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Computed tomography-guided bronchoscopy in the diagnosis of small peripheral pulmonary lesions: A retrospective study of 240 examinations in a single academic center

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ABSTRACT

Background: Factors that affect the diagnostic yield in computed tomography (CT)-guided bronchoscopy have not yet been fully evaluated. To improve the diagnostic yield of peripheral pulmonary lesions (PPLs) by CT-guided bronchoscopy, we quantitatively analyzed factors affecting the diagnostic yield.

Methods: The data were collected for 240 PPLs in 237 patients examined by using CT-guided bronchoscopy between October 2003 and November 2011 in our respiratory center. The association of diagnostic yield with the CT bronchus sign (CT-BS), lesion size, location, number of tissue specimens, and type of bronchoscope was retrospectively assessed.

Results: The diagnostic yield of PPLs with negative CT-BS was significantly lower (2.9%) than that for PPLs with positive CT-BS (52.2%; $p<0.01$). Among the PPLs with positive CT-BS, the yield was significantly higher in those in the left S^3 than for lesions in other bronchial segments (83.3% vs. 50.3%; $p<0.05$). Lesion size was not significantly associated with diagnostic yield. The yield was significantly lower in PPLs without lung tissue specimens than in lesions with biopsy specimens ($p<0.01$). Moreover, a thin bronchoscope produced a higher yield in comparison with other bronchoscope types (66.0% vs. 47.6%; $p<0.05$). Multivariate analysis revealed that the number of biopsy specimens was an independent factor affecting diagnostic yield.

Conclusions: CT-guided bronchoscopy is valuable in the diagnosis of PPLs with positive CT-BS regardless of lesion size; however, PPLs with negative CT-BS are not good candidates for CT-guided bronchoscopy. Obtaining tissue specimens by biopsy is a critical factor in diagnosing PPLs.

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1. Introduction

Developments in computed tomography (CT) and CT-related health screening have enabled the detection of smaller peripheral pulmonary lesions (PPLs) [1–3], including lesions that are invisible under X-ray fluoroscopy. While flexible bronchoscopy with X-ray fluoroscopy can be used to diagnose small PPLs, the diagnostic yield varies with lesion size and location and with the proportion of benign and malignant lesions. Thus, although the diagnostic yield for PPLs is reported to range widely from 18% to 76% with X-ray fluoroscopy [4–14], the range is markedly lower (14–54%) in PPLs less than 20 mm [11,12,14]. Transthoracic needle aspiration (TTNA) or surgical biopsy may also be performed to diagnose small PPLs. However, although TTNA has a high diagnostic yield [15–18], a higher rate of pneumothorax is observed compared with bronchoscopic procedures [14,17–21]. Moreover, TTNA carries the risk of rare but fatal adverse effects including arterial air embolisms [22]. Another common procedure used for both diagnostic and curable purposes is surgical resection. However, surgical resection is highly invasive and it cannot be performed on older patients, patients in poor general condition, or patients with poor lung function.

Although flexible bronchoscopy is a less invasive procedure with fewer complications, the comparatively low diagnostic yield remains an issue. To overcome this problem, adjunct modalities for bronchoscopy, such as endobronchial ultrasonography (EBUS) with a guide sheath (GS), electromagnetic navigation bronchoscopy, and CT-guided bronchoscopy have been developed. In CT-guided bronchoscopy, real-time CT imaging during examination enables visualization of the positional relationship between the PPLs and biopsy forceps. According to Tsushima et al. [23], CT-guided bronchoscopy significantly increases diagnostic yield for small PPLs. However, there are several drawbacks associated with this technique. CT-guided bronchoscopy is labor-intensive, requires a dedicated CT room, and involves high radiation exposure for both bronchoscopists and patients.

With the development of EBUS-GS and other new diagnostic modalities, CT-guided bronchoscopy is no longer the only reliable diagnostic procedure for small PPLs. Several studies [24,25] have reported that the diagnostic yield using CT-guided bronchoscopy is particularly high for PPLs with a positive CT bronchus sign (CT-BS) associated with the target lesion [5]. However, additional factors that affect the diagnostic yield in CT-guided bronchoscopy, such as the size and location of lesions and the number of tissue specimens, have not yet been fully evaluated.

In the present study, we retrospectively reviewed 240 CT-guided bronchoscopy examinations involving the diagnoses of small PPLs to analyze quantitatively the usefulness and application of CT-guided bronchoscopy in PPL diagnosis. In addition, various factors were analyzed to provide a better understanding of their contributions to the diagnostic yield.

2. Patients and methods

2.1. Subjects

The data for 240 consecutive PPLs in 237 patients examined by CT-guided bronchoscopy from October 2003 to November 2011 at Shinshu University were collated. All of the PPLs were detected by chest X-ray, by CT scan screening, or through a follow-up CT scan of other underlying diseases. PPLs that were not visible on X-ray fluoroscopy, were undiagnosed by previous conventional bronchoscopy, or were considerably difficult to approach using conventional bronchoscopy were also included. The data for clinical findings, medical histories, laboratory tests (including the coagulation test), electrocardiograms, pulmonary function tests, and for high-resolution CT were available for all patients. All patients gave informed consent prior to the procedures. This protocol was approved by the Shinshu University Ethical Committee (Date of approval: January 8, 2013, approval number: 2170).

2.2. The definition of CT-BS

The PPL–bronchi relationship on chest CT, described as the air–bronchogram sign on CT or CT-BS, was defined as a bronchus leading to or contained within a PPL [5]. In this study, CT-BS 0 indicated no bronchus in proximity to the lesion, CT-BS 1 indicated a bronchus adjacent to the lesion, and CT-BS 2 indicated a bronchus within the range of the lesion (Fig. 1). CT-BS 0 was equivalent to a negative CT-BS, and both CT-BS 1 and CT-BS 2 were considered positive [5]. Before CT-guided bronchoscopy, negative and positive CT-BS were identified.

2.3. CT-guided bronchoscopy

All procedures were performed in a designated examination room equipped with the CT apparatus. In cases where CT-guided bronchoscopy was performed by a pulmonologist with more than 6 years' experience in bronchoscopy, one (or more) additional experts supervised the procedures. When a pulmonologist with fewer than 6 years' experience performed the CT-guided bronchoscopy procedure, at least two pulmonologists with more than 6 years' experience supervised and assisted. If

Abbreviations: CT, computed tomography; PPLs, peripheral pulmonary lesions; CT-BS, CT bronchus sign; TTNA, transthoracic needle aspiration; EBUS, endobronchial ultrasonography; GS, guide sheath; TBNA, transbronchial needle aspiration; VBN, virtual bronchoscopic navigation; GGO, ground glass opacity.

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