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Building a Visual Search Database for Brain Metastases

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Abstract

Objective: The treatment of brain metastases particularly with radiosurgery builds upon cumulative knowledge and experience of the successful treatment and outcomes of prior patients. However, this expertise often remains confined to the repertoire of individual radiation oncologists. If, instead, we could probe any area of the brain visually on a volumetric atlas, the outcomes of historic radiation therapy could be interactively explored spatially at any specific region-of-interest. Here, we are building a database at our institution that registers all of our patients with brain metastases treated with radiosurgery into a common, normalized template that can be visually searched.

Methods: First, a common template will be derived from our patient cohort using VoxelMorph1, a deformable image registration framework that can also be used to generate a atlas conditioned upon age.2 All patient T1w anatomical MRIs will be warped into the conditioned template, as well as radiation dose and contours including the gross tumor volumes. For patients with large metastases (> 3 cm), previously built virtually brain grafting3 will be invoked to improve deformations. A front-end graphical interface built on WebGL using Pycortex4 will be used for displaying cortical metastases. Pycortex also facilitates metadata, which can be indexed via a relational database including clinical outcomes of overall survival, local recurrence, and distant recurrence as well radiation dose distributions. Color overlays can indicate features such as primary tumor origin, age, and systemic therapies.

Results: We have piloted the infrastructure of the visual database on a small set of n = 20 patients. The registration framework to the template worked well to produce the surface viewer. We are now extending this work to a larger cohort of n = 500 patients treated since 2015. Clinical data for these patients are also being collected and indexed.

Conclusion: Building an interactive database of brain metastases patients holds potential to leverage our collective experiences in treating patients with radiosurgery into a single framework. The viewer can be launched during tumor board meetings, allowing a rapid way to retrieve prior cases with similar anatomical locations of tumors. Additionally, the collation of the data itself will enable population-based statistics with a high degree of spatial accuracy. Overall, we aim to improve the management of patients suffering with brain metastases by making the data rapidly available to clinicians with a volumetric explorer.