CEREBRAL AIR EMBOLISM OCCURRING AFTER CENTRAL VENOUS CATHETERIZATION: A CASE REPORT

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ABSTRACT

Cerebral air embolism (CAE) is a rare but potential iatrogenic complication with severe morbidity and mortality of an invasive procedure, the central venous catheterization. We report a case of cerebral air embolism associated with central venous catheterization. A 45-year old female, known diabetic and hypertensive underwent right internal jugular catheterization, and within an hour became unconscious. The chest X-Ray was normal but plain brain CT revealed multiple Gyriform air (GF) patterns in bilateral fronto-parietal and occipital region, and multiple air bubbles in scalp veins. The possibility of cerebral air embolism should be the primary differential in patients developing dyspnea and neurological impairment after central venous catheterization and prompt diagnostic and therapeutic measures should be taken to contain the cerebral damage.

Key Words: Cerebral air embolism, Central venous catheterization,Gyriform air pattern, Venous air embolism (VAE).

Introduction

The insertion of central venous catheter into the jugular vein is commonly performed invasive procedure. This catheter insertion procedure may have complications such as: local hematoma, pneumothorax,[1] hemothorax and a rare but life threatening and fatal complication; central venous catheter (CVC) related cerebral air embolism[2] (CAE). Here, we report a rare case-report of cerebral air embolism that occurred following an insertion of a venous catheter in right jugular vein. The cornerstone of diagnosis is the presence of air bubbles in brain CT displaying gyriform air patterns and air bubbles in scalp veins.

Many cases of venous air embolism (VAE) are subclinical with no adverse outcome and thus go unreported. Nevertheless, when symptoms manifest, they are nonspecific, and a high index of clinical suspicion for possible CAE is required for prompt investigations and initiation of appropriate therapy to avert morbidity and mortality.[3]

Pathophysiology & Etiology

The two condition which predispose an individual to VAE are i) Direct communication between a source of air and the venous vasculature, ii)The pressure gradient facilitating air into the circulation.[4] The outcome of morbidity and mortality in VAE is determined by volume of gas entrainment, the rate of accumulation, and patient's position at the time of procedure.[5] Generally, small amounts of air are broken up in the capillary bed and absorbed from the circulation without producing symptoms. However, complications have been reported with as little as 20 ml of air[6] and 2 or 3 ml of air into the cerebral circulation can be fatal.[7]

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The rapid ingress of large volumes of air, result in a myriad of cellular changes[6] and lead to direct endothelial damage and accumulation of platelets, fibrin, neutrophils, and lipid droplets along with activation and release of free radicles leading to pulmonary edema.[6] The Central Venous Catheters are used as therapeutic procedure in hemodialysis. These create an iatrogenic pressure gradient leading to cerebral air embolism by introducing atmospheric gas into the systemic venous system.[8]

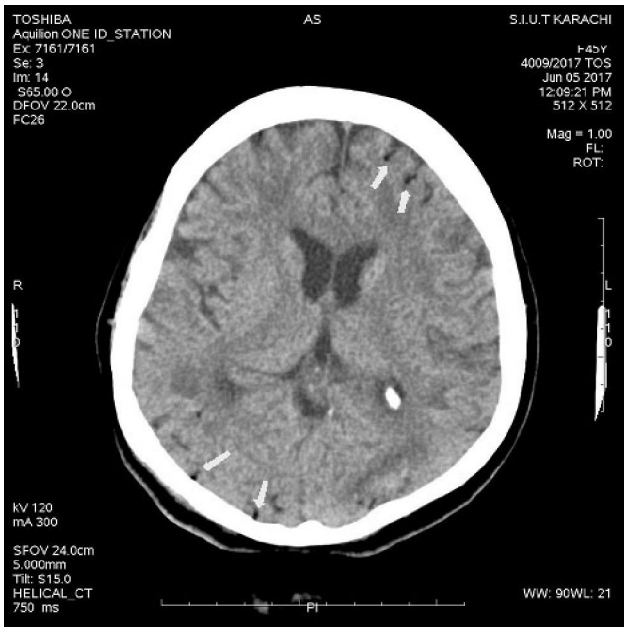

Figure 1: Non-Contrast axial CT Brain shows air bubbles (arrows) in the bilateral cerebral hemisphere

Case Report

A 45-year old married female, known diabetic and hypertensive and treated for chronic renal failure was admitted with raised Serum Creatinine 10 mg/dl and Blood Urea: 112 mmol/dl. The patient was admitted through emergency unit to nephrology intensive care unit and was advised hemodialysis. The central venous catheter was inserted in right jugular vein for more intensive treatment. Within an hour the patient complained of severe chest pain and difficulty in breathing. Later, patient complained of headache, became delirious and confused with sudden loss of consciousness.

