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A SHORT HISTORY OF BRONCHOSCOPY

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In his article titled "*Entfernung eines Knochenstücks aus dem rechten Bronchus auf natürlichem Wege und unter Anwendung der directen Laryngoskopie*" in issue No. 38 (September 1897) of *Münchener Medicinische Wochenschrift*. O. Kollofrath, assistant to Gustav Killian at the Poliklinik of Freiburg University, Germany, in the introduction to his report on the first bronchoscopic extraction of a foreign body wrote, *"On March 30th of this year I had the honor to assist my admired principal, Herrn Prof. Killian in extraction of a piece of bone from the right bronchus. This case is of such peculiarity with respect to its diagnostic and therapeutic importance that a more extensive description seems justified"* [1]. To understand this statement, one must consider the state of the art of airway inspection at that time [2].

THE PRE-ENDOSCOPIC ERA

Access to the airways in the living patient was tried already by Hippocrates (460–370 BC), who advised the introduction of a pipe into the larynx of a suffocating patient. Avicenna of Bukhara (about AD 1000) used a silver pipe for the same purpose. Vesalius' observation around 1542 that the heartbeat and pulsation of the great vessels stopped when he opened the chest of an experimental animal but returned again after he introduced a reed into the airway and inflated the lungs by use of bellows, which mistakenly made him assume that the trachea was part of the circulating system, from which it carried the name τραχυσ ("rough" in Greek language) or *arteria aspera* ("the rough artery" in Latin) [3, 4].

Desault (1744–1795) advised nasotracheal intubation for treatment of suffocation and removal of foreign bodies. For ages, more than half of accidental inhalations of a foreign body caused the death or chronic illness of the patient because of purulent infection, abscess, fistulas, and malnutrition. Diverse instruments have been designed to remove those foreign bodies blindly from the airways via the larynx or a tracheotomy, called "bronchotomy," which was also used for treatment of subglottic stenosis such as caused by diphtheria. Also, until late into the second half of the last century, a tracheotomy also had a high mortality of up to more than 50% [5], methods were developed for blind intubation. When he presented his "Treatise on the Diseases of the Air Passages," Horace Green in 1846, however, was blamed by the Commission of the New York Academy of Medical Sciences as presenting "*. . . a monstrous assumption, ludicrously absurd, and physically impossible, . . . an anatomical impossibility and unwarrantable innovation in practical medicine*" and was removed from the society [6, 7], but Joseph O'Dwyer persisted and introduced the method for emergency intubation of diphtheric children.

THE DEVELOPMENT OF ENDOSCOPY

Although instruments for the inspection of the body cavities such as the mouth, nose, ear, vagina, rectum, urethra, and others had been in use for ages, Porter in 1838 still stated, "*There is perhaps no kind of disease covered by greater darkness or posing more difficulties to the practitioner than those of the larynx and the trachea*" [quoted in (6)], because until then the larynx could be only insufficiently inspected by forcible depression of the tongue with a spatula, a so-called "Glossokatochon." Nobody had ever looked into the living trachea. It was only after the advent of three major inventions – (i) instruments for inspection, (ii) suitable light sources, and (iii) sufficient anesthesia – that direct inspection of the airways and visually controlled treatment became possible.

The Laryngeal Mirror

Experiments on the inspection of the larynx with the help of mirrors had been performed, among others, by Latour (1825), Senn (1829), Belloc (1837), Liston (1840), and Avery (1844), but it was not a physician but a singing teacher in London, Manuel Garcia, who in 1854 first observed his own larynx with the help of a dental mirror that he had bought from the French instrument maker Charriére in Paris [8–10]. Without knowing Garcia's work, laryngologist Ludwig Türck around the same time in 1856 in Vienna performed his first experiments with a similar device, which he borrowed from the physiologist Czermak of Budapest, when in winter the illumination was no longer sufficient for continuation of his studies (Figure 1.1). Czermak reported his findings before Türck, which resulted in a long fight over rights of priority, the so-called "Türkenkrieg" (Turks war) [11, 12].

