

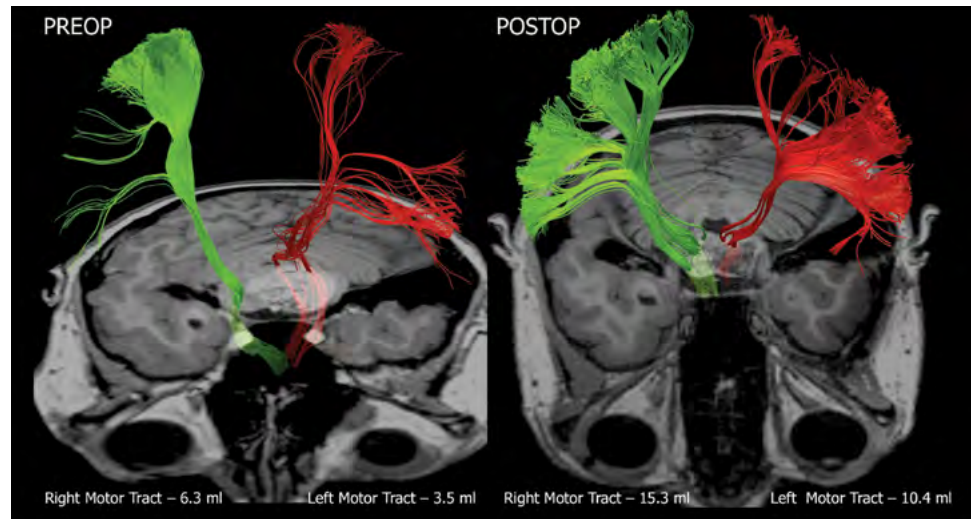
HDFT provides key edge in presurgical planning of brainstem cavernomas

by Robert M. Friedlander, MD; Juan C. Fernandez-Miranda, MD; Amir Faraji

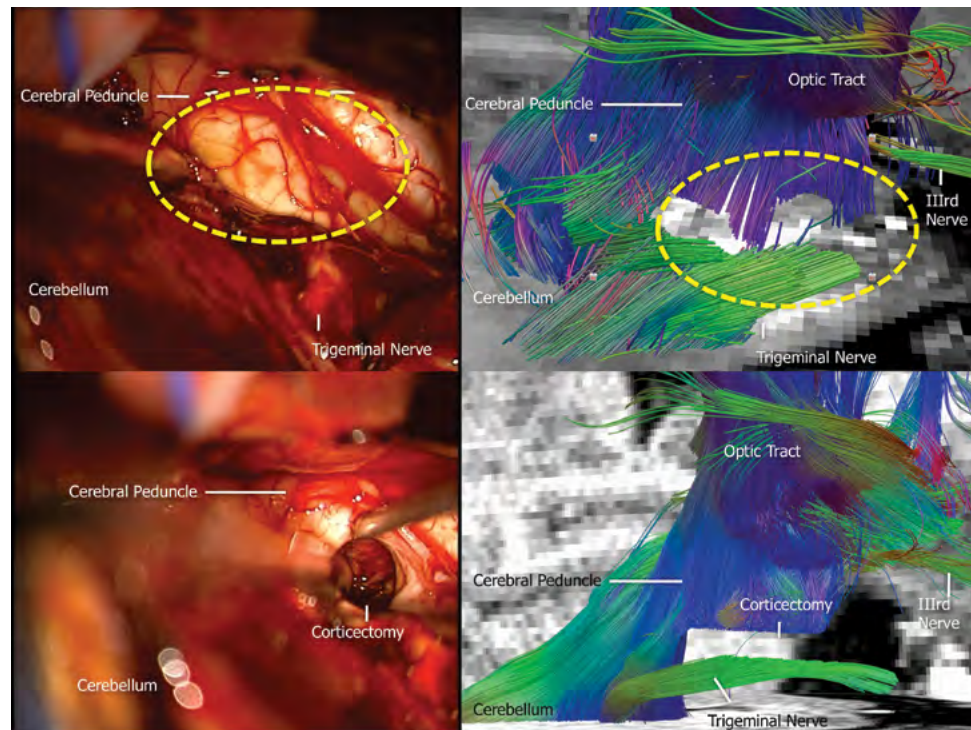
Brainstem cavernomas are one of the most complex challenges a neurosurgeon can face. The natural history of such lesions must be weighed against the risk of surgical resection. Surgical access to the brainstem is extremely delicate given the intricacy and eloquence of the fiber tracts and nuclei that form its structure. Historically resection has been fraught with significant rates of complications. One of the complexities is accessing the brainstem is that it is not predictable in which direction has the cavernomas displaced functional fibers. Here we report the innovative application of HDFT to map the fiber tracts within the brainstem and around a cavernoma to safely access and remove the lesion. HDFT provides information on the remaining normal fibers in relation to the cavernomas.

