

Acute Onset of Refractory Hypoxemia: A Rare Hemodynamic Cause of Dyspnea

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Abstract

Platypnea-orthodeoxia syndrome (POS) is a rare condition of positional dyspnea with hypoxemia that can pose a diagnostic challenge to clinicians. We report two cases of POS with different pathophysiologic triggers and similar clinical features. In our report, both patients manifested a severe hypoxemia with low response to increase of fractional inspired oxygen, unremarkable physical examination of the lungs, and no radiological findings of the pulmonary embolism. In both cases, an interatrial communication was found in association with a right-to-left interatrial shunting. Recognition of POS is crucial because symptoms can be quickly relieved by recumbency, unlike other types of hypoxemia. This simple solution may prevent the use of sedative therapy, invasive ventilatory support, and vasopressor agents, which could even exacerbate the right-to-left extrapulmonary shunt and worsen clinical conditions.

Keywords: Dyspnea, echocardiogram, forame ovale, hypoxemia

INTRODUCTION

Refractory hypoxemia is a critical state that requires immediate action and represents a diagnostic challenge for clinicians. We present two different cases with hypoxia which was unresponsive to supplement oxygen, but quickly relieved by recumbency. This condition is better known as platypnea-orthodeoxia syndrome (POS).

Platypnea is defined as dyspnea and orthodeoxia as arterial oxygen desaturation, induced or accentuated by upright posture and improved with supine positioning. The pathogenesis requires an anatomical substrate for a shunt, most commonly at the atrial level, and an anatomical or functional trigger to reverse the blood flow across it.^[1] For this reason, it represents a very confusing and misleading condition, especially when the patient's medical history is not available, or no congenital cardiovascular defects are known.

In our report, both patients manifested a severe hypoxemia with low response to increase of fractional inspired oxygen, and an interatrial communication was found in association with a right-to-left interatrial shunting, most likely caused by extracardiac functional aberrations.

CASE REPORTS

Case A

A 60-year-old female was admitted to the emergency department (ED) with acute dyspnea following a paracentesis in the Oncology Day Hospital. She was diagnosed to have signet-ring cell carcinoma of the stomach, previously treated by surgery and chemotherapy, and was recently found to have peritoneal carcinomatosis with ascites. She was receiving a second-line chemotherapy treatment.

On arrival in our ED, the patient was afebrile but presented with tachycardia at 95 beats/min, blood pressure of 90/60 mmHg, respiratory rate of 26 breaths/min and oxygen saturation of 80% on room air, and 82% with a 10 L/min oxygen flow. Arterial blood gas showed severe hypoxemia with hypocapnia (PaO₂/FIO₂ ratio <200, PCO₂ 25 mmHg). She denied having chest pain and electrocardiography showed sinus tachycardia with no features suggestive of myocardial

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ischemia. Clinical examination revealed hepatomegaly, mild abdominal tenderness elicited by deep palpation on the right upper quadrant, and decreased breath sounds and dullness over the right lower thorax. Elevation of the right hemidiaphragm was noted on the chest radiography [Figure 1a].

A focused cardiovascular ultrasound revealed a preserved ejection fraction, no valvular heart disease, but an extrinsic compression of the right atrial roof due to peritoneal carcinomatosis [Figure 1b] and subsequent elevation of the right hemidiaphragm [Figure 2a]. Fluid replacement and oxygen therapy through a nonrebreather mask were prescribed, but the gas exchange did not improve significantly. Computerized tomography (CT) pulmonary angiogram was obtained to rule out pulmonary embolism. The examination did not detect lung perfusion abnormalities. However, it was noted that, during the CT scan, while he was lying in a supine position to undertake the scan, oxygen saturation levels improved to normal levels with supplemental oxygen. A contrast echocardiogram, performed in both the supine and sitting positions, revealed a large right-to-left interatrial shunt which worsened in the sitting position. She was therefore transferred to the oncology ward to evaluate the indication for a new cycle of chemotherapy with the aim to reduce the abdominal mass.

Case B

An 87-year-old female was recovering from deep-vein thrombosis and pulmonary embolism in the general medicine unit where anticoagulant therapy had been administered and physical rehabilitation was performed. On admission, a moderately enlarged and elongated ascending aorta was identified by CT. Her medical history was only significant for hypertension and kyphoscoliosis. Her general conditions were gradually improving when, suddenly, she showed acute dyspnea and oxygen desaturation. The patient showed mild tachycardia, with a heart rate of 90 beats/min, and hypoxia, with an oxygen saturation of 84% on room air. The patient denied shortness of breath or chest pain.

