A 47-year-old, right-handed woman initially presented with headaches, left-sided numbness and left hemianopia. Following diagnostic biopsy, she underwent concomitant temozolomide chemotherapy with radiation therapy followed by temozolomide monotherapy. After six months of therapy, the patient was in her usual state of health until the past few weeks, during which she developed worsening headaches, as well as some intermittent visual hallucinations with minimal brain trauma while still allowing for binominal microsurgery to remove the tumor. At UPMC, a significant experience has been developed using the Neuroendosport system to remove deep tumors. Prior experience with endoscopic port surgery has demonstrated that high-definition fiber tracking (HDFT), a MRI-based technique of white matter imaging, can be used to guide cannulation of a tumor using an endoscopic port, minimizing damage to functional surrounding nerve fascicles. This technique helps to ensure that critical fiber tracts, such as the corticospinal tract (CST), the optic radiations, or the arcuate fasciculus are not damaged by the port during deep brain surgery.

Illustrative Case

A 60-year-old physician presented with complaints of headache, left-sided incoordination and mild motor weakness. Magnetic resonance imaging (MRI) scans demonstrated a heterogeneously enhancing mass surrounded by substantial peritumoral T2 signal change. Given the presumptive diagnosis of a high-grade glioma, surgical resection was recommended. The key concern was the presence of the tumor abutting and possibly involving the corticospinal tract (AKA motor tract) at the anterior portion of the tumor. Injury to these fibers would result in a significant risk for motor deficit. In order to better visualize peritumoral motor fibers, the patient underwent HDFT prior to surgical resection. We found that the motor fibers appeared to be displaced anteriorly by the tumor, which infiltrated much of the parietal lobe. One year after surgical resection, her disease remained reasonably controlled, and her Karnofsky performance score was 90, with preserved motor function.

Figure 1: Preoperative and postoperative T1-weighted axial sections with contrast showing a subtotal resection of a right posterior thalamic tumor.

Figure 2: HDFT reconstruction of the fiber tracts in this patient showed the location of the corticospinal (motor) tract just anterior and lateral to the tumor, and the optic radiations (visual system) just lateral and inferior to it. The surgical end point trajectory was planned accordingly.

Figure 3: Tumor. Motor Tract. Figure 2: The cortico-spinal (motor) tract was segmented and incorporated into the intraoperative navigation system for accurate localization. Figure 3: The fibers of the motor tract (red) were identified during the operation, and their location was confirmed with the use of intraoperative cortical mapping.

Intra-operative use of HDFT with image-guidance valuable in awake craniotomy for tumor resection

In many centers, the use of awake craniotomy is a common practice for the surgical treatment of malignant brain tumors. The use of awake craniotomy is particularly useful in cases where the tumor abuts or involves eloquent areas such as the motor cortex or speech areas. The key challenge with awake craniotomy is to ensure that the patient is able to communicate any neurologic deficit in real-time. This is achieved by using image-guidance systems that provide fiber tracking imaging that is more robust in the setting of vasogenic edema and has the ability to deal with fiber crossings. Here, we present a case where we utilized HDFT within the operating room to visualize and preserve the motor fibers during tumor resection.

A 60-year-old physician presented with complaints of headache, left-sided incoordination and mild motor weakness. Magnetic resonance imaging (MRI) scans demonstrated a heterogeneously enhancing mass surrounded by substantial peritumoral T2 signal change. Given the presumptive diagnosis of a high-grade glioma, surgical resection was recommended. The key concern was the presence of the tumor abutting and possibly involving the corticospinal tract (AKA motor tract) at the anterior portion of the tumor. Injury to these fibers would result in a significant risk for motor deficit. In order to better visualize peritumoral motor fibers, the patient underwent HDFT prior to surgical resection. We found that the motor fibers appeared to be displaced anteriorly by the tumor, which infiltrated much of the parietal lobe. One year after surgical resection, her disease remained reasonably controlled, and her Karnofsky performance score was 90, with preserved motor function.

Figure 1: Upper panel: Preoperative coronal and axial T1 weighted sections showing a contrast-enhancing and necrotic tumor near the motor region. The HDFT reconstruction confirmed the spatial relationship of the tumor with adjacent fiber tracts. Figure 2: The cortico-spinal (motor) tract was segmented and incorporated into the intraoperative navigation system for accurate localization. Figure 3: The fibers of the motor tract (red) were identified during the operation, and their location was confirmed with the use of intraoperative cortical mapping.