Ultrathin Bronchoscopy: Indications and Technique

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Introduction and Definition of the Procedure

Flexible bronchoscopes allow direct visualization of the airways. Depending on the indication for bronchoscopy, standard or therapeutic bronchoscopes can be used with outer diameters ranging 5–6 mm and inner diameters ranging 2–3 mm, respectively. In adult patients, standard and therapeutic bronchoscopes can therefore be advanced up to the third–fifth generation bronchi with some variation depending on both bronchoscope and airway anatomy.

Ultrathin bronchoscopy refers to the use of bronchoscopes with outer diameter of 3 mm or less, the thinness of which allows the exploration of the peripheral airways otherwise not reachable with conventional bronchoscopes and, particularly, the achievement of peripheral pulmonary lesions (PPLs). Although there is wide variation depending on the bronchial anatomy of every patient, ultrathin bronchoscopes may allow airway visualization up to the 9th–12th bronchial generation of adult patients. A visual comparison of the thinness of therapeutic, standard, and ultrathin bronchoscopes is shown in Fig. 3.1.

Fig. 3.1 Flexible bronchoscopes of different diameters: 2.8 mm ultrathin bronchoscope with a 1.2 mm channel, 4.9 mm standard bronchoscope with a 2.0 mm channel, and 6.0 mm therapeutic bronchoscope with a 2.8 mm channel

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The main technical differences when performing ultrathin compared to standard bronchoscopy are related to mechanical constraints of the scope and the multiple bronchial divisions, the limitations inherent to the smaller diameter of the working channel, and the difficulty to obtain an optimal endoscopic view of the peripheral airways.

This chapter will review the history of ultrathin bronchoscopy, describe the indications and contraindications, provide step-by-step description of the procedure, and envision a possible evolution of the technique.

History and Historical Perspective

The first ultrathin fiberoptic bronchoscope reported in medical literature was used through the working channel of a conventional bronchoscope. Developed by Tanaka et al. [1], the model Olympus BF-1.8T was composed of fine optical glass fibers and had a tip diameter of 1.8 mm that could go up to 180 mm past the tip of a conventional fiberoptic bronchoscope. It had no working channel and could be bent passively only. Attachment to a special camera allowed for the first photographs of peripheral airways of 2 mm or less and their first endoscopic classification [1, 2]. By the same time, Prakash was using a regular pediatric fiberoptic bronchoscope (Olympus BF-3C4) with an external diameter of 3.5 mm to explore and sample with a cell brush the abnormalities present in subsegmental airways of adult patients [3]. In 1990, Tanaka et al. developed a second model of ultrathin bronchoscope with an outer diameter of 2.2 mm and distal tip that could be bended 120° upward and downward (Olympus BF-2.2T) [4]. Later, in 1994, a new bronchoscope (Olympus BF-2.7T) was released by the same authors with a tip diameter of 2.7 mm and the novelty of incorporating a 0.8 mm working channel that allowed small airways sampling under direct vision with a cell brush (Olympus BC-0.7T) [5]. Since then, newer ultrathin fiber bronchoscopes and video bronchoscopes with working channels up to 1.2 mm have been developed as well as various types of brushes and biopsy forceps that can be passed through these smaller working channels. Most recently, a new prototype of ultrathin hybrid bronchoscope with a working channel of 1.7 mm has been used that allows for radial probe endobronchial ultrasound (EBUS) insertion [6]. Pediatric bronchoscopes from other brands have also been used for exploring the peripheral airways of adult patients, although tube length might be a limitation if bronchoscopes are intended for the pediatric population only.

In essence, the concern to explore peripheral airways and to diagnose processes that occur beyond the physical limits of conventional bronchoscopes has led researchers to develop thinner versions of standard bronchoscopes. Ultrathin bronchoscopes are currently equipped with technologies that provide high-quality imaging, and wider working channels that allow using a greater number of instruments. A summary of the evolution of ultrathin bronchoscopes is shown in Table 3.1.

Table 3.1 Evolution of ultrathin bronchoscopes in medical literature

Image[a]	Year	Type	Working length (mm)	External diameter (mm)	Internal diameter (mm)	Tip angulation (up/down)	Additional imaging techniques	Instruments
F	1984	Olympus BF-1.8T	950	1.8	–	–	–	–
F	1990	Olympus BF-2.2T	1150	2.2	–	120°/120°	–	–
F	1994	Olympus BF-2.7T	1200	2.7	0.8	120°/120°	–	Brush
F	1999	Olympus BF-XP40	600	2.8	1.2	180°/130°	–	
F	2004	Olympus BF-XP60	600	2.8	1.2	180°/130°	–	Brush and forceps
H	2004	Olympus BF-XP160F	600	2.8	1.2	180°/130°	–	
V	2014	Olympus BF-XP190	600	3.1	1.2	210°/130°	NBI	
H	2017	Olympus BF-MP190	600	3.0	1.7	210°/130°	–	Brush, forceps, and rEBUS[a]

F fiber optic bronchoscope, *H* hybrid bronchoscope, *NBI* Narrow Band Imaging, *rEBUS* radial probe endobronchial ultrasound, *V* video bronchoscope
[a] The Olympus UM-S20-17S radial miniature probe

Indications and Contraindications

Unlike standard flexible bronchoscopy, which is used for both diagnostic and therapeutic purposes, the use of ultrathin bronchoscopy is mainly diagnostic of processes occurring in the middle and outer thirds of the tracheobronchial tree and, particularly, the diagnosis of peripheral pulmonary lesions. Although ultrathin bronchoscopes have occasionally been used for other purposes, such as accessing lung cavities or passing through stenotic areas, these potential indications are practically anecdotal compared to the large number of peripheral lesions that need to be studied. As to contraindications, these are very similar to those of standard flexible bronchoscopy.

