Hyperbaric oxygen treatment in delayed post-hypoxic encephalopathy following inhalation of liquefied petroleum gas: a case report

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Abstract

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Delayed post-hypoxic encephalopathy can occur after an episode of anoxia or hypoxia. Symptoms include apathy, confusion, and neurological deficits. We describe a 47-year-old male patient who inhaled gas from a kitchen stove liquid petroleum gas cylinder. He was diagnosed with hypoxic ischaemic encephalopathy 12 hours after his emergency department admission. He received six sessions of hyperbaric oxygen treatment (HBOT) and was discharged in a healthy state after six days. Fifteen days later, he experienced weakness, loss of appetite, forgetfulness, depression, balance problems, and inability to perform self-care. One week later, he developed urinary and fecal incontinence and was diagnosed with post-hypoxic encephalopathy. After 45 days from the onset of symptoms, he was referred to the Underwater and Hyperbaric Medicine Department for HBOT. The patient exhibited poor self-care and slow speech rate, as well as ataxic gait and dysdiadochokinesia. Hyperbaric oxygen was administered for twenty-four sessions, which significantly improved the patient's neurological status with only hypoesthesia in the left hand remaining at the end of treatment. Hyperbaric oxygen has been reported as successful in treating some cases of delayed neurological sequelae following CO intoxication. It is possible that HBO therapy may also be effective in delayed post-hypoxic encephalopathy from other causes. This may be achieved through mechanisms such as transfer of functional mitochondria to the injury site, remyelination of damaged neurons, angiogenesis and neurogenesis, production of anti-inflammatory cytokines, and balancing of inflammatory and anti-inflammatory cytokines.

Introduction

Delayed post-hypoxic encephalopathy has been mostly associated with carbon monoxide poisoning, but it has also been reported in other patients. The clinical presentation is characterised by apathy, confusion, agitation, or progressive neurological deficits developing after an initial period of apparent recovery following a brief episode of anoxia or hypoxia.[1–4]

There is currently no pharmacological treatment with proven efficacy for delayed post-hypoxic encephalopathy. It can progress rapidly and render the patient a dependent individual, posing a great challenge for clinicians both in terms of diagnosis and treatment planning. Reported cases of delayed neurologic sequelae occurring after liquified petrolium gas (LPG) inhalation are limited.[5] We describe a case of delayed neurological sequelae (DNS) after LPG poisoning treated with hyperbaric oxygen (HBO).

Case report

The patient provided written consent for his case and MRI images to be reported.

A 47-year-old male patient attempted suicide by inhaling gas from the kitchen stove cylinder. He was found unconscious and vomiting after approximately 10 hours of gas exposure, and was taken to the emergency department. He was unconscious, and was intubated. Initial arterial blood gas test results (breathing air) showed a PaO_2 of 10.1 kPa (76 mmHg), pH 7.42, and $PaCO_2$ of 4.0 kPa (30 mmHg). The patient had decreased respiratory sounds and diffuse rales. He was diagnosed with hypoxic ischaemic encephalopathy and twelve hours after his admission, he received HBO (242.3 kPa for 120 minutes) followed by five further identical treatments once daily. At the time of discharge, he was in a good general condition, his consciousness was clear, but he still complained of numbness in his left hand.

Fifteen days after discharge, the patient started experiencing weakness, loss of appetite, forgetfulness, depression, balance problems, and inability to perform self-care. He was admitted to the psychiatry clinic in another medical centre. One week after admission he developed urinary and faecal incontinence. The patient was diagnosed with delayed post-hypoxic encephalopathy by the consulting neurologist. The cranial magnetic resonance imaging (MRI) findings were evaluated as consistent with this diagnosis. The patient was referred to the Underwater and Hyperbaric Medicine Department by the neurologist for HBO treatment as a delayed neuropsychiatric sequel of LPG intoxication. The time elapsed between the onset of symptoms and the referral to our clinic was approximately 45 days.

