Case Report

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# Hematoma-Filled Pneumatocele after CT-Guided Percutaneous Transthoracic Needle Lung Biopsy: Two Case Reports

## 컴퓨터단층촬영 유도 경피적 바늘 생검 이후에 발생한 혈종으로 채워진 기종: 두 건의 증례 보고

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CT-guided percutaneous transthoracic needle biopsy (PTNB) plays a key role in the diagnosis of pulmonary abnormalities. Although the procedure is considered safe and effective, there exists a potential for complications, such as pneumothorax, hemorrhage, hemoptysis, air embolism, and tumor seeding. However, pneumatoceles after CT-guided PTNB have been rarely reported. Herein, we report two cases of pneumatoceles that developed immediately after PTNB for primary lung cancer. A pneumatocele filled with hematoma should be considered in cases with a newly developed nodule along the needle tract during short-term follow-up CT after PTNB.

**Index terms** Computed Tomography, X-Ray; Hematoma; Lung Neoplasm; Needle Biopsy; Neoplasm Seeding

## INTRODUCTION

CT-guided percutaneous transthoracic needle biopsy (PTNB) plays a key role in the diagnosis of pulmonary abnormalities (1). Although the procedure is considered safe and effective, it has potential complications such as pneumothorax (17%–27%), hemorrhage (4%–27%), hemoptysis (11%), air embolism (0.061%), and tumor seeding (0.012%–0.061%) (1). However, to the best of our knowledge, pneumatocele after PTNB has not yet been reported in the lit-

erature. Herein, we report two cases of pneumatocele that developed immediately after PTNB for primary lung cancer.

## CASE REPORT

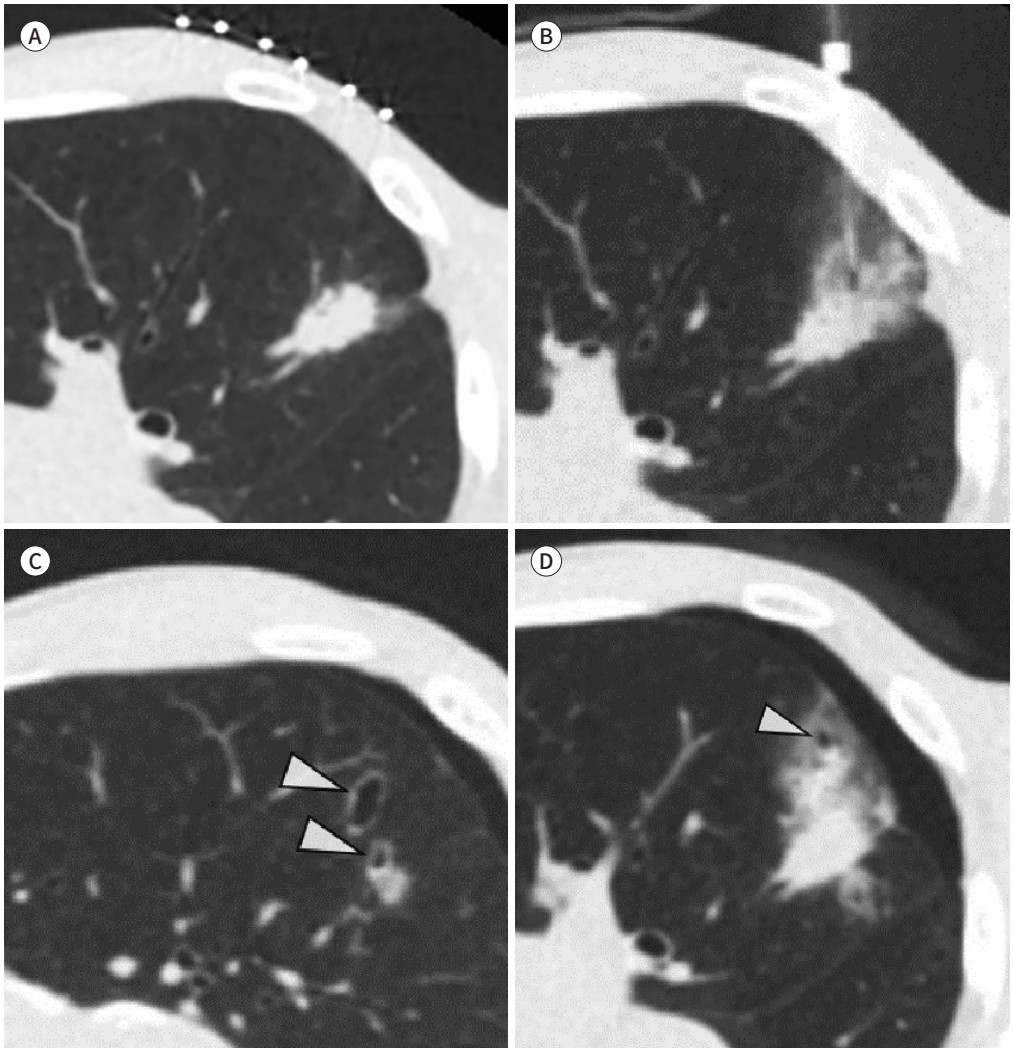
This retrospective study was approved by the Institutional Review Board of our hospital, which waived the requirement for informed consent (IRB No. WKUH 2021-12-022).

