A brief history of endoscopic transsphenoidal surgery—from Philipp Bozzini to the First World Congress of Endoscopic Skull Base Surgery

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Since its inception, one of the major issues in transsphenoidal surgery has been the adequate visualization of anatomical structures. As transsphenoidal surgery evolved, technical advancements improved the surgical view of the operative field and the orientation. The operating microscope replaced Cushing’s headlight and Dott’s lighted speculum retractor, and fluoroscopy provided intraoperative imaging. These advances led to the modern concept of microsurgical transsphenoidal procedures in the early 1970s.

For the past 30 years the endoscope has been used for the treatment of diseases of the sinus and, more recently, in the surgical treatment of pituitary tumors. The collaboration between neurological and otolaryngological surgeons has led to the development of novel surgical procedures for the treatment of various pathological conditions in the skull base.

In this paper the authors review the history of the endoscope—its technical development and its application—from the first endoscope described by Philipp Bozzini to the First World Congress of Endoscopic Skull Base Surgery held in 2005 in Pittsburgh, Pennsylvania. Specifically, in this review the history of endoscopy and its application in endonasal neurosurgery are presented.

KEY WORDS • transsphenoidal approach • endoscope • endoscopic sinus surgery • endoscopic transsphenoidal surgery • skull base surgery • history of neurosurgery

Every step of the procedure must be conducted under the eye of the operator.—Harvey Cushing

THE FIRST ENDOSCOPIES

Until the end of the nineteenth century, the main impetus for the development of endoscopy came from its use in the inspection of the bladder, rectum, and pharynx. The word “endoscopy” was used first by Antonin Jean Desormeaux (1815–1894), a urologist from Paris. It is Philipp Bozzini (1773–1809), however, a German physician born to an aristocratic Italian family, who is credited with the invention of the first endoscope 200 years ago. The “Lichtleiter,” which he demonstrated in 1806 to the Academy of Medicine of Vienna, consisted of an eyepiece and a container for a candle light, which was reflected by a mirror through a tube (Fig. 1). Visualization was quite limited and an evaluation conducted with the instrumentation was painful for the patient.

As detailed by Mouton, et al., Max Nitze (1849–1906) improved on the early design (Fig. 2) and constructed an “apparatus for direct illumination and investigation of human and animal hollow organs” featuring a series of lenses inside a metallic tube (Fig. 3). This German urologist had two fundamental ideas: 1) magnifying the image through lenses, and 2) illuminating the organs by using an internal rather than an external light. Thomas Edison’s invention of the incandescent light bulb in 1879 allowed further improvements to be made to this endoscope (Fig. 4), with replacement of the cumbersome water-cooled platinum wires that had been used as the light source. Max Nitze is credited as well for being among the first to take endoscopic photographs and to use cutting loops for operations inside the bladder.

Expanding Applications

At the beginning of the twentieth century, physicians around the world pioneered the use of the endoscope in different specialties. In 1901 Hirschmann used a modified cystoscope to inspect the maxillary sinus and therefore is considered to be among the pioneers of paranasal endoscopic surgery. A modified cystoscope was used in 1910 by Christian Jacobaeus, professor of medicine in Stockholm, to perform the first endoscopically guided thoracoscopy and laparoscopy, as recounted by Mouton, et al. In the same year Victor Darwin Lespinasse (1878–1946), a urologist from Chicago, performed the first intracranial intraventricular endoscopy and coagulation of the choroid plexus for the treatment of hydrocephalus in two children;
one of his patients died postoperatively, but the second lived for 5 years.35

**Initial Neurosurgical Application: Ventricular Endoscopic Neurosurgery**

Although Lespinasse was the first to use a cystoscope to perform fulguration of the choroid plexus, Walter Dandy is widely recognized as the father of neuroendoscopy. We owe him the name of the procedure, which he first attempted in 1922 with little success.1,24 In 1932, however, he reported using endoscopic ventriculostomy to remove the choroid plexus for the treatment of hydrocephalus (Fig. 5), with outcomes similar to those he had attained with a craniotomy.23 According to Duffner, et al.,30 in 1923 William Mixter reported the first endoscopic third ventriculostomy. Therefore, the endoscope’s initial impact in neurosurgery was in its use within the ventricular system. Intraventricular endoscopic surgery likely represented the most important initial influence of this technical adjunct in the field of neurosurgery.40

