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Case Report

Radiologically Guided Management of Secondary Spontaneous Pneumothorax ☆

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ABSTRACT

Secondary spontaneous pneumothorax is a serious medical condition that typically occurs in patients with an underlying lung pathology such as chronic obstructive pulmonary disease. Those patients are usually compromised and more amenable to higher morbidity and mortality rates. Moreover, they are poor candidates for general anesthesia and mechanical ventilation due to their poor health condition. We report a case of an 86-year-old male, who presented with a non-ST-elevation myocardial infarction and was incidentally found to have secondary spontaneous pneumothorax on a routine chest x-ray. The results of his blood work, international normalized ratio and liver function test were abnormal. Therefore, a novel intervention was introduced to control the air-leak by injecting a sealant material (Progel™, Warwick, Rhode Island, USA) through a thoracostomy tube guided by computed tomography fluoroscopy. The procedure was demonstrated to be a successful method of air-leak repair with minimal complications; as the patient was followed for two and a half years without any evidence of recurrence.

Introduction

Spontaneous pneumothorax occurs when air accumulates in the pleural space without a history of trauma or medical intervention [1]. It is further subdivided into two groups: primary, which occurs without underlying lung pathology, and secondary, where there is an existing lung pathology such as chronic obstructive pulmonary disease (COPD) [2]. The British Thoracic Society recommends observation or aspiration as the initial management of uncomplicated, asymptomatic secondary spontaneous pneumothorax (SSP), and thoracostomy tube drainage (TTD) as the initial treatment for significant pneumothorax [3]. The definitive management of SSP requires a surgical intervention. However, some patients are unfit and require specialized techniques such as chemical pleurodesis or Heimlich valve placement to drain their pneumothorax and prevent recurrence [3]. This case report presents a challenging yet novel approach for the management of SSP.

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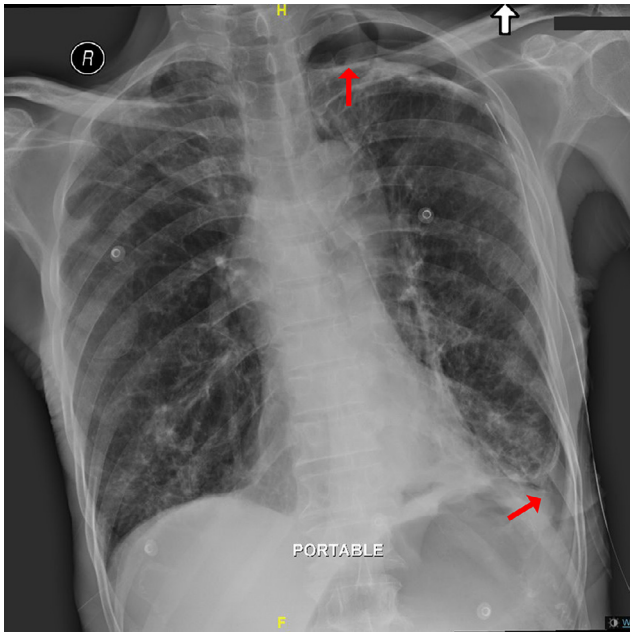

Fig. 1 – A routine chest x-ray shows an incidental left-sided apical and basal pneumothorax (Red arrows). Emphysematos-like changes are observed on both sides of the lung.