Physical examination was unremarkable except for signs of mild dehydration, and laboratory tests suggested an uncomplicated

infection of the urinary tract. Oxygen saturation, tachycardia, and tachypnea did not improve with the administration of supplementary oxygen in the supine position. Arterial blood gas analysis confirmed hypoxemia with respiratory alkalosis. Physical examination of the respiratory and cardiac systems, chest radiography, and electrocardiography showed normal findings. A CT pulmonary angiogram did not reveal any evidence of pulmonary embolism. Her left and right ventricular ejection fractions were both within the normal limits, and there were no indirect signs of elevated pulmonary artery pressure [Figure 1c]. A bubble study followed, and transthoracic echocardiography then revealed an intracardiac right-to-left shunt caused by an aneurysmal interatrial septum with patent foramen ovale (PFO). However, when she was placed supine, her clinical condition improved dramatically. To clarify the etiology of POS, a right heart catheterization was done which revealed normal pulmonary arterial pressure. On the same occasion, endovascular closure of the atrial septal defect was done [Figure 2c]. Her cyanosis and oxygen saturation obtained through transcutaneous oximetry, improved while she was lying in the supine position. The patient experienced an uneventful recovery and cessation of orthodeoxia.

DISCUSSION

Both patients manifested a severe hypoxemia with low response to increase of fractional inspired oxygen, unremarkable physical examination of the lungs, and no radiological findings of the pulmonary embolism. Moreover, oxygen saturation improved slightly with the Trendelenburg position. The diagnosis was POS, a positional dyspnea with hypoxemia paradoxically exacerbated in the upright position.

Pathophysiological issues

Three primary mechanisms have been postulated for this rare syndrome: intracardiac shunting, anatomic pulmonary vascular shunting, and ventilation-perfusion mismatching.^[2] In most cases, right-to-left atrial shunting is caused by a PFO, rarely by an atrial septal defect or an atrial septal aneurysm with septal fenestration.^[3]

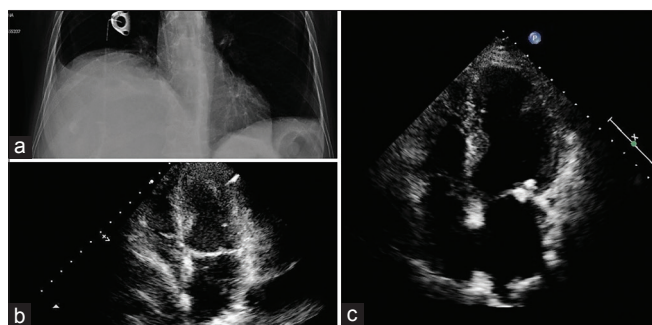


Figure 1: A chest radiography shows an elevation of the right hemidiaphragm (a), and a bedside transthoracic echocardiography demonstrated an ab-estrinsec compression of the right atrium (b). In the other patient, the transthoracic echocardiogram confirmed a note atrial septal aneurysm with patent foramen ovale (c)

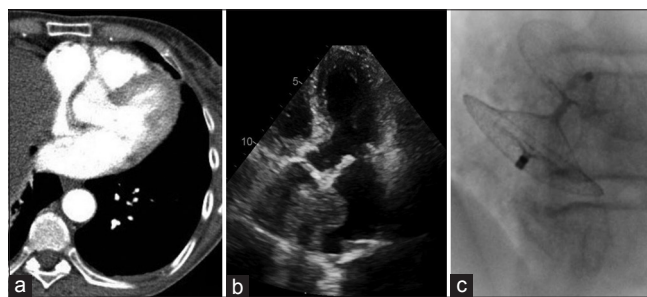


Figure 2: Computerized tomography scan demonstrated an ab-estrinsec compression of the right atrial roof due to peritoneal carcinomatosis and subsequent elevation of the right hemidiaphragm (a), A microbubble contrast-enhanced echocardiogram showed bubbles within the right to the left atrium (b) and endovascular closure of the atrial septal defect was successfully performed (c)

