

Silent Persistent Left Superior Vena Cava Right-to-Left Shunt as a Unique Cause of Recurrent Brain Abscesses

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We present a novel case of recurrent brain abscesses found to be the result of a silent congenital right-to-left extracardiac shunt, a persistent left superior vena cava draining into the left atrium. The patient's brain abscess was evacuated surgically and treated with antibiotics, and his shunt was subsequently repaired. The case suggests that attention should be paid to evaluation for shunt physiology allowing for bypass of the pulmonary circulation in those with recurrent brain abscesses.

Keywords. abscess; brain; shunt.

Right-to-left intracardiac and extracardiac shunts are known to predispose patients to the development of cerebral abscesses and thromboembolic events. The link between recurrent brain abscesses and the most common extracardiac right-to-left shunt—pulmonary arteriovenous malformation (AVM)—is well described in the literature, as far back as 1932 [1, 2]. Transient bacteremia with oral flora occurs with routine oral hygiene such as tooth-brushing and flossing. In the setting of a right-to-left shunt, oral bacteria bypass the pulmonary circulation, which would usually eliminate them [3, 4]. In bypassing the lungs, these bacteria can enter the arterial circulation and embolize to the brain [5]. Here, we present the rare case of a silent congenital right-to-left systemic extracardiac shunt, known as persistent left superior vena cava (PLSVC), resulting in brain abscesses at the age of 6 years and again at 39 years.

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CASE REPORT

A 39-year-old man presented to the emergency department due to 2 episodes of breakthrough seizures. His past medical history was significant for drainage of a right parietal brain abscess at the age of 6 years. At that time, he presented to his pediatrician with headache, vomiting, fever, and a witnessed seizure. Computed tomography (CT) scan of the brain with and without contrast demonstrated a 3.5-cm × 2.7-cm mass in the right parieto-occipital lobe with ring enhancement and surrounding edema. He underwent craniotomy with surgical evacuation of the abscess. Intraoperatively, a large amount of pus was encountered. Aerobic culture grew *Streptococcus intermedius* (minimum inhibitory concentrations [MICs] performed by automated microbroth dilution: susceptible to ampicillin, <0.12 µg/mL, cefamandole <2 µg/mL, cefazolin <2 µg/mL, cefotaxime <4 µg/mL, ceftriaxone <4 µg/mL, cefuroxime <2 µg/mL, chloramphenicol <2 µg/mL, clindamycin <0.25 µg/mL, erythromycin <0.25 µg/mL, gentamicin <1 µg/mL, oxacillin <0.25 µg/mL, penicillin <0.03 µg/mL, rifampin <2 µg/mL, vancomycin <2 µg/mL; resistant to tetracycline, >28 µg/mL). Anaerobic cultures were negative. It is unknown if bacteremia was present, as blood culture results are not reported. Per the available documentation, he did not have otitis, sinusitis, or pneumonia at the time of his presentation. There had been no recent dental manipulation and no dental caries or abscesses noted on examination. He was evaluated by pediatric cardiology for a potential cardiac source (atrial septal defect vs left-sided vegetation), but this was not demonstrated on the 2-dimensional echocardiogram performed (the report of which is not available). There is no mention of a transesophageal echocardiogram (TEE). Of note, a chest radiograph performed during hospitalization to confirm placement of a central line inserted into the left external jugular vein reported that the position of the catheter was indeterminate; it could have been in either the left subclavian artery or the left superior vena cava. He completed a 6-week course of gentamicin (35 mg intravenously every 8 hours) and penicillin G (1.25 million units every 4 hours) with radiographic resolution of his parietal brain abscess. The patient was subsequently maintained on phenytoin for his provoked seizure disorder.

Prior to his current presentation (at age 39 years), the patient denied any mouth pain, sinus congestion, ear pain, shortness of breath, fatigue, dyspnea on exertion, or any recent illnesses. He denied any recent dental work and could not recall the date of his last dental examination. He also denied a history of recurring sinopulmonary infection, or skin and soft tissue infections. He denied being diagnosed with bacteremia between age 6 and the present. He denied a history of any drug use, including intravenous. No pertinent family history was disclosed; in specific

