Hyperbaric Oxygen Therapy for Cerebral Palsy: Two Complications of Treatment

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ABSTRACT. There is growing interest in the use of hyperbaric oxygen therapy (HBO₂) for children with cerebral palsy. Although there is no rigorous evidence to support this management, private hyperbaric centers have been established throughout the United States and Canada. There is likely to be increasing pressure on pediatricians and other health professionals to prescribe HBO₂. We describe 2 children with cerebral palsy who suffered significant morbidity immediately after treatment with hyperbaric oxygen. Both the temporal association and pathologic findings suggest that the hyperbaric treatment is likely to have been responsible for the resulting complications. As with any new therapy, we suggest waiting for the results of a randomized, controlled trial before recommending this treatment.

CASE REPORTS

Case 1

A 4-year-old boy with CP was admitted to our pediatric ICU with severe respiratory distress, 2 hours after completing a hyperbaric oxygen treatment. He was the product of a breech presentation and required extensive resuscitation at birth. By 4 years of age, he could stand with support but had no speech and poor

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comprehension. He required anticonvulsant therapy for a symptomatic seizure disorder. During the day of admission, he received 2 courses of HBO₂; each treatment lasted 90 minutes with 15 minutes for descent and 15 minutes for ascent. The child was dived to 1.75 atmospheres on each occasion. During treatment his head was completely enclosed by a vinyl hood with latex seals around his neck for delivery of oxygen. Between the 2 treatments he was fed orally. He regurgitated his feed during the second treatment. He subsequently developed increasing respiratory distress that prompted his intensive care admission. He had been well on the morning of the treatments and had no past history of aspiration or choking episodes. His chest radiograph revealed dense opacification of the left lung field compatible with an acute aspiration. He was treated with intravenous antibiotics, intensive chest physiotherapy, and bi-level positive pressure mask ventilation. He was discharged to the ward after 3 days in the ICU. A feeding study subsequently revealed free reflux and tracheal aspiration of feeds.

Case 2

A 10-month-old boy with CP was admitted to our ICU with acute respiratory failure that required immediate intubation and ventilatory support. He also required intravenous anticonvulsants for control of what was observed to be a brief generalized tonic clonic seizure that occurred after positive pressure ventilation was instituted. His medical history was significant for severe perinatal asphyxia after uterine rupture during delivery. This resulted in spastic CP with microcephaly and developmental delay, cortical visual impairment, bulbar dysfunction, and recurrent pneumonia. The child had been receiving twice-daily hyperbaric oxygen treatments for the 2 days before admission. Each treatment involved pressurization to 1.5 atmospheres for 1 hour with 15 minutes to dwell on the middle of the treatments and had no past history of in a monoplace chamber, with a parent present, and with ambient oxygen of 100%. There were no obvious complications during treatment. Routine hematology on admission to the ICU revealed a platelet count of 16 × 10⁹/L (normal range: 180–140 × 10⁹/L). A diagnosis of idiopathic thrombocytopenic purpura (ITP) was made, which was believed to be related to the parainfluenza type 3 found on tracheal aspirate. He subsequently had 2 further generalized tonic clonic seizures during the first day of admission. In view of the low platelet count and the ongoing seizure activity, a computed tomography (CT) scan of his head was organized to exclude an acute intracerebral hemorrhage. A CT scan of his head showed a large nonhemorrhagic infarction of the left hemisphere thought to be attributable to a thrombus or embolus to the middle cerebral artery. An echocardiogram demonstrated a patent foramen ovale with bidirectional flow. No other embolic events were identified and coagulation studies were normal, no other investigations for a hypercoagulable state were performed. His thrombocytopenia responded rapidly to treatment with intravenous γ-globulin. In view of this rapid response and the recent association of a number of other children developing ITP in association with parainfluenza type 3, it was believed that a bone marrow aspirate to confirm the diagnosis of ITP was not necessary. He was extubated successfully soon after transfer back to his home state. The only clinical manifestation of the left hemispheric infarction was the onset of seizure activity. There was otherwise no change in his neurological examination.

DISCUSSION

These 2 children with CP suffered significant medical problems shortly after hyperbaric oxygen therapy. We believe that the close temporal relationship between these 2 events, combined with the clinical features of the cases, support the suggestion that HBO₂ is likely to have been responsible for these complications.

In the first case, the child was well on the morning of his admission, did not have a fever, and was subsequently shown to have free gastroesophageal reflux with aspiration. It is likely that he suffered a serious aspiration event during the 90 minutes that his head was completely enclosed within a tight-fitting vinyl hood. Gas buildup in the stomach during pressurization, either from a recent feed or from air swallowing, will conform to Boyle’s law. During ascent from the treatment depth, there will be gas expansion with potential for reflux, aspiration, and vomiting.¹ This may have contributed to this child’s aspiration event. Swallowing disorders and reflux are common among children with CP.¹¹ When planning a treatment regimen for this group of children, consideration of oral feeding, access to the airway, provision of trained personnel, and suction equipment would be a sensible minimum requirement.

Although the second case had a very low platelet count, the CT scan revealed an embolic or thrombotic, rather than a hemorrhagic, stroke. We propose that the most likely mechanism for the middle cerebral artery occlusion was a gas embolism. It was unlikely to have been an air embolism, but theoretically possible to have been an oxygen embolism. When breathing 100% oxygen at 2 atmospheres, the Po₂ in the arterial blood is >1000 mm Hg. During the 15-minute ascent, this begins to fall, dropping to 100 mm Hg when breathing atmospheric pressure air. Oxygen is not highly soluble in plasma, so it is theoretically possible for bubbles of oxygen to form in the arterial blood during this equilibration period leading to occlusion of the middle cerebral artery.

Two other pathophysiological factors may be considered in accounting for the proposed clinical presentation of a cerebral oxygen embolism. During the decompression phase of treatment, oxygen bubbles might form in the lower pressure venous system and be ejected into the left atrium through the patent foramen ovale. They would then travel through the left atrium into the systemic circulation and might lodge in the left middle cerebral artery. Alternatively bubbles might sequester in the pulmonary arterial bed, ultimately pass through to the pulmonary venous bed, travel to the left atrium and left ventricle, and be ejected to lodge in the left middle cerebral artery. Both these mechanisms have been described in the literature.¹²¹³

The Undersea and Hyperbaric Medical Society provides a list of conditions for which HBO₂ is an acceptable treatment. CP is not one of these indications. Their recommendation is that HBO₂ should not be used for any other indication except in the context of controlled clinical trials. Although HBO₂ is a relatively safe treatment, it does have documented risks.³ Until the results of a randomized, controlled trial are available, we would suggest that HBO₂ not be recommended as a treatment for CP in children.

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