Guest Editorial

Contemporary management of meningiomas: radiation therapy as an adjuvant and radiosurgery as an alternative to surgical removal?

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As we proceed into the second century of diagnosis and management of intracranial meningiomas, the proper mixture of definitive surgery and radiation therapy techniques continues to be analyzed. Both the reports of Goldsmith, et al., and Maroon, et al., define a series of patients who benefited from a judicious balance of multimodality management strategies for their meningeal tumors. Modern microsurgical techniques, cranial nerve electrophysiological monitoring, enhanced neuroanesthesia regimens, and superior postoperative rehabilitative services have improved considerably the overall mortality and morbidity statistics for meningioma surgery. Surprisingly, a number of controversial questions remain to be answered despite our more than 100 years of experience.

How Often Is Total Removal of a Meningioma Possible?

Complete surgical resection is a logical treatment choice for meningiomas. Many factors define the likelihood of having successful total removal: patient's age, tumor location, tumor histology, and the reported success of alternative treatment strategies. Mirmiannoff, et al., studied 225 meningioma patients who underwent tumor resection. They described recurrence rates of 5% at 5 years, 10% at 10 years, and 32% at 15 years after total resection. Tumor progression rates 5, 10, and 15 years after subtotal tumor resection were 37%, 55%, and 91%, respectively. Ten years after surgery, Taylor, et al., reported tumor progression rates of 82% after subtotal resection and 33% after total resection of meningiomas. Jääskeläinen, et al., stated that, despite complete resection, patients had a continuing risk of relapse up to 25 years after surgery (the median time of recurrence was 7.5 years). These studies emphasize the importance of long-term analysis of the results of meningioma surgery. As Maroon, et al., have pointed out, postoperative high-resolution magnetic resonance (MR) imaging often reveals residual tumor margins despite the operative surgeon's opinion that complete surgical resection was performed.

Advances in modern skull-base surgery allow a number of meningiomas to be completely resected; some of these patients suffer major neurological morbidity. Sekhar, et al., found that relatively few patients with tumor involving the cavernous sinus were suitable for reconstruction of their cranial nerves at the time of tumor removal. Some patients, especially those who are elderly, have excessive medical risks for surgical resection. Goldsmith, et al., and Maroon, et al., provide additional evidence that surgery short of total removal reduces morbidity. When followed by adjuvant radiation techniques, subtotal surgical removal is one method to obtain tumor control while preserving neurological function.

Modern neuroimaging defines meningeal tumors well. A period of observation is often an appropriate management strategy in patients who present with minimal neurological deficits. Either the development of new neurological deficits or imaging evidence of tumor progression may warrant intervention. After review of the neuroimaging and analysis of the likelihood of undesirable side effects, the treatment strategy should be determined in advance of the surgical procedure itself, especially in patients with meningiomas located in the cavernous sinus and petroclival regions. We need to eliminate "peek and shriek" surgery since open biopsy alone has little utility in most patients with skull-base meningiomas. Even if the preoperative plan is to attempt surgical excision, the goal can be modified appropriately if intraoperative findings such as unanticipated cranial nerve adherence or vascular involvement preclude safe resection.
Does Fractionated Radiation Therapy Improve the Outcome of Partially Resected Meningiomas?

Tumor control rates for meningiomas treated by conventional external beam fractionated radiation therapy vary from 50% to 90%, 2,6-8,11,14,15,16 These results are affected by many factors: follow-up period, tumor histology (benign vs. malignant), treatment technique, radiation dose, the availability of computerized tomography (CT) or MR imaging for radiation dose planning, the use of modern radiation delivery tools such as linear accelerators, and the extent of prior surgical resection. Taylor, et al.,17 report a 15% recurrence rate in patients who underwent subtotal excision followed by radiation therapy; in contrast, 69% of patients who had subtotal excision alone suffered a recurrence.