Understanding this relationship provides the surgeon the ability to plan a trajectory through the brainstem which maximizes the safety of resection of such lesions. Tipping the balance towards increased safety and efficacy allows for the ability to offer a therapy that is overall safer than the natural history of the untreated malformation. We have used HDFT to resect a number of a different types of lesions in eloquent areas of the brain and brainstem. Here we describe a case of the first cavernous malformation removed from the brainstem, using the information provided by HDFT to plan the trajectory and execute the resection.

A 24-year-old female patient experienced a hemorrhage from a previously undiagnosed left pontomesencephalic cavernous malformation, and was subsequently admitted to an outside center. She suffered from a dense right upper and lower extremity hemiparesis, a right gaze preference, and moderate dysarthria. Brain MRI demonstrated a left cavernous malformation within the brainstem. Given the location of the lesion the neurosurgeons recommended conservative management. After approximately one week, she was transferred to a rehabilitation facility where her speech progressively improved and the hemiparesis persisted. While at the rehabilitation facility, she became lethargic and developed a new left gaze preference with diminished mental status. She was emergently transferred to our institution for neurosurgical intervention.



The preoperative HDFT reconstruction of the motor tracts showed the posterior displacement and decreased number of fibers of the left tract (red) when compared to the right tract (green). Postoperatively, the left motor tract (red) recovered most of its normal position and volume of fibers, and the right tract (green) also showed a volume increase as a consequence of the surgical treatment.



Intraoperative photographs (upper and lower right) to be compared with the preoperative (upper left) and postoperative (lower left) HDFT reconstructions. The information provided by the HDFT study was used to plan the trajectory and entry point into the brainstem (lower right and left figures).

Upon arrival the patient was awake, alert and oriented to person, place, and time. She had a right facial droop and double vision. She developed significant weakness of the right arm and leg. She had slurred speech and her tongue deviated towards the right. Brain MRI demonstrated that the cavernous malformation had bled one more time,

and had more swelling around it. Given the aggressive nature of this malformation we recommended that the lesion be resected. The challenges of such a procedure are access as well as deciding the specific location to enter into the brainstem. Once inside the

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brainstem, understanding the location of the remaining normal structures provides the ability to remove the lesion with the greatest degree of safety.

To gather information as to the location of the normal fibers, the patient underwent on MRI study with HDFT imaging analysis. HDFT indicated severe deformation of the ipsilateral motor tract, with apparent disruption of some of its fibers with significant posterior displacement of a large number of motor fibers.

Based on this tractography data and image guidance correlation, the surgical approach was carefully considered and a trajectory was selected to provide more immediate access to the intra-parenchymal hematoma and cavernous malformation, while preserving the intact motor fibers. This trajectory involved accessing the brainstem just in front of the motor fibers that were posteriorly displaced by the hematoma and cavernous malformation. In accordance with this pre-operative planning, the patient underwent a left-sided frontotemporal, subtemporal transpetrous approach to access the pontomesencephalic cavernous malformation under image guidance. The lateral surface of the midbrain was visualized with a surgical microscope and a subtle yellow stain was observed, suggesting that this may be the most superficial location of the malformation. A small opening was made into the brainstem where the cavernous malformation was readily encountered. The hematoma and cavernous malformation were completely resected.

