

Case Report

Basilar Predominant Emphysema: Thinking beyond Alpha-1-Antitrypsin Deficiency

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Basilar predominant emphysema, or disproportionate emphysematous involvement of the lung bases compared to the apices, is an uncommon radiographic pattern of emphysema traditionally associated with alpha-1-antitrypsin deficiency (AATD). We present a case of a 59-year-old female with 41 pack-year tobacco use, Stage IV COPD with supplemental oxygen, and bibasilar predominant emphysema who successfully underwent bronchoscopic lung volume reduction. She presented with recurrent hospitalizations for frequent exacerbations. After lung reduction, the patient displayed improvement in functional status without hospitalizations at the 15-month follow-up. Careful history taking is essential for any patients diagnosed with lower lobe emphysema to elucidate the underlying etiology. This case challenges the notion that basilar emphysema is sensitive or specific for AATD and emphasizes that this pattern of emphysema has a broad differential diagnosis and alternative etiologies should be considered. Our patient was ultimately diagnosed with smoking-related emphysema, with atypical bibasilar involvement. Furthermore, basilar predominant emphysema should be considered a separate entity from its apical predominant counterpart.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is a common and severe disease involving airflow obstruction, of which one manifestation is emphysema. Alpha-1-antitrypsin deficiency (AATD) is an underrecognized genetic disorder involving the SERPINA1 gene, which causes Z-type alpha-1 antitrypsin molecules to form polymers [1]. Polymerization prevents secretion of the alpha-1-antitrypsin (AAT) molecules into the bloodstream, leading to the destruction of the lung parenchyma [1, 2]. This destruction predominantly affects the lower lobes, causing a bibasilar pattern of emphysema [2]. However, not all lower lobe emphysematous disease is due to AATD, and it is important to recognize that this pattern of emphysema can be seen in other etiologies including Swyer-James-MacLeod syndrome, occupational exposures, intravenous injection of crushed methylphenidate tablets, and tobacco use.

2. Case Presentation

A 59-year-old female with a history of cigarette smoking, obstructive sleep apnea, and Stage IV COPD on supplemental oxygen presented for evaluation of surgical management of her lung disease. Within the past year, she had five hospitalizations or emergency room visits for COPD exacerbations. She experienced increasing difficulty with physical activities despite using portable oxygen. She endorsed compliance with her medications, which include an albuterol inhaler and nebulized solution, fluticasone-umeclidinium-vilanter, omeprazole, and roflumilast. She previously worked at a chocolate factory but denied known exposure to fumes or chemicals. She was born and raised in the United States and denied any recent travel. Additionally, she denied any history of childhood pneumonia or respiratory problems. Family history was unremarkable. She quit smoking 15 months prior to the presentation but had

a total 41 pack-year history. She denied using vaporized tobacco. She endorsed occasional drinking and denied any illicit drug use, including injection drug use. AAT level was 169 mg/dL and genotype PI * MM, which were inconsistent with a diagnosis of AATD. Pulmonary function testing (PFT) demonstrated an obstructive pattern with FEV1 0.71L (28%), FVC 1.36L (38%), FEV1/FVC ratio 0.56, TLC 7.9L (150% of predicted), and DLCO 26%. Right heart catheterization showed mean pulmonary arterial pressure of 25 mmHg and pulmonary vascular resistance 3.76 Woods units. Chest X-rays showed bilateral lung hyperinflation, diaphragm flattening, and hyperlucency (Figure 1), and CT chest showed panlobular emphysema with predominantly lower lobe involvement (Figure 2). A 3D reconstruction of the CT showed decreased lung fields on bilaterally lower lobes and the left upper lobe (Figure 3). Due to her progressive symptoms, she underwent bronchoscopic lung volume reduction of the lower lobes. The left lower lobe was intervened first, with the placement of 8 Zephyr valves, followed by her right lower lobe two months later with 6 Zephyr valves placed. She tolerated both procedures well, without complication, and was promptly discharged home. In the 15 months following her BLVR, she has not had any urgent care visits or hospitalizations, requires no supplemental oxygen, and reports increased exercise tolerance. Repeat PFT showed improvements including FEV1 1.07L (40%), FVC 1.77L (60%), FEV1/FVC ratio 0.56, TLC 6.1L (115% of predicted), and DLCO 30%.

3. Discussion

The distribution of emphysema in a patient can be helpful in determining the underlying cause of the emphysema and has their own distinct differential diagnoses. Lower lobe disease is distinct from its upper lobe counterpart in severity of impairment [3], physiology [4], and increased mortality with LVRS [5]. In this patient, the differential diagnosis for lower lobe emphysema is broad and can be distinguished by careful history-taking, including smoking/drug use, occupational exposure, family history, and childhood infections. Here, we discuss each diagnosis considered.

