Neuroimaging Highlight

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Cerebral Air Embolism after Central Venous Catheter Self-Extraction

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Cerebral air embolism associated with central venous catheter insertion and removal is a rare but serious complication. There are many hypotheses on how air bubbles might be transported from the venous system to intracranial vessels. The literature has described how intra-cardiac defects[1,2], transpulmonary passage[3,4], and even retrograde flow of gas bubbles[5,6] can explain this phenomenon. We present a case that illustrates the devastating effects of cerebral air embolism after a patient self-extracted his central venous catheter.

Case

An 83-year-old male presented to hospital with malnutrition and acute kidney injury. A catheter was placed into his right internal jugular vein for hydration and electrolyte replacement. The patient tolerated the procedure well and after six days was scheduled to have his intravenous catheter removed.

Hours before the planned removal, the patient was found by the medical staff seated upright yet unresponsive to verbal or painful stimuli. His neurological exam demonstrated flaccid

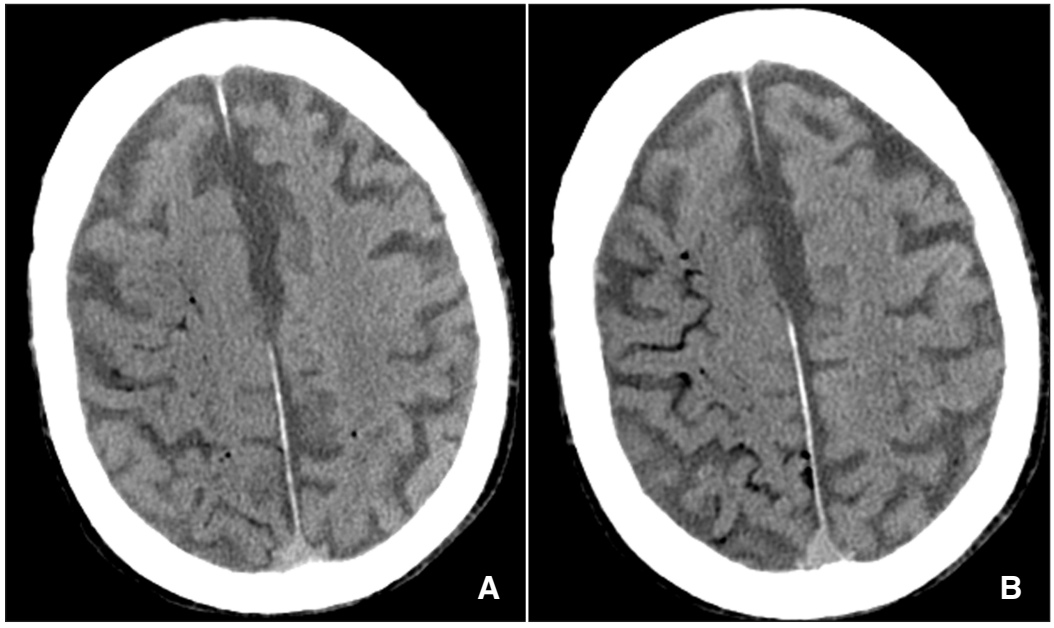

Figure 1: *CT scan of the head on day of the event showing multiple air bubbles scattered within the cerebral sulci in both hemispheres.*

