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Rigid and Flexible Bronchoscopy in the Sitting Position: A Case Report and Historical Review

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Summary and Background: Laryngotracheobronchial endoscopy techniques and equipment have rapidly advanced since the mid-1800s. Techniques and equipment continue to evolve as do the endoscopists. Older rigid equipment and endoscopy techniques have been rapidly replaced by the current modern flexible and video equipment training programs. Historically, sitting bronchoscopy has been utilized in both diagnostic and treatment situations. Upright positioning was more common when rigid bronchoscopy was the only option.

Conclusion: As with many medical advances, older diagnostic and therapeutic techniques frequently are discarded and forgotten. Modifications in equipment have greatly reduced both the need for rigid and the need for the sitting position bronchoscopy. However, sitting or upright bronchoscopy utilization, usually flexible, continues on a limited basis at this time.

Key words: Tracheobronchoscopy

Physicians have examined the human orifices—rectum, vagina, urethra, auditory canal, oral and nasal cavities—for centuries. Initially, these openings were only available by direct manual or ocular examination. John Hunter in 1755 kept a dog breathing artificially by cutting into the trachea and inserting a double lumen bellows after Robert Hooke did such for the Royal Society in 1664.[1] By the early 1800s, Dr. Bozzini, in 1806, performed bladder examination using paper rolled into a tube with a candle behind his ear for illumination.[2,3] Slowly the endoscopy knowledge and enthusiasm grew along with the development of equipment to examine deeper into these structures.

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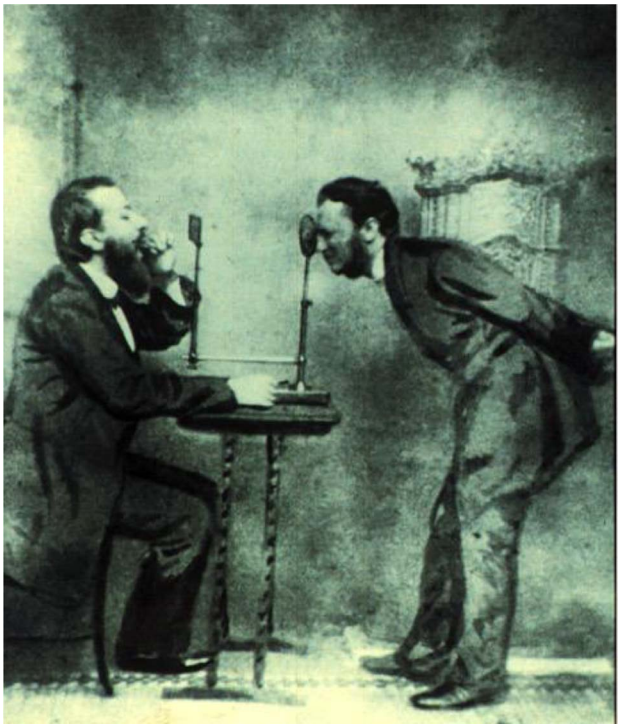

Fig. 1 Indirect laryngoscopy. (Courtesy Heinrich D. Becker.)

Fig. 2 Lower tracheoscopy anterior approach 1896 (Pieniazik) while sitting. (Courtesy Heinrich D. Becker.)

Bronchoscopy, as developed by early physicians, has had a slow evolution since Hippocrates (460–370 BC) first suggested insertion of a pipe into the larynx of a suffocating patient.[3] Avicenna used a silver pipe about 1000 AD and Vesalius used a reed in an animal with an open chest to assist respiration.[3] Nasotracheal intubation for suffocation and foreign body removal was advised in the 1700s. Tracheotomy and blind tracheal intubation were developing in the mid to late 1800s. Limitations existed, however, that required nonmedical scientific advancement before the patient and the physician might benefit from a more revealing interventional endoscopic view. Better mechanisms were developed to assist in the building of a "scope" and to replace candles or sunlight with a more illuminating light source. In the 1870s, electricity was discovered by T.A. Edison, and, through research, techniques were developed to safely direct the light through a specific tube toward the target to be examined.