there was no history of rheumatologic or collagen vascular disease in first-degree relatives. At admission, the patient was afebrile and hemodynamically stable, with an oxygen saturation of 96% on room air. Upon physical examination, he was alert and oriented but had slow dysarthric speech. Ophthalmologic examination was not performed. Examination of the oropharynx noted intact dentition but marked gingival hyperplasia with active periodontitis. His lungs were clear to auscultation, no clubbing was present, no focal neurological deficits were noted, no lesions were observed within the conjunctiva, and no telangiectasias or rashes were seen on the skin. Complete blood count and comprehensive metabolic panel were unremarkable. Blood cultures were obtained and were negative, but after antibiotics had been administered. A CT scan of the brain without contrast revealed hypoattenuation in the left temporal lobe and chronic encephalomalacia in the right parietal lobe, consistent with his previous craniotomy. Magnetic resonance imaging (MRI) of the brain showed a left temporal lobe mass consistent with an abscess. Emergent left temporal craniotomy was performed with the finding of a significant amount of pus, which was evacuated and copiously irrigated. The abscess capsule was resected in its entirety. Purulent material was sent for bacterial gram stain and culture.

Gram stain from the intraoperative specimen showed a gram-negative bacilli whose morphology was suggestive of *Fusobacterium* species. The organism grew only anaerobically, thus was sent out to the Mayo Clinic (Rochester, Minnesota) for identification and susceptibility testing. The patient was discharged prior to the availability of this information on ceftriaxone (2 g intravenously every 24 hours) and metronidazole (500 mg by mouth 3 times daily). Additional workup

as an inpatient included a CT maxillofacial scan, ultrasound of bilateral internal jugular veins, and TEE. All studies were negative for any abnormality that would explain the patient's recurrent brain abscesses. CT pulmonary angiogram was subsequently completed, which revealed an anomalous venous structure proximal to the left subclavian-brachiocephalic junction draining into the left atrium, otherwise known as a PLSVC, effectively causing a systemic-to-systemic right-to-left shunt (Figure 1A; Supplementary Video 1). We postulate that this anomalous venous structure is the cause of the patient's recurrent brain abscesses.

At follow-up 2 weeks postdischarge, the patient reported nausea and occasional vomiting. At this visit, final culture results were reviewed. Both *Fusobacterium nucleatum* (MICs performed via agar dilution: susceptible to penicillin <0.15 µg/mL, ceftriaxone <16 µg/mL, ertapenem <4 µg/mL, clindamycin <2 µg/mL, and metronidazole <2 µg/mL) and *Campylobacter rectus* (MICs performed via agar dilution: susceptible to penicillin <0.5 µg/mL, ertapenem <4 µg/mL, clindamycin <2 µg/mL, and metronidazole <2 µg/mL; resistant to ceftriaxone >32 µg/mL) grew in the anaerobic culture. Due to the possibility of metronidazole causing gastrointestinal upset, this was stopped. Given *Campylobacter* resistance to ceftriaxone, this was not an option for ongoing therapy. In choosing between penicillin and ertapenem for continuation of therapy, the narrowest-spectrum option was chosen. He was transitioned to penicillin G (24 million units over 24 hours, via continuous infusion). Six weeks after evacuation of his brain abscess, he underwent MRI of the brain with gadolinium, which demonstrated no residual abscess. Antibiotics were stopped and he underwent anterior thoracotomy with ligation of the anomalous venous structure

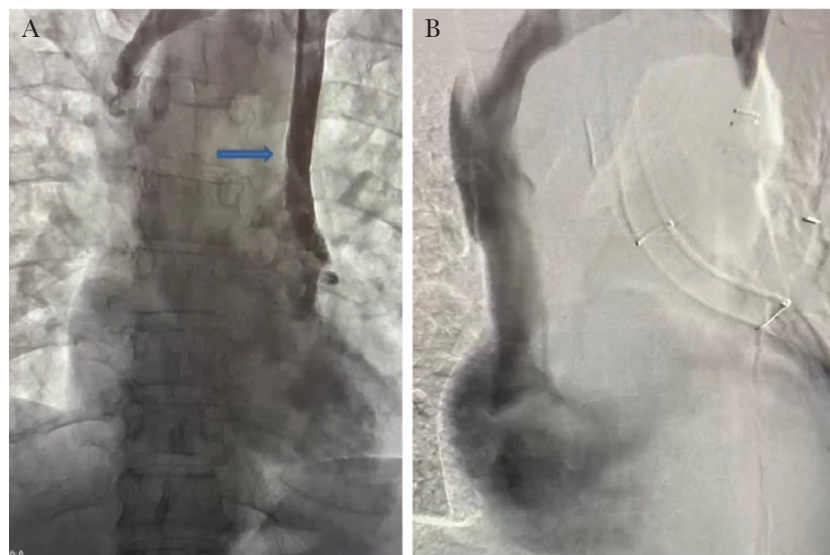


Figure 1. Computed tomography pulmonary angiogram showing an anomalous venous structure proximal to the subclavian-brachiocephalic junction draining into the left atrium. Arrow indicates anomalous venous structure. A, Venogram with catheter inserted into anomalous venous structure originating at the brachiocephalic–subclavian junction and connecting with the left atrium. B, Postligation venogram demonstrating closure of anomalous venous structure.

