The transsphenoidal approach

A historical perspective

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Over the last century, the transsphenoidal approach has evolved into the first-line method of treatment for sellar as well as select groups of parasellar and suprasellar lesions. The journey to its current popularity has been marked by controversy and near abandonment in the late 1920s, followed by its renaissance in the late 1960s. Despite the profound skepticism with which this procedure was viewed, several visionary neurosurgeons persevered through its nadir in popularity, preserving this surgical corridor to the skull base. Advances in medical and surgical techniques, paralleling an improved understanding of pituitary pathophysiology, contributed to its resurgence. The transsphenoidal procedures now performed stem from an array of modifications and refinements accumulated through nearly 100 years of medical and surgical evolution. This era's critical innovations and neurosurgical personalities are the topic of this historical overview.

KEY WORDS • transsphenoidal surgery • pituitary surgery • history of neurosurgery • historical perspective

The frontal transcranial approach to the sella turcica was first described by Fedor Krause⁴⁵ of Berlin in 1905 after others had attempted and failed to perform surgical intervention for pituitary tumors.⁸ In 1906, Sir Victor Horsley of London reported a series of 10 operations in which he successfully reached the pituitary via transfrontal and subtemporal approaches. Pioneering neurosurgeons including Walter Dandy,¹³ George Heuer,²⁵ Charles Frazier,^{18,19} and Harvey Cushing^{11,12} improved on this initial work, providing the foundation for contemporary transcranial approaches. The difficulties associated with these early transcranial operations, including high morbidity and mortality rates, provided an impetus for the development of extracranial approaches to sellar lesions.

According to Liu, et al.,⁵⁴ based on the initial work of Giordano, who proposed a transfacial approach to the pituitary gland in 1897 Hermann Schloffer of Austria reported the first successful resection of a pituitary tumor via a transsphenoidal approach in March of 1907. With local anesthesia provided by cocaine, Schloffer performed a three-stage procedure that appeared to represent a modification of contemporaneous approaches to treat sphenoid sinusitis.^{59,60} In the first stage, a nasal incision was extended to the glabella, the nose was reflected laterally to the right, and the nasal turbinates and septum were removed. The second stage entailed removal of the vomer and sphenoid rostrum with entry into the sphenoid sinus. In the final stage, the sphenoid mucosa was exenterated and the sellar floor was opened with a chisel. The symptoms improved postoperatively, but the patient ultimately died several months later

due to the effects of obstructive hydrocephalus, with massive intraventricular tumor extension confirmed at autopsy.

Theodor Kocher modified the approach in 1909 by resecting the septum submucosally to expand visualization within the sella.⁴³ Although sparing the frontal, ethmoidal, and maxillary sinuses, the septum was still approached through an overt midline incision on the bridge of the nose. Not until 1910, based on a route to the sphenoid sinus that his mentor, Hajek, used for surgical treatment of sinusitis did Oskar Hirsch of Vienna demonstrate the first completely endonasal transseptal transsphenoidal procedure.^{26,31,46} Hirsch performed a multiple-stage tumor resection over a 5-week period, with each session performed after application of local anesthesia. The patient's visual symptoms improved dramatically, following which Hirsch embarked on efforts to develop more effective and efficient surgical techniques, beginning with the addition of the nasal speculum.

Also in 1910, Albert Halstead of Chicago described the sublabial gingival approach to the sphenoid.²² Using this technique, he was able to preserve the cartilaginous septum with superior retraction, thus obtaining more pleasing postoperative aesthetic outcomes. Harvey Cushing further refined the transsphenoidal sublabial approach to the sella, until abruptly abandoning its use from 1929 to 1932 in favor of the transcranial approach.¹⁰⁻¹² The reasons for Cushing's return to the transcranial approach are not entirely known, although it is thought that he considered the extent of resection and intraoperative complications to be more easily evaluated and dealt with from above. He also believed that without accurate means of preoperative

tumor type determination, a transcranial approach, which was suitable for any lesion encountered, was more appropriate. His preferences were publicized when his 2000th tumor resection (an acidophilic adenoma) was performed via a transfrontal approach. As would be expected, the majority of the neurosurgical community followed Cushing's lead.

