Management of Parasellar and Cavernous Sinus Meningiomas

Neil R. Miller, M.D.

Baltimore, MD

Objectives

At the conclusion of this program, the attendee will be able to:

1. Recognize the major presenting signs and symptoms of parasellar and cavernous sinus meningiomas
2. Understand the advantages and disadvantages of the available management options for parasellar and cavernous sinus meningiomas
3. Determine the appropriate management for cavernous sinus and parasellar meningiomas

CME Questions

1. What are the most common visual complaints of patients with cavernous sinus and parasellar meningiomas?
2. What are the management options for patients with cavernous sinus and parasellar meningiomas?
3. What parameters should be used for following patients with cavernous sinus and parasellar meningiomas?

Meningiomas account for approximately 15% of all intracranial tumors. Of these, 15-20% involve the anterior cranial fossa floor and can extend to involve the cavernous sinus. The majority of patients present with visual disturbances, the most common of which are decreased visual acuity, color vision deficits, and visual field defects from optic neuropathy, diplopia from ocular motor nerve pareses, and facial pain or numbness from trigeminal sensory neuropathy. Decisions regarding therapeutic intervention in these histologically benign, slow-growing tumors are frequently predicated on the development, existence, or progression of visual deficits in the ipsilateral eye, or are based on attempting to preserve visual function in the contralateral eye. Options with respect to management include observation without intervention, radical surgery with attempted removal of all tumor within the cavernous sinus, subtotal resection only, subtotal resection followed by conventional fractionated radiation therapy, conventional fractionated radiation therapy alone, and stereotactic radiosurgery performed either as a primary procedure or as an adjuvant to subtotal tumor resection.

Although several studies have reported the results of surgery on visual acuity, visual field, or both in the perioperative period and in the first few years after surgery, little is known about the long-term visual prognosis in these patients, i.e., more than 10 years after surgery. Additionally, many of these studies have not investigated other visual characteristics, such as color vision, pupillary reactivity, appearance of the optic disc, cranial neuropathies, and proptosis.

In a report by Klink et al., multiple visual parameters in 29 patients with parasellar meningiomas and at least 10 years of ophthalmologic follow-up were assessed. These authors found that the majority of patients with parasellar meningiomas present with visual complaints, the most common of which are decreased vision and double vision. Twenty-seven of the patients underwent non-radical microsurgical tumor resection. This entails removal of all intracranial intradural tumor, removal of tumor-bearing dura, exploration of the optic canal when indicated, removal of accessible intracavernous tumor, and removal of hyperostotic bone. This definition excludes radical cavernous sinus extirpation, carotid artery bypass and radical combined intradural-extradural approaches. Seven patients underwent radiation therapy.

Eighty-six percent of the patients reported by Klink et al. retained functional vision in at least one eye over an average follow-up of 13.6 years, with 48% retaining vision in both eyes. Visual function remained stable or improved in 62% of patients. Thirty-eight percent of preexisting motility deficits worsened, but only 9.5% of unaffected patients developed new motility deficits. These results did not significantly differ from reports where radical surgery in this region was performed.

The results of the study by Klink et al. indicate a favorable long-term prognosis for functional vision in patients with parasellar meningiomas treated without radical tumor removal. The study does not, however, address the use of conventional fractionated radiation therapy or stereotactic radiosurgery as the primary or adjunctive treatment of parasellar meningiomas. This is particularly important because tumor progression remains the major concern in these patients as a cause of long-term morbidity. In the study by Klink et al., 18 of 29 tumors (62%) progressed during an average follow-up of 13.6 years. Eighty-nine percent of patients followed for 15 or more years experienced tumor progression. The findings in this study indicate that the risk of tumor progression is greater the longer the patient is followed and appears to be very high beyond 15 years in patients with incompletely excised tumors.