Indications and contraindications of ultrathin bronchoscopy are detailed next.

Indications of Ultrathin Bronchoscopy

The main indication of ultrathin bronchoscopy is the diagnosis of peripheral pulmonary lesions. In the latest American College of Chest Physicians (ACCP) guidelines, the overall sensitivity of flexible bronchoscopy for diagnosing central lesions was 88% compared to 78% for peripheral lesions [7]. This difference in the diagnostic yield between central and peripheral lesions is largely explained by the bronchoscope reaching the lesion. Therefore, it is logical that ultrathin bronchoscopes are used to diagnose peripheral pulmonary lesions.

Other uses of ultrathin bronchoscopy include the exploration of cavitated lesions, especially when aspergilloma formation is suspected, or the
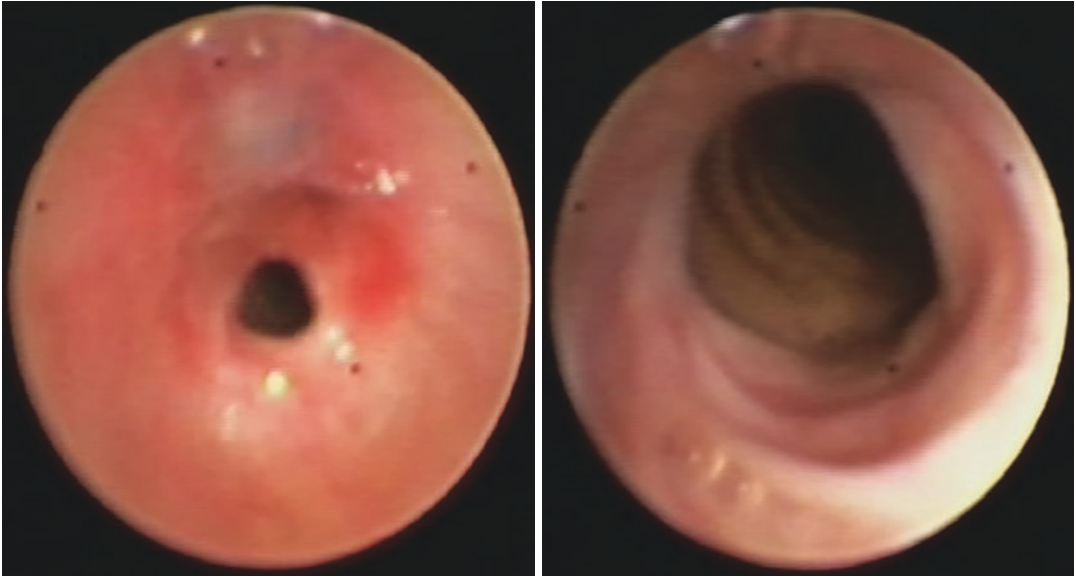
Fig. 3.2 Examination of critical stenosis with the ultrathin bronchoscope: view of the severe stenosis and distal trachea after passing through the stenosis with the ultrathin bronchoscope

study of critical stenosis (see Fig. 3.2), where the ultrathin scope allows minimal contact and airflow limitation when introduced through the stenotic area thus avoiding asphyxia and even barotrauma. Other reported uses include volume reduction through suction application in a giant bulla [8] or peripheral nodule marking with barium prior to surgery [9].

However, as already mentioned, the ultrathin bronchoscope is mainly used for the study of peripheral pulmonary lesions and it is to this indication that we will refer from now on in this chapter.

Contraindications of Ultrathin Bronchoscopy

Ultrathin bronchoscopy is a safe procedure. It should be considered though that the indications for ultrathin bronchoscopy are diagnostic and, mainly, of pulmonary nodules. Therefore, if at the time of the procedure the patient is undergoing any acute process that can be reversed, then the procedure should be postponed. Also, if there is the possibility that the patient will not be eligible for any potential treatment of the lesion after its diagnosis, i.e., oncospecific treatment,

then benefits of performing the procedure should be reconsidered.

On the other hand, it has to be taken into account that the ultrathin bronchoscope is a very fragile instrument and careful manipulation is imperative. Therefore, deep sedation may be necessary in order to prevent abrupt patient movements that could damage the fibers of the bronchoscope. If patient stillness cannot be guaranteed, ultrathin bronchoscopy is discouraged to avoid breaking of the fiber bronchoscope such as that shown in Fig. 3.3.

After these considerations, the contraindications for ultrathin bronchoscopy are basically the same as for any other flexible bronchoscopy. As already explained in Chap. 2, these include:

- Lack of informed consent.
- Lack of patient cooperation.
- Lack of an experienced bronchoscopist to perform or closely supervise the procedure.
- Lack of adequate facilities and personnel to care for emergencies that can occur, such as cardiopulmonary arrest, pneumothorax, or bleeding.
- Inability to adequately oxygenate the patient during the procedure.