**EVOLUTION OF THE “MODERN” ENDSCOPE**

John Logie Baird, who invented the television, patented the idea of transmitting images through a flexible glass cable in 1926. These ideas influenced Harold H. Hopkins, a mathematician and physicist (b. 1918, Leicester, England), who invented the zoom lens in 1948.46 In 1960 Hopkins patented the rod-lens system, which improved the previous Nitze system of a train of glass lenses by interspersing neutral gas between them instead of air.21 The optic efficiency was improved ninefold by lowering the refractive index and increasing the functional diameter of the lenses. Hopkins’ rod lenses had clear advantages over the Nitze system in that they provided greater light transmission, a wider view, better image quality, and a smaller diameter for the system. Clinicians then were able to document their endoscopic findings effectively with cameras and video systems.4

Coincident to this tremendous contribution, Basil Hirschowitz, an American gastroenterologist, developed an endoscope that featured flexible glass-coated fibers (fiberoptics) illuminated by a simple light bulb at the proximal end. He called this system a fiberscope and demonstrated it at a meeting of the American Gastroscopic Society on May 16, 1957, in Colorado Springs, Colorado.34,43 Karl Storz (1911–1996) realized that besides transmitting visual information, the system of glass fibers could be used for the purpose of light transmission, and he licensed the idea of a fiberoptic external cold light transmission coupled with the rod-lens optical system in 1965.55

Many other improvements were made in the field; one of the most important of these is the charge-coupled device camera.41,57 Charge-coupled devices were introduced in 1969 by Bell Laboratories in the US. They are lightweight, low-powered, extremely sensitive image sensors, and are approximately 15 times more sensitive to light than standard regular photographic film.

**Application to Diseases of the Paranasal Sinuses**

Otorhinolaryngologists began to develop maxillary antrostomy, approaching the maxillary sinus primarily through the inferior meatus. Because of technical limitations encountered at the time, however, this technique was not widely accepted.28 The development of fiberoptic and glass-wool light conductors was a decisive step that allowed image-guided biopsy sampling and the more accurate removal of small lesions.29,36,62,76 Messerklinger revitalized endoscopy, applying it to rhinologic and sinus surgery as well as using it to 1) examine the sinuses and identify the cause of sinusitis resistant to medical therapy; 2) locate sites of cerebrospinal fluid rhinorrhea; and 3) perform minor operations while maintaining visual control.5,28 The treatment of medically refractory sinusitis through antrostomies was refined by Reynolds and Brandow,70 David Kennedy, Heinz Stammberger, and Wolfgang Draf are some of the otorhinolaryngologists who popularized the
use of modern endoscopy in the paranasal sinuses. They pioneered endoscopic sinus surgery for the maxillary, frontal, and sphenoid sinuses. David Kennedy coined the term “functional endoscopic sinus surgery” (also known as FESS). With advancements in suction and irrigation, the endoscope could remain in the operative field, and this would lead to the subsequent continued development of endoscopic skull base surgery.

Endonasal Neurosurgery

Gerard Guiot is recognized as the first neurosurgeon to use the endoscope in the transsphenoidal approach, although he abandoned the procedure because of inadequate visualization. It was not until the late 1970s that Apuzzo, et al., as well as Bushe and Halves, reported the use of the endoscope as a technical adjunct in the microscopic resection of pituitary lesions with extrasellar extension. Endoscopy was used initially to augment microsurgery, allowing a view of structures that were out of the line of sight; a view that other surgeons had previously achieved with angled mirrors. Axel Perneczky, who pioneered the use of the endoscope in intracranial neurosurgery, emphasized that endoscopy “improved appreciation of micro-anatomy not apparent with the microscope” and introduced the concept of minimally invasive neurosurgery. Other surgeons reported use of this device in transsphenoidal microsurgery as a technical adjunct that was important for its wider panoramic visualization.

In the early 1990s the pure endoscopic transsphenoidal technique (that is, use of the endoscope as the only visualizing tool) was introduced as a result of the collaboration between neurological and otorhinolaryngological surgeons. In 1992 Jankowski and coworkers from the Central Hospital of the University of Nancy reported on their experience with three cases in which they used a pure endoscopic transsphenoidal approach to the sella turcica. Sethi and Pillay, otorhinolaryngological and neurological surgeons, respectively, from the Singapore General Hospital, reported in 1995 on the use of an endonasal transsphenoidal technique. They used a transnasal–transseptal approach with a hemitransfixion incision to create a bilateral mucoperichondrial flap in 40 patients; the flap was held apart with a self-retaining retractor after removal of the nasal septum. In 1996, Rodziewicz and coworkers reported a similar technique that they had applied without the septal bone removal in 10 patients. Similar techniques were reported by other clinicians.

