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An Unusual Cause of Refractory Hypoxemia in Cirrhosis

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Pulmonary gas exchange abnormalities and refractory hypoxemia cause myriad difficulties in patients with chronic liver disease. In addition to intrinsic cardiopulmonary diseases and hepatopulmonary syndrome, some unusual pathophysiological mechanisms in patients with portosystemic collaterals might contribute to hypoxemia. We report the clinical presentation of an unusual portosystemic anatomic shunt that permits venous admixture with oxygenated blood, causing hypoxemia that is refractory to the administration of supplemental oxygen, and recurrent hepatic encephalopathy. There has been no such report in the published literature. This case highlights the importance of keeping direct portopulmonary venous anastomosis in the differential diagnosis of oxygen-refractory hypoxemia and recurrent hepatic encephalopathy in patients with cirrhosis in the appropriate clinical context. *Key words: hypertension; portal; hypoxemia; hepatic encephalopathy; contrast echocardiography; portosystemic shunt; cirrhosis.* [Respir Care 2015;60(3):1–•. © 2015 Daedalus Enterprises]

Introduction

Pulmonary gas exchange abnormalities and hypoxemia are common in patients with chronic liver disease. In addition to intrinsic cardiopulmonary disorders, a variety of causes of hypoxemia in liver disease have been identified. These include unique problems associated with the presence of liver disease and/or portal hypertension, such as intrapulmonary right-to-left shunt in hepatopulmonary syndrome and intracardiac shunt with predominately right-to-left flow, which may accompany atrial or ventricular septal defects with Eisenmenger physiology.[1] In this report, we describe an unusual cause of unexplained hypoxia and hyperammonemia leading to recurrent hepatic encephalopathy.

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Case Report

A 43-y-old male with hepatitis C virus-related cirrhosis and recurrent hepatic encephalopathy was referred for evaluation of dyspnea. Physical examination determined grade 3 clubbing and oxygen saturation of 87%. His chest x-ray and echocardiogram were normal. Spirometry revealed normal percent-of-predicted values for FEV_1 (86%), FVC (94%), and FEV_1/FVC (0.92), with a moderately reduced diffusing capacity for carbon monoxide (10.8 mL/min/mm Hg, 44% of predicted). His plasma ammonia level was 294 μg/dL (normal values, 12–60 μg/dL). Arterial blood gas analysis revealed a pH of 7.42, a P_{CO_2} of 28 mm Hg, and a P_{O_2} of 52 mm Hg with an alveolar-arterial difference of 58 mm Hg (on room air). His oxygen saturation did not improve on supplemental oxygen (initially 3 L/min supplied via nasal cannula and later with non-rebreathing mask). Saline contrast echocardiography was negative.

During further evaluation, the patient underwent triple-phase computed tomography of the chest and abdomen, which showed a direct shunt connecting the right portal vein to the left atrium via the right inferior pulmonary vein, resulting in a right-to-left extracardiac shunt (Fig. 1). The patient was managed conservatively and discharged later.

Discussion

Portal hypertension is a progressive inevitable consequence of cirrhosis with formation of many collaterals.[2]

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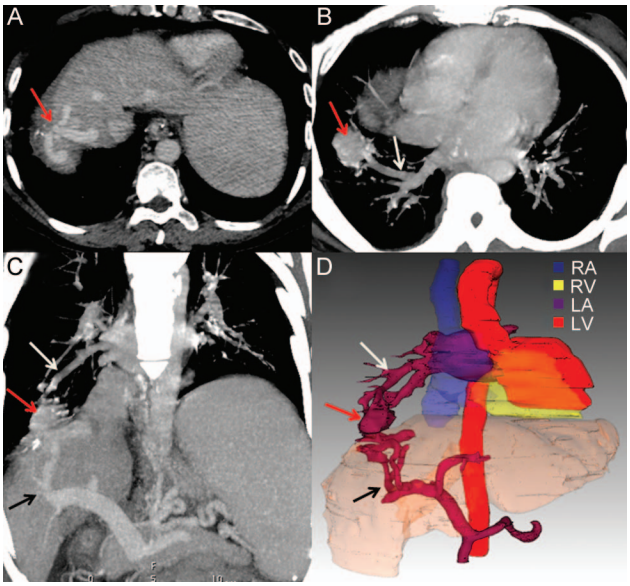

Fig. 1. Axial (A and B), oblique coronal (C), and 3-dimensional maximum intensity projection (MIP) with volume-rendered (D) contrast-enhanced computed tomography images of the chest and upper abdomen revealed a cluster of collaterals (red arrows) from the anterior and posterior branches of the right portal vein (black arrows in C and D) involving the posterior segment of the right lobe of the liver and extending through the diaphragm up to the anterior-basal segment of the right lower lobe and ultimately draining into the left atrium via the right inferior pulmonary vein (white arrows in B–D). See D for cardiac chamber key.