Fig. 3.3 Black dots corresponding to broken fibers after the ultrathin fibrobronchoscope was accidentally bitten by a patient

- Uncorrected coagulopathy or bleeding diathesis.
- Severe refractory hypoxemia.
- Unstable hemodynamic status.
- Recent myocardial infarct or unstable angina.
- Acute superior vena cava syndrome.
- Increased intracranial pressure.

Relative contraindications (benefits should be weighed against potential risks) include:

- Partial obstruction of the central airways.
- Moderate to severe hypoxemia or any degree of hypercapnia.
- Uremia and pulmonary hypertension.
- Lung abscess.
- Debility and malnutrition.
- Known or suspected pregnancy.

Description of the Equipment Needed

Ultrathin bronchoscopy may be performed in a bronchoscopy suit with the patient awake with topical anesthesia, under mild sedation or under general anesthesia. If general anesthesia is preferred, either nasal intubation, orotracheal intu-

bation, or a laryngeal mask can be used. The authors of the present text prefer performing ultrathin bronchoscopy under general anesthesia through a laryngeal mask in order to assure patient stillness during the procedure. This is further explained in the next paragraphs. In any case, intravenous access and patient monitoring of at least heart rate or electrocardiogram, respiratory rate, pulse oximetry, and blood pressure is mandatory. If general anesthesia is preferred, an anesthesiologist and qualified assistant as well as the necessary material for assisted ventilation and advanced cardiorespiratory monitoring must be guaranteed. In any case, resuscitation equipment should be available in the procedure room.

To perform ultrathin bronchoscopy, at least one skilled operator and two qualified assistants are needed.

The basic equipment needed for ultrathin bronchoscopy includes:

- Ultrathin bronchoscope and valve for the working channel.
- Suction valve and catheter.
- Light source and video processor.
- Syringes: 20 and 50 mL.
- Topical anesthesia: 2.5% lidocaine.
- Room-temperature saline in 50 mL syringes connected to a catheter and tip that can be connected to the valve of the working channel.
- Sampling instruments: Mini biopsy forceps and/or mini cytological brush (1 mm diameter). For scopes with a 1.7 mm working channel (Olympus BF-MP190), mini radial EBUS probes can be used.
- Specimen collection devices (bronchial washing receptacle, ThinPrep®CytoLyt, or similar buffered solution to support cells after biopsy).
- Cold saline should be ready to use in case of bleeding.
- Chest tube placement kit should be ready to use in case of pneumothorax.
- C-arm fluoroscopy or computed tomography (CT) should be available to track the position of bronchoscope and/or sampling instruments, as well as to confirm that no pneumothorax is present right after sampling.

Fig. 3.4 Two bronchoscopists and one trained nurse performing ultrathin bronchoscopy with virtual bronchoscopic navigation (LungPoint®) in the endoscopy suite. Note that fluoroscopy is also used

Optional equipment:

- Cone-beam CT to corroborate the position of the ultrathin bronchoscope and the sampling instrument relative to the lesion.
- Virtual bronchoscopy, virtual bronchoscopic navigation, or electromagnetic navigation to assist procedure planning and guiding of the ultrathin bronchoscope to the peripheral pulmonary lesion.

In Fig. 3.4, ultrathin bronchoscopy with virtual bronchoscopic navigation is performed under general anesthesia in the endoscopy suite.

Procedure Description

In general terms, the procedure starts by conducting an accurate planning of the bronchial route leading to the peripheral lesion, either through fine reading of a high-resolution chest CT or supported by a planning software. During the procedure of ultrathin bronchoscopy, target approximation can be accomplished after memorization of the planned bronchial route or assisted by navigation software. Fluoroscopy is usually used to track the position of the ultrathin bron-

choscope and to assist sampling, although CT or cone-beam CT can also be used to corroborate the position of the ultrathin bronchoscope and the sampling instrument relative to the lesion. Sampling is performed with instruments of limited size that can be passed through the working channel of the ultrathin bronchoscope.

To develop all the aforementioned aspects and to provide an integrated understanding of the technologies that can be coupled with ultrathin bronchoscopy, we have structured ultrathin bronchoscopy in the following steps: procedure planning, target approximation, position verification, and sampling.
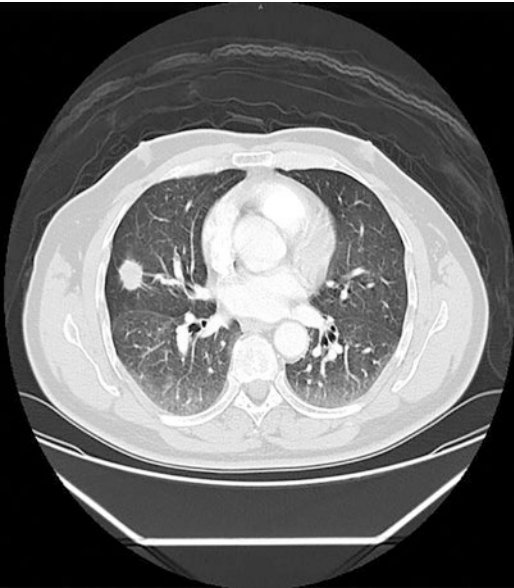
Procedure Planning

First thing to consider when planning the procedure on a CT image is the presence of a bronchus or artery afferent or, within the peripheral lesion, the so called bronchus sign and artery sign. When present, the diagnostic yield of the procedure is significantly higher [10–12]. Examples of bronchus and artery signs are shown in Fig. 3.5.

