Proceedings of Anticancer Research, 2022, Volume 6, Issue 2
http://ojs.bbwpublisher.com/index.php/PAR
ISSN Online: 2208-3553
ISSN Print: 2208-3545

Clinical Efficacy of Hyperbaric Oxygen Therapy at Different Pressures in the Treatment of Sudden Deafness

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Abstract: *Objective:* To analyze the efficacy of hyperbaric oxygen at different pressures in the treatment of sudden deafness. *Methods:* Eighty-two patients with sudden deafness treated in the Affiliated Hospital of Hebei University from September 2019 to September 2021 were selected as the research subjects. The patients were randomly divided into study group 1 and study group 2, and they were treated with hyperbaric oxygen on the basis of routine treatment, in which the pressure used was 1.8 ATA and 2.2 ATA, respectively. Oxygen was delivered via the pressure stabilizing mask for 60 minutes. The patients received two courses of treatment, each lasting 10 days. The changes in hearing (pure tone audiometry) and the clinical efficacy of both the groups were compared before and after treatment. The data obtained were statistically analyzed using SPSS 19.0. *Results:* The total effective rate of study group 1 was 90.00%, while that of study group 2 was 76.19%. The differences between the two groups were statistically significant ($p < 0.05$). *Conclusion:* For patients with sudden deafness treated with hyperbaric oxygen, the clinical efficacy of 1.8 ATA is more significant than that of 2.2 ATA.

Keywords: Sudden deafness; Hyperbaric oxygen therapy; Different pressures; Clinical efficacy

Online publication: March 23, 2022

1. Introduction

Sudden deafness, also known as sudden sensorineural hearing loss, has multiple causes. In this condition, hearing deteriorates in varying degrees over a short period of time, which directly affects the daily life of patients. At present, hyperbaric oxygen is mainly used in the treatment of sudden deafness. In China, there are many reports on treating sudden deafness with hyperbaric oxygen. However, there are minimal studies on the therapeutic effect of different pressures in the treatment of sudden deafness with hyperbaric oxygen [1]. In order to seek more active and effective treatment effect, this study selected several patients from the Affiliated Hospital of Hebei University as the research subjects, aiming at the clinical efficacy of using hyperbaric oxygen at different pressures in the treatment of sudden deafness, in order to provide reference for clinical practice.

2. Materials and methods

2.1. General information

Eighty-two patients with sudden deafness diagnosed and treated in the Affiliated Hospital of Hebei

University from September 2019 to September 2021 were selected as the research subjects.

Inclusion criteria: (1) patients who met the diagnostic criteria based on the "Guidelines for the Diagnosis and Treatment of Sudden Deafness (2015)" [2]; (2) hearing loss > 20 dB with at least two frequencies; (3) age > 18 years old; (4) patients with tinnitus, dizziness, and other vestibular symptoms.

Exclusion criteria: (1) patients with a history of ear disease or family history of deafness; (2) patients with recent noise exposure history; (3) patients with deafness caused by cardiovascular diseases, cerebrovascular diseases, or occupation related to the internal auditory canal; (4) patients with severe cardiac, hepatic, and renal insufficiency; (5) patients with malignant tumor, blood disease, etc.; (6) patients who had recently taken immunosuppressants; (7) patients with contraindications to hyperbaric oxygen therapy.

The patients were randomly divided into study group 1 and study group 2. In study group 1, there were 22 male patients and 18 female patients, age ranging from 21 to 65, with an average age of 46.12 ± 15.18; the time of onset was 3 hours ~ 30 days, with an average of 10.16 ± 6.08 days. In study group 2, there were 19 male patients and 23 female patients, age ranging from 20 to 65, with an average age of 48.16 ± 14.85; the time of onset was 5 hours ~ 30 days, with an average of 11.79 ± 6.07 days. There was no significant difference in gender, age, time of onset, and other general information between the two groups ($p > 0.05$).

2.2. Methods

The two groups were treated with hyperbaric oxygen on the basis of routine treatment, in which the pressure used was 1.8 ATA and 2.2 ATA, respectively. Oxygen was delivered via the pressure stabilizing mask for 60 minutes, and the patients received two courses of treatment, each lasting 10 days. The changes in hearing (pure tone audiometry) and the clinical efficacy of both the groups were compared before and after treatment.

2.3. Observation indicators

2.3.1. Clinical efficacy

The clinical efficacy of both the groups were compared, in which the "Guidelines for the Diagnosis and Treatment of Sudden Deafness" was used as a reference: "recovery" signifies that the hearing threshold of the affected frequency has completely returned to normal or reverted to its pre-onset level; "effective" signifies that the improvement level of hearing loss is between 15~30 dB; "ineffective" signifies that the improvement level of hearing loss is less than 15 dB, or a worsening condition. The total effective rate = cure rate + effective rate.