arising at the subclavian-brachiocephalic junction. A subsequent postligation venogram demonstrated closure of the anomalous venous structure (Figure 1B; Supplementary Video 2). The patient was well at follow-up 9 months after closure of his PLSVC.

DISCUSSION

Brain abscesses are rare in the adult population, with an estimated incidence of 0.3–0.9 cases per 100 000 inhabitants per year [6], and even less frequent in the pediatric population [7, 8]. Given its rarity in the pediatric population, cardiogenic brain abscess has not been extensively studied [9]. In adults, the link between intracardiac and extracardiac shunting and development of brain abscess has been documented. A common cause of shunt-related brain abscesses are pulmonary AVMs, which are estimated to be present in as many as 1 in 2600 persons [5]. Case series outline that brain abscesses occur in 8%–9% of those with pulmonary AVMs [5, 10, 11]. The congenital venous anomaly detected in our patient, PLSVC, occurs in 0.3%–0.5% of the general population [12]. In 90% of PLSVC cases, the duplicate left superior vena cava empties into the coronary sinus and subsequently into the right atrium. However, in 8%–10% of cases, and in our patient's case, the anomalous venous structure drains into the left atrium forming a systemic-systemic right-to-left shunt [12–15]. This physiology may give rise to systemic embolization of bacteria draining from the oral cavity, resulting in brain abscess. The exact incidence of brain abscess development related to this specific congenital malformation is not reported in the literature to our knowledge. However, brain abscesses have a cardiac etiology in about 5% of cases, with endocarditis comprising 2%–4% of the cases and right-to-left shunting responsible for the remaining 1% [16].

To date, 3 case reports of brain abscess associated with PLSVC have been published [3, 17, 18]. A further 2 cases outline recurrent brain abscesses in those with PLSVC [19, 20]. In both of these cases of recurrence, the patients exhibited peripheral cyanosis in the form of hypoxemia, which our patient did not. He demonstrated no clinical or laboratory signs of shunting, outside of brain abscess recurrence. In the previously published cases, recurrent episodes were separated by 2 years and 15 years, respectively, none of them occurring in childhood. In one of the previously published recurrence cases, the patient exhibited an additional cardiac abnormality leading to bidirectional shunting [20]. PLSVC is not commonly found in isolation. It is typically associated with other intracardiac anomalies, specifically partial or complete absence of the roof of the coronary sinus and atrial septal defects [3, 12, 13]. Our case is therefore unique to the other published cases due to the extended interval between episodes (33 years), the silent nature of the shunt, and its occurrence in isolation of other congenital abnormalities. Finally, we question whether

the gingival hyperplasia noted on examination of our patient, which may have been associated with chronic phenytoin exposure (measurable levels documented in 2013, 2014, 2016, and 2021), along with poor oral hygiene, may have increased the bioburden of both oral pathogens and commensals acting as an additional risk factor for brain abscess recurrence. It can be postulated that in persons with anomalous venous return to the left atrium, bacteria from the oral cavity enter the venous circulation during routine tooth-brushing or dental procedures, enter the arterial circulation via the left atrium, and embolize to the brain [17].

CONCLUSIONS

This case highlights the importance of considering evaluation for intracardiac or extracardiac shunting in both pediatric and adult patients in whom a clear etiology of brain abscess is not apparent. In those who experience recurrent brain abscesses, particularly after several decades, a congenital heart defect or pulmonary AVM should be thoroughly investigated. In terms of diagnostic evaluation for these conditions, a CT angiogram of the chest would reveal both pulmonary AVMs and other extracardiac shunts, such as PLSVC. Cardiac MRI, magnetic resonance angiography/venography, and TEE with contrast administration into both extremities can provide additional anatomic detail of congenital intracardiac abnormalities [16, 20]. In those who have suffered from brain abscess or paradoxical emboli attributable to an intracardiac or extracardiac right-to-left shunt, closure should be pursued to prevent recurrence.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Patient consent. The study does not include factors necessitating patient consent.

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