Can Peripheral Bronchopleural Fistula Demonstrated on Computed Tomography be Treated Conservatively? A Retrospective Analysis

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**Purpose:** Peripheral bronchopleural fistulas (BPF) are communications between a peripheral bronchus or the lung parenchyma and the pleural space. Although reported cases with peripheral BPF might have typical symptoms, we postulate that there may be BPF patients without typical symptoms who are diagnosed on computed tomography (CT) for the first time.

**Materials and Methods:** We searched retrospectively for how frequently BPF is found on CT in cases with known or suspected empyema or hydropneumothorax. Also, we examined the clinical charts to ascertain if a diagnosis of BPF was suspected in the CT reports or clinically, and to determine the outcome of each case.

**Results:** Thirty thoracic cavities of 12 patients were included in this study. Of these, BPF was suspected clinically in only 1. Mention in the CT report about the presence of BPF was found in 2 cases. An apparent finding of BPF on CT was found in 7 of 13 (53%) thoracic cavities of 6 cases. The outcomes were that 1 patient died 1 month later due to multiple organ failure, and 1 patient was discharged subsequently after CT. In the other 10 cases, there was no exacerbation of the symptom regardless of definite evidence of BPF on CT.

**Conclusions:** In conclusion, when there is hydropneumothorax on CT, it is important for radiologists to diligently search for findings of peripheral BPF and to document it. However, a reference about the need for a surgical approach for BPF may not be required.

**Key Words:** bronchopleural fistula, peripheral bronchopleural fistula, CT, empyema, hydropneumothorax

**SUBJECTS AND METHODS**

This study was approved by the institutional review boards of the 3 participating institutions. Informed consent was waived because this was a retrospective review of patient records and images.

First, we extracted the cases with a mention in the CT interpretation reports of empyema, its suspicion, or hydropneumothorax among the cases undergoing chest CT from January 2005 to December 2010. Cases were selected and tentatively diagnosed as having BPF if gas was present in a pleural effusion on the CT and if it was unlikely that air had entered the thoracic cavity from the outside, for example, by the insertion of a drainage tube.

One of the authors (S.M.) examined clinical records in these cases to determine if BPF was suspected clinically or radiographically. Also, the clinical record of the patient's course and follow-up CT images after the CT were investigated. If an empyema was confirmed to be caused by gas-producing bacteria, the case was not classified as a BPF case.

Also, we examined CT images in detail to determine the frequency of an apparent BPF, that is, continuation of a bronchus or the lung parenchyma to the pleural space in these cases. The CT...
scanning was performed with multiple scanners: Lightspeed QX/I with 4-row detectors, Lightspeed VCT with 64-row detectors (GE Medical Systems, Milwaukee, WI), Aquilion 4 with 4-row detectors, Aquilion 64 with 64-detectors, and Aquilion ONE with 320-row detectors (Toshiba Medical Systems, Otawara, Tochigi, Japan). Chest CT images with 5- to 10-mm section thickness were acquired first, and subsequently, a thin-section CT with 0.625- to 2.5-mm section thickness was frequently added.

A detailed reinterpretation was performed by 5 diagnostic radiologists (R.I., M.T., N.T., H.K., and T.Y. with 5, 6, 6, 14, and 14 years of experience, respectively) without the knowledge of the patients' outcome to judge the presence of an apparent fistula. Table 1 shows the clinical information and CT findings of cases with peripheral bronchopleural fistula.

### TABLE 1. Clinical Information and CT Findings of Cases With Peripheral Bronchopleural Fistula

| Case No. | Age/Sex | BPF Demonstration on CT | Invasive Procedure to Thorax | Clinical Diagnosis/Status | CT Section Thickness (mm) | CT or Clinical Diagnosis of BPF | Clinical Outcome | Thoracentesis After CT With HP |
|----------|---------|-------------------------|-------------------------------|---------------------------|---------------------------|-------------------------------|-----------------|-------------------------------|
| 1        | 42/F    | Yes                     | No                            | Pneumonia                 | 2.5                       | —                             | Improved        | No                            |
| 2        | 64/F    | Yes                     | No                            | Necrotizing pneumonia     | 2.5                       | —                             | Death due to multiple organ failure | Yes              |
| 3        | 58/M    | Yes                     | No                            | Pulmonary abscess         | 2.0                       | Mention of BPF in CT report   | Improved        | No                            |
| 4        | 54/M    | Yes                     | No                            | Pulmonary tuberculosis    | 2.5                       | —                             | No follow-up    | NA                            |
| 5 right  | 69/F    | Yes                     | No                            | Chronic tuberculous empyema | 2.5                       | —                             | No change       | Yes                           |
| 5 left   | 65/M    | Yes                     | No                            | Chronic tuberculous empyema | 2.5                       | —                             | Improved        | Yes                           |
| 6        | 87/M    | No                      | No                            | Pneumonia                 | 2.5                       | —                             | Improved        | Yes                           |
| 7        | 65/M    | No                      | No                            | S/P hepatectomy for hepatoma | 5.0                       | —                             | Improved        | Yes                           |
| 8        | 77/M    | Yes                     | Yes                           | S/P RFA for lung cancer   | 7.5                       | Mention of BPF in CT report   | Improved        | No                            |
| 9        | 19/M    | No                      | Yes                           | S/P VATS for pleural mass | 2.5                       | —                             | No change       | No                            |
| 10       | 67/M    | No                      | Yes                           | S/P resection of lung cancer | 2.5                       | Clinical diagnosis of BPF     | Improved        | Yes (MRSA was detected)       |
| 11       | 53/F    | No                      | Yes                           | S/P resection of metastatic lung cancer | 1.0                       | —                             | Improved        | No                            |
| 12       | 26/F    | No                      | Yes                           | S/P RFA for metastatic lung cancer | 0.625                      | —                             | Improved        | Yes                           |

