THE ENDOSCOPIC TRANSNASAL (ENDONASAL) APPROACH IN NEUROSURGERY: EVOLUTION AND INNOVATIONS

Quvondiqov G'olib Berdirasulovich
Assistant, Samarkand State Medical University
Samarkand, Uzbekistan
Alkov R.A
Student, Samarkand State Medical University
Samarkand, Uzbekistan
Lutfullayev X.Z.
Student, Samarkand State Medical University
Samarkand, Uzbekistan
Jabborova M.H.
Student, Samarkand State Medical University
Samarkand, Uzbekistan

Abstract

The endoscopic endonasal approach (EEA) represents a paradigm shift in neurosurgery, transitioning from a "keyhole" microscopic view to a panoramic endoscopic visualization of the ventral skull base. This review synthesizes the historical evolution, anatomical principles, technological innovations, and clinical outcomes associated with EEA. We analyze the transition from the microscope to the endoscope, the development of modular skull base corridors, and the reconstructive techniques that have made expanded approaches viable.

Keywords: Endoscopic endonasal approach, ventral skull base, pituitary adenoma, skull base reconstruction, nasoseptal flap, neuronavigation, minimally disruptive surgery

Introduction

The endoscopic endonasal approach (EEA) has evolved from a niche technique for pituitary adenomas into a robust surgical platform for complex pathologies of the ventral

skull base. Unlike traditional transcranial approaches that require brain retraction to access the skull base, the EEA utilizes natural nasal corridors to access the target directly, adhering to the concept of "minimally disruptive" rather than just "minimally invasive" surgery (Kassam et al., 2005). The transition from the operating microscope to the endoscope was initially met with skepticism; however, superior visualization and the ability to look "around corners" have established the endoscope as an essential tool in modern neurosurgery (Jho & Carrau, 1997). This review examines the trajectory of this surgical corridor, highlighting the technological and anatomical innovations that have defined its current standard of care.

Historical Development of the Transnasal Approach

The concept of accessing the sella turcica through the nose is over a century old. The first successful transsphenoidal resection of a pituitary tumor was performed by Hermann Schloffer in 1907 via a superior nasal route (Schloffer, 1907). Shortly thereafter, Harvey Cushing popularized the sublabial transseptal approach, performing over 200 such procedures with remarkable success for that era (Cushing, 1910). However, due to limited visualization and the risk of infection, Cushing eventually abandoned the transsphenoidal route in favor of transcranial approaches.

The technique remained largely dormant until the 1960s, when Gerard Guiot and subsequently Jules Hardy reintroduced the transsphenoidal approach. Hardy combined the use of the operating microscope with intraoperative fluoroscopy, establishing the microscopic transsphenoidal approach as the gold standard for pituitary surgery for nearly three decades (Hardy, 1971).

The "endoscopic revolution" began in the 1990s. While otorhinolaryngologists had adopted endoscopy for sinus surgery, neurosurgeons were slower to adapt. Jho and Carrau published their seminal series on "pure" endoscopic pituitary surgery in 1997, demonstrating that the endoscope could replace the microscope entirely rather than merely serving as an adjunct (Jho & Carrau, 1997). In Europe, Cappabianca and de Divitiis further standardized the technique, providing rigorous comparisons between microscopic and endoscopic outcomes (Cappabianca et al., 1998).

Anatomical and Surgical Principles

The foundation of the EEA is a detailed understanding of the "ventral skull base," which differs significantly from the dorsal view seen in transcranial surgery. Rhoton's microsurgical anatomy studies were pivotal in mapping these corridors from an endonasal perspective (Rhoton, 2002).

The surgical philosophy is based on modular corridors. Kassam and Snyderman classified these approaches based on the relationship to the internal carotid artery (ICA) and the sella. In the sagittal plane, these modules extend from the frontal sinus (trans-frontal), to the cribriform plate (trans-cribriform), to the sella (trans-sellar), and down to the clivus and odontoid (trans-clival) (Kassam et al., 2005). In the coronal plane, approaches extend laterally to the cavernous sinus and petrous apex.