The timing of radiation therapy appears important. Tumor progression occurs more often in patients who undergo only repeated subtotal excision compared to patients who undergo postoperative radiation therapy after repeat subtotal resection. Yamashita, et al.,18 stated that radiation therapy is of little value for recurrent meningiomas. Carella, et al.,2 reported that five of 14 patients who received radiation therapy for recurrent meningiomas later died of local disease. Goldsmith, et al.,4 also advocate early radiation therapy after subtotal meningioma removal. Glaholm, et al.,7 emphasized the importance of histology in the progression-free survival interval after subtotal meningioma surgery and radiation therapy. In a series of 186 patients treated at the Royal Marsden Hospital between 1963 and 1983, they reported 5-, 10-, and 15-year actuarial survival rates of 78%, 67%, and 59%, respectively. Of these, 117 patients had completely benign meningiomas; their 5-, 10-, and 15-year actuarial tumor control rates were 84%, 74%, and 68%, respectively. Six of nine patients with malignant meningiomas died within 5 years of persistent or recurrent disease. Twenty-eight patients with “aggressive benign meningiomas” (excessive mitotic figures without other features of frank malignancy) had actuarial 5-, 10-, and 15-year tumor control rates of 44%, 13%, and 0%, respectively.

The University of California, San Francisco (UCSF), experience reported by Goldsmith, et al.,4 provides compelling evidence that modern multiple-port fractionated radiation therapy with delivery planning based on CT and MR imaging enhances the long-term tumor control rate of meningiomas. The patients with benign histology who underwent subtotal surgery and irradiation after 1980 had an actuarial tumor control rate of 98% compared to the 87% control rate defined for those patients treated before 1980.

Is Fractionated Radiation Therapy Safe?

Any analysis of the risk:benefit ratio must review both the success and risks of radiation therapy. Al-Mefty, et al.,1 defined a number of concerns relative to the potential long-term side effects of radiation therapy for benign brain tumors. Such risks include loss of vision, pituitary dysfunction, delayed radiation-induced injury of the brain, and the development of secondary neoplasms. Maroon, et al.,13 provide additional evidence that conventional radiation therapy (performed at experienced centers using currently available technology) has relatively few risks. In the UCSF experience, five (3.6%) of 140 patients had complications suspected to be radiation-induced injuries of the brain or cranial nerves.

Selection of the appropriate management strategy at a particular interval in an individual patient is clearly important. For example, a patient who presents with rapidly progressive deterioration from a parasellar meningioma is likely to require early microsurgical removal in order to preserve or restore vision. Radiation therapy is unlikely to reverse this process. Our literature is replete with anecdotal reports about secondary development of neoplasms after radiation therapy. In general, radiation-induced neoplasia is associated with the use of older orthovoltage radiation techniques and wide radiation fields. Modern technology should significantly reduce the possibility of secondary radiation-induced neoplasia.

Does Fractionated Radiation Therapy Reduce the Likelihood of Subsequent Complete Surgical Removal of a Meningioma?

Sekhar, et al.,15 expressed concern that definitive microsurgical removal is more difficult or hazardous in patients who have previously undergone subtotal removal followed by radiation therapy. On the one hand, reduction in the tumor blood supply induced by radiation may improve the possibility of surgical removal. On the other hand, radiation-induced fibrosis or increased tumor adherence to vital vascular or cranial nerve structures may increase the likelihood of a bad outcome with attempted radical surgical removal. I suspect that such “failed surgical and radiation” patients in fact have a more aggressive meningioma with adverse biological behavior. It is unclear whether the difficulty encountered with removal of such a tumor is a reflection of the basic biology of the neoplasm or is a side effect of prior surgery or of adjacent radiation.

Is Stereotactic Radiosurgery an Effective Alternative to Either Total Resection or Fractionated Radiation Therapy?

Stereotactic radiosurgery is a potentially effective alternative for surgical removal of a wide variety of small to moderate-sized meningiomas. The goals of radiosurgery (precise single-fraction stereotactic delivery of radiation conformal to the tumor margin) are twofold: preservation of neurological function and prevention of further tumor growth. Meningiomas possess a number of features that make them potentially well suited for radiosurgery: 1) they are usually well encapsulated; 2) unless malignant, they rarely invade brain; 3) the steep radiation falloff achieved by radiosurgery can be conformed to the irregular tumor margins; 4) they are readily defined by current-generation contrast-enhanced MR imaging and CT; 5) they are being recognized even when small; and 6) the dual blood supply can often be included within the high radiation dose in order to achieve delayed vascular obliteration.

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