Incidental Diagnosis of Swyer-James-MacLeod Syndrome in a Military Pilot

Michael F. Harrison; Clayton T. Cowl

BACKGROUND: Swyer-James-MacLeod syndrome (SJMS) is a specific form of bronchiolitis obliterans that occurs rarely, but represents recognized sequelae of common pediatric respiratory illness, and presents as unilateral hyperlucency on chest imaging. This case study describes such an incidental radiographic finding identified during the assessment of chest wall discomfort in a military pilot.

CASE REPORT: A 35-yr-old military pilot presented to his flight surgeon with vague intermittent chest discomfort. Initial evaluation revealed an abnormal chest radiograph with unilateral hyperlucency and mild expiratory airflow limitation on pulmonary function testing. The evaluation also included computed tomography imaging with contrast infusion and echocardiography, though the presenting complaint had resolved. The airman was referred to our clinic for further evaluation and aeromedical recommendations regarding returning to flight duties. He was diagnosed with SJMS and recommended to be returned to flight duties.

DISCUSSION: SJMS can be challenging to recognize to the untrained eye. An inflammatory response from viral or bacterial infection in childhood results in dysfunctional growth of the affected region of the lung, causing radiographic asymmetry. Although destruction of the alveoli and emphysema may occur, for most cases, there are minimal clinical sequelae. SJMS is not known to be progressive and is not associated with systemic conditions. The pilot likely had the abnormal chest radiograph at the time of commission and had not experienced any in-flight complications. His chest pain had resolved without intervention and SJMS was determined to be unlikely to impact his flight performance (such as response to supplemental oxygen) or life expectancy.

KEYWORDS: Swyer-James-MacLeod syndrome, brochiolitis obliterans, constrictive bronchiolitis, aeromedical assessment, unilateral hypolucent lung.

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Bronchiolitis obliterans, sometimes referred to as constrictive bronchiolitis[7,13] despite key histological differences between these two conditions,[15] describes small airway inflammation that presents with dyspnea associated with obstructive airflow on pulmonary function tests that is not reversible following bronchodilator inhalation. Histopathological diagnosis is confirmed with transthoracic lung biopsy demonstrating active proliferation of pale-staining immature collagen depositions that are isolated to the airspace lumen and hypoplasia of pulmonary vascular structures.[2,11,15,16] Bronchiolitis obliterans syndrome is the clinical term introduced in 1993 to describe this suspected diagnosis when the patient has not undergone confirmatory transthoracic lung biopsy.[3] This condition is the clinical manifestation of small airway injury that results from a wide range of inhalational agents (sulfur mustard gas[5,15]; ammonia[15]; phosgene[15]; chlorine[15]), occupational exposure (military deployment to the Middle East[7]; first responders at the World Trade Center after 9/11[10]), infections (adenovirus[13,15,16]; RSV[15,16]; mycoplasma[15]; *Bordetella* pertussis[1,12]; tuberculosis[1]; measles[16]), systemic inflammatory or autoimmune conditions (systemic lupus erythematosus[15]; rheumatoid arthritis[15]; ulcerative colitis[15]), specific insults

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(foreign body aspiration[2]; postradiation pneumonitis[2]; *Sauropus androgynus* ingestion[13,15]), and lymphocytic infiltration or chronic rejection after hematopoietic cell or lung transplantation.[3,13,15]

Swyer-James-MacLeod syndrome (SJMS) refers to an irreversible, specific form of bronchiolitis obliterans that presents with unilateral hyperlucency on chest imaging. Although its prevalence is rare, SJMS typically follows common viral or bacterial pediatric respiratory illnesses.[8,14] This case study describes a military aviator without toxic exposure or systemic disease who presented to our clinic for a second opinion evaluation of vague nonspecific chest heaviness. The airman had been evaluated at his local aviation medical examiner's office with a workup that included an abnormal chest radiograph. After evaluation, we diagnosed him with SJMS and recommended he be medically cleared for return to flight duties without restriction.