With the use of these instruments, diagnosis and treatment of laryngeal diseases became much easier, so that G.D. Gibb in 1862 said, "It has fallen to my lot to see cases of laryngeal disease . . . that have existed for ten or twenty years, and submitted to every variety of treatment, without the slightest benefit, at the hands of some of the foremost amongst us, wherein the symptoms have depended upon a little growth attached to one or both vocal chords, which was recognized in as many seconds as the complaints had existed years. The nature of the malady thus being made out, the plan of treatment to be persued became obvious" [13]. It was also in 1862 that the German surgeon Victor von Bruns in Tübingen, with the help of this laryngoscopic mirror, could remove the first polyp from a vocal chord in his own brother. Without suitable anesthetics, the procedure needed weeks of preparation by gradual desensitization on the patient's side and much training on anatomical preparations and living larynxes of volunteers. Also his report was rejected as ". . . a daring deed that should not be imitated and the practical importance of which seems less as there would be hardly another opportunity for its repetition." One of the major problems was the indirect and

FIGURE 1.1. Czermak demonstrating the laryngeal mirror.

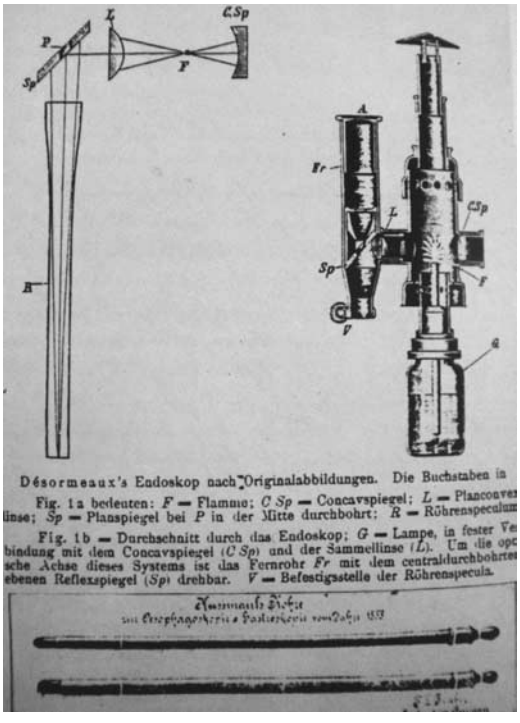
reverse view of the image, which added to the difficulties [14].

The First Endoscopes and Light Sources

In contrast to other fields of endoscopy, where daylight or candlelight could be introduced for inspection of the vagina, rectum, urethra, an so on, it was only after Philipp Bozzini, a general practitioner in Frankfurt, had developed his "illuminator" in 1805 that a suitable light source for the inspection of the trachea came within sight. The still somewhat clumsy device consisted of a box containing a candle, the light of which was reflected by a hollow mirror into a "conductor," a split metallic tube that could be spread by a simple mechanism. For the inspection of organs that could not be visualized by direct inspection he used a tube with a mirror for reflection of the light and image [15].

The first suitable successor was in 1853: the instrument of Desormeaux, who also introduced the word "endoscope" for his instrument to inspect the body cavities (Figure 1.2). It was by Desormeaux' endoscope that A. Kußmaul in 1867–1868 performed the first esophagoscopies [16]. The illumination by spirit, however, was insufficient for the inspection of the stomach. The first suitable gastroscope in 1881 by von Mikulicz and Leiter was a closed optic with lenses and prisms that were electrically illuminated at the distal end by a glowing platinum wire that had to be cooled by a constant flow of water and thus was not suitable for application in the airways [17].

Esophagoscopy was performed mainly by use of hollow tubes and spatulas that were connected to proximal illumination sources. It was also the Viennese endoscope maker Leiter who in 1886 produced the first so-called panelectroscope, a tube that was connected to a handle that contained an electric bulb and a prism for illumination. The instrument was modified by many specialists, such as Gottstein, who was the first to attach a metal tube in 1891, Rosenheim, who accidentally first passed into the trachea, and Kirstein in Berlin. Kirstein



Désormeaux's Endoskop nach Originalabbildungen. Die Buchstaben in Fig. 1a bedeuten: *F* — Flamme; *C Sp* — Concavspiegel; *L* — Planconvexlinse; *Sp* — Planspiegel bei *P* in der Mitte durchbohrt; *R* — Röhrenspeculum. Fig. 1b — Durchschnitt durch das Endoskop; *G* — Lampe, in fester Verbindung mit dem Concavspiegel (*C Sp*) und der Sammellinse (*L*). Um die optische Achse dieses Systems ist das Fernrohr *Fr* mit dem centraldurchbohrten ebenen Reflexspiegel (*Sp*) drehbar. *V* — Befestigsstelle der Röhrenspecula.