On evaluation it was observed that his self-care was poor. An apathetic facial expression was observed. The content and fluency of speech were normal, but the speech rate was significantly slow. Cranial nerve examination and global muscle strength and tone were normal. However, there was a broad-based ataxic gait, bilateral dysdiadochokinesia, and dysmetria. Hypoaesthesia was observed in the distal left upper extremity. Deep tendon reflexes were normal. The minimental state examination (MMSE) test revealed decrements in attention and executive functions, and the overall score was 11/30. The patient still had urinary and fecal incontinence.

In the initial cranial MR images, in the fluid attenuation inversion recovery (FLAIR) and T2 weighted (T2W) series, there were widespread, symmetrical hyperintensities with a tendency to coalesce in the vertex, corona radiata, centrum semiovale and the periventricular white matter. There was restricted diffusion in these areas on the diffusion-weighted imaging series. Symmetrical hypointensities were observed in the bilateral basal ganglia, more prominent in the globus pallidus (Figure 1).

We explained to the patient and his family that delayed post-hypoxic encephalopathy after LPG inhalation is not an accepted indication for HBO treatment and that there has been no scientific study about this subject. Nevertheless, given the resemblence of the underlying mechanism to carbon monoxide (CO) intoxication, it was possible that HBO treatment may have beneficial effects. After the approval of the patient and his family, a total of twenty-four

Figure 1

Bilateral lesions on FLAIR (fluid attenuation inversion recovery), T2W (T2 weighted) and DWI (diffusion weighted imaging) sequences at the level of basal ganglia