CASE REPORT

A 35-yr-old active-duty United States Air Force (USAF) pilot flying multiengine transport aircraft presented to our clinic approximately 4 mo after initial evaluation at his unit flight surgeon's office. The airman had initially presented with complaints of nonspecific chest heaviness for the preceding 3 wk. He noted that his father had experienced a neurological event just prior to this and consequently, he wanted to ensure his chest heaviness did not represent an ominous underlying condition. The airman rated his chest discomfort as minimal (0 to 1 on a 10-point scale) and the sensation was not exacerbated by exertion, posture, or any other identifiable factors or conditions. He described waxing and waning symptoms but had not required either over-the-counter or prescription medications for symptom relief. He denied any systemic symptoms including, specifically: fevers, chills, night sweats, weight loss, or gastrointestinal symptoms. The airman was a nonsmoker who engaged regularly in vigorous cardiovascular exercise (including at elevated terrestrial altitude) without symptoms or limitations. His past medical history was significant for pneumonitis as a child and perhaps a remote recurrence of a nonspecific pneumonitis later in life, but he had experienced no recent respiratory issues. His family history was not significant for any cardiovascular or pulmonary conditions.

The initial work up in the flight surgeon's office included a 12-lead electrocardiogram (ECG) and a chest X-ray (CXR). The ECG demonstrated a sinus bradycardia without evidence of ischemia. The CXR revealed hyperlucency in the right upper lobe without evidence of infiltrates, nodules, pleural effusion, pneumothoraces, or pulmonary edema (**Fig. 1**). Subsequently, the airman performed pulmonary function testing (PFT) that demonstrated mild expiratory airflow limitation (**Fig. 2**) with a baseline forced expiratory volume in the first second (FEV1) of 2.89 L (68% predicted), a forced vital capacity (FVC) of 4.80 L (91% predicted), FEV1/FVC of 74%. and no postbronchodilator response (Fig. 2). Additional testing at that time included

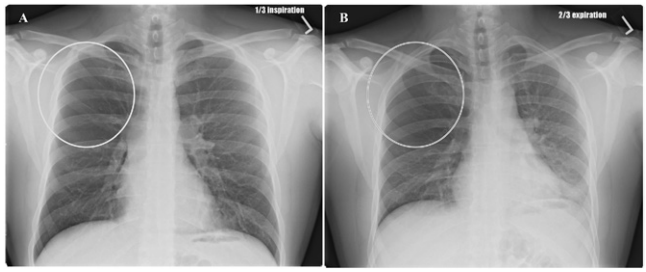


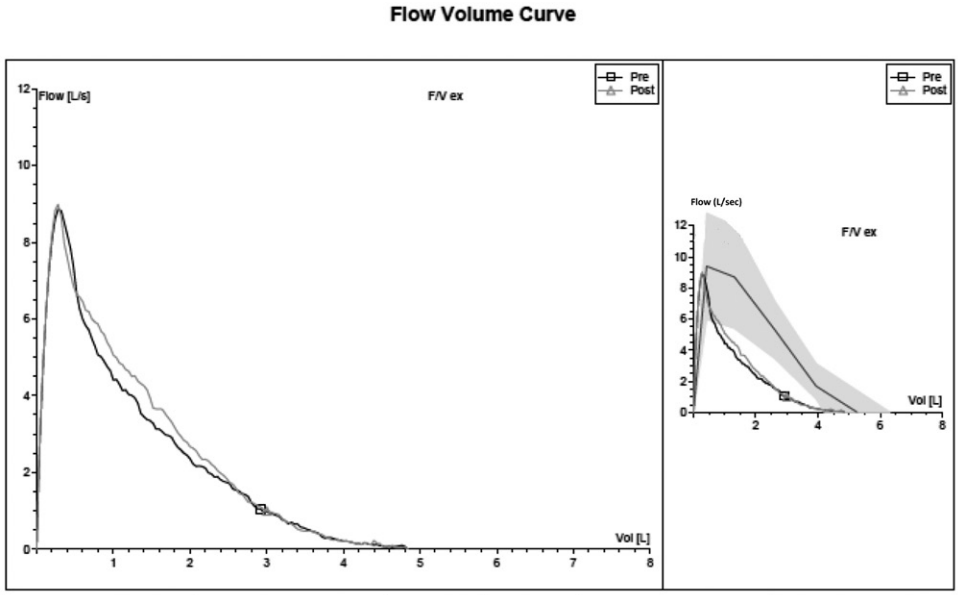
Fig. 1. Chest X-ray demonstrating hyperlucency (circle) in the right upper lung fields during A) 1/3 inspiration and B) 2/3 inspiration.

transthoracic echocardiography with normal myocardial and valvular function and no evidence of pericardial effusion.

