ORIGINAL ARTICLE

Efficacy and safety of hyperbaric oxygen therapy for acute central retinal artery occlusion in Hong Kong: results of the first 3 years

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Abstract

Purpose: To review the efficacy and safety of hyperbaric oxygen therapy (HBOT) for central retinal artery occlusion (CRAO) in Hong Kong patients.
Methods: Patients diagnosed with CRAO with symptom onset ≤6 hours who failed emergency bedside ocular treatment were referred to a course of HBOT. Changes in best-corrected visual acuity (VA) after HBOT and adverse effects and complications of HBOT were recorded. Changes in best-corrected VA between the pre-COVID-19 group and the COVID-19-pandemic group were compared.
Results: 34 men and 26 women with CRAO aged 27 to 89 years were included for analysis. The mean follow-up period was 169±226 days. The mean number of HBOT sessions received was 8.6±3.2. The mean best-corrected VA improved from 2.02±0.36 to 1.53±0.61 logMAR after HBOT (p<0.00001). 65% of patients had improvement and 33.3% had no improvement. VA changes between the pre-COVID-19 group (n=22) and COVID-19-pandemic group (n=38) were comparable (-0.53±0.58 vs -0.46±0.57 logMAR, p=0.59), despite a delay in hospital attendance. 41.7% of patients failed to equalize the pressure during treatment requiring myringotomy or even grommet insertion. 20% of patients had barotrauma. Other adverse events included convulsion, confusion, sinus pain, and hypoglycemia.
Conclusion: In patients with CRAO, HBOT may be effective in improving best-corrected VA, even during the COVID-19 pandemic.

Key words: COVID-19; Hyperbaric Oxygenation; Retina; Retinal artery occlusion

Introduction

Central retinal artery occlusion (CRAO), also known as ocular stroke, is an ophthalmic emergency that may cause blindness.[1,2] Managements for CRAO include breathing into a paper bag, carbogen inhalation,[3] topical and/or systemic medical treatment for lowering intraocular pressures, ocular massage, anterior chamber paracentesis,[4] or even thrombolytic therapy.[5] Nonetheless, there is no consensus on the gold standard management.[6]

In Hong Kong, hyperbaric oxygen therapy (HBOT)[7] for CRAO was started in November 2018 at the Pamela Youde Nethersole Eastern Hospital,[8] which receives referrals from both public and private practitioners 24 hours every day,[9] even during the COVID-19 pandemic.[10] We have previously reported an absence of SARS-CoV-2 among our cohort and delayed hospital presentation during the COVID-19 pandemic.[11-13] This study aims to review the efficacy and safety of HBOT for CRAO in Hong Kong patients.

Methods

Patients diagnosed with CRAO with symptom onset ≤6 hours who failed emergency bedside ocular treatment were referred to a course of HBOT. Patients with iatrogenic CRAO secondary to cosmetic facial filler injection, neurosurgical interventional radiology procedures, or intraarterial chemotherapy injection were excluded, as were those who presented beyond the 6-hour timeframe or had contraindications of HBOT such as untreated pneumothorax or bleomycin usage.

Patients underwent slit lamp and dilated fundus examinations to confirm the diagnosis, and their visual acuity (VA) and intraocular pressure were measured. Eyes with pathologies other than CRAO were excluded from HBOT. Patients with acute visual loss arising from branch retinal artery occlusion (BRAO) or cilioretinal artery occlusion were excluded, although evidence supporting HBOT to treat BRAO is increasing.[14] Patients were treated by a multidisciplinary team of internal medicine physicians and emergency department HBOT practitioners.

Patient data (age, sex, ethnicity, follow-up duration, onset-to-door time, diseased eye laterality, best-corrected VA, past ophthalmic history, past medical and drug history) were retrieved from the electronic health record system of the Hospital Authority.[15] The best-corrected VA was measured on the Snellen charts and converted to the logarithm of minimal angle of resolution (logMAR) units for analysis,[16] with finger count=1.7 logMAR, hand movement=2.0 logMAR, light perception=2.3 logMAR, and no light perception=3.0 logMAR.

The primary outcome was the VA changes after HBOT. Secondary outcomes were adverse effects and complications of HBOT. As there was a delay in hospital presentation during the COVID-19 pandemic,[13] the pre-COVID-19 group (before 23 January 2020 when the first confirmed COVID-19 case was recorded in Hong Kong) was compared with the COVID-19-pandemic group to determine the difference in VA changes. Normality of data distribution was tested by the Shapiro-Wilk test.[17] Statistical analysis was performed using the SPSS (version 27, IBM, Armonk [NY], USA).

Results

As of 30 November 2021, 70 patients who required an emergency call for HBOT were identified. 10 patients were excluded owing to ophthalmic artery occlusion from internal carotid artery pathologies such as carotid artery dissection from hypertension (n=1) and carotid artery stenosis from previous radiotherapy for nasopharyngeal cancer (n=1) as well as non-CRAO cases such as BRAO, retrobulbar optic neuritis, orbital apex tumor, and central serous chorioretinopathy (n=8).

