Platypnoea–orthodeoxia syndrome after percutaneous treatment of ruptured sinus Valsalva complicated by SARS-Cov-2 pneumonia: a case report

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Received 3 November 2020; first decision 24 November 2020; accepted 7 April 2021

Background
Rupture of sinus of Valsalva (RSV) to right atrium (RA) causes significant left to right shunt, tricuspid regurgitation, and right ventricular failure. If left uncorrected it can lead to biventricular heart failure. Hence, early invasive management is advised. To date, there is no report about platypnoea–orthodeoxia syndrome (POS) after device closure of ruptured sinus of Valsalva.

Case summary
A 50-year-old woman with dyspnoea of exertion and rupture of sinus valsalva to right atrium was referred to our hospital. On admission, chest computed tomography (CT) was normal. After closure of the rupture, she developed orthostatic hypoxemia and frequent cough. A repeat chest CT was suggestive of COVID-19 infection which most probably occurred during the hospitalization. Although COVID-19 was thought to be the only culprit, her symptoms were not solely justified by COVID-19. Transthoracic echocardiography showed patent foramen ovale (PFO) with significant shunt. PFO device closure was performed under intracardiac echocardiography guidance.

Discussion
Interatrial septum deformation may happen after RSV correction and right to left shunt from PFO may become more significant. POS is an important indication for PFO closure which should be noticed by careful examination. As COVID-19 is the most frequent pathology these days, it may delay other probable diagnosis, and hence detailed history taking and physical examination is mandatory.

Keywords
Platypnoea–orthodeoxia syndrome • Rupture of sinus of Valsalva • COVID-19 infection • Case report

Learning points
• As COVID-19 is the most frequent pathology these days, it may delay other probable diagnosis, hence detailed history taking and physical examination is mandatory especially in patients with dyspnoea.
• Orthostatic hypoxia is an important indication for patent foramen ovale closure which may be missed if the physician does not notice and does not perform physical examination.

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Handling Editor: Poonam Valagapudi
Peer-reviewers: Anna Giulia Pavon and Andreas Mitsis
Compliance Editor: Daniel Tardo
Supplementary Material Editor: Elhosseyn Guella
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Introduction

Rupture of sinus of Valsalva (RSV) to right atrium (RA) causes significant left to right shunt, tricuspid regurgitation and right ventricular (RV) failure. If not corrected, it will result in biventricular heart failure. Therefore, early invasive management (mostly surgical approach) is recommended. If possible, transcatheter percutaneous approach should be considered over open heart surgery in patients with high and prohibitive risk of surgery. The device used in this situation is a self-expanding double-disk tool which is connected by a joint in the centre of the disks. Co-existing cardiac malformations may be present in patients with RSV. Ventricular septal defect (VSD) or aortic valve regurgitation may be present in approximately 30–40% of patients. Recently, Mittal et al. described a case with newly diagnosed un-ruptured sinus of Valsalva aneurysm and history of closure of atrial septal defect during childhood. Platypnoea-orthodeoxia syndrome (POS) is also a rare condition in which the patient becomes hypoxic in the upright position. Herein, we presented a case with POS after RSV device closure in a patient with COVID-19.

Timeline

| 8 months before admission | Dyspnoea on exertion |
|--------------------------|---------------------|
| Admission day (8:00 a.m.)| The patient was admitted in the morning |
| Admission day (2:00 p.m.)| The patient underwent first procedure (device closure for rupture of sinus Valsalva) |
| 2 days after the first procedure | Chest computed tomography scan was done and was in favour of COVID-19; antiviral drugs initiated |
| 5 days after the first procedure | Platypnoea–orthodeoxia syndrome was diagnosed and patient was planned for the second procedure (patent foramen oval (PFO) closure) |
| 6 days after the first procedure | PFO closure was done successfully |
| 7 days after admission | The patient was discharged in good condition |