The CXR and PFT results prompted the flight surgeon's office to request CT imaging of the thorax with contrast to evaluate for thromboembolic disease and to clarify the right-sided pulmonary abnormality. No evidence of pulmonary embolism was noted but, the imaging results did demonstrate a well-defined area of hyperlucency involving the right thorax. It was associated with localized decreased pulmonary vascularity and mild-to-moderate airway thickening involving the right middle and upper lobes (**Fig. 3**). In addition, there was no evidence for congenital abnormalities of vascular structures, and normal coronary arteries were present.

As a result of the imaging results and questions related to their significance both with respect to the airman's complaints as well as his fitness to perform duties as a military aviator, the patient was referred for additional evaluation and recommendations. The results of the imaging modalities described above were reviewed by a board-certified pulmonologist who was also a Senior Aviation Medical Examiner as appointed by the Federal Aviation Administration and by a board-certified thoracic radiologist. Repeat PFT assessment confirmed a mild obstructive pattern similar to his previous assessment, noting concavity of the expiratory limb of the flow-volume curve. Maximal voluntary ventilation was also mildly reduced. Total lung capacity as measured by body plethysmography as well as the diffusing capacity was within normal limits.

The airman was diagnosed with unilateral bronchiolitis obliterans most likely to have resulted from his pediatric history of pneumonitis. This postinfectious form of bronchiolitis obliterans is also known as Swyer-James-McLeod syndrome (SJMS). His vague, nonspecific, waxing-and-waning chest discomfort had not recurred and it was likely unrelated to the diagnosis of unilateral bronchiolitis obliterans. Based upon the extensive cardiac and pulmonary workup that only identified an incidental radiographic finding determined to be highly unlikely to impair his ability to perform his operational duties, the pilot's rigorous physical fitness regimen, and his risk factor profile, the pilot was deemed fit to fly. It was recommended that he be returned to flight duties at his unit. No specific follow up or treatment was prescribed. This recommendation was accepted by the USAF and he was issued a waiver that returned him to flight duty status without restriction. Currently, he has rejoined his unit and his waiver must be renewed every 3 yr.



	Patient Result	Normal	Lower Limit	% Predicted	% Change with Bronchodilator
Plethysmography					
TLC (L)	7.72	7.03	5.88	110%	-
VC (L)	4.72	5.25	4.21	90%	-
FRC (L)	4.63	3.36	2.37	138%	-
Spirometry					
FVC (L)	4.80	5.25	4.21	91%	1%
FEV_1 (L)	**2.89**	**4.28**	**3.40**	**68%**	3%
FEV1/FVC	**60.2**	**81.7**	**70.2**	**74%**	3%
PEF	8.9	9.4	6.0	95%	1%
Diffusion Capacity					
DLCO	30.9	34.0	26.0	91%	-

Fig. 2. Results from pulmonary function testing with bronchodilator challenge, demonstrating mild expiratory airflow limitation. TLC = total lung capacity; VC = vital capacity; FRC = functional residual capacity; FVC = forced vital capacity; FEV_1 = forced expiratory volume in 1 s; PEF = peak expiratory flow rate; DLCO = diffusing capacity of the lungs for carbon monoxide.

