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Assessing Effective Transvascular Particle Delivery to the Brain Parenchyma: A Challenge to Neuroradiology

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Noninvasive Surgery for Epilepsy: The Era of Image Guidance

Epilepsy affects approximately 1% to 2% of the US population. It is a family of conditions that, if left untreated, results in recurrent seizures. The underlying disease processes resulting in epilepsy are myriad, and include destructive lesions of the brain, congenital malformations and dysplasias, neoplasms, vascular malformations, medial temporal sclerosis, and metabolic lesions. Fortunately, most of these conditions are controlled well with medical management. Epilepsy in approximately 10% of patients, however, becomes refractory to medical management, with devastating social and medical consequences. In this group of patients, surgical resection of the seizure focus, if possible, has become the mainstay of therapy. MR imaging, and to a lesser extent FDG-PET scanning, have become invaluable preoperative tools for surgical planning. In various series of adult-intractable epilepsy, 80% to 90% of lesions is visible on MR images, especially those of mesial temporal sclerosis. The remaining lesions may have foci, which are smaller or microscopic, and are not as easily detected with traditional anatomic imaging methods. Magnetoencephalography, PET, high-resolution surface coil MR imaging, and MR spectroscopy have been useful in demonstrating focal lesions that are below the threshold of conventional MR imaging.

Image guidance techniques have made a dramatic and rapid impact on neurosurgical practice. In our own institution, we now have four different surgical guidance systems in our operating rooms, and obtain an average of four preoperative MR scans each morning for the sole purpose of image guidance during surgery. A patient rarely enters the operating room for resection of a mass lesion without having undergone preoperative MR imaging for guidance purposes. Obviously, this trend has significantly increased the volume of MR scans we perform. MR imaging is also used for gamma-knife radiosurgery localization, and is performed the morning of the treatment after placement of the radiosurgical head frame on the patient. These tools can be quite effective in treating lesions that would normally be surgically resected.

Clinical experience with radiosurgery for tumor and arteriovenous malformation–associated epilepsy has led to the possibility of gamma-knife treatment for intractable epilepsy of other causes. Regis et al (1) were among the first to report the use of gamma-knife radiosurgery in the mesial temporal lobe. Whang and Kwon (2) reported the results of a series of 23 patients with medically intractable epilepsy who were treated with radiosurgery and followed for longer than 1 year. Electroencephalography and MR imaging were performed in all patients to identify and localize the seizure focus. The lesions on MR images were not progressive and less than 2 cm in diameter. At follow-up, 12 patients had an excellent result (class I according to Engel's classification) including three patients whose antiepileptic medication was discontinued. In two patients, the seizure frequency decreased (class II and III), and in the remaining nine patients, the frequency of seizures was unchanged (class IV). Radiation-induced edema did not seem to affect the outcome of seizure control. There are few other well-documented series of patients with intractable epilepsy treated radiosurgically.

In this issue of the *American Journal of Neuroradiology*, Regis et al (page 213) report the long-term imaging follow-up results of a patient treated with gamma-knife radiosurgery for mesial temporal lobe epilepsy. They found that the changes induced by radiosurgery were manifest on MR images 10 months after treatment, demonstrating the typical feature of radionecrosis—vasogenic edema surrounding a focus of contrast enhancement. This pattern evolved over 1 year with a decrease in edema, mass effect, and enhancement that left a focal region of atrophic hippocampal tissue with intrinsic T1 shortening. This report not only underscores the potential utility of gamma-knife radiosurgery in intractable epilepsy but also illustrates the potential effect of this treatment on normal surrounding tissue. This emphasizes the need for precise anatomic localization of seizure foci with image-guidance techniques, and the fusion of metabolic, functional, encephalographic, and anatomic tools. Neuroradiologists will need to meet the challenge of accurate localization of seizure foci with all the tools at our disposal, and via the fusion of metabolic and functional imaging data.

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