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CASE SERIES
Cardiac imaging

Platypnoea–orthodeoxia syndrome induced by short-term weight loss: a case series

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Background Platypnoea–orthodeoxia syndrome (POS) is an uncommon condition characterized by dyspnoea and arterial desaturation in the standing or sitting position that improves in the supine position.

Case summary We report two cases of POS caused by an atrial septal defect (ASD) and a patent foramen ovale (PFO). Both cases reported a recent decrease in body weight of more than 10 kg in a short time period. Transoesophageal echocardiography (TOE) with agitated saline bubble study revealed and a large amount of contrast bubble through the ASD (Patient 1) or the PFO (Patient 2) from the right atrium to the left atrium in the sitting position. Both patients were diagnosed by the finding of positional dyspnoea and the results of TOE using agitated saline bubble contrast.

Discussion Taken together, their presentations suggest that weight loss in a short time period could be a pathogenic factor for POS.

Keywords Platypnoea-orthodeoxia syndrome • Weight loss • Patent foramen ovale • Atrial septal defect • Continuous positive airway pressure • Case report

Learning points

- The development of cardiac platypnoea–orthodeoxia syndrome (POS) needs both anatomical factor and acquired functional factor.
- Weight loss in a short time period could be associated with the right-to-left shunt in patients with patent foramen ovale or atrial septal defect.
- Recognize the potential benefit of continuous positive airway pressure in patients with cardiac POS without elevated right atrial pressure.

Introduction

Platypnoea–orthodeoxia syndrome (POS) is an uncommon condition defined by dyspnoea and hypoxaemia in the standing or sitting position that improves when patients move to the supine position.[1] Although there are several aetiologies, the pathophysiology by which intracardiac abnormalities may cause POS remains poorly understood. The onset of POS must require an acquired factor in addition to an intracardiac abnormality, because positional dyspnoea is not present at birth—it occurs decades later. Although several contributing factors have been reported, there are no reports indicating an association between POS and weight loss.[2–5] We report herein two women—one with an atrial septal defect (ASD) and the other with a patent foramen ovale (PFO)—who experienced POS after a decrease in body weight of more than 10 kg over several months.

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Timeline

Case 1	
July 2018	Laparoscopic total gastrectomy for gastric cancer
	Body weight 62.9 kg (BMI 33.6 kg/m^2)
	Normal percutaneous oxygen saturation (SpO2) and no shortness of breath
Early October 2018	Positional dyspnoea
	Body weight 44.8 kg (BMI 23.9 kg/m^2)
	No pulmonary hypertension
	Secundum atrial septal defect (ASD) and position the right-to-left shunt
Mid October 2018	Surgical repair of ASD
Three weeks after surgery	Discharge with no dyspnoea and normal SpO2 on room air in the sitting position
Case 2	
October 2019	Treatment for cerebral abscess
	Body weight 52.6 kg (BMI 19.8 kg/m^2)
Mid April 2020	Discharge without dyspnoea or hypoxaemia
Late April 2020	Dyspnoea in the sitting position
	No pulmonary hypertension
Early May 2020	Dyspnoea and hypoxaemia in both the sitting and supine positions
	Body weight 42.5 kg (BMI 16.0 kg/m^2)
	Patent foramen ovale (PFO) and the right-to-left shunt in both the sitting and left lateral decubitus
Mid May 2020	Percutaneous transcatheter closure of the PFO
One week after the procedure	Discharge with normal SpO2 on room air in the sitting and supine positions

Case series

Patient 1

A 79-year-old woman was admitted to our hospital after reporting several days of positional dyspnoea. She had no previous arrhythmias including atrial fibrillation. Her regular medication consisted of edoxaban (30 mg once a day), azosemide (30 mg once a day), and spironolactone (25 mg once a day). She had a history of gastric cancer without metastasis for which she underwent laparoscopic total gastrectomy as curative approach at our hospital 3 months prior. During the previous admission, she had normal percutaneous oxygen saturation (SpO_2) and no shortness of breath. Over the course of 3 months after surgery, her body weight decreased from 62.9 kg to 44.8 kg and body mass index (BMI) 33.6 kg/m^2 to 23.9 kg/m^2.

