Non-uniform dose distributions in cranial radiation therapy

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Radiation treatments are often delivered to patients with brain metastases. For those patients who receive radiation to the entire brain, there is a risk of long-term neuro-cognitive side effects, which may be due to damage to the hippocampus. In clinical MRI and CT scans it can be difficult to identify the hippocampus, but once identified it can be partially spared from radiation dose. Using deformable image registration we demonstrate a semi-automatic technique for obtaining an estimated location of this structure in a clinical MRI or CT scan.

Deformable image registration is a useful tool in other areas such as adaptive radiotherapy, where the radiation oncology team monitors patients during the course of treatment and adjusts the radiation treatments if necessary when the patient anatomy changes. Deformable image registration is used in this setting, but there is a considerable level of uncertainty. This work represents one of many possible approaches at investigating the nature of these uncertainties utilizing consistency metrics. We will show that metrics such as the inverse consistency error correlate with actual registration uncertainties.

Specifically relating to brain metastases, this work investigates where in the brain metastases are likely to form, and how the primary cancer site is related. We will show that the cerebellum is at high risk for metastases and that non-uniform dose distributions may be advantageous when delivering prophylactic cranial irradiation for patients with small cell lung cancer in complete remission.