Indirect laryngoscopy (Fig. 1), and examination with a laryngeal mirror and the illuminator (a box with a candle) was followed by Edison's electric bulb. Endoscopy and thoracoscopy then became possible with the use of local anesthesia—especially cocaine.[2] With the concept of endoscopy now proven, development of techniques to remove foreign bodies or examine specific areas improved and attachment of electric light sources to a hollow metal tube bronchoscope followed (Fig. 2). Gustav Killian developed direct tracheobronchoscopy for foreign body extraction after working on cadavers[4] (Fig. 3). Early on, Killian also developed the "Killian's Chair" for the sitting position bronchoscopy[4] (Fig. 4). Unfortunately, this chair technique proved cumbersome for some patients and physicians.[3,4]

Meanwhile, the first esophagoscopy was performed by Adolf Kussmaul in 1868 at Strassburg.

Killian used his endoscope for bronchoscopy. In 1897, Killian performed the first translaryngeal bronchoscopic study.[3] Shortly after, in the United States, Chevalier Jackson, Karl-Storz, and Pillings all added to the advancement of bronchoscopy. Jackson showed a keen interest in bronchoscopy and further development of the equipment required to perform such (Fig. 5). By the early 1900s, many other physicians also became interested in thoracic endoscopy. This included a Swedish internist, Hans C. Jacobaeus, who in 1906 showed an interest in invasive thoracoscopy.[5] Shortly thereafter, further refinement of the endoscopic techniques and safety design was followed by rigid esophagoscopy.

The extent and quality of the procedures were limited by the available anesthetic—local or general. Cocaine, ether, and procaine became available as

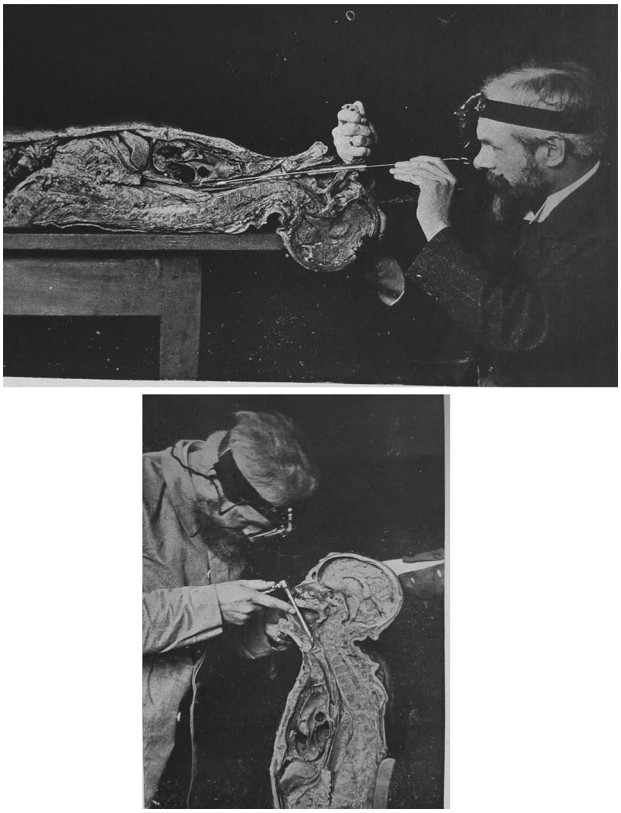

Fig. 3 Killian developing tracheoscopy and laryngoscopy techniques on frozen corpse for upper airway exam. (Courtesy Heinrich D. Becker.)

these early physicians developed and modified their new endoscopic procedural techniques. The location and available facilities for performance of these procedures were limited as was patient monitoring. Unfortunately, complications and patient discomfort led to shortened and incomplete procedures on many occasions, stimulating further development of safer scopes (Fig. 6).

