# Safe Resection of a Left Frontal Glioma in an Awake Bilingual Patient Guided by Language Mapping and Tractography

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## Clinical Presentation

The patient is a 33-year-old who presented to the emergency room after sustaining new onset seizure activity. His initial seizure caused him to lose consciousness and fall from his bed onto the floor. Seizure activity ceased after several minutes only to begin again upon arrival of EMS. The patient was given a total of 10 mg of versed en route by EMS for recurrent right upper extremity focal motor seizures. In the emergency room the patient was found to be neurologically intact and amnestic for the preceding events. MRI of the brain demonstrated an area of left superior frontal gyral edema and subcortical T2 signal abnormality extending over a region measuring 4.5 cm with enhancement that was suspicious for a primary brain neoplastic process lodged in the dorsal prefrontal cortex, spanning the rostral superior frontal gyrus anteriorly and the caudal middle frontal gyrus posteriorly (Fig. 1).

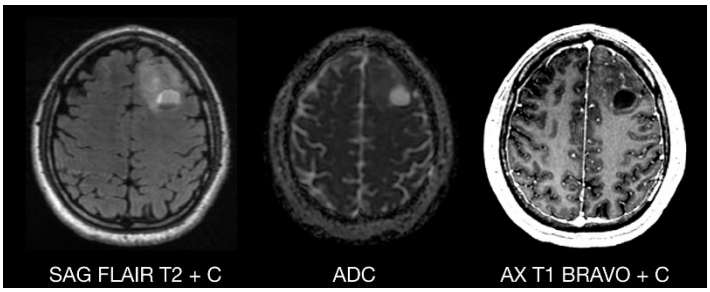


Figure 1: Pre-op MRI.

The patient underwent left frontal brain biopsy using image guidance. Biopsy revealed anaplastic astrocytoma, IDH-mutant type. It was therefore decided to return the patient to the OR for a left frontal craniotomy and gross total resection of the lesion.

## Surgical Planning

Whole-brain tractography was generated using Synaptive presurgical planning software, which demonstrated mass effect of frontal white matter fibers caused by the neoplasm. Virtual dissections of frontal tracts were performed on the basis of both lesion proximity and neurological risk minimization of functionally relevant tracts (e.g., language, motor, limbic networks) (Fig. 2).

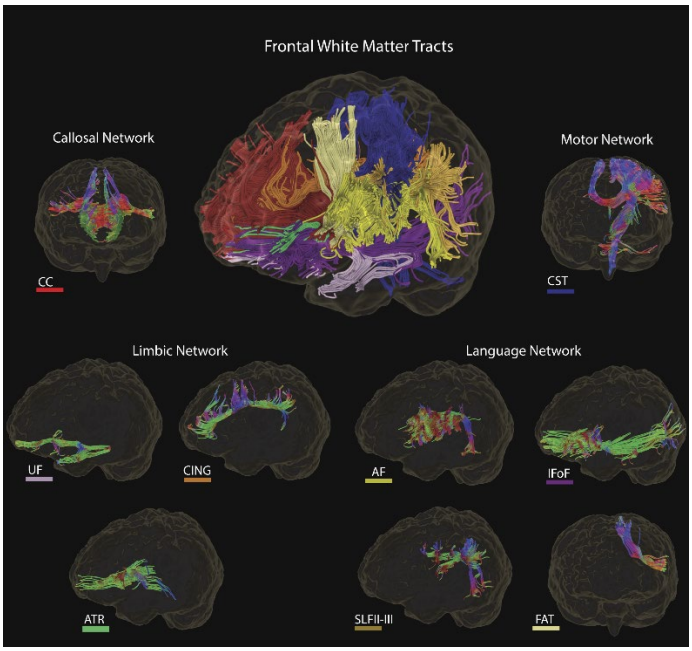


Figure 2. Relevant language networks.

Directly posterior to the lesion, white matter of the frontal aslant tract (FAT) - interconnecting the supplementary motor areas (SMA/preSMA) with Broca's area in the inferior frontal gyrus - was displaced along premotor cortex, with the precentral projection fibers of the pyramidal motor network uninvolved. Laterally, the peri-sylvian language fibers of the 2nd and 3rd sub-branches of the superior longitudinal fasciculus (SLFII-III) and arcuate fasciculus (SLF-IV) were visibly intact in their terminations in dorsal and ventral premotor cortex, respectively. Ventral to the pathology, the anterior thalamic radiation (ATR), inferior fronto-occipital fasciculus (IFoF), and uncincate fasciculus (UF) appeared intact as they coursed into orbitofrontal and ventrolateral frontal cortex. Along the medial margins, fibers of the cingulum were intact, but with an apparent infiltration and compression of the frontal corpus callosum (Fig. 2). The set of fiber tracts were dissected and segmented for intraoperative visualization with