Most PFOs are not expected to cause sufficient right-to-left shunting to elicit hypoxemia due to higher left atrial pressure and greater compliance of the right atrium and ventricle.^[4] Shunt across the interatrial communication has been suggested in the presence of an elevated right atrial pressure, as in chronic obstructive pulmonary disease, pulmonary hypertension, pulmonary embolism, constrictive pericarditis, pericardial effusion, or pneumonectomy.^[1] However, many patients with platypnea are found to have normal pulmonary artery pressure.^[5] Another possible mechanism to explain shunting in the absence of elevated right heart pressure is called “flow phenomenon:” the preferential flow of the blood, exacerbated by the upright position, is directed from the inferior vena cava toward the foramen ovale, as seen during intrauterine life.^[6]

Certain cardiac or pulmonary functional aberrations can preferentially direct the blood flow through the interatrial defect worsening the shunt in the absence of a pressure gradient.^[1] These functional aberrations can be classified in intrinsic cardiac anatomical pathologies, such as ascending aorta elongation^[7,8] and in extracardiac intrathoracic pathologies, such as severe kyphosis^[9] or hemidiaphragm paralysis.^[10]

Clinical picture

The first patient had a PFO, and the trigger was represented by an extrinsic compression of the right atrial roof due to peritoneal carcinomatosis and subsequent elevation of the right hemidiaphragm [Figure 2a]. Although an elevated hemidiaphragm with atelectasis of the lower lobe can potentially cause a variable hypoxemia, in the presence of severe impairment in arterial oxygenation that does not improve with high-flow oxygen supplementation, a POS should be suspected.^[11] In the presence of an elevated right hemidiaphragm or after pneumonectomy, the inferior vena cava becomes more directly aligned with the foramen ovale due to horizontal positioning of the interatrial septum.^[12]

In the second patient, the transthoracic echocardiogram confirmed a known atrial septal aneurysm as well as PFO. A microbubble contrast-enhanced echocardiogram showed the movement of bubbles from the right to the left atrium, mostly in an upright position, confirming the presence of an intracardiac shunt [Figure 2b]. A right heart catheterization measured normal pressure waves in the cardiac chambers and allowed, at the same time, to perform a successful endovascular closure of the atrial septal defect [Figure 2c]. Our hypothesis is that multiple factors may have contributed to cause POS, including kyphoscoliosis, ascending aorta elongation, and hypovolemia. The phenomenon of worsening of the shunt as a consequence of dehydration has been previously described.^[4,6,13,14] Interatrial shunting in the upright position is thought to be possibly related to decreased compliance of the right ventricle on standing.^[6] Reduction of intravascular volume, as in our patient, can reduce right ventricular compliance, further exacerbating the shunt.^[3]

Diagnostic assessment

The first assessment should be the evaluation of a possible association between dyspnea and upright posture.^[15] For

this reason, pulse oximetry and blood gas analysis should be performed both in recumbency and upright positions. The finding of orthostatic desaturation can direct the diagnosis toward an atrial septum discontinuity.^[16] Echocardiography with Doppler mode and conjunct contrast-enhanced echocardiography are paramount to establish the diagnosis. Both examinations should ideally be performed in the lying and upright positions. These investigations may allow one to identify, localize, and semiquantitate the shunt at the atrial level because of the passage of microbubbles from the right chambers to the left within three cardiac cycles.^[17]

Other modalities for assessing intracardiac defects include right heart catheterization, Doppler transesophageal echocardiogram in the sitting position,^[18] ventilation-perfusion scan, and transcranial Doppler study. However, these tests should typically be employed only in the setting of an inconclusive echocardiographic study.^[19]

Treatment

Treatment of platypnea-orthodeoxia should always be directed at the underlying source of vascular shunting.^[20] Percutaneous transcatheter closure remains the treatment of choice for PFO presenting with POS.^[21] Closure of the interatrial shunt results in a good prognosis, with symptoms often resolving quickly,^[22] as seen in the patient described in our report.

CONCLUSION

Before making a diagnosis of POS, it is important to exclude other causes of hypoxemia. In most cases, right-to-left atrial shunting is caused by a PFO associated with a functional aberration. POS represents a very confusing and misleading condition, but its recognition is crucial because symptoms can quickly relieve by recumbency preventing the use of sedative therapy, invasive ventilatory support, and vasopressor agents, which could even exacerbate the right-to-left extrapulmonary shunt.^[23]

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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