Endoscopic endonasal approach (EEA)

Endoscopic endonasal skull base surgery has dramatically changed and expanded over recent years due to significant advancements in instrumentation, techniques, and anatomic understanding. With these advances, the need for more robust skull base reconstructive techniques was vital.

Since 1995 there is a remarkable advancement in endonasal approach by endoscope. Refinements in camera definition, neurosurgical instruments, neuronavigation, and surgical technique.

Since 2000s, Endoscopic endonasal approach has become the most popular choice of neurosurgeons and otolaryngologists to treat lesions of the skull base, with minimal invasiveness, lower incidence of complications, and lower morbidity and mortality rates compared with traditional approaches.

The dual surgeon team, have facilitated purely endonasal endoscopic approaches to the majority of the midline skull base that were previously difficult to access through the transsphenoidal approach via microscope.

History

The history of the endoscope in skull base surgery is de facto the history of pituitary surgery. The first pituitary operation was likely performed by Sir Victor Horsley in 1889 via a transfrontal approach though he did not publish his results.

His compatriots, Caton and Paul, were the first to publish the results of this operation in 1893 in which they reported that their patient was cured of his headaches for the three months he survived post operatively.

But, it is Schloffer who is widely regarded as the father of modern pituitary surgery. In 1906 he published a seminal paper discussing the possibility of pituitary surgery via a transsphenoidal approach and performed this operation on March 16, 1907. The operation was performed via nasal translocation and lasted about 75 min. Though there were no intraoperative complications, the patient died two months later and on autopsy was found to have hydrocephalus as a result of residual tumor blocking the foramen of Monro.

Then in 1910, Oskar Hirsh, an otolaryngologist, introduced a transseptal, transsphenoidal approach to the pituitary gland an operation which is still in use today. Cushing performed his first pituitary operation in 1909 using Schloffer's method but then rapidly adopted Hirsh's approach adding a sublabial incision and a headlamp to improve visualization of the sella. Using this approach he performed 231 operations with a 5.6% mortality rate.

Hirsch continued to perform transphenoidal hypophysectomy and by 1937 had performed the operation on 277 patients with a mortality rate of 5.4%. After being displaced from Austria by the Nazis shortly thereafter, he emigrated to the US and continued to operate at Massachusetts General Hospital in collaboration with a neurosurgeon, Hannibal Hamlin. The other surgeon who kept the technique alive was Norman Dott, a British neurosurgeon who learned the approach in 1923 from Cushing and by 1956 had performed 80 procedures with no deaths.

The modern advent of the transsphenoidal approach as the preferred approach to the pituitary began in 1956 when a French neurosurgeon, Gerard Guiot, learned the technique from Dott and brought it
back to Paris and reintroduced it to skeptical colleagues. He ultimately performed over 1,000 transsphenoidal hypophysectomies and also introduced the use of intraoperative fluoroscopy. A student of Giguot, Jules Hardy revolutionized the transsphenoidal pituitary approach when he introduced the use of the operating microscope and microsurgical instrumentation in 1967. The microscope with increased illumination and magnification permitted a more thorough and safer resection without deaths or major morbidities.

Indeed, Hardy's contributions led to a paradigm shift in pituitary tumor surgery. Previously, the operation was performed to debulk large tumors off the optic apparatus, but now microsurgical techniques were introduced allowing for surgical cure of hormonal disease in microadenomas.

Although the procedure described by Hardy underwent numerous modifications (including extended approaches to other skull base sites: clival and suprasellar tumors as well as cavernous sinus lesions), it was the main procedure performed by neurosurgeons for removal of pituitary tumors from the 1960's through the early 1990's.

Although Griffith and Veerapen reported a case of endonasal approach to the sellar region in 1987, the transsphenoidal endonasal approach did not gain popularity.

### Types

- **Endoscopic transsphenoidal approach.**
- **Extended endoscopic transsphenoidal approach.**

### Disadvantages

Potential disadvantages of this procedure include the relatively restricted working space and the danger of an inadequate dural repair with cerebrospinal fluid leakage and potential for meningitis resulting. These approaches often require a large opening of the dura mater over the tuberculum sellae and posterior planum sphenoidale, or retroclival space. In addition, they typically involve large intraoperative CSF leaks, which necessitate precise and effective dural closure.

Sinus opacity is still present after one year of advance endoscopic skull base surgery but symptoms seems to return to basal after 12months of follow-up.

### Advantages

The major potential advantage of the endoscopic endonasal approach to the skull base is that it provides a direct anatomical route to the lesion without traversing any major neurovascular structures, obviating brain retraction. Many tumors grow in a medial-to-lateral direction, displacing structures laterally as they expand, creating natural corridors for their resection via an anteromedial approach.

Refinements in approach and closure techniques have reduced the risk of cerebrospinal fluid leak and infection. This has allowed surgeons to more aggressively treat a variety of pathologies. Now its a
safe and effective procedure for various parasellar lesions. Selection of patients who are unlikely to develop complications seems to be an important factor for procedure efficacy and good outcome.

Indications

Endoscopic endonasal approaches (EEAs) constitute a reasonable option for the treatment of lesions that involve the sellar and clival regions.

The evolution of the endoscopic endonasal transsphenoidal approach, which was initially reserved only for sellar lesions through the sphenoidal sinus cavity, has lead in the last decades to a progressive possibility to access the skull base from the nose. This route allows midline access and visibility to the suprasellar, retrosellar and parasellar space while obviating brain retraction, and makes possible to treat transsphenoidally a variety of relatively small midline skull base and parasellar lesions traditionally approached transcranially.

