Endoscopic Endonasal Surgery for Pituitary Adenomas

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Key words
- Endoscopic endonasal surgery
- Neuroendoscopy
- Pituitary adenoma
- Pituitary surgery
- Transsphenoidal surgery

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
ICA: Internal carotid artery

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BACKGROUND: **Pituitary surgery is a continuous evolving specialty of the neurosurgeons' armamentarium, which requires precise anatomic knowledge, technical skills, and integrated culture of the pituitary pathophysiology. Actually it cannot be considered only from a technical standpoint, but rather a procedure resulting from the close cooperation among different specialists (e.g., ophthalmologists, neuroradiologists, endocrinologists, neurosurgeons, otorhinolaryngologists, anesthesiologists, neurophysiologists, pathologists, instrument manufacturers).**

METHODS: **The "pure" endoscopic endonsal surgery is a procedure performed through the nose, with the endoscope alone throughout the whole approach and without any transsphenoidal retractor. The procedure consists of three main aspects: exposure of the lesion, removal of the relevant pathology, and reconstruction, going through three different steps, the nasal, the sphenoid, and the sellar phases.**

CONCLUSIONS: **The endoscopic approach offers some advantages due to the endoscope itself: a superior close-up view of the relevant anatomy and an enlarged working angle are provided with an increased panoramic vision inside the surgical area. Concerning results in terms of mass removal, relief of clinical symptoms, cure of the underlying disease, and complication rate, these are, at least, similar to those reported in the major microsurgical series, but patient compliance is by far better. Besides the advantages to the patients, the surgeons—because of the wider and closer view of the surgical target area and the increase of the scientific activity as from the peer-reviewed literature on the topic in the past 10 years, the smoothing of interdisciplinary cooperation—, and the institutions (shorter postoperative hospital stay and increase of the case load)— the adoption of endoscopy in transsphenoidal surgery has gained a strong foothold.**

INTRODUCTION

The use of the endoscope through an endonasal route requires detailed knowledge of the anatomic structures and their variations. In addition, precise technical skills are needed, combined with an appreciation of the pituitary pathophysiology to guarantee a residual pituitary function and to attain the lowest rates of morbidity and mortality in a safe and practical way. It is simplified to consider endoscopic pituitary surgery as merely a surgical procedure, rather the final result is a close cooperation between different specialists (e.g., ophthalmologists, neuroradiologists, endocrinologists, neurosurgeons, otorhinolaryngologists, anesthesiologists, neurophysiologists, pathologists, instrument manufacturers) (7, 36).

The endoscope was introduced in clinical neurosurgical practice in 1963 by Gerard Guiot et al. (31) who first proposed its use during a classic transsphenoidal transnasorhinoseptal approach to explore the sellar cavity. However, the idea remained unrecognized until the further contribution of Apuzzo et al. (1) in 1977, followed by Bushe and Halves (2) who shed light again on the use of the endoscope. Its use was further developed thanks to optical technical advances. Nevertheless, the endoscope was adopted only in selected cases to complement the microscope in the early or late stages of a traditional procedure, determining the first example of "endoscope-assisted" technique (29, 55). The use of the endoscope in transsphenoidal surgery was successively reconsidered with the development of adequate endoscopic instrumentation and the widespread use of endoscopes in nasal and paranasal sinus surgery by otolaryngologists (33, 42, 62). Three decades after Guiot's intuition, Jho (35) and Carrau (12) and their colleagues, a neurosurgeon and an ENT surgeon, described in detail a "pure" endoscopic endonasal transsphenoidal technique, with the endoscope used as the sole visualizing tool throughout the entire procedure. Thanks to their efforts the shift from the microscope to the endoscope in transsphenoidal surgery has known its affirmation. After these investigators, the new technique was adopted by our group (4, 7) in Naples with new challenges for the succeeding neurosurgeons.

Since 1997, at the Department of Neurosurgery of University of Naples we have done more than 1000 procedure through a "pure" endoscopic endonasal transsphenoidal approach to the sellar region (7). Starting in 2004, the approach was extended to the surrounding areas of the skull base (9, 13, 20, 38). When the endoscope was introduced in neurosurgery, it totally transformed the way to look at the pituitary, and more recently, the midline skull base. Compared with the previous transsphenoidal microsurgical approach, the endoscopic technique represents a newly established technique, well defined in its main aspects, that offers a panoramic vision, close to the surgical target and within the relevant anatomy (8). At the same time, it allows a less traumatic route to the sella, associated with a lower complication rate (6). During the past decades, endoscopic pituitary surgery has been progressively accepted by surgeons and patients (36, 45, 49). Thanks to the efforts of few valid pioneers this technique is, at present, routinely adopted in many centers worldwide, using the same indications as the conventional microsurgical technique (56).

INSTRUMENTATION

Proper endoscopic equipment and specially designed surgical tools are needed to obtain the safety and effectiveness in the use of the endoscopic transsphenoidal approach (5, 48).

