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HYPERBARIC OXYGEN THERAPY IN A DIALYSIS-RELATED PNEUMOCEPHALUS CASE

DİYALİZ İLİŞKİLİ PNÖMOSEFALİ VAKASINDA HİPERBARİK OKSİJEN TEDAVİSİ

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ABSTRACT

The presence of gas in the cranial cavity is called “pneumocephalus”, and is usually seen after invasive surgical procedures. Although symptoms are non-specific, such as headache, it can cause neurological distortion, coma, and death. Oxygen therapy is the most effective way to treat pneumocephalus and accelerates the reabsorption of the air. Hyperbaric oxygen treatment (HBOT), with its direct high pressure effect, causes the air mass to shrink. In the case reported in this paper, the pneumocephalus manifested with the symptom of sudden loss of consciousness and the etiology was an invasive intervention of dialysis catheter placement while the patient was in a sitting position. HBOT was applied as an emergency treatment, after which a dramatic radiological improvement was detected with computed tomography. Although this patient needed consecutive HBOT sessions for the best result, only a single session of HBOT could be applied because she was under the observation in the intensive care unit of another hospital due to the lack of space in the intensive care unit of our hospital. One of the main points is that the clinicians should not decide to cease HBOT only after the first session. Consecutive HBOT sessions can dramatically improve the radiological and clinical findings in these cases.

Keywords: Hyperbaric oxygen therapy, Pneumocephalus, Dialysis catheter

ÖZ

İntrakranial kavitedeki gaz varlığı “pnömosefali” olarak adlandırılır ve genellikle invaziv cerrahi işlemlerden sonra görülür. Baş ağrısı gibi spesifik olmayan semptomlar görülse de nörolojik bozulma, koma ve ölüme neden olabilir. Oksijen tedavisi, pnömosefaliyi tedavi etmenin en etkili yoludur ve havanın rezolüsyonunu hızlandırır. Hiperbarik oksijen tedavisi (HBOT), doğrudan yüksek basınç etkisiyle hava kütlesinin küçülmesine neden olur. Bu yazıda bildirilen olguda pnömosefali ani bilinç kaybı semptomu ile kendini göstermiş ve etiyolojisinde; hastanın oturur pozisyonda iken diyaliz kateteri yerleştirilmesine yönelik invaziv bir girişim yer almaktadır. Acil tedavi olarak HBOT uygulanan vakada, tedavi sonrası bilgisayarlı tomografi ile dramatik radyolojik düzelme saptandı. Bu hastada en iyi sonucun alınabilmesi için ardışık HBOT seanslarına ihtiyaç duyulmasına rağmen hastanemizin yoğun bakım ünitesinde yer olmaması nedeniyle başka bir hastanenin yoğun bakım ünitesinde müşahede altında olduğu için sadece tek seans HBOT uygulanabildi. Ana noktalardan biri, klinisyenlerin HBOT’ni sadece ilk seanstan sonra bırakma kararı vermemeleri gerektiğidir. Bu vakalarda ardışık HBOT seansları radyolojik ve klinik bulguları önemli ölçüde iyileştirebilir.

Anahtar Kelimeler: Hiperbarik oksijen tedavisi, Pnömosefali, Diyaliz kateteri

INTRODUCTION

The introduction of air into the venous or arterial system can cause cerebral air embolism which can lead to severe neurological deficits. The most common causes reported in the literature are iatrogenic, with the embolism occurring as a result of invasive medical procedures or surgery. Normally, the lungs have a very effective filtering capacity against venous gas embolism. If the gas volume exceeds 1.5-3 ml/kg, the filtration capacity of the lungs is overwhelmed. In another condition, if there is a right-to-left intracardiac shunt (e.g. patent foramen ovale is observed at the rate of 30% in the community), the risk of paradoxical arterialization of the bubbles increases significantly [1]. Neurological deficit has been estimated to occur in 19-50% of the patients with cerebral gas embolism. Arterial gas embolism, which requires urgent treatment, has high morbidity and mortality. The primary treatment modality is hyperbaric oxygen treatment (HBOT). A delay in recompression therapy of more than 4 hours reduces the recovery chance by nearly 50% [2]. We aimed to present our treatment approach to a very rare case with the presence of air in the skull (pneumocephaly).

