Mirrors and Reflections: The Evolution of Indirect Laryngoscopy

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Indirect laryngoscopy traditionally entails the use of both a head mirror and laryngeal mirror. It is the first and most basic successful technique for viewing the larynx, and arguably remains the most commonly used diagnostic method for laryngoscopy today. This article reviews its evolution, from Albuque's early applications of reflection and succeeding experiments with refraction, to Hoffman's design of the head mirror and subsequent modifications with illumination, culminating in Manuel Garcia's description of mirror laryngoscopy in 1854 and its refinement by Türck and Czermak.

Methods
Relevant articles were identified via a MEDLINE search using the medical subject heading (MeSH) terms “laryngoscopy” and “laryngoscopes” and the terms “head mirror” and “laryngeal mirror” followed by a secondary search of references cited by retrieved articles. Search engines, indexing services and repositories such as the Global Health Library and Index Medicus (World Health Organization), Open Library (Internet Archive), Royal Society Publishing (The Royal Society) and Google Scholar were also utilized to trace documents as far back as 1854. The University of the Philippines Medical Library also facilitated acquisition of copies of original documents. Qualitative content-analysis of available documents formed the basis for discussion.
Reflection: Mirrors and Images

The first use of reflected sunlight from a glass mirror to view the uterine cervix was recorded by the great Arab surgeon, Albusca of Cordoba (Abu Al-Qasim Khalaf ibn Abbas az Zahrawi) (AD 936–1013).11,12 Tulio Caesare Aranzi in 1585 was the first to focus sunlight through a flask of water and project the light into the nasal cavity.13

In 1743, the French surgeon André Levret (1703–1780) introduced an angled-mirror device for viewing the larynx indirectly. Though not as technically sophisticated, it preceded Philipp Bozzini’s work by over half a century, and apparently succeeded in visualizing and ligating antrochoanal polyps, rather than the larynx.14,15 In 1789, Archibald Cleland, an English Army surgeon, described an apparatus bearing a candle and a biconvex lens “to dart the collected rays of light into the bottom of the ear, or the bottom of any cavity that can be brought into a straight (sic) line.”14 Unfortunately, it did not allow him to see around corners, and therefore was not useful for laryngoscopy.

It was not until 1806 that Philipp Bozzini (1773–1809) described the principles for laryngoscopy, namely “if a person wishes to see around a corner . . . the rays must be broken and a mirror is required for illumination and reflexion.”14 He first employed candlelight with a “beeswax candle as a light source and a silver mirror to reflect the light through the speculum, down which he peered through a small hole in the centre of the mirror” to examine various body cavities.12,16 The various “attachments allowed inspection of the vagina, urethra, the female bladder, the rectum and the upper air passages” but it was too unwieldy for use in laryngoscopy.12,16 Despite proper principles, he was a prophet ahead of the time, and his “Lichtleiter” (light conductor) never gained popularity.17 Besides, as Stell18 points out, Bozzini himself intended his device called “the light conductor, or a simple apparatus for the illumination of the internal cavities and spaces in the living animal body,” for physiologic experiments on animals, and not for examination of the larynx.15,19

In 1825, the French physicist Charles Cagniard de la Tour (1777–1859), introduced a small mirror to the back of the throat, hoping to see the larynx with the aid of sunlight reflected by a second mirror. He only saw the epiglottis, but unfortunately did not persevere in his quest.14,19

The use of an elongated, angled speculum with double convex lenses similar to a periscope was introduced by John D. Fisher (1797–1850) in 1827, inspired by a “strong and chivalrous desire to protect the feelings of delicacy” of a shy maiden “who could not countenance him coming so close to her pudenda as was required by the standard vaginal speculum.”12,16 The awkward contraption did not become popular, although his patient was probably grateful for his efforts.