Meanwhile, the chest x-ray appeared normal but CT brain revealed gyriform air pattern and air inflow in cortical veins. No cerebral infarct was seen.The gyri-

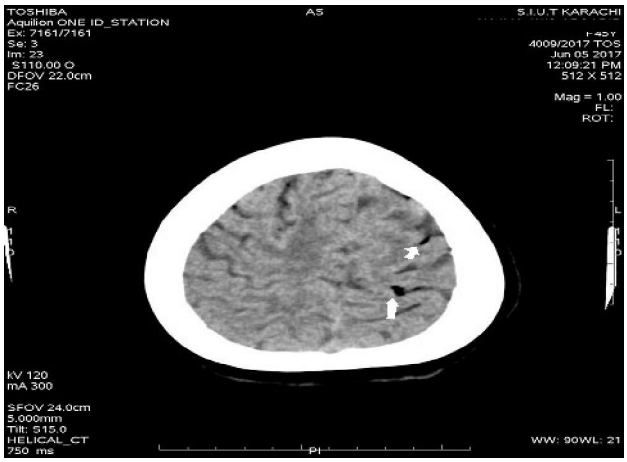

Figure 2: Non-Contrast axial CT scan above the ventricular level shows Gyriform air pattern

form air is defined as the branch or linear- shaped air density filled between the cortical gyrus.[10] The parenchymal and subarachnoid bubbles display as round-shaped bubbles in the parenchymal and subarachnoid space.[6,7] The patient was suggested to have cerebral air embolism, a rare but potential complication of central venous catheterization. The patient was placed in left lateral decubitus position; source of air entry was identified and circuit was clamped, restored hemodynamic support, CPR (Cardio-Pulmonary Resuscitation) was initiated and shifted to intensive care unit. There 100% Oxygen was administered along with other focused treatment. The patient had recovered and there were no long term adverse sequelae.

Figure 3: Non-Contrast Sagittal CT scan through the body of lateral ventricles shows multiple air bubbles

Discussion

The cerebral embolism is a catastrophic complication of central venous catheterization (CVC) and involves venous or arterial vasculature.[2] The common conditions leading to cerebral air embolism are insertion or removal of central catheter,[11] cardiac ablation, and pulmonary barotrauma, cardiac or thoracic surgery.[2] Although the frequency of this complication is 0.1%[1] to 2%[9] but the total mortality rate is 23%.[12] The risk factors for cerebral air embolism are long term placement of CVC, failure to occlude needle hub and decreased Central venous pressure (CVP) during placement or removal of CVC,[2,13] deep inspiration during catheter insertion or removal, hypervolemia and upright position of the patient. The reported patient was hypovolemic and became susceptible to air embolism.This finding is important because this notifies a possible predictor of unfavorable prognosis in patients with venous catheter- related cerebral air embolism (CAE).

In 10-80% of cases the sitting position of patient precipitates silent air emboli[13] but the barotrauma owing to high pressure ventilation or diving disrupts pulmonary alveolar structure and opens communication between vasculature and air.[2] This may happen at any time during insertion or removal of the catheter. The CVP is reduced during deep inspiration or upright positioning and makes patients vulnerable to cerebral air embolism (CAE).

The cerebral air embolism occurs when air enters the arterial system. This may be through a septal defect or pulmonary arterial malformations.[4] The pulmonary capillary incompletely filters the large air emboli which move these from veins to arteries and reaches the end organ to cause ischemia.

The Jugular and Subclavian catheters are the most common placement sites for CVC. However, the site of skin penetration is slightly higher with internal jugular catheters and predisposes to increased pressure gradient between the atmosphere and venous system.

The diagnosis of cerebral air embolism requires highly level of suspicion in patients with CVC exhibiting subtle to gross neurological symptoms. The diagnostic strategies include: arterial blood gas analysis, chest radiography, and computed tomography (CT) or magnetic resonance imaging (MRI). If the CT or MRI is delayed, this may or may not show the air bubbles in the cerebral vasculature.

The treatment aims to identify the source of air entry and prevent further air embolization[2,10] The initial general ICU measures should be initiated as soon as possible, including oxygen supply and cardiopulmonary resuscitation. The general guidelines for preventing air embolism must be put in place, such as the trendelenburg position, if possible correction of hydration prior to CVC placement, tightly secured connections of in-placed catheter, occlusion of the needle, adequate central venous catheter care and monitoring of CVC for cracks or broken seals, and occlusive dressing after removal.[10]

RECOMMENDATIONS:

All the clinical personnel who use central venous catheters should remain alert and inspect all catheter hubs for hairline cracks when attaching the catheter and keep the patient in the trendelenburg position.[12] When infusing fluid through a central venous line, ensure no leakage and use an infusion pump or controller with an air-in-line detector or other protective mechanism to detect air embolism.[13]

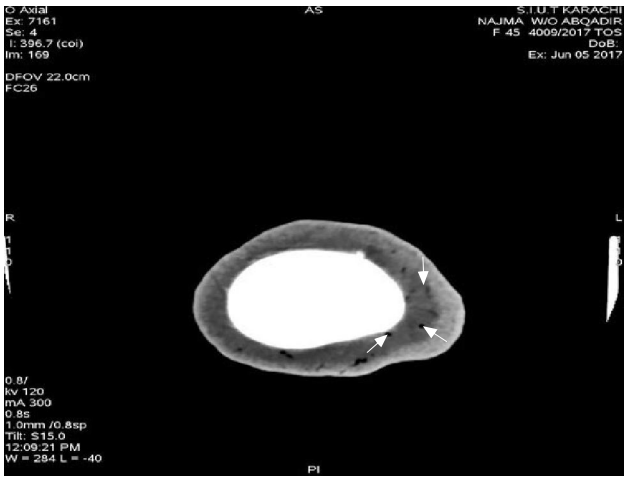

Figure 4: Non contrast CT brain shows multiple air bubbles in scalp veins

Conclusion

The case report demonstrates that in patients with central venous-catheterization the presence of Gyriform air(GF) on brain imaging suggests potentially fatal complication of venous-catheter related cerebral air embolism (CAE).[14] And should the patients with hypervolemia, and jugular venous catheterization

exhibit symptoms of respiratory distress or deteriorating neurological symptomsa high index of suspicion is essential for prompt diagnosis and institution of effective treatment.[8] The prevention and early diagnosis may decrease morbidity and mortality.

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