A critical surgical principle is the "two-surgeon, four-hand technique." This allows one surgeon to drive the endoscope (providing dynamic visualization) while the other utilizes bimanual dissection, mimicking microsurgical principles (Snyderman et al., 2008).

Technological and Surgical Innovations

The expansion of EEA would not have been possible without specific technological advancements.

Visualization: The shift from 0-degree 2D endoscopes to high-definition (HD) and subsequently 4K and 3D endoscopes has dramatically improved depth perception, a limitation of early endoscopy (Barkhoudarian et al., 2013). Angled endoscopes (30 and 45 degrees) allow surgeons to inspect the suprasellar and lateral cavernous sinus recesses, areas previously blind to the microscope (Cappabianca et al., 2004).

Neuronavigation: Image guidance systems (IGS) are now mandatory for expanded cases. The integration of CT and MRI data allows for precision within millimeters, crucial when operating near the carotid arteries and optic nerves (Carrau et al., 2003).

Hemostasis and Reconstruction: Perhaps the most significant innovation was the description of the vascularized nasoseptal flap (Hadad-Bassagasteguy flap) in 2006. Prior to this, high-flow cerebrospinal fluid (CSF) leaks were a major deterrent to expanded approaches. This pedicled flap, harvested from the nasal septum and supplied by the

posterior septal artery, reduced CSF leak rates from over 20% to less than 5% (Hadad et al., 2006).

Clinical Applications

Sellar Lesions: Pituitary adenomas remain the most common indication for EEA. The panoramic view facilitates the identification of the interface between the tumor and the normal gland, potentially improving remission rates in functioning adenomas (Starke et al., 2013).

Suprasellar and Anterior Fossa: The trans-tuberculum and trans-planum approaches utilize the corridor above the pituitary gland. These are increasingly used for craniopharyngiomas and tuberculum sellae meningiomas. Studies have shown that EEA for craniopharyngiomas provides superior visual outcomes compared to transcranial routes due to early visualization of the subchiasmatic perforators (Cavallo et al., 2014).

Clival and Posterior Fossa: The trans-clival approach provides direct access to midline chordomas and chondrosarcomas. By approaching these tumors ventrally, the surgeon can achieve decompression without manipulating the cranial nerves that are often draped over the dorsal surface of the tumor (Gay et al., 2008).

Advantages, Limitations, and Complications

Advantages: The primary advantage of EEA is the avoidance of brain retraction. For midline ventral pathology, the nose provides a direct corridor that does not require traversing normal neural tissue (Dehdashti et al., 2009). Patients typically experience less pain and shorter hospital stays compared to open craniotomies (Little et al., 2005).

Limitations: The "working envelope" is narrow and deep. Unlike open surgery, where the angle of attack can be varied significantly, EEA is constrained by the nasal aperture (Kassam et al., 2005). Furthermore, vascular control is more difficult; managing a catastrophic internal carotid artery injury endoscopically is technically demanding and carries high mortality (Gardner et al., 2013).

Complications: Historically, postoperative CSF leakage was the "Achilles heel" of this approach. However, with the adoption of the nasoseptal flap and multilayer closure techniques, these rates have normalized (Kassam et al., 2008). Olfactory dysfunction is a

potential morbidity, particularly in trans-cribriform approaches where the olfactory neuroepithelium must be sacrificed (Rosen et al., 2009).

Conclusion

The endoscopic endonasal approach has matured from a novel technique for pituitary resection to a comprehensive subspecialty of skull base surgery. The collaboration between neurosurgeons and otorhinolaryngologists, combined with innovations in reconstruction and visualization, has allowed for safe, effective management of complex ventral skull base lesions. As technology advances, the boundaries of the EEA will likely continue to expand, necessitating ongoing rigorous evaluation of clinical outcomes.