### CASE 1

A 74-year-old male with a nodule in the left upper lobe referred for CT-guided PTNB. The procedure was performed by a radiologist with 20 years of experience in PTNB, after informed consent was obtained. A coaxial biopsy system with a 19-gauge introducer needle and a 20-gauge core biopsy needle (length, 16 cm; Bard Maxcore, Bard Peripheral Vascular Inc., Tempe, AZ, USA) was selected, and a CT (Aquilion PRIME; Canon Medical Systems, Otawara, Japan; 2-mm slice thickness and no interval) scan was performed for this procedure. During the procedure, the patient was placed in a supine oblique position and instructed to hold his breath when requested. Prior to biopsy, a CT scan of the thorax was conducted to determine needle trajectory and depth to be inserted, which showed a 22 mm-sized, lobulated contoured nodule in the left upper lobe apicoposterior segment (Fig. 1A). The biopsy was performed as follows: 1) following local anesthesia with an injection of 2% lidocaine, a 19-gauge introducer needle was inserted into the sterilized skin, 2) the introducer needle was advanced along the planned trajectory to the arranged depth, 3) a CT scan was subsequently acquired to confirm the location of the needle tip, 4) after confirming the location of the needle tip, the inner stylet was removed and immediately replaced by the biopsy needle, which was advanced into the lesion, 5) following the sample acquisition, the biopsy needle was removed and immediately replaced by the stylet of the introducer needle, 6) the samples were then fixed in 10% neutral buffered formalin, and 7) finally, the introducer needle was removed rapidly. We located the needle tip outside the tumor (Fig. 1B), and specimen acquisition was performed once. In addition, we did not use a blood patchy or other form of sealant prior to removal of the biopsy needle. During the procedure, the patient remained stationary on the table, had no cough, and held his breath following inspiration as instructed. Breath hold after inspiration was determined by considering the location of the tumor on CT. An immediate post-biopsy CT scan of the entire thorax revealed a 3-mm-sized, air-filled cystic lesion in the path of the biopsy needle, which suggested a pneumatocele (Fig. 1C). It showed extension along the adjacent bronchovascular bundle (Fig. 1D). In addition, there was accompanied ground-glass opacity and consolidation due to hemorrhage, as well as minimal ipsilateral pneumothorax. Histological examination of the PTNB revealed pulmonary adenocarcinoma.

Ten days after sampling, the patient underwent chest CT with an enhancement for preoperative staging of lung cancer. It presented well-defined, tubular-shaped, non-enhancing nodules with heterogeneous attenuation (15–45 Hounsfield unit [HU] on pre-contrast images) in the area where pneumatoceles had been previously observed (Fig. 1E). In addition, the previous pulmonary hemorrhage and ipsilateral pneumothorax were almost completely resolved. On $^{18}$F-fluorodeoxyglucose (FDG) PET/CT for the staging of primary lung cancer, there

Fig. 1. Case 1. Hematoma-filled pneumatocele after PTNB in a 74-year-old male with primary lung cancer.
A. A chest CT image obtained before PTNB shows a 22-mm-sized, lobulated contoured nodule in the apicoposterior segment of the left upper lobe.
B. A chest CT image obtained during PTNB shows the needle tip located outside the tumor.
C, D. The CT images obtained immediately after PTNB show a 3-mm-sized, air-filled cystic lesion in the path of the biopsy needle (arrowheads, C), suggesting a pneumatocele. The image shows extension along the adjacent bronchovascular bundle (arrowhead, D). In addition, accompanied ground-glass opacity and consolidation due to hemorrhage and ipsilateral pneumothorax can be observed.
PTNB = percutaneous transthoracic needle biopsy




was no hypermetabolism in the nodules, whereas adjacent primary lung cancer showed hypermetabolism (maximum standardized uptake value [SUVmax], 6.0) (Fig. 1F). They were considered as pneumatoceles filled with hematoma rather than tumor seeding, given the short period of time. He had no fever, respiratory symptoms, or hemoptysis which reflects secondary complications of a pneumatocele. Left upper lobectomy was performed for the treatment of primary lung cancer, and the specimen revealed no other specific lesions except lung cancer, which suggested that the nodules were not tumor seeding. The patient was discharged after 1 month with no other symptoms.

