Rigid Bronchoscopy

Current Role of Rigid Bronchoscopy in Modern Bronchology

Hermann Tonn, M.D.

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Hypothesis for Optimal Bronchoscopy.

In general, the more it is possible to perform rigid bronchoscopy on a routine basis, the more it will be performed when necessary. If there are circumstances, which make it more difficult for a department to perform rigid bronchoscopy, the less rigid bronchoscopy will be performed. This is not meant to be a scientific statement, simply an observation of daily experience.

A. General Aspects

The frequency of usage of rigid bronchoscopy differs from department to department and from one country to another. Several factors influence the usage of rigid bronchoscopy by pneumologists (Table 1). There is an international consensus that, especially for difficult interventional procedures under emergency circumstances, rigid bronchoscopy under general anaesthesia is the method of choice. \(^\text{1-3}\).

B. Indications for Rigid Bronchoscopy

Whenever the patient’s condition is severe because of a tracheobronchial disease, and whenever it is expected that a bronchoscopic intervention will lead to an improvement of the patient’s condition, the rigid bronchoscope offers some features, which can make the procedure

Table 1 Factors influencing the usage of rigid bronchoscopy by pneumologists

<table>
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<th>Factor</th>
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<tr>
<td>1. Hospital’s structure and organization of bronchoscopic emergency treatment</td>
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<td>a. Bronchoscopic emergency treatment by pneumologist only</td>
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<td>b. Emergency bronchoscopy by thoracic surgeon</td>
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<td>c. Emergency bronchoscopy by ENT-surgeon</td>
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<td>d. Emergency bronchoscopy of children by pediatrician</td>
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<td>e. Absence of emergency patients due to structure of hospital</td>
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<td>2. Examiner’s qualification (education, training and experience in bronchology)</td>
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<td>3. Availability of an anaesthetan</td>
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<td>4. Access to an operating room or a similar facility</td>
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<td>5. Patient’s attitude (cultural influence) towards general anaesthesia</td>
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* Heidehaus Hospital, Hannover, Germany

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quicker and safer than fiber-bronchoscopy.\textsuperscript{4,5} 

Fiber-bronchoscopy can be time-consuming because the instruments, especially the forceps, are much smaller than the instruments of the rigid scope. A mechanical removal of an endobronchial tumor, which does not bleed excessively, is, of course, possible by fiber-bronchoscopy, but the use of bigger instruments with the rigid scope usually makes the procedure much faster. Additionally, general anaesthesia offers the possibility of working under optimal conditions. There are no unexpected movements of the patient and no co-operation of the patient is required. This is essential for precise endobronchial manoeuvres e.g. for laser therapy. There are some strong indications for therapeutic procedures and some diagnostic indications for rigid bronchoscopy\textsuperscript{6-12} (Table 2).

### C. Anaesthesia for Rigid Bronchoscopy

#### C. I Local Anaesthesia

Nowadays local anaesthesia for rigid bronchoscopy has only very rare indications such as:

1. Suction of sticky secretion in patients who are in a poor general and respiratory condition. The rigid sucker does not get obstructed as fast as the suction channel of the fiber-bronchoscope.
2. Removal of a foreign body in patients who are in the same condition described in item 1.
3. Patients in condition mentioned above with severe tracheobronchial stenosis, in which a passage of the stenosis with the fiber-bronchoscope would lead to a complete obstruction of the airway.

#### C. II General Anaesthesia

General anaesthesia greatly facilitates rigid bronchoscopy. Safety-requirements are met if an experienced anaesthetist is performing the anaesthesia. Patients in a compromised condition should be monitored by an anaesthetist anyway, even if rigid bronchoscopy is performed under local anaesthesia or under so called "deep sedation".

General anaesthesia can also be applied to patients who refuse local anaesthesia, who are expected not to co-operate during local anaesthesia (mentally disordered people, foreign people with communication problems because of language problems, children). If clinical examination, blood tests, ECG, (in some cases additional echocardiogram) pulmonary function tests and blood gas analysis do not show any contraindications against general anaesthesia, we perform rigid bronchoscopy. In these cases, where general anaesthesia is needed due to the patient's condition, we prefer intubation with the rigid tube, although fiber-bronchoscopy via a flexible oral or nasal tube for ventilation is technically possible.

**TIVA** (total intravenous anaesthesia) is the method of choice as an anaesthetic technique\textsuperscript{13-15}. All volatile substances that are potential health hazards for the examiner and his staff should be avoided. Exceptions can be made in children's general anaesthesia\textsuperscript{16}.

