Letter: Early Experience Using Omniscient Neurotechnology Fiber Tracking Software for Resection of Intra-Axial Brain Tumors

To the Editor:

Connectomics is a rapidly evolving field of study dedicated to mapping and understanding the structural and functional topology of the human brain. As opposed to the traditional localization-based approach to neuroanatomy, wherein isolated regions of brain are linked to basic neurological functions, connectomics provides a unified, network-based view that reveals the brain as a navigable tangle of integrated circuits.[1] The challenge has been to translate this revised cartography to the surgical sphere, where awareness of functionally important networks can optimize surgical decision making. Toward this end, Omniscient Neurotechnology has harnessed the power of big data and machine learning analytics in its Quicktome (Omniscient Neurotechnology) program, a cloud-based Health Insurance Portability and Accountability Act–compliant software that allows physicians to cross-reference patient-specific diffusion tensor imaging (DTI) studies against a data repository which allows for prompt mapping of cortical and subcortical connections. The resulting map is unique to each patient and can be viewed as a personalized connectome. The extent of this database and the ease of using its interface for selecting and displaying networks distinguish Quicktome from other fiber tracking applications. Moreover, its algorithm for edema correction, thereby allowing fiber mapping immediately adjacent to tumors even when significant peritumoral edema is present, is a significant advance for such DTI-based software.

For patients undergoing brain tumor surgery, preservation of the connectome is paramount in preventing postoperative functional deficits. Despite our current methods, patients develop significant postoperative higher-order cognitive deficits that negatively affect quality of life and that such deficits can occur even when surgery is performed in what are traditionally considered "noneloquent" areas.[2,3] Ultimately, such outcomes provide evidence for patient-to-patient variability of brain neural network architecture and speak to the need for a more refined understanding of brain connectivity. Quicktome (Omniscient Neurotechnology) names, defines, and maps these critical networks, such as the default mode and salience networks, which have become well characterized only over the past few years.[4,5]

To date, Westchester Medical Center is among the first institutions in the United States to integrate Omniscient fiber tracking software into a neurosurgical oncology practice. Before Food and Drug Administration approval of Quicktome (Omniscient Neurotechnology) in March 2021, we were one of a few sites nationally to implement a Beta version of the software and the first site to use the software upon market release in July 2021. Currently, we are the busiest user of Quicktome (Omniscient Neurotechnology) in the United States, using it for nearly all supratentorial intra-axial tumor resections, inclusive of low-grade gliomas, glioblastomas, and occasional deep-seated metastases. These patients undergo preoperative DTI along with standard MRI sequences, which adds only 7 minutes to the scan acquisition. The DTI is then uploaded into the Omniscient platform and networks relevant to the tumor are automatically displayed. Additional networks can be chosen from a list and displayed accordingly. The neurosurgeon can use this information in multiple ways: (1) preoperative counsel to the patient regarding goals of surgery and what deficits may be acceptable in the name of greater tumor resection ("oncofunctional balance"), (2) selection of an optimal trajectory to the tumor and awareness of adjacent functional areas that need to be preserved, and (3) assessment of adjacent areas for networks that may limit a supramaximal resection. Moreover, we now obtain postoperative

TABLE. Clinical Characteristics of Patients With Brain Tumor Treated With Resection at Westchester Medical Center Using Preoperative and Postoperative Omniscient Fiber Tracking Software

Patient identifier	Age	Sex	Tumor type	Tumor location	Major network/fibers involved
1	38	F	Grade 3 astrocytoma	L parietal	Language/SLF
2	73	F	GBM	L temporal	Language/SLF
3	38	M	GBM (recurrent)	R frontal	DMN/IFOF
4	49	M	Grade 2 oligo	R parietal	Sensorimotor
5	25	F	Grade 2 astrocytoma	R frontal	DMN/IFOF
6	64	F	GBM	R frontal	Sensorimotor
7	70	F	GBM	L temporal	Language/SLF
8	40	F	Ovarian metastasis	L parietal	Language/ILF
9	66	M	Opercular GBM	L frontal	Language/SLF
10	53	F	GBM	R frontal	Sensorimotor
11	57	F	GBM	L frontal	Sensorimotor
12	59	F	Vasculopathy (non-neoplastic)	L frontal	Language/SLF

DMN, default mode network; F, female; GBM, glioblastoma; IFOF, inferior fronto-occipital fasciculus; ILF, inferior longitudinal fasciculus; L, left; M, male; Oligo, oligodendroglioma; R, right; SLF, superior longitudinal fasciculus.

