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PULMONARY ARTERIOVENOUS MALFORMATION: NOT ALL HYPOXEMIA DURING COVID-19 IS THE SAME

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ABSTRACT

Hypoxemia in coronavirus disease 2019 (COVID-19) patients is not solely due to alveolar damage but can also involve factors like vascular shunts, such as pulmonary arteriovenous malformation, contributing to persistent hypoxemia. We report a case of a 59-year-old male, with COVID-19 pneumonia, requiring high-flow respiratory support, who later was also diagnosed with a large pulmonary arteriovenous fistula, which probably worsened because of COVID-19 infection.

KEYWORDS

Pulmonary arteriovenous malformation, hypoxemia, COVID-19

LEARNING POINTS

- Hypoxemia in coronavirus disease 2019 (COVID-19) patients is multifaceted not only with alveolar damage but also with other factors such as vascular shunts, like pulmonary arteriovenous malformation.
- Diagnosing pulmonary arteriovenous malformation can be difficult due to overlapping symptoms with other respiratory disorders.
- Management of pulmonary arteriovenous malformation typically involves transcatheter embolization to block abnormal vascular connections and reduce the risk of complications like paradoxical emboli. Surgical options are reserved for severe cases, while pharmacological treatments are less common.

INTRODUCTION

During the initial phase of the coronavirus disease 2019 (COVID-19) pandemic, the prevalence of vascular disorders was high[1]. Until now, the relationship between virus induced inflammatory disorders and biological and morphological changes has been very difficult to understand[2]. The refractory hypoxemia seen in COVID-19 patients seem to be caused by more complex processes than alveolar damage with low gas exchange alone because COVID-19 leads to severe respiratory failure even though the lung gas volumes are well preserved[3]. Pulmonary arteriovenous malformations (PAVMs) are vessels that are structurally abnormal that provide direct capillary free communication between pulmonary and systemic circulation, and thus resulting in an anatomical right-to-left shunt with poor gas exchange as well as systemic venous circulation[4].

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CASE DESCRIPTION

A 59-year-old male with coronary artery disease who had undergone coronary angioplasty was found to have developed COVID-19 pneumonia, while he was in another hospital, where he was intubated for clinical deterioration and worsening dyspnoea. He was transferred to our centre for further evaluation and management. On admission he was in type-2 respiratory failure and sepsis requiring extensive inotropic support. Chest X-ray on admission to our unit showed diffuse bilateral opacities *(Fig. 1)*. A high-resolution computed tomography (HRCT) scan done at the previous hospital showed multifocal ground glassing opacities in bilateral lung fields with right middle lobe consolidation and significant pulmonary involvement due to COVID-19; and COVID-19 Reporting and Data System grading was 5 (CO-RADS 5). He was treated with intravenous (IV) antimicrobials including piperacillin and tazobactam, remdesivir, methyl prednisolone infusion, anticoagulants and other supportive measures. Despite high ventilator support with positive end-expiratory pressure (PEEP) of 16, fraction of inspired oxygen (FiO_2) of 100%, and prone ventilation, he was in refractory hypoxemia (peripheral oxygen saturation, SpO_2: 85-87%, partial pressure of oxygen, PaO_2: 56-61 mmHg with a haemoglobin level of 19.5g/dl). A CT pulmonary angiogram (CTPA) was done to rule out pulmonary embolism. CTPA revealed a large AV fistula in the left lower lobe along with collapse of left lower lobe basal segments *(Fig. 2)*. Multifocal ground glass opacities were seen in bilateral lung fields and the CT severity score was 18/25. A CT scan of the brain was also done in view of his poor sensorium and showed multiple small infarcts bilaterally, suggestive of embolic infarcts. He underwent emergency plug and coil embolization of the left lower lobe (anteromedial) segmental pulmonary artery to fix the AV fistula *(Fig. 3)*. A perioperative transthoracic echocardiography was done which showed severe left ventricular systolic dysfunction, and a dilated and scarred left ventricle; cardiac anomalies were ruled out.

