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Removal of foreign bodies from the airways and esophagus development of the method and equipment over the centuries

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Abstract

The problem of aspiration of foreign bodies was already known in antiquity. The first described death of man was the case of the Greek poet Anakreon, who in 475 BC choked himself with a grape.

Initially, the treatment was limited to the pneumonia caused by the presence of a foreign body, then treatment of surgical procedures was attempted.

The first documented case of tracheotomy (known as bronchotomy) for removing a foreign body was described in 1717 by Verdue.

Unfortunately there was a significant disadvantage of the devices used to remove foreign bodies from the airways and esophagus - lack of a proper light source. At the beginning doctors were using candles, but their light was insufficient to observe anatomical structures. Philipp Bozzini developed the first light source which allowed to view the upper part of the esophagus - He called it a "lichtleiter".

However a milestone in the endoscopy was made by the French urologist Antonin Desormeaux. He presented an improved device, which he called the "endoscope". For this reason, he was hailed as "father of endoscopy".

Nevertheless scientific and technical progress is still continuing. Doctors have at their disposal more and more modern equipment for the diagnosis and removal of foreign bodies from the airways and esophagus. But even the most perfect endoscope will not replace the doctor's skills combined with assurance of maximum safety during and immediately after the procedure.

Key words: Foreign body; endoscopy

The problem of aspiration of foreign bodies was already known in antiquity. The first described death of man due to asphyxia caused by airway obstruction was the case of the Greek poet Anakreon, who in 475 BC choked himself with a grape. Doctors were trying to deal with such problems in different ways. Some of them wrote even instruction works about problems related to aspiration and ways of dealing with them. The first known one was written in the year 400 BC by Hippocrates. "Threats caused by aspiration" [Bielecki, Shareef]. Author recommends in it different ways to treat pneumonia caused by aspiration of food content. Hieronim Fabrycysz, anatomist, who worked on cadavers recommended bronchotomy as a way of removing foreign bodies. Until the mid-seventeenth century, the incision of the trachea at the neck was called "bronchotomy". For the first time the term "tracheotomy" was used by Thomas Fienus in 1649. In 1650 Frederic Bonetus (Bonet) recommended bronchotomy in a boy who inhaled a piece of bone. Because he was not a surgeon, he was not allowed to perform such a procedure and the child died. In 1664 Frederic Manavius described bronchotomy procedure as a way to remove foreign body from trachea and advocated it as the main procedure to fight with asphyxia. His descriptions are similar to these featured by modern laryngologists.

The first documented case of tracheotomy for removing a foreign body was described in 1717 by Verdue in "Pathological Surgery" [Kamath]. This event preceded other cases of removing a foreign bodies in 1788 by Gabriel Pelletan, a French surgeon [Marsh].

In 1781 John Hunter conducted the first experimental bronchial aspiration in a cat [Bielecki, Shareef, Tietjen]. This great Scottish surgeon and scientist performed the whole series of

experiments of aspiration and removal of foreign bodies from airways. Seventy-three years later (in 1854) Samuel Gross described 200 cases of aspiration of foreign bodies in a paper: "A practical Treatise of Foreign Bodies In the Air Passage" [Bielecki, Gross].

A significant disadvantage of the devices used to remove foreign bodies from the airways and esophagus was the lack of a proper light source. At the beginning doctors were using candles, but their light was insufficient to observe anatomical structures. Philipp Bozzini developed the first light source which allowed to view the upper part of the esophagus (as well as the rectum and vagina). He called it a "lichtleiter" - a guide of light and introduced it in 1806. He placed the wax candle in front of the concave mirror. Unfortunately, his invention was criticized and condemned by the Vienna Medical Society, which recognized the device of Bozzini as "a magic lantern placed in the human body." The creative doctor's career was interrupted and he died of typhus 3 years later. The device itself was improved by the successors of Bozzini. The first of them was Pierre Salomon Segalas d'Etchepare, then John Avery, but the most famous - John Fisher from Boston, whose device had angular bend, facilitating the the inside view of the body through natural orifices using lenses placed in them. [Marsh, Moore].

A milestone in the endoscopy was made by the French urologist Antonin Desormeaux. On November 29, 1853, he presented an improved device, which he called the "endoscope". For this reason, he was hailed as "father of endoscopy". because he made significant improvements to the early endoscope and was the first to successfully use it to operate on a living patient (his device would be called a cystoscope today). The main improvements in his device were the use of a gas lamp, which consisted of a burning mixture of alcohol and turpentine and provided superior illumination to previous technologies, and improvements in focusing the light coming from the endoscope.

Richard Criuse from Dublin has found a stronger source of light - a blend of petroleum and camphor. In 1865, his work entitled "Application of Endoscopy in Diagnostics and Treatment" was published. It was the first publication showing the use of endoscopes in the respiratory and esophageal systems. [Moore]. In 1867 Gerald Adelman analyzed 314 cases of untreated foreign bodies in esophagus, 109 of which were fatal. Thirty-one people developed perforation of the pericardium, aorta or other large vessels [Marlow]. The German professor Adolf Kussmaul (internist) in 1868 made the first ezofagoscopy with the Desormeaux uretrocystoscope. He improved the technique of placing a rigid endoscope based on observation of a knife swallower, Mueller, whom he designated as his assistant. The German surgeon, Friedrich Trendelenburg, blindly removed foreign bodies from the esophagus and stomach using a rigid esophagoscope. Samuel Gross, an American surgeon, described in 1854 the foundations for the diagnosis and treatment of foreign bodies in the airways, many of which are still valid [Marsh].

