Spontaneous Pneumothorax Following Partial Resolution of Total Bronchial Obstruction*

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Spontaneous pneumothorax following chest irradiation is thought to occur in patients with radiation fibrosis several months or more after the completion of therapy. In the four patients presented herein, spontaneous pneumothorax was seen during or immediately after therapeutic radiation of lung cancer. All patients had bronchoscopic findings of bronchial obstruction by the tumor before treatment and radiographic improvement of atelectasis was observed during therapy. The interval between the improvement of atelectasis and the development of pneumothorax varied by less than three weeks. These common findings suggest that rupture of alveoli or emphysematous bullae and subsequent pneumothorax might be due to overinflation of the affected lung caused by partial bronchial obstruction. We should be aware of the occurrence of spontaneous pneumothorax following partial resolution of total bronchial obstruction. (Chest 1993; 104:60-63)

Radiotherapy plays an important role in the treatment of lung cancer.1-3 Many patients have been treated by chest irradiation alone or combined with other therapeutic modalities.4-6

Numerous complications may result from radiotherapy.5 Radiation pneumonitis is one of the most common complications and it may result in acute respiratory failure.6,7 Spontaneous pneumothorax following radiotherapy is a rare complication and usually occurs in patients with radiation fibrosis.5,8-10

We have seen spontaneous pneumothorax recently in four patients with lung cancer without radiographic evidence of radiation fibrosis during or immediately after radiation therapy. We herein present the cases and discuss the possible mechanism of pneumothorax during or immediately after radiation treatment.

METHODS AND MATERIALS

All patients were men between 59 and 70 years. Three patients had histologic confirmation of squamous cell carcinoma and one had small-cell carcinoma. One patient had received chemotherapy in another hospital.

The patients received radiation therapy by a 10-MV linear accelerator. Anteroposterior-posteroanterior opposing fields were used to treat the primary tumor and the ipsilateral hilar and bilateral mediastinal lymph nodes. The initial treatment was followed by boost irradiation to the primary tumor bed.

Radiation was given five days a week. Three patients were treated with once-a-day fractionation of a dose of 2 Gy per fraction and another patient received hyperfractionated therapy using a twice-a-day fractionation of a dose of 1.5 Gy per fraction. Three patients received simultaneous chemotherapy that started the day before the beginning of radiation therapy.

Pneumothorax was evaluated using standard chest radiographs in all patients and computed tomographic (CT) scans to demonstrate the extent of intrapleural air in three patients.

CASE REPORTS

CASE 1

A 59-year-old man with squamous cell carcinoma was referred to our hospital for radiotherapy. Bronchoscopy showed narrowing of the right middle lobe bronchus and obstruction of the right lower lobe bronchus.

The patient received radiation therapy by conventional fractionation. The chest radiograph taken on the 14th day after the beginning of the treatment demonstrated atelectasis of the right middle and lower lobes (Fig 1A, left). The chest radiograph on day 28 showed the improvement of atelectasis in the middle lobe. The patient developed right-sided chest pain on day 42 after completion of a total of 60 Gy. The pain continued for several days. A chest radiograph on day 49 revealed pneumothorax of the right lung (Fig 1B, right).

After pneumothorax persisted for two weeks, reexpansion occurred spontaneously. Follow-up for two months revealed no recurrence of pneumothorax.

CASE 2

A 68-year-old man with a history of cough and fever presented to our hospital. A chest radiograph showed right upper lobe atelectasis (Fig 2A, left). Bronchoscopy revealed a submucosal tumor obstructing the right upper lobe bronchus and a biopsy specimen was diagnostic of small-cell carcinoma.

The patient received hyperfractionated radiotherapy combined with chemotherapy. Chest pain developed on day 8, followed by back pain and cough. At that time, a total dose of 21 Gy had been delivered to the patient. Because the chest radiograph revealed a large pneumothorax (Fig 2B, right), drainage of intrapleural air was performed. On the next day, a chest radiograph demonstrated a decrease of intrapleural air. Reexpansion of the right lung was evident and emphysematous bullae in the bilateral upper fields were observed.

Although chest radiotherapy was reinitiated on day 22, pneumothorax did not recur.

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Spontaneous Pneumothorax after Bronchial Obstruction (Nishioka et al)
FIGURE 1A (left). Chest radiograph on day 14 of the treatment protocol for case 1 demonstrates right middle lobe and right lower lobe atelectasis. 1B (right). Chest radiograph on day 49 shows a pneumothorax in the right lung. Intrapleural air is seen in the apical and the inferior pleural spaces.

