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Case Report

Ultrasonographic detection of air in the superior sagittal sinus in a neonate with transposition of the great arteries

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ABSTRACT

Cerebral venous air embolism is a relatively rare condition that arises from iatrogenic or traumatic introduction of air into the venous system. We describe the ultrasonographic findings in a 1-day-old infant with iatrogenic retrograde cerebral venous air embolism, which to our knowledge, is the earliest case reported in the literature to date. This case highlights the role of cerebral ultrasonography in the detection and surveillance of cerebral venous air embolism in neonates.

Introduction

Cerebral venous air emboli typically occur secondary to iatrogenic or traumatic injury with vascular access being a leading iatrogenic cause [1]. They result from either retrograde passage of air emboli into the cerebral veins via the neck veins or through antegrade passage into the intracranial venous sinuses via the epicranial emissary veins. The clinical presentation of cerebral venous air emboli is varied and affected individuals may be asymptomatic or experience significant neurological morbidity and even mortality [2,3]. Computed tomography (CT) is the primary imaging modality used to detect cerebral venous air emboli, both incidentally and in symptomatic individuals. In this case, an iatrogenic retrograde cerebral venous air embolism was detected incidentally with ultrasonography in a 1-day-old infant with congenital heart disease. We present the ultrasonographic images to highlight the role of cerebral ultrasonography in the detection and surveillance of cerebral venous air embolism in neonates.

Consent: Written informed consent for publication of this case report and accompanying images was obtained from the patient's mother. A copy of the written consent is available for review by the Editor-in-Chief of this journal.
Authors' contributions: SL was the patient's attending ICU physician. PS interpreted the ultrasound examinations. All authors wrote, read, and approved the final manuscript.
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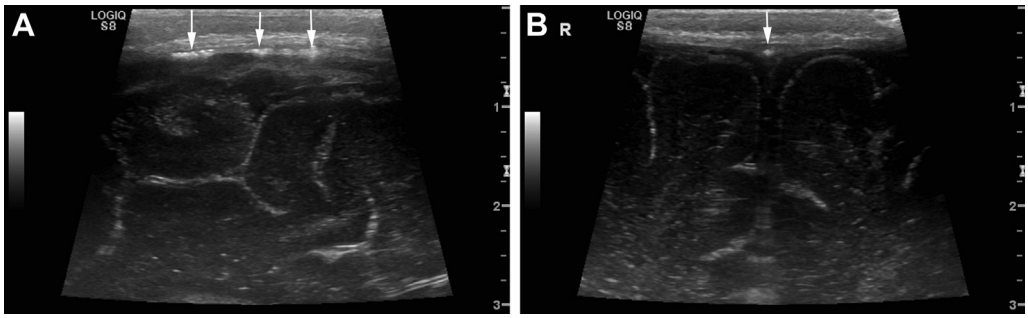

Fig. 1 – Mobile, echogenic foci (arrows) consistent with air locules are demonstrated in the superior sagittal sinus in the (A) sagittal and (B) coronal planes.

Case report

A 1-day-old term male infant with D-transposition of the great arteries was transferred to our institution for cardiac surgery. The infant remained drowsy after discontinuation of a fentanyl infusion used for sedation during the helicopter transfer. The infant's level of consciousness did not return to the expected level after discontinuation of a fentanyl drip used for sedation during the helicopter transfer. A full cerebral ultrasonographic examination performed at the bedside as part of the preoperative cerebral assessment demonstrated oscillation of multiple nondependent echogenic foci within the superior sagittal sinus synchronous to cardiac pulsation consistent with air locules (Fig. 1). Cross-sectional imaging was not performed given the characteristic ultrasonographic findings and concerns of radiation exposure for CT and sedation for magnetic resonance imaging. Additional history obtained from the clinical transport team indicated multiple indwelling peripheral venous catheters, none of which were inserted in the scalp.

Our patient had no localizing neurological deficits and received 4 hours of 15 L/min high flow 100% FiO_2. Repeat cerebral ultrasonography the next day was unremarkable and failed to demonstrate a residual retrograde cerebral venous air embolus. The patient's clinical status remained stable and he subsequently underwent a successful Jatene arterial switch procedure and was discharged home after an uneventful postoperative course. Clinical follow-up at 1 year has been unremarkable.

Discussion

Peripheral and central venous catheters have been implicated in iatrogenic cases of both arterial and venous cerebral air emboli. Antegrade movement of the air into the arterial system via right to left shunting is known as a paradoxical embolism. However, air may also reach the cerebral veins via retrograde motion in the superior vena cava and/or jugular venous system, which is referred to as a retrograde embolism. Semi-seated or upright positioning, Valsalva maneuvers, and venous valve insufficiency have been offered as possible explanations for retrograde air flow within moving blood [1].

CT has been used to detect retrograde cerebral venous air emboli in both the pediatric and adult populations. Additional reports have described antegrade cerebral venous air emboli in neonates after scalp vein cannulation in which air was introduced into the intracranial venous sinuses via the epicranial emissary veins [4,5]. Two cases were detected with CT at 4 and 12 weeks of age [4], and one was detected with ultrasonography at day 5 [5]. In both cases, serial imaging with the same modality demonstrated resolution without neurological sequelae. To our knowledge, our case of an iatrogenic retrograde cerebral venous air embolism in a 1-day-old infant is the earliest reported to date.

Patients with retrograde cerebral venous air emboli may be asymptomatic or symptomatic with venous infarcts having been described in a few cases [2,3]. Treatment of symptomatic cerebral venous air emboli typically involves hyperbaric oxygen therapy, which has been described in both successful [6] and unsuccessful patient outcomes [3]. Much of the experience in treatment of cerebral air emboli has been acquired in the setting of arterial involvement. In a review of clinical studies employing hyperbaric oxygen therapy for cerebral air emboli, 33%-75% of patients had a complete neurologic recovery, whereas mortality rates ranged from 8%-33% [7,8]. Trendelenburg positioning has also been proposed as a therapeutic adjunct to hyperbaric oxygen therapy for cerebral venous air emboli [9].

Neonatologists and pediatricians should be aware of retrograde cerebral venous air embolism as a potential complication of peripheral and central venous catheterization given the potential for severe side-effects up to and including neurologic compromise and death. In asymptomatic cases, such as ours, monitoring with short interval follow-up imaging is appropriate. This case highlights the importance of careful catheter placement, maintenance, and removal to minimize the likelihood of air embolism. It also illustrates the utility of ultrasonography for the detection of air within the neonatal intracranial venous sinuses without the need for advanced cross-sectional imaging.

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