34 men and 26 women with CRAO aged 27 to 89 (mean, 67.5±14.4) years were included for analysis. 31 left eyes and 29 right eyes were involved; no patient had bilateral presentation. The mean follow-up period was 169±226 (range, 4-912) days. The mean number of HBOT sessions received was 8.6±3.2 (range, 1-10). The mean best-corrected VA improved from 2.02±0.36 (range, 0.7-3.0) logMAR (Snellen equivalent to around hand movement) pre-HBOT to 1.53±0.61 (range, 0.1-3.0) logMAR (Snellen equivalent to 20/640) after treatment ($p<0.00001$), with an improvement of 0.49±0.57 logMAR. 39 (65%) eyes had improvement, 20 (33.3%) eyes had no improvement, and one eye had a decrease in VA.

Given VA of light perception or worse cannot be accurately converted to LogMAR, 15 such patients were excluded. In the remaining 45 patients, the mean best-corrected VA improved from 1.87±0.25 (range, 0.7-2.0) logMAR pre-HBOT (Snellen equivalent to 20/1400) to 1.41±0.63 (range, 0.1-2.0) logMAR (Snellen equivalent to 20/500) after treatment ($p<0.00001$), with an improvement of 0.47±0.63 logMAR.

VA changes between the pre-COVID-19 group (n=22) and COVID-19-pandemic group (n=38) were comparable (-0.53±0.58 vs -0.46±0.57 logMAR, $p=0.59$).

No patient had CRAO in the contralateral eye during the follow-up period. Two patients had cerebrovascular stroke shortly after the diagnosis of CRAO, and HBOT was terminated after one or two sessions for the treatment of stroke. The first patient had left common carotid artery atherosclerosis, and CRAO was the first presentation before the full presentation of middle cerebral artery stroke 1 day later. The patient required thrombectomy subsequently. The second patient was 45 years old and had right lateral dorsal pontine lacunar infarct, and was later found to have hypertension, hyperlipidemia, and moderate obstructive sleep apnea. 33 (55%) patients had adverse events including failure to equalize the pressure during treatment requiring myringotomy or even grommet insertion (n=25), barotrauma of grade 1 to 3 (based on the modified Teed Classification[18]) but without any perforation (n=12), convulsion secondary to oxygen toxicity (during the first session while decompressing from 180 kPa to 139 kPa at 94 minutes) [n=1], confusion with agitation and aggressive behavior (n=1), sinus pain (n=1), and shortness of breath (n=1). Three patients had hypoglycemia; two of them had diabetes mellitus.

Discussion

In the present study, the best-corrected VA improved significantly after HBOT, which is consistent with a case series of 128 patients that reported a mean VA improvement from 2.14±0.50 logMAR (Snellen equivalent to hand movement) to 1.61±0.78 logMAR (Snellen equivalent to 20/800) [$p<0.0001$].[19] To the best of our knowledge, the present study includes the largest case series of Chinese/Asian patients on visual outcomes of HBOT for CRAO.

The incidence of ischemic stroke within 15 days of CRAO

has been reported to range from 2.2% to 5.3%,[20-22] which is similar to the 3.3% among our cohorts. None of our patients had hemorrhagic stroke. However, occurrence of transient ischemic attack around CRAO was not recorded. In Chinese patients with retinal artery occlusion, the stroke risk was 2.07 times higher than controls.[23]

Middle ear barotrauma is a common adverse effect of HBOT, with incidence ranging from 9.2% to 66.7%.[24,25] 20% of our patients had barotrauma; all were older than 55 years except one. Female sex and age >55 years are risk factors.[26] Hypoglycemia is a complication of HBOT and can precipitate other neurological complications. HBOT can decrease blood glucose level even on healthy subjects.[27] The incidence of hypoglycemia during or immediately after HBOT is 1.5% (range, 0.8%-2.1%).[28] One of the three patients with hypoglycemia did not have diabetes mellitus. There is evidence suggesting a reduction in glycemia following HBOT in patients with diabetes mellitus, but the sample size is small and potentially underpowered.[29]

There are a few limitations to the study. Only subjects with symptoms onset of ≤6 hours were included, and thus many patients were unable to benefit from HBOT, although the Undersea and Hyperbaric Medical Society recommends HBOT within 24 hours of symptoms onset.[30] In most patients, HBOT were initiated before the serological investigation results were available, particularly results of the erythrocyte sedimentation rate were only available during office hours. Thus, patients with arteritic CRAO may have been included, despite the low prevalence of giant cell arteritis in Chinese populations.[31] Such patients are known to have poor visual outcomes. During the COVID-19 pandemic, hospital attendance patterns changed drastically.[32] Despite this, the pre-COVID-19 group and the COVID-19-pandemic group were comparable in terms of VA improvement. There was no comparative arm to determine the efficacy of HBOT for CRAO. Randomized studies comparing HBOT with conservative treatment for CRAO are warranted.

Conclusions

In patients with CRAO, HBOT may be effective in improving best-corrected VA, even during the COVID-19 pandemic.

Contributors

All authors designed the study, acquired the data, analyzed the data, drafted the manuscript, and critically revised the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

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Data Availability

All data generated or analyzed during the present study are available from the corresponding author on reasonable request.

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