For quick recovery of the patient, especially for the outpatient, in our department supplementary topical local anaesthesia is not used.

### Table 2: Indications for Rigid Bronchoscopy

<table>
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<th>Strong therapeutic indications:</th>
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<tr>
<td>1. Emergency interventional procedures</td>
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<tr>
<td>2. Massive hemoptysis, (suction, insertion of tamponades)</td>
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<td>3. Laser (argon beam, electrocautery) treatment in well vasculated tumors</td>
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<tr>
<td>4. Treatment in high-grade malignant and non-malignant tracheobronchial stenosis (stenling, dilatation, multimodal endobronchial procedures)</td>
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<td>5. Double stenting in one session (esophageal and tracheobronchial)</td>
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<td>6. Removal of (big and sharp-edged) foreign bodies</td>
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### Diagnostic indications:

1. Deep staging biopsies
2. Perbronchial puncture of lymph nodes or tumor with the usage of the deflecting device
3. Pediatric bronchoscopy (therapeutic is supposed to follow)
Our anaesthesiological department uses methohexital as the hypnotic drug, remifentanil as the analgetic drug. Both are given continuously via perfusor after a bole also is given via perfusor for induction. For muscle relaxation succinylcholine is given for induction after precurarisation with alcuronium and - if necessary - repetitive doses of succinylcholine follow, given manually. For interventional procedures, which last more than about half an hour, propofol and midazolam are given. In this case cisatracurium replaces succinylcholine for muscle relaxation. TIVA used by our anaesthesiological department is shown in Table 3.

In principle, general anaesthesia for bronchoscopy can be performed without using muscle relaxants\(^{17}\), but in our opinion intubation with the rigid scope and performance of bronchoscopy are easier and safer with usage of muscle relaxants.

If spontaneous ventilation is not maintained, either jet ventilation or manual ventilation is used\(^{18}\).

Manual ventilation requires good cooperation between anaesthetist and bronchoscopist, especially in interventional bronchoscopy, since there is a rapid change between a half open and an open ventilatory system, which leads to many interruptions of ventilation. In spite of sufficient oxygenation of the patient monitored via oxymetry, CO\(_2\) retention can occur, if CO\(_2\) is not monitored by repetitive blood gas analysis, transcutanously or via a separate channel of a special bronchoscope.

<table>
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<th>Table 3</th>
<th>TIVA (total intravenous anesthesia)</th>
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<tr>
<td>Induction:</td>
<td>Remifentanil 1(\mu g/kg) in 90–120 seconds</td>
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<td></td>
<td>Methexital 1–1.5 mg/kg</td>
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<tr>
<td>Precurarisation:</td>
<td>Alcuronium 2–3 mg</td>
</tr>
<tr>
<td>Relaxation:</td>
<td>Succinylcholine 1–2 mg/kg</td>
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<tr>
<td>Maintenance:</td>
<td>Remifentanil 0.3–0.7 (\mu g/kg/min) continuously</td>
</tr>
<tr>
<td>Extra bole:</td>
<td>Remifentanil 0.5 (\mu g/kg)</td>
</tr>
<tr>
<td>(facultative)</td>
<td>Methexital 0.03 mg–0.05 mg/kg/min continuously</td>
</tr>
<tr>
<td></td>
<td>Succinylcholine 0.2–0.5 mg/kg on demand</td>
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</table>

C. III Postoperative Care

All patients are monitored with ECG, pulse oxymetry, blood pressure measurement and of course clinical surveillance in the recovery room. Patients who have received interventional procedures are surveyed for at least 24 hours in the ICU. Some patients need to be intubated and ventilated after interventional bronchoscopy. Repetitive fiber-bronchoscopic suction might become necessary due to oozing haemorrhage.

D. Techniques of Rigid Bronchoscopy

In the early years of rigid bronchoscopy the examination was carried out under local anaesthesia. Nowadays, this technique is only used in rare exceptions as there are suction of sticky secretions in elderly patients or patients in a compromised general condition as mentioned already above. Suction with a fiber-bronchoscope would lead to rapid obstruction of the suction channel of the fiber-bronchoscope.