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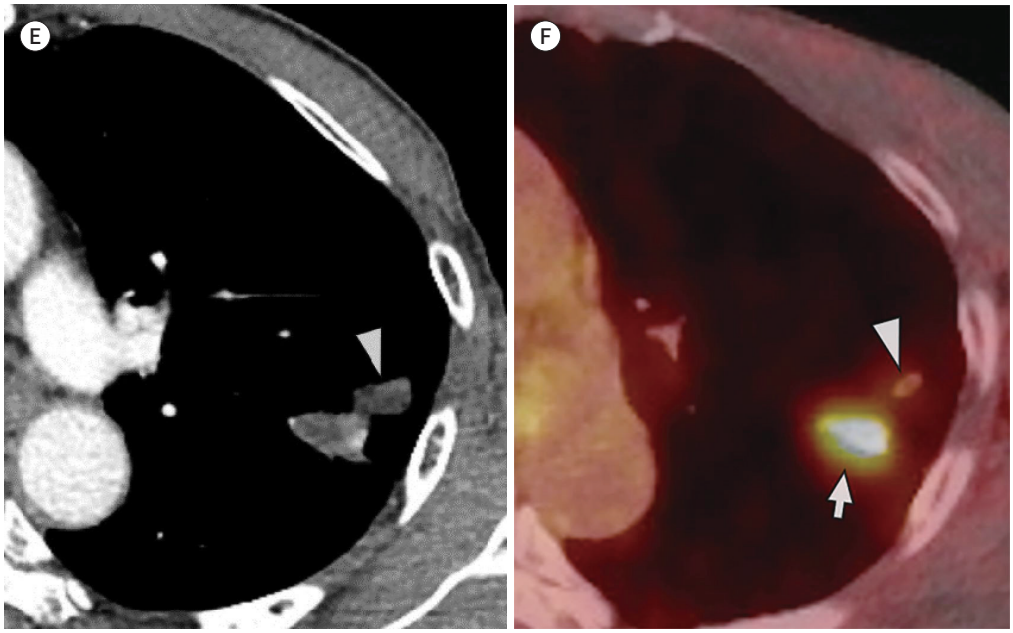
Fig. 1. Case 1. Hematoma-filled pneumatocele after PTNB in a 74-year-old male with primary lung cancer (Continued).
E. A CT image obtained 10 days after PTNB shows a well-defined, tubular-shaped, non-enhancing nodule with heterogeneous attenuation (arrowhead) in the area where pneumatoceles had been previously observed.
F. $^{18}$FDG PET/CT obtained 14 days after PTNB shows no hypermetabolism in the nodule (arrowhead), whereas the adjacent tumor shows hypermetabolism (SUVmax, 6.0) (arrow).
FDG = fluorodeoxyglucose, PTNB = percutaneous transthoracic needle biopsy, SUVmax = maximum standardized uptake value

