Hiroshima J. Med. Sci.
Vol. 56, No. 1·2, 19~22, June, 2007
HIJM 56–3

Endobronchial Ultrasonography with a Guide-Sheath and Virtual Bronchoscopy Navigation Aids Management of Peripheral Pulmonary Nodules

Seiji OKIMASA[1,*)], Shinkichiro YOSHIOKA[1)], Satoshi SHIBATA[2)], Yoshikazu AWAYA[3)], Yukiyasu NAGAO[3)], Isao MURAKAMI[3)], Eriko SHIGETO[3)] and Toshimasa ASAHARA[4)]

1) Department of Surgery, Hiroshima General Hospital of West Japan Railway Company, Hiroshima, Japan
2) Department of Thoracic Surgery
3) Department of Pulmonology, National Hospital Organization, Higashi-Hiroshima Medical Center, Hiroshima, Japan
4) Department of Surgery, Division of Frontier Medical Science, Programs for Biomedical Research, Graduate School of Biomedical Science, Hiroshima University, Hiroshima, Japan

ABSTRACT

Occasionally, we have difficulty in diagnosing small peripheral pulmonary nodules. However, efforts have been made to resolve this problem. For instance, computed-tomography (CT), positron emission tomography (PET), flexible bronchoscopy examination (BF), and video-assisted thoracic surgery (VATS) have been performed to investigate such nodules. We have used endobronchial ultrasonography with a guide-sheath (EBUS-GS) for BF examination, and recently applied the virtual reality technique "virtual bronchoscopy (VB)". Here, we present a case in which a combined technique with VB and EBUS-GS was useful. The patient was a 54-year-old man with a persistent cough and chest pain. Small nodules were seen in the bilateral lungs on the chest CT taken at the local hospital. A slight increase in the CEA level (6.1 ng/ml; normal level < 5.0 ng/ml) was shown as well as an uptake in the latter term on PET. As a result, he was referred to our hospital for a detailed work-up. We applied VB to confirm the location of the tumor, which allowed us to approach the lesion easily. Furthermore, we precisely localized the lesion using EBUS-GS. Then a biopsy was performed, which demonstrated bronchiolitis obliterans organizing pneumonia (BOOP). As seen in this case, combining VB and EBUS-GS seems beneficial for diagnosing peripheral pulmonary nodules.

Key words: *Virtual bronchoscopy, Endobronchial ultrasonography, Guide-sheath, Small pulmonary nodule*

The evolution of diagnostic technology to detect pulmonary lesions is constantly progressing. Multidetector computed-tomography (MDCT) scanners provide high-resolution images of the chest, which provide a virtual reality by way of three-dimensional (3-D) construction. PET provides high-quality useful information. However, we occasionally depend on VATS for diagnosis. A less invasive procedure is better if possible. We applied a combination technique using VB and EBUS-GS for BF examination. VB is useful for navigation, and EBUS-GS for confirmation of the lesion. Here, we report an instructive case in which a combination of VB and EBUS-GS was highly beneficial.

CASE REPORT

The patient was a 54-year-old man who presented with a persistent cough and chest pain. He underwent examinations at a local clinic, and chest CT demonstrated pulmonary nodules in the bilateral lungs. A slight increase in the CEA level (6.1 ng/ml; normal level < 5.0 ng/ml) was also confirmed. Increased uptake from the early term to the latter term was observed on PET, with the highest standardized uptake value (SUV) being 5.0. He had smoked 40-60 cigarettes daily for 34 years. Above all, malignancy could not be ruled out. Therefore, he was referred to our hospital for a detailed work-up. We scheduled BF examination. On chest CT, the bronchus ran

* Corresponding author : Dr. Seiji Okimasa, 3-1-36 Futabanosato, Higashi-ku, Hiroshima 730-0057, Japan
Tel:+81-82-262-1171 Fax:+81-82-262-1499 E-mail: sokimasa@mail.goo.ne.jp