Her immediate post-operative examination revealed improvement in her double vision, her facial droop, as well as her right sided weakness. Her sensation remained intact throughout. Post-operative HDFT study was completed to evaluate the impact of surgical resection on the motor fibers, demonstrating preservation of the posteriorly displaced motor fibers and transection of the previously disrupted fibers, as expected.

Over the course of the next six months, the physical displacement of white matter fibers continued to resolve, as revealed by a third HDFT scan. Moreover, her neurological examination continued to progressively improve. She is able to perform her activities of daily living with minimal-to-no assistance.

HDFT provided us an edge in order to be able to offer a procedure in this specific young patient. Knowing the exact location of critical fibers within the brainstem provides us the ability to approach and remove these lesions with much higher degree of safety. The surgeon can not see these fibers when operating under the microscope. However knowing where they are located allowed us to provide the excellent result to our patient.



Robert Friedlander, MD, with brainstem cavernoma patient Ashly Hunt.

news & NOTES

Monaco to Receive Leksell Radiosurgery Award

PGY-6 resident Edward A. Monaco, III, MD, PhD, has been selected to receive the 2012 Leksell Radiosurgery Award by the AANS/CNS Section on Tumors. The award, in recognition for Dr. Monaco's paper "The risk of leukoencephalopathy after whole brain radiation therapy plus radiosurgery versus radiosurgery alone for metastatic lung cancer," will be presented at the 2012 AANS Annual Scientific Meeting in Miami, FL, in April.

Study Ranks Pitt at Top for Stereotactic Research

The *British Journal of Neurosurgery* published findings online in November of a bibliometrics study showing the University of Pittsburgh ranking first in the world in global scientific production in stereotactic-related research. The study—using data from 1993 through 2008—sought "to provide insights on the characteristics of the stereotactic related research patterns, tendencies, and methods that might exist in the papers, as well as in leading countries and institutes." According to the paper, "the results analyzed by this bibliometric method can show the research performance, significant events and major inventors, those attributed to stereotactic neurosurgery, and trend of stereotactic related research."

In the Media

- **L. Dade Lunsford, MD**, appeared on a *Journal of Neurosurgery* podcast November 11 summarizing the findings presented in a landmark six-part journal article on the Center of Image-Guided Neurosurgery's 20-year arteriovenous malformations experience.

- **Peter C. Gerszten, MD**, was featured in the Spanish publication *Diario Medico* article "Evaluar al paciente, clave en el manejo de columna vertebral." The national newspaper is distributed to all hospitals in Spain.

Prominent Lectures and Appearances

- **Joseph Maroon, MD**, presented a keynote address at the 19th Annual World Congress on Anti-Aging and Aesthetic Medicine held in Las Vegas, NV, December 10. The title of his talk was, "A Metabolic Approach to Malignant Brain Tumors."

- **Peter C. Gerszten, MD**, was the invited keynote speaker of the First Spanish Symposium of Radiosurgery held in Castellon, Spain, January 27, 2012.

- **Juan C. Fernandez-Miranda, MD**, was the invited keynote speaker at the International Neuroanatomy Symposium held at University of Florida in Gainesville, January 28 to celebrate the 40th anniversary of Albert Rhoton, MD, at the university.

Congratulations

- **Elizabeth Tyler-Kabara, MD, PhD**, and **Mandeep Tamber, MD, PhD**, are now diplomates of the American Board of Pediatric Neurological Surgery.

- **Marianna Hegedus** received her MBA from Chatham University in December.

Welcome

- **Melissa Hart-Gibson**, front desk receptionist; **Yalikus Suofu, PhD**, postdoctoral fellow; **Lisa Pareso, J. William Book-walter group**.