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Review

Advanced bronchoscopy for the diagnosis of peripheral pulmonary lesions

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ABSTRACT

Bronchoscopy to examine peripheral pulmonary lesions is performed using a bronchoscope with an outer diameter of 5–6 mm under fluoroscopy, but the diagnostic yield can be insufficient. Problems with transbronchial biopsy include a limited range of bronchoscope insertion, difficulty in guiding a bronchoscope and biopsy instruments to lesions, and insufficient confirmation of the arrival of biopsy instruments at the target lesion; as such, new techniques have been used to overcome these individual problems.

Radial-endobronchial ultrasound is used to identify peripheral pulmonary lesions and sampling sites. In a meta-analysis, the diagnostic yield, that of lesions smaller than 2 cm, and complication rate were 73, 56.3, and 1.0%, respectively. Virtual bronchoscopic navigation is a method to guide a bronchoscope to peripheral lesions under direct vision using virtual bronchoscopic images of the bronchial route, and the diagnostic yield, that of 2-cm or smaller lesions, and complication rate were 73.8, 67.4, and 1.0%, respectively. Electromagnetic navigation utilizes electromagnetism; the diagnostic yield was 64.9–71%, and the pneumothorax complication rate was 4% for this modality. Ultrathin bronchoscopes can be advanced to the peripheral bronchus under direct vision in contrast to normal-size bronchoscopes, and the diagnostic yield and pneumothorax complication rates were reported to be 63 and 1.5%, respectively. The overall diagnostic yield of these new techniques on meta-analysis was 70%, a higher yield than that obtained with conventional transbronchial biopsy. Each technique has advantages and disadvantages, and the investigation of appropriate combinations corresponding to individual cases is necessary.

Contents

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1. Introduction

With the increasing clinical use of computed tomography (CT), we increasingly encounter small peripheral lesions in routine medical practice. Given that the effectiveness of lung cancer screening using CT has been demonstrated, the number of such cases will increase further. Although many of these lesions are benign, it is important to detect lung cancer lesions at their earliest stages in such cases [1]. The gold standard of lung cancer diagnosis is to collect a specimen from the lesion and diagnose it pathologically, an approach for which surgical biopsy, transthoracic needle aspiration (TTNA), and transbronchial biopsy are available for selection. Surgical biopsy is the most reliable; however, it requires general anesthesia and one-lung ventilation, thus subjecting patients to substantial stress as part of a procedure that is used only in making a diagnosis. Moreover, when the lesion is small, it is likely to be a benign lesion not requiring resection. The diagnostic sensitivity of TTNA varies depending on the use of CT, the lesion size, and whether the disease is benign or malignant; the guidelines established by the American College of Chest Physicians (ACCP) reported that the sensitivity and specificity were 90% and 97%, respectively [2]. However, the incidence of complications is high with TTNA. In a survey on CT-guided TTNA performed in Japan, the mortality rate in 9783 cases was 0.07%, the incidence of severe complications (tension pneumothorax, hemopneumothorax, air embolism, and dissemination) was 0.75%, and the incidence of pneumothorax was 35% [3]. Regarding complications caused by transbronchial biopsy, the mortality rate in 37,485 cases performed in 2010 in Japan was 0.003%, and the overall complication rate was 1.79% (hemorrhage: 0.73%, pneumothorax: 0.63%) [4]. Transbronchial biopsy using a bronchoscope is the first choice for peripheral lesions in Japan because of a low incidence of complications. However, the diagnostic yield with transbronchial biopsy is insufficient, and according to the ACCP guidelines, the diagnostic yield for 2-cm or smaller lesions is 34% [2].

The main lesion-associated factors affecting transbronchial diagnosis of solitary peripheral pulmonary lesions include the size, location, presence or absence of an involved bronchus, and malignant or benign lesion status, and operator-associated factors include the instruments used and the techniques and experience of the operators [5–8]. At present, bronchoscopy of peripheral pulmonary lesions is performed using a bronchoscope with an outer diameter of approximately 5–6 mm under fluoroscopy. Important problems with transbronchial biopsy include a limited range of bronchoscope insertion, difficulty in guiding a bronchoscope and biopsy instruments to lesions, and insufficient confirmation of whether or not biopsy instruments have reached the lesion. To overcome such problems, new techniques such as ultrathin bronchoscopy, navigational bronchoscopy, and radial-endobronchial ultrasound (R-EBUS), as well as combinations of these, have been established. In navigational bronchoscopy, various 3-dimensionally displayed data of CT are related mutually to actual patient information acquired in real time during bronchoscopy, to guide a bronchoscope and biopsy instruments to the lesion, and virtual bronchoscopic navigation (VBN) and electromagnetic navigation (EMN) are available. These are similar with regard to the use of 3-dimensional CT displays and virtual bronchoscopy but differ with respect to the methods of using virtual images. Another difference is the use of an electromagnetic sensor in EMN [9]. Of these new techniques, radial EBUS and EMN already are recommended in the 3rd edition of the ACCP guidelines. In this report, the results and complications of these new techniques applied for peripheral solitary lesions are reviewed.

2. Radial EBUS

Radial EBUS is a probe that houses an ultrasound transducer that provides a 360° radial image of the surrounding structures. It has been reported to be useful in the identification of the lesion and sampling site on bronchoscopy of peripheral pulmonary lesions [10] and in improving the diagnostic yield [11]. On meta-analysis, the pooled sensitivity and specificity for the detection of lung cancer in peripheral lesions using radial EBUS were 73% (95% CI: 70–76%) and 100% (95% CI: 99–100%), respectively. The diagnostic yield depended on the lesion size and prevalence of malignancy, and the diagnostic yield of lesions <2 cm was 56.3% (95% CI: 51–61%), and that of 2-cm or larger lesions was 77.7% (95% CI: 73–82%) [12]. Because the diagnostic yield is high, the 2013 ACCP guidelines on lung cancer diagnosis recommend radial EBUS when the appropriate instruments and a skilled operator are available [2]. In EBUS using a guide sheath (EBUS-GS), after the operator has confirmed that the ultrasonic probe with a guide sheath has reached the lesion, the lesion is biopsied through the guide sheath placed on it [13]. EBUS-GS is advantageous in that specimens can be collected repeatedly and accurately from the lesion. The radial EBUS-induced pneumothorax complication rate was 1.0%, and that requiring drainage was 0.4% [12].

3. Virtual bronchoscopic navigation (VBN)

VBN is a method to guide a bronchoscope to a peripheral lesion under direct vision using virtual bronchoscopic images of the bronchial route [14]. Virtual images can be prepared using commercial general-purpose image preparation software, and yet there are challenges: setting a threshold to