Functional Neural Tract Sparing Stereotactic Radiosurgery using Plato’s Computer Augmented Virtual Environment (Plato’s CAVE) and Diffusing Tensor Imaging Mapping

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Stereotactic radiosurgery (SRS) is a standard treatment option for brain metastasis. To preserve function, it is important to localize critical neural tracts that may be in close proximity to intended targets. To achieve this goal, the authors describe a novel approach to treating brain metastases in eloquent brain integrating anatomic and functional imaging of critical neural structures and fiber tracts for SRS treatment planning.
An 89 year-old woman with metastatic invasive ductal carcinoma of the breast presented with gait instability and was diagnosed with a solitary 1.7cmx1.7cmx1.7cm presumed metastasis in the Left thalamic-midbrain junction by MRI. To mitigate neural toxicity, an SRS treatment plan was formulated that accounted for the adjacent corticospinal tracts by combined use of the Plato’s Computed Augmented Virtual Environment (CAVE) multi-dimensional imaging system and diffusion tensor functional MR imaging (DTI). Plato’s CAVE is a unique and intuitive virtual reality environment. It accepts all medical images in DICOM format and integrates them into one seamless virtual environment.
Results

With this approach, the mass was treated to 14Gy and the majority of the corticospinal tract was spared from the 50% isodose curve, with the maximum dose of 12.98 Gy (92.7% of prescription dose). Interval scanning has demonstrated a reduction in all dimensions by 4mm and reduced edema with neurological improvement.
Figure 1 shows the delineation of target (solitary brain metastasis in the thalamus) and critical surrounding structures including optic pathway, brainstem and lateral corticospinal tract.
Results

Figure 2. Images from Plato’s CAVE. Top: The motor tracts are labelled in color, and they are seen in close proximity to the tumor. Bottom: As shown in more detail in the axial slice, the tumor is in close association with the corticospinal tract.
Results

Figure 3 (Left) Shows the isodose distribution for SRS treatment planning with the Dose-volume histogram of the left corticospinal tract (Right)
Discussion

As the population ages and cancer rates with brain metastasis rise, strategies to mitigate treatment related toxicity become imperative. Here we present the successful combined use of The Plato’s CAVE and DTI as complementary approaches to personalize dose volume histogram (DVH) constraints on important neural tracts. As we gain more understanding of dose threshold tolerance for vital neural structures, this approach is expected play a critical role in tumor control, limiting SRS toxicity and improving quality of life.
Summary

Fusion of functional and DTI data and incorporation into SRS treatment planning is a useful adjunct for radiotherapy.