



Original Contribution

Presenting hydrothorax predicts failure of needle aspiration in primary spontaneous pneumothorax^{☆,☆☆}

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ABSTRACT

Objective: The objective was to evaluate if existence of hydrothorax in initial chest radiograph predicts treatment outcome in patients with primary spontaneous pneumothorax who received needle thoracostomy.

Methods: This is a retrospective cohort study carried out from January 2011 to August 2014 in 1 public hospital in Hong Kong. All consecutive adult patients aged 18 years or above who attended the emergency department with the diagnosis of primary spontaneous pneumothorax with needle aspiration performed as primary treatment were included. Age, smoking status, size of pneumothorax, previous history of pneumothorax, aspirated gas volume and presence of hydropneumothorax in initial radiograph were included in the analysis. The outcome was success or failure of the needle aspiration. Logistic regression was used to identify the predicting factors of failure of needle aspiration.

Result: There were a total of 127 patients included. Seventy-three patients (57.5%) were successfully treated with no recurrence upon discharge. Among 54 failure cases, 13 patients (10.2%) failed immediately after procedure as evident by chest radiograph and required second treatment. Forty-one patients (32.3%) failed upon subsequent chest radiographs. Multivariate logistic regression showed factors independently associated with the failure of needle aspiration, which included hydropneumothorax in the initial radiograph (odds ratio [OR] = 4.47 [1.56–12.83], $P = .005$), previous history of pneumothorax (OR = 3.92 [1.57–9.79], $P = .003$), and large size of pneumothorax defined as apex-to-cupola distance ≥ 5 cm (OR = 2.75 [1.21–6.26], $P = .016$).

Conclusions: Hydropneumothorax, previous history of pneumothorax, and large size were independent predictors of failure of needle aspiration in treatment of primary spontaneous pneumothorax.

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1. Introduction

Primary spontaneous pneumothorax (PSP) is a common medical condition encountered in emergency departments (EDs). It occurs in patients with no evidence of other underlying pulmonary disease [1]. It is believed to result from blebs or from other abnormalities of the pleural surface [2,3]. A study suggested that change in atmospheric

pressure is associated with the occurrence in PSP [4]. The exact mechanism of the spontaneous pneumothorax remains unknown [5].

Needle aspiration was advocated by international guidelines as the initial intervention for PSP [6,7]. It is considered as a less painful and less invasive procedure as compared with conventional chest drain insertion. It showed similar successful rate ranging from 30% to 80% [7]. Needle aspiration was increasingly adopted as the initial treatment for selected group of patients with pneumothorax in Hong Kong. Needle aspiration was considered a failure when there are persistent air leak and failure of pulmonary reexpansion. Various factors had been proposed to predict persistent air leak for patients with PSP. Small amount of hydrothorax in the presenting chest radiograph, presented with blunted costophrenic angle, was not uncommonly seen in patients with PSP (Fig. 1). In those patients, no significant pleural effusion was observed after pulmonary reexpansion without drainage of pleural fluid. We observed that presence of hydropneumothorax in the presenting chest radiograph (CXR) is associated with higher failure rate of needle aspiration. In our study, we try to assess this association in a retrospective cohort.

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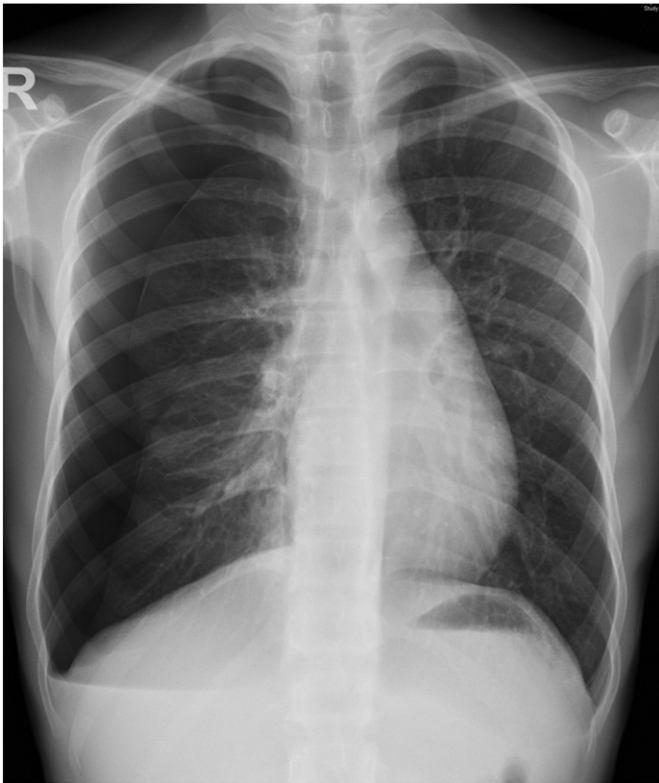


Fig. 1. Patient presented with hydropneumothorax.

