New fMRI technology making brain tumor surgery safer

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Brain specialists at The Neuroscience Institute at University Hospital and the University of Cincinnati have taken a significant step forward in their quest to treat difficult tumors while preserving areas of the brain that are responsible for speech and movement. The Cincinnati specialists are among the first in the country to use new technology that integrates functional MRI (fMRI) data into high-tech surgical navigation systems.

The fMRI data, which pinpoint language, cognition, and mobility centers of the brain, allow neurosurgeons to remove tumors to the greatest extent possible without harming areas that are critical to the patient's quality of life.

Functional MRI creates a series of images that capture blood oxygen levels in parts of the brain that are responsible for movement, perception, and cognition. Functional MRI, which reveals the brain in action, differs from standard MRI, which provides a static image.

"This is a quantum leap in what we're able to do," said Dr. James Leach, a brain-imaging specialist (neuroradiologist) with UC Radiology and The Neuroscience Institute. "It has significantly affected how neurosurgeons plan to do neurosurgery and how much tumor they can remove while still avoiding critical areas of brain function."

Said Christopher McPherson, M.D., a neurosurgeon with The Neuroscience Institute: "It's easier and safer for the patient, and it can reduce the length of surgery."

The fMRI technology is manufactured by BrainLAB and marketed as iPlan BOLD (blood oxygen level dependent) MRI Mapping. It has been used successfully in 12 surgical cases so far at University Hospital.

The technology involves collaboration between the Mayfield Clinic, one of the nation's leading physician organizations for clinical care, education, and research of the spine and brain, and UC Radiology, which purchased the BrainLAB planning station hardware. Both physician practices are closely affiliated with The Neuroscience Institute, an international center of excellence located at University Hospital and UC.

Neurosurgeons have never simply guessed at where critical areas of the brain begin and end. First and foremost, they are trained to understand the fundamentals of the brain's anatomy. But boundaries are not always clear, and the growth of a tumor can cause functional areas to shift from their original locations. Large tumors can cause these critical regions to shift dramatically.

To identify functional areas of the brain that should not be harmed, neurosurgeons traditionally have applied a small electrical stimulation with a wand-like instrument during surgery. If a motor area is stimulated, for example, the patient's hand will move.

Electrical stimulation has had drawbacks, however. "Stimulating the brain with an electrode can cause a seizure," Dr. McPherson said. "And to accurately identify language areas in some cases we had to keep the patient awake. We also were forced to make a larger opening of the skull and expose more areas."

The need for electrical stimulation also can lengthen a surgical procedure by 30 to 60 minutes.

While neurosurgeons make the transition to the fMRI-assisted navigation technology, they are continuing to perform brain stimulation to double-check for accuracy. Thus far, Dr. McPherson said, the double checks have confirmed the technology's accuracy while suggesting that the technology may make brain stimulation unnecessary for many surgeries in the future.

The new BrainLAB equipment also enables physicians to integrate diffusion tensor imaging (DTI), which provides a map of critical white-matter tracts in the brain. “White-matter tracts,” said Dr. Leach, “are like the electrical connections between different parts of a house. If you disrupt that connection, you have no communication between those two areas.”

FMRI scans are performed several days prior to surgery on a 3 Tesla scanner at West Image, a Cincinnati imaging facility owned by Set Shababian, M.D. “We perform various language, motor and vision tasks with the patient in the MRI scanner,” Dr. Leach explained.

FMRI scanning takes approximately 75 minutes, about 30 minutes longer than traditional MRI. The DTI scan, which takes five minutes, is performed in the same setting.

Dr. Leach processes those images, highlighting the location of speech and movement areas and white matter tracts. He also highlights the tumor location, then imports all of the information into BrainLAB’s navigation software at University Hospital.

Source: The Neuroscience Institute