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Strategic Planning of Multiple Brain Targets Using Robotic Radiosurgery

Kiernan McCullough [1]

1. Medical Physics, Colorado Associates in Medical Physics

✉ **Corresponding author:** Kiernan McCullough, k.mccullough@campphysics.com

Categories: Medical Physics
Keywords: stereotactic radiosurgery, brain metastases, robotic radiosurgery, cyberknife, whole brain radiation therapy

How to cite this abstract
Mccullough K (June 16, 2016) Strategic Planning of Multiple Brain Targets Using Robotic Radiosurgery. Cureus 8(6): a85

Abstract

Objectives: Patients seeking radiation treatment presenting with multiple brain tumors typically have two options for recourse: whole brain radiation therapy (WBRT) or stereotactic radiosurgery (SRS). WBRT historically has been the preferred technique for many practicing physicians, using the number of brain targets as an important qualifying metric. However, more recent literature elucidates a survival benefit using SRS, even when presenting with many tumors. The purpose of this study is to explore different planning strategies to treat multiple brain targets using robotic radiosurgery that will optimize coverage, treatment time, and normal tissue sparing.

Methods: From August 2012- April 2015, 24 patients who underwent spine SRS in this institution were retrospectively reviewed. Pain outcome was measured using the Numerical Rating Pain Scale. Acute effects were scored according to the Common Terminology Criteria for Adverse Events v4. The mean age of patients was 58 ± 16.06 years. Radiation was delivered via intensity modulated radiation therapy (IMRT) and prescribed to cover at least 80% of the planning treatment volume (PTV), with organs-at-risk doses kept to tolerance level. Patients were treated to a median dose of 16Gy (range 12-25Gy), given in 1-5 fractions.

Results: In the isolated tumor distribution, the all-target plan had a higher V20 by 11%, with a conformality index (CI) of 1.81 versus 1.63. However, the V2 and V10 were nearly identical between the two approaches (<1%). The ability to focus the optimization problem on each target individually produces more conformal plans without any detriment due to the addition of low isodoses. However, planning on all targets at once did have enormous time savings, with expected patient treatment time estimated at 146 min in comparison to 267 min. Additionally, the all-target approach is considerably faster to plan and process, reducing the number of plans necessary to review, dose files to sum, and paperwork to generate. The all-targets plan also has lower V12 and V5 by 2.6% and 6.5% respectively. In the clustered tumor case, the results differed greatly. The individually targeted plans had the highest dose volumes for each metric, with a V20, V12, V10, V5, and V2 that were 40%, 46%, 56%, 96%, and 106% higher than the all-targets plan (CI of 2.29 versus 1.63). The clustered plan approach, which focused on each group of 3-4 targets individually, had the best conformality with a V20 13% lower than the all-targets plan (CI of 1.42 versus 1.63), but had higher V12, V10, V5, and V2 by 14%, 14%, 19%, and 48%. Additionally, treating the targets at once had time savings similar to the isolated distribution, with an estimated treatment time of 101 minutes versus 161 minutes for the clustered plans and 285 minutes total for the individual treatments.

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Published 06/16/2016

Conclusions: Each patient's radiation treatment plan presents with a unique set of challenges. By implementing the appropriate planning strategy, multiple brain tumors can be targeted simultaneously while still achieving acceptable target conformality and normal tissue sparing. In many cases, treating tumors simultaneously can achieve more favorable conformality, low-dose volumes, and reduced treatment time. Evaluating tumors by their number, proximity to other targets/critical structures, and complexity should guide decision making when determining the most appropriate combination of plans that will lead to an optimum solution.