Case 5 had BPF bilaterally. In case 7, unintentional thoracentesis during abdominal drainage tube insertion (possible malpractice) was suspected. RFA indicates radiofrequency ablation; VATS, video-assisted thoracic surgery; MRSA, methicillin-resistant *Staphylococcus aureus*; HP, hydropneumothorax; S/P, status post; F, female; M, male.

FIGURE 1. Case 2: A 64-year-old woman with necrotizing pneumonia. A, CT scans obtained in a woman who had persistent pneumonia show a cavitary, round lesion (arrow) in the consolidated right middle lobe that is a probable lung abscess. B, Follow-up CT scan obtained one month later demonstrates the air-containing abscess with an open communication (arrow) between the abscess and the pleural space. In this case, the fistula was not noted in the CT report. The patient died of multiple organ failure approximately 2 months later.
BPF using axial images of the most thin section series by consensus, and the ratio of cases with an apparent BPF in them was calculated.

RESULTS

There were 35 CT reports that mentioned empyema, its suspicion, or a hydropneumothorax. Intrathoracic air was judged as not having entered the thoracic cavity from the outside of the body, for example, by the insertion of drainage tubes, in 12 cases. In 1 case, both the right and left thoracic cavities were involved; therefore, 13 thoracic cavities were included in this study. Table 1 shows the details about the clinical information and CT findings in each case.

Five cases underwent invasive procedures of the thoracic cavity before the CT scan, including 2 with lung tumor resection, 2 with radiofrequency ablation therapy for lung tumors, and 1 with surgical biopsy of a pleural mass. As for the other cases, 3 had tuberculous pleurisy or pneumonia, 2 had pneumonia, and 1 had necrotizing pneumonia. One case was suspected to have tube insertion error with thoracenteses during abdominal drainage.

A statement in the CT report about the presence of BPF was found in 2 cases. There was only 1 case in which BPF was suspected clinically because of an air leak. In this case, the communication of a bronchus or lung with the pleural space was not proven with the bronchoscope and could not be observed on CT. As for the other 9 cases, the diagnosis of BPF was not made. A pleural effusion needle aspiration or drainage was

FIGURE 2. Case 3: A 58-year-old man with empyema. CT scan shows multiple ectatic airways (A–D, arrows) at the periphery of the right lower lobe, communicating with a pocket of pleural air. These defects are multiple peripheral bronchopleural fistulas. In this case, the fistulas were mentioned in the CT report. The fistulas were reduced during the course of conservative treatment.

FIGURE 3. Case 9: A 77-year-old man after CT-guided radiofrequency ablation therapy for a primary lung cancer. The CT shows a large parenchymal defect (arrow) in the tumor after radiofrequency ablation therapy, with communication to the pleural space in the setting of a localized pneumothorax. A parenchymal pleural fistula was mentioned in the CT report. The fistula and pleural air disappeared 2 months later.
possibility of having air flow into the thoracic cavity from outside thoracic gas was due to BPF because it is clear that there was no evidence of continuation of a bronchus or the lung to the pleural space, but with a clinically apparent air leak. For the other cases.

Among the cases that we evaluated, 8 were diagnosed with BPF: 7 thoracic cavities in 6 cases with apparent continuation of a bronchus or the lung to the pleural space, and 1 case with no apparent BPF on CT, whereas in the cases with no apparent BPF, all underwent conservative treatment. Ricci et al. concluded that it was necessary to perform a closure operation when BPF was found on CT because it was larger than a BPF that was not found on CT.