The history of the patient was reviewed, but he did not have any episodes of epistaxis, haemoptysis or other evidence of bleeding. He did not have a prior history of breathlessness, other than a week before leading to his myocardial infarction and coronary angioplasty. He did not have history of recurrent admissions for respiratory infections. Family history of epistaxis, intracranial bleed or recurrent pneumonia were ruled out although a sibling was also noted to have a history of myocardial infarction. Initial investigations had revealed polycythaemia, though clubbing was absent.

Post-procedure, the patient gradually improved both clinically and radiologically *(Fig. 4)* and the ventilator settings were gradually reduced based on the clinical improvement. However, he required tracheostomy due to his prolonged ventilatory requirement but was weaned off to a portable ventilator on controlled mode of ventilation. Later, the patient was gradually weaned off to pressure support mode of ventilation (PSV). T-piece trials were also given intermittently which he failed to tolerate. He was therefore continued on

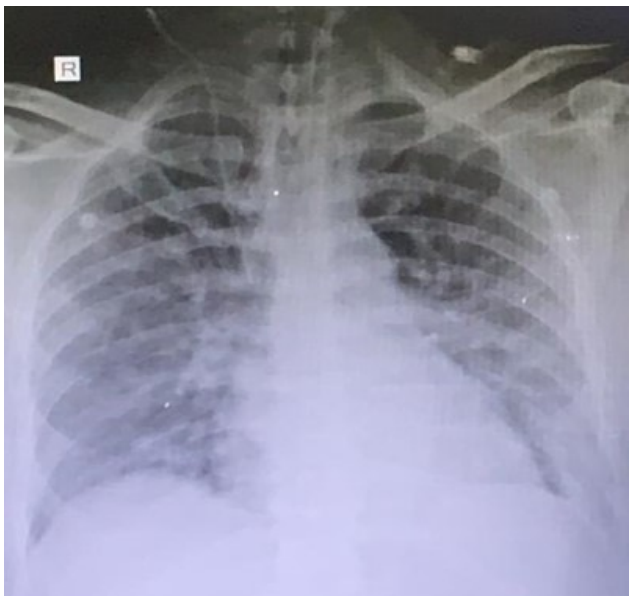


Figure 1. Chest X-ray on admission.

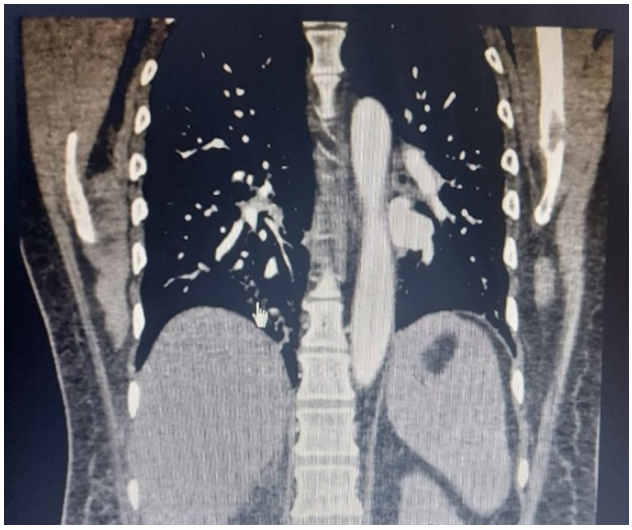


Figure 2. Computed tomography pulmonary angiogram showing pulmonary arteriovenous malformations.

PSV. A repeat CT scan revealed pneumomediastinum and an increase in density of parenchymal shadows compared to the previous CT scan. Clinically, the patient was stable on PSV and was shifted out of the intensive care unit (ICU), after more than 1 month of stay. However, he was later shifted back to the ICU in view of secondary sepsis and shock. Later he developed multi-organ failure, requiring high vasopressor support and haemodialysis and ultimately succumbed to his illness.