AATD is an underrecognized disease with pulmonary and hepatic manifestations. The proposed mechanism for emphysema is the imbalance between a serine protease and its inhibitor leading to parenchymal destruction. Cigarette smoking and recurrent infections often accelerate AATD progression [2]. AATD should be suspected in patients with emphysema diagnosed at a young age (<45 years old), nonsmokers, a family history of early lung disease, or basilar predominant distribution. Diagnosis is confirmed by low AATs followed by genotyping showing homozygous Z alleles [2]. One rare genotype of AATD is the FF genotype. The F allele produces a normal quantity yet dysfunctional AAT, and thus, the risk of pulmonary manifestation is similar to that of ZZ AATD. Simultaneous testing of both the AAT

level and genotype is preferred. The patient's AAT level and genotype were determined to be inconsistent with AATD.

Intravenous drug use of crushed talc- or magnesium silicate-containing tablets such as methylphenidate causes perivascular deposition leading to chronic inflammation [6]. It is linked to pulmonary hypertension and emphysema, particularly in the lower lobes [7]. However, our patient displayed no drug use behaviors.

Occupational exposure to fumes and chemicals is well known to cause a large spectrum of lung disease. Chronic exposure to diacetyl, a volatile organic compound that is used as flavoring chemical, causes airway epithelial injury which leads to bronchiolitis obliterans, called "popcorn lung" [8]. Bronchiolitis obliterans causes fibrosis due to excessive granulation tissue affecting the small conducting airways and can mimic COPD on imaging but often results in a restrictive or mixed restrictive/obstructive pattern on pulmonary function testing [9]. "Popcorn lung" was considered given her occupational history; however, her PFTs were not consistent with the restrictive disease.

Swyer-James-MacLeod syndrome is a rare entity associated with postinfectious bronchiolitis obliterans, typically during childhood [10]. The characteristic radiological pattern is hypoplasia/hypogenesis of the pulmonary arteries with hypoperfusion, giving a translucency to unilateral lung. It is associated with recurrent pulmonary infections during childhood [10]. The patient in our case underwent CTA of the chest which did not reveal any hypogenesis of the pulmonary arteries. Furthermore, she denied recurrent childhood respiratory infections.

Cigarette smoking remains the most important risk factor for developing emphysema [11]. Smoking-related emphysema is typically upper lobe predominant [12], although lower lobe predominant emphysema can be seen [13]. This patient's significant smoking history and negative workup for other causes made smoking-related emphysema most likely.

This patient had Stage IV COPD with frequent exacerbations despite maximum medical therapy. The bibasilar manifestation of emphysema is most likely smoking-related. Smoking-related emphysema is typically upper lobe predominant, and bibasilar manifestation is relatively uncommon. She was offered lung volume reduction at our lung center, with clinical improvement in her symptoms and functional status. Although LVRS is the current gold standard treatment of hyperinflation in COPD with mortality and symptomatic benefits, it also confers an increased risk of perioperative morbidity. These benefits are most obvious in patients with upper lobe predominant disease and poor functional status [14]. On the contrary, patients with nonupper lobe predominant emphysema are likely poor candidates for LVRS. BLVR is a minimally invasive technique for lung volume reduction using either endobronchial valves or coils. It has been shown to offer improvement in exercise tolerance and lung function for patients who do not



FIGURE 1: Chest X-rays of posteroanterior and lateral view showing bilateral lung hyperinflation, diaphragm flattening, and hyperlucency.

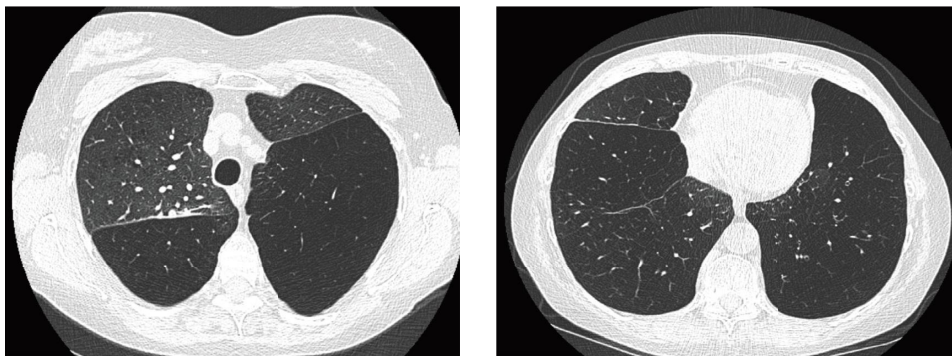


FIGURE 2: CT chest of upper and lower lobes showing panlobular emphysema with predominantly lower lobe involvement.

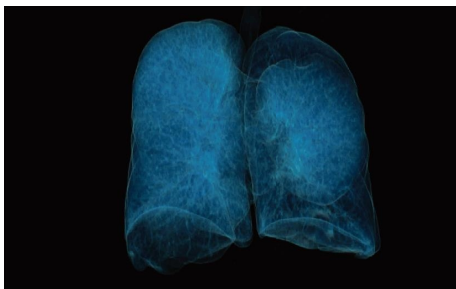


FIGURE 3: CT chest 3D reconstruction showing decreased lung field on bilaterally lower lobes and the left upper lobe.

qualify for LVRS or are poor surgical candidates. Similar to LVRS, greater benefits are seen in patients with upper lobe predominant emphysema. To date, no large studies have shown improved survival with BLVR, but it still remains an option for patients with severe COPD for symptomatic management [15].

