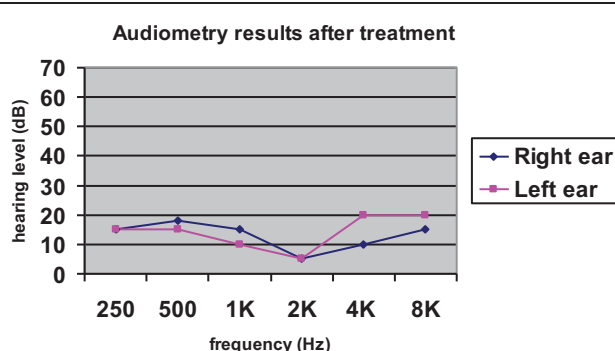


Figure 2. Audiometry results after treatment.

HBO varies in a range from 11% to 80% of cases.<sup>[4,9]</sup> In literature on treatment of abrupt idiopathic hearing loss, special attention is paid to the time elapsed between the occurrence of symptoms and the commencement of treatment, with emphasis on the necessity of quick therapy implementation. However, there is an absence of guidelines defining the timeframe for the introduction of HBO therapy to gain the best possible effect. The most favorable prognoses concern patients with medium level or deep hearing loss (>41dB) for whom HBO was implemented within 14 days of the occurrence of hearing loss symptoms. In presented case, combination of corticosteroids and early HBO therapy introduced 4 days after symptoms onset led to full recovery of hearing. This result confirms previous reports of HBO therapy as very efficacious with systemic corticosteroids.<sup>[2,4,9,10]</sup>

It is quite well documented in literature that patients receiving HBO had statistically significant hearing gains across all frequencies, with tinnitus patients showing the greatest hearing improvement.<sup>[11]</sup> Some authors consider that HBO therapy should be used to treat acute hearing deterioration only if patients do not recover their hearing ability following conventional treatment.<sup>[12]</sup>

Presented case suggests benefits from early HBO as an adjunctive agent to the conventional therapy, which confirms results from earlier studies showing significant efficacy utilizing HBO as an adjunct to medical therapy, especially in patients younger than 60 years old who receive corticosteroids.<sup>[4,13]</sup> The optimal number of HBO sessions in the treatment of sudden hearing loss depends on the severity and duration of symptoms and the response to the treatment, but there are no data to suggest benefits of HBO treatment beyond the 10 to 20 sessions.<sup>[4]</sup>

Among ocular complications of HBO therapy, a short-sightedness (myopia) is reported. Myopia is a transient ailment at approximately 20% of people treated with HBO. Eyes of these patients returned to normal gradually over a period of 3 months from the date of completion of HBO.<sup>[14]</sup> The cause of periodic visual impairment related to HBO intervention is unknown. It is believed that temporary visual impairment can be *inter alia* because of changes in the curvature of the cornea caused by variations in pressure during the compression and/or decompression or metabolic changes in cornea or changes in the refractive lens.<sup>[14]</sup> Presented case study shows that myopia may occur due to HBO treatment; spontaneous healing within 1 week confirms reported in literature transient character of this effect.

#### 4. Conclusion

Presented case confirms the high effectiveness of early HBO implementation together with high-dose corticosteroids in the treatment of idiopathic sudden sensorineural hearing loss. There is a need for systematic research to establish guidelines for optimal number of HBO sessions in relation to the timeframe from sensorineural hearing loss symptoms onset to implementation of HBO therapy.

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