If the slice thickness of the CT is sufficient to allow identification of small bronchi and if a bronchus leading to the lesions is present, then it

will be feasible to reconstruct a three-dimensional bronchial route to the peripheral nodule. With this information alone, highly trained bronchoscopists have the ability to reconstruct the bronchial route from the CT and mentally reproduce the route during the procedure. Fortunately, complementary technologies have been developed to assist procedure planning. The mainstay technology for procedure planning is virtual bronchoscopy. Dedicated software is used for multiplanar
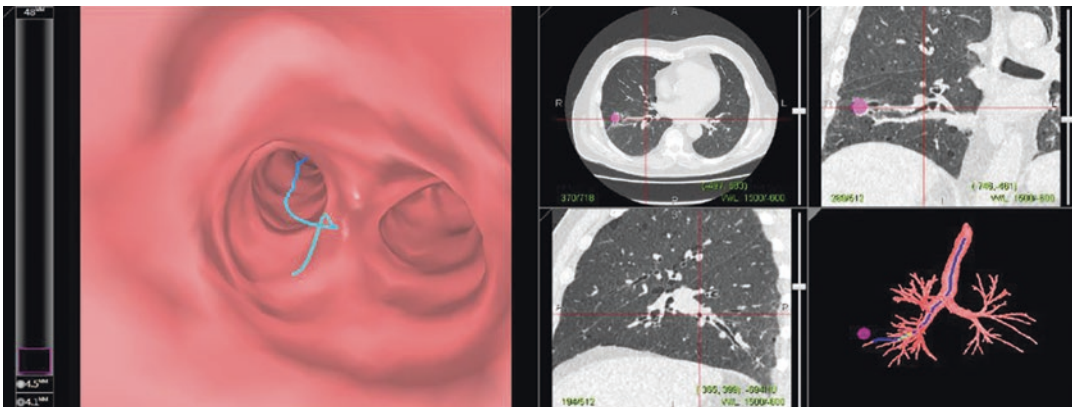
reconstruction of CT images and segmentation of the airways. After manual identification of the nodule in the CT, the bronchial route to the nodule can be followed through the inner lumen of the segmented airways. This route can be memorized by the bronchoscopist to be reproduced in the bronchoscopy suite. Otherwise, a virtual bronchoscopic navigation platform can be used to perform virtual bronchoscopy in the endoscopy suite and match virtual and endoscopic images during the procedure to facilitate orientation. A screenshot of a virtual bronchoscopy is shown in Fig. 3.6.

Target Approximation

In order to guarantee patient stillness during the procedure, the authors of the present text prefer performing ultrathin bronchoscopy under general anesthesia and laryngeal mask or endotracheal intubation. This facilitates bronchoscope manipulation in the smaller subsegmental bronchi, allows application of short controlled apneas to gain greater operator control during sampling, and may also avoid accidental damaging of the fiber bronchoscope due to abrupt patient movements. It has to be pointed out that, in some cases, cutting some centimeters of the proximal end of the orotracheal tube may be necessary to warrant full insertion of the 600 mm working length of the ultrathin bronchoscope and avoid falling

Fig. 3.5 Chest CT showing both a bronchus and artery leading to a PPL (bronchus and artery signs, respectively)


Fig. 3.6 Procedure planification with a virtual bronchoscopy navigation system (LungPoint®). This system allows matching the virtual bronchoscopy seen in the Figure with the endoscopic images during the procedure

short to the lung periphery, especially in relatively tall patients. However, general anesthesia is not mandatory and moderate sedation is preferred in many centers.

As previously mentioned, target approximation can be accomplished after memorization of the planned bronchial route or assisted by virtual bronchoscopic navigation software. This software allows matching virtual and endoscopic images during the procedure to guide the ultrathin bronchoscope through every bifurcation leading to the afferent bronchus. In either case, fluoroscopy is usually used to track the real-time position of the ultrathin bronchoscope.