Case presentation

A 50-year-old woman with the chief complaint of exertional dyspnoea (functional class III) from 8 months ago and suspicious intracardiac shunt referred to Tehran Heart Center, a referral educational hospital in Tehran, Iran, for further evaluation. At the time of admission her vital signs were as following; blood pressure 128/68 mmHg, heart rate 93 beat/minute, and respiratory rate 19/minute. Her O₂ saturation in ambient air was 94% with no sign of peripheral or central cyanosis. Cardiorespiratory examination revealed a continuous murmur at the left parasternal border. No rales or crackles were heard. Electrocardiogram was unremarkable (sinus rhythm with heart rate of 93 beats per minute and no significant ST-T change). Chest computed tomography (CT) scan was normal. Based on initial physical examination, the diagnosis of patent ductus arteriosus (PDA) and VSD was considered. Echocardiography showed normal left ventricle function (ejection fraction 55%), mildly dilated right ventricle, and moderate tricuspid regurgitation with no PDA or VSD. An important finding was diastolic turbulent flow from right coronary cusp (RCC) of aortic valve to RA at the level of tricuspid valve septal leaflet, suggestive for RSV. On admission Chest CT scan was normal.

Past medical history was unremarkable except for hypertension. Left heart catheterization revealed non obstructive coronary artery disease. Right heart catheterization results were as follows: pulmonary artery pressure (PAP); 53/22 mmHg, RV pressure; 50/12 and RA pressure: 12 mmHg. Transoesophageal echocardiography (TOE) showed rupture of RCC with continuous flow shunt to RA (Figure 1A). The aortic and RA orifices were 8 and 6 mm, respectively. The distance between aortic valve to right coronary artery was 12 mm. Cardiac catheterization showed significant flow from aorta to RA in aortic root injection (Figure 1B). The Qp/Qs ratio was 2.3 in favour of significant left to right shunt (aorta to RA).

The patient was discussed in the heart team committee (including structural interventionalist, general surgeon, echo-cardiologist, and anaesthesiologist). She was planned for device closure at the next session with PDA device.

After aortic root injection, wiring (0.035 wire) was done through sinus rupture to pulmonary artery and was snared and externalized via right femoral vein. Delivery sheath was inserted through rupture and Occlutech PDA occluder 12–15 was deployed to close the rupture (Figure 1C). Afterwards, aortic root injection and TOE showed successful closure of the rupture with mild residual shunt.

The patient was transferred to the critical care unit and monitored closely. However, she had ongoing dyspnoea on exertion nd also frequent coughing was added to her symptoms. Two days after the procedure, chest CT scan was repeated. Peripheral densities with ground glass appearance in favour of COVID-19 appeared. Real-time reverse transcription polymerase chain reaction (rRT-PCR) test was sent and came back positive the next day. Symptom therapy and also anti-viral drug were initiated. In our hospital at that time Remdesivir was the antiviral choice for in hospital management of COVID-19 among patients with low O₂ saturation and baseline comorbidities. Coughing improved however exertional dyspnoea persisted. The new important finding was the difference in O₂ saturation in supine and upright position. In supine position the O₂ saturation was 86% which fell down to 79% while the patient was upright. Another finding was the resistance of hypoxia to O₂ therapy; even 100% O₂ did not increase the level of O₂ saturation. Transthoracic echocardiography Afterwards showed patent foramen ovale (PFO) with significant shunt on colour Doppler study. Hence, this platypnoea–orthodeoxia, with severe orthostatic hypoxia, was thought to be related to PFO. General situation of the patient was getting better but she was still symptomatic. The pulmonary pressure after the procedure was near normal and lung disease did not solely justify the POS. Therefore, POS was attributed to PFO shunt in the presence of COVID pneumonia. This was a challenging decision however the heart team
arrived at the decision to perform the second procedure (PFO closure).

After 5 days of the first procedure, she was then, planned to undergo PFO device closure.

The next day (6 days after the first procedure), she transferred again to the cath-lab for the second procedure. The right to left shunt was visible in intracardiac echocardiography (ViewFlex Xtra ICE Catheter, St. Jude Medical) (Figure 2A). Cardiac oximetry was done before device closure. The O₂ saturation in pulmonary vein was 97%, however, significant step-down to 88% was seen in the left atrium. In addition balloon closure of PFO resulted in rapid increase of systemic saturation up to 95%.