FIGURE 1.2. Desormeaux' illumination apparatus for endoscopes.

intentionally started to intubate the larynx with the esophagoscope and, after his first experience in 1894, began systematic direct inspection, which he called "autoscopy" (Greek: "αυτοσ," meaning directly without help of a mirror). "I convinced myself . . . that one can pass the vocal chords intentionally with a middle sized esophagoscope into the cocainized trachea and right down to the bifurcation; this experience should be eventually fructified." But as "the region of the lower trachea is a very dangerous place! . . . The rhythmic protrusion of its wall is . . . a regular and awe-inspiring phenomenon, which gives cause for utmost care in introducing rigid instruments," he did not "fructify," i.e. expand, his experiments [18]. It was the rhinolaryngologist Gustav Killian of Freiburg University who on June 4, 1895, attended Kirstein's lecture in Heidelberg at the 2nd Congress of the Society of South German Laryngologists, immediately recognized the importance of Kirstein's observation on the diagnosis and treatment of

laryngotracheal diseases, and began his experiments with the new method.

In 1877 the urologist Nitze of Dresden and the instrument maker Leiter of Vienna constructed the first lens optic in which electrical illumination was performed by a glowing platinum wire at the distal end that had to be cooled by a constant flow of water when not used inside the urinary bladder, such as in von Mikulicz' first gastroscope. In 1879, T. A. Edison invented the electric bulb, which was further miniaturized by Mignon distal electric illumination to be applied to endoscopy of the airways.

The Development of Local Anesthesia

In his first report on the invention of direct bronchoscopy, Killian said, "Whether one stops inspection with the rigid tube at the bifurcation or passes on for some distance into a major bronchus does not matter for the patient. If he is sufficiently cocainized he does not even realize it" [19]. Before the discovery of cocaine, many attempts had been made to anesthetize the airways by use of potassium bromide, ammonia, belladonna, iodine solution, chloroform, morphine, and others. Nothing proved sufficient, and the patients had to be desensitized by weeks of rehearsing touching the pharynx and vocal chords by themselves before a procedure could be performed. The examiner had to be extremely skilled and swift as operations had to be performed within seconds before the view disappeared. Von Bruns suggested training on an excised larynx and on a head that had been severed from a corpse and hung from a hook before training on a volunteer ". . . who certainly could be found rather easily for a little amount of money and would suffer such not really pleasant but not at all painful or dangerous experiments" [14].

Although Morton in Boston had already introduced general anesthesia by chloroform in 1848, its use was so dangerous that it was only rarely applied in laryngoscopic operations. In 1882, a young scientist at the Pharmacological Institute of Vienna, Sigmund Freud, experimented with cocaine, a sample of which he had bought from Merck Co. [20]. He was eager to make a fortune with a breakthrough invention in science to be able to marry his fiancée. But to his later dismay his experiments in withdrawing morphine addicts from their addiction resulted in disaster. Although he had advised his colleague Koller, an eye specialist, to use a cocaine solution for pain relief when he suffered from severe conjunctivitis, he failed to recognize the importance of his observation himself that cocaine caused numbness when he put it to his tongue. Koller, however, immediately realized the importance of this observation, and after feverishly experimenting with this new "miracle drug" on rabbits and patients, inaugurated local anesthesia in his lecture on September 15, 1884, at the Annual Congress of German Ophthalmologists in Heidelberg. At the same time, the Viennese laryngologist Jellinek introduced cocaine as a local anesthetic for the inspection of the airways: "By eliminating the reflexes of the pharynx and the larynx it was possible to perform some of the operations in which even the most skillful artists in surgery had failed. The procedure completely changed. Virtuosity gave way to careful methodology, skill to exactness, and the former almost endless preparation that so often tried the patience of the physician as well as of the patient could be almost completely abandoned" [quoted in (6)]. Thus the way was paved for Gustav Killian to pursue his experiments with bronchoscopy after he had attended Kirstein's lecture in Heidelberg.