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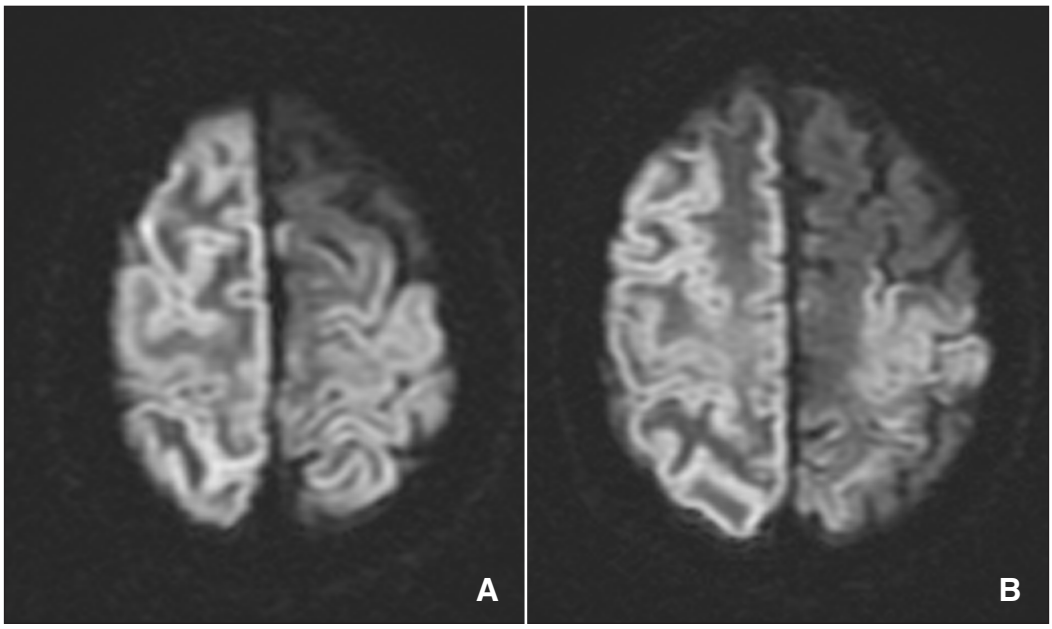

Figure 2: *MRI DWI (Diffusion weighted imaging) of the head on the day of the event showing multiple signal abnormalities.*

paralysis of all extremities and bilateral upper motor neuron signs (plantar responses were extensor). The immediately striking finding was that his sutured central venous catheter was partially pulled out and hanging loosely out of his neck. An urgent computed tomogram (CT) scan of his head was arranged which showed multiple gas bubbles in both hemispheres (Figure 1). Magnetic resonance imaging/angiography (MRI/MRA) of the head and neck on the same day showed an infarct in the right occipital lobe and multiple signal abnormalities in both hemispheres with diffusion weighted imaging (DWI) (Figure 2). The clinical history, physical examination, and imaging findings, suggested the patient suffered cerebral air embolic strokes from the self-extraction of his central venous catheter.

An echocardiogram with agitated saline did not reveal any inter-atrial defect. As hyperbaric oxygen therapy was not available, a trial of 100% oxygen was tried but this did not improve the patient's outcome. After the third day, the patient had no signs of recovery and started to have seizures. He passed away six days after his central venous catheter was pulled out. An autopsy was not performed.

Discussion

The clinical findings and outcome of our patient match well with the "Group A" phenotype described by Heckmann *et al*[7] in their review of patients with cerebral air embolism. The authors categorize patients according to global (Group A) or focal (Group B) neurological dysfunction after embolism. They report that in comparison to Group B patients, Group A patients are older (mean age 63.9 years vs. 44 years), have a lower rates of good or complete recovery (29% vs. 50%), and higher mortality rates (36% vs. 8%). Our patient was elderly, had generalized encephalopathy, quadriparesis, and seizures. He did not show any signs of recovery and in fact died shortly after his air embolic strokes.

Our case also highlights some important features of cerebral air embolism previously reported in the literature. Firstly, with regards to positioning, the upright posture after our patient removed the catheter not only increased the risk of introducing air into the venous circulation but also the likelihood of air bubble transit "upwards" into the cerebral vessels.[8,9] Secondly, paradoxical embolism may occur in the absence of cardiac defects.[3,4,7,10] Although a trans-esophageal echocardiogram or a trans-thoracic echocardiogram with Valsalva is more sensitive in diagnosing intra-atrial shunts[11], the absence of cardiac defects in this patient lead us to suspect the paradoxical embolism was related to transpulmonary passage of air bubbles.

Healthcare practitioners must understand the multiple, common and uncommon risks associated with central venous catheters. While air embolism is a rare event, it is often underappreciated or under-diagnosed by medical staff due to the rarity of its occurrence and the poor sensitivity of traditional non-contrast head CT scans.[7,12] In addition, while there is available literature on the proper techniques to safely insert and remove such catheters,[1,13,14] more discussion is needed around the safety of using invasive central venous catheters in agitated or delirious patients. Unfortunately, many such patients have poor peripheral venous access and need central venous catheters for extended periods of time for blood work monitoring and/or treatment. These patient groups seem to be particularly vulnerable to the complications associated with catheter self-extraction.

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