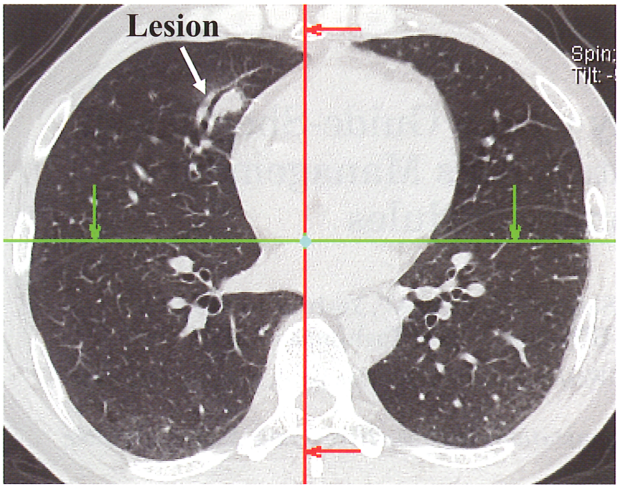

Fig. 1. The bronchus ran through the nodule at a medial segment of the right middle lobe.

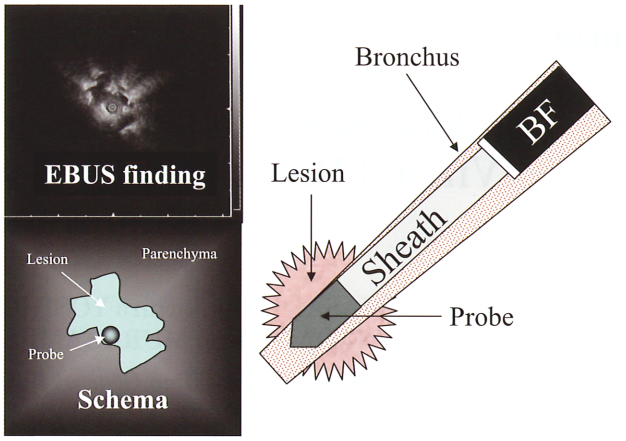

Fig. 3. By way of EBUS-GS technique, a hypo-echoic homogeneous lesion could be detected.
Thereafter, a biopsy forceps was passed through the GS after withdrawing the miniature ultrasound probe. Then TBB was performed.

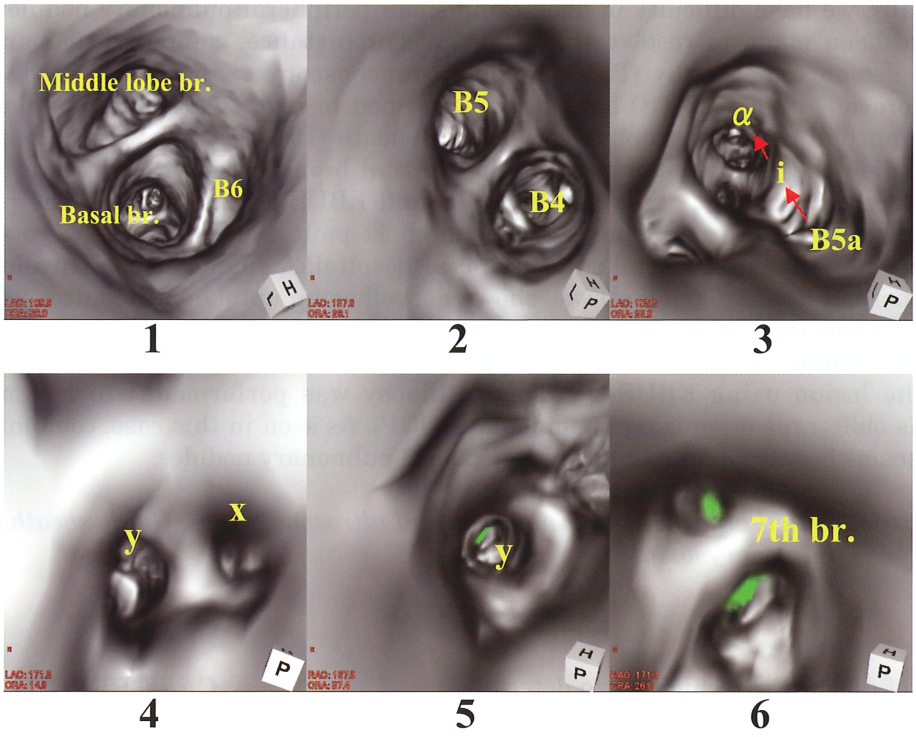

Fig. 2. VB showed the route toward the lesion (1 → 2 → 3 → 4 → 5 → 6).

