

COMMUNICATION
UDC 617.7:15.835.3THE EFFECTS OF
HYPERBARIC OXYGEN
ON VISUAL FUNCTIONS
IN ISCHAEMIC OPTIC
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Received May 17, 1993

The effects of hyperbaric oxygen therapy were studied in nine patients with non-arteritic anterior ischaemic optic neuropathy, who had been unsatisfactorily treated with corticosteroids. In four patients with signs of optic disc atrophy there was no improvement of visual functions after hyperbaric oxygen treatment, whereas in the other five patients, who had no signs of optic disc atrophy, visual acuity and visual field improved. The achieved improvements were maintained at a control examination six months later. Results suggest that hyperbaric oxygen might be a new remedy for the selected cases of non-arteritic ischaemic optic neuropathy and call for a controlled clinical study aiming to accurately assess its efficacy.

Key terms:
hyperbaric oxygenation, non-arteritic ischaemic optic neuropathy, visual acuity, visual field

Non-arteritic ischaemic optic neuropathy (NAION) is characterized by sudden, painless, usually irreversible loss of central or peripheral vision (or both), and an afferent pupillary defect associated with optic disc swelling and peripapillary haemorrhage (1-3). It is a frequent cause of impaired vision in persons past the middle age.

It is well established that NAION produces permanent loss of visual acuity and visual field in its natural history. Only few patients experience the slightest degree of spontaneous visual recovery (2-5). It is of fundamental importance to appreciate that there is a wide range of ischaemia in NAION (1). Probably the ischaemia is due to transient non-perfusion without an organic block in the vessels (1).

A variety of treatment modalities have failed to prevent visual loss in NAION patients. There is no medication known to prevent this progressive course. Recent reports suggest a beneficial effect of optic nerve sheath decompression (6-8).

Hyperbaric oxygen or hyperbaric oxygenation (HBO) have been widely used (9). Recent advances in retinal anoxia treatment raised a new interest in the possibility to use it for ischaemic conditions of the retina (10).

Findings indicating that ischaemia of the optic nerve is one of the leading factors in the pathogenesis of ischaemic optic neuropathy (1, 11), inspired us to carry out a clinical trial on the effects of HBO in NAION patients. The main objective of HBO treatment would be to eliminate hypoxia of the neurons and reduce oedema of the optic disc, which in turn can help restore function of the still living but non-functioning neurons.

SUBJECTS AND METHODS

The clinical trial included nine Caucasian patients, aged 60-69 years (mean 65.11), suffering from NAION (Table). The patients were previously treated in different hospitals with high doses of oral corticosteroids, ranging from 80 to 100 mg daily, without any improvement in visual functions. They reached a maximal dose in an average of eight days, after which the dose was gradually decreased. The corticosteroid therapy lasted from 14 to 41 days (mean 31.8), and was neither randomized nor controlled.

The objective of the trial was explained to all the patients who then signed an agreement to participate. They had no contraindications for HBO.

A complete ophthalmological examination, including visual field testing by kinetic perimetry after Goldmann (perimeter type Marco 2000), was performed two days before HBO, after the course of treatment, and six months later.

At admission all the patients presented with decreased central visual acuity and visual field defects associated with pallid disc oedema and peripapillary retinal haemorrhages. No anterior or posterior vitreous inflammatory cell reaction was found. Vasculitis screening, including determination of erythrocyte sedimentation rate yielded normal findings. No patient had a history of visual loss consistent with optic neuritis or a history of neurologic disease consistent with multiple sclerosis. On ophthalmoscopy four patients (cases 6-9) showed the first slight signs of optic disc atrophy. The time between the onset of the disease and the initial HBO session was variable and ranged from 21 to 84 days (mean 42.0) (Table).

HBO was conducted in a large walk-in hyperbaric chamber, for three patients (cases 1-3) at the pressure of 2.8 bars for 60 minutes twice a day, and for the others at 2.0 bars for 90 minutes once daily. The total number of sessions was: 30 for the first three patients (cases 1-3), 20 for the next three patients (cases 4-6), 18 for the next one (case 7) and 14 for the last two patients (cases 8 and 9) (Table). The last three patients (cases 7-9), for personal reasons, attended fewer than 20 planned sessions. In 1969, at the beginning of HBO administration at the Naval Medical Institute in Split, the treatment was performed at 2.8 bars

Table Patients with non-arteritic anterior ischaemic optic neuropathy treated with hyperbaric oxygen

Case	Age (y) Sex	Disease to treatment interval (weeks)	Visual acuity		Visual field defects	
			Before HBO	After HBO	Before HBO	After HBO
1	65 M	12	0.4	0.7	Central scotoma	Relative paracentral scotoma
2	67 F	4	0.02 HM	0.7	Inferonasal involving fixation	Paracentral scotoma, enlarged blind spot, sparing fixation
3	60 F	3	0.2	0.4	Central and paracentral scotoma	Relative central scotoma, mild peripheral constriction
4	63 F	4	CF	0.2	Relative inferior altitudinal involving fixation	Relative inferonasal quadratic defect
5	68 F	5	CF	0.08	Relative inferior altitudinal involving fixation	Relative central inferonasal defect
6	62 M	7	0.02 HM	0.02 HM	Absolute inferior altitudinal hemianopsia	Absolute inferior altitudinal hemianopsia
7	69 F	6	0.06 HM	0.06 HM	Inferior nasal quadratic defect	Inferior nasal quadratic defect
8	64 F	6	CF	0.02 HM	Inferior altitudinal defect	Inferior altitudinal defect
9	68 M	7	0.08 HM	0.08 HM	Central scotoma, mild peripheral constriction	Central scotoma, mild peripheral constriction

HM indicates hand motions, and CF counting fingers.

twice a day for three to four weeks on the average. HBO at 2.0 bars once a day was introduced in 1985 for ophthalmological diseases. That accounts for the difference in pressure and number of treatments.

