

Diffuse Pulmonary Arteriovenous Fistulas With Pulmonary Arterial Hypertension

Case Report and Review

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Abstract: Pulmonary arteriovenous fistulas (PAVFs) are rare. Diffuse type PAVFs with pulmonary arterial hypertension (PAH) are even rarer and can elude anatomy imaging like a plain chest film or a computed tomography. The rapid blood flow that ensues due to lack of a capillary bed leads to various degrees of ischemia depending on the number and size of the PAVF. This is a case report of diffuse PAVF in a patient with PAH.

This case report describes a patient with recurrent hemoptysis and chest pain. Systemic examination was unremarkable except for P2 attenuation on auscultation. Echocardiography showed confirmed pulmonary hypertension with mild dilation of right atrium and ventricle and a tricuspid regurgitation pressure gradient of 40 mm Hg and ruled out congenital heart diseases. Right heart catheterization revealed precapillary PAH with mean pulmonary arterial pressure of 88 mm Hg. Pulmonary angiography showed enlarged pulmonary arterial trunk and diffuse spiral tortuous pulmonary arterial branches indicating diffuse PAVFs. The patient was diagnosed as PAH and began treatment of 25 mg tid of sildenafil.

The case highlights a rare and unique presentation of PAH.

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Abbreviations: ALK1 = activin receptor-like kinase, BCPS = bidirectional cavopulmonary shunts, HHT = hereditary hemorrhagic telangiectasia, HPS = hepatopulmonary syndrome, NT-proBNP = N-terminal pro-B-type natriuretic peptide, PAH = pulmonary artery hypertension, PAVF = pulmonary arteriovenous fistulas, RAP = right atrial pressure, RHC = right heart catheterization, RVP = right ventricle pressure, TGF- β = transforming growth factor β , TPG = tricuspid regurgitation pressure gradient.

INTRODUCTION

Pulmonary arteriovenous fistulas (PAVFs) are abnormal pulmonary vascular structures that connect a pulmonary

artery to a pulmonary vein, bypassing the normal capillary bed resulting in an intrapulmonary right-to-left shunt.¹ PAVFs may be congenital or acquired with a majority being associated with hereditary hemorrhagic telangiectasia (HHT)^{2–5} which is caused by mutations in Endoglin (HHT 1) and activin receptor-like kinase (ALK1) (HHT 2).² Despite gene identification HHT remains a clinical diagnosis with clinical diagnostic criteria.⁶ The majority of non-HHT-related PAVFs are idiopathic, but other etiologies include chest trauma,⁷ Fanconi syndrome,⁸ amyloidosis, and infections like schistosomiasis⁹ and actinomycosis.⁷ Clinically, PAVF is generally classified into 2 types: focal and diffuse. Compared with the local type, the diffuse type is rarer, more severe and therapy is limited. Reports on diffuse PAVF with pulmonary artery hypertension (PAH) are rare.

CASE REPORT

A 28-year-old male presented with an 8-year history of recurrent hemoptysis and a year of chest pain. Systemic examination was unremarkable except for P2 attenuation on auscultation. He had no digital clubbing and no telangiectasia. Arterial blood gas showed partial pressure of arterial oxygen (PaO₂) of 79 mm Hg and arterial oxygen saturation (SaO₂) of 95.7% at room air. N-terminal pro-B-type natriuretic peptide (NT-proBNP): 33 pg/mL (0–125 pg/mL). Electrocardiogram showed right axis derivation and echocardiography showed confirmed pulmonary hypertension with mild dilation of right atrium and ventricle and a tricuspid regurgitation pressure gradient (TPG) of 40 mm Hg. Congenital heart conditions including atrial septal defect, ventricular septal defect, and other intracardiac shunts were ruled out by echocardiography as well. There were no differences in SaO₂ of lower and upper extremities, which combing echocardiography may rule out patent ductus arteriosus. Connective tissue disease serology and thyroid function revealed negative. The patient had no history of chronic lung diseases. He has excellent pulmonary function [Forced inspiratory vital capacity (FVC) = 4.04 L, FEV₁ (pred %) = 83.3, FEV₁/FVC = 0.78, and DLCO (pred %) = 90.9 mL/min per mm Hg]. A computed tomography pulmonary angiogram demonstrates wedge shadow near the pleura and along the airway distribution around with flake fuzzy shadow in the upper lobes (Figure 1) and excluded chronic thromboembolic disease. Right heart catheterization (RHC) revealed precapillary pulmonary arterial pressure (PAP) (right atrial pressure [RAP]: 6/–1/1 mm Hg; right ventricle pressure [RVP]: 144/–10/11 mm Hg; PAP: 139/59/88 mm Hg; pulmonary arterial wedge pressure: 17/4/8 mm Hg; cardiac output: 5.53 L/min; cardiac index: 3.48 L/min per m²; pulmonary vascular resistance: 14.47 wood Units) without vasodilatory response to inhaled iloprost. Pulmonary angiography showed enlarged

