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Endobronchial Valves in the Management of Persistent Air Leak in Coronavirus Disease 2019

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Pneumothorax and persistent air leak are documented complications of severe acute respiratory syndrome coronavirus 2 infection. Patients who fall into this category are often poor candidates for invasive thoracic surgical intervention. Endobronchial valves offer an effective and less invasive treatment option and can successfully treat persistent air leak and support the weaning of patients with severe acute respiratory syndrome coronavirus 2 pneumonia off ventilation.

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Infection with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) leads to a range of disease presentations, from fever and cough to life-threatening embolic events and acute respiratory distress syndrome.[1] Some authors have highlighted spontaneous pneumothoraxes and persistent air leaks (PAL) as a potential complication.[2-4] Despite conservative efforts some patients require thoracic surgical intervention[4] that must be balanced against their premorbid status and ability to tolerate surgery, especially in the setting of single-lung ventilation.[5] We herein report the use of endobronchial valves (EBVs) in the definitive management of persistent pneumothorax and PAL in the setting of SARS-CoV-2 infection, avoiding invasive thoracic surgical intervention.

A 49-year-old man was transferred to our center after a 2-month history of bilateral SARS-CoV-2 pneumonitis treated with dexamethasone and tocilizumab and a 3-week history of PAL causing significant respiratory failure. Past medical history included a recent diagnosis of sarcoidosis.

On arrival the patient received ventilation supported through a tracheostomy on a slow weaning regimen. However he was still on fraction of inspired oxygen of 70% with a positive end-expiratory pressure of 6 cm H_2O, achieving tidal volumes of 554 mL, oxygen saturations of 98%, and a $Paco_2$ of 8.9 kPa. Two right-sided chest drains were in situ with a large continuous air leak. Nasopharyngeal swabs were negative for SARS-CoV-2 on admission to our unit, although the diagnosis was confirmed earlier in the course of admission. Other relevant laboratory findings included a white blood cell count of 4.7×10^9/L, C-reactive protein 328 mg/L, hemoglobin 85 g/L, and the isolation of *Haemophilus influenza* from sputum, methicillin-sensitive *Staphylococcus aureus* from the tracheostomy site, and *Escherichia coli* from the pleural fluid. The patient was initially started on meropenem before deescalating to co-amoxiclav antibiotics. Composite chest radiographs are illustrated in Figure 1.

A chest computed tomography (Figure 1) confirmed a right pneumothorax, pneumomediastinum with a slight left shift, bilateral consolidation, bronchiectasis, pneumatoceles, septal thickening, and gross surgical emphysema. There was no clear site of bronchopleural fistulation.

Despite adequate drainage on suction the patient continued to suffer from recalcitrant pneumothorax with PAL. Given the high oxygen requirements and risks of single-lung ventilation, a decision was made to treat with endoscopic insertion of an EBV. A flexible bronchoscopy was performed under general anesthetic and a PulmonX Chartis catheter (Redwood City, CA) was inserted through the bronchoscope side channel into the right upper lobe with occlusion of the lobar bronchus resulting in no air leak. A similar occlusion of the right upper segmental bronchus did not reduce the air leak. We therefore proceeded with isolation of the entire right upper lobe. Three endobronchial Zephyr valves (PulmonX), 2 size 4 low profile and 1 size 4 standard, were positioned into the upper lobe segments, resulting in the immediate cessation of air leak. These steps are illustrated in Figure 2.

The procedure was completed without complication. A postintervention chest x-ray showed complete lung inflation with resolution of the pneumothorax (Figure 3). The chest drain was kept in situ for 24 hours on -3 kPa of suction and then removed. The patient was transferred back to the referring center and progressed to decannulation of the tracheostomy and discharged to ward-based physiotherapy and rehabilitation. The EBVs remain in situ and are not planned for removal.