At the time of the current admission, her cardiopulmonary physical examination was normal. Her SpO_2 on 10 L/min supplementary oxygen was 93% with a mask while supine and 77% while sitting. Arterial blood gas obtained in the recumbent position revealed a pH of 7.523, a partial pressure of carbon dioxide (pCO_2) of 34.9 mmHg, a partial pressure of oxygen (pO_2) of 63.6 mmHg, and arterial oxygen saturation of 92.8%. Computed tomography (CT) revealed no evidence of pulmonary embolism or lung disease. Transthoracic echocardiography showed no evidence of shunting or pulmonary hypertension (tricuspid regurgitation pressure gradient 19 mmHg). In addition, there was no dilatation of the inferior vena cava (IVC), right atrium, or right ventricle on transthoracic echocardiography. Transoesophageal echocardiography (TOE) revealed a thin, hypermobile interatrial septum, and a secundum ASD measuring 22 × 21 mm with poor IVC rims (*Figure 1A*). Use of agitated saline bubble contrast in the sitting position and left lateral decubitus position revealed an abundant passage of contrast from the right atrium to the left atrium in sitting position (*Figure 1B*).

Because of the deficient IVC rims, we opted not to perform percutaneous transcatheter closure but rather performed surgical repair of her ASD. After surgery, she reported no dyspnoea and her SpO_2 on room air in the sitting position was 98%. She was discharged on hospital Day 23. Six weeks after surgical repair, her SpO_2 was normal on room air in the standing and supine positions.

Patient 2

A 73-year-old woman was admitted to our hospital with the complaint of dyspnoea in the sitting position. Her regular medication consisted of levetiracetam (500 mg twice a day), apixaban (5 mg twice a day), losartan (50 mg once a day), and amlodipine (5 mg once a day). She had a history of a cerebral abscess 7 months prior and had been discharged from the hospital 1 month prior to the current admission

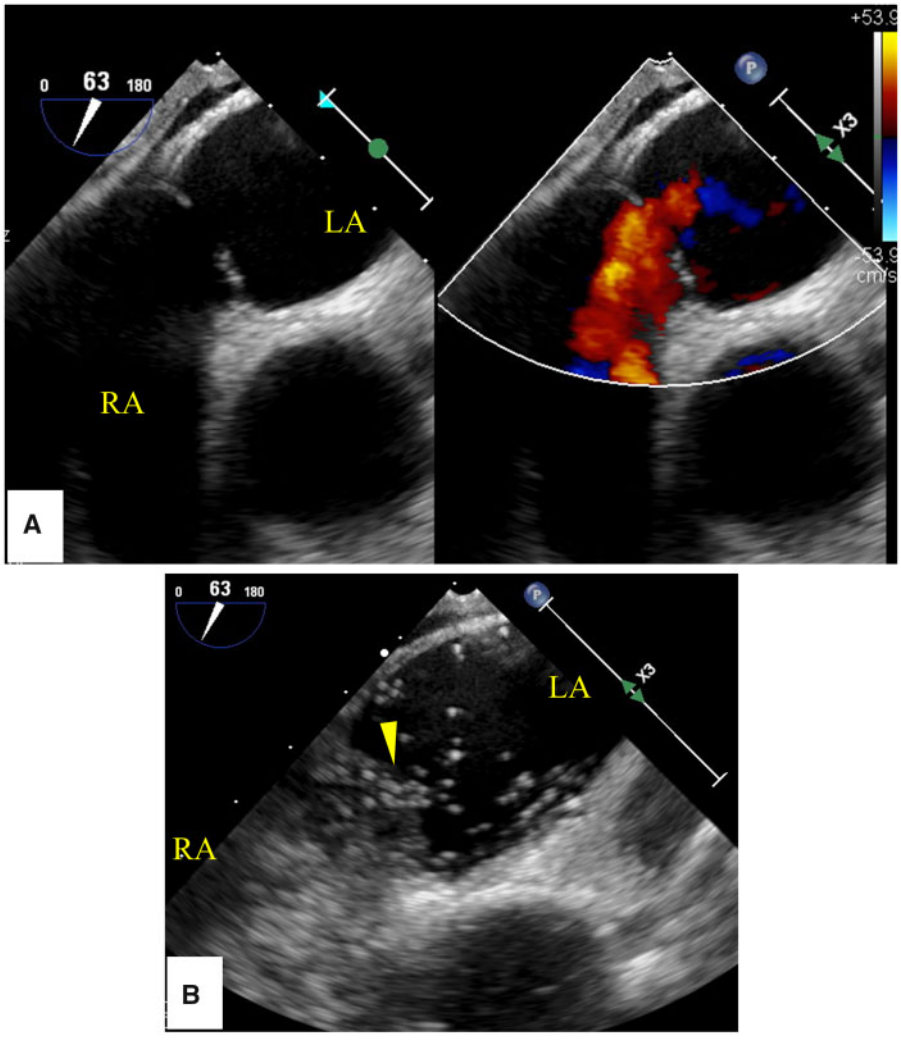

Figure 1 Patient 1. (*A*) Transoesophageal echocardiography with colour-flow Doppler imaging in the sitting position shows a secundum atrial septal defect and right-to-left shunting through the defect. (*B*) Transoesophageal echocardiography using agitated saline bubble contrast in the sitting position demonstrates a large number of contrast bubbles moving through the defect (arrowhead), from the right atrium to the left atrium. LA, left atrium; RA, right atrium.