The instrumentation consists of different components: the endoscope, the fiberoptic cable, the light source, the camera, the monitor, and the video recording system. In the operating room these instruments are ergonomically placed behind the head of the patient and in front of the operator, who stands at the right side of the patient and with the assistant surgeon usually at the left in such a way that the operating surgeon and the second surgeon can comfortably look at the monitor. The scrub nurse is positioned at the level of the patient's legs. Finally, the anesthesiologists with the proper equipment are on the left side of the patient, at the level of the head, whereas the image guidance system, when used, is put besides the main endoscopic monitor. Each component of the equipment should be checked before the start of the procedure.

Usually, the entire procedure is performed with a rigid 0-degree endoscope, 18 cm in length, 4 mm in diameter (Karl Storz & Co, Tuttlingen, Germany). Angled scopes (30- or 45-degree lenses) are used in selected patients or during specific steps of the operation, usually at the end of lesion dissection, either to complete the tumor resection or to inspect for possible tumor remnants. The endoscope, which does not have any working channel, can be inserted in a sheath and connected to a manual irrigation shaft to keep the lens clean, thus avoiding exertion on the nostril.

A preoperative neuroradiologic plan is essential in disclosing the nasal anatomy (septal deviations, presence of concha bullosa or onodi cells), the pneumatization of the sphenoid sinus, configuration of its septa, and their relationship to the optic canal and the internal carotid artery (ICA) (16).

SURGICAL PROCEDURE

The patient is placed under general anesthesia with orotracheal intubation, and positioned supine in the operating table. The trunk is generally elevated 10 degrees and the head, in neutral position, is turned 10 degrees toward the operating surgeon and fixed with tape in a horseshoe headrest. Patient's eyes can be protected with antibiotic eye cream and a wet pad is generally inserted into the throat to plug the oropharynx and avoid collection of fluid in the airway and stomach during the operation. Before starting the surgical procedure, the nasal cavities are packed with gauze soaked with a diluted 5% chlorexide gluconate solution, gently inserted through a small Killian nasal speculum, avoiding damage to the nasal mucosa. The face and the nose are prepped with the same agent, and then the patient is aseptically draped. Finally, before scrubbing up, the surgeons should adjust the operating table to a comfortable working height.

The operation is usually performed through a single nostril up to the anterior sphenoidotomy. During this phase of the procedure the endoscope is held in the surgeon's nondominant hand. The posterior part of the septum is removed to gain enough space for both the endoscope and one instrument, inserted through one nostril, whereas the main instrument is inserted through the other nostril. The procedure becomes a two-surgeon, two-nostril approach.

We can consider three main surgical steps: a nasal phase, a sphenoidal phase, and a sellar phase. In the first two steps, exposure of the lesion is performed to create a comfortable working area and a wide surgical corridor to the lesion, In the sellar phase the tumor is removed and the reconstruction of the osteodural defect is realized.

Nasal Phase

The procedure starts with an initial anatomic orientation. Once the endoscope is inserted into the right nostril, parallel to the floor of the nasal cavity, the anatomic landmarks become visible. At this level the first structures to be identified are the inferior turbinate laterally and the nasal septum medially. In addition, above the inferior turbinate the head of the middle turbinate can be observed. Then, as the endoscope advances along the nasal floor, the choana is easily reached (Figure 1). It is limited medially by the vomer, which represents an optimal midline marker and, superiorly, by the floor of the sphenoid sinus. Cottonoid pledgets soaked with diluted adrenaline (1/10,000, 1:20 dilution) are inserted between the middle turbinate and the nasal septum to enlarge the virtual space that separate these structures and obtain decongestion of the nasal mucosa (Figure 2A). A sharp instrument, usually a Freer dissector, is then used to gently push laterally the head of the middle turbinate to widen the nasal corridor between the middle turbinate and the nasal septum and create an adequate surgical pathway (Figure 2B). The middle turbinate should be protected with cottonoids during this maneuver to avoid any mucosal tearing, which would lead to unwanted bleedings.

Looking upward with the endoscope along the roof of the choana and the sphenoethmoid recess, the sphenoid ostium, usually located approximately 1.5 cm above the roof of the choana, can be identified. The sphenoid sinus can be approached either through its natural ostium or through the sphenoid prow. The sphenoid ostium is extremely variable in shape, size, and position. It can be covered by either the superior or the supreme turbinate. These can be gently lateralized or removed, protecting the lateral lamella of the cribriform plate, on which the turbinate is inserted. In fact, the risk of an ethmoid cerebrospinal fluid (CSF) leak secondary to damage to the cribriform plate during these maneuvers must be considered. Finally, when the sphenoid ostium is not visible, once the choana is identified, access to the sphenoid cavity can be achieved ascending the endoscope along the sphenoethmoid recess for approximately 1.5 cm, applying pressure with a blunt instrument (Figure 3).

Sphenoid Phase

To avoid arterial bleeding from septal branches of the sphenopalatine artery, the

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