Fluoroscopy was the first imaging technique used for guiding the ultrathin bronchoscope to the nodule [1]. Biplanar fluoroscopy is desirable but, when not accessible, the C-arm must be rotated adequately. Although it is not a guidance tool per se, it can be useful to confirm the position and direction of the bronchoscope throughout the procedure and relative to the peripheral lesion, as long as the lesion is fluoroscopically visible (see Fig. 3.7). Unfortunately, peripheral pulmonary nodules are not always visible with fluoroscopy. In one study, the authors reported that from a population of 1369 individuals at high risk for lung cancer, 15 small peripheral lung
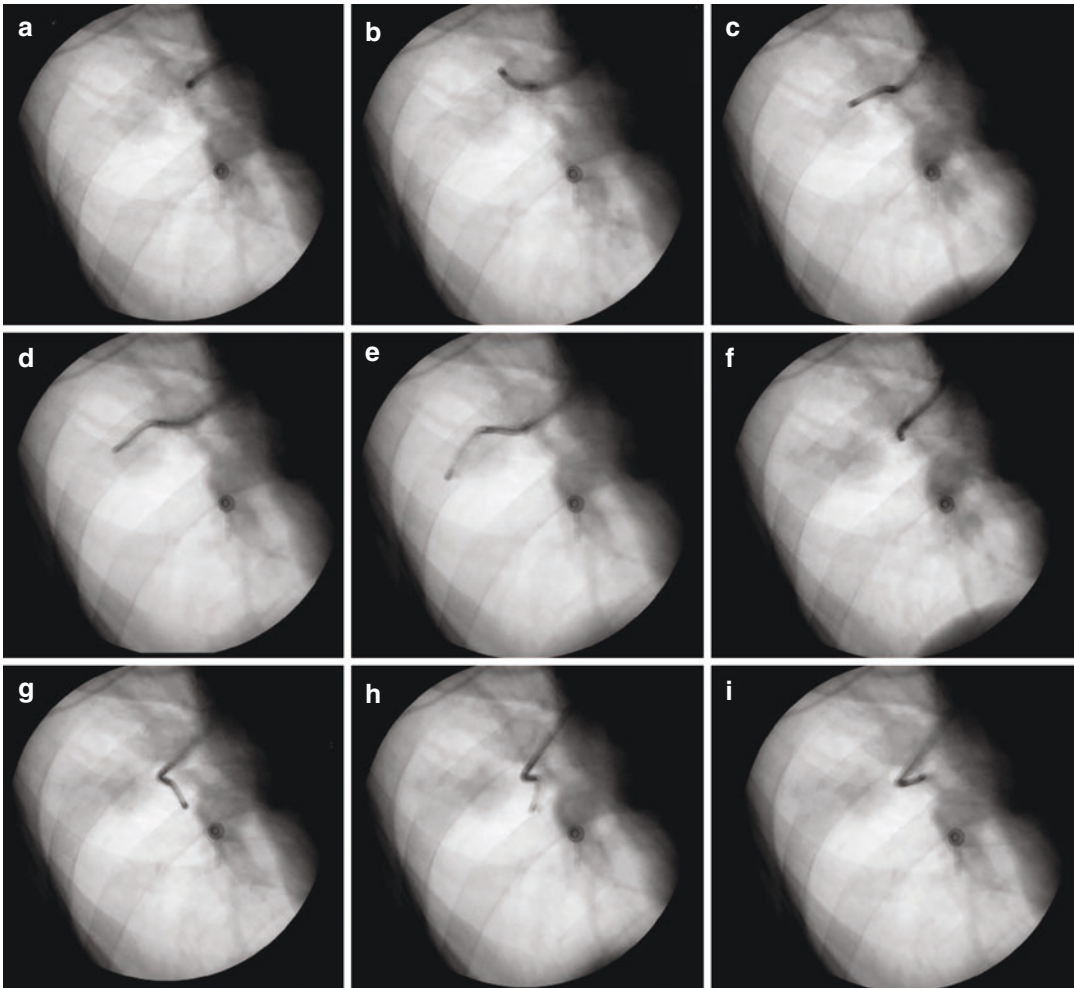
Fig. 3.7 Fluoroscopy Fluoroscopy can be used to track down the path leading to the peripheral pulmonary lesion. To assure that the right direction is followed, fluoroscopy is performed in every bifurcation (**a**–**i**). Whenever misdirected, the bronchoscope is pulled backward to the previous bifurcation and another bronchus followed

cancers were detected with low-dose CT. Of these, 73% had negative chest radiography [13]. Because CT allows for nodule detection independent of size, localization, and characteristics of the PPL, it has also been used for verifying the position of the instrument when exploring the peripheral airways [14].

Virtual bronchoscopic navigation can also be used to assist in lesion approximation. When using virtual bronchoscopic navigation systems, a trained bronchoscopist is needed to perform the virtual bronchoscopy through the previously selected path. The assistant bronchoscopist will guide the operator through the airways and will indicate the right direction in each encountered bifurcation. To date, there is only one large randomized trial comparing ultrathin bronchoscopy with and without use of virtual bronchoscopic navigation. This study by Asano et al. showed no significant differences in diagnostic yield on both groups (67.1% vs. 59.9%; $p = 0.173$) in 350 patients with peripheral nodules ≤3 cm. However, subgroup analysis of these data showed that the navigation system could be helpful for achieving nodules located in the peripheral third of the lung, those invisible in the postero-anterior radiographs and when located in the upper right lobe. Fluoroscopy was used in both groups to ensure location of the ultrathin bronchoscope and sampling of the desired location [15]. In a later study, we compared ultrathin bronchoscopy with and without virtual bronchoscopic navigation and evaluated the influence of segmentation on diagnostic yield [16]. We compared 55 cases of virtual bronchoscopic navigation-guided ultrathin bronchoscopy to 110 unguided controls. Although the diagnostic yield did not differ between both arms (47% and 40%, respectively; $p = 0.354$), an 85% diagnostic yield was observed when segmentation was optimal and the peripheral nodule was endobronchial, compared to a 30% diagnostic yield when the segmentation was suboptimal and a 20% diagnostic yield when segmentation was optimal but the lesion extrabronchial. In fact, the position of the lesion relative to the bronchus, that is, if the lesion is endo- or extrabronchial, will determine the diagnostic yield of the procedure. This point is further commented in the next section on position verification.

