New perspectives for a huge traumatic pneumatocele treatment in a young adult

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Keywords
Chest computed tomography, conservative treatment, traumatic pneumatocele.

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Received: 15 October 2019; Revised: 21 January 2020; Accepted: 23 January 2020; Associate Editor: Daniel Ng.

Respirology Case Reports, 8 (3), 2020, e00537
doi: 10.1002/rcr2.537

Abstract
Traumatic pneumatocele (TP) is a very rare condition that occurs mostly in children and young adults. Conservative treatment is full-fledged for uncomplicated cases. We presented here an 18-year-old young adult with chest trauma caused by a fall. Chest computed tomography disclosed a cavity lesion \(10.5 \times 8.5 \times 6.4 \text{ cm}^3\) over right upper lobe (RUL) with bilateral lower lung contusion and a mild haemopneumothorax but without rib fractures. Under conservative treatment, the condition lasted for ~8 months before complete resolution. Detailed temporal changes in chest X-ray were recorded for the analysis of natural healing processes.

Introduction
TP is a rare condition in children and young adults, which occurs within a few days after chest trauma, mostly due to vehicle collisions and falls. The theory of a two-stage injury is widely accepted to account for the underlying pathophysiological processes [1]: (1) an explosive compression force tearing the lung parenchyma; (2) followed by a decompression force on the pliable chest wall generating a negative pressure that lacerates the lung, and after trapping air and/or blood, the lungs retract. Clinical manifestations are subtle or non-specific. These include chest pain, cough, haemoptysis and dyspnoea, and in rare cases irritability and mental changes [2]. Conservative treatment is typically suggested for TP with self-limited processes. Initial surgical management is also suggested for large TP and complicated TP to improve post-injury recovery and to minimize complications [3,4]. To the best of our knowledge, we unveiled here a case of the largest TP without rib fractures and presented a treatment experience.

Case Report
An 18-year-old young man, unremarkable in the past, suffered in a fork-lift lateral-toppling accident when his chest wall collided with the ground. He was immediately sent to our emergency department due to dyspnoea and severe chest pain. Chest X-ray (CXR) disclosed large ground glass opacity \((13.1 \times 8.9 \text{ cm}^2)\) located over the right upper and middle lung field. Chest computed tomography (CT) showed a cavitary lesion \((10.5 \times 8.5 \times 6.4 \text{ cm}^3)\) over RUL of lung, with a bilateral lower lung contusion and a mild haemopneumothorax but without rib fractures (Fig. 1). Two days later, CXR showed a blunting of right side C-P angle and the haemoglobin level dropped from 14.4 to 11.9 mg/dL. Chest tube insertion was therefore performed for blood drainage. The patient recovered smoothly and his agony of chest pain readily ameliorated due to no rib fractures and the cyst shrank a week later. To determine serial changes of the diminishing cyst, we measured the circumference, lengths of longitudinal and transverse axes as indicators using image software (Smartiris, TEDPC UltraQueryEx 0.0.56.66 Build22) to estimate dimensions of the cyst to gain insights of the healing process (Fig. 2). The computed data showed that cyst sizes markedly diminished during the first week, and the transverse dimension reduced to half of the original. Air-fluid level emerged in the cavity starting on day 8. In which, air level rose initially for three days prior to a steady drop to vanishing during the next three weeks. The patient was discharged in a stable condition for 18 days in the hospital, and...
was closely followed up in the outpatient department (OPD). The patient’s CXR showed recovery to normality with complete resolution of cyst in about 249 days (Fig. 2).

**Discussion**

The presence of a traumatic pneumatocele (TP) indicates that extensive tissue damages with injury more severe than simple contusions. In 2018, Lindsey [5] found 13% of children patients (25/204) presented with both pulmonary contusion and pneumatoceles. In these patients, the largest pneumatocele is 3.7 cm in diameter. In 2006, a larger series of TPs in adults was reported by Chon et al. [2]. In their patients, 8.3% (81/918) of them showed blunt chest trauma on CT. Computed tomography scan verified at an accuracy of 96%, higher than 20% in CXR (size <2 cm, or masked by lung contusions). Management of TPs is traditionally focused on supportive measures and treating the associated injuries and to detect delayed complications.

Pneumatocele is mostly found in children with bacterial pneumonia due to their more vulnerable lungs, but it can also develop after blunt thoracic trauma, positive-pressure ventilation, or caustic aspiration [4]. This kind of lesion is often classified as “complicated TP” and “uncomplicated TP” depending on to the presence or absence of blood inside the cavity [2]. We postulated the healing processes of the large TP based on this case. Chon et al., described for uncomplicated TP an average resolution time of 25.3 days, and for blood filled complicated pneumatoceles of 145.8 days [2]. Plain CXR does not allow 3D volume estimation. Therefore we took the alternative of estimating the cyst at volume based on its lengths on the longitudinal and transverse axes plus its circumference. Our numerical data showed a reduction of the cyst size by half within the first week. If the retracting cyst continues to change in size, one can rule out the possibility of a predated lesion (i.e. a congenital cyst with coincident haemorrhage after chest trauma). If the cyst size decreases rapidly, the implication is that there is a re-expansion of the lung due to effective drainage of the haemothorax, along with a reabsorption of blood inside and/or outside the cyst with rebound pliancy of the lung parenchyma. Air-fluid levels when emerge in cyst reflect blood reabsorption and it may stretch to ~2/3 of the cyst size ahead of air-level drops. The recovery plateau lingering in later phase implies the regeneration of lung tissue filling the retracted space. During the absorption of TP, the rate of change in the length of the circumference was 0.15 cm/day, the longitudinal axis 0.03 cm/
Figure 2. Evolution of chest X-ray film in chronological order and trend curve showing shrinkage of cyst size. (A) Day 3. Hemothorax and blunting C-P angle. (B) Day 5. S/P chest tube for 2 days. (C) Day 8. Cyst emerging the air-fluid level. (D) Day 11. Air level ascended with mild cyst changes. (E) Day 29. Air-fluid level vanished. (F) Day 71. Steady drop in cyst size. (G) Day 156. A tiny cyst remained. (H) Day 249. Completed resolution.
day, and the transverse axis 0.03 cm/day. The marked dwindling of the above three measurements was respectively 1.28 cm/day, 0.0095 cm/day, and 0.59 cm/day in the first week. Our patient denied experiencing any haemoptysis episode, so we therefore presumed that the ruptured lung did not involve notable vessels. In the absence (or mild case) of haemoptysis with intact ribs, the patient recovered uneventfully even in the presence of a huge TP. Concerning the seemingly formidable manifestations in huge TP, all emergency physicians and chest experts should be familiar with the diagnosis and management of this condition.

Disclosure statement
Appropriate written informed consent was obtained for publication of this case report and accompanying images.

Acknowledgments
Special thanks to Professor Paul W. F. for his help with the English language.

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