1 Fundamentals of Bronchoscopy
Endobronchial ultrasound (EBUS) can depict five to seven structural layers in bronchial walls, and it has been useful in diagnosing invasion depth [3]. In lesions that do not extend beyond the third layer with EBUS, that is tumors that have not gone beyond the collar of cartilage, there is a possibility of complete recovery with PDT. Moreover, the possibility of using NBI to diagnose invasion depth based on the pattern of surface vessels in the lesion area is currently being investigated.

Of great importance is the careful insertion and withdrawal of bronchoscopes while investigating whether there are also lesions in the nasal cavity, pharynx, and larynx, as the bronchoscope passes through these areas. Careful observation should also be made, particularly among heavy smokers and heavy drinkers, for the presence of pharyngeal and laryngeal cancer.

In cases of advanced central lung cancer, flexible bronchoscopy is used in histological diagnosis by direct-vision biopsy, in assessing the patency of the airway lumen in cases of intervention, and in assessing whether there is pressure invasion of lesions within the airway walls or from outside the walls.

Rapid advances are also being made in the diagnosis of peripheral lung cancer using flexible bronchoscopy. Lesions are reached from the bronchial lumen, and cells or tissue are collected using techniques such as exfoliative or lavage cytology, transbronchial biopsy, and transbronchial needle aspiration (TBNA) from the lesion area. These cells or tissue are then presented for histopathological examination.

Until recently, the bronchi involved in lesions were judged by the doctor while looking at segmental, subsegmental, and sub-subsegmental bronchi on chest plain films or chest CT, while considering anatomy. With recent advances in CT, it has become possible to see the length of bronchi up to the peripheral lesions before any tests are performed through the use of virtual bronchoscopy [4,5]. Thus, there is little

The development of flexible bronchoscopy was started by Ikeda et al. in 1965. In the history of flexible bronchoscopy, there have been several developments and improvements as a result of higher resolutions and finer scopes. Higher-resolution bronchoscopes have mainly been used for bronchial lesions in central lung cancer, which can be observed by bronchoscopy, while thinner bronchoscopes have been used to reach peripheral lung lesions that cannot be directly observed. With high resolution images, the properties of the tracheal surface and microvessels can be evaluated with the use of fluorescence bronchoscopy to diagnose epithelial thickness via the attenuation of autofluorescence, and narrowband imaging (NBI), which results in narrow bands at wavelengths that are absorbed by hemoglobin [1]. Large absorption peaks exist near 415 nm and 540 nm due to the absorption characteristics of hemoglobin. Light at 415 nm and 540 nm, which is readily absorbed by hemoglobin, is used for high-contrast images to determine whether blood or blood vessels are present. As the wavelength of light becomes shorter, transmission depth becomes shallower, and thus the presence or absence of blood is more strongly reflected with narrowband light than with broadband light.

When bronchoscopy is conducted for the diagnosis of central lung cancer following examination for bloody sputum and sputum cytology abnormalities, fluorescence bronchoscopy, which can show attenuation of autofluorescence emitted from bronchial walls at lesion sites, is very useful in addition to regular white light bronchoscopy [2]. Diagnosis of the range and depth is essential in determining whether central lung cancer can be treated by photodynamic therapy (PDT) rather than surgery. In diagnosing the extent of central lung cancer, the border between diseased and healthy tissue can be observed with fluorescence bronchoscopy. Special optical observation with NBI has also proven to be effective in identifying the margin of lesions and evaluating microvessels on the lesion surface.

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difference between doctors in reading CTs, and there is a greater likelihood that the lesion can be reached.

Procedures are performed under fluoroscopy in order to help determine whether a lesion has been reached. However, some lesions are difficult to see under fluoroscopy, and it has become possible to depict lesions present in the lung by guiding the thin ultrasound probe of EBUS into lesions from the bronchi [6]. Moreover, a method has appeared in which the thin ultrasound probe is covered with a sheath [7] in order to ensure a route to the lesion, and then exfoliative or lavage cytology is performed, or cells or tissue are collected through transbronchial biopsy (Fig. 1.1).

There has also been an increase in shadows presenting ground glass opacity (GGO). As pure GGO cannot be seen on radioscopy or EBUS in confirming whether the lesion has been reached, there have been reports of bronchoscopy under CT guidance. Exposure and other problems with this method have been pointed out, but this is a trend that should be followed in the future.

Staging is an important issue in diagnosing lung cancer. There has been dependence on CT, PET, and other diagnostic imaging techniques, particularly in diagnosing lymph node metastasis, but diagnostic imaging has its own limitations. In the past, surgery and mediastinoscopy were necessary for cytohistological diagnosis of mediastinal lymph node metastasis, and the burden on patients was great. In 2003, the use of ultrasound bronchoscopy with a convex ultrasound probe fixed to the tip of the bronchoscope became possible. This technique makes it possible to obtain cross-sectional images in the longitudinal direction around the trachea and bronchi, and ultrasound imaging and transbronchial needle aspiration (TBNA) with a guide are now being performed. EBUS-TBNA conducted under local anesthesia has made cytological and histological diagnosis easier, and this technique has

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**Fig. 1.1** Diagnosis of pulmonary adenocarcinoma from biopsy results. A. Chest CT showed a small nodule in the lower left lobe. B. Virtual bronchoscopic navigation (VBN), in combination with C. EBUS-GS confirmed the location of the nodule at B6b. D. A 20MHz probe could clearly visualize the internal structure of the lesion. E. Fluoroscopy was used to guide the probe to the site of the lesion.
spread rapidly worldwide [8]. While mediastinoscopy has the advantage of enabling tissue collection from numerous lymph nodes, the advantages of EBUS-TBNA in comparison with mediastinoscopy are: (i) it can be performed under local anesthesia; (ii) it is possible to observe the interior of the lymph node and avoid aspiration of necrotic areas; (iii) it is possible to puncture lymph nodes from the left and right main bronchi (nodes #10, 11, and 12); and (iv) there are few serious complications such as severe hemorrhage.

The future outlook for flexible bronchoscopy includes the application of NBI and cytological evaluation by high-magnification bronchoscopy for airway lesions, development of easy-to-use tools such as navigation screens interfaced with bronchoscope screens for peripheral lesions, and evaluation of lymph node regions with high-resolution ultrasound images, blood analysis with pulsed Doppler, and adjustment of collected tissue with puncture needle modifications in EBUS-TBNA.

References