Effect of modern radiation techniques on the surgery of nonmalignant intracranial tumors

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I was asked by Dr. Johnson, the editor of this issue of Neurosurgical Focus, to write an editorial describing how current radiation techniques may have influenced my surgical attitude toward nonmalignant intracranial tumors. I am delighted to have been given this opportunity and would like to begin with 2 disclaimers.

The first disclaimer is that I personally do not perform radiosurgery in any of its forms. Obviously, I am not an expert either in any of the modern forms of fractionated radiotherapy. Therefore, I will not discuss specific forms of delivery of radiation, advantages of one form of radiation over another, or radiation dosing.

The second important disclaimer is that I have never engaged in scientific investigation concerning benign intracranial tumors and practically none of my writings have addressed this topic. Furthermore, until about 13 or 14 years ago, although I was always interested in the surgery of specific benign intracranial tumors, such as craniopharyngiomas and some pineal tumors in particular, I operated on benign intracranial tumors only sporadically and 75–80% of my practice consisted of neurovascular surgery. However, with the advent of radiosurgery for arteriovenous malformations, endovascular surgery for aneurysms, a greater number of well-trained neurovascular surgeons competing for these cases, and other reasons, the volume of my neurovascular practice has gradually declined. As a consequence, I have become more and more engaged in the surgery of benign intracranial tumors to the point that, at the present time, that aspect of my practice exceeds the volume of my neurovascular cases. The experience acquired in skull base exposures for vascular lesions helped considerably as my practice with benign tumors of the base of the skull increased.

I would like to organize my comments by addressing specific intracranial locations of tumors and then, in a very general way, discuss how modern radiation techniques may have influenced my current surgical attitude towards tumors in these different locations.

Cerebral Convexity Tumors

In this section on cerebral convexity, I will refer only to meningiomas. I believe that the most important decision with meningiomas of the convexity is not how to remove them, but when. I tend to see many more asymptomatic patients with convexity meningiomas in my clinic than patients with truly symptomatic meningiomas. The decision to operate is easy in clearly symptomatic patients or in patients with relatively large meningiomas with significant mass effect. I tend to use the presence of significant edema, even if the tumor itself is not too large, as an indication for surgery, but I know that the evidence supporting this policy is meager to nonexistent. Not infrequently, I would recommend surgery for an asymptomatic tumor—even if it is not producing significant mass effect—when the tumor is close to a major venous sinus (including the cavernous sinus) under the presumption that if the tumor is allowed to grow to the point of involving the sinus, the surgery may become riskier at that time and the possibility of a “cure” decreases substantially. In general, if I recommend treatment for a convexity meningioma, that treatment is excision, and only rarely would I recommend radiosurgery unless the patient is elderly or has substantial surgical comorbidities. With atypical meningiomas that have been removed completely, including their dural attachments, I prefer observation because the evidence for the effectiveness of radiosurgery in this setting is inconclusive.1 For the occasional malignant meningioma, I recommend, as I suspect do most neurosurgeons, postoperative fractionated radiotherapy with a relatively wide margin around the tumor. This is also my recommendation for most instances of recurrent tumor given the propensity for second recurrences to occur more commonly and more rapidly.2

Parasagittal Tumors

In discussing parasagittal tumors, we are again usually talking about meningiomas. There is little controversy about surgery for meningiomas involving the anterior third of the sagittal sinus, which can generally be removed radically, including resection of the sinus and falx when necessary. More posterior parasagittal meningiomas—particularly those involving the middle third of the sagittal sinus—are more problematic, and I recently had the opportunity to write an editorial commenting on the excellent article by Sindou and Alvernia4 reviewing their outstanding experience with the surgery of these tumors.4 Essentially, my point in that editorial was that I personally, not pos-
sessing the technical skill and experience of Dr. Sindou with tumors in this location, have a more conservative attitude toward tumors that do not completely occlude the sinus. Rather than removing these tumors radically and either exploring or reconstructing the sinus, as performed so skillfully by Dr. Sindou and others, I prefer to leave residual tumor when the sinus is involved but still patent and treat those patients with observation if there is no grossly visible residual tumor on the magnetic resonance image, or with radiosurgery if the amount of residual tumor is small enough to be treated in this manner. Additionally, when the sinus is occluded I resect it, but may leave some tumor at one or the other end of the sinus resection when there are important veins draining into that partially patent portion of the sinus. The residual tumor is then treated using radiosurgery.

