Kai Hill
January 6, 2020

New Study Shows Artificial Intelligence Provides Game-Changing Intraoperative Brain Tumor Diagnostics

New cutting-edge technology that uses artificial intelligence along with optical imaging is providing neurosurgeons a near real-time method of diagnosing brain tumors during surgery, according to a recent study.

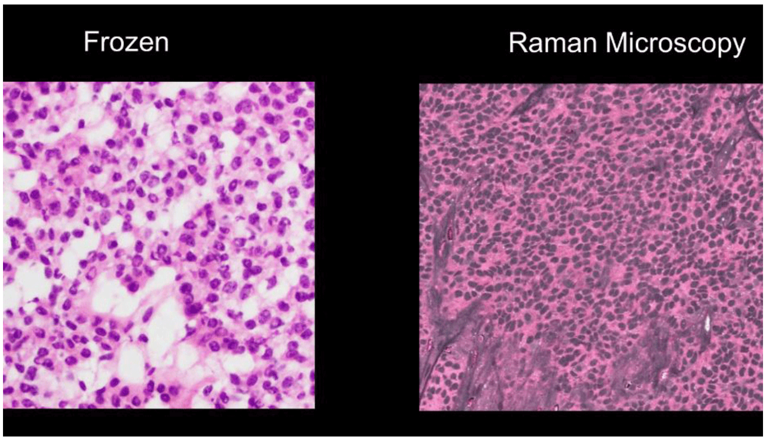
Dr. Michael Ivan in surgery.

The collaborative study, co-authored by neurosurgeons with Sylvester Comprehensive Cancer Center, part of the University of Miami Miller School of Medicine, was published on January 6 in the journal *Nature Medicine.*

"It's really a step forward in providing rapid intraoperative diagnoses of malignant and benign tumors, which is essential information needed to make critical decisions during safe and effective brain tumor surgery," said Sylvester neurosurgeon and study co-author Michael Ivan, M.D., M.B.S., who played a major role in developing the Stimulated Raman Histology (SRH) technology with leading collaborators at New York University and the University of Michigan. “This digitized process provides surgical teams a diagnosis in less than three minutes as opposed to a 20-30 minute wait time during a traditional process.”

Accurate histopathologic diagnosis is crucial for planning during the actual surgical removal of brain tumors. Conventional methods for intraoperative histology are time consuming and require sectioning and freezing and necessitate tissue transport to a pathology laboratory, specimen processing, slide preparation by highly trained technicians, and interpretation by pathologists, with each step representing a potential barrier to delivering safe, timely, and effective surgical care.

Titled “Near Real-time Intraoperative Brain Tumor Diagnosis Using Stimulated Raman Histology and Deep Neural Networks,” the study examined the diagnostic accuracy of brain tumor image classification through machine learning, compared with the accuracy of conventional histologic images interpreted by pathologists. The results for both methods were comparable: the AI-based diagnosis was 94.6% accurate, compared with 93.9% for the pathologist-based interpretation on a frozen specimen.



A conventional brain tumor image, left, with a Stimulated Raman Histology image.

One of the most significant advantages of Stimulated Raman Histology is ensuring more precision in completely removing cancerous brain tumors, said Dr. Ivan, who is leader of the Neuro-oncology Site Disease Group at Sylvester and assistant professor of neurological surgery at the Miller School of Medicine.

“In many of our surgeries on malignant tumors, the ability to remove all of the tumor makes a difference in a patient’s overall survival,” said Dr. Ivan. “Artificial intelligence provides more rapid and frequent information to the surgeon while operating to ensure the boundaries of the surgical resection are clear of cancer.”

This game-changing technology is an exciting step forward in the management of brain tumors, said Sylvester neurosurgeon Ricardo Komotar, M.D., who also served as a study co-author and is the director of surgical neuro-oncology and the Brain Tumor Initiative at Sylvester.

How Stimulated Raman Histology Works

The pioneering imaging technique reveals tumor infiltration in human tissue by collecting scattered laser light that illuminates essential features not typically seen in standard histologic images.

The microscopic images are then processed and analyzed with artificial intelligence, and in under two and a half minutes, surgeons are able to see a predicted brain tumor diagnosis. Using the same technology, after the resection, they were able to accurately detect and remove otherwise undetectable tumor.

"This is a very complex AI system, which looks at patterns, intensity, and coloration of the specimen's digital image to provide an instantaneous diagnosis," said Dr. Ivan.

How The Study Was Conducted

To build the tool, researchers designed an artificial intelligence model trained on over 2.5 million images – a deep convolutional neural network (CNN) composed of 415 patient samples to classify tissue into 13 histologic categories that represent the most common brain tumors, including malignant glioma, lymphoma, metastatic tumors, and meningioma.

In order to validate the CNN, Dr. Ivan and researchers and neurosurgeons at two other sites enrolled 278 patients undergoing brain tumor resection or epilepsy surgery in the clinical study. Brain tumor specimens were biopsied from patients, split intraoperatively into sister specimens and randomly assigned to the control or experimental arm.

Specimens routed through the control group – the current standard practice – were transported to a pathology laboratory and went through conventional specimen processing. The experimental group was performed intraoperatively, from image acquisition and processing to diagnostic prediction via CNN.

The study showed that the diagnostic errors in the experimental group were unique from the errors in the control group, suggesting that a pathologist using the novel technique could achieve close to 100 percent accuracy. The system's precise diagnostic capacity could also be beneficial to centers that lack access to expert neuropathologists.

"As surgeons, we're limited to acting on what we can see; this technology allows us to see what would otherwise be invisible, to improve speed and accuracy in the OR, and reduce the risk of misdiagnosis," said senior author Daniel A. Orringer, M.D., associate professor of neurosurgery at NYU Grossman School of Medicine, who helped develop SRH and co-led the study with colleagues at the University of Michigan. "With this imaging technology, cancer operations are safer and more effective than ever before."

In addition to accelerating the workflow of pathologists, researchers conclude that the technology can be used in other medical settings that depend on the expert analysis of tumor samples obtained during surgery.

"The combination of artificial intelligence and surgical experience is an example of what separates Sylvester Comprehensive Cancer Center from other centers in the state of Florida," said Dr. Komotar.