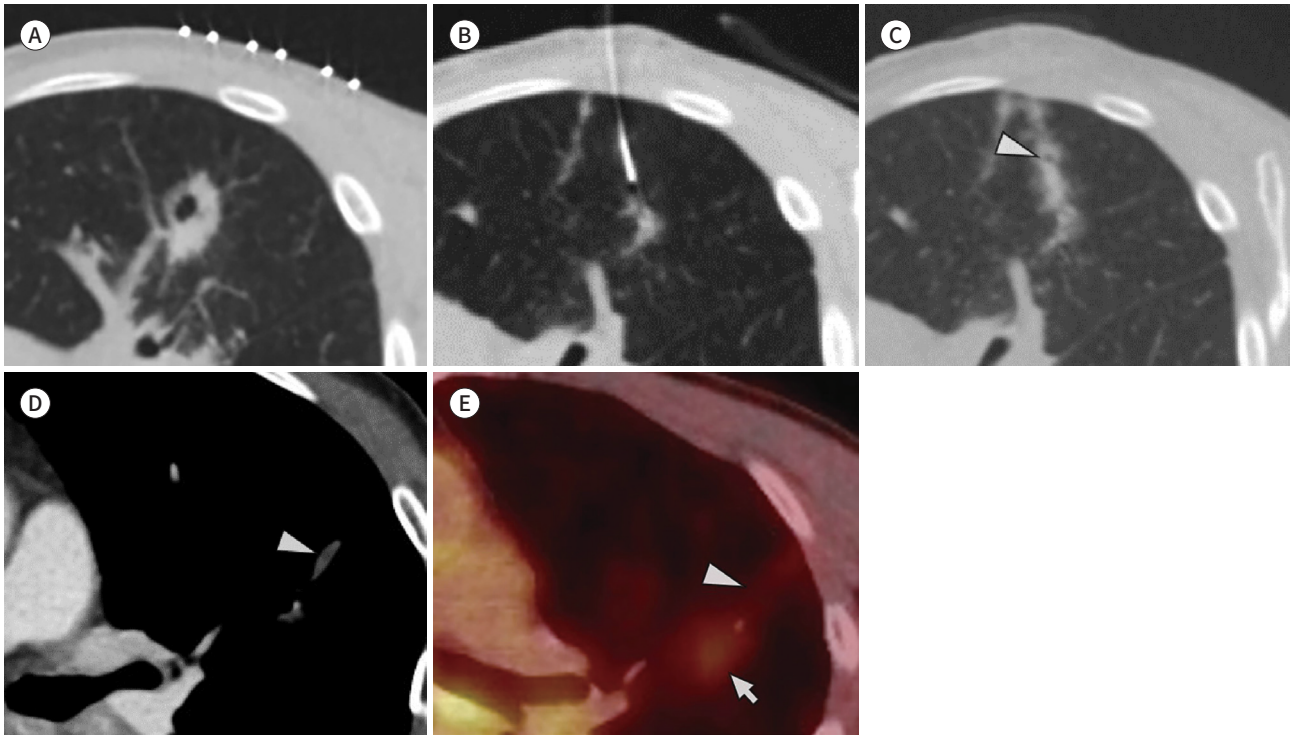



## CASE 2

A 69-year-old male with a nodule in the left upper lobe was referred for CT-guided PTNB. The procedure was performed by a radiologist with 1 year with experience in PTNB, after informed consent was obtained. PTNB was performed in the same manner using the same coaxial biopsy system and CT scan as in Case 1. During the procedure, the patient was placed in a supine oblique position. Chest CT obtained before biopsy showed a 24 mm-sized, microlobulated contoured nodule with pseudocavitation in the anterior segment of the left upper lobe (Fig. 2A). The needle tip was located outside the tumor (Fig. 2B), and specimen acquisition was performed four times. During the procedure, the patient remained immobile, had no cough, and held his breath following inspiration as instructed. An immediate post-biopsy CT scan of the entire thorax revealed a 3 mm-sized, air-filled cystic lesion accompanied by ground-glass opacity and consolidation in the path of the biopsy needle, as in Case 1. This suggested a pneumatocele with pulmonary hemorrhage (Fig. 2C). Histological examination of the PTNB revealed pulmonary adenocarcinoma.

Seven days after sampling, the patient underwent chest CT with an enhancement for preoperative staging of lung cancer. It presented a 14-mm-sized, well-defined, tubular-shaped, non-enhancing nodule with heterogeneous attenuation (20–42 HU on pre-contrast images) in the area where a pneumatocele had been previously observed, such as in Case 1 (Fig. 2D). In addition, the previous pulmonary hemorrhage was completely resolved. On $^{18}$FDG PET/

Fig. 2. Case 2. Hematoma-filled pneumatocele after PTNB in a 69-year-old male with primary lung cancer.
A. A chest CT image obtained before PTNB shows a 24-mm-sized, microlobulated nodule with pseudocavitation in the anterior segment of the left upper lobe.
B. A chest CT image obtained during PTNB shows the needle tip located outside the tumor, targeting the lower aspect of the tumor.
C. The CT image obtained immediately after PTNB shows a 3-mm-sized, air-filled cystic lesion along the path of the biopsy needle (arrowhead), suggesting a pneumatocele. In addition, accompanied ground-glass opacity and consolidation due to hemorrhage can be observed.
D. A CT image obtained seven days after PTNB shows a 14-mm-sized, well-defined, tubular-shaped, non-enhancing nodule with heterogeneous attenuation (arrowhead) in the area where a pneumatocele had been previously observed.
E. $^{18}$FDG PET/CT obtained seven days after PTNB shows no hypermetabolism in the nodule (arrowhead), whereas the adjacent tumor shows mild hypermetabolism (SUVmax, 2.4) (arrow).
FDG = fluorodeoxyglucose, PTNB = percutaneous transthoracic needle biopsy, SUVmax = maximum standardized uptake value




CT, there was no hypermetabolism in the nodule, whereas adjacent primary lung cancer showed hypermetabolism (SUVmax, 2.4) (Fig. 2E). The patient had no symptoms reflecting secondary complications of pneumatocele. Because the patient was transferred to another hospital close to his residence, the nodule could not be histologically confirmed. However, a pneumatocele filled with hematoma was considered, on the basis of experience in Case 1.

