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Language centers revealed, brain surgery refined with new mapping

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Neurosurgeons from the University of California, San Francisco are reporting significant results of a new brain mapping technique that allows for the safe removal of tumors near language pathways in the brain. The technique minimizes brain exposure and reduces the amount of time a patient must be awake during surgery.

Perhaps even more profound, the study provides new data that refines scientists' understanding of how language is organized within the human cortex. It identifies new regions involved in speech production, reading and naming. The team used this data to generate a three-dimensional cortical language map that is more detailed and integrates more data than any language map of the brain ever generated.

"This study represents a paradigm shift in language mapping during brain tumor resection," said senior author Mitchel Berger, MD, professor and chairman of the UCSF Department of Neurological Surgery and director of the UCSF Brain Tumor Research Center. "Not only have we proven this technique can be safely relied upon for brain tumor resection, we have shown functional language organization to be much more diverse and individualized than previously thought."

"Accurately understanding cortical language organization has clinical implications for more than just brain tumor patients," said lead author Nader Sanai, MD, senior resident in neurological surgery at UCSF. "Any patient with a seizure-disorder, stroke or head injury who has language-related difficulties can now be better understood in the context of this revised anatomy."

The findings are presented in the January 3, 2008 issue of The New England Journal of Medicine.

The technique, which Berger and his team helped pioneer, is known as "negative brain mapping." It eliminates neurosurgeons' dependence on traditional language mapping methods that typically require the removal of large sections of skull and extensive brain mapping while the patient is awake. It also allows for smaller craniotomies that expose only the tumor and a small margin of surrounding brain tissue, rather than several centimeters or more of the patient's brain. After the craniotomy, the neurosurgeon "maps" the brain by stimulating a section (1 cm by 1 cm) at a time with a bipolar electrode. The strategy does not require positive identification of language sites (defined as an arrest in speech, inability to name objects or read, or difficulty in articulating words), as in traditional brain mapping, but rather is driven by localization of negative sites -- areas that contain no language function.

"Nearly half our patients had no positive language sites in the area exposed, yet their functional outcomes remained nearly identical or better than patients who underwent extensive positive language mapping," said Sanai. "In addition, our results show that negative language mapping can be relied upon even when language function is already affected by tumor growth."

Language mapping, originally created to help guide epilepsy surgery, has proved to be an essential tool in helping neurosurgeons identify which parts of the tumor can be safely removed and in protecting patients from damage to speech and language centers, according to Berger. This is the largest study of its kind to show that this technique can be further refined for brain tumor resection without harming the patient.

The language map generated during the study shows that areas processing language function in the brain are widely distributed, sometimes varying in location by as much as several centimeters from patient to patient. This has implications for language organization models, which are currently based on the assumption that specific language functions have fixed anatomical locations.

Over eight years, Berger and his team tested negative language mapping on a total of 250 consecutive patients (146 men and 104 women), all of whom had gliomas -- a common and often fatal brain tumor -- affecting the dominant hemisphere of their brain.

One week following surgery, 194 of the 250 patients (77.6 percent) retained the language function they had prior to surgery. Six months later, only four of the 243 surviving patients (1.6 percent) exhibited worsened language function. Cumulatively, the neurosurgeons stimulated 3281 cortical sites in the brains of the 250 patients.

“The map we have generated addresses the critical question of how cortical language sites for motor speech, naming and reading are distributed within the dominant hemisphere of the human brain,” added Sanai. “It represents a comprehensive set of language coordinates that will serve as a guide for neurosurgeons to plan operations more safely and effectively.”

It is estimated that 20,500 men and women will be diagnosed with, and 12,740 men and women will die of, cancer of the brain and other areas of the nervous system in 2007, according to the American Cancer Society.

Source: University of California - San Francisco