Intraoperative Mapping During Repeat Awake Craniotomy Reveals the Functional Plasticity of Adult Cortex

Derek G. Southwell MD PhD; Shawn L. Hervey-Jumper MD; Mitchel S. Berger MD

Department of Neurological Surgery, University of California, San Francisco

Oral Presentation
Tuesday, 7:54am
Section on Tumors

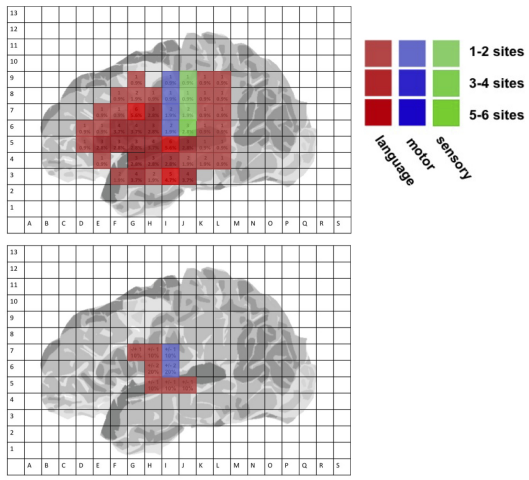
BACKGROUND

To avoid iatrogenic injury during brain tumor surgery, direct electrical stimulation (DES) is often used to identify brain areas critical for language, motor and sensory function. In rare cases in which a patient undergoes a repeat surgery for tumor recurrence, the use of DES provides an opportunity to study brain reorganization in the setting of neurologic disease.

METHODS

We examined 561 consecutive patients who underwent DES mapping during awake surgery for glioma resection. "Positive" and "negative" sites (i.e., discrete cortical regions where electrical stimulation did or did not, respectively, produce transient sensory, motor or language disturbance) were identified prior to tumor resection and documented by photography for categorization into functional maps. Of the 561 patients, we identified 18 who underwent a repeat surgery in which one or more stimulation sites overlapped with those tested during the initial surgery. We compared intra-operative sensory, motor or language mapping results between these patients' initial and repeat surgeries, and evaluated the patients' clinical outcomes.

Sites tested by DES during both initial and repeat surgeries (top) and sites at which change of function occurred (bottom).



(TOP) Lateral view of the dominant-hempshere indicating the number of overlapping sites tested within each square centimeter of cortex. Percentages indicate the fraction of total sites that were located within the region of interest. Color indicates the function tested (red, language; blue, motor; green, sensory). A total of 117 cortical sites were tested by DES during both an initial and repeat surgery. Of these, 107 (91.5%) exhibited stable (negative-negative or positive-positive) function. (BOTTOM) Ten sites (8.5%) exhibited change of function (positive-negative (+/-) or negative-positive (-/+)). Percentages indicate the fraction of stable or unstable sites that were located within the region of interest. Color indicates the function tested (red, language; blue, motor; green, sensory).

RESULTS

A total of 117 sites were tested for either sensory (7 sites; 7.9%), motor (9 sites; 8.8%) or language (101 sites; 86.3%) function during both initial and repeat surgeries. During initial surgeries, 95 of 117 sites (81.2%) were found to be negative and 22 of 117 sites (18.8%) were found to be positive. During repeat surgeries, 103 of 117 sites (89.5%) were negative and 14 of 117 (10.5%) were positive. Of the 95 sites that were negative at the initial surgery, 94 (98.9%) were also negative at the repeat surgery, while 1 (1.1%) site was found to be positive. Of the 22 sites that were initially positive, 13 of these (59.1%) remained positive at repeat surgery, while 9 (40.9%) had become negative. Overall, 6 of 18 patients (33.3%) exhibited loss of function at one or more motor or language sites between surgeries. Surprisingly, loss of function at these sites was not associated with weakness or speech impairment, indicating that neurologic function was preserved through neural circuit reorganization.

CONCLUSIONS

The adult central nervous system reorganizes motor and language areas in the setting of glioma. This plasticity may help to preserve motor and language function. In order to maximize the extent of tumor resection and avoid iatrogenic injury, surgeons should not rely on maps obtained from a previous craniotomy when performing a re-operation.