toma: management recommendations based on a 35-year experience. *Int J Radiat Oncol Biol Phys* 67: 1145–1154, 2006
21) Lenzi J, Salvati M, Raco A, Frati A, Piccirilli M, Delfini R: Central neurocytoma: a novel appraisal of a polymorphic pathology. Our experience and a review of the literature. *Neurosurg Rev* 29: 286–292, 2006
22) Martin JM, Katati M, Lopez E, Bullejos JA, Arregui G, Busquier H, Minguez A, Olivares G, Hernandez V, Arjona V: Linear accelerator radiosurgery in treatment of central neurocytomas. *Acta Neurochir (Wien)* 145: 749–754, 2003
23) Maruyama I, Sadato N, Waki A, Tsuchida T, Yoshida M, Fujibayashi Y, Ishii Y, Kubota T, Yonekura Y: Hyperacute changes in glucose metabolism of brain tumors after stereotactic radiosurgery: a PET study. *J Nucl Med* 40: 1085–1090, 1999
24) Mrak RE: Malignant neurocytic tumor. *Hum Pathol* 25: 747–752, 1994
25) Pollock BE, Stafford SL: Stereotactic radiosurgery for recurrent central neurocytoma: case report. *Neurosurgery* 48: 441–443, 2001
26) Rades D, Fehlauer F, Lamszus K, Schild SE, Hagel C, Westphal M, Alberti W: Well-differentiated neurocytoma: what is the best available treatment? *Neuro Oncol* 7: 77–83, 2005
27) Rades D, Schild SE: Value of postoperative stereotactic radiosurgery and conventional radiotherapy for incompletely resected typical neurocytomas. *Cancer* 106: 1140–1143, 2006
28) Schild SE, Scheithauer BW, Haddock MG, Schiff D, Burger PC, Wong WW, Lyons MK: Central neurocytomas. *Cancer* 15: 790–795, 1997
29) Sgouros S, Carey M, Aluwihare N, Barber P, Jackowski A: Central neurocytoma: a correlative clinicopathologic and radiologic analysis. *Surg Neurol* 49: 197–204, 1998
30) Sgouros S, Jackowski A, Carey MP: Central neurocytoma without intraventricular extension. *Surg Neurol* 42: 335–339, 1994
31) Suh JH, Barnett GH: Stereotactic radiosurgery for brain tumors in pediatric patients. *Technol Cancer Res Treat* 2: 141–146, 2003
32) Taylor CL, Cohen ML, Cohen AR: Neurocytoma presenting with intraparenchymal cerebral hemorrhage. *Pediatr Neurosurg* 29: 92–95, 1998
33) Therasse P, Arbuck SG, Eisenhauer EA, Wanders J, Kaplan RS, Rubinstein L, Verweij J, Van Glabbeke M, van Oosterom AT, Christian MC, Gwyther SG: New guidelines to evaluate the response to treatment in solid tumors. European Organization for Research and Treatment of Cancer, National Cancer Institute of the United States, National Cancer Institute of Canada. *J Natl Cancer Inst* 92: 205–216, 2000
34) Tomura N, Hirano H, Watanabe O, Watarai J, Itoh Y, Mineura K, Kowada M: Central neurocytoma with clinically malignant behavior. *AJNR Am J Neuroradiol* 18: 1175–1178, 1997
35) Tyler-Kabara E, Kondziolka D, Flickinger JC, Lunsford LD: Stereotactic radiosurgery for residual neurocytoma. Report of four cases. *J Neurosurg* 95: 879–882, 2001
36) Yasargil MG, von Ammon K, von Deimling A, Valavanis A, Wichmann W, Wiestler OD: Central neurocytoma: histopathological variants and therapeutic approaches. *J Neurosurg* 76: 32–37, 1992
37) Yen CP, Sheehan J, Patterson G, Steiner L: Gamma knife surgery for neurocytoma. *J Neurosurg* 107: 7–12, 2007