One of the concerns for these early diagnosticians was the positioning of the patient. Should the patient be supine or in a lateral, prone, or upright position (Fig. 7). Each position had its advantages and risks. Many physicians favored the patient to be supine during bronchoscopy with a registered nurse assistant to hold and maintain the proper head and body position for safe performance of the procedure. Others found the upright or sitting position to be more favorable—the "sword swallowing" technique. We have used the rigid bronchoscopic and esophagoscopic techniques in both the sitting and the supine positions on many occasions in many facilities. A case report might illustrate both the rigid technique and an indication for bronchoscopy in the sitting patient.

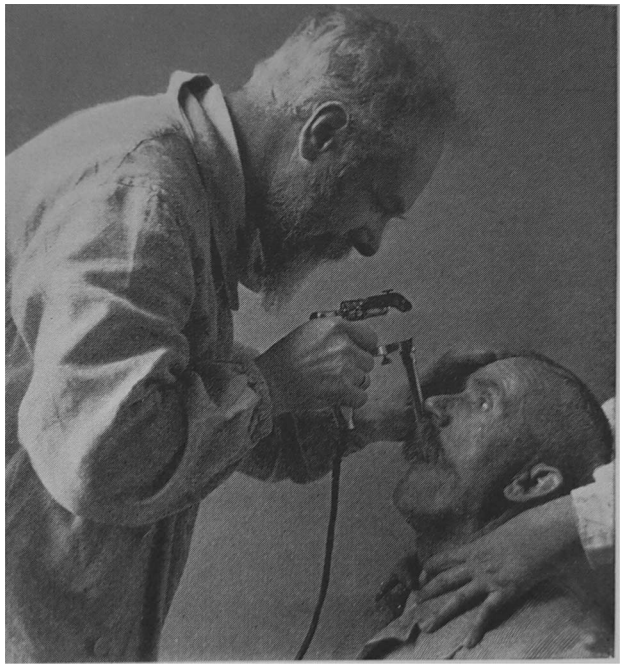

Fig. 4 Killian sitting chair position for bronchoscopy procedure. (Courtesy Heinrich D. Becker.)

Case Report

A healthy young, registered female nurse was 7 1/2 months pregnant when seen in emergency consultation by us at 9:00 PM one Sunday evening. She related a history of "progressive asthma" treated over the previous 3 years and was now severely dyspneic and markedly cyanotic while sitting upright in a chair. She

Fig. 5 Jackson traveling case showing various bronchoscopic equipment. (Courtesy Heinrich D. Becker.)

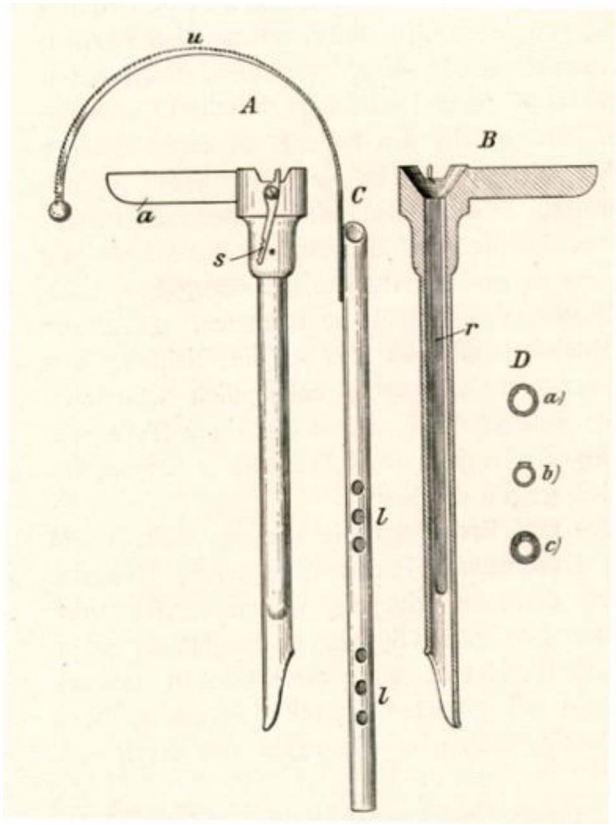

Fig. 6 Double scope (one within the other) with a spring to prevent intratracheal scope loss due to slippage. (Courtesy Heinrich D. Becker.)

