Platypnea-Orthodeoxia Syndrome: An Unusual Complication of Partial Liver Resection

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Abstract

Platypnea-orthodeoxia syndrome (POS) is a rare syndrome of severe hypoxemia upon assuming an upright position. It is classically described as shunting from the right atrium to the left atrium usually via a patent foramen ovale (PFO). Alterations in the intrathoracic anatomy after liver resection and regeneration may trigger this condition in patients with clinically silent PFO—a previously unreported cause of POS.

Key words: liver resection, hepatoma, liver regeneration, platypnea-orthodeoxia, patent foramen ovale

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Introduction

Platypnea-orthodeoxia syndrome (POS) is a rare syndrome of severe dyspnea and hypoxemia upon assuming an upright position. The mechanism of POS is shunting of deoxygenated blood from the right atrium to the left atrium usually via a previously clinically silent patent foramen ovale (PFO). Pneumonectomy and ascending aortic elongation are the most common underlying conditions associated with the development of POS. We herein report a case of an elderly patient who developed POS after a partial liver resection, a previously unreported cause of POS. We also demonstrate immediate resolution of this syndrome with transcatheter closure of the inter-atrial shunt.

Case Report

A 71-year-old man with diabetes and a history of liver lobectomy for a hepatocellular carcinoma two years ago presented with progressively worsening dyspnea of 3 months duration. The patient has no history of lung disease and did not smoke. His physical exam was remarkable with a heart rate of 78, blood pressure of 110/65, arterial blood oxygen saturation of 77% at rest, and a body mass index of 29.4. His complete blood counts, metabolic panel, thyroid function tests, and D-Dimers were normal. A chest X-ray showed an elevated right hemi-diaphragm and the liver ultrasound showed a normal sized, left-sided liver with no focal parenchymal lesions or cirrhotic features. Pulmonary function tests did not show any evidence of obstruction or restriction. A ventilation/perfusion scan suggested intracardiac shunting and a low likelihood of pulmonary embolism. CT scan of the thorax showed an elevated right hemidiaphragm with significant liver regeneration of the left hepatic lobe (Fig. 1). Echocardiography with micro-bubble contrast study in the left lateral decubitus position revealed a much distorted right atrial anatomy and suggested a right to left atrial shunt (Fig. 2). A transesophageal echocardiogram showed a compressed right atrium and bidirectional shunting across a patent foramen ovale PFO in the supine position. Cardiac catheterization revealed no significant coronary artery disease and the patient had normal hemodynamics in the supine position (right atrial pressure 10 mmHg, right ventricular pressure 38/11 mmHg, mean pulmonary artery pressure of 24 mmHg, and a pulmonary artery wedge pressure of 12 mmHg). The baseline supine arterial partial pressure of oxygen (pO₂) was 55 mmHg on room air, which dropped to 33 mmHg when the patient moved to an upright position. Therefore, the diagnosis of platypnea-orthodeoxia was made. The patient underwent a successful transcatheter closure of the PFO with a 30 mm cribriform occluder (St. Jude Medical, St. Paul, USA). The patient’s dyspnea resolved and his oxygen saturation rose to 99% in both the supine and upright positions. He remained symptom-free and had normal oxygen saturations at the 1-, 3-, 6-, and 12-
month follow-up visits.

Discussion

PFOs are present in 25% of the general population, typically asymptomatic, yet they represent a potential source of intra-cardiac shunting (1). Platypnea refers to dyspnea that occurs in an upright posture and is relieved by recumbency, while as orthodeoxia refers to hypoxemia in an upright position that is relieved by recumbency (2). The development of POS requires the simultaneous presence of two unrelated pathologies: [1] an anatomical defect in the inter-atrial septum, such as an atrial septal defect (ASD) or a PFO or [2] an abnormal geometry of the right atrium (RA) leading to alignment of inferior vena cava (IVC) flow with an anatomical defect (PFO or ASD) such that streaming of venous blood from the IVC through the PFO or ASD will lead to hypoxemia, especially in the upright position (3). This pathophysiological mechanism was elegantly demonstrated by Medina et al. using a positional transesophageal echocardiogram in a POS patient with an elongated aorta and a PFO (4).

In patients with POS, PFO was the most common anatomical defect while pneumonectomy and ascending aortic elongation were the most common precipitating factors (5). Other precipitating causes of POS include kyphoscoliosis, diaphragmatic paralysis, persistent eustachian valve, pericardial disease, right ventricular infarction, pulmonary embolism, chest wall trauma and cardiac lipoma (5-12).

