Evaluation of a dedicated brain metastases treatment planning optimization for radiosurgery: a new treatment paradigm?

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Abstract

Objectives: Stereotactic radiosurgery alone has become a popular treatment option in the management of patients with brain metastases. Multi- or single-isocenter dynamic conformal arcs (DCA) and volumetric modulated arc therapy (VMAT) are two common used delivery techniques. Recently, a dedicated inverse optimized brain metastases treatment planning solution using single isocenter multiple DCA (SIDCA) has been developed, with intend to carefully balance normal tissue protection, target coverage and treatment speed. The purpose of the current study was to investigate the feasibility of this novel software and to benchmark it against well-established multi-isocenter DCA and single isocenter VMAT approaches.

Methods: Ten previously treated patients were selected representing a variable number of lesions (1-8), range of target sizes and shapes most frequently observed in the practice of SRS for brain metastases. The original multi-isocenter DCA (MIDCA) were replanned with both single-isocenter VMAT approach and the novel brain metastases tool (Elements, Brainlab AG, Germany). The treatment dose was 20 Gy at the 80% prescription isodose. For all the plans, the dose to the surrounding healthy brain tissue (brainstem, cochlea, optical nerve, eyes and lens) was optimized to minimize normal tissue complications. The plans were evaluated by calculation of Paddick conformity and gradient index, and the volume receiving 10 and 12 Gy indicating risk of radionecrosis.

Results: All plans were judged clinically acceptable, but differences were observed in the dosimetric parameters. The mean conformity of the automated single-isocenter planning tool (SIDCA) compared similarly to the established MIDCA and VMAT treatment techniques (CISIDCA=0.65 ± 0.08, CIMIDCA=0.66 ±0.07 and CIVMAT=0.67 ±0.16). Comparable mean dose fall off was observed between SIDCA and MIDCA (GISIDCA =3.9 ± 1.4 and GIMIDCA=4.5 ± 1.6). On the other hand, the GI of the VMAT plans (GIVMAT=7.1 ± 3.1) were significantly higher compared to the SIDCA. The V10 and V12 were significantly higher for VMAT plans (V10VMAT=67.9 ±55.9cc, V12VMAT=46.3 ±35.9cc) (p<0.05) compared to MIDCA (V10MIDCA=49.0 ±38.1cc, V12MIDCA=35.6 ±26.4cc) and SIDCA (V10=48.5 ± 35.9cc, V12=36.3 ± 27.1cc).

Conclusions: The automated brain metastases treatment planning element, based on an inversely-optimized SIDCA approach, revealed comparable results to the general accepted

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MIDCA approach. By reducing the time on planning, patient and treatment setup, this software tool improves the planning and delivery efficiency while preserving the plan quality of the MIDCA technique and lowering low dose spread of the VMAT approach, suggesting that this novel software offers the best of both worlds (i.e. efficient single-isocenter DCA delivery).

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