had an audible stridor while maintaining her chin stretched upward and forward in order to breath. Her chest x-ray reportedly showed no abnormality from 2 years prior. Indeed, it appeared normal on the posterioanterior view. But, on the lateral chest roentgenogram, a "defect" in the tracheal air column was present at the level of the carina. After discussing the findings and options with her, she was immediately prepared for a tracheobronchoscopy. Local 4% xylocaine was administered percutaneously intratracheally with a #22-gauge needle with the patient sitting upright in a straight back chair. Then, with her neck stretched upward to breathe and her head tilted backward and slightly to the right to lay against my abdomen, she opened her mouth wide. A "4 × 4" sponge covered her teeth while holding her lips back. Then, with the senior author (R.A.D. Jr) standing on a low operating room (OR) footstool behind her, a rigid 8 × 40 Jackson bronchoscope was readily inserted. The bronchoscope readily passed between the open vocal cords and almost fell into the straightened trachea. Immediately, a large tumor was visualized nearly totally occluding the tracheobronchial junction at the level of the carina with only a tiny thin moon-shaped anterior space in front of the tumor through which air could pass on inspiration. This points out on exam that not all wheezing in an adult is due to asthma.

After multiple telephone consultations with experienced tracheal surgeons from 2 local and 2 national medical centers, all of whom declined to accept the patient in transfer, emergency surgery was planned. Six hours later, at 6:00 AM the following morning, she was again taken to the OR and a peroral rigid bronchoscope was passed directly through the tumor in order to ventilate the left lung. Four and one-half minutes later, a healthy female infant was delivered by cesarean. After closure of the uterus and abdominal incision, the patient was positioned on her left side for a right lateral thoracotomy. En bloc resection of the carina and distal trachea along with the tumor was followed by a primary anastomosis of the right and left bronchi to the proximal trachea—forming a new carina. Three decades later, she showed no evidence of recurrence, was breathing well, and both she and her daughter were doing well.[6]

Early History

The early rigid bronchoscopes had a clear cap or lens through which one could look and yet not have material coughed into the examiner's eyes. The bronchoscopes were straight, rigid, and of various sizes (2 to 8 mm) with the light source near the examiner's eye and multiple side port access (Fig. 8). As time progressed, a light channel was added so that the illuminating light bulb was placed at the tip end of the scope, near the pathology. This provided much better visualization of both the endo-bronchial regions and the pathology, but with the bulb occasionally covered by mucus or blood. By turning the patient's head from side to side, the tip of the scope could then be maneuvered into either the right or the left bronchus. Long rigid telescopes, with various mirror and light angles for better segmental orifice and pathology visualization, were developed to pass through the bronchoscope. Long forceps were devised for tissue biopsy or for removal of foreign bodies. Locally, with the availability of the Jackson bronchoscope and the improved light sources at the distal end of the bronchoscope, bronchoscopy was performed more readily and in special bronchoscopy rooms.

The opportunity to bronchoscope a patient was first presented to the senior author at Cook County hospital—first as a medical student and then as an intern. From that time forward, hundreds of

Fig. 7 Rigid bronchoscope performed in various live patient positions. 335 Examination in prone position; 336 Examination in left lateral position; 337 Examiner standing behind sitting patient; 338 Examination lying on back. (Courtesy Heinrich D. Becker.)

rigid bronchoscopic procedures were performed at multiple facilities with the patient in both the sitting and reclining positions. Table 1 demonstrates the health care locations at which rigid bronchoscopy was performed in the upright sitting position.

Routinely, in each hospital or the university, when it was suggested that we perform the procedure in a sitting position, the staff nurse or OR supervisor would say "no"—you can't do it that way—it can't be done with the patient sitting. In the 1950s to the 1980s, a head holder was always available for positioning the patient's head during rigid bronchoscopy and rigid esophagoscopy. This person was rarely found to be necessary by ourselves when performing bronchoscopy with the patient in either the sitting or lying position. The staff would repeatedly express concern that it was not possible to perform the procedure without a head holder, whether the patient was sitting up or lying. But, after the procedure, they were always amazed to see its ease of performance during which the mediastinal structures did not compress the airway.

