Flexible Bronchoscopy

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KEYWORDS

• Flexible bronchoscopy • Bronchoalveolar lavage • Transbronchial lung biopsy
• Transbronchial needle aspiration • Bronchial brush

KEY POINTS

- Despite rapid advancements in technology and applications in flexible bronchoscopy, core procedures remain a critical role in the diagnosis of bronchopulmonary diseases.
- Core procedures include as bronchoalveolar lavage, transbronchial lung biopsy, and transbronchial needle aspiration.
- It is essential that pulmonary trainees continue to train and gain proficiency in the core bronchoscopic procedures.
- All bronchoscopists should be fully aware of the indications, contraindications, risks, and diagnostic value of the procedures they perform.
- The indications for both diagnostic and therapeutic flexible bronchoscopy are continually expanding in parallel with technological advances.

INTRODUCTION

As we approach the 50th anniversary of the first commercially available flexible bronchoscope, it is difficult to imagine diagnosing and treating diseases of the lungs and bronchi without this valuable tool. In addition to allowing complete visualization of the airways to the subsegmental level, various biopsy and therapeutic instruments have been developed for the diagnosis and treatment of pulmonary diseases, often with only moderate sedation. This article briefly discusses the development and history of the flexible bronchoscope and its accessory instruments, as well as the technical aspects of conventional biopsy tools, and concludes with discussion of the indications, contraindications, and complications associated with the flexible bronchoscopic procedures. Although we reference some of the more advanced tools used in flexible bronchoscopy, these are covered in detail in other articles in this issue; this article focuses exclusively on conventional flexible bronchoscopy.

HISTORY OF FLEXIBLE BRONCHOSCOPY

The Japanese thoracic surgeon Shigeto Ikeda developed the first flexible fiberoptic bronchoscope in the 1960s, revolutionizing pulmonary medicine.[1–3] However, years of previous scientific advancements were necessary to reach this point. The concept of total internal reflection or "bending light" was first described in 1854 by John Tyndall, who demonstrated that, by shining a light into a

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tank of water attached to an open-ended pipe, the light would follow the arc of water as it fell from the pipe. In 1888, a team of physicians in Austria were the first to incorporate this concept into medical care when they developed bent glass rods for illuminating body cavities. In the 1920s and 1930s, multiple separate groups independently realized that, in addition to simple light transmission, images could also be transmitted through glass fiber bundles.[4] In 1954, physicists Hopkins and Kapany developed the first prototype flexible endoscope using fiberoptic bundles.[5] In 1958, Hirscowitz patented a flexible gastroscope to visualize the stomach.[6,7] In the early 1960s, Dr Ikeda, who was already experimenting with fiberoptic rigid telescopes, approached the Machida Endoscope CO, and the Olympus Optical Company with his vision for the first flexible fiberoptic bronchoscope. In 1964, Dr Ikeda presented the first prototype flexible bronchoscope at the "IX International Congress of Diseases of the Chest" in Copenhagen, Denmark.[1] Although this early rendering had major limitations, including an inability to bend or direct the distal tip, and did not include a working channel, the clinical importance of the flexible bronchoscope was readily apparent to the society; his presentation was published in *The New York Times* shortly after the conference concluded. The first commercially available flexible bronchoscope, which allowed angulation of the distal tip, manufactured by Machida Company, was commercialized in 1968. This development was quickly followed by an Olympus bronchoscope that included a working channel for suction or passage of instruments.[1–3] Over the next few years, rapid improvements in image quality, flexibility, and angulation followed, and by the mid-1970s the flexible fiberoptic bronchoscope was being commonly used worldwide. A major advance occurred when Asahi Optical Company (later renamed Pentax Corporation), using the technology from video camcorders, could replace the flexible fiberoptic bundle system with a miniaturized charge-coupled device integrated into the distal tip of a bronchoscope, creating high-quality video images that could be viewed on a large screen rather than just through an eyepiece.[1,8,9] As charge-coupled device technology progressed, newer generations of bronchoscopes with improved image quality and smaller footprints continue to be developed. Despite the advancements in video technology the fiberoptic technology used by Dr Ikeda has maintained its relevance in the form of hybrid bronchoscopes, which combine the minimal space requirements of the fiberoptic bundles with the superior video quality of the charge-coupled device chip allowing the development of a new generation of "ultrathin" bronchoscopes.

The flexible bronchoscope opened a new era in bronchoscopy and, in the decades since its initial commercial release, there have been numerous innovations that have expanded the field of pulmonary medicine. Some of these innovations were originally used in rigid bronchoscopy, but were not widely adopted because of the limitations of reach and flexibility intrinsic to rigid instruments. One of the most important innovations in flexible bronchoscopy was in 1974 when Reynolds and Newball[10] first introduced bronchoalveolar lavage (BAL). This innovation allowed bronchoscopists to obtain material from the lower respiratory tract to aid in the diagnosis of infectious, inflammatory, and malignant disease, while additionally influencing the understanding of the cellular response to diseases of the lung. Although transbronchial lung biopsy (TBLB) using a rigid bronchoscope had been used at selected centers for several years before the invention of the flexible bronchoscope, the inability to reach lesions with precision, particularly in the upper lobes, limited its clinical usefulness.[11,12] Dr Ikeda recognized the potential of the flexible bronchoscope in the diagnosis of malignancy and specifically designed the original commercially available bronchoscope with this in mind. The original forceps were rudimentary; however, as the design of the flexible forceps evolved, TBLB became a standard procedure easily learned and performed by the general pulmonologist.[13–15] Transbronchial needle aspiration (TBNA), also originally developed for rigid bronchoscopy by Schiepatti in 1948, had the same limitations as rigid TBLB and was uncommonly performed.[16,17] Kato Oho first developed a needle that could be used through the flexible bronchoscope for the aspiration of paratracheal pathology in 1979, 1 year after Ko-Pen Wang first demonstrated the technique of mediastinal TBNA with the use of the rigid bronchoscope. These monumental achievements forever expanded the role of the bronchoscopist beyond disease of the airways, and were an essential step in the development of modern linear endobronchial ultrasound (EBUS) imaging.[18–20]

Numerous advanced modalities have been developed, expanding the role of the bronchoscopist for both diagnosing and treating diseases of the airways and lungs. In 1979, 2 independent discoveries proved that the flexible bronchoscope could be used for more than just biopsying suspect malignancy. Doiron and colleagues[21,22] expanded the role of bronchoscopy in the detection of early airway malignancies by introducing fluorescence bronchoscopy, and Toty