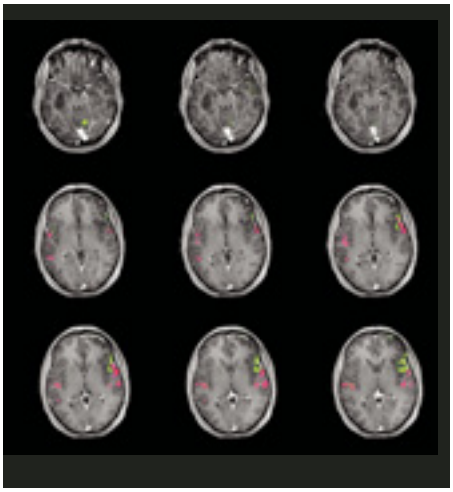
Advanced fMRI Techniques Provide Valuable Information, Change Course of Treatment for Neurosurgical Patients

The Methodist University Hospital Neuroscience Institute, in collaboration with the University of Tennessee Health Science Center, provides neuroscience clinical programs, medical education and research that are comprehensive and interdisciplinary.

Backed by the latest technologies, including a GE Signa® HD 3.0T MR, the Institute showcases advanced neurology applications, including functional magnetic resonance imaging (fMRI) and diffusion tensor imaging (DTI) – both powerful tools that help in planning treatment in patients with brain tumors.

fMRI and DTI help physicians identify areas of the brain that affect a patient's ability to function, (i.e., speech, hearing, vision, muscle control) and therefore must not be disturbed during surgery. fMRI also detects changes in the MR signal that are coupled to changes in neuronal activity. An fMRI scan can produce high-quality images that indicate which areas of the brain are being activated by diverse stimuli. In contrast, DTI is used to examine the wiring of the organized regions of the brain, mapping, the orientation of diffusion along white matter tracts and helping physicians visualize neural pathways.



fMRI activation areas are co-registered with 3D datasets for custom visualization.

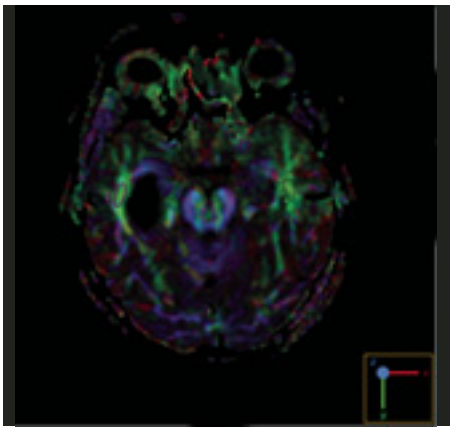
Immediate Benefits

Soon after the Signa HD 3.0T system was installed in November 2006, Frank Parks, M.D., Chairman of Radiology for Methodist Healthcare noticed an immediate impact on patient care.

Of the first 215 patients scanned using fMRI and DTI, the results changed the course of treatment in 70 cases. "In some of those patients, it has made a very dramatic difference, such as the differences between no surgery versus surgery, or vice versa," Dr. Parks said. "It has also made a difference in the quality of patient outcomes and the speed of recovery.

"In my years in radiology, I've seen many new technologies, but I am surprised at the immediacy of impact in this case," he continued. "It's not every day we see a technology that directly impacts patient care so quickly after implementation."

The technology has helped the staff at Methodist provide better options for patients with tumors considered unresectable or inoperable. "In such cases, somebody had looked at an MRI and said, 'That must be functional tissue,'" said Allen Sills, M.D.,



Create DTI 3D fiber maps with GE FiberTrak.

Associate Professor of Neurosurgery at the University of Tennessee and medical Director of the Methodist University Hospital Neuroscience Institute. "As it turns out, many times that estimation is just wrong. We've been able to use fMRI to show ourselves that indeed we can probably take the tumor out without excessive risk."

The technology's immediate impact on patient cases soon won over some skeptics. "At first, some neurosurgeons said they were not interested," Dr. Parks recalled. "A few who have seen the results now say, 'I want to get my patients scanned.'"

Changing Treatments

In case after case, fMRI/DTI scanning non-invasively provides crucial information that helps surgeons like Dr. Sills make informed decisions on:

- Whether to resect or not resect, based on whether a tumor has infiltrated functional brain tissue
- How much tumor tissue can be safely removed
- What surgical access to a tumor is the safest

Choosing the Safest Path

The first patient scanned at the Methodist University Hospital with fMRI/DTI was a 20-year-old woman with a right brain tumor diagnosed by MR at another hospital. The team integrated fMRI and DTI with acquisition of 3D anatomical images for the patient's scheduled image-guided surgery.