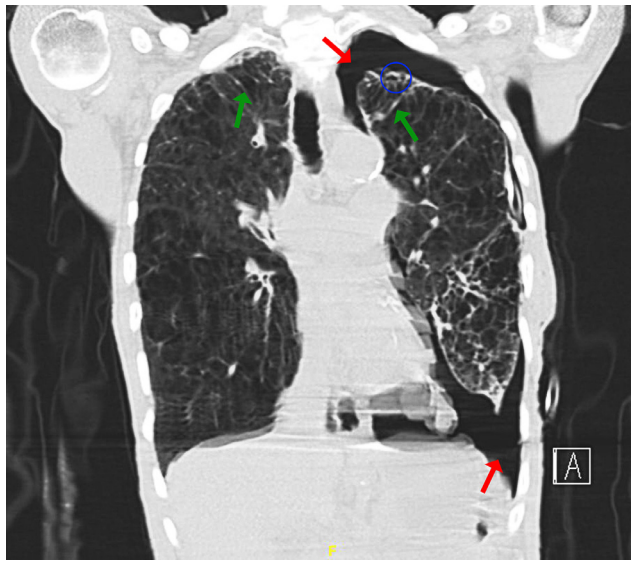

Fig. 2 – Computed tomography (CT) scan shows a moderate pneumothorax noticed at the apical and basal area of the left lung (Red arrows). Diffuse emphysematous changes bilaterally can be seen (Green arrows). Small subpleural blebs are noted at the anterior aspect of the left apex (Blue circle).

Case History

An 86-year-old male, known case of COPD, benign prostatic hyperplasia and a history of smoking index of 30 pack-year. He presented to the emergency department with a complaint of exertional dyspnea associated with sweating for a one-day duration. The physical examination was unremarkable, and upon further investigations, the patient subsequently was diagnosed with a non-ST-elevation myocardial infarction (NSTEMI). He was admitted to the coronary care unit and managed according to NSTEMI protocol. A same-day chest x-ray revealed a left-sided pneumothorax (Fig. 1), and an additional computed tomography (CT) scan was requested and confirmed a moderate-size pneumothorax (Fig. 2). Consequently, the decision to insert a thoracostomy tube (TT) was made. Within 24 hours, the patient became dyspneic with an additional radiograph revealing a moderate-size pneumothorax (Fig. 3) with a persistent air-leak.

The patient was transferred to our center to receive a higher level of care. Although he was vitally stable, his lab work-up showed a hemoglobin level of 8.3 (g/Ll), total and indirect bilirubin levels were 1.6 (mg/dL) and 0.9 (mg/dL), respectively. Moreover, the alkaline phosphatase (ALP) level was 139 (U/L), the aspartate transaminase (AST) level was 54 (U/L), the gamma-glutamyl transferase (GGT) level was 99 (U/L), with a normal kidney function test.

Due to the patient's recent NSTEMI, COPD and the elevated INR of 3.9, he was a poor candidate for sedation or surgical intervention, which remained a concern. Therefore, it was decided to control the air-leak 10 days post-admission by applying Progel™, an FDA-approved air-leak

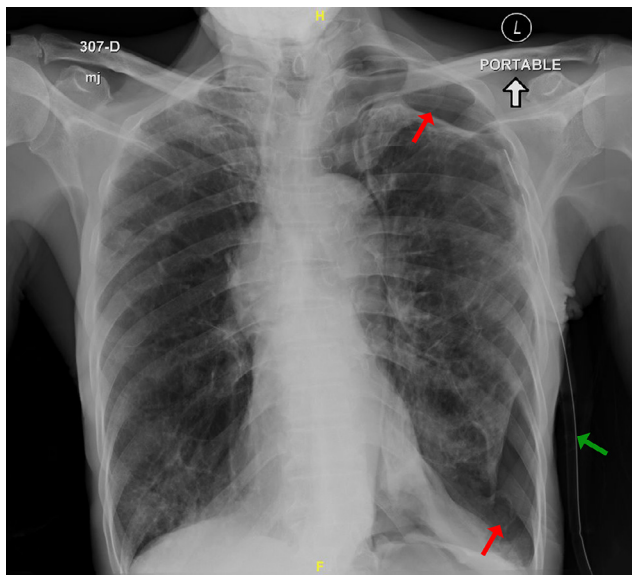

Fig. 3 – A follow-up chest x-ray following insertion of the thoracotomy tube (Green arrow), showing left-sided apical and basal pneumothorax (Red arrows).

sealant for use in open and minimally invasive thoracic surgical procedures. The patient was positioned in a semi-lateral position with his left side being slightly elevated. The TT site was at the 5th intercostal space, mid-axillary line. With the patient being under moderate sedation; local anesthesia with Lidocaine 5% in 5cc was injected subcutaneously and intercostally with a partial pleural infiltration. A4-sized French catheter was then introduced through a 28-sized