2.3.2. Severity of hearing impairment

The severity of hearing impairment was compared between the two groups, and the criteria were as follows: "mild" signifies a hearing loss ranging from 26 dB to 55 dB; "moderate" signifies a hearing loss ranging from 56 dB to 70 dB; "severe" signifies a hearing loss of more than 71 dB. Pure tone audiometry was carried out using a pure tone audiometer. Two consecutive measurements were made in a soundproof room, and the error between the two measurements was less than 5 dB.

2.4. Statistical analysis

SPSS 19.0 was used for data processing. The measurement data were expressed in $\bar{x} \pm s$, and t test was carried out. The counting data were expressed by phase logarithm, and X^2 test was carried out. Rank-sum test was used for rank data analysis. $p < 0.05$ signifies that the difference is statistically significant.

3. Results

3.1. Clinical efficacy

The total effective rate of study group 1 was 90.00%, which was significantly higher than that of study group 2 (76.19%) ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of clinical efficacy between the two groups [n (%)]

Group	Number of cases	Recovery	Effective	Ineffective	Total effective rate
Study group 1	40	10	26	4	36 (90.00)
Study group 2	42	8	24	10	32 (76.19)
X^2					4.121
p					0.039

3.2. Hearing improvement

Before treatment, there was no significant difference in the hearing threshold between the two groups ($p > 0.05$). After treatment, the hearing threshold of both groups decreased, but the improvement of hearing threshold in study group 1 was significantly better than that in study group 2 ($p < 0.05$), as shown in **Table 2**.

Table 2. Comparison of hearing improvement between the two groups before and after treatment ($\overline{x} \pm s$, dB)

Group	Number of cases	Hearing threshold		*t*	*p*
		Before treatment	After treatment		
Study group 1	40	78.82 ± 3.21	49.21 ± 4.55^{ab}	36.069	0.000
Study group 2	42	77.68 ± 3.89	63.06 ± 3.68^{a}	14.812	0.000
t		1.018	18.682		
p		0.312	0.000		

Note: Compared with this group before treatment, $^{a}p < 0.05$; compared with study group 2 after treatment, $^{b}p < 0.05$

4. Discussion

Sudden deafness is a blood supply disorder of the inner ear caused by many factors. The disease occurs rapidly, and if it is not treated in time, it will develop into total deafness and eventually cause permanent deafness. The pathogenic causes are viral labyrinthitis and blood circulation disorders in the inner ear [3].

Hyperbaric oxygen therapy involves inhaling a high concentration of pure oxygen. This treatment rapidly increases the blood oxygen content in the human body and promotes the diffusion of oxygen to blood vessels. Moreover, it extends the diffusion distance. The improvement of capillary hypoxia reduces cellular edema [4]. The microcirculation of the inner ear improves with the increase of the speed and amount of supplied oxygen from the capillaries to the ear. In addition, hyperbaric oxygen can also improve blood viscosity. Hyperbaric oxygen can reduce vascular resistance, restore cell function, and promote the oxygen supply to cells [5]. Increasing the partial pressure of oxygen improves hypoxic and ischemic symptoms, stabilizes the heart rate and arterial blood pressure, normalizes cerebral vasoconstriction, as well as returns the function of damaged sensory cells [6]. At present, hyperbaric oxygen therapy is used for treating sudden deafness, and the pressure used is often 1.8 ATA to 2.5 ATA. However, there are minimal studies on the clinical efficacy of hyperbaric oxygen at different pressures.

The results of this study showed that the total effective rate of 1.8 ATA hyperbaric oxygen therapy in study group 1 was 90.00%, and that of 2.2 ATA in study group 2 was 76.19%. The total effective rate of study group 1 was significantly higher than that of study group 2 ($p < 0.05$). Before treatment, there was no significant difference in the hearing threshold between the two groups, ($p > 0.05$). After treatment, the hearing threshold of both groups decreased, but the improvement in study group 1 was significantly better than that in study group 2 ($p < 0.05$). This shows that hyperbaric oxygen therapy at 1.8 ATA has more significant therapeutic effect on sudden deafness, which can improve the inner ear circulation, increase the oxygen supply, and restore the patient's hearing level with an ideal effect.

In conclusion, hyperbaric oxygen therapy for sudden deafness can improve the microcirculation of the inner ear. The clinical efficacy of 1.8 ATA hyperbaric oxygen therapy is evident, and it significantly improves hearing; thus, it is worthy of clinical application.

Funding

The Youth Scientific Research Fund of the Affiliated Hospital of Hebei University, "Observation on the Efficacy of Different Pressure Hyperbaric Oxygen in the Treatment of Sudden Deafness" (Grant Number: 2021Q040).

Disclosure statement

The authors declare no conflict of interest.

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