

Gamma Knife® radiosurgery

Meningioma



Introduction

Meningiomas are generally slow-growing, intracranial or intraspinal extra-axial tumors that develop from the arachnoid cap cells of the dura mater. Although most tumors grow slowly, some grow quickly and can double in volume within six months to a year. Stereotactic radiosurgery has greatly expanded the management options since patients no longer have to choose simply between resection and observation. Resection is indicated for larger tumors with disabling brain or nerve compression, hydrocephalus, intractable headache or trigeminal neuralgia. Many patients have smaller tumors and do not have severe symptoms. Although the outcomes of surgical removal at centers of excellence have improved markedly over the last two decades, patients increasingly seek lesser invasive options.

Gamma Knife Radiosurgery Technique for Meningiomas

Patients with meningiomas are evaluated with high resolution MRI. For meningioma radiosurgery, a 3-D volume acquisition MRI using a gradient pulse sequence is performed in order to cover the entire lesion and surrounding critical structures. A T2 weighted 3-D volume sequence is performed to visualize the brain parenchyma, any edema, and cranial nerves if appropriate. Planning is performed on narrow slice thickness axial MR images with coronal and sagittal reconstructions. Conformality and selectivity is necessary for brain function preservation. Meningioma planning is usually performed using a combination of small beam diameter (4mm and 8mm) collimators. The treatment isodose, maximum dose, and dose to the margin (edge) are jointly decided by a neurosurgeon, radiation oncologist, and medical physicist. In Gamma Knife® radiosurgery a dose of 11-16Gy is typically prescribed to the 50% (or other) isodose line that conforms to the tumor margin.

Clinical Results

Long-term results of Gamma Knife® radiosurgery for meningiomas have been documented. Recent reports suggest a post-radiosurgery tumor control rate above 90% for grade 1 tumors. In a 2008 report, the University of Pittsburgh group provided further data. The larger patient cohort consisted of 972 patients with 1045 intracranial meningiomas managed during an 18-year period. The overall control rate for

patients with benign meningiomas (World Health Organization Grade I) was 93%. Santocroce et al provided results from a large European multi-center study. From 15 participating centers, they reported a retrospective observational analysis of 4,565 consecutive patients harboring 5,300 benign meningiomas. Five- and 10-year progression-free survival rates were 95.2% and 88.6%, respectively. Tumor control was higher for imaging defined tumors vs grade I meningiomas ($P < .001$), for female vs. male patients ($P < .001$), for sporadic vs. multiple meningiomas ($P < .001$), and for skull base vs. convexity tumors ($P < .001$).

Conclusion

Gamma Knife® radiosurgery has become a well documented management option for patients with intracranial meningiomas that is both safe and effective over the long-term. The most data is for grade 1 tumors, either as initial management or for residual or recurrent tumors with known histology. Data past ten years of follow-up are now published, and systematic, serially collected outcomes data are available on patients with for this tumor. Radiosurgery is now a common treatment choice for many patients with smaller volume tumors.

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