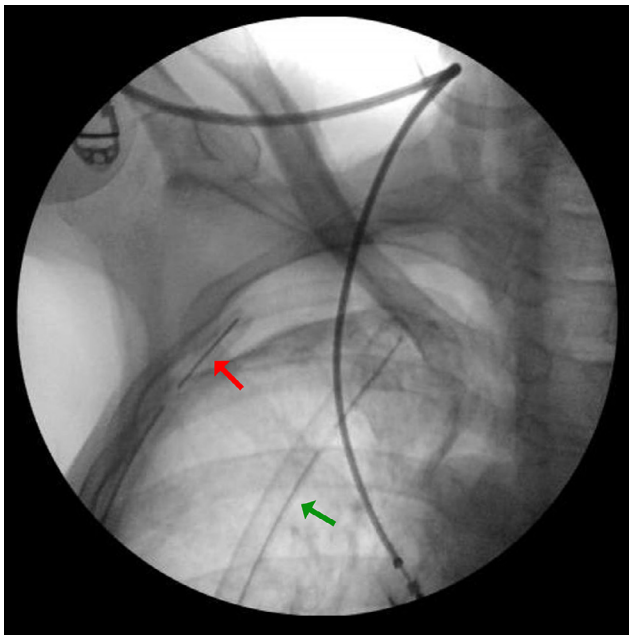

Fig. 4 – Fluoroscopy-guided thoracostomy shows the placement of a 28-sized French catheter thoracotomy tube during the intervention (Red arrow) and the old thoracostomy tube (Green arrow).

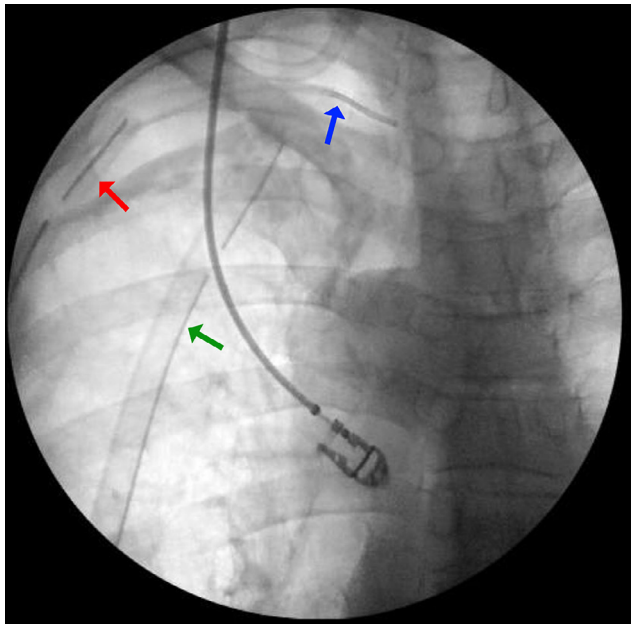

Fig. 5 – Fluoroscopy-guided thoracostomy shows a 4-sized French catheter (Blue arrow) introduced through a 28-sized French catheter (Green arrow) during the intervention, and the old thoracostomy tube (Green arrow).

French TT guided by c-arm computed tomography fluoroscopy (CTF) intra-operatively (Fig. 4). The sealant Progel™ was injected through the catheter over the apical bullae located in the apicoposterior segment of the left upper lobe (Fig. 5). The application of the sealant was based on the CT-scan finding, as the apex was the most likely source of the air-leak. The technique was successful as the air-leaking ceased immediately. Further, to ensure a full lung expansion with a resolution of the air-leak, the patient was kept on the TT for two days (Fig. 6), and subsequently the TT was removed. The patient was followed-up by a serial of chest x-ray for two and a half years without any evidence of recurrence (Fig. 7).

Discussion

SSP is most likely to develop in patients with COPD, malignancy, pulmonary fibrosis, bronchial asthma or tuberculosis [2]. With an already diminished pulmonary function, the development of SSP places these patients at an even greater risk, resulting in decreased forced expiratory volume in 1 second (FEV1) along with a decreased ratio of FEV1 and forced vital capacity (FVC) [4,5]. Clearly, the higher recurrence rate of SSP in these patients [1], confirms the need for an innovative intervention.