Also in 1827, Dr. Senn of Geneva “had a little mirror constructed for introduction to the back of the pharynx” with which “he tried to see the upper part of the larynx—the glottis.”18 Senn’s attempt at mirror laryngoscopy in a little girl probably failed because he did not have a light source. He remarked that “this method could be employed with advantage in the case of adults and, in certain cases of laryngeal phthisis it might assist in diagnosis.”14,19

In 1829, Benjamin Guy Babington (1794–1866) presented his “glottiscope” before the Hunterian Society.18,20 It was a double-bladed device with an oblong stainless steel mirror attached to a long shank and a tongue retractor united to it by a simple mechanism.14 Sunlight from behind the seated patient would be reflected by an ordinary looking glass held in the left hand, onto the laryngeal mirror introduced with the right, while the tongue depressor retracted the tongue base forward.18,20 He used the glottiscope on many patients, but left no record of his results.14 Although his design made laryngoscopy theoretically possible, it required two hands and lacked a practical source of illumination. It never became popular, and Babington himself abandoned the combination for a mirror without the tongue depressor.15 Indeed, but for the lack of documentation of his findings, Babington may well have been the first to successfully perform mirror laryngoscopy repeatedly.

In 1832, Francesco Bennati of Paris, “reported seeing the vocal cords with the aid of two tubes, one to carry light to the larynx and the other to send back the laryngeal image, from a mirror in the distal end.”14,18 According to Clerf, the eminent clinician Trousseau, who had ordered one for his own use, “asserted that it was impossible to see the larynx, because the apparatus set up so much gagging with closure of the throat, that the larynx would have been concealed from view.”14 The tubes had been invented by Bennati’s patient, “a mechanic named Selligue who was suffering from laryngeal phthisis, and complete recovery rewarded the ingenious patient for his clever invention.”21

In 1838, Baumès exhibited a mirror about the size of a two-franc piece or 3 centimeters at the Medical Society of Lyons,14,18,21 “which he described as being very useful for examining the posterior nares and larynx.”21 However, it was the Scottish surgeon Robert Liston (1794–1847) who in 1840 described the technique of using what was probably a dentist’s mirror carried well back in the throat to examine the larynx.18
Thomson quotes Liston's description "by means of such a glass as is used by dentists on a long stalk, previously dipped in hot water, introduced with its reflecting surface downwards, and carried well into the fauces." Johann Nepomuk Czermak (1828-1873) acknowledges the method of Liston in Chapter II "Description of the mode of examination of Liston and Garcia" of his 1861 monograph.

Illumination: The Head Mirror and Other Light Sources

In 1841 Friedrich Hofmann (1806-1886) of Burgsteinfurt, Westphalia described a concave mirror with a central aperture in it as the ideal instrument that allowed reflecting and focusing the light into the EAC (external auditory canal) and simultaneously inspecting the TM ( tympanic membrane) and other concealed regions of the body without obstructing either the light or the view. Although Adam Politzer (1835-1920) of Vienna is widely credited with inventing the head mirror also in 1841, he would have only been 6 years old at the time, and credit really belongs to Hofmann.

The mirror afforded co-axial vision through the reflected light, and because the other eye remained open, binocular vision as well, eliminating parallax. The fixed focal distance of the mirror was solved by the examiner moving the head nearer or further away from the patient, as needed. Stell enumerates several variations on the mirror, including attachment to the head by spectacle frame ( Friedrich Semeleder, 1866), by frontal band (recommended by Kramer, first employed by Bruns), worn over one eye (Czermak), in front of nose and mouth (Bruns), or on the forehead ( Fournie, Johnson, etc.). This device revolutionized the ability to peer into cavities, and though it was not accepted immediately, it has not been replaced to this day, as it is still in use by physicians around the world. It was not until 1852 that Christian Georg Theodor Ruete (1810-1867) first proposed the concept of perforated metallic mirror for indirect ophthalmoscopy, here mentioned because it is alluded to in later accounts as being adapted by Czermak for laryngoscopy.