CASE 3

The patient was treated with split-course radiotherapy combined with chemotherapy. On day 38, after having received a total dose of

FIGURE 2A (left). Chest radiograph before treatment in case 2 demonstrates right upper lobe atelectasis. 2B (right). Chest radiograph on day 8 reveals a large pneumothorax in the right lung.
32 Gy, pain in the left axilla was noted. Chest radiography performed on the next day revealed a pneumothorax as well as improvement in atelectasis. The pneumothorax disappeared radiographically on day 60 without specific intervention. There were no episodes of recurrent pneumothorax despite the continuation of therapy.

CASE 4

A 70-year-old man was referred to our hospital for the evaluation of abnormal findings on a chest radiograph. A repeated radiograph taken in our hospital showed right upper lobe atelectasis. Bronchoscopic examination revealed a nodular tumor obstructing the upper lobe bronchus. It was proven histologically to be squamous cell carcinoma.

The patient was treated with split-course chest radiotherapy combined with concomitant chemotherapy. A chest radiograph taken on day 27 demonstrated pneumothorax. Several days later, cough symptoms worsened and right shoulder pain developed. A follow-up radiograph showed not only improvement in the atelectasis of the right upper lobe, but also increased intrapleural air. However, a radiograph taken on day 48 showed spontaneous disappearance of the pneumothorax. Subsequently, there was no recurrence of the pneumothorax, but right upper lobe atelectasis worsened due to tumor recurrence four months later.

DISCUSSION

Although primary spontaneous pneumothorax is generally attributed to the rupture of subpleural blebs or emphysematous bullae,\textsuperscript{11,12} it can complicate primary or secondary lung tumors.\textsuperscript{13-15} Sarcomas are the most common malignant neoplasms that cause pneumothorax.\textsuperscript{13} Spontaneous pneumothorax is rarely related to primary lung cancers.\textsuperscript{15-18} Proposed mechanisms of pneumothorax complicating primary lung cancer include direct rupture of necrotic neoplasm into the pleural space or rupture of alveoli or emphysematous bullae due to overinflation of the affected lung caused by the tumor acting as a check-valve.\textsuperscript{13}

Treatment-related pneumothorax has been reported in combination chemotherapy and radiotherapy for primary malignancy.\textsuperscript{6,10,14,26} When the pneumothorax occurred with apparent tumor regression, it was thought to be related to rapid tumor lysis and rupture into the pleural space.\textsuperscript{19,20} The development of this mechanism can occur only in cases with tumor located in the peripheral lung parenchyma. On the other hand, pneumothorax following radiotherapy was reported to occur several months or more after mantle irradiation for Hodgkin's disease.\textsuperscript{6-10} Because many reported cases had radiographic evidence of radiation fibrosis at the time of the pneumothorax, it was suggested that fibrosis was responsible for the complication.

The four patients presented herein had pneumothorax without radiographic evidence of fibrosis. Insufficient time had elapsed from the administration of therapy for fibrosis to occur, as the radiographic changes proceed gradually from pneumonitis to fibrosis over a period of several months.\textsuperscript{6} Especially interesting is the improvement of atelectasis seen less than three weeks before or after the occurrence of pneumothorax. Two mechanisms are likely related to pneumothorax in our patients: (1) tumor necrosis produced by the treatment may have caused a bronchopleural fistula; (2) overinflated alveoli or bullae caused by the check-valve mechanism of the partial bronchial obstruction may have ruptured. Though histologic or physiologic proof was not available, the central location of the tumors and the short intervals between the improvement of atelectasis and the appearance of pneumothorax suggests that the check-valve mechanism is more likely. In case 1, an emphysematous bullae was found in the reexpanded lobe, supporting this proposed mechanism.

Radiotherapy has been used to improve atelectasis in patients with bronchial obstruction caused by lung cancer, with variable degrees of success being reported.\textsuperscript{19} Perhaps pneumothorax during or immediately after treatment, such as presented herein, may be seen more frequently with more aggressive protocols. Moreover, the mechanism described herein could be caused by chemotherapy alone. Oncologists should consider the appearance of spontaneous pneumothorax following partial resolution of total bronchial obstruction.

REFERENCES

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