During target approximation with an ultrathin bronchoscope, several considerations should be made. First of all is the limited suction capability of the ultrathin bronchoscope due to the small working channel. Therefore, if abundant or thick secretions are present, it might be recommended that bronchial hygiene with a conventional bronchoscope is performed either prior to starting or during the procedure. Also, angulation of the tip of the ultrathin bronchoscope can be challenging in the upper lobes. Sometimes it might be simply impossible to overcome some anatomical angulations with the ultrathin bronchoscope. Leaving the biopsy forceps inside the working channel may provide greater stiffness to the bronchoscope in some cases. Finally, another disadvantage of ultrathin compared to conventional bronchoscopes is the quality of the endoscopic vision, not only in regard to technical manufacturing details but also to bronchial anatomy in the lung periphery. Particularly, a greater collapsibility is found in the periphery due to progressive loss of stiffness in the intrapulmonary airways. To overcome bronchial collapsibility and improve endoscopic vision in the peripheral airways, it is recommended that secretions are not aspirated and saline is continuously instilled instead. In our institution, a 50 mL syringe with room-temperature saline is connected to the working channel of the ultrathin bronchoscope. The assistant instills saline as requested, thus facilitating bypassing of secretions and bronchial lumen widening. A view of ultrathin bronchoscopy in peripheral airways under saline infusion is shown in Fig. 3.8.

Position Verification

Once the peripheral pulmonary lesion is approximated and no endobronchial abnormality is visualized, then two issues might have occurred: either approximation to the lesion has not been accurate enough, or the lesion is extrabronchial. At this point, fluoroscopy, CT, or cone-beam CT can be used to verify the position of the ultrathin bronchoscope relative to the lesion. Also, a radial
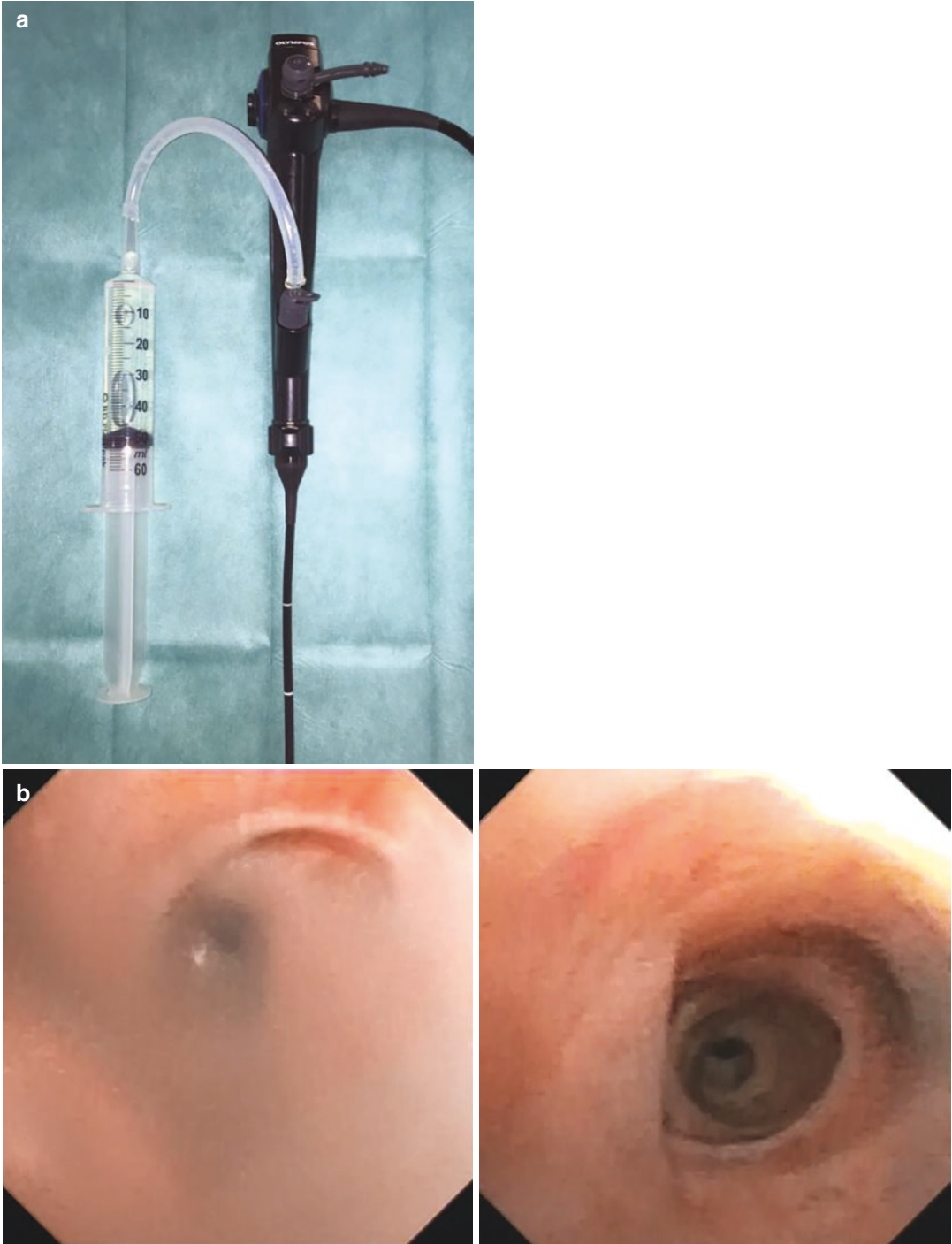
Fig. 3.8 Ultrathin bronchoscopy in peripheral airways: (**a**) 50 mL aliquot with saline connected to the working channel. (**b**) Views before and after saline infusion
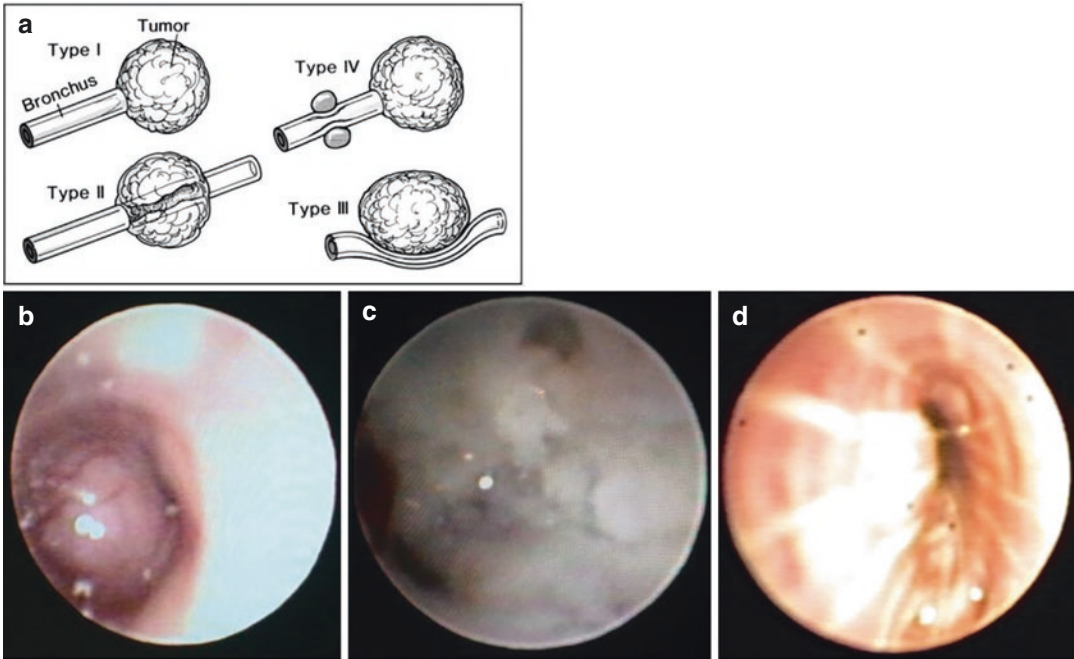
Fig. 3.9 Tsuboi's classification of the relationship between the bronchus and the nodule (**a**). *Type I*: bronchus leads to the nodule. *Type II*: the bronchus is completely surrounded by the nodule. *Type III*: extrinsic compression without bronchial mucosal invasion. *Type IV*: the bron-chus is proximally obstructed either by the peribronchiolar disease or by lymphadenopathy and then continues on to communicate with the tumor distally [17]. Figure from reference [18]. Bronchoscopic examples of each type: (**b**) Type I; (**c**) Type II; (**d**) Type III/IV

