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should be considered when evaluating spinal abnormalities, particularly because CSF flow studies can be accomplished quite readily on virtually all current MR systems. In essence, we should begin to turn our attention to functional spinal MR studies, look for causes of potential CSF pressure shifts, and ''go with the flow.''

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What Is the Role of MR Spectroscopy in the Evaluation and Treatment of Brain Neoplasms?

The examination and treatment of a patient with a malignant neoplasm of the brain involves many factors. First, a diagnosis must be established. This usually begins with diagnostic imaging studies, such as MR, followed by surgical biopsies or resections of the lesion in question. Histologic analysis is a major factor in determining the appropriate treatment protocol for the patient, in combination with such prognostic indicators as age, Karnofsky rating, and location of the tumor. While somewhat controversial, most neurooncologists believe that the best opportunity for local control exists if the majority of the primary neoplastic tissue is resected prior to chemo- or radiation therapy. Although surgical resection may not prolong survival in patients with glioblastoma, there is evidence that the quality of life to recurrence may be lengthened. The widespead use of surgery means that the ability to predict histologic grade noninvasively may be clinically irrelevant for many patients.

After surgical resection and external beam radiation, brachytherapy or radiosurgery may be used to provide a single high-dose boost to regions of residual or recurrent tumor. The efficacy of such therapy is controversial and remains under investigation at a number of centers. Occasionally a neoplasm may arise in a region of the brain that is too delicate even for biopsy, such as the pons or midbrain. In these cases treatment is sometimes given without the benefit of a biopsy, but these cases are rare. After therapy, patients are usually monitored clinically and with serial MR studies, which, at our institution, are obtained every 2 to 6 months during the first 2 years after initial therapy. Throughout this period, we monitor the patient's clinical status and the tumor progress based on the overall size of the lesion, the volume of contrast enhancement, and the presence of distant spread of disease. The interpretation of these studies has great impact on treatment decisions, and this is the major impact we as neuroradiologists have in the care of patients with brain tumors.

When using the techniques available with conventional MR imaging, it is often difficult to verify whether a tumor is recurring. The development of a new contrast-enhancing lesion or area of T2 prolongation within the radiated field may represent dedifferentiation of the original tumor signifying a higher grade, tumor recurrence, radiation effect, or postsurgical change. When a patient receives gamma knife radiosurgery or brachytherapy, the treating physician must determine if a new contrast-enhancing lesion is a tumor or a local effect of the treatment. One would also like to have an earlier, and more precise measure of the efficacy of noxious pharmacologic treatment to establish whether a particular chemotherapy protocol is working.

These are questions that anatomic imaging often cannot answer definitively, fueling the interest in MR spectroscopy, PET scanning, and other functional imaging techniques.

In this issue of the *American Journal of Neuroradiology*, Meyerand et al (page 117) report on the use of single-voxel proton MR spectroscopy to classify selected primary malignant tumors of the brain. They used the point-resolved spectroscopic sequence (PRESS) technique in a selected group of patients with biopsy-confirmed glioblastoma, anaplastic astrocytoma, and low-grade astrocytoma, and found that there were significant differences in the single-voxel spectra among these selected histologic diagnoses. Metabolite peak areas were normalized to water peak. The lactate/water ratio was useful in distinguishing between all three groups while the choline/water ratio distinguished low-grade astrocytomas from the other two high-grade classifications of tumors.

Although these features have been reported as characteristic of brain neoplasms in many other articles, this is one of the first attempts to apply MR spectroscopy for predicting histologically confirmed diagnoses noninvasively. While we applaud this effort to use a widely available MR spectroscopic technique to improve characterization of brain neoplasms, the clinical usefulness of such information is rather limited. The information from this study will not eliminate the need for biopsy, because most lesions will require surgical resection anyway. Despite the good separation between three selected tumor categories, tumors containing a mixture of diagnoses, nonneoplastic lesions, and treated neoplasms may demonstrate overlap and heterogeneity in MR spectra. Therefore, the specificity of the spectral results described in this article is in question. A further limitation is that, because of the nature of the single-voxel technique, the authors did not consider regions outside the contrast-enhancing tumors. These may show significant, and often greater, spectral abnormalities than contrast-enhancing regions. In our experience with 3D spectroscopic imaging, the most metabolically active portion of a tumor is often at the leading edge be-