In 1844, Adam Warden of Edinburgh reported two cases of laryngoscopy using a tube and two prisms. He employed a powerful argand-lamp, with a large prism attached, so as to throw the full light of the lamp into the fauces and pharynx and the other at the distal end to cast light upon the glottis. To aid in this difficult examination he advised "quietening the irritability of the throat by touch with the finger, depressing the tongue, dilating the fauces, and encouraging the patient to swallow" in order to raise the larynx. Clerf opines that "to have seen the larynx in two patients by this method is indeed remarkable" and the method never became popular.

Also in 1844, John Avery, a surgeon of the Charing Cross Hospital used candle power "to examine the various canals of the body with the aid of a speculum and reflector." Jan and Blitzer illustrate his modification of the Palmer’s lamp used by miners to concentrate and direct candlelight down a modification of Bozzini’s speculum. Clerf describes the speculum as "a single tube with a reflecting mirror at its distal extremity," while the light source is an "artificial light and a concave perforated reflector before the examiner’s eye, to reflect light into the laryngoscope" but concludes "the apparatus was clumsy and heavy and the tube was poorly tolerated by the patient." In 1853 Antoine Jean Desormeaux (1815-1894) redesigned Bozzini’s ‘Lichtleiter’, attaching gaslight from a lamp burning alcohol and turpentine and condensers to project a beam of light down the tube. His brighter light afforded better illumination, allowing him to use smaller specula. Overall, his device was smaller and lighter than Bozzini’s and he is credited with actually performing operative endoscopic procedures on the urethras and urinary bladders of live patients, earning him credit as the ‘father of endoscopy’.

Culmination: The Laryngoscopic Triumvirate

It was during this time that the Spanish singing teacher Manuel Patricio Rodríguez García (1805-1906) made the discovery that is widely recognized as the “true” birth of laryngoscopy, and the discipline of laryngology. In his address before the Seventh Session of the International Congress of Medicine in London in 1881, he said:

One September day, in 1854, I was strolling in the Palais Royal, preoccupied with the ever-recurring wish so often repressed as unrealizable, when suddenly I saw the two mirrors of the laryngoscope in their respective positions, as if actually present before my eyes. I went straight to Charriere, the surgical-instrument maker, and asking if he happened to possess a small mirror with a long handle, was informed that he had a little dentist’s mirror, which had been one of the failures of the London Exhibition of 1851. I bought it for six francs. Having obtained also a hand mirror, I returned home at once, very impatient to begin my experiments. I placed against the uvula the little mirror (which I had heated in warm water and carefully dried): then, flashing upon its surface with the hand mirror a ray of sunlight, I saw...
at once, to my great joy, the glottis wide open before me, and so fully exposed, that I could perceive a portion of the trachea. When my excitement had somewhat subsided, I began to examine what was passing before my eyes. The manner in which the glottis silently opened and shut, and moved in the act of phonation, filled me with wonder. From what I then witnessed, it was easy to conclude that the theory which attributed to the glottis alone the power of engendering sound was absolutely confirmed, from which it followed that the different positions taken by the larynx in front of the throat have no action whatever in the formation of sound; although, combined with diverse elevations of the soft palate, they change the shape and the dimensions of the pharynx.