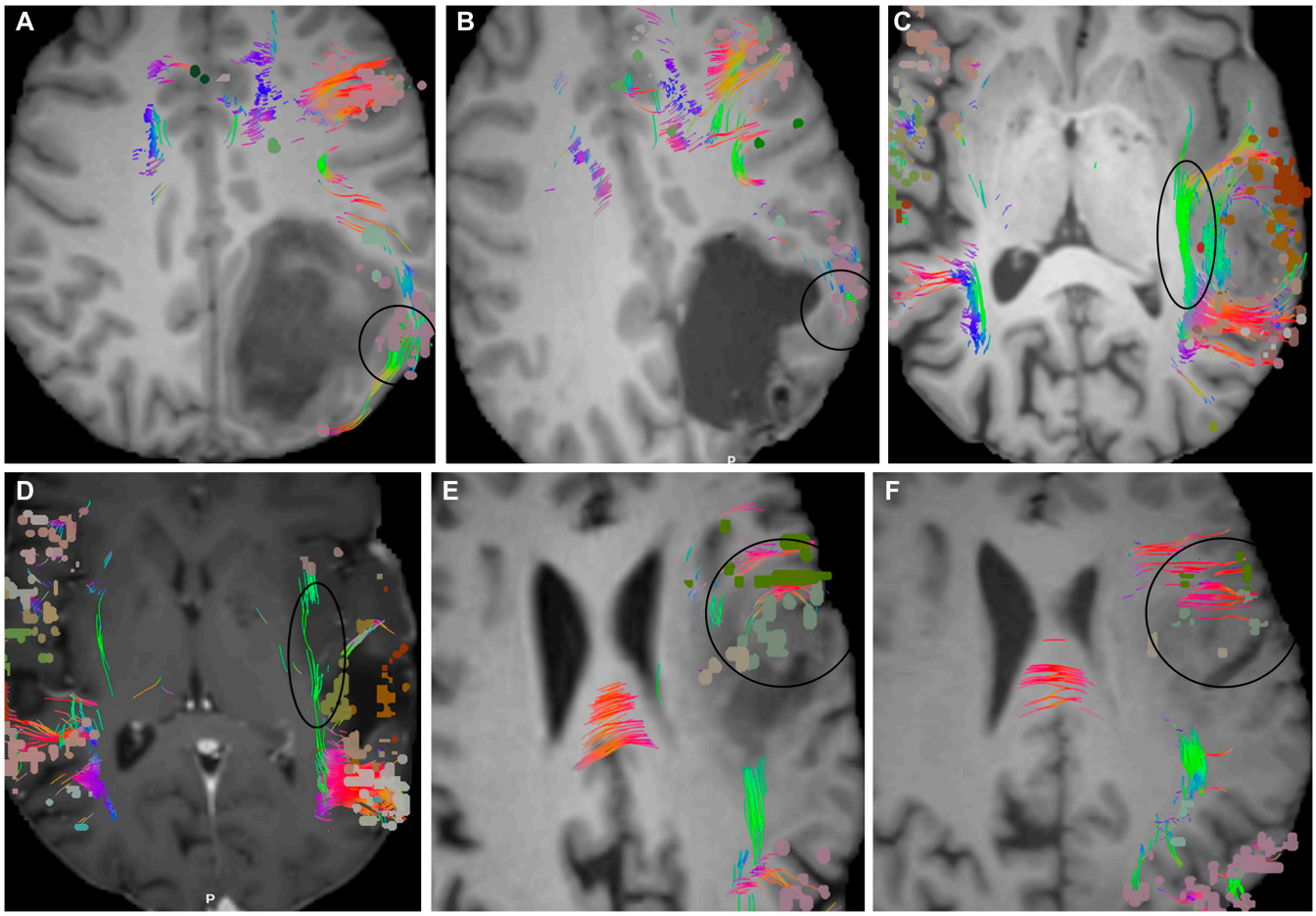

FIGURE *Preoperative and postoperative T1 precontrast MRI images using Omniscient software for cortical and subcortical fiber identification.* **A**, *Preoperative imaging and* **B**, *postoperative preservation of language parcellations along the lateral edge of grade 3 astrocytoma.* **C**, *Preoperative imaging and* **D**, *postoperative preservation of SLF and arcuate fasciculus fibers along medial boundary of a glioblastoma.* **E**, *Preoperative imaging and* **F**, *intraoperative disruption of a fiber bundle contributing to the SLF leading to intraoperative and postoperative phonemic paraphasias. SLF, superior longitudinal fasciculus.*

DTI to account for either preserved or diminished function as a correlate to fiber integrity.

Tumor characteristics of the 12 patients for whom this technology has been implemented are summarized in Table, and 3 representative cases were chosen to highlight its functionality. To date, this is the largest series of patients who have been run through the Quicktome (Omniscient Neurotechnology) program, and each tumor would be traditionally regarded as eloquent or perieloquent. In the first case, language parcellations adjacent to a grade 3 astrocytoma (Figure A) were identified, thereby limiting resection to the lateral border of the tumor, whereas a supramaximal resection in this region was initially considered. Traditionally, this area of the parietal lobe would not be viewed as integral to language function, but Quicktome (Omniscient Neurotechnology) mapped the parcellations and network connections to the superior longitudinal fasciculus (SLF). Postoperative imaging revealed intact fibers with preserved language function (Figure B). In the second case, Quicktome (Omniscient Neurotechnology) identified SLF and arcuate fasciculus fibers coursing along the medial boundary of a glioblastoma (Figure C). These visualized adjacent fibers, enabled by the edema correction feature, prompted extreme caution in this area during the surgery with more