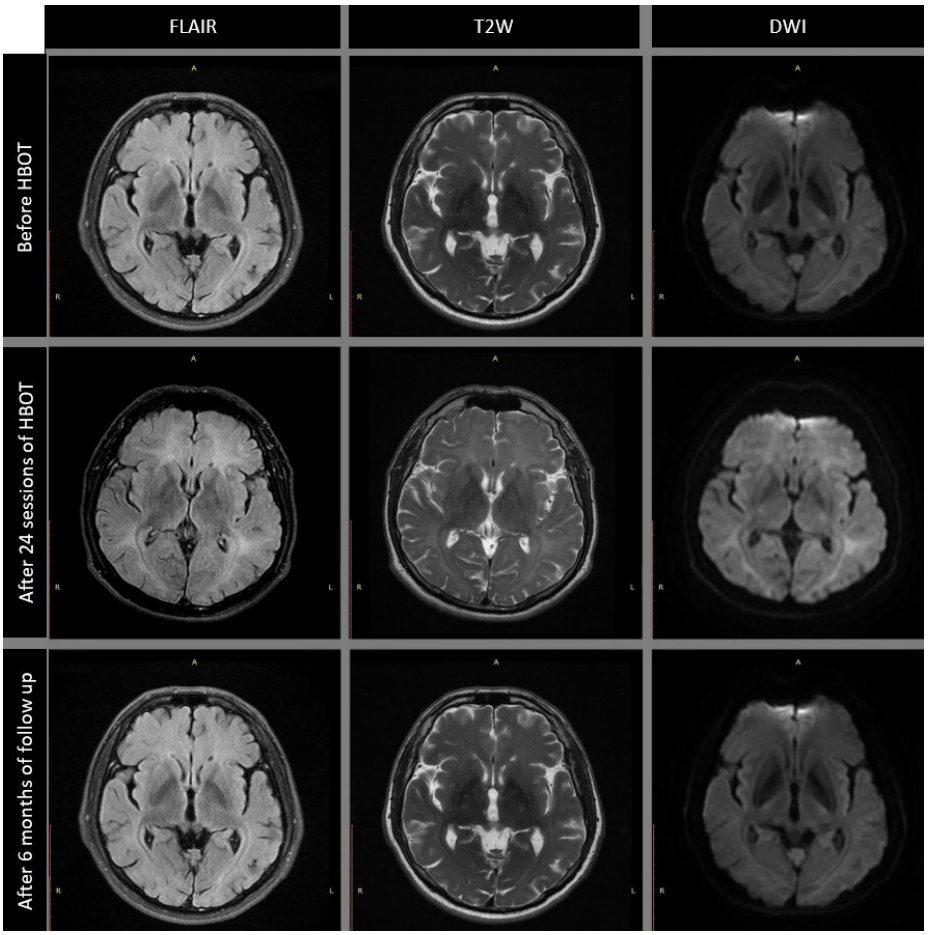
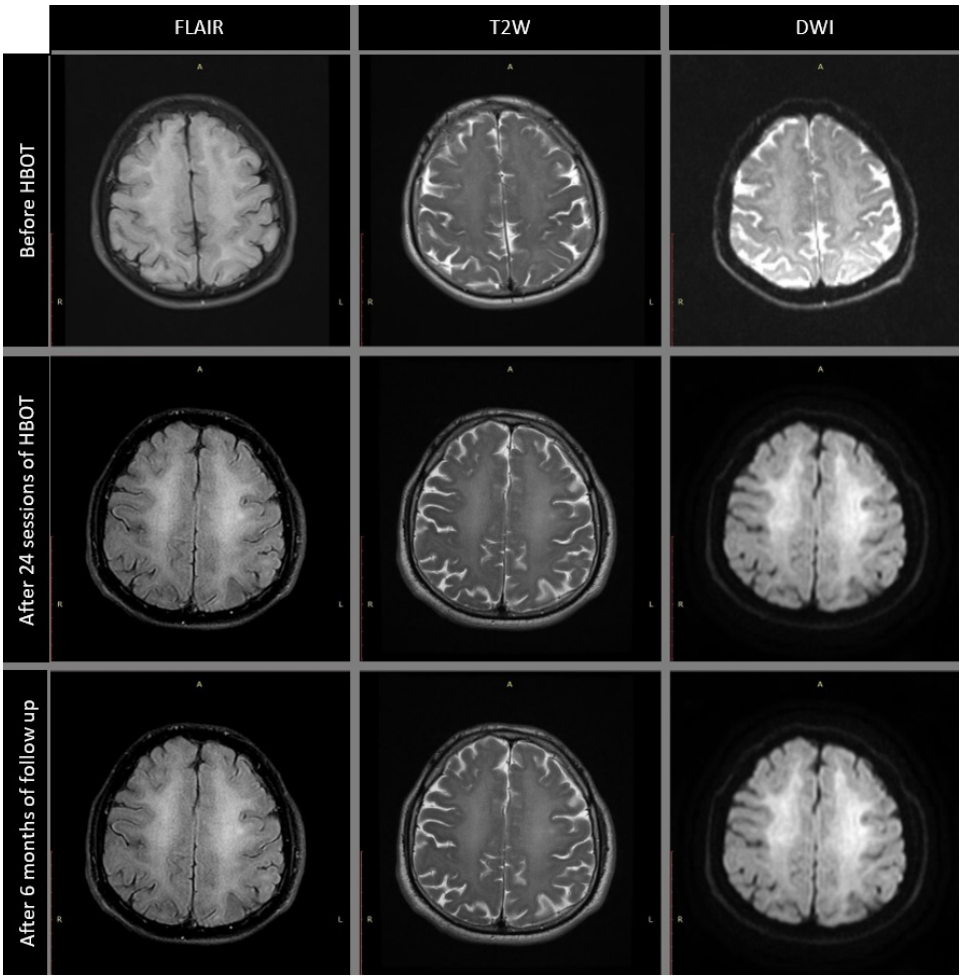


Figure 2
Bilateral lesions on FLAIR (fluid attenuation inversion recovery), T2W (T2 weighted) and DWI (diffusion weighted imaging) sequences at the level of the centrum semiovale



HBO treatments were administered once daily, 120 minutes at 242.3 kPa, five days a week. The patient did not receive concurrent medical treatment during these treatments. After the 10th session, the bilateral dysdidiokinesia, dysmetria and ataxic gait were completely resolved, a significant improvement was observed in the MMSE (29/30). However, it was also noted that there was still hypoaesthesia in the distal part of the left upper extremity, and the patient continued with HBO treatment.