miniature endobronchial ultrasound (EBUS) probe could be used to locate an extrabronchial lesion [6, 19], although it has to be noted that the radial miniature EBUS probe mentioned in these studies was used through a novel prototype ultrathin bronchoscope that had a 1.7 mm working channel. Otherwise, if the problem is that approximation was not accurate enough, then renavigation is mandatory, when possible.

In Fig. 3.9, a classification of the relationship between the bronchus and the lesion is shown.

Sampling

Concerning the instruments that can be passed through the working channel of an ultrathin bronchoscope, the only commercialized and widely available sampling tools are "mini" versions of the cytological brush and biopsy forceps: the mini cytology brush (Olympus BC-201C-1006) and the mini biopsy forceps (Olympus FB-56D-1). Caution must be taken to manipulate the forceps as they can break more easily than larger ones and their cost is relatively high (around €1000 in Europe). A visual comparison of the sizes of the sampling instruments is shown in Fig. 3.10. The limited size of these mini sampling instruments implies that a greater number of samples need to be taken. In our institution, four to six biopsies along with cytological brush and bronchial washing samples are performed when studying peripheral pulmonary lesions.
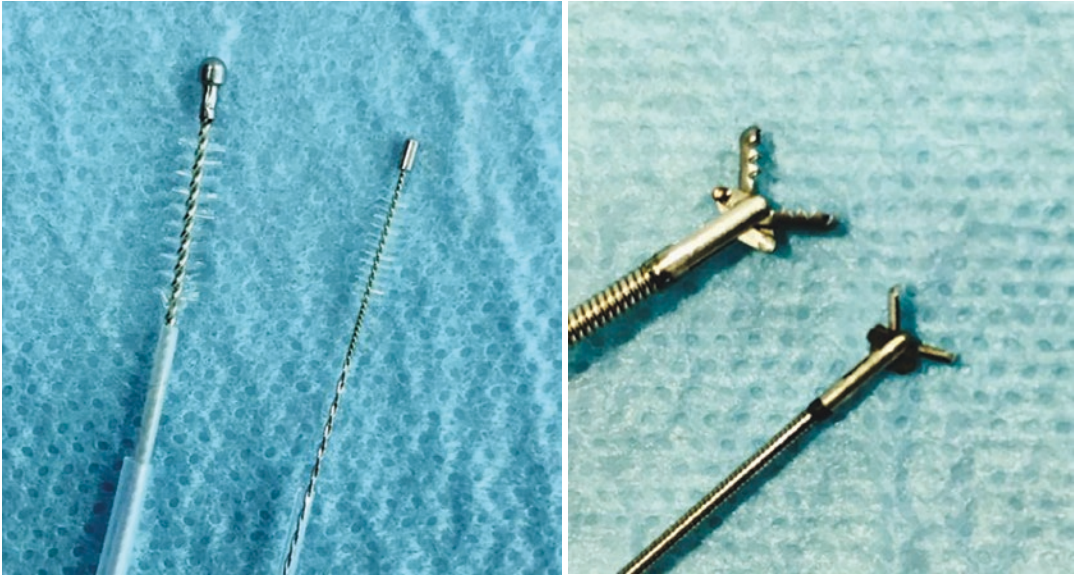
Fig. 3.10 Sampling instruments of different sizes: regular cytology brush and biopsy forceps compared to the 1 mm wide "mini" versions