Despite its popular rejection, Hirsch continued to perform the endonasal transseptal transsphenoidal procedure. Traveling from Vienna to Boston, he acquired a reputation and moniker as an "obscure voice in the wilderness."⁶⁵

Hirsch was not a lone transsphenoidal enthusiast; Norman Dott, who studied Cushing's transsphenoidal approach at the Peter Bent Brigham Hospital from 1923 to 1924, continued to use and modify the approach after his return to the Royal Infirmary in Edinburgh.¹⁵ He designed instruments specifically for the transsphenoidal route, such as a speculum with an attached lighting apparatus.⁴⁷ Grace Allison, a professional photographer by trade, publicized Dott's success with the procedure after herself undergoing a successful resection of a pituitary lesion that had caused severe visual loss when she was a child.

Fig. 1. Photographs showing key personalities in the evolution of the transsphenoidal approach (from left to right) Row 1: Fedor Krause, Sir Victor Horsley, Walter Dandy, Charles Frazier; Row 2: Harvey Cushing, Oskar Hirsch, Norman Dott, Jules Hardy; Row 3: Martin Weiss, Ed Oldfield, Edward Laws Jr, Enrico de Divitiis; Row 4: Hae-Dong Jho, Paolo Cappabianca, Giorgio Frank.

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Gerard Guiot, a French neurosurgeon, learned the technique from Dott in the 1950s and introduced intraoperative radiofluoroscopic guidance for trajectory confirmation.²¹ Jules Hardy from Montreal learned these techniques from Guiot and subsequently augmented them with the incorporation of the operating microscope, which provided dramatically superior illumination and magnification.^{23,24,62} Using microscopic dissection techniques, Hardy introduced the concept of microadenectomy and demonstrated the possibility of surgical cure in patients with hyperfunctioning lesions not visualized on preoperative imaging. It was at this time that the surgical aim in pituitary surgery underwent a remarkable expansion, from its sole purpose of mass effect decompression to that of a sophisticated method for complex endocrinological symptom relief. Equally significant advances in the fields of endocrinology and radiology during this period indisputably contributed to the transsphenoidal renaissance that occurred in the late 1960s. Fluoroscopy was introduced, hormones were isolated, their physiological roles elucidated, and radioimmunoassays were developed for both diagnosis and posttreatment surveillance.^{39,52,53,56} These innovations provided the foundation for the modern transsphenoidal approach to simple intrasellar lesions that is used universally by neurosurgeons today.

Further refinements, including the introduction of the endoscope as the primary or adjunctive imaging modality, use of frameless stereotactic guidance, and aggressive resection of the cranial base have provided corridors to previously inaccessible tumors while preserving anatomical structures.^{1-4,7,9,14,16,17,28-30,32-38,40,41,55,58,61} Principles of cranial base surgery were extrapolated to transsphenoidal surgery by Martin Weiss at the University of Southern California, who published his experience with the "extended" approach in 1987.⁶¹ In this approach, Weiss described removal of the tuberculum sellae and posterior planum sphenoidale to achieve access to tumors with suprasellar, parasellar, and/or anterior cranial base extension. The approach also provided a passageway for the safe and effective resection of certain primary suprasellar tumors in the setting of a normal-sized sella, while preserving the healthy pituitary gland. This approach has revolutionized the treatment of lesions such as craniopharyngiomas, tuberculum sellae meningiomas, and Rathke cleft cysts. As contemporary neurosurgical leaders, including Oldfield, Kato, Laws, Jho, Frank, de Divitiis, and Cappabianca further modify the procedure and expand the armamentarium of specialized instrumentation, the indications for this approach continue to grow.^{5-7,14,17,27,28,32,36-38,40,42,44,48-51}

The transsphenoidal approach is the result of an evolutionary process rather than a revolutionary one (Fig. 1). It has involved the innovative thoughts and perseverance of multiple generations of neurosurgical pioneers, advances in medical science and surgical technique, and technological progress, all of which continue to develop today.⁴⁶ The corridor continues to expand, with the superior limits of the approach extending well into the third ventricle and the inferior limits now including the craniocervical junction.^{20,57,63,64} Brain retraction is minimized and the morbidity and mortality rates have become exceedingly low. Improving technical experience, advanced instrumentation, and fiberoptic technology will undeniably facilitate radical resection with better preservation of sellar and suprasellar structures.

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