Probability Maps of Glioblastoma Indicate Variation in Surgical Decisions between Ten Surgical Teams

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Introduction

The aim of glioblastoma surgery is to maximize the extent of resection, while preserving functional integrity. Standards are lacking for surgical decision-making and consequently surgical strategies may differ between neurosurgical teams. In this study we quantitated and compared surgical decision-making throughout the brain between neurosurgical teams for patients with a glioblastoma using probability maps.

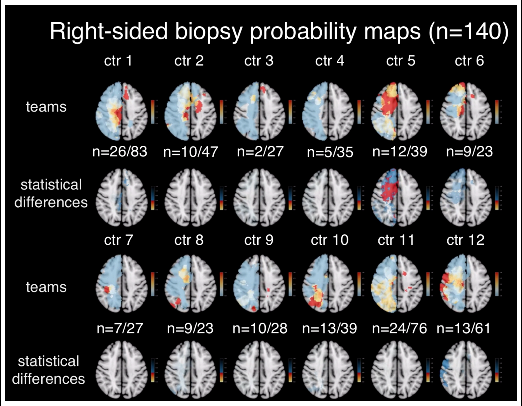
Methods

All adults with first-time glioblastoma surgery in 2012-2013 from twelve tertiary referral centres for neuro-oncological care were included in this study. For each patient, pre- and postoperative tumor were manually segmented on MRI and aligned to standard brain space. Resection probability maps and biopsy probability maps were constructed in 1 mm resolution for each team's cohort. Brain regions with differential biopsy and resection results between teams were identified.

Results

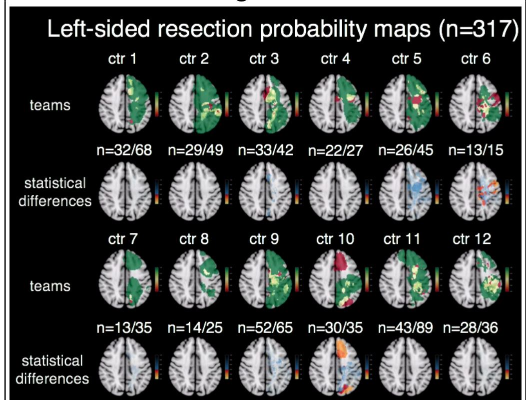
The study cohort consisted of 1079 patients of whom 336 received a biopsy and 743 a resection. Biopsy probability maps demonstrated differences between teams in biopsy rate per brain location, such as for the right supplementary motor area, indicating variation in biopsy decisions (Fig1). Resection probability maps demonstrated differences between teams in residual tumor rate per brain

Figure 1.



Transversal slices from the biopsy probability maps (BPM) comparison of all twelve neurosurgical teams to evaluate decision-making on biopsy decisions for the right hemisphere. A BPM is calculated by the voxel-wise summation of the number of patients with a biopsy divided by the summation of the number of patients with a tumor before surgery for each voxel where any patient had a tumor before surgery. A value of zero represents a location where all patients have had a resection, and a value of one represents a location where all patients have had a biopsy. Each first row indicates the team's preference; each second row indicates statistical differences after voxel-wise randomization in which p-values were thresholded at a false discovery rate of 0,4, hence voxels with a lower value are declared significant. The color codes correspond with the adjacent legends and the number correlates to the number of patients with a biopsy relative to the number of all included patients for the right hemisphere.

Figure 2.



Transversal slices from the resection probability maps (RPM) comparison of all twelve neurosurgical teams to evaluate decision-making on residual disease for the left hemisphere. An RPM is calculated by the voxel-wise summation of the number of patients with residual disease divided by the summation of the number of patients with a tumor before surgery for each voxel where any patient had a tumor before surgery. A value of zero represents a location where tumor was never removed, and a value of one represents a location where tumor was always removed. The layout and statistical analysis is identical to Figure 1. The color codes correspond with the legends and the number correlates to the number of patients with a resection to the number of all included patients for the left hemisphere.

Conclusions

Biopsy and resection probability maps indicate treatment variation between teams for patients with a glioblastoma. This conveys useful objective arguments for quality of care discussions between surgical teams for these patients.

Future

Future research will focus on exploring functional and oncological outcome of patients within differently biopsied/resected regions for future guidance of surgical decision-making.