without dyspnoea or hypoxaemia. Over the 6 months of her hospital admission, her body weight decreased from 52.6 kg to 42.5 kg and BMI 19.8 kg/m^2 to 16.0 kg/m^2. Three weeks prior to the current admission, she had presented to another hospital with the complaint of dyspnoea. At that time, her SpO_2 on 10 L/min supplemental oxygen with a mask was 90% while supine and 70% while sitting. Right heart catheterization at that time showed normal pulmonary artery and right atrial pressures (14/6 mmHg and 3 mmHg, respectively) without a significant increase in oxygen saturation in any chamber. An enlarged ascending aorta was detected on CT, with an inner diameter of 46 mm (*Figure 2*). There was no evidence of pulmonary disease that could cause dyspnoea or hypoxaemia.

On her current admission, although physical and cardiovascular examination was unremarkable, her SpO_2 was even lower in both the sitting and supine positions. Arterial blood gas performed on 10 L/min supplemental oxygen with a mask in the recumbent position

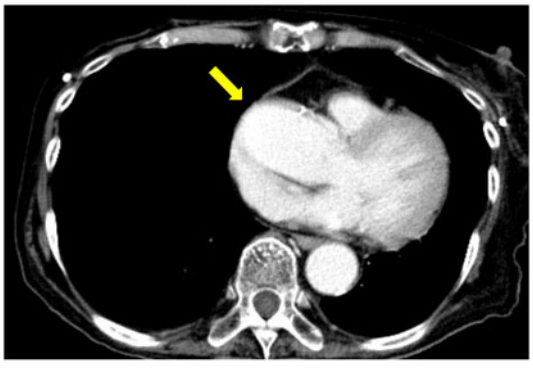

Figure 2 Patient 2. Computed tomography shows an enlarged ascending aorta with an inner diameter of 46 mm (arrow).

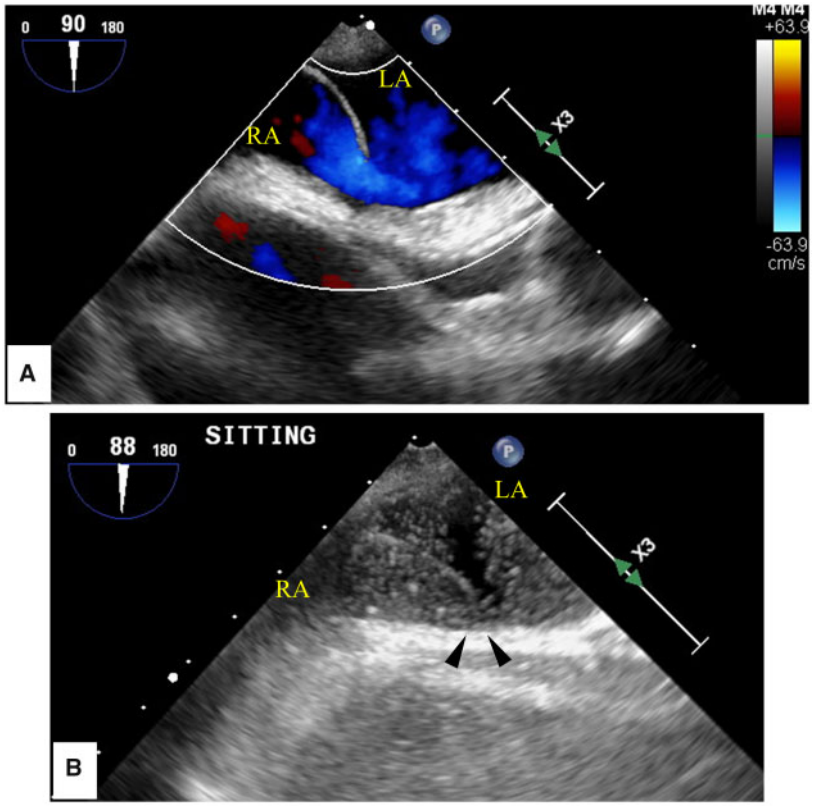

Figure 3 Patient 2. (*A*) Transoesophageal echocardiography reveals a patent foramen ovale, with a right-to-left shunt through the foramen visible on colour-flow Doppler imaging. (*B*) Transoesophageal echocardiography using agitated saline bubble contrast in the sitting position reveals a large shunt with abundant passage of contrast bubbles (arrowheads) from the right atrium to the left atrium. LA, left atrium; RA, right atrium.