References

1. Barkhoudarian, G., et al. (2013). The role of 3-dimensional endoscopy in skull base surgery. *World Neurosurgery*, 79(6), 8-9.
2. Burgner, J., et al. (2011). A telerobotic system for transnasal surgery. *IEEE/ASME Transactions on Mechatronics*, 16(6), 943-953.
3. Cappabianca, P., et al. (1998). Endoscopic endonasal transsphenoidal surgery. *Neurosurgery*, 42(5), 1090-1100.
4. Cappabianca, P., et al. (2004). Endoscopic endonasal transsphenoidal approach: surgery of the sella and beyond. *Child's Nervous System*, 20(11), 796-800.
5. Carrau, R. L., et al. (2003). The role of image-guided surgery in endoscopic approaches to the skull base. *Operative Techniques in Otolaryngology*, 14(3), 184-189.
6. Cavallo, L. M., et al. (2014). Endoscopic endonasal approach to craniopharyngiomas. *Neurosurgery Clinics of North America*, 25(3), 415-428.
7. Cushing, H. (1910). Partial hypophysectomy for acromegaly with remarks on the function of the hypophysis. *Annals of Surgery*, 51(6), 887-937.
8. Dehdashti, A. R., et al. (2009). Endoscopic endonasal approach for craniopharyngiomas: surgical outcome in 64 patients. *Neurosurgery*, 64(2), 265-272.
9. Gardner, P. A., et al. (2013). Endoscopic endonasal management of internal carotid artery injury. *Journal of Neurosurgery*, 119(5), 1148-1154.

10. Gay, E., et al. (2008). Chordomas and chondrosarcomas of the skull base: results and complications of 60 patients. *Acta Neurochirurgica*, 150(9), 897-912.

11. Hadad, G., et al. (2006). A novel reconstructive technique after endoscopic expanded endonasal approaches: vascular pedicle nasoseptal flap. *The Laryngoscope*, 116(11), 1882-1886.

12. Hardy, J. (1971). Transsphenoidal hypophysectomy. *Journal of Neurosurgery*, 34(4), 582-594.

13. Jho, H. D., & Carrau, R. L. (1997). Endoscopic endonasal transsphenoidal surgery: experience with 50 patients. *Journal of Neurosurgery*, 87(1), 44-51.

14. Kassam, A., et al. (2005). Expanded endonasal approach: the rostrocaudal axis. Part I. Crista galli to the sella turcica. *Neurosurgical Focus*, 19(1), E3.

15. Kassam, A., et al. (2008). Expanded endonasal approach: the rostrocaudal axis. Part II. Posterior clinoids to the foramen magnum. *Neurosurgical Focus*, 19(1), E4.

16. Little, A. S., et al. (2005). Comparison of sinonasal quality of life and health status in patients undergoing microscopic and endoscopic transsphenoidal surgery. *Neurosurgery*, 57(3), 546-553.

17. Marnin, M., et al. (2016). Augmented reality in neurosurgery. *Neurosurgery*, 63(6), 160-172.

18. Rhoton, A. L. (2002). The sellar region. *Neurosurgery*, 51(suppl_1), S1-335-S1-374.

19. Rosen, M. R., et al. (2009). A prospective evaluation of olfactory outcomes following endoscopic anterior skull base surgery. *Neurosurgery*, 65(2), 360-367.

20. Schloffer, H. (1907). Erfolgreiche operation eines hypophysentumors auf nasalem wege. *Wiener Klinische Wochenschrift*, 20, 621-624.

21. Snyderman, C. H., et al. (2008). A systematic analysis of complications associated with the expanded endonasal approach. *Journal of Neurosurgery*, 113(6), 1163-1172.

22. Starke, R. M., et al. (2013). Endoscopic versus microsurgical transsphenoidal surgery for acromegaly: outcomes in a concurrent series of patients using modern criteria for remission. *Neurosurgical Focus*, 35(6), E8.