Portopulmonary collaterals, also called portopulmonary venous anastomoses, connect with the pulmonary circulation. We highlighted the clinical presentation of an unusual anatomic shunt that permits venous admixture with oxygenated blood, causing hypoxemia that is refractory to the administration of supplemental oxygen, and recurrent hepatic encephalopathy.

In portal hypertension, collaterals can be either intrahepatic or extrahepatic. Dynamic contrast computed tomography is regarded as the best tool for evaluation of the status of portosystemic collaterals in patients with portal hypertension.[3,4] Portopulmonary venous anastomosis has been recognized as one of the cephalad hepatofugal collaterals in patients with portal hypertension.[5] Portopulmonary venous anastomosis was first reported by Schoenmackers and Vieten in 1953.[6] Incidences have been reported to be 1–30% in portal hypertension.[5,7,8] In previous reports, portopulmonary venous anastomosis was detected on postmortem angiography and percutaneous transhepatic portography. However, computed tomography imaging of direct portopulmonary shunts has not been described in the literature.

Saline contrast echocardiography is used widely in screening intracardiac and intrapulmonary shunts. However, portopulmonary venous anastomosis is typically detected during transhepatic portography rather than saline contrast echocardiography because it provides enough contrast echoes to be picked up even at a location distant from the injection site.[5] This explains the negative contrast echocardiography study in our case.

Extrapulmonary accumulation of Technetium-99m macroaggregated albumin (MAA) is also used to detect right-to-left shunts. The appearance of the radiotracer in the systemic circulation to document visualization of brain, kidneys, and spleen after intravenous administration of MAA indicates right-to-left intrapulmonary or intracardiac shunts because macroaggregated albumin particles (20–60 μm) supposedly bypass the pulmonary bed ($<$ 15 μm) in these cases, instead of becoming trapped in a normal scenario without such shunts.[9] However, the MAA scan was also expected to be negative in our case, as there was no intrapulmonary shunting, and macroaggregated albumin particles would still be trapped in the normal pulmonary bed.

When performing contrast echocardiography by the portal approach, 3 main routes might produce contrast echoes in the left heart: (1) portopulmonary venous anastomosis, (2) intracardiac right-to-left shunt, and (3) intrapulmonary right-to-left shunt (hepatopulmonary syndrome). The latter 2 produce contrast echoes first in the right cardiac chambers via the portacaval route and subsequently in the left cardiac chambers. Intracardiac shunt requires one cardiac beat or less, whereas intrapulmonary shunt requires a time interval of 4–6 cardiac beats.[10,11] Portopulmonary venous anastomoses show characteristic contrast echo patterns: an earlier and stronger appearance of echoes in the left cardiac chambers than in the right. These results allow real-time differential diagnosis of portopulmonary venous anastomosis from other causes of intrapulmonary shunt.[5]

As the portal vein carries deoxygenated blood, portopulmonary venous anastomosis causes venous admixture, resulting in a significant reduction in arterial oxygen saturation, especially when the portal venous blood has very low oxygen saturation and/or the shunt is large enough to carry a significant amount of cardiac output.[8,12] The hemodynamics in such cases involves a functional right-to-left shunt. Embolic and infective agents that migrate to the draining vein from the portal circulation have the potential to directly reach the left atrium through the [redundant] portopulmonary venous anastomosis, and systemic embolization can occur. Patients with portosystemic shunts may in fact present with neurological abnormalities and high ammonia levels even in the absence of significant liver damage.[13] The passage of neurotoxic substances coming from the bowel into the systemic circulation can be involved in the pathogenesis of recurrent hepatic encephalopathy, as in our case.[14]

We reported the first case of direct spontaneous portopulmonary venous anastomosis connecting the portal vein

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to the pulmonary veins and subsequently draining into the left atrium. This case highlights the importance of considering direct portopulmonary venous anastomosis in the differential diagnosis of oxygen-refractory hypoxemia and recurrent hepatic encephalopathy in patients with cirrhosis and the use of contrast-enhanced computed tomography in the ultimate diagnosis.

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