intraoperative testing. This resulted in greater fiber preservation (Figure D) and unchanged postoperative language function. The third case demonstrates utilization of Quicktome (Omniscient Neurotechnology) after surgery, prompted by a patient's development of phonemic paraphasias in the latter stages of an awake craniotomy for a glioblastoma. Although the preoperative connectome suggested that areas adjacent to the tumor were not particularly robust (Figure E), postoperative Quicktome analysis detected the clear loss of a fiber bundle arching into the SLF (Figure F). We believe these fibers accounted for the observed speech deficit.

In summation, our experience as early Omniscient (Omniscient Neurotechnology) adopters at Westchester Medical Center has enhanced our ability to preserve functionality and counsel patients undergoing intra-axial neoplasm resection. It is our hope

that such preliminary evidence will encourage other practitioners to consider this software in a collective effort to optimize outcomes for patients with brain tumor.

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REFERENCES

1. Fornito A, Zalesky A, Breakspear M. The connectomics of brain disorders. *Nat Rev Neurosci.* 2015;16(3):159-172.
2. Dadario NB, Brahimaj B, Yeung J, Sughrue ME. Reducing the cognitive footprint of brain tumor surgery. *Front Neurol.* 2021;12:711646.
3. Rijnen SJM, Kaya G, Gehring K, et al. Cognitive functioning in patients with low-grade glioma: effects of hemispheric tumor location and surgical procedure. *J Neurosurg.* 2020;133(6):1671-1682.
4. Chand GB, Wu J, Hajjar I, Qiu D. Interactions of the salience network and its subsystems with the default-mode and the central-executive networks in normal aging and mild cognitive impairment. *Brain Connect.* 2017;7(7):401-412.
5. Putcha D, Ross RS, Cronin-Golomb A, Janes AC, Stern CE. Salience and default mode network coupling predicts cognition in aging and Parkinson's disease. *J Int Neuropsychol Soc.* 2016;22(2):205-215.

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