At the end of the twenty-fourth session, the patient once again scored 29/30 on the MMSE and showed no change in the hypoaesthesia in the left hand. He was able to perform self-care. On the MR images taken after 24 HBO treatments, the previously described signal changes had regressed (Figure 2). The patient's HBO treatment was discontinued as his symptoms and depressive mood had improved. After six months, the MRI findings had completely returned to normal (Figure 2). During a phone interview after five years follow-up, the patient stated that he continues with daily life activities without any problem. He has no health problems but the numbness in his left hand still persists.

Discussion

This patient was initially admitted to the psychiatry service with a new onset of depressive mood, loss of balance, and dementia fifteen days after LPG poisoning and initial recovery following HBO treatment. He was evaluated by neurology because of the onset of urinary and fecal incontinence. The patient was diagnosed with late neuropsychiatric sequelae based on the MRI findings by the consulting neurologist. After twenty-four sessions of HBO treatment the MMSE score was 29/30 and the clinical symptoms completely resolved. No other treatment was given concomitantly.

Liquified petroleum gas is a flammable hydrocarbon gas mixture used as a fuel with propane as the main component and it additionally contains isobutane.These substances

are lipophilic, so after inhalation and absorption into the bloodstream from the lungs, they distribute in high concentrations in lipid-rich tissues, especially the brain.[6] Following a case of Parkinsonism due to LPG inhalation it was suggested that LPG may have a direct toxic effect on the brain by creating histotoxic hypoxia similar to CO intoxication.[5] It was stated that ataxia, dystonia, bradykinesia, widespread plastic rigidity and dysarthria continued after one year follow up in the patient who was not treated with HBO.[5] Ours is the only reported case of apparently delayed neurological pathology (hypoxic-ischaemic encephalopathy) following LPG inhalation. Unlike the other case, HBO treatment was administered and the symptoms completely regressed, with only hypoaesthesia remaining in the left hand.

The clinical course and MRI abnormalities in our patient can be associated with brain injury caused by histotoxic hypoxia, as well as being similar to DNS cases associated with CO poisoning. The brain regions affected by CO toxicity include the basal ganglia, especially the globus pallidus, substantia nigra, and hippocampus. These are areas with high metabolic rate and high oxygen demand. Laminar necrosis of the cerebellar cortex and Purkinje cell loss are frequently seen in CO intoxication.[7] Similar MRI findings were found in our case as shown in Figures 1 and 2. It has been reported that HBO treatment has sometimes been associated with positive results in patients with DNS associated with CO poisoning.[8,9]

Studies have suggested that HBO can transfer functional mitochondria to an injured area and reduce inflammation by decreasing cytokines that cross the blood-brain barrier, which play a role in secondary cell damage mechanisms.[10] After the development of DNS, HBO treatment may have aided recovery by transferring functional mitochondria to the injury site, re-myelination of damaged neurons, angiogenesis and neurogenesis, production of anti-inflammatory cytokines, and balancing of inflammatory and anti-inflammatory cytokines.[11–13]

Conclusions

In the present case, we believe that LPG, which is considered to have low neurotoxicity, may have caused direct toxic damage to the brain through a histotoxic hypoxia mechanism, similar to CO poisoning. Hyperbaric oxygen treatment has been reported to have positive results in treating DNS following CO intoxication in some cases, and it is possible that HBO therapy may also be effective in delayed post-hypoxic encephalopathy related to LPG poisoning. There is a need for better understanding of the pathophysiology of DNS in these settings and for further investigation of potential benefit from HBO treatment.

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