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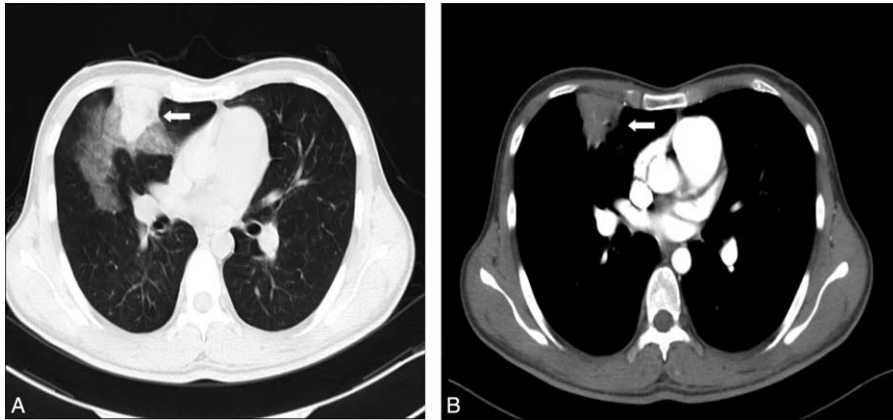


FIGURE 1. Computed tomography pulmonary angiography. (A) Representative axial computed tomography image displayed with lung window settings demonstrates wedge shadow (arrow) near the pleura and along the airway distribution around with flake fuzzy shadow in the upper lobes. (B) Mediastina window.

pulmonary artery trunk and diffuse spiral tortuous pulmonary arterial branches indicating diffuse PAVFs (Figure 2). Bronchography showed tortuous and dilated internal thoracic artery and bronchial artery and peripheral small vessels with diffuse PAVFs (Figure 3). He was diagnosed as PAH and began treatment of 25 mg tid of sildenafil.

One year later, the patient was followed up by telephone, he told us his exercise tolerance had improved and had no symptoms of hemoptysis with treatment of sildenafil.

DISCUSSION

We report a patient with diffuse PAVFs with severe PAH. PAVFs are rare, autopsy reports describing only 3 in 15,000 autopsies performed.¹⁰ The approximate incidence of PAVF has been described to be 2 to 3 per 100,000^{11,12} with a male-to-female ratio of approximately 1:1.5 to 1.8.^{2,13} PAVFs may be single or multiple, unilateral or bilateral, simple or complex. Most solitary PAVFs are seen in the lower lobes, with the left lower lobe being the most common location.^{3,4} The majority of multiple PAVFs are also confined to the lower lobes, with the

incidence of bilateral PAVFs ranging from 8% to 20%.⁷ The abnormal segment between the pulmonary artery and the pulmonary vein is fragile and may rupture and bleed as the PAVF size increases, manifesting as hemoptysis or a hemothorax. Small subsets of patients have a more diffuse and severe type of PAVF that involves segmental pulmonary arteries. Diffuse PAVFs result in severe hypoxemia and are challenging to treat.

Most PAVFs are hereditary, with about 90% occurring in patients with HHT.^{14,15} The majority of non-HHT-related PAVFs are idiopathic, but other etiologies include chest trauma, Fanconi syndrome, amyloidosis, and infections such as schistosomiasis and actinomycosis. PAVFs also occur secondary to hepatopulmonary syndrome (HPS) or bidirectional cavopulmonary shunts (BCPS). The majority of patients with HHT have HHT1 because of mutations in endoglin (ENG) encoding endoglin¹⁶ or HHT 2 because of mutations in ACVRL1 encoding ALK1.¹⁷ PAH occurs almost exclusively in individuals with ACVRL1 mutation. The genes mutated in HHT encode proteins involved in the transforming growth factor β (TGF- β) superfamily signaling pathway.¹⁸ The TGF- β pathway is important in