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Commentary

Matsunaga et al. reported a case series of seven patients with eight central neurocytomas managed with adjuvant gamma knife radiosurgery (GKS). Tumor control was achieved in seven of eight tumors without radiation-related complications. Interestingly, authors showed a unique experience that the response to GKS was different with malignant transformation in a patient. The total resection of tumor is curative, but is not always feasible because of hypervascularity, deep location and surrounding critical structures. The radiosurgery is an attractive adjuvant treatment modality for central neurocytoma. Firstly, the results of conventional radiotherapy revealed radiosensitive characteristics and long-term tumor control. Secondly, there were several structural advantages for radiosurgery. The tumor is located in the ventricle and only a small portion of tumor is attached to the normal parenchyma. The cerebrospinal fluid (CSF) between tumor and surrounding structures makes it possible to reduce radiation to normal parenchyma. In addition, the tumor is round in shape and the margin is easily demarcated from the surrounding tissue on imaging studies. Based on these features, GKS for central neurocytoma showed satisfactory results in local tumor control, survival, and treatment-associated complications. Typical radiological findings such as intraventricular location, multiple intratumoral cysts and calcification allow the presumptive diagnosis and the trial of GKS as a primary treatment without histopathologic evidence. The planning of radiosurgery is the most important factor for successful results. In some cases, it is not easy to delineate the whole tumor margin because the signal intensity of tumor on magnetic resonance (MR) imaging is similar to that of CSF or normal white matter. There-

fore, regular long-term follow-up MR imaging should be mandatory to validate the procedure. This manuscript pointed out the role of GKS as an important adjuvant treatment and is a valuable contribution to the management of central neurocytoma.

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Matsunaga and colleagues report a series of seven cases of intracranial central neurocytomas treated by multimodality management which included one or more surgical procedures and one or more gamma knife radiosurgical procedures in follow up. All patients had histological confirmation of the diagnosis prior to radiosurgery. One patient died of tumor progression and delayed intracranial bleeding. Most patients with central neurocytomas require multimodality management, and early radiosurgery is important. Because of their histological properties and anatomic location arising from the septum pellucidum or in the region of the fornix and lateral ventricle, histological diagnosis is critical to separate this tumor out from those tumors that can mimic their initial imaging presentation. Such tumors include subependymoma, ependymoma, and oligodendroglial tumors.

This paper also reports the potential of neurocytomas to undergo malignant progression after both surgery and radiosurgery. Such anaplastic tumors behave aggressively and have high recurrence rates, either locally or in distant regions within the brain or in the cerebrospinal fluid pathways. The radiosurgical dose that is necessary to control such tumors is not currently well defined. Doses of 12 Gy at the edge of the imaging-defined tumor volume correspond to a minimal tumor dose of fractionated radiation therapy of approximately 48 Gy, although during radiosurgery most of the tumor gets a much higher radiobiological dose. This is most likely one tumor where dose reduction may increase the chance of delayed tumor progression and ultimate failure. We have found that dose reduction in hemangiopericytoma is also associated with higher recurrence rates. The critical structure is often the fornix in the midline, and the overall radiation tolerance of this structure is not clear. It is certainly a white matter pathway, tended by oligodendroglia which represent the most radiation-sensitive cells. It is likely that the overall dose and volume of radiation to the fornix may be the most important dose-limiting factor. Forniceal injury could be associated with a significant amnestic syndrome. In our experience, central neurocytomas often ''melt away'' after radiosurgery. They are, in fact, the most likely tumor to have significant regression of all the glial/neuronal tumors. Long-term follow up is critical for such patients, and the need for re-operation may present itself over time. The goal of multimodality treatment (initial aggressive resection followed by radiosurgery) is to provide the longest opportunity for symptom-free recurrence while at the same time minimizing the risk of early deficits associated with aggressive resection, especially if the tumor is invasive in the fornix. We have found that stereotactic endoscopic resection using an Endoport system is a valuable way to initially resect the tumor in one or more operations.[1] Early radiosurgery is important, as delayed regrowth is expected in subtotally resected tumors, and the risks of treatment are much less when the tumor volume is smaller.

The authors' case of malignant progression after radiosurgery (or was it the surgery itself that led to this malignant degeneration?) is of concern. We believe that such rare tumors can be best evaluated using multicenter consortia. It is for this reason that, 2 years ago, we formed the North American Gamma Knife Consortium to evaluate outcomes of radiosurgery in rare tumors as well as to develop prospective clinical trials using common technology. Hopefully, the outcomes after central neurocytoma radiosurgery may be a topic in the future.

Reference

1) *Engh JA, Lunsford LD, Amin DV, Ochalski PG, Fernandez-Miranda JC, Prevedello DM, Kassam AB:* Stereotactically-Guided Endoscopic Port Surgery for Intraventricular Tumor and Colloid Cyst Resection. *(in press)*

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