



Radiographic evaluation of the pleural fluid accumulation rate after pneumonectomy



Reginald F. Munden^{a,*}, Paul J. O'Sullivan^b, Ping Liu^c, Ara A. Vaporciyan^d

^a Department of Radiology, Houston Methodist Hospital, Houston, Texas

^b Radiology Department, Univeristy College Cork Bon Secours Hospital, Cork, Ireland

^c Department of Biostatistics, University of Texas, MD Anderson Cancer Center, Houston, Texas

^d Department of Thoracic Surgery, University of Texas, MD Anderson Cancer Center, Houston, Texas

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ABSTRACT

Purpose: Understanding the radiographic appearance and normal rate of fluid accumulation after pneumonectomy is important in order to detect postoperative complications.

Methods: Upright posterior–anterior chest radiographs of 94 postpneumonectomy patients were assessed for the rate of pleural fluid accumulation as a percentage of hemithorax volume.

Results: Overall median time to 70% hemithoracic opacification was 3 days and mean time was 27 days. The median time to 100% opacification was 66 days and mean time was 96 days.

Conclusion: The median time to 70% hemithoracic opacification postpneumonectomy is 3 days, while median time to 100% opacification was 66 days.

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1. Introduction

Pneumonectomy is most commonly performed for the management of malignancies, primarily bronchogenic carcinoma, and less commonly for trauma, transplant, and chronic disease from tuberculosis or bronchiectasis. The postoperative assessment of the patient after pneumonectomy is routinely performed with conventional radiography. The radiographs are used to evaluate the expected progression of postoperative changes of pneumonectomy side as well as for complications, some of which are life threatening. Understanding the normal and expected rate of fluid filling the operative pleural space is important for the radiologist, but this timing of the fluid opacification has not been well studied.

As serosanguineous pleural fluid fills the evacuated hemithorax, there is a shift of the mediastinum towards the pneumonectomy side along with hyperexpansion of the remaining lung [1]. Traditional teaching has suggested that the rate of fluid accumulation should be at a rate of one to two ribs per day with complete opacification of the hemithorax in 3–4 weeks, although it may take 7 months [2,3]. However, these teachings were not referenced and presumed to be based on the author's experience; a statistical analysis of the actual rate of opacification could

not be found in our literature search. In addition, current surgical advances and postoperative care may have altered the traditional estimates of time to opacification. We undertook a study of pneumonectomy patients to better document the rate of fluid opacification because understanding the rate of fluid opacification is important in order to differentiate complications from the usual expected rates.

2. Materials and methods

A retrospective search of a thoracic surgery database was performed for patients who underwent pneumonectomy during a 3-year period at the University of Texas MD Anderson Cancer Center. Institutional review board approval was obtained, and the study was compliant with the Health Insurance Portability and Accountability Act.

There were 144 oncology patients in the database, of which 41 were excluded based on criteria described below, resulting in 94 patients. All available surgical and clinical notes were reviewed on the electronic medical record for clinical information. All images were reviewed on the institutional patient archive communication system by two experienced, fellowship-trained thoracic radiologists.

All chest radiographs after surgery were reviewed. Thoracic surgical patients at our institution undergo upright posterior–anterior (PA) chest and lateral radiographs prior to chest tube removal. In order to standardize calculations, the first upright PA chest radiograph without a chest tube was used as the baseline, and only subsequent upright PA chest radiographs were used to determine fluid accumulation rates. If follow-up radiographs or medical history indicated that the patients underwent interval procedures that could result in changes in fluid

* Corresponding author. Department of Radiology, Houston Methodist Hospital and Research Institute, 6565 Fannin Street, Houston, Texas 77030. Tel.: +1 713 441 4863; fax: +1 713 793 7110.

E-mail addresses: rfmunden@houstonmethodist.org (R.F. Munden), sullypos@yahoo.com (P.J. O'Sullivan), pliu9297@yahoo.com (P. Liu), avaporci@mdanderson.org (A.A. Vaporciyan).

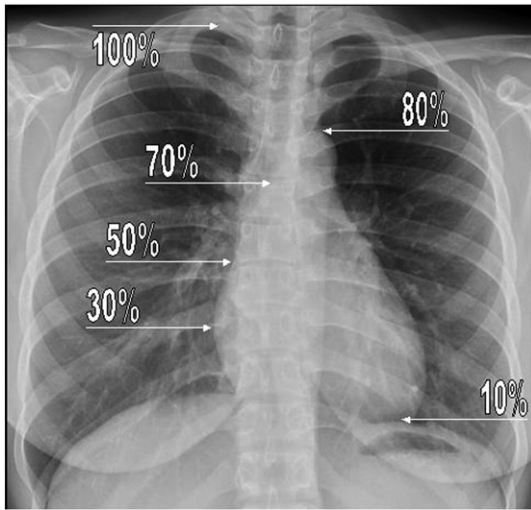


Fig. 1. PA radiograph demonstrates the landmarks used in calculating percentage of hemithorax opacification.

accumulation rates, then the patients were excluded. The initial portable radiographs were not used for assessment because patient positioning was variable and air–fluid level estimation is problematic on semierect portable radiographs. PA chest radiographs with a chest tube present were not included because of the confounding factor of determining the role of the chest tube in fluid accumulation. The percentage of hemithorax opacification and the number of days after chest tube removal for each subsequent radiograph were recorded.