Radiation therapy has been advocated as a means of reducing progression of meningiomas. Miralbell et al. demonstrated an increase in progression-free survival in patients treated with external beam radiation therapy after primary or a second surgery for benign meningiomas, and Peele et al. reported delayed recurrence in patients with sphenoid wing meningiomas treated with postoperative radiation. Dufour et al. performed a retrospective study of 31 patients with cavernous sinus meningiomas.
malignant meningiomas. Seventeen of these patients (55%) were treated with surgery and conventional fractionated radiation therapy, whereas 14 patients (45%) were treated with radiation therapy alone. The overall progression-free survival rate in this study was 92.8% at 10-year follow-up, with only two patients exhibiting tumor progression after initial treatment. One patient experienced worse visual acuity in one eye after surgery and a second patient experienced worsening of a pre-existing third nerve palsy after surgery. None of the patients developed late radiation toxicity, and the follow-up status as measured by the Karnofsky Performance Scale was the same or improved in 93% of patients. The authors therefore concluded that combined “nonradical” surgery and radiation therapy or radiation therapy alone was associated with a high rate of tumor control and a low morbidity, and that complete aggressive surgical removal of cavernous sinus meningiomas, which is associated with a high incidence of morbidity and mortality, is probably unwarranted.

Despite the findings of Dufour et al., other authors have found that conventional radiation therapy is not without risk. For example, Al-Mefty et al. reported radiation-induced complications after treatment of basal skull meningiomas that included decreased acuity, hypopituitarism, parenchymal changes, and secondary tumors.

In recent years, stereotactic radiosurgery (high-dose single-fraction focal radiation therapy) has gained increasing acceptance as an alternative to microsurgery for parasellar and cavernous sinus meningiomas. Radiosurgery appears to control tumor growth with acceptable side effects. Duma et al. reported no growth in 34 patients followed for a mean of 26 months after stereotactic radiosurgery in addition to or as an alternative to surgery for cavernous sinus meningiomas. In this series, patient clinical status was improved in 24% of patients and unchanged in 67%. However, as noted above, the follow-up period was short, with the longest follow-up being 4.5 years.

Liscak et al. reported follow-up data on 53 patients with cavernous sinus meningiomas with stereotactic radiosurgery using the gamma knife. These investigators observed a reduction in tumor volume in 52% of cases, whereas 48% of cases showed no change in volume by neuroimaging over a follow-up period of 2 to 60 months, with a median of 19 months. Clinical symptoms and signs improved in 35% of cases. Although the authors emphasized the safety and effectiveness of the procedure, once again, the follow-up period was so short as to make their data almost meaningless.

Roche et al. (part of the same group that reported their results in reference 16) reported the results of stereotactic radiosurgery using the gamma knife in 80 patients with cavernous sinus and parasellar meningiomas, of whom 50 (62.5%) received this treatment as an alternative to surgery, whereas the remaining 30 patients received the treatment as an adjuvant to microsurgery. Over a follow-up period that ranged from 12 to 79 months (median, 30.5 months), tumor stabilization by neuroimaging was noted in 51 patients, with tumor shrinkage in 25. No new ocular motor deficit developed in any patient during this period, and in 23 patients (29%), ocular motor deficits either improved or resolved. Among 13 patients with tumor-related trigeminal neuralgia, seven (54%) either improved or experienced resolution of pain, whereas in five patients, the pain was unchanged. One patient’s pain worsened. Although this paper has a better range and longer median follow-up, it still provides no true long-term results of radiosurgery. Similar comments apply to the series reported by Chen et al. (35 patients; median follow-up, 122 weeks), Iwai et al. (seven patients; mean follow-up, 39 months).

Shin et al. reported the best data to date. These authors reviewed their experience with stereotactic radiosurgery in the treatment of 40 patients with cavernous sinus meningiomas. The range of follow-up in their series was 12 to 123 months, with a median of 42 months. The tumor control rate was 86.4% at 3 years and 82.3% at 10 years. There was no mortality and no permanent neurologic morbidity over the follow-up period. Recurrence was associated with inadequate or lack of radiation to part of the tumor. The authors concluded that when stereotactic radiosurgery is used to treat cavernous sinus meningiomas, the whole mass should receive more than 14 Gy. They recommend that when optimum radiosurgical planning is not feasible because of the large size, irregular shape, or proximity to visual sensory pathways, limited surgical resection should precede the radiosurgery.