DISCUSSION

Bronchiolitis obliterans can result from a number of conditions including postlung transplant complications,[3,13,15] inflammatory systemic disease,[15] and toxic exposures such as those encountered in the military theater of operations in the Middle East.[7] However, these factors were not applicable to this airman. He was diagnosed with SJMS, a specific and rare form of bronchiolitis obliterans that was originally described nearly simultaneously in the 1950s by Swyer and James in Canada[14] and MacLeod in England.[8] The defining characteristics of SJMS as per the original and subsequent publications on the condition include unilateral radiographic translucency, small to normal size of the affected lung, pulmonary vascular hypoplasia, air trapping without evidence of obstruction, and often normal bronchoscopic examination.[1,2,8] Similar to the data in this case, this condition may not be diagnosed until adulthood with symptoms that can include recurrent pulmonary infections, exertional dyspnea, wheezing, coughing with and without sputum production, and hemoptysis.[1,11,12] In some cases, the patient presents with symptoms attributed to a presumed history of asthma that is not responsive to bronchodilator therapy.[12] Often the correct diagnosis is made as the result of additional testing that may include chest radiography,[1,12] high resolution CT imaging,[1,11,16] ventilation-perfusion scanning,[1] or histopathologic analysis of a transthoracic biopsy sample.[11] The characteristic findings on these evaluations is fibrosis of the interalveolar septae[1,11] and occasionally the imaging will uncover a mosaic pattern of bilateral lung involvement.[1] Case reports of SJMS indicate that complications of bronchiolitis obliterans such as recurrent infections become less frequent over time in pediatric patients[2] and, currently, the management of SJMS is often supportive due to its nonreversible and nonprogressive nature.[16] If structured management is required in specific patients who are experiencing complications such as recurrent infections, it often focuses upon a preventive approach to ensure the patient receives appropriate immunization, chest physiotherapy, and early infection control.[12,16] Antibiotic[10] and steroid[16] therapy have been demonstrated to be potentially but not conclusively beneficial in these more serious cases and are perhaps most beneficial for patients with other risk factors such as systemic inflammatory and autoimmune disease[11] or immunocompromised states such as postlung transplant. Intermittent use of bronchodilators is sometimes included in the treatment algorithm[16] but only to provide subjective symptom relief given the lack of objective response to bronchodilator challenge on spirometry.

Recent publications highlight the normal life expectancy and functional status of the vast majority of patients with SJMS,[12] particularly those with postinfectious or idiopathic bronchiolitis obliterans.[15,16] This is one of the most significant

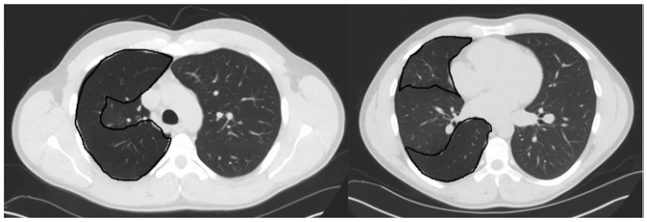


Fig. 3. Representative slices of CT of the airman's thorax with contrast; note paucity of vascular structures in highlighted lung fields.

differences between SJMS and other forms of bronchiolitis obliterans such as those that develop post-transplantation and post-toxic exposure. Often, as is the case in this report, the insult associated with SJMS occurs early in life as a result of viral pneumonia or pneumonitis[2] and is followed by a stable and benign course thereafter.

This case represents the typical natural history of SJMS. It is highly probable that his incidental radiographic finding is a result of a pediatric respiratory illness and it has not limited his ability to perform flight duties and strenuous physical exertion including during hypobaric hypoxic conditions at elevated terrestrial altitude. His chest pain was evaluated extensively and determined not to represent serious and undiagnosed cardiopulmonary disease; incidentally, it had occurred during a period of personal stress due to a serious illness in a close family member and had resolved without intervention or recurrence at the time of our evaluation. The natural history of SJMS is one that is not progressive and poses no risk to physical limitations or life expectancy. He was granted a waiver by the USAF and returned to flight duty without restriction on a medical waiver.

The diagnosis of SJMS and the lack of specific treatment or follow-up associated with it is an important diagnosis. Bronchiolitis obliterans is an overarching descriptor of distal airway disease but it is not to be confused with SJMS. Bronchiolitis obliterans has been documented in young military recruits in numerous recent publications[1] with an incidence rate of 3–4% of biopsy-proven constrictive bronchiolitis in symptomatic soldiers.[9] This is greater than the rates observed in the general population, despite some opinions that this condition is underdiagnosed following exposures associated with combat and terrorist events.[10] Among the most significant of these exposures, possibly associated with an incidence rate of up to 80% as was the case following a sulfur mine fire near Mosul, Iraq,[4,7] is operational deployment in the Middle East with exposure to either burnpits[6,7] or chemical weapons.[5] These risk factors were not present in our aviator and provide further support that SJMS is the correct diagnosis. The clinical course of these two conditions does vary based upon the exact diagnosis[11] and the specific etiology[15] with postinfectious bronchiolitis being associated with an excellent prognosis.[16] Bronchiolitis obliterans represents a major cause of morbidity and mortality status post lung transplant.[3] However, specific to our particular case secondary to a remote pediatric illness in an otherwise healthy military aviator, there is no evidence that his current disease burden will cause impaired performance of his flight duties and he can be expected to have prolonged survival without evidence of progressive disease.[13] Review of the available scientific literature suggests that it is rare for bronchiolitis obliterans to impair the diffusion capacity[11]; in the cases for which it does, spirometric results demonstrate significant deficits with FEV1 values $<$ 25% predicted requiring either lung transplantation or systemic immunomodulation therapy for autoimmune disease. One case series demonstrated normal results of arterial blood gas analyses in the majority of mild unilateral cases with appropriate increases in arterial oxygen partial pressure and saturation response to supplemental oxygen therapy[2] such as would be used in a military aviation setting. Given that it is rare for bronchiolitis obliterans to develop in an immunocompetent adult as a result of a respiratory infection[13] and the airman's lack of other exposures in this case, it is very reasonable to assume this was a pre-existing condition that predated his commission and previous completion of flight duties without restriction to date.