GUSTAV KILLIAN AND THE INVENTION OF BRONCHOSCOPY

Gustav Killian was born on June 2, 1860, at Mainz on the Rhine. After graduation from high school in 1878, he began to study medicine at the University of Strassburg, where one of his teachers was Adolf Kußmaul. After 1880, he continued clinical education at Freiburg, Berlin, and Heidelberg, where he passed his final

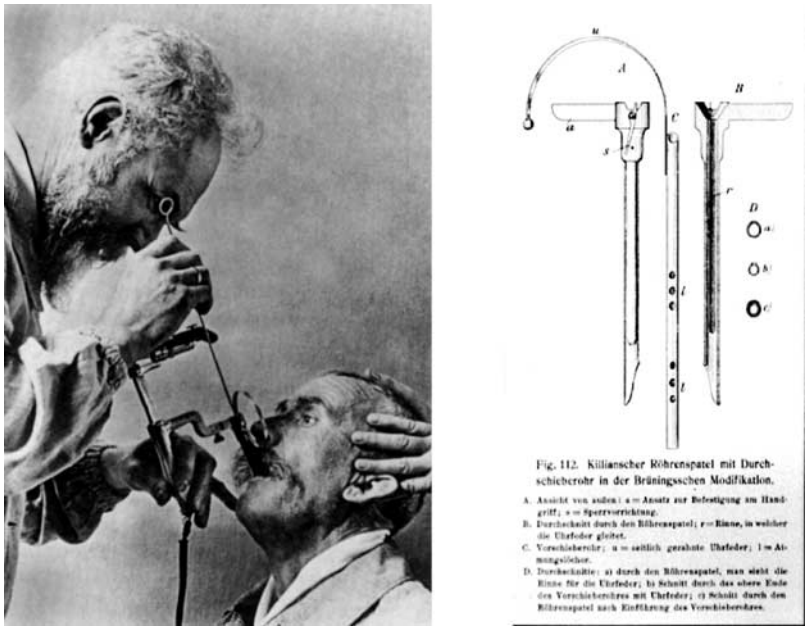


FIGURE 1.3. G. Killian performing tracheoscopy with Kasper's electrical handle for illumination attached to his bronchoscope.

examination in 1882. Afterward he started practical work at the municipal hospital of Mannheim close to Heidelberg and later in Berlin to get an education in ENT medicine by Hartmann and Fraenkel. As he could not find employment, Killian settled down as a practitioner in Mannheim in 1887. Four months later, he left when he was asked to become head of the section of rhinolaryngology at Freiburg that was part of the large faculty of internal medicine [3, 21].

At the meeting of the Society of South German Laryngologists in Heidelberg in 1889, he gave a short report on a new technique for examination of the dorsal wall of the larynx. Killian learned about Kirstein's new technique at the meeting of the Laryngological Society in Heidelberg in 1895. Because of the experiences in Krakow of Pieniazek, who had introduced direct lower tracheoscopy via tracheostomy without any complications [22], Killian at once realized the potential of this new method of direct inspection of the trachea and in 1896 began experimental work. In tracheotomized patients, he passed the bifurcation with the "bronchoscope," a somewhat modified esophagoscope of Rosenheim, and noticed that the bronchi were elastic and flexible; he was "stopped only when the diameter of the tube was surpassing that of the bronchi" (Figure 1.3).

After he had confirmed his findings in corpses without tracheotomies as well, he dared to perform the first direct endoscopy via the larynx in a volunteer. He noticed the flexibility of the trachea and how easily he could adjust it to the angle of the main bronchi and introduce the endoscope down to the lobar level. "I think I have made an important discovery," he noted afterwards. Bronchoscopy was born. In the same year (1897), he removed the first foreign body via the translaryngeal route on which his coworker Kollofrath reported in his paper [1].