4. Conclusion

While lower lobe emphysema is commonly attributed to AATD, the differential diagnosis is broad and often distinct from its upper lobe counterpart. Careful history taking is essential for any patients diagnosed with lower lobe emphysema to elucidate the underlying etiology.

Abbreviations

COPD: Chronic obstructive pulmonary disease
 AATD: Alpha-1-antitrypsin deficiency
 AAT: Alpha-1-antitrypsin
 OSA: Obstructive sleep apnea
 FEV1: Forced expiratory volume per 1 second
 FCV: Forced vital capacity
 TLC: Total lung capacity
 RV: Residual volume
 DLCO: Diffusing capacity for carbon monoxide
 LVRS: Lung volume reduction surgery
 BLVR: Bronchoscopic lung volume reduction.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

LG and HY drafted and edited the manuscript and approved the final submitted version. HY created the figures.

References

- [1] M. G. Foreman, C. Wilson, D. L. DeMeo et al., "Alpha-1 antitrypsin PiMZ genotype is associated with chronic

- obstructive pulmonary disease in two racial groups,” *Annals of the American Thoracic Society*, vol. 14, no. 8, pp. 1280–1287, 2017.
- [2] J. K. Stoller and L. S. Aboussouan, “A review of α 1-antitrypsin deficiency,” *American Journal of Respiratory and Critical Care Medicine*, vol. 185, no. 3, pp. 246–259, 2012.
 - [3] D. G. Parr, B. C. Stoel, J. Stolk, and R. A. Stockley, “Pattern of emphysema distribution in α 1-antitrypsin deficiency influences lung function impairment,” *American Journal of Respiratory and Critical Care Medicine*, vol. 170, no. 11, pp. 1172–1178, 2004.
 - [4] A. Boueiz, Y. Chang, M. H. Cho et al., “Lobar emphysema distribution is associated with 5-year radiological disease progression,” *Chest*, vol. 153, no. 1, pp. 65–76, 2018.
 - [5] A. Fishman, F. Martinez, K. Naunheim et al., “A randomized trial comparing lung-volume-reduction surgery with medical therapy for severe emphysema,” *New England Journal of Medicine*, vol. 348, no. 21, pp. 2059–2073, 2003.
 - [6] W. C. Roberts, “Pulmonary talc granulomas, pulmonary fibrosis, and pulmonary hypertension resulting from intravenous injection of talc-containing drugs intended for oral use,” *Baylor University Medical Center Proceedings*, vol. 15, no. 3, pp. 260–261, 2002.
 - [7] S. Ward, L. E. Heyneman, P. Reittner, E. A. Kazerooni, J. D. Godwin, and N. L. Müller, “Talcosis associated with IV abuse of oral medications: CT findings,” *American Journal of Roentgenology*, vol. 174, no. 3, pp. 789–793, 2000.
 - [8] G. Kullman, R. Boylstein, W. Jones, C. Piacitelli, S. Pendergrass, and K. Kreiss, “Characterization of respiratory exposures at a microwave popcorn plant with cases of bronchiolitis obliterans,” *Journal of Occupational and Environmental Hygiene*, vol. 2, no. 3, pp. 169–178, 2005.
 - [9] T. E. King, “Bronchiolitis obliterans,” *Lung*, vol. 167, no. 2, pp. 69–93, 1989.
 - [10] M. Tortajada, M. Gracia, E. García, and R. Hernández, “Consideraciones diagnósticas sobre el llamado síndrome del pulmón hiperclaro unilateral (síndrome de Swyer-James o de Mc-Leod)*,” *Allergologia et Immunopathologia*, vol. 32, no. 5, pp. 265–270, 2004.
 - [11] B. Lamprecht, M. A. McBurnie, W. M. Vollmer et al., “COPD in never smokers: results from the population-based burden of obstructive lung disease study,” *Chest*, vol. 139, no. 4, pp. 752–763, 2011.
 - [12] G. Mair, J. J. Miller, D. McAllister et al., “Computed tomographic emphysema distribution: relationship to clinical features in a cohort of smokers,” *European Respiratory Journal*, vol. 33, no. 3, pp. 536–542, 2009.
 - [13] T. Stavngaard, S. B. Shaker, and A. Dirksen, “Quantitative assessment of emphysema distribution in smokers and patients with α 1-antitrypsin deficiency,” *Respiratory Medicine*, vol. 100, no. 1, pp. 94–100, 2006.
 - [14] K. S. Naunheim, D. E. Wood, Z. Mohsenifar et al., “Long-term follow-up of patients receiving lung-volume-reduction surgery versus medical therapy for severe emphysema by the national emphysema treatment trial research group,” *The Annals of Thoracic Surgery*, vol. 82, no. 2, pp. 431–443.e19, 2006.
 - [15] M. Gordon, S. Duffy, and G. J. Criner, “Lung volume reduction surgery or bronchoscopic lung volume reduction: is there an algorithm for allocation?” *Journal of Thoracic Disease*, vol. 10, no. Suppl 23, pp. S2816–S2823, 2018.