Complications

Ultrathin bronchoscopy is a very safe procedure. Since it is a scheduled diagnostic procedure in the great majority of cases, complications are not frequent. However, like any invasive technique, it is not without risks. Most frequent complications of ultrathin bronchoscopy include:

- Transient fever and pneumonia, especially if a relatively high amount of saline is retained and in those patients with purulent secretions. In our institution, if purulent secretions are observed during bronchoscopy, prophylactic antibiotics with 2 g of amoxicillin/clavulanate (or equivalent in patients with penicillin allergy) are administered during the procedure.
- Pneumothorax can occur during or after sampling. Performance of a chest X-ray or thoracic echography is recommended when biopsies are performed without fluoroscopic control. A pneumothorax is seen in Fig. 3.11.

Overall, the reported complication rate for ultrathin bronchoscopy is 3% and includes pneu-

Fig. 3.11 Apical laminar pneumothorax after sampling a peripheral pulmonary nodule in the right lower lobe with an ultrathin bronchoscope

monia, bleeding, bradycardia, chest pain, extensive coughing, hypertension, lidocaine intoxication, lung abscess, and pneumothorax (in 1% of cases) [6, 11, 12, 15, 20–25].

Future Directions

Ultrathin bronchoscopes are and will be very relevant tools for the diagnosis of pulmonary nodules. Historical perspective offers a clear tendency to design wider working channels that allow use of diagnostic tools with higher diagnostic yield. These include mini probes to confirm the location and the relation to the bronchial lumen, mini cryoprobes (1.1 mm) to sample intra- and peribronchial nodules, or the expected bendable, thin, and short needles for extrabronchial lesions. One of the robotic bronchoscopy platforms (IonTM Endoluminal System Intuitive Surgical) uses a 3.5 mm outer diameter bronchoscope with a 2.0 mm diameter working channel and few mechanical constrictions as the catheter can articulate 180° in any direction. These characteristics are unbeatable, but its costs (€1 M approximately) are currently unaffordable for most centers.

As for mini cryoprobes, these may allow sampling intra- and extrabronchial lesions and may therefore improve the quality and quantity of tissue obtained [26]. A French randomized trial comparing mini cryobiopsy vs. forceps has been recently initiated (ClinicalTrials.gov Identifier: NCT05230992, March 2022) and results are expected by next year.

Nevertheless, the significant change will be the introduction of single-use ultrathin bronchoscopes. Since the Coronavirus Disease-2019 (COVID-19) pandemic, single-use scopes have experienced a substantial boost and are considered a substitute for conventional bronchoscopes in some settings (intensive care units, operating rooms, etc.). The different brands (Boston Scientific, Ambu, Bronchoflex, or Vathin) have similar external diameters of 3.8 mm with inner diameter of 1.2 mm. These single-use scopes can perfectly substitute the conventional ultrathin reusable bronchoscopes because they are cheaper (cost of acquisition and maintenance) and do not suffer a prolonged repair time when damaged. Nevertheless, the authors consider that the evolution of these scopes to longer working length

(from 60 to 70 cm) and bigger inner diameter of the working channel (from 1.2 to 1.7 mm), with less image resolution if needed to maintain the outer diameter of 3.8 mm, can let the proceduralists achieve better results with different diagnostic tools, and even consider therapeutic probes.

Summary and Recommendations

The ultrathin bronchoscope is a versatile instrument that is mainly used for diagnosing peripheral pulmonary lesions. Although it is a flexible bronchoscope, just like the standard, its small diameter allows exploring the peripheral airways and selecting the bronchial route at each bifurcation encountered. To advance the bronchoscope through the peripheral airways, however, infusion of saline might be necessary to maintain an optimal endoscopic view, facilitating bypass of secretions and bronchial lumen widening. Finally, the limited size of the working channel of ultrathin bronchoscopes implies not only that the suctioning capacity is limited but also that smaller sampling instruments must be used.

Ultrathin bronchoscopy procedure can be broken down into four steps: (1) procedure planning, which can be performed after fine reading of a high-resolution chest CT or can be supported by a planning software; (2) target approximation, which can be accomplished after memorization of the planned bronchial route or assisted by navigation software; (3) position verification, with either fluoroscopy, CT, or cone-beam CT; and (4) sampling, using small instruments that can be passed through the working channel of the ultrathin bronchoscope.

To get the utmost of ultrathin bronchoscopy in the diagnosis of peripheral pulmonary lesions, the combination of various technologies is recommended to increase the diagnostic yield.

The single-use slim bronchoscopes are more affordable than the conventional reusable flexible scopes and will progressively let this technique be broadly used.

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