After further experience and removal of two more foreign bodies, Killian felt safe to present his new method of "direct bronchoscopy" at the sixth meeting of the Society of South German Laryngologists in Heidelberg on May 29, 1898, and in the same year his first publication on direct bronchoscopy was printed [19]. The

following years at Freiburg were full of technical improvements of the new method and the quest for more and more indications of its use. He published 34 papers concerning discovery, technique, and clinical application of his invention. In 1900, he received the award of the Wiener Klinische Wochenschrift for his paper on "Bronchoscopy and its Application in Foreign Bodies of the Lung." Because of his publications and many lectures he was famous, and Freiburg became the Mecca for bronchoscopy. Hundreds of physicians came from all over the world (the list of participants notes 437 foreign guests from all continents, more than 120 from the United States), and up to 20 training courses had to be held every year. He was invited as a popular speaker all over Europe, and patients were sent to him from as far as South America for treatment of foreign bodies, as his son, Hans Killian, a famous surgeon himself, later reported [23].

To fully understand the importance of endoscopic removal of foreign bodies, one has to consider the state of thoracic surgery in Killian's time. Most patients fell chronically ill after the aspiration of a foreign body, suffering from atelectasis, chronic pneumonia, and hemorrhage (to which half of them succumbed if untreated). Surgical procedures were restricted to pneumotomy when the bronchus was occluded by extensive solid scar tissue and the foreign body could not be reached by the bronchoscope, and it had a very high mortality rate. Lobectomy or pneumonectomy could not be performed before Brunn and Lilienthal developed the surgical techniques for lobectomy after 1910, and Nissen, Cameron Haight, and Graham introduced pneumonectomy after 1930 because techniques in safe closure of the bronchial stump were missing [24].

Thus for those who were confronted with these patients, it must have seemed like a miracle that already shortly after the introduction of bronchoscopy almost all patients could be cured. According to a statistical analysis of Killian's coworker Albrecht of 703 patients who had foreign bodies aspired during the years 1911–1921, in all but 12 cases the foreign body could be removed bronchoscopically, although many had remained inside the airway for a considerable time; this result showed a success rate of 98.3% [25]. In light of this situation, Killian's triumphant remarks become understandable when he states, "One has to be witness when a patient who feels himself doomed to death can be saved by the simple procedure of introducing a tube with the help of a little cocaine. One must have had the experience of seeing a child that at 4pm aspirated a little stone, and that, after the stone has been bronchoscopically removed at 6pm, may happily return home at 8pm after anesthesia has faded away. Even if bronchoscopy was ten times more difficult as it really is, we would have to perform it just for having these results" [21].

Besides numerous instruments for foreign body extraction, other devices (e.g., a dilator and even the first endobronchial stent) were constructed [26]. Although the development of bronchoscopy was Killian's main interest in the years at Freiburg, he pushed ahead in other fields, too. He developed the method of submucosal resection of the septum and a new technique for the radical surgery of chronic empyema of the nasal sinuses with resection of the orbital roof and cover by an osseous flap [27]. In about 1906 he began intensive studies of the anatomy and the function of the esophageal orifice, and found the lower part of the m. cricopharyngeus to be the anatomical substrate of the upper esophageal sphincter. According to his observations, it was between this lower horizontal part and the oblique upper part of the muscle (where the muscular layer was thinnest) that Zenker's pulsion diverticulum developed. One of his scholars, Seiffert, later developed a method of endoscopic dissection of the membrane formed by the posterior wall of the diverticulum and the anterior wall of the esophagus.

In 1907 he received an invitation by the American Oto-Rhino-Laryngological Society, and it was on his triumphant journey through the United States that on July 3, 1907, he gave a lecture on these findings at the meeting of the

German Medical Society of New York. This lecture was published in *Laryngoscope* in the same year [28]. Lectures were followed by practical demonstrations of his bronchoscopic and surgical techniques and by banquets at night. On his journey he visited Washington, where he had a brief encounter with Theodore Roosevelt. In Pittsburgh he met Chevalier Jackson, then an already outstanding pioneer in esophagobronchology at the University of Pennsylvania. He was awarded the first honorary membership in the Society of American Oto-Rhino-Laryngology and also became an honorary member of the American Medical Association and received a medal in commemoration of his visit [21].

