The Evolution of Deep Brain Stimulation Surgery

Case Study

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Littleton Adventist Hospital is a full-service medical center providing compassionate health care and treatment to the City of Littleton, Colorado and surrounding metro area communities for over 25 years. Their medical teams specialize in services including neurology, neurosciences, cardiology, oncology, orthopedics, women and children's services, and more. The hospital is part of Centura Health, the largest healthcare system in Colorado and western Kansas.

South Denver Neurosurgery, a Centura Health Clinic, is a state-of-the-art neurosurgical center providing diagnostic and treatment programs for a wide range of brain and spinal disorders. They offer comprehensive neurosurgery services, including spine surgery, surgery for brain tumors, epilepsy, and deep brain stimulation for Parkinson's disease and other movement disorders.

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Deep brain stimulation, also known as DBS, is a surgical procedure that is far from new. It's been around for nearly 40 years, however, the technique has remained primarily the same for much of its existence.

As technology continues to evolve, it is crucial that we as surgeons continue to enhance our techniques in order to make surgeries such as DBS more efficient, affordable and accessible to those who need it most. Our current healthcare environment demands it.

An evolving procedure

DBS is a neurological procedure primarily used to treat those with Parkinson's disease. The surgery has the ability to rewind symptoms roughly seven years by reducing the motor symptoms of Parkinson's such as slowness, tremors and shuffling, while simultaneously improving facial expression, rigidity, and fine and coarse motor skills. On average, only 2 to 10 percent of those who need DBS ever have the opportunity to receive it. One of the major reasons for that is if a hospital is outside of an academic institution it is simply unaffordable for both the hospital and the patient. With today's healthcare system, the reimbursement rates from insurance companies are lower, limiting the ability for hospitals to provide care.

For more than 30 years, surgeons performed DBS the same way. The process, known as microelectrode mapping, requires the surgeon to place a head frame, acquire MRI and CT images, and then line up to the target. From there, the surgeon creates a burr hole and passes fine wire microelectrodes through the brain multiple times, recording cell firings to create a map of the brain from a physiologic point of view.

The surgeon then places the lead, and, while the patient is awake, fine-tunes the location and passes an electrode down to test it. While testing the electrode, the surgeon uses physiologic majors to improve their symptoms. Once dialed in, the electrode stays in place permanently. The process can take 8 to 10 hours and is typically done over the course of two days and sometimes separated by months or even years.

In 2010, Dr. Kim Burchiel of the Oregon Health & Science University wanted to develop a new technique that would allow surgeons to perform DBS under anesthesia. In order to do this, he needed to find the leads in their proper locations, which he solved by using a CT system. Dr. Burchiel was the first surgeon to use the CereTom, a portable 8-slice CT scanner, in an operating room in order to place a lead. He realized that this technique, which focused on anatomy rather than physiology, worked just as well. He used live images fused with a preoperative MRI in order to check where the lead was. By following this technique, he was able to eliminate the physiological testing completely and rely on the accuracy of the CereTom images.

In 2013, our team adopted Dr. Burchiel's technique here in Colorado. Then in 2014, we revised his technique by adopting the

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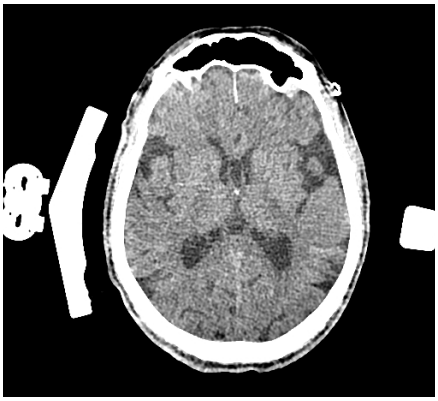
Mazor robot to reduce the deviation of the initial pass to .87 millimeters. The lead itself is 1.27 millimeters in diameter, making our deviations on average less than the size of the lead itself.

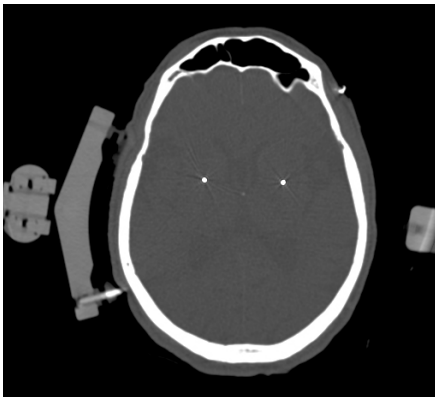
Making DBS more cost-effective

All surgeons and leaders of hospitals know that OR time is expensive. According to The Journal of Clinical Anesthesia, it costs roughly $62 per minute. The lengthy nature of traditional DBS surgery makes it challenging for hospitals to build out that procedure.

With our approach of using the robot and the CereTom, what used to take 8 to 10 hours now takes one and a half or two hours. This means we can complete three bilateral cases in one day, rather than one. If you are only able to produce one surgery per day, the finances simply don't add up. Here at South Denver Neurosurgery, even considering our declining reimbursements, the hospital makes a profit on our DBS procedures. The major reasons for that are our ability to image soft tissue portably in the OR (something we couldn't do before obtaining the CereTom), produce an excellent estimate of the lead location before the person ever wakes up and the speed in which are able to operate. The greater precision we gain by using the CereTom allows us to place a lead with a single penetration nearly 85 percent of the time. This decreases the amount of intracranial hemorrhages and lowers infection rates, which can lead to fewer readmissions for additional surgeries needed to fix complications.



Pre-DBS



Post-DBS

Fulfilling a known need

Surgeons know that there is a growing number of patients who could benefit from DBS. As centers adopt an anatomy-based approach to DBS using portable CT imaging, they will be able to perform more than 100 cases a year. Using the image-guided approach is the only way to scale to serve this number of patients and expect it to be cost-efficient. On average, those that adopt this technique will likely see a return and profit within a year or two of the initial investment.

And in a healthcare industry increasingly focused on patient experience, not having to lie awake for up to 10 hours, or return for an additional surgery, certainly contributes to a patient being more satisfied. It also makes it more attractive to insurance company approvals, which don't want to have to pay for a second surgery. If a hospital is able to provide the same surgery in a fraction of the time, it will be more successful in marketing itself as a preferred site.

The future of DBS

As imaging technology improves, so will our ability to perform DBS surgery. For example, I believe the OmniTom, the latest upgrade to the CereTom, will make lead placement even more precise. The 24-bit accuracy should reduce the fiducials by a fraction of a millimeter while increasing the lead placement accuracy also by a fraction of a millimeter. That might not seem like a lot, but that increase in precision may drop the reposition rate from 15 percent to 1 percent.

A healthcare system with tightening reimbursements and a heightened focus on patient experience combined with a growing number of patients who could benefit from DBS surgery means that hospitals will have to rethink how they perform the procedure in order to meet that need. To do this in a financially viable way, hospitals will need to adopt a new approach to the procedure that is image-based. It's not just the best path forward, it's the only path forward.