D. I Intubation

D. I a Positioning of the Head

After induction of general anaesthesia the head is somewhat retroflexed, the position of the chin is nearly upright. Depending on the anatomical conditions of the patient (size of patient’s head, length of neck, shape of thoracic spine, special problem: kyphosis!) a little cushion is laid under the neck, under the head or between the shoulders. Overextension of the head must be avoided. Preferably before intubation with the rigid scope, a preview of the larynx as well as the proximal
Table 4 Variants of intubation technique

1. Intubation without laryngoscope, with direct view through the rigid bronchoscope tube
2. Intubation without laryngoscope under direct vision of 30-degree telescope
3. Intubation without laryngoscope with 30-degree telescope and video camera
   a. Visualization on monitor only
   b. "Split beam adapter", allows for direct view as well as visualization on monitor
4. **Intubation with laryngoscope and direct view through the rigid bronchoscope tube**
5. Intubation with laryngoscope under direct vision of 30-degree telescope
6. Intubation with laryngoscope with 30-degree telescope and video camera
   a. Visualization on monitor only
   b. "Split beam adapter", allows for direct view as well as visualization on monitor

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**Fig. 1** Laryngoscope in position and preview with 30-degree telescope.

**Fig. 2** Laryngoscope in position and intubation with rigid tube.

**Fig. 3** Bevel of rigid tube elevates epiglottis.

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The vocal cords can be seen (Fig. 3). Before passing the vocal cords, the rigid scope is rotated 90 degrees clockwise (Fig. 4). The laryngoscope is removed after intubation. Sometimes it has to be removed
before intubation, because in some patients both instruments do not fit into the oral cavity at the same time.

The middle finger of the left hand is placed on the upper gum (Fig. 5). The rigid bronchoscope is advanced with the right hand between the index finger and the thumb of the left hand. The uppermost pressure lies on the thumb of the left hand protecting the teeth of the upper gum and the gum itself. Sometimes it is easier to lead the bronchoscope via the right corner of the mouth than via mid-position. The upper incisor teeth can create difficulties in intubation. The longitudinal axis of the trachea and the longitudinal axis of the rigid scope should be parallel. Sometimes it is necessary to correct the position of the patient’s head and neck after intubation with the help of a cushion.

D. I c Difficult Intubation

Intubation without a laryngoscope or after withdrawal of the laryngoscope has to be made in cases of small oral cavities, big and/or faulty, loose teeth. In contrast to an intubation with an oral flexible tube - this is an advantage at the same time - during intubation the epiglottis can be elevated by the rigid bronchoscope and during intubation vision through the scope is possible, allowing visualization of the tip of the instrument all the time. After passage of the vocal cords by an oral flexible tube, the tip of the flexible tube cannot be seen anymore, making this part of the intubation “a blind one”.

D. I d Failure of Intubation with the Rigid Tube

There are always patients who cannot be intubated with the rigid bronchoscope due to anatomical conditions. If in these cases sufficient ventilation via mask is possible, it may be attempted to intubate the patient either with an oral flexible tube or a nasal tube under fiberoptic control. After this the examination can be done via fiber-bronchoscope. If the patient cannot be intubated even with an oral flexible tube and if ventilation with the mask is sufficient, a fiberoptic examination can be performed via a special mask adapter. Another alternative is the fiber-bronchoscopic examination via a laryngeal mask[20][21].

If it is not possible to ventilate the patient via mask, the whole procedure should be stopped, before multiple manipulations lead to an oedema of the larynx and cause severe respiratory symptoms. Sometimes later on, the examination might be performed under local anaesthesia with the flexible bronchoscope. (Irrespective of bronchoscopic procedures, intubation in the difficult airway with the help of the fiber-bronchoscope does play an enormous role in anaesthesiology[21])

D. I e Risks of Intubation

Intubation with the rigid tube must be carried out very carefully to prevent any damage to the patient. The main risks concerning intubation are
tooth’s damage, damage of lips and gums, trauma of larynx and laceration of the posterior wall of the trachea.

D. II Sequence of Examination
The narrowest spot of the trachea is the cricoid. After passing the cricoid and inspection of the trachea and the bifurcation, the side of the bronchial system, which is supposed to be healthy, is inspected first. Generally we use the 30-degree telescope; the 90-degree telescope is used for inspection of the upper lobes and sometimes also for the segment 6 on both sides. For inspection of the right side the head of the patient is turned a little bit to the left, in analogy for inspection of the left side the head is turned a little bit to the right.

For manipulation inside the central airways of adults, rigid instruments are recommended in general. We work with “optical forceps”, therefore biopsies and removal of foreign bodies can be performed under vision.

In children, small lumen instruments are used and “non-optical forceps” in very small diameters are available. In this case, the telescope and forceps must be inserted and directed separately, which often is much more difficult than in adults.

