Combined stereotactic biopsy and stepping-source interstitial irradiation of unresectable glioblastoma multiforme.


Abstract

Patients diagnosed with glioblastoma multiforme receiving stereotactic biopsy only either due to tumor localization or impaired clinical status face a devastating prognosis with very short survival times. One strategy to provide an initial cytoreductive and palliative therapy at the time of the stereotactic biopsy is interstitial irradiation through the pre-defined trajectory of the biopsy channel. We designed a novel treatment planning system and evaluated the treatment potential of a fixed-source and a stepping-source algorithm for interstitial radiosurgery on non-spherical glioblastoma in direct adjacency to risk structures. Using both setups, we show that radiation doses delivered to 100% of the gross tumor volume shifts from sub-therapeutic (10-12 Gy) to sterilizing single doses (25-30 Gy) when using the stepping source algorithm due to improved sparing of organs-at-risk. Specifically, the maximum doses at the brain stem were 100% of the PTV dose when a fixed central source and 38% when a stepping-source algorithm was used. We also demonstrated precision of intracranial target points and stability of superficial and deep trajectories using both a phantom and a body donor study. Our setup now for the first time provides a basis for a clinical proof-of-concept trial and may widen palliation options for patients with limited life expectancy that should not undergo time-consuming therapies.

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