As Killian was the most famous German laryngologist, when Fraenkel in Berlin retired in 1911 he became successor to the most important chair in rhinolaryngology. Although bronchoscopy seemed to have reached its peak, he felt that visualization of the larynx was unsatisfactory. Using Kirstein's spatula, Killian realized that inspection of the larynx was much easier while the head is in a hanging position, and he had a special laryngoscope constructed that could be fixed to a supporting construction by a hook, a technique he called "suspension-laryngoscopy" by which he could use both hands for manipulation [29]. His coworker Seiffert improved the method by using a chest rest, a technique that later was perfected by Kleinsasser and is still used for endolaryngeal microsurgery.

In 1911, Killian had been nominated Professor at the Kaiser Wilhelm Military Academy of Medicine and, as during World War I, he had to treat laryngeal injuries. He visited the front line in France, where he also met his two sons who were doing service there. After his return from this visit, he founded a center for the treatment of injuries of the larynx and the trachea. During this era he was very much concerned with plastic reconstruction of these organs, especially as he could refer to the work of Dieffenbach and Lexer, two of the most outstanding plastic surgeons of their time, who had also worked in Berlin. The article on the injuries of the larynx would be his last scientific work before he died in 1921 from gastric cancer.

During his last years, Killian prepared several publications on the history of laryngotracheobronchoscopy [30]. For teaching purposes, in 1893 he had already begun illustrating his lectures by direct epidiascopic projection of the endoscopic image above the patient's head. Phantoms of the nose, the larynx, and the tracheobronchial tree were constructed according to his suggestions [31]. Because of his always cheerful mood he was called the "semper ridens" (always smiling) and, in his later years, his head being framed by a tuft of white hair, his nickname was "Santa Claus." He founded a school of laryngologists, and his pupils dominated the field of German laryngology and bronchology for years. Albrecht and Brünings published their textbook on direct endoscopy of the airways and esophagus in 1915 [25]. Like Carl von Eicken in Erlangen and Berlin and Seiffert in Heidelberg, they had become heads of the most important chairs of oto-rhino-laryngology in Germany. It was to Killian's merit that the separate disciplines of rhinolaryngology and otology were combined. When Killian died on February 24, 1921, his ideas had spread around the world. Everywhere skilled endoscopists developed new techniques, and bronchoscopy became a standard procedure in diagnosis of the airways. His work was the foundation for the new discipline of anesthesiology as well, providing the idea and instruments (laryngoscope by Macintosh) for the access to the airways and endotracheal anesthesia.

Throughout all his professional life, Gustav Killian kept on improving and inventing new instruments and looking for new applications. He applied fluoroscopy, which had been detected by K. Roentgen of Würzburg in 1895, for probing peripheral lesions and foreign bodies [32]. To establish the x-ray anatomy of the segmental bronchi, he introduced bismuth powder [34]. He drained pulmonary abscesses and instilled drugs for clearance via the bronchial route, and he even used the bronchoscope for "pleuroscopy"

(thoracoscopy) and transthoracic "pneumoscopy" when abscesses had drained externally [32]. Foreign bodies that had been in place for a long time and had been imbedded by extensive granulations were successfully extracted after treatment of the stenosis by a metallic dilator and, in case of restenosis, metallic or rubber tubes were introduced as stents. Although cancer was a comparatively rare disease (31 primary and 135 secondary cancers in 11,000 postmortems), he pointed out the importance of preoperative and postoperative bronchoscopy [34]. In 1914, he described endoluminal radiotherapy with mesothorium in cancer of the larynx [35], and in the textbook published in 1915 by his coworkers Albrecht und Brünings, we find the first description of successful curation of a tracheal carcinoma after endoluminal brachyradiotherapy [25]. By taking special interest in teaching his students and assistants to maintain high standards in quality management by constantly analyzing the results of their work and always keeping in mind that he was standing on the shoulders of excellent pioneers, he kept up the tradition of the most excellent scientists in his profession like Billroth, of Vienna. In his inaugural lecture in Berlin on November 2, 1911, he pointed out that it was internal medicine from which the art spread to the other faculties, that patience and empathy should be the main features of a physician, and that one must persist in following one's dreams because "to live means to fight." He ignited the flame of enthusiasm in hundreds of his contemporaries, who spread the technique to other specialties thus founding the roots of contemporary interventional procedures like microsurgery of the larynx (Kleinsasser) and intubation anesthesia (Macintosh, Melzer, and Kuhn).

