Intraoperative high-field MR guides neurosurgery

The introduction of open-bore technology spurred the spread of MR imaging from preoperative diagnosis to intraoperative monitoring. But MR's surgical scope could go only as far as low-field systems allowed.

Not anymore. Neurosurgeons can now use high-field intraoperative guidance to fine-tune their procedures, according to a study in the October issue of Radiology. Researchers at the University of Erlangen in Germany had devised a neurosurgical scheme combining simultaneous microscope-based neuronavigation with MR intraoperative imaging. The 0.2T magnet they used, however, couldn't match the diagnostic image quality of high-field scanners. They decided instead to adapt a 1.5T scanner for intraoperative use.

From April 2002 to July 2003, Dr. Christopher Nimsky and colleagues enrolled 200 patients presenting with cryptogenic epilepsy and diverse brain tumors, mostly gliomas or pituitary adenomas. The patients underwent high-field MR imaging during tumor or temporal lobe resection. The investigators found intraoperative MRI added useful information that changed some surgical strategies while they performed these procedures within the periphery of the magnet.

The researchers performed 77 transsphenoidal resections, 100 craniotomies, and 23 burr-hole procedures. Intraoperative MRI directly influenced surgical strategy changes in 27.5% of patients. Physicians operated on 108 patients using their microscope-based neuronavigation system, integrating functional imaging and neuronavigation data in 37 patients. The pre- and intraoperative MRI quality was nearly identical, while the intraoperative workflow was fast and safe, with no record of complications.

Intraoperative MRI helped achieve complete resection of gliomas, pituitary tumors, and damaged temporal lobes, lowering morbidity. Despite massive resections, simultaneous neuronavigation allowed neurosurgeons to preserve crucial brain areas, according to the investigators.

The intraoperative protocol for transsphenoidal surgery included a localizer sequence followed by T2-weighted, half-Fourier rapid acquisition with relaxation enhancement, T1-weighted spin-echo, and T2-weighted turbo spin-echo sequences in coronal and sagittal planes. Glioma surgery included T2-weighted turbo spin-echo, fluid-attenuated inversion recovery, T1-weighted spin-echo, and fluid-suppressed echo planar sequences in the transverse plane. Epilepsy surgery required a reduced imaging protocol.

Besides MR-compatible instruments, the neuronavigation system entailed the development of microscopes that could be used in the fringe magnetic field of the scanner, which voided time-consuming and cumbersome patient transportation to and from the imaging unit. Unlike standard neuronavigation based on anatomic information, integrated preoperative magnetoencephalography and functional MRI can be used to localize brain areas associated with speech and movement.

In addition to planning and monitoring resection, intraoperative high-field MR also helped avoid complications such as intracerebral hemorrhage. But the technique is complex and pricey. Further studies are needed to establish its proper indication and cost-effectiveness, researchers said.

Development of intraoperative techniques that rely on the latest updates in imaging technology has brought intervention to a highly sophisticated level requiring not only interdisciplinary approaches, but wider and wiser use of scanners as well. Partnership efforts between radiologists and neurosurgeons recorded in the clinical literature testify to this trend.

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