CASE REPORT

A 69-year-old female patient with diabetes mellitus, chronic renal failure, hypertension and coronary arterial disease was consulted by the emergency medicine department. Sudden loss of consciousness and convulsion when placing a dialysis catheter in her right hand, in the sitting position were reported. The patient was intubated after respiratory arrest and was unresponsive to painful stimuli (Glasgow coma score=3). Both pupils were myotic, direct and indirect light reflexes were bilaterally weak, but there was no neck stiffness. Blood creatinine level was 1.76 mg/dL. The head computed tomography (CT) was immediately examined by a radiologist after the incident and a large number of pneumocephalic areas in the right hemisphere and an appearance compatible with leukorysis in the periventricular area were reported. The patient was referred to the Neurosurgery Department, but surgical intervention was not considered. Afterwards, the patient was referred to our department for HBOT at the 8th hour after the first symptoms.

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The United States Navy Treatment Table 6 (USN TT-6) (Fig. 1) was applied in our multiplace hyperbaric chamber (Barotech Multi12®-2016-Turkey) accompanied by an anesthesiologist inside with the diagnosis of arterial gas embolism. There were no complications developed during HBOT. Brain and diffusion weighted magnetic resonance imaging (MRI) were planned immediately after the HBOT session to eliminate the dialysis disequilibrium syndrome and cerebrovascular diseases due to sudden hypotension.

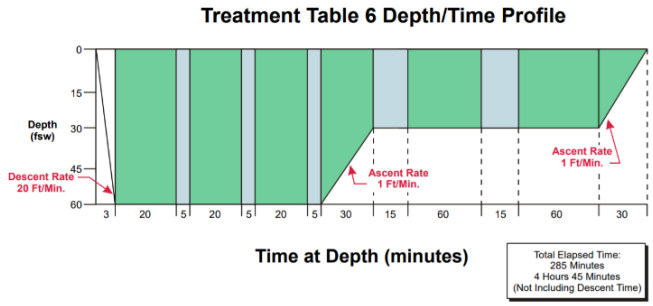

Fig 1. The United States Navy Treatment Table 6 (USN TT-6). (USN Diving Manual, Revision 7. SS521-AG-PRO-010. 01 December 2016)

Mega sisterna magna variation was observed in the posterior fossa on diffusion weighted MRI. In the right temporal, parietal and occipital regions, moderate thickening and suspicious diffusion restriction were observed in the cortex (Fig. 2a). The appearance was considered to be postictal change due to seizure which happened during the catheterization.

The follow-up CT revealed regression of the free air densities after the first HBOT session (Fig. 2b). At the level of vertex, in the right lateral neighborhood of the falx in the parietooccipital sulcus in the right hemisphere, millimetric density of free air (pneumocephalus) was observed.

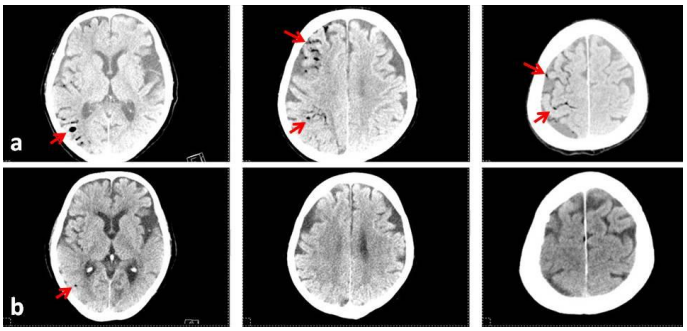

Fig 2a/b. Pneumocephalus areas on CT images before/after hyperbaric oxygen therapy

Neurological examination showed no changes during the HBOT session or immediately after. Any complications did not occur due to HBOT during this first session. Due to the need for advanced intensive care, the patient was referred to another hospital. Despite additional HBOT sessions were planned by hyperbaric medicine specialists, her condition was unstable and she could not be transferred for further HBOT sessions. Unfortunately, on the 5th day after the incident, the patient died due to cardiac arrest.