RIGID BRONCHOSCOPY IN THE 20TH CENTURY

Main Schools

Because of the enthusiastic activities of Killian and his assistants in teaching and spreading the new technique, hundreds of specialists all over the world learned bronchoscopy and many improvements were added to the instrument. Thus already by 1910 Killian had collected 1,116 papers on esophagoscopy (410), gastroscopy (34), and laryngotracheobronchoscopy (672) for his paper on the history of bronchoscopy and esophagoscopy [30]. It was hardly possible to follow all traits in every continent where, soon after the introduction by pioneers, separate schools developed.

Killian's coworkers von Eicken, Albrecht, Brünings, Seiffert, and others for decades held the chairs of all important departments in Germany. They improved Killian's instruments and introduced new methods such as endoscopic treatment of Zenker's diverticulum by Seiffert, who also developed the chest rest for laryngoscopy (1922), which was perfected by Kleinsasser to the current device for micro-laryngoscopy (1964). Unfortunately after World War II the development took separate ways until recently. In Western Germany, Huzly of Stuttgart was the most prominent researcher in rigid bronchoscopy. In 1961, he edited his photographic atlas of bronchoscopy [36]. Riecker introduced relaxation by curare in 1952, which was replaced with succinylcholine by Mündnich and Hoflehner in 1953. Maassen introduced bronchography via double lumen catheter in 1956. Two companies, Storz and Wolf, became the most important instrument makers in Germany and introduced new technologies such as the Hopkins telescope and television cameras. E. Schiepatti of Buenos Aires wrote about transtracheal puncture of the carinal lymph nodes, and Euler reported on pulmonary and aortic angiography by transbronchial puncture in 1948–1949 and later on the technique of rigid transbronchial needle aspiration (TBNA) for mediastinal masses in 1955, which was further perfected by Schießle in 1962 [38].

In the United States, where A. Coolidge (on May 11, 1898) performed the first lower tracheobronchoscopy at Massachusetts General Hospital [4], it was Chevalier Jackson in Philadelphia (whom Killian had met on his visit to the United States in 1907) who, with his

FIGURE 1.4. Chevalier Jackson, father and son, and introduction of the bronchoscope with laryngoscope.

instrument maker Pillings, made many improvements in instruments for bronchoscopy and esophagoscopy and became the "father of American bronchoesophagology" (Figure 1.4). During his training to become a laryngologist he had visited London in 1886 where he was shown the "impractical device designed by Morel Mackenzie in an effort visually to inspect the esophagus" [39]. In 1890 he constructed the first endoscope "worthy of the name" for esophagoscopy and in 1904 he constructed the first American bronchoscope. After Einhorn in New York had added an integrated light conductor and Fletcher Ingals of Chicago had introduced distal illumination to the esophagoscope, Jackson equipped his bronchoscope with a light carrier with a miniaturized electric Mignon bulb at the distal end and an additional suction channel. Confronted by many patients suffering from aspiration of foreign bodies, he invented many instruments for retrieval. In 1907 he published the first systematic textbook on bronchoesophagology, which he dedicated to Gustav Killian, the "father of bronchoscopy." In this book he addressed modern issues of quality management such as analysis and prevention of complications, rational construction of bronchoscopy suites, and arrangement of equipment and staff. Being a philanthropist, he constantly refused to have his inventions patented as he wanted them to be spread as widely as possible, and by his persistence with the government he pushed for a law for the prevention of accidents by ingestion of caustic agents. He was a perfectionist in techniques and was totally convinced that teaching had to be performed on animals before patients were treated. Therefore, he always refused to go back to England where animal rights activists prevented such training courses. In 1928, in recognition of his "conspicuous achievements in the broad field of surgical science," the Boston Surgical Society awarded him the Bigelow Medal, which was presented to him by H. Cushing "for his eminent performances and creative power by which he opened new fields of endeavor" and in acknowledgement of his "indefinable greatness of personality" [40]. He simultaneously held five chairs of laryngology at different hospitals in his hometown (Pittsburgh) and in Philadelphia. His son Ch. L. Jackson also became a laryngologist and was his successor at Temple University in Philadelphia. He was the founder of the Pan American Association of