2. Method

A retrospective cohort study was performed in the ED of one of the regional hospitals in Hong Kong. All patients aged 18 or more who attended the ED from 1 January 2011 to 30 August 2014 and who were diagnosed with primary pneumothorax were included. Needle aspiration was performed in all the included cases. All cases were retrieved by the electronic clinical data analysis and retrieval system with *International Classification of Diseases, Ninth Revision*, codes 512.0 (spontaneous pneumothorax) and 512.8 (spontaneous tension pneumothorax). Traumatic pneumothorax, secondary pneumothorax with preexisting respiratory disease, and wrong diagnosis were excluded. Patients with hydropneumothorax with significant residual pleural effusion after drainage or other findings of underlying lung pathologies were excluded. Patients with lung pathologies identified after 1 year of follow-up that may account for the pleural effusion in the initial CXR were also excluded. Written and electronic patient record, medical history, and the CXR were retrieved and analyzed.

Primary spontaneous pneumothorax is defined as spontaneous pneumothorax in a person without underlying lung disease [1]. Patient characteristic including age, sex, smoking status, previous history of pneumothorax, symptom onset to time of aspiration, size of the pneumothorax, aspirated gas volume, presence of hydropneumothorax, and the side of pneumothorax were investigated.

The size of pneumothorax was measured through digital radiography. The apex-to-cupola distance and the interpleural distance at mid hilum level were measured. *Signs of mediastinal compression* were defined as near-complete pulmonary collapse in CXR with heart rate drop of 20 beats per minute after decompression was recorded. *Symptom onset to aspiration time* was defined as the onset of symptoms of pleuritic chest pain or dyspnea to the time of needle aspiration.

Needle aspiration was performed at the second intercostal or third intercostal space at mid clavicular line in the affected side. Primary outcome was *successful needle aspiration*. It is defined as no further procedures required, which include repeated needle aspiration, chest drain

insertion, or pleurodesis. Patients who had failed pulmonary reexpansion after needle aspiration was defined as *immediate failure*. Pneumothorax that developed again within 4 weeks of index admission was defined as *recurrence and delayed failure*. The medical records were traced for at least 1 year for patients with hydrothorax in presentation to detect any lung pathologies noticed in the subsequent period.

Baseline characteristics were described using descriptive statistics. Categorical variables were shown as frequencies and percentages. They were compared with χ^2 test or Fisher exact test when appropriate. Continuous variables with standard distribution were shown as mean and standard deviation. For continuous variables with skewed distribution, median and interquartile range were shown, respectively. They were compared with independent-sample *t* test or median test depending on the distribution. Relevant predictors of successful needle aspiration were sorted out. They were entered into a binomial logistic regression for confounding control if $P < .1$ in univariate analysis. Adjusted odd ratios and confidence intervals were reported. Hosmer-Lemeshow test was used in assessing model calibration and goodness of fit. Data analysis was performed by using SPSS version 22.0 for Windows (IBM Corp, Armonk, NY). Statistical significance was accepted as a $P < .05$. Ethics approval was obtained from the local institutional review board (no. NTWC/CREC/15,120).

3. Result

A total of 373 cases of pneumothorax were retrieved from the database. Two hundred forty-one cases were primary pneumothorax. One hundred twenty-seven (52.7%) of the PSP cases underwent needle aspiration as primary treatment. Eighty-four (34.9%) had been conservatively managed with oxygen alone. Thirty (12.4%) had chest drain insertion. For those who received needle aspiration as primary treatment, the outcomes were shown in Fig. 2. Around one-fifth of the cases had initial small amount of hydrothorax in the presenting radiographs. None of them had identified significant lung pathologies after 1 year of follow-up.

Univariate analysis of treatment outcome was listed in Table 1. Different variables were comparable between successful and failed group, including age, sex, smoking status, presenting vitals, and symptom onset to aspiration time. There were significant differences between the 2 groups in size of pneumothorax, hydropneumothorax in initial radiograph, sign of mediastinal compression, and previous history of pneumothorax.

Table 2 lists relevant variables which were entered into binomial logistic regression for confounding control. There were 3 significant independent predictors of failure of needle aspiration which included the presence of hydropneumothorax in initial CXR (odds ratio [OR] = 4.47 [1.56–12.83], $P = .005$), previous history of pneumothorax (OR = 3.92 [1.57–9.79], $P = .003$), and large pneumothorax with apex-to-cupola distance ≥ 5 cm (OR = 2.75 [1.21–6.26], $P = .016$). Hosmer-Lemeshow test showed that the model demonstrated satisfactory goodness of fit.

4. Discussion

Primary spontaneous pneumothorax is a common clinical condition encountered in EDs. Incidence was reported to be 18–28/100,000 per annum for men and 1.2–6/100,000 for woman [7]. Different approaches in treating this condition were postulated including active surgical management or conservative management [8,9]. Guidelines by the British Thoracic Society (BTS) in 2010 suggested needle aspiration as the initial intervention for PSP [7]. It had benefit on reducing hospitalization and length of hospital stay.

In our study, hydropneumothorax on presentation was demonstrated to be an independent predictor of failure of needle aspiration with strong association (OR = 4.47). This study is the first to report this association with hydropneumothorax. There were case reports showing that

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