The amount of pleural fluid accumulation was estimated as a percentage of hemithorax volume using predetermined anatomical landmarks on the erect PA chest radiograph (Figs. 1, 2). Landmarks for estimation of opacification consisted of 100% by complete opacification, 90% by a midpoint between top of aortic arch and lung apex, 80% by the top of aortic arch, 70% by a point just above the carina, 60% by the carina, 50% by the inferior end plate of T6, 30% by a midpoint between the inferior end plate T6 and the diaphragm, and 10% by a blunting of costophrenic sulcus.

The mean time and median time (in days and months) to 70% and 100% hemithorax opacification were calculated. Seventy percent was used because this usually is the point whereby the surgical stump is covered by fluid, an important event for surgical evaluation, and 100% is indicative of complete opacification. Variables tracked for consideration of differences in accumulation rates included intrapleural (IPP) versus

extrapleural pneumonectomy (EPP), chest tube usage, side of pneumonectomy, tumor histology, and lymph node dissection.

2.1. Exclusion criteria

The patients in whom a major complication occurred (myocardial infarction, unstable arrhythmia, major cerebrovascular accident, pleural space infection, empyema, bronchopleural fistula, severe pneumonia, adult respiratory distress syndrome, respiratory failure, hemothorax, chylothorax, gortex graft failure/organ herniation, pulmonary hemorrhage) or resulted in a prolonged intensive care unit stay were not included. Accurate assessment of progressive pleural fluid accumulation was not thought possible in these patients. For example, the presence of an empyema or major cardiac event could potentially affect the rate of pleural fluid accumulation. Furthermore, most radiographs attained in these patients were portable anterior–posterior studies, on which the gradual assessment of pleural fluid accumulation is difficult. Patients in whom a chest tube was reintroduced were excluded.

Patients with minor complications (focal pneumonia, wound sepsis, fluid overload, limited transient ischemic attack, minor arrhythmias, ileus, anemia, limited urinary infections) were included in the calculation of time to hemithorax opacification. All patients that did not achieve 100% opacification were excluded from calculation of complete opacification but used for 70% calculations.

3. Results

Of the 94 patients, there were 63 men and 31 women with an average age of 60 years (range, 21–83 years). There were 50 patients that underwent extrapleural pneumonectomy and 44 patients that underwent intrapleural pneumonectomy. Postoperative chest tube placement was present in 75 patients and not in 19 patients. Left-side pneumonectomy was performed in 43 and right side in 51. Lymph node dissection was performed in 46 and not in 48. The most frequent tumor types were mesothelioma ($n=44$) and non-small-cell lung cancer (NSCLC) ($n=32$). Tumor histology of the remaining patients was as follows: metastases ($n=7$), sarcomatoid carcinoma ($n=3$), carcinoid tumors ($n=3$), small cell carcinoma ($n=2$), primary sarcoma ($n=1$), malignant fibrous tumor ($n=1$), and pleomorphic carcinoma ($n=1$).

3.1. Time to opacification

3.1.1. All patients

For all patients ($n=94$), the median time to 70% hemithorax opacification by pleural fluid accumulation was 3.0 days (range,

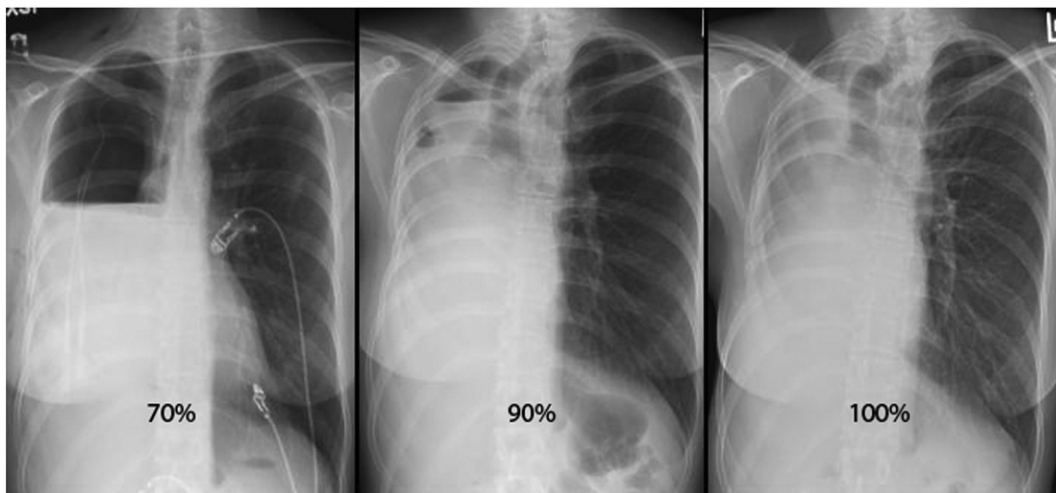


Fig. 2. Three sequential PA radiographs showing the normal pattern of filling the postpneumonectomy hemithorax.

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