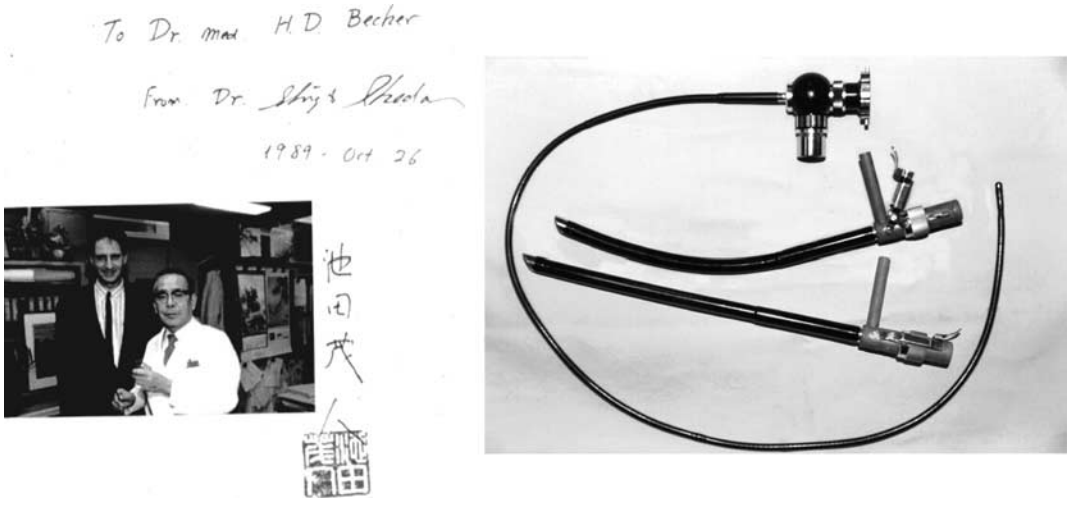


FIGURE 1.5. S. Ikeda demonstrating the first prototype of the flexible bronchofiberscope to the author. In the transition from rigid to flexible technology he introduced the fiberscope via an orotracheal tube that could be fixed in a straight position for introduction of a rigid optic and forceps if flexible biopsy was insufficient.

Otorhinolaryngology and Bronchology and of the International Bronchoesophagological Society, and was cofounder of the World Medical Association. With his father he edited the last issue of the textbook [41].

Their school extends well into our time as many of today's specialists' teachers were trained by the Jacksons, such as E. Broyles in Baltimore, who after additional training by Haslinger in Vienna introduced the telescope optic for bronchoscopy in 1940, the optical forceps in 1948, and fiber illumination for the rigid bronchoscope in 1962. His student G. Tucker became professor at Jefferson in Philadelphia, where he trained B. Marsh who keeps the tradition alive today along with Ch. M. Norris. P. Hollinger and Brubaker, who became specialists in pediatric bronchoscopy, introduced color photography in the 1940s. Hollinger's son is now a famous pediatric laryngologist. Andersen was the first to perform bronchoscopic transbronchial lung biopsy (TBLB) via the rigid bronchoscope in 1965. Sanders in 1967 introduced jet ventilation for rigid bronchoscopy.

After staying with Killian in Freiburg, it was Inokichi Kubo of Kyushu University in Fukuoka who first introduced bronchoscopy to Japan in 1907. He was joined by S. Chiba who, after training with Brünings, stayed in Tokyo from 1910. Joe Ono (who was trained by Jackson in 1934) founded the Japan Broncho-Esophagological Society in 1949. Shigeto Ikeda, who later developed the flexible fiberscope, introduced glasfiber illumination for the rigid bronchoscope in 1962 (Figure 1.5). When Ikeda, who found rigid bronchoscopy under local anesthesia in the sitting position on "Killian's chair" cumbersome, introduced the flexible bronchoscope, he used it in combination with a flexible tube that could be straightened by a locking mechanism so that he was still able to introduce the rigid optic in the same session. In the era of expanding interventional procedures, this method of combining both the rigid and the flexible endoscope today regains new attention (Figure 1.6).

Technical Developments

ILLUMINATION. After the advent of the electrical bulb, illumination became sufficient for the illumination of the airways. At first the lamps were installed separately on statives or fixed to a