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We have come full circle from spinning quarks to three-dimensional (3D) medical images. The bulk of MRI is now performed using slice-selective gradients, where radio-frequency energy is applied to excite the hydrogen nuclei. By stepping a phase-encoding gradient during each repetition time and using a frequency-encoding gradient as the data are sampled, the 3D human object can be reduced to many individual points or voxels. By acquiring multiple slices at once, the time efficiency of imaging can be vastly improved. Many newer strategies use variations of this technique to acquire multiple lines of data during a single echo, enshrining spin warp imaging as the most important method of signal acquisition for MRI.

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In this article, a parallel image processing tool chain to correct preoperative functional MRI data with respect to the brain shift phenomenon based on intraoperative MRI scans of the patient's head is introduced. For this purpose, nonrigid image registration of anatomic intraoperative MRI based on a fluid dynamical model is performed to gain a three-dimensional displacement field reflecting deformations of the brain tissue. To achieve a clinically acceptable run time, the use of grid computing is aimed at intensive computing on a remote personal computer cluster. To obtain a secure and reliable computation service over the Internet, a newly developed European grid technology is used.

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Mapping of cerebellar function by functional MRI now enables us not only to re-establish older anatomic findings of somatotopic representations but to gain new insights in the function of the cerebellum and its intimate relations of cerebral regions to serving sensorimotor function, sensory discrimination, and cognitive processing. Consequently, it will change our understanding of neurologic and psychologic failures in patients with inborn errors or neurodegenerative diseases or after neurosurgical procedures.

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<p>The current state of standard tumor diagnostics using contrast-enhanced MRI and biopsy is assessed in this review, and the progress of proton magnetic resonance spectroscopy (MRS) over the last 15 years is discussed. We summarize MRS basics and describe a typical magnetic resonance session for noninvasive routine tumor diagnostics at 1.5 T, including two-dimensional magnetic resonance spectroscopic imaging (MRSI). The results that can be obtained from such procedures are illustrated with clinical examples. Attention is turned to cutting-edge methodologic and clinical research at 3 T, with examples using high-resolution or very short echo-time three-dimensional MRSI. The current status and limitations in proton MRSI are discussed, and we look to the potential of faster data collection and even higher field strength.</p>	
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<p>Diffusion tensor imaging (DTI) appears to offer the possibility of adding important information to aid in presurgical planning. Although experience is limited, DTI seems to provide useful local information about the structures near the tumor. In the future, DTI may provide an improved way to monitor intraoperative surgical procedures as well as their effects. Evaluation of the response to treatment with chemotherapy and radiation therapy may also become possible. Although DTI has some limitations, its active investigation and further study are clearly warranted.</p>	
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<p>Compact imagers for intraoperative MRI (iMRI) designed for use in a regular neurosurgical operating room (OR) are an attractive alternative to modifying a diagnostic MRI (dMRI) suite for surgery or altering an OR to accommodate dMRI. The PoleStar N-10 iMRI system incorporates a 0.12-T magnet and was fashioned as a tool for intracranial neurosurgery. In our experience, this system proved to be a valuable aid for a wide variety of surgery, mostly for intracranial tumors. Expansion of this compact unit to a unit with a 0.15-T magnet has recently been accomplished, addressing some of the limitations of the previous device. We discuss the pros and cons of surgery with these low-field compact iMRI systems.</p>	

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