

Perturbation in Magnetic Resonance Images (MRIs) from Brain Metastatic Target Stereotactic Radiosurgery (SRS)

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Objectives: Stereotactic Radiosurgery (SRS) is an efficacy procedure in treatment of brain disease. The complicated SRS procedure includes simulation, target definition, treatment planning, target localization and dose delivery. The external accuracy verification of whole procedure have been investigated with different quality assurance methodologies. However, the final estimation of SRS procedure should be reflected in the disease lesions inside the patient, and this could be done by employing different imaging modalities at different temporal points but challenges exist in abstracting the weak signal due to radiation in the images. Therefore, in this study, a method was used to estimate the perturbation information in MRIs at different temporal points after a brain metastatic target SRS.

Methods: A cerebellum target was under a SRS with a single ARC small aperture cone on a Linac machine from Varian Medical system. A series of MRIs in different temporal points have been attained, the temporal range were 0 month, 3 months, 6 months and 9 months. The volume of interested scans were defined by the isodose volume in the dosimetric plan, which included target volume, and isodose volumes which were at different isodose levels including 100%, 90%, 75%, 60%, 30% and 15% of prescription dose. Through image fusion method, these volumes of interest were defined in the MRIs through the function of copy structures to registered image. Then structure property function to attain the structure statistics including minimum Hounsfield Unit (HU), maximum HU, mean HU and standard deviation (SD) of HU inside the volume of interested. Vectors were used to represent the separate volumes of interest and corresponding statistics in HU. A relative percentage difference method, which was defined to be the ratio between the differences of SD and mean SD divided by the mean SD to separate the technical variation from imaging procedure.

Results: For the selected volumes of interest, the mean SD HUs were 20.8, 20.4, 24.1, and 26.21 for T1 MRIs, and was 35.2, 17.4, 31.9, and 37.1 for T1 MRIs with contrast. And the least difference in SD HU vector elements was at 3 month, and the average absolute SD HUs was about 3 in magnitude. Moreover, the relative percentage difference showed time-spatial vector pattern with special characteristics.

Conclusions: Some significant HU variation can be seen from T1 and T1 with contrast MRIs in temporal and volume discrete matrix. Data analysis could be further improved by eliminating the uncertainty due to technical inconsistency, and similar investigation approach could be applied to the MRIs acquired right after radiation irradiated for SRS.