Efficacy of Quality Verification Computation for Multiple-Lesions VMAT SRS Simulation with Dream Phantom

Kaile Li [1] , Shanna Pervola [2]

1. Radiation Oncology, John R Marsh Cancer Center, Hagerstown, USA 2. Physics, OMPC, Columbus, USA

Corresponding author: Kaile Li, goolkl@gmail.com

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Abstract

Objective: With the increase of knowledge in multi-lesions brain SRS, technique in treatment of multiple targets have been developed. However, there are still challenges in efficacy for these clinical approaches such as target distribution, dose control, quality assurance, localization accuracy and so on. This study is to evaluate the multiple-lesion treatment plan in quality assurance of efficacy the clinical procedure, more specifically, VMAT multi-lesion SRS plans and related second check evaluation.

Methods: The multiple-lesions were simulated with the small balls inside the Dream Phantom (DP-850), which was used as for geometry scale accuracy check, quality assurance of imaging system such as CT and on-board imaging system, and localization displacement verification. To implement these functions, there were five marker balls being fabricated inside the DP-850 phantom. After DP-850 phantom was scanned with SIEMENS Biography (version PET syngoVG6x) in 0.6mm slice thickness. The CT set was used to contour these 5 marker balls with imaging threshold technique. These balls were combined as a Prescription Target Volume (PTV), treatment plans were accomplished with Eclipse Treatment Planning systems with same optimization setup with target center at different ball centers and PTV center. Total 6 plans were generated based on the plan with initial plan optimization with field isocenters at individual marker centers and the structure center with combing all the ball together. And then these 6 plans were sent to Mobius3D for second dosimetric computation. Clinical appropriateness was evaluated by plan conformity index, volume mean dose computation, target dose coverage, and single point dose check for individual arc field.

Results: Given the condition of 100% PTV covered by prescription dose, the conformity index for the 6 plans with different isocenter initial settings were 1.74, 1.83, 2.17, 166, 1.91 and 2.07. And the average mean dose different for these plans with different initial optimization isocenters was 2.7%, -3.2%, -2.7%, -2.8%, -3.0% and -2.7% with standard deviation at 0.9%, 1.2%, 0.8%, 0.7%, 0.7% and 1.1%. For PTV at 95% coverage, the computational differences between Mobius3D and Eclipse treatment planning system were 4.0%, 4.6%, 4.2%, -3.9%, -4.7%, and 4.2% with standard deviation at 0.6%, 1.6%, 0.4%, 0.9%, 0.9% and 0.7%. For the 12-fields point dose check, the average difference between treatment planning and Mobius3D is 0.13% with standard deviation at 0.25%.

Conclusion: The study extended the DP-850 application in multi-lesion SRS simulation for evaluation of treatment planning system and Mobius3D second check software in efficacy by utilizing the inherited small makers inside the phantom. The calculation results showed the differences between treatment planning system and Mobius3D due to volumetric computational algorithms. Further application could improve the ball heterogeneity characteristics of the DP-850 phantom for high resolution and precise Monte Carlo planning system and clinically, the volumetric computation algorithm accuracy relationship with treatment outcome could be another analysis direction.