through the nodule at a medial segment of the right middle lobe (Fig.1). VB was performed for navigation before BF examination. It showed a route toward the lesion from the Truncus intermedius to the right B5aiαy (Fig. 2). We used BF with an outer diameter of 4 mm (Olympus BF type P260F, Tokyo, Japan). It was advanced to the right B5aiα referring to navigation by way of VB. Then a miniature ultrasound probe (20 MHz, mechanical-radial type) [UM-S20-20R; Olympus Optical; Tokyo, Japan] with an outer diameter of 1.7 mm was placed into the right B5aiαy through a guide-sheath (GS) measuring 2.0 mm in diameter. Using this procedure, we were able to detect the nodule (Fig. 3). Thereafter, a biopsy forceps was passed through the GS after withdrawing the miniature ultrasound probe. Transbronchial biopsy (TBB) was performed. Bronchial brushing was also performed by the same procedure. Since the findings showed bronchiolitis obliterans organizing pneumonia, the patient was followed up on an outpatient basis, and the lesions have reduced or disappeared since.

DISCUSSION

Accurate diagnosis before therapy is indispensable for both patients and doctors. In the case of pulmonary nodules, blood tests, chest CT, PET and other tests are performed to obtain information on the lesions. However, cytological and/or histological diagnoses provide decisive findings to select the appropriate medical treatment. Therefore, BF is applied to evaluate pulmonary nodules in most cases[9]. There is no problem if we can confirm that the lesion is benign. However, when a decisive diagnosis cannot be obtained by BF examination, VATS is subsequently considered for further investigation[7]. If a decisive diagnosis of malignancy can be obtained on the first examination, a great deal of time and labor during surgery (for example, by excluding the need for intra-operative diagnosis based on frozen sections) could be saved. This allows us to complete the operation in one attempt. There is no doubt that a high level of accuracy is needed for BF examination in order to ascertain the distance to the lesion, and to confirm its precise localization. Therefore, we performed a combination technique using VB and EBUS-GS on BF examination to obtain a more accurate diagnosis.

With regard to endobronchial ultrasonography (EBUS), physicians are now performing this procedure to diagnose and stage lung cancer and many different tumors of the chest region[1,3,6]. It goes without saying that EBUS is an exciting new diagnostic tool that will add very significantly to the diagnosis and staging of lung cancer and other thoracic diseases. EBUS combines two procedures known as BF and real-time ultrasonography. This allows physicians to obtain precise biopsies of lymph nodes and masses within the chest cavity. Additionally, EBUS can delineate the anatomy of the airway wall to characterize tumors, and can determine invasion of tumors into surrounding structures[6]. Visualization of the lesion by EBUS provides considerable information. Furthermore, EBUS-GS is reported to provide a guide for transbronchial biopsy (TBB) in order to diagnose peripheral pulmonary lesions, which improves diagnostic accuracy[5]. A route can be secured if GS is used as in this case. However, this procedure has limitations. Especially when we approach peripheral pulmonary lesions on BF, we occasionally have difficulty in finding the correct route. This forces us to choose the bronchus indiscriminately in peripheral areas. This is time consuming and, at worst, we may need to cancel the procedure. Therefore, VB plays an important role[2,4]. By way of our current system, we can approach to sixth-generation bronchi. Thus, nodules up to seventh-generation bronchi can be detected with VB and EBUS-GS. As for complications in this procedure, bleeding and pneumothorax are well known. Actually we have experienced one bleeding case. However, it did not lead to a critical condition due to GS. We could catch and keep blood in GS, and removed it after the blood coagulated.

