Cortical Plasticity of Motor-eloquent Areas Measured by Navigated Transcranial Magnetic Stimulation in Glioma Patients

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Introduction

Better understanding of the mechanisms behind cerebral plasticity, coupled with non-invasive detection of its presence, harbors a huge potential to improve glioma therapy. Our aim was to demonstrate the frequency of plastic reshaping, find patterns behind it, and prove it can be recognized non-invasively using navigated transcranial stimulation (nTMS).

Methods

We used nTMS to map cortical motor representation in 22 patients with gliomas affecting the precentral gyrus immediately pre-op, and 3-42 months post-op. Location changes of the primary motor area, defined as hotspots and map centers of gravity, were measured.

Results

Overall, 8 out of 16 (50%) high-grade and 3 out of 6 (50%) low-grade glioma patients showed a functional shift of over 10 mm at the cortical surface level (Figure 1).

Figure 1

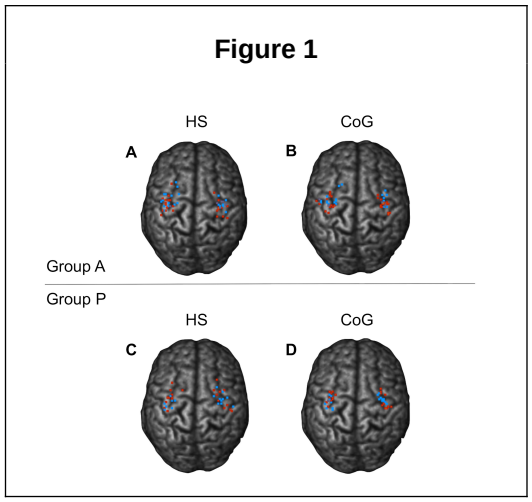

Figure 1: Normalized and fused nTMS motor maps of all patients are visualized as overlays on standardized brain templates. Red points are hotspots (HS) and map centers of gravity (CoG) from map 1; blue points mark the locations they were found at in map 2. Group A contains all patients whose tumors were located anterior to the precentral gyrus, while group P consists of patients whose tumors were posterior to the precentral gyrus. 1A: HSs in group A; 1B: CoGs in group A; 1C: HSs in group P; 1D: CoGs in group P.

Spatial normalization of nTMS and MRI data showed an average primary motor area shift of 4.7±0.8mm standard error of the mean (SEM) on the mediolateral axis, and 9.7±1.5mm SEM on the anteroposterior axis. Motor-eloquent points tended to shift towards the resection cavity by 4.5±3.6mm SEM if the lesion was anterior to the rolandic region and by 2.6±3.4mm SEM if it was located more posteriorly.

Concerning the speed we saw a correlation between time span between mappings and extent of shift (Figure 2).

Figure 2

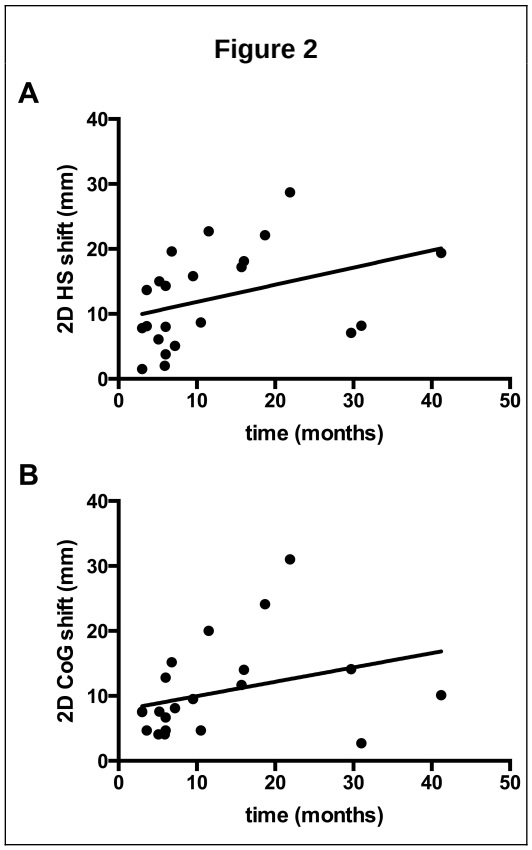

Figure 2: Extent of shift as a function of time interval between mappings. Scatterplots displaying the extent of Hotspot (HS; Figure 2A) and map center of gravity (CoG; Figure 2B) shift at the brain surface level on the y -axes in mm. The x-axes represent the time intervals between mappings in months. The lines plotted were rendered by linear regression.

Conclusions

Despite the series' small size, analysis of these data shows impressively that cortical functional reorganization occurs quite frequently. Moreover, nTMS is shown to detect such plastic reorganization non-invasively. However, since tumor- and deficit-related subgroups might show different patterns, multicentric analysis of a larger cohort seems compulsory. This provides further motivation to join our newly founded multicentric international study group.

Learning Objectives

By the conclusion of this session, participants should be aware of the oncological potential of neuroplasticity