Fig. 8 Rigid bronchoscope with multiple access ports. (Courtesy Heinrich D. Becker.)

Before elective procedures, the patient usually received a light sedative and then gargled a topical anesthetic, either liquid or gel. Frequently, elective patients received preoperative morphine, atropine, and Nembutal, without any complications. Local intratracheal anesthetic was then injected using an indirect laryngeal mirror for guidance. Initially, 2 mL of 10% intratracheal cocaine was used as a topical anesthesia. Later 4% xylocaine (2 to 4 mL) was injected percutaneously intratracheally with a #22 needle.

Usually, direct upper lobe segmental visibility was obtained with the rigid bronchoscope while using right angle telescopes. The remainder of the segmental

Table 1 Facilities where sitting rigid bronchoscopy was performed by the senior author (Raymond A. Dieter, Jr, MD)

Year	Place	Position	City
1960–1961	Cook County Hospital	Student/Intern	Chicago, Illinois
1961–1963	USPHS Hospital	Lieutenant	Mt. Edgecumbe, Alaska
1965–1966	Hines Veterans Hospital	General surgery resident	Hines, Illinois
1967–1969	Hines Veterans Hospital	Thoracic resident	Hines, Illinois
1969–1979	Loyola University	Attending	Maywood, Illinois
1970–1985	Central DuPage Hospital	Attending	Winfield, Illinois
1972–1985	Elmhurst Hospital	Attending	Elmhurst, Illinois

bronchi were visualized directly. When the flexible bronchoscope became available, the number of rigid bronchoscopy procedures and the use of the sitting position for bronchoscopy were reduced. We did continue to perform the occasional upright or semi-upright flexible transnasal bronchoscopy in those patients who could not lie down due to severe dyspnea or in those who had marked physical deformities. As with the rigid bronchoscope, few complications were noted while performing the flexible procedure in the sitting position. We further found that certain patients, such as with the preceding case report, continued to benefit from the sitting or upright position (Table 2).

However, there are situations that prohibit the sitting procedure for bronchoscopy. The very apprehensive patient or the medically unstable individual requiring anesthesiology assistance and/or general anesthesia usually contraindicates the upright endoscopy position except as an assistance for endotracheal intubation (Table 3). Further, patients with foreign bodies, especially those objects that are difficult to grasp or very heavy, have required a head-down–foot-up Trendelenburg position, in order to remove the object with the aid of gravity and the more modern endoscope. Other trans-bronchial therapeutic procedures including brachytherapy and bronchial tamponade for bleeding are usually best performed with the patient lying supine.

Literature Review

Over the years, a number of authors have discussed the performance of bronchoscopy in various positions, including the sitting or upright position.[7] With the development of the flexible fiberoptic bronchoscope, a rapid utilization conversion from the rigid to the new flexible bronchoscope occurred. As a result of this transition, many newer or more recent endoscopic trainees have never seen or performed rigid bronchoscopy. But those with the rigid bronchoscopy experience almost certainly have never seen the procedure performed under local anesthesia with the patient sitting upright in a chair.

Fifty years ago, the only bronchoscopes were rigid in construction and the light source was less than dependable—frequently burning out during the procedure. The light carrier would then be replaced, or a new bulb placed. In addition, the bronchoscopes of that era had a lens near the physician's eye for visualization but a long distance from the area of potential pathology to the eye, while placing the physician's eye in a direct line with the coughed or expectorated material. Hence, a protective "welders" wrap around head shield, a rotating clear plastic disk, or glasses were worn by the endoscopist between the bronchoscope and the bronchologist—a valuable protective eye device. This aided in the prevention of infectious agents, such as tuberculosis, or of tumor cells being coughed in the face or eye of the endoscopist or, when present, the head holder.