The patients with SSP usually present with severe dyspnea and chest pain requiring an urgent hospitalization, supplemental oxygen, aspiration and TTD according to the severity of the pneumothorax [2,4,6]. A protocol to operate on a patient experiencing 7 to 10 days of an air-leak is agreed upon by the majority of physicians, and video-assisted thoraco-

Fig. 6 – One-day post-operative chest x-ray showing improvement in lung expansion and a thoracostomy tube.

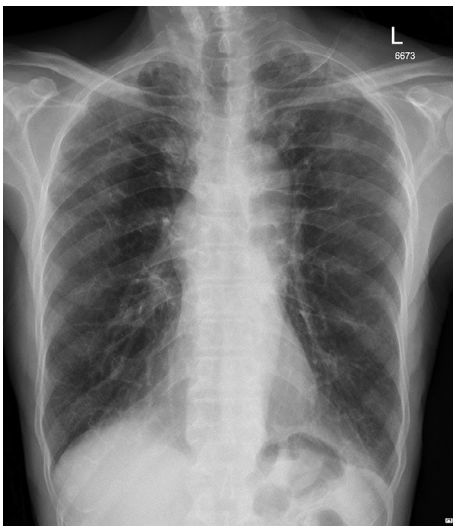

Fig. 7 – Chest x-ray was taken two and a half years following the procedure showing complete lung expansion with no evidence of pneumothorax.

scopic surgery bullectomy is one of the preferred methods in the treatment of SSP due to a prolonged air-leak [1,4]. While the benefits of surgical intervention are widely accepted, patients with SSP are often poor candidates due to their underlying lung disease and the potential for complications resulting from general anesthesia (GA) and mechanical ventilation (MV) [1,4]. Post-operatively, these patients usually require a prolonged period of TTD and a lengthier hospitalization [7]. Moreover, further complications may arise in the form of impaired cardiac function, hemodynamic instability, empyema, lung infections, or deep vein thrombosis [5,7].

In contrast to GA, locoregional anesthesia has been shown to improve the outcomes of these patients [5]. This is due to the diaphragm being kept in motion and avoiding muscle relaxation, which in turn preserves the compliance of the non-operative lung and minimizes the risk of hypoxia [5]. Furthermore, avoiding both the orotracheal tube and MV reduces the risk of lung infections and mucosal damage to the trachea or bronchus [5].

Progel™ consists of human serum albumin and polyethylene glycol, which reacts spontaneously on the tissues, causing them to adhere and coagulate without known toxicity [7]. Progel™ is characterized as being easy to apply, fast to act, highly adherent, resistant to tear, flexible, biodegradable, safe and an effective surgical sealant [8]. In a multi-center, randomized controlled trial to assess the safety and efficacy of Progel™ sealant for containing air leaks caused by pulmonary operations, it was found that 77% of the sealant group experienced a decrease in air-leaks intra-operatively compared to the control group ($P < 0.001$) [9]. Sixty-five percent of the sealant group experienced post-operative air-leaks in comparison with the control group 86% ($P < 0.005$) [9]. The hospitalization stay was also decreased in the sealant group by one day compared to the control group ($P < 0.028$) [9]. There was no difference between the two groups in mortality, morbidity, duration of the TTD, or immune responses [9]. With our patient, the use of a drainage catheter in conjunction with the Progel™ material revealed no post-interventional air-leak.

Patients with SSP are a heterogenous group based on their underlying lung pathology and overall health status; therefore, with its superior delineation of control, surgery is generally recommended to address the source of an air leak. However, as our patient had experienced a recent NSTEMI, we performed the procedure using locoregional anesthesia and moderate sedation, which exposed him to a lesser risk than an open surgery or thoracoscopic intervention under GA. Nonetheless, as our approach is based on a CT-scan prediction of the air-leak source and thus, semi-blind; we cannot consider it as a total replacement to surgery.

Conclusion

Patients with SSP who are poor candidates for GA and surgical intervention, they can be managed with aid of moderate sedation and locoregional anesthesia. We have introduced a novel approach in the management of SSP using the Progel™ sealant material which was used to seal the lung bullae. The sealant was injected through the TT under the guidance of CTF. The technique has demonstrated a successful approach to seal the lung bullae and resolution of the air-leaks in a critically ill patient.

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