Endonasal Endoscopic Management of Parasellar and Cavernous Sinus Meningiomas

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KEYWORDS

• Cavernous sinus meningioma • Parasellar meningioma • Endonasal endoscopic approach
• Minimally invasive neurosurgery

KEY POINTS

- Aggressive surgical resection of cavernous sinus meningiomas (CSMs) and parasellar meningiomas may result in significant morbidity.
- Multimodality treatment is required for effective treatment of CSMs and parasellar meningiomas.
- Bony sellar, cavernous sinus, and skull base decompression with conservative tumor debulking through an endonasal endoscopic approach seems a safe and effective option for initial management of invasive skull base meningiomas.

INTRODUCTION

The management of CSMs and parasellar meningiomas offers a significant challenge to skull base surgeons because of their close proximity and potential involvement of cranial nerves (CNs) II–VI, the carotid arteries, and the pituitary-hypothalamic axis. Over the past 30 years, an evolution in the treatment of these tumors has occurred. In the 1980s and 1990s, relatively aggressive lateral, anterolateral, and posterolateral skull base approaches were developed. This movement was fostered by a better understanding of skull base surgical anatomy and the rationale that extent of resection was inversely related to recurrence rates. Reports of significant rates of new CN deficits with low rates of improvement of preoperative CN deficits,[1,2] however, resulted in this aggressive approach for CSM gradually reconsidered and falling out favor at many centers. Concurrently, reports of good tumor control with stereotactic radiosurgery (SRS)[3–7] and stereotactic radiotherapy (SRT)[6] led to a paradigm shift to a more conservative surgical management of CSMs and parasellar meningiomas followed by observation and possible adjuvant radiation[8–10] or radiation alone as a first-line treatment.[4,7]

A more conservative transcranial surgical approach was described by Couldwell and colleagues[11] in 2006 who documented their management of CSMs in 11 patients using a frontotemporal craniotomy followed with planned SRS or SRT. The goal of surgery was to use selective intercavernous and extracavernous tumor removal to decompress the CNs and reduce the overall tumor volume that would be treated with postoperative radiation. Although the study had

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a small sample size, 3 of 5 patients with eye motility difficulty and 2 of 4 patients with visual loss improved and no patient suffered a new CN deficit after surgery. Tumor control was achieved in all patients with a median follow-up of 22 months (range 9–39 months). Akutsu and colleagues[12] in 2009 reported their results using a similar conservative surgical from the microscopic transsphenoidal route in 21 patients with CSMs. The sellar and cavernous sinus dura was opened and modest tumor debulking was performed. Overall, 32 of 34 CN deficits improved and there was no worsening. Of endocrine abnormalities, improvement was noted 16 of 28 (57.1%). Tumor control was 100% at median follow-up of 65 months.

Kano and colleagues[13] evaluated the role of previous surgery in patients treated with SRS for CSM. Of 272 patients with CSM treated over a 23-year period with SRS, 99 patients had a previous craniotomy with microsurgery for tumor removal. Microsurgery was not found to effect overall progression-free survival, which was 83.4% at 10 years. Patients who had undergone microsurgery were less likely to have an improvement of a preoperative CN deficit after SRS than patients with SRS alone (12%–15% vs 39%, respectively). One explanation for this discrepancy is that patients who had previous microsurgery may have had CN deficits secondary to surgical injury during an aggressive surgical resection given that a large proportion of the surgical patients were treated in the early and middle 1990s. Another possible explanation is that a lateral approach to the cavernous sinus may disrupt the delicate blood flow to the CNs that reside in the lateral cavernous sinus wall. Further injury with SRS may result in nerve ischemia and failure of the existing neuropathy to improve.[14]

Therefore, as previously demonstrated by Couldwell and colleagues[11] and Akutsu and colleagues,[12] an ideal surgical approach may be one that allows for selective decompression of the cavernous sinus structures, optic apparatus, and pituitary gland, with conservative tumor debulking while minimizing direct CN manipulation. Given that most CSMs and parasellar meningiomas can be directly accessed by the transsphenoidal route, the endonasal endoscopic route may offer an excellent surgical option for these challenging tumors. This approach may also enhance the efficacy and safety of SRT. This article describes endonasal endoscopic surgical management of CSMs and parasellar meningiomas, including those involving Meckel cave.

SURGICAL GOALS AND INDICATIONS

At the authors' center, an extended endonasal endoscopic approach has been adopted for performing bony decompression and selective tumor debulking of select meningiomas involving the cavernous sinus, Meckel cave, and the petroclival region. The goals of surgery are

1. Decompression of the CNs within the cavernous sinus and Meckel cave by bony removal of the parasellar skull base
2. Maximal but safe tumor removal within the sella, Meckel cave, and cavernous sinus to further optimize CN function and pituitary gland function
3. For tumors with optic canal involvement or clival extension, bony decompression of the optic canal and clivus to reduce mass effect on optic nerve and/or brainstem
4. For large tumors with significant petroclival extension and brainstem compression, endonasal parasellar debulking can be part of a 2-stage surgery that includes a retromastoid approach then endonasal approach followed by SRT (see **Fig. 6**).
5. Reduce overall tumor volume for future radiotherapy.
6. Obtain a histopathologic diagnosis and tissue for genomic profiling.[15–18]

The advantages of this approach over a conventional frontotemporal craniotomy are no use of brain retraction and direct access to and visualization of the pituitary gland for removal of any sellar component of the tumor. The potential disadvantages of this approach are higher rates of postoperative cerebrospinal fluid (CSF) leakage and poor access to tumor lateral to the CNs III–VI and the carotid arteries. The main indications and contraindications for the endonasal endoscopic approach are based on anatomic considerations and are listed in **Table 1**.

SURGICAL TECHNIQUE/PROCEDURE

Preoperative Planning

- A detailed history and physical examination are completed on all patients, with special focus on the function of CNs II–VI as well as signs and symptoms of anterior and posterior pituitary dysfunction.
- All patients undergo a volumetric MRI with gadolinium for purposes of intraoperative navigation as well as assessment of the intercavernous/carotid corridor. Additionally, a CT angiogram is often performed to provide useful information regarding sinus