For manipulations in the periphery, we use the so-called “deflecting device” or the fiber-bronchoscope. The deflecting device needs more experience of the examiner, guidance of the instrument is more difficult and the range of access is not as wide as with the fiber-bronchoscope\(^{21}\). One advantage of the deflecting device however is its rigidity, which prevents puncture needles or forceps from involuntarily moving to the contra-lateral side of the biopsy or puncture, which sometimes occurs in biopsies and per-bronchial punctures with the fiber-bronchoscope.

One main advantage of the rigid bronchoscope is the rigid suction tube, which does not occlude as easily as the suction channel of the fiber-bronchoscope due to blood or other sticky secretions. In heavy bleeding two or even three suction tubes can be brought into the rigid scope. In addition, in contrast to the flexible fiber-bronchoscope, the insertion of tamponades is possible. The removal of foreign bodies is often faster and safer with the rigid bronchoscope.

In stenting\(^{23-26}\), sometimes it is necessary to use a tracheoscope, which is shorter than a conventional rigid bronchoscope. In stenting of the trachea, the length of the stent plus the length of a conventional bronchoscope would prevent the possibility of suction via fiberscope of the distal part or parts of the stent just placed.

In general, the rigid scope gives a wide range of possibilities in using different bronchoscopic tools, which can be used according to the underlying diseases and the concurrent situation of the examination.

E. Complications and Risks of Rigid Bronchoscopy
The risks of rigid bronchoscopy in comparison to fiber-bronchoscopy are hard to evaluate. Patients with critical respiratory conditions are more likely to receive rigid bronchoscopy. If these patients were scored with a special risk score for bronchoscopy, the patients would have higher scores than those who are examined under local anaesthesia by fiber-bronchoscope. Also some interventions absolutely cannot be managed by fiber-bronchoscopy, e.g. high-grade subglottic stenosis or high-grade tracheobronchial stenosis due to hard extra tracheobronchial tumor compression (Fig. 6). That means that it is not possible e.g. to plan a double blind study to compare both methods.
In addition to the intubation problems that are already mentioned above, there are some other risks and complications. The most severe phase of the examination is the postoperative phase in which the patient, who is already compromised by his respiratory disease, must come over the effects of general anaesthesia. Also, during and after bronchoscopy barotrauma and possible tension pneumothorax can occur.

Bleeding as an indication for bronchoscopy and bleeding after manipulations in the bronchial system (biopsy, laser treatment) can cause severe problems. On the one hand, the big biopsies taken with rigid biopsy forceps can more easily lead to heavy bleeding. On the other hand, the management of heavy bleeding is easier with rigid instruments than with fiber-bronchoscopic tools under local anaesthesia. Efficient suction is needed as well as the possibility to insert tamponades, and sometimes after tamponing immediate operation must follow. Sometimes, an alternative to tamponing is the intubation with a double lumen oral tube with the possibility to ventilate only the healthy lung.

During examination, CO₂ retention can be a problem. Especially during manipulation on one side of the bronchial system, the contra-lateral lung may not be sufficiently ventilated. This can occur in laser treatments that last for a long time. In these cases smoke inhalation trauma can occur.

In stenting, sometimes misplacement of a stent can lead to several attempts of placing the stent properly. In some cases, the stent has to be pulled out together with the rigid scope, since the stent does not fit into the rigid scope anymore once it has expanded within the bronchial system. Therefore sometimes it is necessary to perform several re-intubations with the rigid scope. Placement of the dynamic stent is performed in apnea after extubation of the rigid tube anyway. The re-intubations must follow quickly in patients who do not have respiratory reserves. Thus a quick and perfect intubation technique of the bronchologist is mandatory.

Training of the bronchologist is the key to make rigid bronchoscopy a safe procedure. In some departments lack of experience may lead to problems in performing rigid bronchoscopy.

It cannot be expected that every department can perform rigid bronchoscopy every day. Since in our department this possibility is given, there are enough opportunities in gaining experience with rigid bronchoscopic procedures. In our point of view it is a decisive advantage to perform rigid bronchoscopy as if it was "routine". In departments in which this "routine basis" is for whatever reasons not given, extra rigid bronchoscopy training is believed advisable.

Summary

Several factors influence the use of rigid bronchoscopy, including the patient’s bronchopulmonary disease and accompanying illnesses, the examiner’s qualification in bronchology, and the hospital’s structure. The domain of rigid bronchoscopy now includes interventional procedures like laser therapy, tracheobronchial stenting and removal of foreign bodies. Whenever rigid bronchoscopy is used and when the technical possibilities of rigid bronchoscopy are used in addition to the technical possibilities of fiber-bronchoscopic tools, a broad variety of endobronchial procedures can be performed. Nevertheless potential risks and complications of rigid bronchoscopy must be taken into consideration.

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