DISCUSSION

Cerebral arterial gas embolism (CAGE) can usually present with stroke-like findings, such as changes in consciousness, confusion, seizures, or neurological deficit. Patient position during invasive procedures, and the direction, speed and amount of air are considered to be important for the development of air embolism. The mechanism of bubble-induced tissue damage depends not only on mechanical blockage of the blood stream, but also on bubble-induced inflammatory processes. CAGE can be easily detected on CT or MRI, but it may rapidly disappear from the images. However, cerebral infarcts can be observed on diffusion-weighted MRI [3].

Gas embolism affects both the shaped elements of the blood and the biochemical processes. Platelet aggregation leads to complement activation, endothelial damage, adhesion of the polymorphic leukocytes to the damaged endothelium, and an activated inflammatory response. The activation of C5a activates neutrophils, leading to the formation of various membrane attack complexes and thus the destruction of cells with damaged membranes. With the adhesion of activated leukocytes to the vascular endothelium, increased permeability and diapedesis is observed. The activation of free oxygen radicals formed by the leukocytes activates the inflammatory cascade, further impairs perfusion due to edema and thrombosis, and decreases gas elimination, resulting in permanent damage [4]. Although there are rare cases reported in the literature, pneumocephalus generally responds well to HBOT. In a case report by Lin et al, the patient was treated immediately at the 8th hour after endoscopic lumbar discectomy and recovered without neurological deficit [5].

In another study of 24 cases, Paiva et al. compared patients, who received normobaric or hyperbaric oxygen, and observed that the size of the gas bubbles was decreased on the follow-up CT after HBOT, the length of hospital stay was shorter in the HBOT group and complications such as meningitis were less common [6].

Popa et al. reported a case of iatrogenic arterial gas embolism due to esophagogastroduodenoscopy. The presented patient was with bradycardia, hypoxia, and tonic and clonic convulsions. After multiple HBOT sessions, a significant improvement was seen in the neurological status. It was emphasised that emergency physicians must be aware of CAGE [7]. Shih et al. presented a summary of reported severe complications caused by epidural injection or epidural anesthesia-associated pneumocephalus. All the patients were mechanically ventilated and only one patient was treated with HBOT. The consciousness of the patient, who underwent HBOT, improved rapidly compared to the other patients, and no deaths were reported [8].

The effects of HBOT are explained by several mechanisms. In accordance with Boyle's Law, the volume of a gas is inversely proportional to the pressure on it. Smaller bubbles pass from the arterial circulation to the capillary and venous system and can be retained in the lungs. A reduction in gas volume minimizes the surface area of the bubbles. Therefore, the inflammatory effects of the bubble/blood interface are reduced. The high nitrogen/oxygen partial pressure gradient inside and outside of the bubble makes the nitrogen pass into the blood and finally the bubble shrinks. Cerebral edema, which is characteristic of cerebral gas embolism, also decreases with HBOT [9].

CONCLUSION

In conclusion, CAGE is a complication of various invasive medical interventions. It should be kept in mind especially in open heart surgery, neurosurgery, and diagnostic or therapeutic neuroradiology. Preventative strategies should be employed as CAGE contributes to increased procedural morbidity and mortality. In case of any suspicion, the patient should be transferred to a pressure chamber immediately with oxygen support. Even if sometimes the diagnosis cannot be confirmed radiologically, it can be made according to the patient's response to the HBOT. Another extremely important point is that sometimes the patient will need consecutive HBOT sessions for the best results, so clinicians should not decide to cease HBOT after the first session.

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