COMMENT

Infection with SARS-CoV-2 can lead to substantial alveolar damage and parenchymal fibrosis that in conjunction with positive pressures from ventilation can lead to

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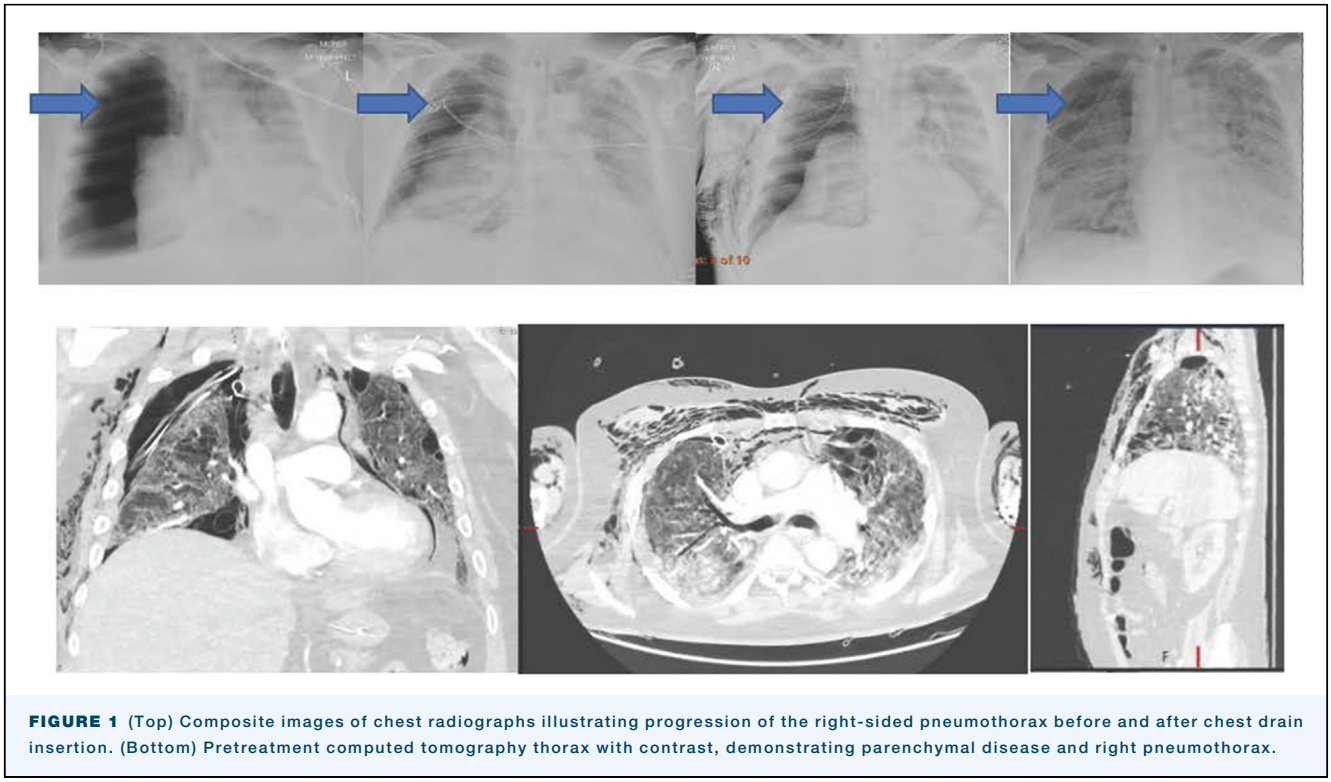

FIGURE 1 (Top) Composite images of chest radiographs illustrating progression of the right-sided pneumothorax before and after chest drain insertion. (Bottom) Pretreatment computed tomography thorax with contrast, demonstrating parenchymal disease and right pneumothorax.

the formation of bronchopleural fistulae and PAL. Traditional management of PAL includes video-assisted thoracoscopic surgery or thoracotomy for resection or repair of the air leak and/or pleurodesis.[6] In the setting of coronavirus disease 2019 (COVID-19) these invasive procedures are less desirable because patients typically suffer an already compromised physiologic reserve.[5] Furthermore talc pleurodesis is contraindicated in active infection, as in this case, and must be balanced against the potential for future lung transplantation, particularly in this age group.