Most endoscopists used a "head holder" for stabilization of the patient's hyperextended head during a supine rigid procedure. This was not a requirement for the senior author during a sitting (as presented) or a supine bronchoscopic procedure during which he would sit on a stool and rest the patient's head on his

Table 2 Possible indications for upright or sitting bronchoscopy

1. Severe dyspnea lying down
2. Large tumor masses in neck (e.g., a huge tracheal compressing thyroid)
3. Pediatrics—to discern acute, upper airway obstruction
4. Patient apprehension when lying down
5. Assist in endotracheal intubation
6. Postoperative intensive care patients in an intensive care unit bed

Table 3 Situations that may prohibit the sitting bronchoscopy

1. Patient medically unstable
2. Extreme apprehension
3. Concern for bleeding
4. Need for upper lobe biopsy
5. Mobile foreign bodies (especially heavy) (We have found the head-down supine position may be best.)

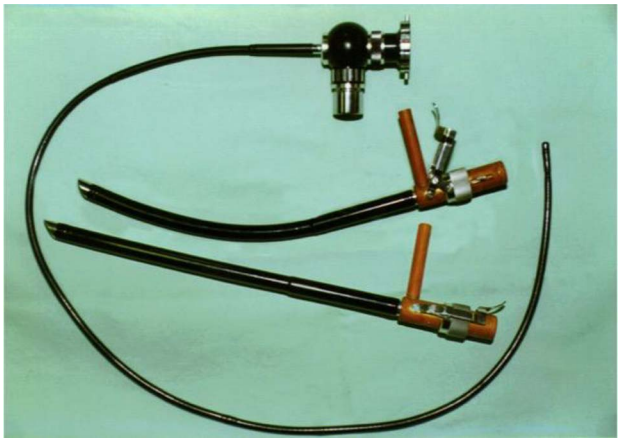

Fig. 9 Rigid and flexible bronchoscope. (Courtesy Heinrich D. Becker.)

knee and manipulate the OR table and headrest as necessary. When performing bronchoscopy with the patient sitting in a chair or in the upright position in an intensive care unit bed, one would stand behind the patient with the neck hyperextended and the head slightly turned to the right. The rigid endoscope (usually an 8 × 40 in the adult) would almost fall between the cords into the trachea. The patients were able to breathe more readily with the delivery of oxygen through a side port on the bronchoscope and usually were very "comfortable." Many required little or no anesthesia—topical or intravenous (Fig. 9).

Bronchoscopic techniques have advanced rapidly, with most procedures now performed in the supine position using a flexible bronchoscope. There does still remain an occasional need to perform the endoscopic procedure in the upright position. This has been highlighted in a number of circumstances such as the patient with a large or enlarging neck mass, especially when the patient requires tracheal intubation.[8] Diagnosis of and treatment for children's upper airway obstruction has also utilized the sitting position for the acutely dyspneic child.[9] Other physicians, however, have felt that a supine position with low flow supplemental oxygen was preferable.[10]

Kedla *et al*[11] evaluated the use of the flexible bronchoscope in upright patients with coexistent airway disease and poor lung function. They, and others, concluded that bronchoscopy was an acceptable safe procedure performed in the upright and sitting position in these pulmonary limited patients.[9] We have also found that diagnosis or treatment of patients in the sitting position may be safely accomplished by using either the rigid or flexible scope. Carcinomas may be diagnosed, and tracheal or bronchial stenosis located and dilated. Routine analgesia and possible sedation have been used before, during, and after the procedure; but, in the severely dyspneic, cyanotic, and unstable adult situation with severe post long-term endotracheal tube–induced tracheal stenosis (2–3 mm orifice), the patients were preferentially dilated under general anesthesia while supine through progressive rigid bronchoscopic dilation using progressively larger bronchoscopic sizes.

On occasion, the only anesthetics used were the topical agents. Using this policy, some physicians have preferred the supine over the upright position in the pneumocystis carinii suspect.[12] However, the awake patient on a respirator with an endotracheal tube in place may be more comfortable in the sitting or semi-upright position during endoscopy. These patients may thus tolerate bronchoscopy better in the upright or semi-erect position. As previously mentioned, the individual patient in whom little or no sedation and little or no anesthesia will be utilized has accepted and tolerated the upright or nearly upright sitting position rigid or flexible bronchoscopy—some on a daily basis when in the intensive care unit for a week or more.

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