A Colorado first

Brain Surgery Comes to the MRI Suite

By Todd Neff

Deeply implanted electrodes. DBS, as it’s called, quells tremors and other symptoms associated with movement disorders, such as Parkinson’s disease, essential tremor, and dystonia.

Thousands of DBS procedures have been done in operating rooms around the world, and with much success. For many patients, the new approach could make a good thing better.

Two-step. DBS surgery typically happens in two phases. Radiologists image the patient’s brain, and then the surgeon does the procedure in the operating room. It’s in this gap that variability creeps in. DBS targets – typically in the thalamus, the subthalmic nucleus and the globus pallidus – are deep within the skull and can be as small as a few millimeters in diameter. Physicians and technologists affix a stereotactic frame to the patient’s skull before the imaging to keep the head still. But even a slight movement of the head, or what’s known as “brain shift” within the head from fluid buildup or other causes, can render the scans inaccurate.

“The technology suffers from the changes that happen in between when you did the imaging and when you place the needle or electrode,” Ojemann said.

So in the OR, the neurosurgeon uses microelectrode recording, or MER, to confirm that the DBS electrode will go in exactly the right place. That involves drilling a small hole – or holes – in the skull to test suspected target regions. The patient must be awake for this because his or her physiologic responses to the probing are a key part of the procedure, Ojemann said.

Frameless. The new MRI-based procedure eliminates the need for a stereotactic frame and MER. Ojemann uses real-time MRI images

University of Colorado School of Medicine Neurosurgeon Steven Ojemann, MD, after placing the deep brain stimulation leads into a patient in the MRI bore on Oct. 10. (Courtesy Christopher R. Thompson)
and DBS-MRI-specific medical devices and software from MRI Interventions, Inc., to place the DBS electrode with an accuracy of less than a millimeter.

The procedure is quicker and less invasive, and patients can be under anesthesia. That's more than a matter of comfort for some DBS patients.

“There are cases where it’s not possible for a patient to endure an awake operation, either because the movement disorder is too severe or, sometimes, because anxiety or discomfort can set in,” Ojemann said.

It took preparation for the hospital to get to the point where clinicians could perform neurosurgery in an MRI suite. The MRI-based procedure was pioneered at the University of California, San Francisco, where Ojemann did his residency. He kept tabs on the technique's progress and development there as well as on the enabling technologies. Eighteen months ago, both had advanced enough that Ojemann felt he could bring it to Colorado.

“It really became clear that in experienced hands, this could be a really powerful technique,” Ojemann said.

Prep work. He led a group that included UCH Radiologist Jody Tanabe, MD, and hospital CT/MR Practice Manager Nancy Pritchard to San Francisco to observe a case. Preparatory meetings involved UCH leaders as well as radiology, neurosurgery and anesthesiology experts.

“The logistics are formidable,” Ojemann said. “You’re bringing an OR into a diagnostic MRI suite.”

The hospital invested in the enabling hardware and software as well as an MRI monitor compatible with the room, installed panels in the MRI suite to allow access for the surgical drill’s air line, and figured out billing arrangements, among other things. OR staff had to buy titanium drill bits to ensure immunity to the MRI magnet.

The number of people involved on the day of surgery presented a challenge in itself, said UCH MRI Technologist Christopher Thompson. The typical census in a magnetic resonance imaging suite tops out at two: one patient, one MRI technologist. On Oct. 10, Thompson counted a dozen people directly involved in the procedure.

That alone caused worries. The MRI’s 1.5-tesla magnet can turn metal objects into projectiles hurtling toward the tube’s opening – and the patient’s head – not to mention tripping up pacemakers and erasing the magnetic strips on credit cards.

“Safety is certainly a big concern,” Thompson said. “The more procedures you start doing with non-MRI techs and others involved, the more the element of error goes up.”

Success. The procedure took more than six hours, on a par with the traditional approach. With experience, things will go a good deal faster, Ojemann said. UC San Francisco reports that MRI DBS procedures take about half the time as of traditional DBS surgery.

Ojemann says MRI suites could become a nexus for other neurosurgeries, as well as deep-brain drug delivery and biopsies. But the traditional approach still has one big advantage: with the patient awake and providing feedback, the surgeon knows immediately that the electrode is doing its job. With the MRI-based surgery, one can’t be assured until the pulse generator and its wires are installed a couple of weeks later.

“I guess my feeling is a lot of this is going to be driven by patients and what they want, and what I’m encountering is there’s a good population of patients who would prefer to have the operation done using this technology,” Ojemann said.