To construct virtual reality images, from 400–500 contiguous images of the thorax were obtained using MDCT scanners (CT Somaton Emotion 6; Siemens Corp., Erlangen, Germany). The standard technique in our hospital is 1.0 collimation and 9.0 mm feed/rotation (0.6 second), with a reconstruction interval of 1.25 mm and overlap of 0.7 mm. Virtual bronchoscopy images (VBI) were obtained using a TOSHIBA Zio M 900 workstation with adjustment of the threshold based on axial images and sagittal and coronal multiplanar reconstruction (MPR) images displayed simultaneously with VBI. First, a 3-D thorax image with a colored lesion was constructed, and then merged with another 3-D thorax image with a non-colored lesion. Then, the viewpoint was placed in the trachea. We performed VB examination in flythrough mode. As we came close to the lesion, we could see the colored area. This technique allows the lesion to be detected easily, and shows us an accurate navigation route on BF examination. The beneficial points of this manual technique are as follows[2,8]: 1) additional CT is not necessary for VB; 2) it is useful to plan navigation during bronchoscopy examinations; 3) it is a noninvasive modality for identifying bronchial obstructions, endoluminal lesions, fistulae between the esophagus and airway, and airway injury; 4) it can assess the tracheobronchial tree beyond stenoses; 5) it can detect foreign bodies; and 6) it can used as a substitute for conventional bronchoscopy in non-cooperative patients or in situations in which the airway or respiratory function are compromised.

Cases such as that described here are relatively common. It is therefore important to pursue a safer and more decisive technique. The results presented here are instructive as we applied a technique combining VB and EBUS-GS to obtain conclusive evidence. We consider that this procedure facilitates high quality and safe medical treatment.

We are currently collecting information regarding cases in which this combined technique has been applied for diagnosis. The further evolution of this technique and its employment in pulmonology will improve the diagnostic rate and lessen the burden imposed on patients during diagnosis and therapy.

(Received May 8, 2007)
(Accepted June 8, 2007)

REFERENCES

1. **Becker, H.** 1996. Endobronchialer Ultraschall-Eine neue Perspektive in der Bronchologie. Ultraschall. Med. **17:**106-112.
2. **Finkelstein, S., Summers, R., Nguyen, D., Stewart, J., Tretler, J. and Schrump, D.** 2002. Virtual bronchoscopy for evaluation of malignant tumors of the thorax. J. Thorac. Cardiovasc. Surg. **123:** 967-972.
3. **Hurtur, T. and Hanrath, P.** 1992. Endobronchial sonography: feasibility and preliminary results. Thorax. **47:** 565-567.
4. **Kiraly, A., Helferty, J., Hoffman, E., McLennan, G. and Higgings, W.** 2004. Three dimensional path planning for virtual bronchoscopy. IEEE. Trans. Med. Imag. **23:** 1365-1379.
5. **Kurimoto, N., Miyazawa, T., Okimasa, S., Maeda, A., Oiwa, H., Miyazu, Y. and Murayama, M.** 2004. Endobronchial ultrasonography using a guide sheath increases the ability to diagnose peripheral pulmonary lesions endoscopically. Chest. **126:** 959-965.
6. **Kurimoto, N., Murayama, M., Yoshioka, S., Nishizaka, T., Inai, K. and Dohi, K.** 1999. Assessment of usefulness of endobronchial ultrasonography in determination of depth of transbronchial tumor invasion. Chest. **115:** 1500-1506
7. **Lang-Lazdunski, L. and Pilling, J.** 2007. Video assisted thoracoscopic surgery is still the standard. BMJ. **10:** 34 (7588): 273.
8. **Okimasa, S., Shibata, S., Awaya, Y., Nagao, Y., Murakami, I. and Shigeto, E.** 2005. The trial of virtual bronchoscopy in our hospital. J. Hiroshima Med. Ass. **58:** 557-561.
9. **Zavala, D.** 1975. Diagnostic fiberoptic bronchoscopy: techniques and results of biopsy in 600 patients. Chest. **68:** 12-19.