The Expanding Spectrum of Disease Treated by the Transnasal, Transsphenoidal Microscopic and Endoscopic Anterior Skull Base Approach: A Single-Center Experience 2008–2015

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■ INTRODUCTION: **The transsphenoidal approach was initially developed in neurosurgical practice as an operative approach to the pituitary gland. The introduction of the operating endoscope has improved the versatility of the transsphenoidal approach, broadening the spectrum of lesions that can be treated effectively with this operative strategy.**

■ METHODS: **We performed a retrospective review of all patients who underwent transnasal, transsphenoidal operations at Brigham and Women's Hospital from April 2008 to February 2015 and categorized each case by pathologic diagnosis.**

■ RESULTS: **A total of 792 transnasal, transsphenoidal operations (512 endoscopic) were performed by 9 neurosurgeons for 33 pathologies over a 7-year period. Pituitary adenomas (535, 67.55%) were the most common impetus for a transsphenoidal operation. Others included Rathke cleft cysts (86, 10.86%), craniopharyngiomas (25, 3.16%), lympocytic hypophysitis/pituitary inflammation (21, 2.65%), arachnoid cysts (8, 1.01%), spindle cell oncocytoma (4, 0.51%), colloid cysts (4, 0.51%), and pituicytoma (2, 0.25%). Pituitary hyperplasia was treated in 9 cases (1.14%) and pituitary apoplexy in 7 (0.88%). Nineteen operations were undertaken for postoperative repairs (2.40%) and 3 for abscesses (0.38%). Other diseases treated transsphenoidally included chordomas (12, 1.52%), metastases (9, 1.14%), meningiomas (5, 0.63%), clival lesions (4, 0.51%), germinomas (3, 0.38%), granulomas (2, 0.25%), dermoid tumors (2, 0.25%), and 1 (0.13%) each of esthesioneuroblastoma, granular cell tumor, Wegener granulomatosis, olfactory neuroblastoma, glioneuronal tumor, chondromyxoid fibroma, epidermoid, meningoencephalocele, aneurysm, neuroendocrine carcinoma, chondrosarcoma, and lymphoma.**

■ CONCLUSIONS: **Although initially devised in neurosurgical practice for tumors of the pituitary gland, developments in technology now make the transsphenoidal approach an effective operative strategy for a wide range of anterior skull base lesions.**

INTRODUCTION

The transnasal transsphenoidal approach to the skull base and brain has a history dating to the time of the Ancient Egyptians. On death, royal Egyptians of ancient times underwent extensive burial rites, part of which involved removal of organs and mummification. Using a metal or wooden rod, Egyptian embalmers performed a transnasal craniotomy, breaking through the bones at the base of the skull to access the brain from below. The embalmers then removed some brain matter through the nose, liquefying the rest, and allowing it to drain through the nose by gravity (36).

In modern times, the first successful transsphenoidal approach was described by Hermann Schloffer, who reported the resection of a pituitary tumor by the transsphenoidal approach in March 1907 (31-33). Transcranial approaches to the pituitary had been attempted by pioneering neurosurgeons such as Victor Horsley, Fedor Krause, Charles Frazier, Harvey Cushing, and Walter Dandy, but high complication rates encouraged the development of extracranial approaches that could spare the vital anatomy of the region (8). In 1909, Theodor Kocher modified Schloffer's

Key words
- Craniopharyngioma
- Endoscopic surgery
- Meningioma
- Pituitary adenoma
- Skull base
- Transsphenoidal surgery

Abbreviations and Acronyms
ACTH: adrenocorticotropic hormone
DA: dopamine agonist

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approach to the sella, resecting the nasal septum submucosally to improve visualization (23). In 1910, Oskar Hirsch used an endonasal transsphenoidal approach for a pituitary tumor, and later introduced the nasal speculum for the operation (14).

Following this rapid expansion in use, the transsphenoidal approach entered a period of relative dormancy in 1929, when Harvey Cushing, then the world's most admired neurosurgeon, abandoned the transsphenoidal approach to the sella in favor of various transcranial approaches (8). Nevertheless, some neurosurgeons resisted Cushing's lead and continued to innovate the transsphenoidal method, including Norman Dott, one of Cushing's trainees, who introduced a nasal speculum with attached lighting apparatus (7). Later, Gerard Guiot introduced intraoperative fluoroscopic guidance and Jules Hardy adopted the operative microscope for pituitary surgery (7, 10, 13). More recent improvements came with the introduction of advanced imaging, hormone isolation and radioimmunoassays, and selective microsurgical operations for hyperfunctioning microadenomas (8).