DISCUSSION

PAVMs have now evolved to be common clinical conditions[4]. Most cases are innate, frequently related to hereditary haemorrhagic telangiectasia. Symptoms initially may be totally absent and can also extend to severe cyanosis, congestive heart failure and even severe respiratory failure[5]. Patients with PAVM can have the following presentation: (i) one or more pulmonary nodules corresponding with typical radiographic findings, (ii) mucocutaneous telangiectasis, and

(iii) hypoxemia, polycythaemia, clubbing, cyanosis, etc.[6]. Our patient had elevated haemoglobin levels (ranging from 16-19 g/dl) which could be due to the existing AV fistula.

PAVMs allow systemic venous blood to bypass gas exchange and provide anatomic right-to-left shunts. Hypoxemia and increased ventilatory requirements result, although both do not cause symptoms[4].

Dyspnoea is the most frequently observed respiratory symptom in patients with PAVM[7]. Patients presenting with hypoxemia along with only partial correction with supplemental oxygen along with elevated alveolar-arterial gradient should make the clinician think of a right-to-left shunt and the possibility of PAVM[8].

The prevalence of pulmonary AV anastomoses has been studied. since the 1950's and described to be located at the apex of and within the lobular divisions of the lung[9,10]. Data suggests that such anastomoses can be triggered by exercise or supine position, and actively due to vascular redistribution under hyperoxia and hypoxia[11]. The result of these combined mechanisms, in COVID-19 pneumonia, is aggravated hypoxia, which could be a better explanation for the contradiction between the relatively preserved lung mechanics, the severity of respiratory failure, and the limited response to invasive ventilation[3].

PAVMs are different from other vascular abnormalities in that the right-to-left shunt puts the patient at high risk of paradoxical emboli. Paradoxical emboli cause strokes and cerebral abscesses, especially in individuals with previously undiagnosed PAVMs. To reduce these risks, PAVM occlusion by embolization is the standard therapy[4].

In the case discussed here, symptoms of PAVM overlapped the symptoms of COVID-19 pneumonia. COVID-19 is well known to cause abnormalities of the pulmonary vasculature[12] and probably in this case the COVID-19 infection worsened a preexisting minor PAVM. The typical radiological appearance of a PAVM is that of a uniformly dense round oval mass, mostly lobulated but sharply defined, more commonly in the lower lobes, and ranging from 1-5 cm in diameter[13]. Chest X-ray is not a very accurate diagnostic tool in PAVM[14]. In our patient, chest X-ray showed bilateral diffuse opacities due to acute respiratory distress syndrome with features impossible to differentiate from features of PAVM.

Refractory hypoxemia despite high PEEP, 100% FiO_2 and prone ventilation was the factor that led to suspicion of pulmonary embolism because of which CTPA was planned, and ultimately led to the identification of PAVM. Despite advances in the techniques mentioned thus far, contrast CTPA remains the gold standard in diagnosing PAVM, and is usually necessary if resection or obliterative therapy is being considered.

The three approaches for the management of the various types of PAVMs are: (i) transcatheter embolization therapy, using various devices such as coils, detachable balloons, etc.; (ii) surgical approach, which includes lobectomy, segmentectomy or fistulectomy, redirecting hepatic venous flow to the pulmonary circulation, and heart or heart/lung transplantation; (iii) pharmacological treatments[14]. Embolization is the treatment of choice; however, surgery is restricted to patients with fatal haemorrhages[15].



Figure 3. Chest X-ray post-embolization.



Figure 4. Chest X-ray after 7 days of prone ventilation.

When treating this patient, we were able to significantly reduce the FiO_2 requirement and he was gradually weaned off ventilation. The case thus highlights the importance of ruling out all possible vascular complications of refractory hypoxia before going on for proning and extracorporeal membrane oxygenation.

