“Ex Vacuo” Pneumothorax

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Ex vacuo pneumothorax is a form of pneumothorax that occurs after pleural intervention, such as thoracentesis when the lung is unable to expand to fully fill the pleural space. Unlike other iatrogenic pneumothoraces, it may not respond to pleural drainage and is not caused by puncture of the visceral pleura and underlying lung.

CASE REPORT

A 74-year-old woman with a refractory right pleural effusion was referred for chronic indwelling pleural catheter (Fig. 1). Using ultrasound guidance, the effusion was punctured and a Pleurx catheter (Denver Biomedical, Golden, CO) was inserted into the pleural space using a modified Seldinger technique (Fig. 2). The procedure was uneventful and 1 L of straw-colored fluid was withdrawn. A postprocedural chest radiograph showed a small pneumothorax, which was asymptomatic. The patient was discharged but several days after placement, the patient returned to clinic when the tube began drawing air from the pleural space.

An upright chest radiograph was obtained showing a hydropneumothorax (Fig. 3). The thoracentesis catheter was noted to be within the pleural space, cephalad to the level of the fluid. Similar findings were apparent on computed tomography (Fig. 4). The catheter was managed for several days to water suction without improvement. The catheter was therefore removed and the effusion slowly reaccumulated.

DISCUSSION

Pneumothorax ex vacuo was first used to describe a condition usually occurring in children in which bronchial obstruction from mucous plugs, aspirated foreign bodies, or malpositioned endotracheal tubes caused lobar collapse with gas accumulation into the pleural space

originating from the pulmonary venules or from the pleural vesicles or subpleural bullae.¹ This type of pneumothorax resolves with treatment of the obstruction. More recently, the term has been used to describe a complication following thoracentesis, when a marked increase in negative intrapleural pressure around the collapsed lobe results in pneumothorax due to the inability of the lung to completely reexpand after fluid removal.

Two hypotheses have been postulated as the basis for the lung's inability to reexpand. The first is that underlying pleural disease restricts the lung, trapping it and thus preventing reexpansion. The second is that there is insufficient pulmonary surfactant, which exhausts the lung's ability to maintain the stability of the pulmonary tissue after aeration. “Trapped lung” may occur when a malignant effusion causes a fibrous peel to develop on the visceral pleura. When the effusion is drained, the lung's inability to reexpand leaves a space that may appear initially as an ex vacuo pneumothorax and then, as fluid reaccumulates, a hydropneumothorax.²

Figure 1 Chest radiograph showing large right pleural effusion.

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Figure 2 Small-bore thoracostomy tube insertion. (A) Ultrasound image obtained during pleural puncture shows right pleural effusion. (B) Chest radiograph after tube insertion shows reduction in pleural effusion with small anterior pneumothorax.

In Boland et al's study² of 17 patients treated with catheter drainage for ex vacuo pneumothorax, no lungs reexpanded and patients eventually reaccumulated effusions and remained asymptomatic. The conclusion of this study was that treatment by drainage of the pleural space is ineffective because of the stiff lung.

Without any intervention, typically after various amounts of time, the observed pleural effusion will recur, initially leading to hydropneumothorax and finally to a complete replacement of the residual pleural space by pleural fluid. An additional report by Ponrartana et al³ noted no difference in outcome

Figure 3 Hydropneumothorax. Upright (A) and lateral (B) chest radiographs show hydropneumothorax. The drainage catheter is noted to be entering the pleural space above the air-fluid level. Axial images from computed tomography (C, soft tissue window; D, lung window) show hydropneumothorax despite indwelling drainage catheter.

Figure 4 A 59-year-old woman with metastatic breast cancer and malignant pleural effusion was treated with chronic pleural catheter. (A) Chest radiograph shows large right pleural effusion. (B) Postprocedural fluoroscopic image showing Pleurx catheter positioned at the right lung base and resolution of pleural effusion. (C) Chest radiograph obtained 24 hours later shows ex vacuo pneumothorax. (D) Chest radiograph obtained after several days of continued drainage shows resolution of pneumothorax.

of 10 patients with ex vacuo pneumothorax who were treated by either observation or catheter drainage. All patients eventually reaccumulated effusions. In contrast, Pien and associates⁴ studied 11 patients with trapped lung syndrome treated with Pleurx catheters and found

that these catheters provided good symptomatic relief with few complications. Indeed, in our experience, unlike the patient presented in this case report, we have treated other patients whose pneumothoraces resolved without developing overt bronchopleural fistulae; the patients

obtained good symptomatic relief from these catheters after development of ex vacuo pneumothorax (Fig. 4).

Despite the failure of lung reexpansion after tube drainage, surprisingly, it is common for patients to describe partial or complete improvement of their condition immediately following thoracentesis, despite the development of large pneumothorax. This explanation potentially lies in the effect of intercostal musculature. The performance of the musculature and the cortical response to dyspnea are related. If a patient is unable to stretch the chest wall musculature, the feeling of dyspnea may ensue despite normal oxygenation. After thoracentesis, patients may feel relieved of their symptoms due to the fact that the intercostal muscles can stretch again. When fluid reaccumulates, this benefit is lost and patients usually develop dyspnea again.⁵

In our anecdotal experience, ex vacuo pneumothorax is more common when vacuum bottles are used to facilitate fluid evacuation. Currently, after evacuating one bottle of pleural fluid, we open the drainage catheter to room air to determine whether there is continued fluid egress or alternatively, if air is drawn into the pleural space. If the latter occurs, we discontinue fluid removal. If pneumothorax ex vacuo does occur, it is important to

recognize that it does not typically respond to chest tube drainage, enlarge, or develop into a tension pneumothorax. Most commonly, this condition will resolve spontaneously or will be replaced by reaccumulating pleural effusions.

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