More modern innovations of the transsphenoidal approach involve extensions beyond the sella for more diverse midline lesions of the skull base. Craniopharyngiomas, cystic tumors that arise in the sellar and suprasellar region, had been treated by the transsphenoidal approach as early as 1909 (25). In the years after, transcranial routes were favored by Cushing and others because of the high morbidity and incomplete resection often resulting from the transsphenoidal approach. During the second half of the 20th century, however, advances in technology made the transsphenoidal approach to craniopharyngiomas attractive yet again. In 1980, the senior author reported a series of patients with craniopharyngiomas who were treated transsphenoidally, arguing that in certain patients with an enlarged sella turcica, the transsphenoidal approach could match or exceed the effectiveness of transcranial routes (25).

The introduction of the operating endoscope further improved the ability of the transsphenoidal approach to rival the visualization obtained by transcranial routes for midline skull base lesions. Around the turn of the century, numerous reports by endoscopic pioneers including Hae Dong Jho, Paolo Cappabianca, Amin Kassam, Theodore Schwartz, and the senior author demonstrated the efficacy of the endoscope in treating a range of midline lesions, including pituitary adenomas, meningiomas, craniopharyngiomas, chordomas, and Rathke cleft cysts (2-4, 16-20, 22, 27, 38). Recent adoption of the three-dimensional endoscope has improved visualization during transsphenoidal operations even further, although studies have yet to demonstrate a significant difference in postoperative outcomes between patients undergoing operations with two-dimensional versus three-dimensional endoscopes (1, 15, 21).

Today, most diseases treated transsphenoidally fall into 4 main categories (**Table 1**): 1) congenital lesions, including arachnoid, colloid, pars intermedia, and Rathke cleft cysts, craniopharyngiomas, epidermoid and dermoid tumors, hamartomas, and germ cell tumors; 2) infectious and inflammatory lesions, including bacterial and fungal abscesses, mucocele and mucopyocele, Wegener granulomatosis, lymphocytic and granulomatous hypophysitis, tuberculosis, and sarcoidosis; 3) vascular lesions, the least commonly treated transsphenoidally, including carotid and anterior communicating artery aneurysms, cavernomas, and carotid-cavernous fistulae; 4) most commonly, neoplasms, including pituitary adenomas and hyperplasia, astrocytomas, gangiogliomas, fibrosarcomas, pituicytomas, granular cell tumors, meningiomas, lymphomas, plasmacytomas, and metastatic cancer.

Table 1. The Modern Diversity of Diseases Treated Transsphenoidally

Congenital	Neoplasms
Arachnoid cyst	Pituitary adenoma
Rathke cleft cyst	Pituitary hyperplasia
Craniopharyngioma	Granular cell tumor
Epidermoid tumor	Pituicytoma
Dermoid tumor	Neuroendocrine carcinoma
Teratoma	Astrocytoma
Encephalocele	Ganglioglioma
Germ cell tumor	Gangliocytoma
Hamartoma	Fibrosarcoma
Pars intermedia cyst	Meningioma
Colloid cyst	Hemangiopericytoma
McCune-Albright syndrome	Chordoma
Cholesteatoma	Chondrosarcoma
Empty sella	Hemangioblastoma
Inflammatory/Infectious	Plasmacytoma
Tuberculosis	Lymphoma
Sarcoidosis	Metastatic carcinoma
Lymphocytic hypophysitis	Chondromyxoid fibroma
Granulomatous hypophysitis	Pituitary carcinoma
Wegener granulomatosis	Neuroendocrine carcinoma
Rosai-Dorfman disease	Vascular
Bacterial abscess	Carotid aneurysm
Fungal abscess	Anterior communicating artery aneurysm
Cysticercosis	Carotid-cavernous fistula
Langerhans cell histiocytosis	Other
Mucocele	Fibrous dysplasia
Mucopyocele	Esthesioneuroblastoma
Tolosa-Hunt syndrome	Juvenile angiofibrosarcoma
Graves disease	Sinu-nasal sarcinoma
Giant reparative granuloma	Acinic cell tumor
	Sphenoid cyst
	Salivary cyst
	Basilar impression