**Falcine Meningiomas**

Most meningiomas involving the anterior third of the falx can be removed radically with or without excision of the superior sagittal sinus, depending on whether the sinus is completely occluded, the pattern of venous drainage, and other factors. Most meningiomas of the posterior falx can also be removed completely, provided that they do not involve the sagittal or the straight sinus; when they do and the sinus is still partially patent, I leave residual tumor rather than sacrifice the sinus and then proceed with postoperative radiosurgery if the residual tumor is small enough, or use fractionated radiotherapy if the amount of residual tumor is larger. Again, falcine tumors involving the middle third of the superior sagittal sinus are more problematic. Very frequently, these tumors are bilateral, and accessing them when the sagittal sinus is patent and cannot be removed is problematic because it requires retraction of the primary motor/sensory regions of the brain. With these tumors, I make every effort to remove the tumor, if possible, from one side and try to avoid opening the opposite side to avoid bilateral damage to the brain and/or central veins in this region, which of course is poorly tolerated. If all of the tumor cannot be removed from one side, I personally prefer to not open the opposite side and leave that residual tumor unless the tumor is very soft and the removal of the tumor could be accomplished with minimal brain retraction and without damage to any of the important central draining veins. When there is residual tumor, I prefer observation, knowing that it will probably have to be treated at some point in the future. Radiosurgery, or more frequently, fractionated radiation, depending upon the size of the residual tumor, is used in elderly patients in hopes of minimizing the chances of having to reoperate in these patients.

**Sphenoid Wing Meningiomas**

The more lateral pterional meningiomas frequently cannot be removed completely because of involvement of bone. Obviously, we always attempt as radical a removal as possible, with extensive bone drilling including removal of the superior and lateral walls of the orbit and any intraorbital tumor, but we know that the chances of removing all of the bone containing tumor in these en plaque meningiomas is small. Even when we know that the resection is incomplete, however, I prefer to observe these patients rather than treat them with postoperative radiation because usually these tumors are relatively indolent and the time to recurrence is relatively long. Globular tumors of the middle portion of the sphenoid wing can usually be removed completely. The problem occurs with meningiomas of the medial third of the sphenoid wing, which very frequently involve the cavernous sinus. In spite of my early enthusiasm for radical removal of these tumors after a delightful visit to Vinko Dolenc in Ljubljana, it did not take me long to realize that I did not have the skill required to operate safely in the cavernous sinus and that the postoperative morbidity (cranial nerve deficits) resulting from a few of my early attempts was unacceptable. I now routinely leave residual tumor involving the cavernous sinus, although I make every effort to decompress the optic nerve if it is being compressed by tumor so as to leave enough distance (at least 3–4 mm) between the optic nerve and the residual tumor to allow radiosurgical treatment of the residual.

Finally, within this general group we could include the specific case of meningiomas that appear to be centered in the anterior clinoid and project more superiority. Peculiarly, these tumors usually do not involve the cavernous sinus and can be removed completely. I prefer to perform a thorough extradural removal of the clinoid and unroofing of the optic nerve, which facilitates the subsequent intradural removal of the tumor. If, at surgery, it appears that the tumor involves the cavernous sinus, I prefer to leave residual tumor there, but the issue of whether to proceed with postoperative radiosurgery is complicated in these cases because the residual tumor is frequently very close to the optic nerve. Although my radiosurgical colleagues believe that as long as the dose to the optic nerve does not exceed 10 Gy, radiosurgery could be used, I may prefer to observe these tumors rather than risk damage to the optic nerve.

**Midline Anterior Fossa Tumors**

Olfactory groove meningiomas, although frequently giant in size, can of course be removed radically in most patients. Occasionally, the tumors have grown back far enough to be intimately adherent to the anterior cerebral arterial complex and—particularly in elderly patients—it may be preferable to leave some residual tumor, which I do not hesitate to do when it appears that the risk of complete removal is too high. That residual tumor can then be postoperatively observed with the likelihood of a second operation in the future, possibly from a more lateral (pterional/transsylvian) approach as opposed to the initial midline bifrontal approach that I usually use for most olfactory groove meningiomas. In older patients, it may be preferable to use either radiosurgery or fractionated radiotherapy, depending upon the size of the residual tumor, in an effort to avoid a second operation. I prefer to approach meningiomas of the planum sphenoidale anterolaterally (pterional approach) rather than from the front. Almost always, these tumors can be removed completely. Meningiomas of the tuberculum are more difficult of course because they frequently involve 1 or both optic nerves. Depending on the situation at surgery, I frequently leave some residual tumor rather than risking blindness (which I have produced more frequently than I want to remember) in an attempt to radi-