revealed a pH of 7.540, pCO_2 of 19.9 mmHg, pO_2 of 42.8 mmHg, and arterial oxygen saturation of 78%. Her hypoxaemia resolved with the use of 5 mmHg continuous positive airway pressure (CPAP), using room air (fraction of inspired oxygen, 0.21). Arterial blood gas performed while on CPAP demonstrated a pH of 7.440, pCO_2 of 28.2 mmHg, pO_2 of 119 mmHg, and arterial oxygen saturation of 98%.

Transthoracic echocardiography demonstrated a PFO. The use of TOE with agitated saline bubble contrast in the sitting and left lateral decubitus positions confirmed the presence of a PFO with a right-to-left shunt and a large amount of contrast traversing the PFO, from the right atrium to the left atrium (*Figure 3*). She underwent percutaneous transcatheter closure of the PFO using the Amplatzer PFO Occluder 35-mm device (Abbott, St. Paul, MN, USA) (*Figure 4*). After the procedure, her SpO_2 on room air in the sitting and supine positions improved to 96%. She was discharged on hospital day 11. One month after percutaneous transcatheter closure, her SpO_2 was normal on room air in the sitting and supine positions.

Discussion

The rare condition of POS is characterized by dyspnoea and arterial desaturation in the standing or sitting positions that improves when patients assume a supine position.[1] The mechanisms of POS are classified into three groups: intracardiac abnormalities (causing interatrial communication due to an anatomic defect), extracardiac abnormalities, and miscellaneous aetiologies.[2] Our two patients had conditions involving cardiac shunts, which places them in the first group. Intracardiac POS can be further divided into two types according to the right atrial pressure: normal or elevated.[3] Both of our patients had normal right atrial pressures.

Both PFO and ASD are congenital structural cardiac abnormalities. Although 20–34% of general population have a PFO,[6] most are asymptomatic. Patients with POS typically have no symptoms for several decades after birth. Therefore, intracardiac POS with normal right atrial pressure requires not only anatomic but also functional factors, also known as acquired factors.[3,7] These include an enlarged or tortuous ascending aorta, cardiac surgery, pneumonectomy, paraoesophageal hernia repair, and severe kyphosis.[2–5] Joseph *et al.*[3] reported that these factors can reposition the atrial septum or redirect blood flow from the IVC. Although our second patient had an enlarged ascending aorta, our first patient had no known functional factor. Both of our patients experienced a significant decrease in body weight over a short time period. Our first patient could not eat enough solid food after total gastrectomy for gastric cancer, resulting in the short-term weight loss. The reason of weight loss in our second patient is speculated loss of appetite due to a cerebral abscess