At first, PFO closure device FigullaFlex 23–25 mm (Occlutech GmbH, Jena, Germany) was used but retrieved due to significant residual shunt. Then the Amplatzer ASD occluder (AGA Medical Corp, Golden Valley, MN, USA) 14, was successfully deployed without any significant residual shunt in contrast injection (Figure 2B). The oximetry showed immediate improvement (89–94%).

Fortunately, the POS was relieved after the procedure and the patient was discharged from hospital with Aspirin (81 mg daily) and Pantoprazole (40 mg daily) in good condition (and negative PCR test for COVID-19) after a week.

Discussion

Here, we described a 50-year-old female patient with dyspnea of exertion (DOE) from 8 months ago and echocardiographic finding of ruptured sinus of Valsalva to RA. After, transcatheter device closure she was diagnosed with COVID-19 and antiviral treatment was started. At first, respiratory symptoms were thought to be due to COVID-19 alone. Coughing improved but orthostatic hypoxia (platypnoea) became more evident. PFO with significant shunt was noted in follow-up echocardiography after RSV closure.

The aneurysm of sinus of Valsalva may be congenital or acquired after infective endocarditis, atherosclerosis or dissection. This rare lesion, may originate from RCC (65–85%), the non-coronary sinus (10–30%), and, rarely, the left coronary sinus (1–5%). This pathology is more often seen in Asian male and is frequently asymptomatic.

Symptoms of patients with RSV are mostly acute or subacute. However, the disease course of our patient was chronic. One explanation was the presence of PFO which decreased the amount of left to right shunt. High RA pressure because of massive regurgitated flow from aorta caused right to left shunt and decreased RV inflow. This patient did not experience acute RV failure and both the size and function of RV were within normal range.
POSO is a rare disorder. Both dyspnoea and $O_2$ saturation deteriorates in upright position compared to supine state.\textsuperscript{10} Interstitial pneumonia and high PAP has been suggested to cause reversible POS.\textsuperscript{11} On the other hand, if no significant pneumonia is present POS may happen in patients with PFO under specific circumstance.

Occurrence of this syndrome requires two things; one, intracardiac interatrial septal defect (such as PFO) or intrapulmonary shunt and two, a functional component during upright standing; interatrial septum deformation. Atrial septum will be deformed while standing and may allow easy streaming of blood from inferior vena cava.\textsuperscript{12} The relation between aortic pathologies and POS has been reported in two previous cases. One, in a patient with thoracic aortic aneurysm and another one after transcatheter aortic valve implantation.\textsuperscript{13,14}

Hence, both COVID-19 pneumonia (although the severity was not considerable and PAP was not high) and deformation of septum after aortic intervention may be the reason for POS in our patient. This syndrome is one of the indications of PFO closure.\textsuperscript{14} The patient was clearly asymptomatic and after consultation with heart team members we decided to close the PFO in this situation.

As far as we know this is the first case of POS after transcatheter device closure of RSV. The patient had dyspnoea on exertion rom 8 months ago, however, during many visits; no one carefully did the physical examination and heart auscultation; therefore, the diagnosis of RSV was delayed. After the first procedure, due to COVID-19 infection early echocardiography was not performed to evaluate the other causes of dyspnoea.

**Conclusion**

RSV is a serious pathology which should be corrected as soon as possible. Intracardiac septum deformation may happen after RSV correction and right to left shunt from patent foramen oval may become more significant. It may cause POS in patients with pre-existing PFO. As COVID-19 is the most frequent pathology these days, it may delay other probable diagnosis, hence detailed history taking, physical examination and para-clinic evaluation are mandatory.

**Ethical approval**

IR.TUMS.VCR.REC.1399.011.

**Lead author biography**

Dr Yaser Jenab is an Interventionist in Iran working at the Tehran heart Center. He performs complex coronary intervention and also structural procedures. He and his colleague Dr Kaveh Hosseini who is the assistant professor of cardiology undertake research in cardiology.

**Supplementary material**

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

**Acknowledgments**

Our gratitude goes to all catheterization laboratory staff and technicians.

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

**Consent:** The authors confirm that written consent for submission and publication of this case report, including images and associated text, has been obtained from the patient in line with COPE guidance.

**Conflict of interest:** None declared.

**Funding:** None declared.

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