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REFERENCES

1. Arslan N, Ilgan S, Ozkan M, Yuksekol I, Bulakbasi N, et al. Utility of ventilation and perfusion scan in the diagnosis of young military recruits with an incidental finding of hyperlucent lung. Nucl Med Commun. 2001; 22(5):525–530.
2. Cumming G, Macpherson R, Chernick V. Unilateral hyperlucent lung syndrome in children. J Pediatr. 1971; 78(2):250–260.
3. Estenne M, Maurer JR, Boehler A, Egan JJ, Frost A, et al. Bronchiolitis obliterans syndrome 2001: an update of the diagnostic criteria. J Heart Lung Transplant. 2002; 21(3):297–310.
4. Ghanei M, Harandi AA, Tazelaar HD. Isolated bronchiolitis obliterans: high incidence and diagnosis following terrorist attacks. Inhal Toxicol. 2012; 24(5):340–341.
5. Ghanei M, Mokhtari M, Mohammad MM, Aslani J. Bronchiolitis obliterans following exposure to sulfur mustard: chest high resolution computed tomography. Eur J Radiol. 2004; 52(2):164–169.
6. Jani N, Falvo M, Sotolongo A, Osinubi O, Tseng C-L, et al. Self-reports of constrictive bronchiolitis among service members participating in the Veterans Administration and Department of Defense Airborne Hazards and Open Burn Pit Registry. Chest. 2017; 152(4):A822.
7. King MS, Eisenberg R, Newman JH, Tolle JJ, Harrell FE Jr., et al. Constrictive bronchiolitis in soldiers returning from Iraq and Afghanistan. N Engl J Med. 2011; 365(3):222–230.
8. MacLeod WM. Abnormal transradiancy of one lung. Thorax. 1954; 9(2):147–153.
9. Madar CS, Lewin-Smith MR, Franks TJ, Harley RA, Klaric JS, Morris MJ. Histological diagnoses of military personnel undergoing lung biopsy after deployment to Southwest Asia. Lung. 2017; 195(4):507–515.

10. Mann JM, Sha KK, Kline G, Breuer FU, Miller A. World Trade Center dyspnea: bronchiolitis obliterans with functional improvement: a case report. Am J Ind Med. 2005; 48(3):225–229.
11. Markopoulou K, Cool C, Elliot T, Lynch D, Newell J, et al. Obliterative bronchiolitis: varying presentations and clinicopathological correlation. Eur Respir J. 2002; 19(1):20–30.
12. Patel J, Chang C-F. New diagnosis of Swyer-James-Macleod syndrome in an adult: a case report. [Abstract.] B45 Obstructive Lung Disease: Interesting Cases. American Thoracic Society 2016 International Conference; May 13–18, 2016, San Francisco, CA. New York (NY): American Thoracic Society; 2016:A3607.
13. Schlesinger C, Meyer CA, Veeraraghavan S, Koss MN. Constrictive (obliterative) bronchiolitis: diagnosis, etiology, and a critical review of the literature. Ann Diagn Pathol. 1998; 2(5):321–334.
14. Swyer PR, James G. A case of unilateral pulmonary emphysema. Thorax. 1953; 8(2):133–136.
15. Visscher DW, Myers JL. Bronchiolitis: the pathologist's perspective. Proc Am Thorac Soc. 2006; 3(1):41–47.
16. Yalçın E, Doğru D, Haliloğlu M, Özçelik U, Kiper N, Göçmen A. Postinfectious bronchiolitis obliterans in children: clinical and radiological profile and prognostic factors. Respiration. 2003; 70(4):371–375.