In our survey, a closure procedure for BPF by surgery or bronchoscopy was not performed in all 12 cases probably for 2 reasons. First, an aggressive surgical intervention would not be performed in our institution for a case without an air leak. The other considerable reason is that only 2 cases had BPF documented in a CT report, and a clinician did not notice the presence of BPF in most cases. However, conservative treatment was successful in 10 of 11 patients who could be followed-up. Even in 5 cases with apparent BPF seen on CT and followed-up, conservative treatment worked in 4 cases (80%).

The conclusion of Ricci et al. is “because BPF observed on CT is large enough to be depicted on CT and too large to be cured by the conservative treatment, they may need surgical adaptation.” Based on the results of the previous reports, it was uncertain whether a BPF large enough to be depicted on CT could be relieved even by conservative treatment. From the results of our data, we consider that initially, conservative treatment is enough, even if a peripheral BPF is found on CT.

However, we had a case of significant lung deficiency produced by necrotizing pneumonia shown in Figure 1. Although a surgical approach for disclosure of the BPF should have been performed, it was not done because both radiologists and clinicians did not notice its presence. In this case, we cannot deny that BPF led to an exacerbation of the respiratory status. When a large pulmonary defect communicating to the pleural space is depicted on CT, a recommendation for urgent interventional closure is probably necessary.

In conclusion, when initially there is hydropneumothorax on a CT image, whether it is caused by empyema or not, it is important that radiologists diligently search for findings of peripheral BPF and clearly describe it if present. However, a reference about the need for a surgical approach for BPF may not be required.

Because the present study is retrospective and the CT reports were searched by the key words of empyema, empyema suspicion, and hydropneumothorax, a question remains whether the search precisely extracted all cases of BPF. Also, the number of enrolled cases is too small to definitively prove the conclusion. Further prospective studies will be necessary to determine whether conservative treatment is enough for cases with apparent peripheral BPF observed on CT.

REFERENCES

1. Ricci ZJ, Haramati LB, Rosenbaum AT, et al. Role of computed tomography in guiding the management of peripheral bronchopleural fistula. J Thorac Imaging. 2002;17:214–218.
2. Stern EJ, Sun H, Haramati LB. Peripheral bronchopleural fistulas: CT imaging features. *AJR Am J Roentgenol*. 1996;167:117–120.

3. Williams NS, Lewis CT. Bronchopleural fistula: a review of 86 cases. *Br J Surg*. 1976;63:520–522.

4. Hankins JR, Miller JE, Attar S, et al. Bronchopleural fistula. Thirteen-year experience with 77 cases. *J Thorac Cardiovasc Surg*. 1978;76:755–762.

5. Høier-Madsen K, Schulze S, Møller Pedersen V, et al. Management of bronchopleural fistula following pneumonectomy. *Scand J Thorac Cardiovasc Surg*. 1984;18:263–266.

6. Westcott JL, Volpe JP. Peripheral bronchopleural fistula: CT evaluation in 20 patients with pneumonia, empyema, or postoperative air leak. *Radiology*. 1995;196:175–181.

7. Baumann MH, Sahn SA. Medical management and therapy of bronchopleural fistulas in the mechanically ventilated patient. *Chest*. 1990;97:721–728.

8. McManigle JE, Fletcher GL, Tenholder MF. Bronchoscopy in the management of bronchopleural fistula. *Chest*. 1990;97:1235–1238.

9. Friedman PJ, Hellekant CA. Radiologic recognition of bronchopleural fistula. *Radiology*. 1977;124:289–295.

10. Frytak S, Lee RE, Pairolero PC, et al. Necrotic lung and bronchopleural fistula as complications of therapy in lung cancer. *Cancer Invest*. 1988;6:139–143.

11. May IA, Samson PC, Mittal A. Surgical management of the patient with complications of pulmonary infarction due to nonseptic pulmonary emboli. *Am J Surg*. 1972;124:223–228.

12. MacMillan JC, Milstein SH, Samson PC. Clinical spectrum of septic pulmonary embolism and infarction. *J Thorac Cardiovasc Surg*. 1978;75:670–679.

13. Gaur P, Dunne R, Colson YL, et al. Bronchopleural fistula and the role of contemporary imaging. *J Thorac Cardiovasc Surg*. 2014;148:341–347.

14. Hollaus PH, Lax F, el-Nashef BB, et al. Natural history of bronchopleural fistula after pneumonectomy: a review of 96 cases. *Ann Thorac Surg*. 1997;63:1391–1396.

15. Seo H, Kim TJ, Jin KN, et al. Multi-detector row computed tomographic evaluation of bronchopleural fistula: correlation with clinical, bronchoscopic, and surgical findings. *J Comput Assist Tomogr*. 2010;34:13–18.