He went on to examine and document his own, and other larynges in motion, and presented a paper on “Observations on the Human Voice” before the Royal Society of London on May 24, 1855.27 According to Garcia “the voice is formed in one unique manner—by the compressions and expansions of the air, or the successive and regular explosions which it produces in passing through the glottis.”27 He continues, “As soon as the air has accumulated sufficiently, it parts these folds and produces an explosion. But at the same instant, by virtue of their elasticity, and the pressure from below being relieved, they meet again to give rise to a fresh explosion. A series of these compressions and expansions, or of explosions, occasioned by the expansive force of the air and the reaction of the glottis, produces the voice.”27 Although Garcia was certainly not the first to view the larynx, nor the first to describe it, he is rightfully credited for documenting it to such a degree as to have made its mark on professional voice users and the various specialists who attend to them, even if this was hardly his aim. This attitude was seen 25 years later in his parting statement before the international congress of medicine: “The laryngoscope in itself is not an invention—it is a simple idea; and when I suggested … that they should test its usefulness in the practice of healing, I was far from anticipating the brilliant future your science and skill reserved for it.”28 Unfortunately, the non-physician’s contributions were not appreciated by the medical community for a quarter of a century. It took two physicians to change their minds.29 Indeed, none of them were truly “first,” between (whether due to scarce documentation or sketchy scholarship); at other junctures they were multiple and convergent. Arguments on priority must be weighed the end of fall when there was little sunshine.14,15 Enter the physiologist Dr. Johann Nepomuk Czermak (1828-1873) of Pest (Budapest), to whom Türck had shown the method.14,15 In November that year, he borrowed the mirror Türck had stopped using and improved the technique using artificial light and the large concave ophthalmoscopic head mirror of Ruete for concentrating the rays.14,25 Successful, he proceeded to improve the design of the mirrors and refine the methods for their use. For instance, Czermak’s mirror was square with a curved handle, while Türck’s had been round, with a straight handle.15 In the words of Sir Morell Mackenzie, mirror laryngoscopy had been freed from “the clock and the barometer” and its method nearly perfected.14,15 Succeeding where Türck had failed, Czermak presented his findings before the Viennese medical community in the spring of 1858, claiming to be the “first physician to visualize the living larynx.”25 This resulted in a “long fight over rights of priority, the so-called “Türkenkrieg” (“Turks war”).14,28 Although Czermak eventually apologized after Türck contested his claims, the die had been cast, and the “non-laryngologist became known as the inventor of medical laryngoscopy.”15 The question of primacy has today given way to recognition of their contributions.29 Indeed, none of them were truly “first,” but the various strands and developments that preceded them certainly intertwined and culminated in the crossing of their paths. Fifty years later, on the occasion of the Türck-Czermak Golden Jubilee in 1908, the BMJ paid tribute to all three men:25

The controversies are ended. Our gratitude is due to all three. Honour to Garcia who brought the laryngoscope amongst its own, and, with shame it must be added, its own received it not. Honour to Türck, who endeavoured to give to humanity the benefit of Garcia’s nearly forgotten work. Honour to Czermak who overcame the difficulties with which Türck had to contend, and caused to be known far and wide the untold possibilities lying hidden In the little mirror. Honour to all three. They rendered a lasting service to science, and conferred an inestimable boon upon suffering humanity.

The myriad developments in laryngoscopy have come together in multiple combinations and applications. The turning points for each development brought together precedent parallel strands and intertwined them to such an extent that subsequent developments followed suit. At times the strands were few and far between (whether due to scarce documentation or sketchy scholarship); at other junctures they were multiple and convergent. Arguments on priority must be weighed...
against practicality in evaluating these precursor devices.\textsuperscript{20} None of the culminating events of “tying together” loose precedent strands would have taken place without the prior strands existing.

In retrospect, André Levret may have first described mirror laryngoscopy, followed independently by Bozzini, de la Tour and Senn. But was it Babington who first truly succeeded in performing mirror laryngoscopy? Or because he left no clear descriptions thereof, was it Bennati, Baumès or Liston? The triumvirate of García, Türck and Czermak tied these strands together as perfected by them is still used in many settings. However, mirror laryngoscopy needs to be paired with a head mirror reflecting an external light source introduced by Hofmann, or a head mirror reflecting an attached artificial light source introduced by Avery, or a direct beam from a headlight without a reflecting head mirror, heralded by the argand-lamp of Warden. But were mirrors and reflections described by Albucasis unknown before his time?

**Conclusion**

What is the future of the head mirror\textsuperscript{10} and indirect laryngoscopy? The list goes on, into the future as much as the past. Ultimately, our ability to visualize the larynx harkens back, full circle, to our predecessors who first peered and probed into the cavities of the human body, and the mirrors and reflections, illumination and magnification that followed. Indeed, our journey into the past is what allows us to gaze into the future.

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