Hyperbaric Oxygen Therapy as Salvage Therapy for Sudden Sensorineural Hearing Loss

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OBJECTIVE: To measure the effect of hyperbaric oxygen (HBO) therapy as salvage therapy after the failure of steroid therapy for sudden sensorineural hearing loss (SSNHL).

MATERIALS and METHODS: Ninety-three patients with SSNHL were unsuccessfully treated with systemic steroid therapy. Following steroid therapy, 43 patients received additional HBO therapy while 50 did not. Hearing levels at 0.25, 0.5, 1, 2, 4, and 8 kHz before and after therapy were measured.

RESULTS: A significant difference in hearing thresholds after HBO therapy was found at all frequencies in patients with a hearing loss of >61 dB. The group of patients with a hearing threshold of ≤60 dB had a significant improvement only at 250 and 500 Hz, while group of patients without additional therapy control group showed no hearing improvement.

CONCLUSION: Hyperbaric oxygen therapy as salvage therapy for SSNHL showed some benefits in hearing improvement. Better results could be expected in patients with severe hearing loss, while in patients with mild-or-moderate hearing loss, recovery should be expected only at low frequencies.

KEYWORDS: Hearing loss, sudden, hyperbaric oxygen therapy, salvage therapy
**Table 1. Clinical characteristics of patients with SSNHL**

<table>
<thead>
<tr>
<th>Patients</th>
<th>HBO therapy group</th>
<th>Group without additional therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>43</td>
<td>50</td>
</tr>
<tr>
<td>Age, years (mean)</td>
<td>53.2±19.4</td>
<td>55.5±22.2</td>
</tr>
<tr>
<td>Sex (male/female)</td>
<td>21/32</td>
<td>23/25</td>
</tr>
<tr>
<td>Initial mean hearing level (dB)</td>
<td>80.57±5.14</td>
<td>75.52±9.42</td>
</tr>
<tr>
<td>Days from onset of SSNHL to the initiation of steroid therapy</td>
<td>11.4±8.12</td>
<td>13.2±6.52</td>
</tr>
<tr>
<td>Days from the end of steroid therapy to the initiation of HBO therapy</td>
<td>23±19.1</td>
<td></td>
</tr>
</tbody>
</table>

HBO: hyperbaric oxygen therapy; SSNHL: sudden sensorineural hearing loss

**Table 2. Mean hearing levels before and after HBO therapy at six frequencies (43 patients)**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Initial mean hearing levels (dB)</th>
<th>Mean hearing levels after HBO therapy (dB)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 Hz</td>
<td>64.3±27.52</td>
<td>42.3±29.17</td>
<td>0.0003*</td>
</tr>
<tr>
<td>500 Hz</td>
<td>66.1±29.11</td>
<td>46.2±29.26</td>
<td>0.0008*</td>
</tr>
<tr>
<td>1000 Hz</td>
<td>49.4±35.23</td>
<td>48.5±31.92</td>
<td>0.828</td>
</tr>
<tr>
<td>2000 Hz</td>
<td>47.6±31.94</td>
<td>47.5±34.12</td>
<td>0.97</td>
</tr>
<tr>
<td>4000 Hz</td>
<td>51.2±36.72</td>
<td>51.4±33.51</td>
<td>0.97</td>
</tr>
<tr>
<td>8000 Hz</td>
<td>43.1±30.71</td>
<td>55.2±32.91</td>
<td>0.04*</td>
</tr>
</tbody>
</table>

*Statistically significant
HBO: hyperbaric oxygen therapy

Initial mean hearing levels were found at 0.25 and 0.5 kHz (Table 2). There were no significant differences at 1, 2, and 4 kHz, while at 8 kHz, there was a small decrease in the mean hearing threshold (Table 2). Patients were divided in those with severe hearing loss (>61 dB) and those with moderate hearing loss (≤60 dB). Patients with a hearing loss of ≤60 dB had significant improvement only at 0.25 and 0.5 kHz (Table 3), while those with a hearing loss of >60 dB had significant improvement at all frequencies (Table 4). Two patients had Eustachian tube dysfunction during HBO therapy, and myringotomy and ventilation tube installation were required. No other side effects were noticed during HBO therapy. In the patients in the group not receiving additional therapy, there were no significant differences in hearing thresholds 1 month after the failure of primary therapy.