## DISCUSSION

A pneumatocele is a thin-walled, gas-filled lesion within the pulmonary parenchyma, which is filled with air or an air-fluid level. The fluid content of the cavities is hemorrhage, originating from surrounding alveolar capillaries or pulmonary vessels (2, 3). Pneumatoceles are usually caused by infection, trauma, or aspiration of hydrocarbon fluid (2). It is a quite rare condition as a complication after lung procedure. Although there are some reports of pneumatocele developed after radiofrequency ablation of lung tumors (4) or transbronchial lung cryobiop-

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sy (5), PTNB-related pneumatocele has not been reported in the literature. Our report reveals that small pneumatoceles can develop after PTNB.

Depending on the cause, two mechanisms have been proposed to explain the pathogenesis of pneumatoceles. First, in non-traumatic conditions, evacuation of pulmonary necrotic foci causes bronchial obstruction and subsequent check-valve mechanism, or inflammation and necrosis of the airway wall makes a direct communication between the bronchovascular interstitium and pulmonary parenchyma (6). Second, in traumatic conditions, physical forces directly rupture the alveolar tissue, transmitted forces cause compression of the peripheral bronchial tree and subsequent check-valve mechanism, or shearing forces tear the lung parenchyma (7). In our cases, it is presumed that air flows into the pulmonary parenchyma through a pulmonary laceration caused by needle insertion and then becomes trapped with the sealing of the defect, which is similar to the mechanism of penetrating traumatic pneumatocele (8). While the exact cause of pneumatoceles is unclear, the coaxial biopsy system, position of the needle tip outside the tumor, and breath-holding following inspiration are considered to cause air trapped within the pulmonary parenchyma. Given the mechanism of the PTNB-related pneumatocele, it is unlikely to be an extremely rare complication even though it has never been reported.

Pneumatoceles may increase in size over the following days or weeks until a balance is achieved between the pressure within the cavity and that of the surrounding lung parenchyma (3). However, it usually resolves after weeks and months without specific intervention (2). Our cases revealed that pneumatoceles grew in size with suspected internal hemorrhage content, appearing as non-enhancing tubular nodules with heterogeneous attenuation, but was asymptomatic, and observation was the only treatment required. In addition, in Case 1, the pneumatoceles extended along the bronchovascular bundle out of the needle tract. It was suspected that entrapped air in the pulmonary parenchyma centripetally extended through the pulmonary interstitium along the bronchovascular bundle toward the pulmonary hila by Macklin effect (9).

In our cases, the diagnosis of pneumatocele was straightforward, based on the imaging findings and the accompanying history of the procedure. However, for a new nodule that develops along the needle tract on follow-up CT after PTNB, tumor seeding should be ruled out. Hiraki et al. (10) reported two cases of needle-tract seeding developing 4 and 29 months following percutaneous radiofrequency ablation of lung cancer. On the other hand, in our cases, the interval from PTNB to the follow-up CT scan was too short to develop a seeding nodule. Moreover, the nodule appeared as a non-enhancing tubular lesion along the needle tract, with no hypermetabolism on $^{18}$FDG PET/CT. Therefore, it was not difficult to differentiate pneumatoceles filled with hematoma from seeding nodules.

In conclusion, rapid development of lung nodules over short period of time favors them to be procedural related complication such as hematoma-filled pneumatocele rather than tumor seeding. Interventionists need to be familiar with this condition because hematoma-filled pneumatocele generally represents a benign, self-limited condition that only requires observation.

### Conflicts of Interest

The author has no potential conflicts of interest to disclose.

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# 컴퓨터단층촬영 유도 경피적 바늘 생검 이후에 발생한 혈종으로 채워진 기종: 두 건의 증례 보고

강세리*

컴퓨터단층촬영 유도 경피적 바늘 생검은 폐 이상 진단에 중요한 역할을 하며, 안전하고 효과적이지만 기흉, 출혈, 객혈, 공기 색전증 및 종양 파종과 같은 합병증의 위험이 있다고 알려져 있다. 그러나 시술 후 발생한 기종에 대한 증례 보고는 드물다. 저자들은 원발성 폐암의 경피적 바늘 생검 직후 발생한 기종 2예를 보고하고자 한다. 시술 후 단기 추적검사 컴퓨터단층촬영에서 바늘 경로를 따라 새로 생긴 결절의 경우 혈종으로 찬 기종을 의심해야 한다.

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