Clinicians located the tumor in the eloquent cortex near the patient's motor strip. "It was in an area where we knew the surgery would be delicate," said Dr. Sills. "We had identified one particular trajectory to the tumor, based on what we believed to be the safer corridor. When we did the fMRI, much to our surprise we found that functional tissue – the tissue that controlled her leg movement – would have been right in the middle of what we had considered our corridor.

"The information definitely caused me to change my approach and come in by a different route that would be much safer. The patient had been adamant on the front end that she didn't want any motor deficit, and we were able to accomplish that for her."

A post-operative physical exam found no evidence of foot or ankle weakness.

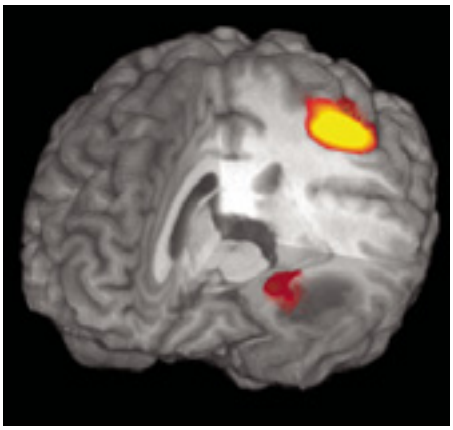
"There is really no substitute for the real-time, exact, precise information you get from studies like (fMRI and DTI)."

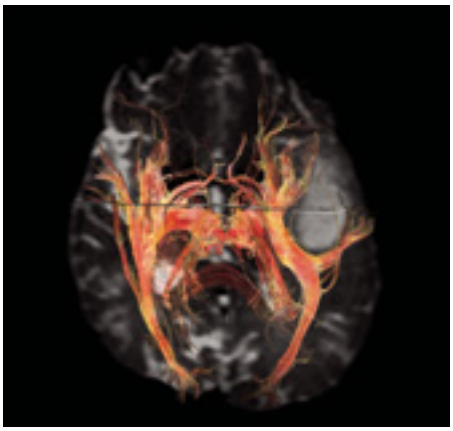
Dr. Allen Sills

Deciding on Operability

In another case, a 51-year-old man was diagnosed with anaplastic astrosarcoma affecting the temporal lobe. Surgeons needed to determine whether the tumor could be resected without significant loss of function.

Using fMRI and DTI scanning, clinicians found the area of concern was already disrupted by the tumor, causing the neurosurgeon to proceed with the surgery. "The tumor had been well worked up in previous MR images," explained Dr. Parks. "The additional information from fMRI and fiber tracking was the tipping point for go or no go."





22-year-old female with right temporal lesion. 2D color directional image (top) shows the displaced white matter. The fMRI image (bottom) demonstrates activation from speech and passive listening paradigms.

"In the end, the (DTI) exam gave us two critical pieces of information. First, it helped us decide whether we could even think about surgery. Second, it helped determine our surgical approach."

Dr. Frank Parks

Another patient, a 38-year-old man, had three areas of brain tumor, including a large growth at the back of the brain near his vision area. Clinicians suspected the lesions were benign, but to remove the large tumor would involve significant resection.

"We used fMRI to localize his visual function and were able to see that we could in fact go in and take out that very large lesion – at least 8 cm in size – and not put the patient's vision at risk," Dr. Sills said. "It gave us confidence preoperatively that while the risk wasn't zero, the risk was certainly low that we would cause harm to his vision."

Tracking White-Matter Fibers

Another beneficiary of fMRI and DTI was a 22-year-old woman who had a right temporal tumor. "She was left-handed, so the assumption was that her language function must be in the right temporal area," explained Dr. Sills. "Obviously, there was a great deal of trepidation about approaching this lesion.

"It looked like a benign lesion, but she was having seizures and didn't like being on seizure medicines. She wanted to have the lesion taken out if she could. Our concern was, can we do that safely? fMRI was very helpful. It showed that she had language function in both hemispheres, rather than just one, and that language function area was not anywhere near the lesion.

"The DTI was incredibly useful because it showed beautifully that the fibers were displaced laterally by the tumor, rather than being infiltrated by it," he continued. "Without DTI, we would have had no way of knowing that with any degree of certainly. In the end, the exam gave us two critical pieces of information. First, it helped us decide whether we could even think about surgery. Second, it helped determine our surgical approach."