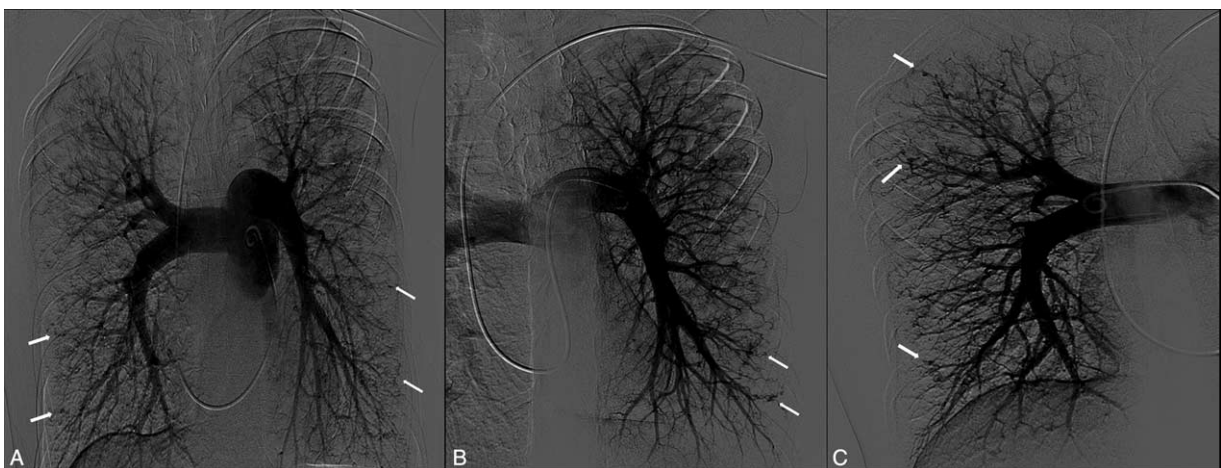


FIGURE 2. Pulmonary angiography showing diffuse pulmonary arteriovenous fistulas. Pulmonary angiography showing the absence of capillary blush and arteriovenous fistulas (arrow). (A) Main pulmonary artery angiography. (B) Left pulmonary artery angiography. (C) Right pulmonary artery angiography.

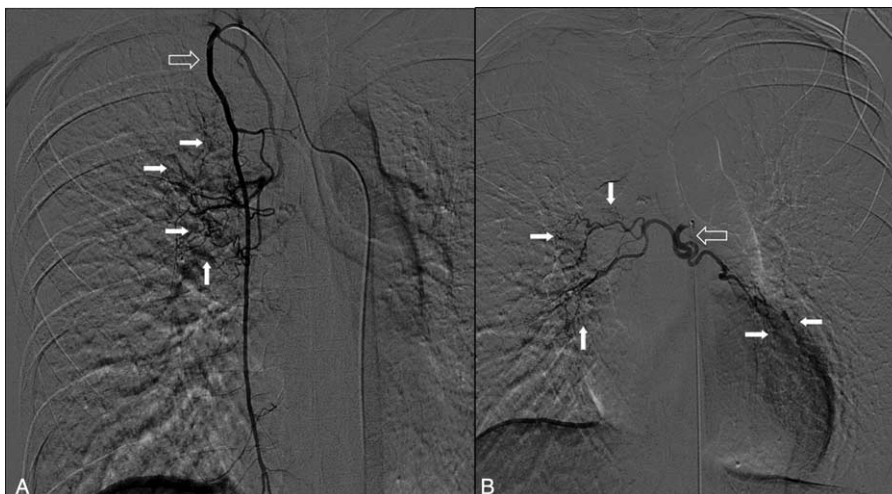


FIGURE 3. Bronchography showing tortuous and dilated internal thoracic artery and bronchial artery (hollow arrow) and peripheral small vessels with diffuse distortion (diffuse pulmonary arteriovenous fistulas) (solid arrow) (both Figure 3A and Figure 3B).

regulating proliferation, differentiation, adhesion, and migration which are key processes in angiogenesis.

This patient denied any history of hepatic diseases, epistaxis, telangiectasia, visceral lesions (except pulmonary malformations), and family history. According to mainstay of the Curacao criteria,^{6,19} the patient was unlikely to have HHT. Thus, although unusual the diagnosis was idiopathic PAH.

In this case report, despite of high PAP by RHC, the RAP did not increase accordingly which may be due to compensated RV systolic and diastolic function to pulmonary vascular diseases. Early in PAH, the adaptive ventricular remodeling and preserved right ventricle reserve could adapt PAP and maintain RVP and RAP.²⁰ The good exercise tolerance and normal NT-proBNP level implied the patient had adaptive right ventricle reserve. It may explain why the patient did not have significant increased RAP.

For this patient, a TPG by echocardiography was 40 mm Hg while systolic PAP [pulmonary arterial systolic pressure (PASP)] by RHC was 139 mm Hg. The TPG was estimated based on the modified Bernoulli equation and was then added to an estimate of RAP to obtain an estimate of PASP in the absence of right ventricular outflow obstruction²¹; however, Bernoulli method systematically underestimated or overestimated the PASP when actual PAP was too high or too low.^{22,23} Echocardiography has its inherent limitation; echocardiography may frequently be inaccurate in estimating PAP in patients being evaluated for PH.

CONCLUSIONS

The case highlights a rare and unique presentation of PAH. Most cases of PAVF can remain asymptomatic until the third or fourth decade of life. Moreover, the shunting may facilitate passage of emboli into the cerebral circulation thereby being implicated in various other pathologies. Although prognosis is poor, such patients would benefit tremendously by early detection and appropriate management.

CONSENT

The patient signed informed consent for the publication of this case report and any accompanying images. Ethical approval

of this study was obtained by the ethics committee of Shanghai Pulmonary Hospital.

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