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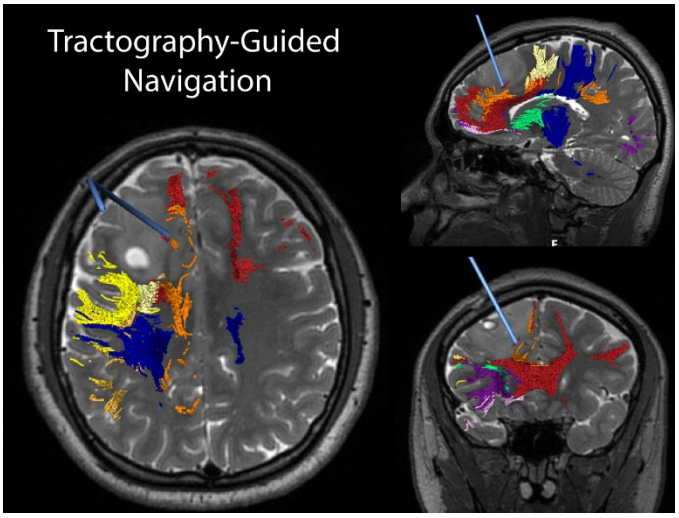
Synaptive's image-guided navigation system, BrightMatter™ Guide.

## Surgical Approach and Awake Mapping

The approach was initiated along anterior lesion margins, with awake craniotomy performed under local anesthesia. Due to the proximity of the posterior extent of the pathology to perisylvian (e.g., SLFII-III, AF, and IFoF) and intra-frontal language fibers (e.g., FAT), tests for naming, repetition, reading, and counting were administered. In addition, given the implications for executive control functions of the dominant dorso-lateral and dorso-medial frontal lobe, the Stroop test was incorporated into the mapping protocol, simultaneously testing for reading ability, naming, and task-switching between reading and naming (i.e., cognitive control). In between tasks, the patient was also tasked with communicating with the intraoperative monitoring team in both English and Spanish to ensure that both primary and secondary conversational speech capacities were not compromised during the surgical resection.

The glioma resection margins were determined using image-guided neuro-navigation and intraoperative fluorescence with 5-aminolevulinic acid (5-ALA) - visualized using a standard operative microscope. Upon exposure of cortex and subsequent pathology, 5-ALA confirmed pre-operative glioma diagnosis with visible PpIX accumulation and illumination under blue light. Throughout the resection, proximity to eloquent tracts were carefully evaluated using tractography-navigation and transections of the implicated frontal white matter fiber bundles were avoided (Fig. 3). The resection margins were confirmed and verified using the contrast-enhanced MRI scans.




The patient's post-operative course was uneventful and was discharged home on post-operative day one. He remained neurologically intact. Post-surgical MRI scans showed non-overlap between the resection cavity and the fiber tracts identified pre-operatively (Fig. 4).

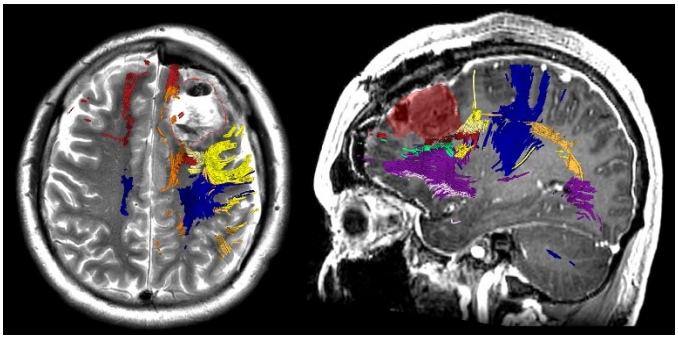


Figure 4. Post-operative resection cavity.

## Conclusion

This case demonstrates the benefit of a combined intraoperative fluorescence and tractography-based strategy to achieve safe maximal resection while facilitating onco-functional decision-making in the operative dominant hemisphere. By mapping structural networks prior to surgery, our multi-modal strategy minimized the need for extensive electrical stimulation mapping to identify eloquent structures and thereby increased surgical efficiency in an otherwise complex procedure.

## Highlights

- Automated pre-operative tractography confirmed the optimal surgical approach to reduce risk to eloquent fibers in a complex frontal glioma resection
- Fluorescence and tractography guided surgery improved surgical efficiency by minimizing the need for extensive electrical stimulation
- The patient was discharged on post-operative day one, with post-operative MRI and tractography demonstrating fiber tracts of interest were maintained

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