Hypoxemia is not uncommon in patients with chronic liver disease. In fact, up to 88% of patients with hepatopulmonary syndrome (HPS) develop the typical features of POS (13, 14). In these patients, POS results from extracardiac shunting due to a substantial increase in the number and the size of the pulmonary precapillary and capillary vessels, as well as the presence of portopulmonary shunting. HPS is associated with poor prognosis with a 2-year mortality exceeding 50% (15). Liver transplantation is considered the only curative treatment for HPS (13, 15).

POS due to intra-cardiac shunting in patients with liver disease is, however, exceedingly rare. Patakas et al. reported a case of POS due to large hydatid cysts compressing the right heart chambers (16). In this patient, POS was reversible with the surgical removal of the hydatid cyst. Our patient developed progressive dyspnea less than two years after receiving a right liver lobectomy. His laboratory work up revealed orthostatic dyspnea and hypoxemia, typical features of POS. He had the common risk factors: an anatomical defect, a PFO and an abnormal geometry in the thoracic cavity due to liver regeneration. The patient had no other explanation for his POS; he had no evidence of lung disease, pericardial effusion, liver cirrhosis or HPS. The right-to-left shunt in this case may have been triggered by two mechanisms: (1) compression of the RA by the regenerated liver (Fig. 2), leading to a relative increase in RA pressure and therefore right-to-left shunting when the RA pressure exceeds the left atrial pressure or (2) the regenerated liver tilted the heart to the left, leading to a more horizontal position of the heart and direct alignment of IVC flow with the PFO. In the upright position, the heart descends to its lowest location in the chest, which leads to maximal contact with the regenerated liver and therefore an exaggeration of the above-mentioned mechanisms. In the supine position, the heart assumes a more cephalic position, minimizing the effects of the regenerated liver on the RA and abating significant right-to-left shunting.

Liver regeneration after partial liver resection is a well-documented phenomenon (17-19). Compared to those with cirrhotic features, non-cirrhotic livers undergo substantial regeneration and reach or exceed their pre-resection volumes (18). The regeneration process starts within 12 hours.

Figure 1. A chest CT scan shows an absent right hepatic lobe (replaced by bowel loops, white arrow) and a regenerated left hepatic lobe near the inferior border of the heart (star). SVC: superior vena cava, RA: right atrium, LV: left ventricle, AO: ascending aorta, PA: pulmonary artery

Figure 2. A standard 4-chamber 2-dimensional echocardiogram shows an enlarged left-sided liver (asterisk) compressing the right atrium (arrows). It also shows early crossing of the micro-bubbles from right to left (dashed arrows) while the right chambers are still opacified.
after surgery and achieves 200% of its post-resection volume in 12-18 months (17-19). Liver regeneration leads to changes in the thoracic cavity geometry similar to those in diaphragmatic paralysis, a condition that could trigger POS if a PFO or ASD is present (17). Contrary to POS in patients with HPS, which can only be treated effectively with liver transplantation, POS in patients with an anatomical liver disease (enlarged liver due to hydatid cyst or post-lobectomy regeneration) can be cured with transcatheter closure of the ASD or PFO (5, 19, 20).

A definitive treatment of POS may be achieved by nulling one of the two conditions required for its development (the anatomical defect in the intra-arterial septum or the geometrical change in the thoracic cavity leading to IVC/RA alignment). While it might be difficult to reverse the changes in the thoracic cavity caused by liver regeneration, fixing the PFO is feasible and can be done percutaneously. The largest study in the treatment of patients with POS comes from the multicenter French registry and other small series (5, 19, 20). In these studies, transcatheter treatment with a PFO closure devise was noted to be safe and curative in these patients. Our patient was treated with a 30 mm crible form PFO occluder with immediate and durable resolution of his orthoencephalitis and his platypnea at the 12-month follow-up.

Our case illustrates a rare and disabling complication of platypnea-orthodeoxia syndrome after liver resection in a patient with a clinically silent, inter-ASD like PFO. The diagnosis of POS can be challenging and requires a high index of suspicion. Transcatheter closure of the inter-atrial shunt provides a safe, efficient and definitive treatment of POS.

The authors state that they have no Conflict of Interest (COI).

References