Finally, Sibtain and Plowman compared the efficacy of stereotactic radiosurgery with conventional fractionated radiation therapy in 28 patients with cavernous sinus meningiomas. These authors concluded that fractionated radiation therapy should be used to treat patients with large tumors (>3 cm in diameter), whereas radiosurgery is best for small (<3 cm in diameter) tumors. They also believe that subtotal excision of these tumors followed by appropriate-dose radiation is preferable to attempted radical excision.

Despite these relatively glowing reports of the beneficial effects of stereotactic radiosurgery as either primary therapy or adjuvant treatment for parasellar and cavernous sinus meningiomas, the lack of long-term follow-up and disparate treatment protocols have made the role of radiosurgery for parasellar meningiomas difficult to define. Furthermore, the structures of the anterior visual...
system appear to exhibit a higher sensitivity to single-fraction radiation than other cranial nerves, which may affect long-term visual outcomes for patients treated in this manner.

A somewhat innovative radiation therapy for parasellar/clival meningiomas was advocated by Vuorinen et al. These authors permanently implanted I-125 seeds into 25 parasellar/clival meningiomas using stereotactic technique and 3-D dose planning. There was no procedural mortality and no serious bleeding, although one of the patients developed a third nerve paresis from inadvertent puncture of the nerve during the procedure. Over a follow-up period that ranged from 6 to 32 months (median, 19 months), 17 of the 25 tumors (68%) showed some degree of shrinkage by neuroimaging. Among 17 patients with ocular motor nerve pareses or trigeminal sensory neuropathies, eight experienced improvement in their deficits, whereas in nine patients, facial numbness developed or increased. As with stereotactic radiosurgery, the long-term effects of this form of treatment on both tumor growth and neurologic function remain to be seen.

Conclusions
Some authors advocate aggressive surgery in the region of the cavernous sinus in an attempt to achieve total tumor resection, reduce recurrence rates, and avoid long-term neurologic and ophthalmologic morbidity. Reports of invasion of cranial nerves and the internal carotid artery in the cavernous sinus, however, raise the question whether radical surgery can completely remove a tumor in this location. DeMonte et al. performed radical cavernous sinus surgery on 41 patients over a 10-year period. In that study, three of 27 patients (11%) without a CN III deficit developed one over a mean follow-up of 45 months.

In the study by Klink et al., three of 22 patients (14%) without a preexisting CN III palsy developed one over a mean follow-up of 13.6 years. This suggests that radical surgery in the cavernous sinus does not provide any advantage in delaying or preventing the subsequent development of new cranial neuropathies. Furthermore, radical surgery exposes the patient to the immediate risk of ocularmotor dysfunction and almost always results in temporary motility problems in the ipsilateral eye. Given that non-ophthalmologic sequelae of tumors confined to the cavernous sinus are uncommon, the rationale behind aggressive surgery in this region may need to be reassessed. This is especially true in patients in whom vascular bypass is being considered, because this increases the attendant morbidity. It seems that nonradical surgical debulking of extra-cavernous tumor followed by either conventional fractionated radiation therapy or stereotactic radiosurgery is the best option for many patients harboring cavernous sinus or parasellar meningiomas, and it is even possible that some form of radiation should be the major treatment and that surgery should play little or no role in the management of these tumors, although further long-term studies are required to settle this issue. Nevertheless, available data indicate a favorable long-term prognosis for functional vision in patients with parasellar meningiomas treated without radical tumor removal. Long-term visual deficits are no more likely to occur than are the deficits resulting from radical surgery, and the combined operative follow-up mortality and morbidity is much less. These issues must be considered when determining the optimum management of a patient with a parasellar or cavernous sinus meningioma.

References