Physicians of specialisation which did not have much in common with respiratory and alimentary tracts also took part in developing techniques for removing foreign bodies. American gynecologist Joseph O'Dwyer not only invented and improved the method of laryngeal intubation, but also designed and then used a metal thin-walled tube to remove foreign bodies from the lungs. He laid down his patients in the then-known Trendelenburg position. The German laryngologist doctor Gustav Kilian removed foreign body (the pork bone) from the right main bronchi of the German farmer with the help of the so-called Kirstein's laryngoscope (metal tube with external light source) and local anesthesia with cocaine, and then described this fact in 1897 [Brownlee, Murray, Pirożyński M., Pirożyński M., Zerella]. Originally, he intended to perform tracheostomy, but as an laryngology specialist, he did not get approval from the medical commission (in those days, most laryngologist were internists, not surgeons) [Gross, Marsh]. Kilian constructed a bronchoscope with longitudinal side openings, which improved the conditions of patient ventilation during the study and was named the creator of modern bronchology. Kilian's

student - Brunning- improved the bronchoscope by introducing the lens system [Pirożyński M, Pirożyński, Zawadzka]. Poles also took part in the development of bronchoscopy. Since 1879, Przemysław Pieniążek, a laryngologist at the Jagiellonian University, observed the lower respiratory tract through a funnel inserted into the trachea through the tracheostomy hole. It is even believed that Pieniążek made the world's first bronchoscopy, which he later described with von Schrötter as lower bronchoscopy (in opposite to Kilian's upper or direct bronchoscopy) [Bloom]. In 1902 George Kelling made a prototype of a flexible esophagoscope The father of thoracic surgery- Jan Mikulicz-Radecki, a German surgeon with Polish origin, placed an electric light source at the end of esophagoscope [Clarnette]. In 1904, Chevalier placed the light source [Montoya] at the end of Kilian's endoscope. When visualization of upper parts of respiratory and digestive tract became possible, doctors began to construct special tools suitable for diagnostic and surgical procedures. Scientists introduced various types of pliers "crocodile clips", magnets and wire baskets, which greatly facilitated the removal of foreign bodies [Pirożyński M, Pirożyński]. In 19th century the equipment and procedure became very popular and were introduced to wide common use. Herbert Tilley in 1910. removed the pin from the esophagus in a 5-month-old baby [Marsh]. In 1936. Jackson removed the foreign body from the airways using his new device [Heyer]. He recommended inserting the bronchoscope in the airways in the supine position and using a laryngoscope (except for infants and young children). Jackson's determination and commitment to the development of endoscopy resulted in a decrease in mortality associated with aspiration and treatment of foreign bodies in the airways and gastrointestinal tract from 50% to less than 2%. At the age of 51, he became the head of the laryngology department at the University of Philadelphia, where he created the biggest school of endoscopy in the medical world,. In the following years of the 20th century, optical systems in classical bronchoscopes were improved. Prisms were introduced which revealed the bronchial outlet at an angle of 30°, 90° and 120°. Thanks to all mentioned inventions , the range of view widened, the appearance of high-level and segmental bronchi became apparent. In the sixties the use of glass fibers followed by quartz eliminated ordinary light bulbs from bronchoscope lights. They were replaced with halogen and xenon lamps, giving stronger light and the possibility of clear photographic documentation [Pirożyński M., Pirożyński]. Paul Holinger introduced many improvements in the first half of the twentieth century, among others: diagnostic laryngoscope, pediatric bronchoscopes, anesthesiological adapter for bronchoscopy enabling general anesthesia (at the beginning available only to children). Son of Paul Holinger, Lauren, made a huge contribution to the development of pediatric endoscopy. Together with Douglas Sanders (an anesthesiologist), they presented a device called the Sanders device or the English language "jet ventilator". It serves until now, enabling patients ventilation during classical bronchoscopy [Kalyanappagol, Marsh]. In 1966, the first so-called flexible endoscope (bronchofiberscope) was introduced and a year later it was used for clinical trials [Pirożyński M]. The breakthrough was the introduction of Hopkins telescope optics in 1976 [Tan, Zerella]. In 1978, Robert Wood and Robert Fink described for the first time bronchofiberscopy in children, but appropriately small sizes of equipment began to be used since 1981 [Brownlee]. In some situations, classical (rigid) bronchoscope is irreplaceable to this day. The best example is the removal of foreign bodies in children, where rigid bronchoscopy remains a golden standard. The procedure for a small patient must be performed under general anesthesia, and it is possible with a Jet bronchoscope (Sanders apparatus) [Farrell, Kohira, Little, Pirożyński M].

Scientific and technical progress is still continuing. Doctors have at their disposal more and more modern equipment for the diagnosis and removal of foreign bodies from the airways and esophagus. But even the most perfect endoscope will not replace the doctor's skills combined with assurance of maximum safety during and immediately after the procedure.

The authors of the article were basing on the following literature.

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