Jho and Carrau, a neurosurgeon and otorhinolaryngologist, respectively, working at the University of Pittsburgh Medical Center, are recognized as the pioneers of the pure
endoscopic endonasal approach for the treatment of pituitary adenomas. Their experience reflects the history of the procedure; they started using the endoscope as an adjunct to the microscopic technique, and then changed to a pure endoscopic technique. In 1997 they were able to report on 50 patients, 46 of whom were treated via a pure endoscopic approach. Paolo Cappabianca and Enrico de Divitiis from Naples were among the first to report their experience with the use of the pure endoscopic technique, introducing the term “functional endoscopic pituitary surgery” (also known as FEPS). Their work cannot be underestimated; they developed dedicated endoscopic instrumentation, suggested technical improvements, and contributed significantly to the scientific basis and critical assessment of the technique. These reports were followed by many others from around the world.

More recently, thanks to the introduction of other technical adjuncts such as neuronavigation and microvascular Doppler ultrasonography, endoscopic transsphenoidal surgery has been extended to the treatment of lesions outside the sella turcica, introducing the concept of extended approaches to the skull base. Giorgio Frank and Ernesto Pasquini, a neurosurgeon and otorhinolaryngologist, respectively, from Bologna, developed the ethmoid-pterigoïd-sphenoid (known as EPS) endoscopic approach for the treatment of cavernous sinus lesions. They also applied the pure endoscopic technique for resection of suprasellar lesions, performing an extended transplanum sphenoidale approach aided by the operating microscope, as described by Weiss in 1987 and used by Laws, et al., and Maira, et al. This endoscopic approach includes the initial removal of the tuberculum sellae and posterior part of the planum sphenoidale, and culminates with the opening of diaphragma sellae, which allows access to the suprasellar subarachnoid space, as described by Laws in 1980 for the treatment of suprasellar craniopharyngiomas with the aid of an operating microscope. More recently, Amin Kassam, a neurosurgeon, and Ricardo L. Carrau and Carl Snyderman, otorhinolaryngologists from the University of Pittsburgh Medical Center, following the lead of Kaptain, et al., and Maroon, reported the use of the pure endonasal endoscopic technique for the treatment of various pathological conditions of the skull base, widening the concept of transsphenoidal surgery. The sphenoid sinus remains a fundamental anatomical landmark for extended skull base approaches, extending from the floor of the anterior cranial fossa to the odontoid process.

The recent interest and developments in endoscopic transnasal techniques led to the First World Congress of Endoscopic Surgery, held in Pittsburgh, Pennsylvania in

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Fig. 3. Drawing of Nitze’s first cystoscope, in which the light source was situated at the terminal end of the endoscope and was a platinum filament lamp. A water cooling system was included. (Reprinted with permission from Jackson C: Bronchoscopy and Esophagoscopy; a Manual of Peroral Endoscopy and Laryngeal Surgery. Philadelphia and London: W.B. Saunders Company, 1922.)

Fig. 4. Photograph of an endoscope used mainly in the 1940s, a device in which the light source (magnified in circle) was an Edison lamp positioned at the terminal end of the endoscope, distal to the optic system (courtesy of the Claude Moore Health Science Library Historical Collections, University of Virginia).
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2005. Neurological and otorhinolaryngological surgeons from around the world met to suggest new surgical techniques, present surgical outcomes, and discuss complications of this evolving modality. We hope that this Congress will mark the beginning of a constructive, worldwide critical appraisal of the endoscope and its application in endonasal skull base surgery.

CONCLUSIONS

The history of the endoscope is an example of how technical advancements have influenced medicine. The relatively recent technical improvements led to its introduction in the everyday practice of many different specialties. Its use in endonasal skull base neurosurgery appears to hold promise but will need to pass the test of time. As stated by Harvey Cushing22 at the very beginning of the history of transsphenoidal surgery in 1912, interdisciplinary work is proving once again to be a major component in its development. To quote Cushing, "The performance becomes progressively simplified by the combined suggestion and experience of many."

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References


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