CONCLUSION

We conclude that structural abnormalities such as PAVM need to be ruled out in case of unexplained hypoxemia, especially during COVID-19 related vascular complications. COVID-19 associated macroscopic vascular changes seen *in vivo* are all not exclusively due to thromboembolic events. Although difficult to establish in vivo, vascular shunts could explain why our patient's clinical course was worse than expected given the relatively modest parenchymal involvement and absence of visible local thromboembolism.

REFERENCES

1. Qanadli SD, Beigelman-Aubry C, Rotzinger DC. Vascular Changes Detected With Thoracic CT in Coronavirus Disease (COVID-19) Might Be Significant Determinants for Accurate Diagnosis and Optimal Patient Management. *AJR Am J Roentgenol* 2020;**215**: W15.
2. Qanadli SD, Rocha AC, Rotzinger DC. Case Report: Intrapulmonary Arteriovenous Anastomoses in COVID-19-Related Pulmonary Vascular Changes: A New Player in the Arena? *Front Med (Lausanne)* 2021;**8**:639152.
3. Gattinoni L, Coppola S, Cressoni M, Busana M, Rossi S, Chiumello D. COVID-19 Does Not Lead to a "Typical" Acute Respiratory Distress Syndrome. *Am J Respir Crit Care Med* 2020;**201**:1299-1300.
4. Shovlin CL. Pulmonary arteriovenous malformations. *Am J Respir Crit Care Med* 2014;**190**:1217-1228.
5. Allen SW, Whitfield JM, Clarke DR, Sujansky E, Wiggins JW. Pulmonary arteriovenous malformation in the newborn: a familial case. *Pediatr Cardiol* 1993;**14**:58-61.
6. Moussouttas M, Fayad P, Rosenblatt M, Hashimoto M, Pollak J, Henderson K, et al. Pulmonary arteriovenous malformations: cerebral ischemia and neurologic manifestations. *Neurology* 2000;**55**:959-964.
7. Cottin V, Chinet T, Lavolé A, Corre R, Marchand E, Reynaud-Gaubert M, et al. Pulmonary arteriovenous malformations in hereditary hemorrhagic telangiectasia: a series of 126 patients. *Medicine (Baltimore)* 2007;**86**:1-17.
8. Mangla A, Nevares A, Yamani N, Ansari N. Pulmonary arteriovenous malformation: a rare cause of dyspnoea on exertion. *BMJ Case Rep* 2014;**2014**:bcr2014204087.
9. Tobin CE. Arteriovenous shunts in the peripheral pulmonary circulation in the human lung. *Thorax* 1966;**21**:197-204.
10. Tobin CE, Zariquiey MO. Arteriovenous shunts in the human lung. *Proc Soc Exp Biol Med* 1950;**75**:827-829.
11. Lovering AT, Duke JW, Elliott JE. Intrapulmonary arteriovenous anastomoses in humans--response to exercise and the environment. *J Physiol* 2015;**593**:507-520.
12. Mohamed I, de Broucker V, Duhamel A, Giordano J, Ego A, Fonne N, et al. Pulmonary circulation abnormalities in post-acute COVID-19 syndrome: dual-energy CT angiographic findings in 79 patients. *Eur Radiol* 2023;**33**:4700-4712.
13. Gossage JR, Kanj G. Pulmonary arteriovenous malformations. A state of the art review. *Am J Respir Crit Care Med* 1998;**158**:643-661.
14. Mottaghi H, Kahrom M, Nezafati MH, Kahrom H. Congenital pulmonary arteriovenous malformation: a rare cause of cyanosis in childhood. *Pan Afr Med J* 2009;**8**;3-12.
15. Faughnan ME, Palda VA, Garcia-Tsao G, Geisthoff UW, McDonald J, Proctor DD et al. HHT Foundation International - Guidelines Working Group. International guidelines for the diagnosis and management of hereditary haemorrhagic telangiectasia. *J Med Genet* 2011;**48**:73-87.