**DISCUSSION**

The most commonly used salvage therapies for sudden hearing loss are HBO therapy and intratympanic steroid therapy [17-21]. A comparison of these two methods was recently described [22, 23]. Both methods have been successful. Although a positive result was shown using both therapies, there is no consensus on which therapy is better. While previous studies showed that younger patients had better response after HBO therapy, in our study, we found no hearing improvement related to age. Our study showed that HBO therapy as salvage therapy significantly improves the outcome in patients with a hearing loss of >61 dB, while some previous studies have found the benefit of HBO therapy only among patients presenting with profound hearing loss (>80 or >90 dB) [19, 21, 22]. In the group of patients with a hearing loss of ≤60 dB, improvement was noticed only at low
frequencies (0.25 and 0.5 kHz), which is consistent with a previous study on SSNHL that showed that the apical part of the cochlea recovers better than the basal parts [24]. Spontaneous recovery of hearing has been described in the first few weeks from the onset of SSNHL, but hearing recovery after the failure of primary therapy is very low. We used a control group of 50 patients who did not receive additional therapy after the failure of steroid therapy. One month after the initial therapy, hearing levels were measured and no improvement was observed. We are aware that our control group did not receive HBO therapy for the real comparison; however, because of ethical reasons and technical difficulties, it is difficult to perform this kind of research. We used patients who did not receive HBO therapy after the failure of the primary therapy as it was unavailable at that time or they refused the treatment. The high costs of HBO therapy and a lack of randomized studies are the main reason for not using it as the primary therapy for patients with sudden hearing loss. It is very important to start primary and salvage therapies as soon as possible because salvage therapy has no effect if it is used 4 months after the initial hearing loss [7].

Intratympanic steroid therapy as salvage therapy is more effective at low frequencies than at high frequencies [19]. Our results suggest that HBO therapy is also more effective at low frequencies in patients if the hearing loss is less severe. An explanation for better hearing recovery at low frequencies is that hearing cells in the apical part of the cochlea are more resistant to ischemia than those in other parts of the cochlea.

Hyperbaric oxygen therapy is used for primary and salvage therapy. Combination of HBO and steroid therapy compared to steroid therapy alone significantly improved hearing outcome [28]. The addition of HBO therapy to primary conventional therapy improved the results when started early after the onset of SSNHL and was more successful in patients with a hearing loss greater than 60 dB [15]. A recent study compared four primary therapy protocols for patients with SSNHL: oral steroid therapy, intratympanic steroid therapy, HBO therapy, and HBO therapy combined with oral steroid therapy [19]. The results showed that the combination of oral steroid therapy and HBO therapy was the most effective.

A high rate of spontaneous recovery, up to 65%, has been described within the first two weeks after the initiation of steroid therapy [23]. This natural course of the disease could be attributed to the success of primary therapy.

Hyperbaric oxygen therapy is a safe and successful salvage therapy for patients with sudden hearing loss. Our results indicate that HBO therapy as salvage therapy for SSNHL is effective and should be used, particularly in patients with severe hearing loss. Without salvage therapy, no significant changes in the hearing threshold can be expected. We could not have divided the group of patients with a hearing loss of >60 dB into even more groups because the number of patients is small and statistical analyses would be inadequate. Further studies with a larger number of patients and comparison with other types of salvage therapy are needed.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of University Hospital Centre Sestre Milosrdnice, Zagreb, Croatia.

Informed Consent: Written informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.


Conflict of Interest: No conflict of interest was declared by the authors.

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