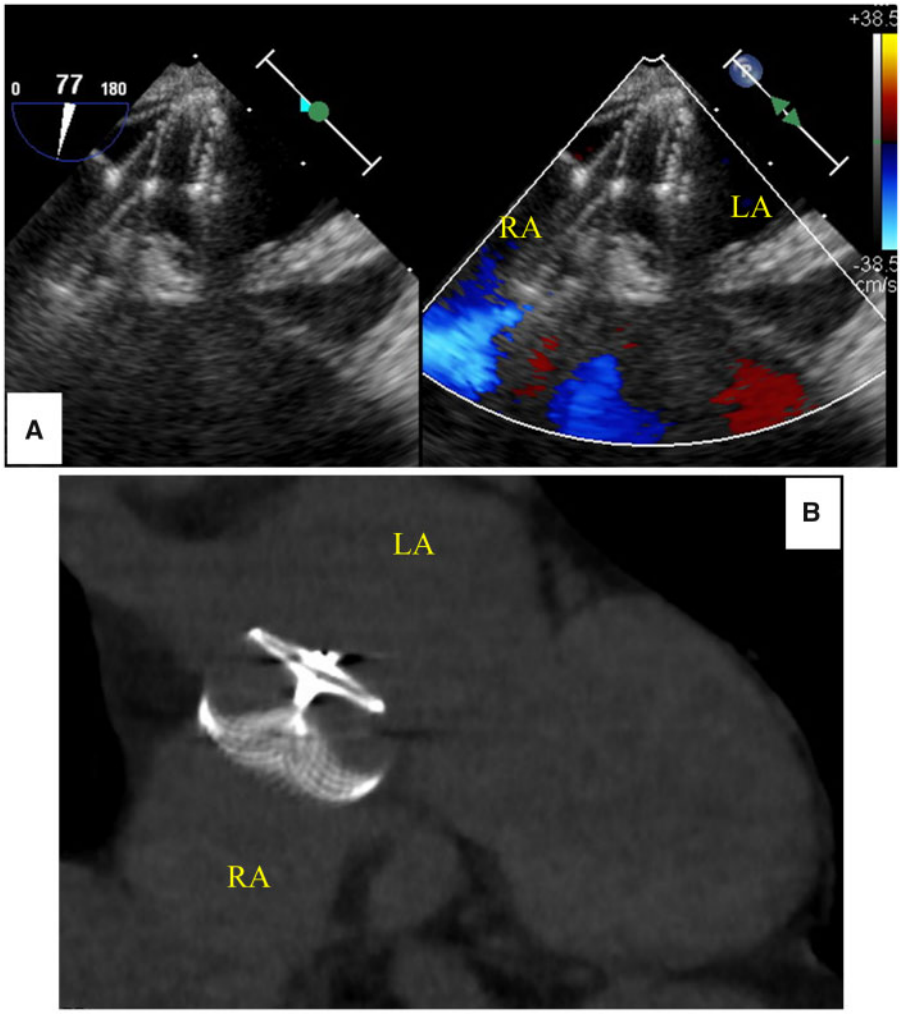

Figure 4 Patient 2. (*A*) Transoesophageal echocardiography shows the closure device without residual shunting after percutaneous closure of the patent foramen ovale. (*B*) Computed tomography shows the occluding device in position. LA, left atrium; RA, right atrium.

and poor activity. Therefore, we suspect that weight loss is associated with the development of the right-to-left shunt in each patient. Several previous case reports have shown the associations between pneumonectomy and POS, which is caused by change of the anatomical relation due to mediastinal deviation.[2,8] Additionally, Sakagianni *et al.*[9] reported that hemidiaphragmatic paralysis can relate to POS by a similar mechanism. Therefore, weight loss probably modified the spatial relations of organs in the thoracic cavity, including mediastinum and diaphragm, which changed the position of the atrial septum and shifted the intracardiac anatomy. This acquired remodelling is capable of changing the relation between the direction of blood flow from the IVC and the atrial septum, resulting in a right-to-left shunt. However, to the best of our knowledge, there are no studies reporting an association between weight loss and POS. Perhaps future studies of patients with POS can include an assessment of changes in body weight.

Patient 2 experienced a return to normal oxygen saturation with CPAP (fraction of inspired oxygen, 0.21). Supplemental oxygen is not a treatment for hypoxaemia resulting from a right-to-left shunt, and positive pressure ventilation may actually worsen hypoxaemia in patients with POS due to an interatrial pressure gradient.[10] However, CPAP can be effective for POS of cardiac aetiology without elevated right atrial pressure. A previous case report describes a patient with a right-to-left shunt whose symptoms resolved with positive pressure ventilation.[9] These phenomena suggest that positive pressure ventilation may change the position of the interatrial septum or the intracardiac anatomic relations.

An accurate diagnosis is of utmost importance for patients with POS, because there are definitive treatments that can greatly improve their clinical status. The treatment for intracardiac POS is either surgical repair or percutaneous closure of the causative defect. Recently, transcatheter device closure has become the preferred intervention for patients with both ASD and PFO. A previous report describes the percutaneous closure of interatrial communications using transcatheter devices in 52 patients.[1] All patients were successfully treated and experienced acute improvement in oxygen

saturation. A high degree of clinical suspicion is crucial for proper diagnosis. Any patient who describes positional dyspnoea should be asked whether the symptoms occur while sitting or upon standing, and whether they resolve upon lying down.

Lead author biography

Yudai Tamura is a clinical cardiologist specialized in echocardiography in structural heart disease. He graduated from Kanazawa University and received the MD degree in 2012. He worked as a staff at Department of Cardiovascular Medicine, Kanazawa University from 2014 to 2018. Since 2018, he serves as a staff cardiologist at Saiseikai Kumamoto Hospital, Japan.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

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Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as Supplementary data.

Consent: The author/s confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patients in line with COPE guidance.

Conflict of interest: none declared.

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