Visual improvement was defined as a final visual acuity at least two lines better than at visual nadir or increased by at least one level of central visual function (such as from hand motion to 0.06). The best corrected visual acuity was measured at 5 m with international visual acuity chart with standard light.

Assessment of visual field improvement was based on lessening of central scotoma, sparing fixation and increased peripheral field (an expansion of at least 10° of the I₄ isopter).

RESULTS

The table shows results for visual acuity and visual field testing before and after the HBO course.

Five patients (cases 1-5) exhibited a marked improvement in visual functions. Visual field improvement defined as lessening of central scotoma (cases 1 and

3), sparing fixation (case 2) and increased peripheral field (cases 4 and 5) was also noted. In these patients, ophthalmoscopy performed during the HBO course and immediately after demonstrated a markedly reduced oedema of the optic disk without any signs of atrophy.

After six months, the improvements persisted in five patients (cases 1-5), whereas other patients (cases 6-9) failed to show any sign of improvement.

No side-effects or complications of HBO were observed.

DISCUSSION

There is considerable controversy concerning the use of corticosteroids in NAION patients, but the most recent opinions do not advocate it (12, 13). Treatment with corticosteroids did not appear to influence the outcome in our patients.

Our rationale for HBO treatment of NAION patients was based mainly on beneficial effects of HBO in ischaemic areas. Increase in partial alveolar oxygen pressure produces an increase in physically dissolved oxygen content in the arterial blood, which is beneficial in ischaemic areas. Besides this direct elementary mechanism, showing immediately in the course of HBO, there are important indirect late effects such as oedema and blood viscosity drop, becoming manifest after HBO and lasting for several months, adding to hypoxia correction (9, 10, 14, 15).

Van Gool and Jong described improvements in visual acuity and visual field in four patients with ischaemic damage of the optic nerve head treated with HBO (16). *Andreev and co-workers* used HBO in a complex treatment of several eye diseases including optic nerve atrophy (17).

HBO failed to produce a beneficial effect in our patients who showed first signs of optic disc atrophy (cases 6-9), probably because of irreversible organic changes in the optic nerve. Five patients (cases 1-5) demonstrated improvements in visual acuity and visual field. Unfortunately, computerized perimetry and electroretinography were not applied for lack of equipment.

The interval between the onset of NAION and the beginning of HBO was variable. A relatively long interval did not seem to preclude improvement in visual function.

The reversible nature of axon dysfunction in the optic nerve may, in part, be explained by a compensatory shift from aerobic to anaerobic glycolysis that takes place in ischaemic axons. This metabolic adaptation may be responsible for the delay of irreversible tissue damage (18).

Beneficial effects of HBO on visual field were probably achieved by direct and indirect mechanisms of action on the optic nerve.

Our results speak in favour of HBO application in NAION patients at a stage when optic disc does not show signs of atrophy.

CONCLUSION

In the NAION patients with optic disc atrophy HBO, like classical drugs, failed to bring about any improvement. The patients without optic disc atrophy, on the other hand, displayed a marked improvement. Present results, however, do not yet allow to conclude that HBO is a better treatment. They call for a controlled clinical study to compare more accurately HBO efficacy with that of standard treatment.

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Sažetak

UČINCI HIPERBARIČNOG KISIKA NA VIDNE FUNKCIJE U BOLESNIKA S ISHEMIČNOM OPTIČKOM NEUROPATIJOM

Ispitivani su učinci tretmana hiperbaričnim kisikom u devet bolesnika s nearteritičnim oblikom prednje ishemične optikoneuropatije, koji su prethodno liječeni kortikosteroidima bez uspjeha. U četiri bolesnika sa znakovima atrofije optičkog diska, nakon tretmana hiperbaričnim kisikom, nije nađeno nikakvo poboljšanje vidnih funkcija, dok je u ostalih pet, bez znakova atrofije optičkog diska, ustanovljeno poboljšanje oštine vida i vidnog polja. Ova poboljšanja nađena su i na kontrolnom pregledu nakon šest mjeseci. Rezultati ispitivanja sugeriraju hiperbaričnu oksigenaciju kao mogući način liječenja selekcioniranih slučajeva nearteritičnog oblika ishemične optikoneuropatije, kao i kontrolirani klinički pokus, radi egzaktnijeg utvrđivanja efikasnosti hiperbarične oksigenacije u ovih bolesnika.

Ključne riječi:

hiperbarična oksigenacija, nearteritična ishemična optikoneuropatija, oština vida, vidno polje

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