In a cadaveric model, the piezoelectric endoscopic transsphenoidal craniotomy (PETC) is technically feasible. This technique allows the surgeon to create a bone flap in endoscopic transnasal approaches similar to existing standard transcranial craniotomies. Future trials will focus on skull base reconstruction using this bone flap.

Preserving normal sinonasal physiology by limiting middle turbinate resections, avoiding unnecessary maxillary antrostomies, and reducing the use of nasoseptal flaps when feasible results in less sinonasal morbidity and more rapid recovery during the postoperative period.

Pituitary surgery

see Endoscopic endonasal approach for pituitary adenoma.

Cerebral Aneurysm

see Endoscopic endonasal approach for intracranial aneurysm

Optic neuropathy

Based on the anatomic relationship between sinonasal complex and orbit, this approach could be a smart solution for approaching the medial orbital region.

These techniques should be considered a valid option for optic nerve decompression in cases of Graves ophthalmopathy and post-traumatic optic neuropathy as well as for addressing extraconal or intraconal lesions placed medially to the optic nerve course.

Four main pathologies with outcomes after treatment were identified for discussion: pituitary adenomas, craniopharyngiomas, anterior skull base meningiomas, and chordomas. Within all four of these tumor types, articles have demonstrated the efficacy, and in certain cases, the advantages over more traditional microscope-based techniques, of the endonasal endoscopic technique.
The endoscopic endonasal approach is a safe and effective procedure for the management of recurrent and/or regrowing pituitary tumors previously treated by either a microsurgical or an endoscopic approach.\textsuperscript{26}

see Endoscopic endonasal approach for intracranial aneurysm

**Craniopharyngiomas**

see Craniopharyngioma endoscopic endonasal approach

**Anterior skull base meningiomas**

Is feasible and safe for the complete resection of anterior skull base meningiomas with intra- and extracranial extension in one stage in selected cases.

Although the endonasal endoscopic approach has been applied to remove olfactory groove meningiomas, controversy exists regarding the efficacy and safety of this approach compared with more traditional transcranial approaches.

Cavernous sinus lesion.

**Petrosus apex Cholesterol granulomas**

The EEA is a safe and effective alternative to traditional open approaches to petrous apex CGs.\textsuperscript{27}

**Cerebrospinal fluid leakage**

Endoscopic endonasal approach for cerebrospinal fluid leakage

**Access to the intraorbital optic nerve segment**

see transorbital approach.

**Nonvestibular schwannomas**

Nonvestibular schwannomas of the skull base often represent a challenge owing to their anatomic location. With improved techniques in endoscopic endonasal skull base surgery, resection of various ventral skull base tumors, including schwannomas, has become possible.

To assess the outcomes of using endoscopic endonasal approach (EEA) for nonvestibular schwannomas of the skull base.

Seventeen patients operated on for skull base schwannomas by EEA at the University of Pittsburgh
Medical Center from 2003 to 2009 were reviewed.

Three patients underwent combined approaches with retromastoid craniectomy (n = 2) and orbitopterional craniotomy (n = 1). Three patients underwent multistage EEA. The rest received a single EEA operation. Data on degree of resection were found for 15 patients. Gross total resection (n = 9) and near-total (>90%) resection (n = 3) were achieved in 12 patients (80%). There were no tumor recurrences or postoperative cerebrospinal fluid leaks. In 3 of 7 patients with preoperative sensory deficits of trigeminal nerve distribution, there were partial improvements. Patients with preoperative reduced vision (n = 1) and cranial nerve VI or III palsies (n = 3) also showed improvement. Five patients had new postoperative trigeminal nerve deficits: 2 had sensory deficits only, 1 had motor deficit only, and 2 had both motor and sensory deficits. Three of these patients had partial improvement, but 3 developed corneal neurotrophic keratopathy.

An EEA provides adequate access for nonvestibular schwannomas invading the skull base, allowing a high degree of resection with a low rate of complications 38).

**Technique**

Supine position with the trunk raised 10° and the head in neutral position rotated 10° towards the surgeon. The head is secured in a Horseshoe Headrest without rigid three-pin fixation. The nose is prepared by placing pledgets soaked with 0.02% of Oxymetazoline into each nostril, followed by Povidone Iodine solution applied over the nose and upper lip as well as into the nares with cotton tip applicators.

Pediatric population

Endonasal endoscopic skull base approaches are viable in the pediatric population, they are not impeded by sphenoid sinus aeration, and they have minimal risk of cerebrospinal fluid leak and meningitis. Outcomes and complications can be predicted based on specific radio anatomical skull base measurements rather than age 29).

**Challenges**

One challenge performing endoscopic endonasal approaches is the surgical conflict that occurs between the surgical instruments and endoscope in the crowded nasal corridor. This conflict decreases surgical freedom, increases surgeon frustration, and lengthens the learning curve for trainees.

The application of a malleable endoscope to transsphenoidal approaches to the parasellar region decreases instrument-endoscope conflict and improves surgical freedom 30).

Endoscopic endonasal surgery (EES) of the skull base often requires extensive bone work in proximity to critical neurovascular structures.

In selected EES, the ultrasonic bone curette was successfully used to remove loose pieces of bone in narrow corridors, adjacent to neurovascular structures, and it has advantages to high-speed drills in these specific situations 31).
Complications

see Endoscopic endonasal approach complications.

Outcome

The Endoscopic Endonasal Sinus and Skull Base Surgery Questionnaire (EES-Q), is a comprehensive, multidimensional, disease-specific instrument. A distinguishing characteristic is that, apart from the physical and psychological domains, the EES-Q also encompasses a social domain. Understanding different HRQoL aspects in patients undergoing EES may help caregivers restore, improve, or preserve the patient's health through individualized care, which depends on identifying their specific needs.

Case series

Endoscopic endonasal approach case series.

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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2671797/