Parks added that the fMRI/DTI findings enabled clinicians to avoid performing an invasive Wada test to locate the speech center. Surgery went forward, and the woman's speech was not affected.

Clinical Value Added

The addition of fMRI and DTI was a natural one for Methodist University Hospital, a consistent state leader for brain tumor cases. "At the time we made the investment, it appeared these technologies had moved out of the research lab and had reached the point of being clinically relevant," Dr. Parks recalled. "We saw them as consistent with our belief in individualized care. They provide information we can use to customize therapy based on the patient's exact anatomy and pathology."

Clinicians at Methodist scan many brain tumor patients on the Signa® HD 3.0T scanner with fMRI and DTI before craniotomy. Hospital leaders believe the decision to move up to a high-field 3.0T system benefits both clinicians and patients. In addition, Parks has found the procedures easier and the results more reproducible on the Signa HD 3.0T system than on the hospital's other MR scanners.

Technologists use the BrainWave and DTI/FiberTrak suite of applications from GE Healthcare, which offer comprehensive, easy-to-use tools to acquire and

post-process high-definition 3D anatomical images, neurofunctional brain maps and white-matter trajectories projection.

During the procedures, the technologists scan brain anatomy, run the patient through a series of brain stimulations called paradigms that are necessary to perform an fMRI exam, generate DTI images, integrate and post-process the data. The study results are provided to the physicians as 3D, color-coded data sets that can be easily manipulated to best visualize areas of interest.

The physicians can study the 3D datasets as part of surgery planning and display the images in the operating room, integrating them with the surgical navigation system.

Gratifying Experience

Besides helping clinicians, the information helps put patients at ease. "The exam is not an anxiety-provoking experience," Dr. Sills explained. "Our technologists and radiologists are superb. They make the experience comfortable, so it's not a test that patients dread and fear." The exams are also non-invasive, unlike alternative technologies that are used intra-operatively, and so provide no opportunity for the surgeon to consult with the patient in advance.

Dr. Sills notes that the fMRI/DTI data helps inspire confidence in patients and loved ones. He often shows color-coded brain maps to patients before surgery, explaining in simple terms what the images indicate. "I can walk the patients through and show them what we're looking at," he added. "Patients and family members can easily understand it.

"I think it's a source of comfort to them to know we have this kind of advanced technology available for planning and studying lesions. It also helps them to understand that we're doing everything we can to minimize risk."

Hospital staff members at all levels are gratified with the results of fMRI and DTI. Surgeons especially appreciate the technology. "When you're the guy the patients trust to take them into surgery and bring them out of it safely, you want to have every weapon at your disposal," Dr. Sills added.

"We all learned the classic models of anatomy that tell where functions are located. More and more, we're finding that those are only approximations, and there's a lot of variability from patient to patient. There is really no substitute for the real-time, exact, precise information you get from studies like these."

Robert Laster, M.D., a neurointerventionalist with Methodist Healthcare says the technologists are also enthusiastic about fMRI/DTI. "They're getting feedback from the neurologists and radiologists that, 'Hey this is helping my patients.' And the technologists say, 'This is why I went into the medical field – to help make a difference.'"

Vic Perini, Vice President of Operations at Methodist University Hospital, expects fMRI and DTI technologies to support continued growth in the Neuroscience Institute. "The institute is of vital strategic importance," he said. "We saw a great opportunity to add differentiating technology that would enable even more outstanding, safer care for every patient." ■

About Methodist University Hospital

The 693-bed Methodist University Hospital, founded in 1924, is a tertiary care and referral center and the flagship hospital for Methodist Healthcare, a seven-hospital system ranked a Top 100 Integrated Health Network (IHN) by Modern Healthcare magazine. The hospital has a long history of leadership in brain tumor treatment and MR diagnostics. Methodist treated nearly 300 brain tumor cases in 2006, and Le Bonheur Children's Medical Center, part of Methodist Healthcare, is a major regional referral center for brain tumors.

In 1985, Methodist Hospital became the first in its area to offer MR imaging. It has continued to add state-of-the-art MR scanning technology, the most recent purchase being a GE Signa HD 3.0T scanner with fMRI and DTI in November 2006.

Other cutting-edge neurological tools offered by this leading facility include magneto encephalography (MEG) scanning and gamma knife surgery.