EBVs are therefore an attractive and less invasive alternative in the treatment of PAL, with a 1-way valve collapsing the culprit site by allowing air to exit while preventing entry. The optimal timing of EBV insertion must be carefully considered and balanced against the risk of procedure failure. The thick, copious secretions in the COVID-19 lung pose a risk of EBV occlusion. Medical management of the infection and drainage of the air leak are therefore crucial first steps in managing these patients before EBVs can be considered.

In conclusion, EBVs may have a potential role in the treatment of PAL and can support the weaning of patients with COVID-19 off ventilation without the need for invasive intervention. Here we report a novel case

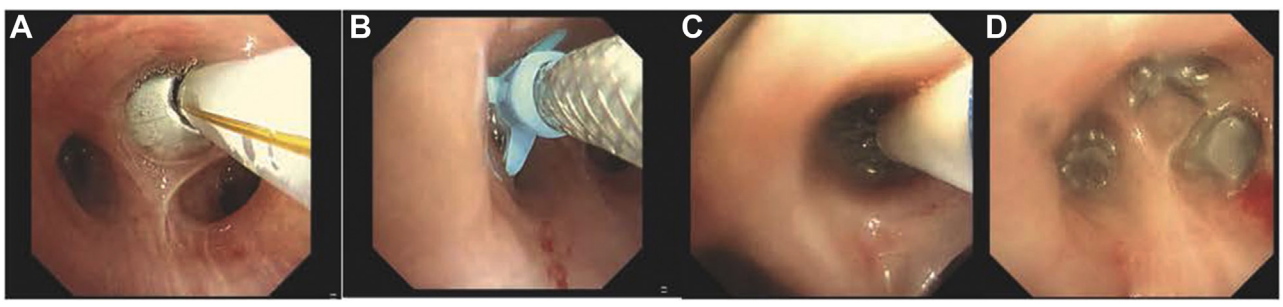

FIGURE 2 (A) Chartis catheter (PulmonX, Redwood City, CA) systematically isolating the segmental bronchi to find the source of the air leak. (B) Catheter sizing the bronchi. (C, D) Zephyr valves (PulmonX) being deployed and then in situ.

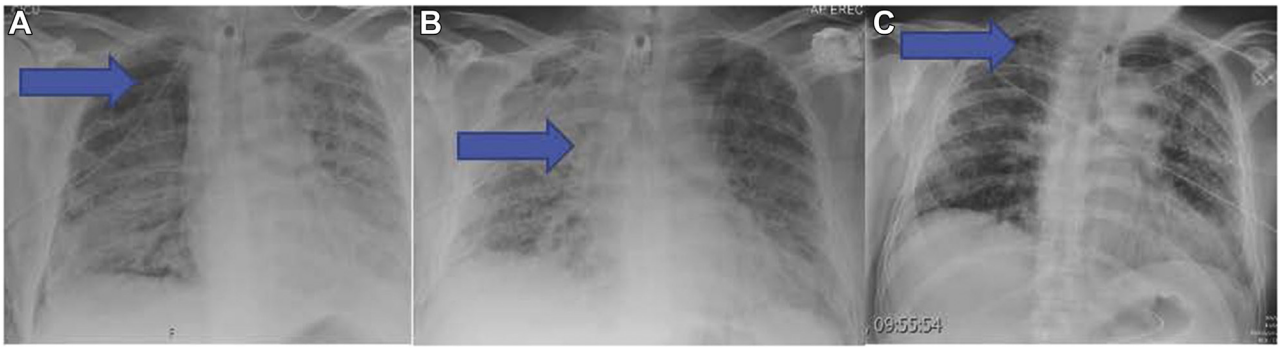

FIGURE 3 (A) A preprocedure chest radiograph showing right-sided pneumothorax. (B) A postprocedure chest radiographs demonstrating the endobronchial valve in situ followed by (C) a post–drain removal radiograph highlighting the edge of the right upper lobe.

demonstrating the use of a Chartis catheter and Zephyr valves in the definitive management of PAL and pneumothorax caused by a bronchopleural fistula in a patient with COVID-19. We hope this case report offers some insight into the alternative interventions available for this patient group, avoiding the need for surgery.

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