

Conclusion: With appropriate immobilizations and 4DoF corrections, a uniform PTV margin of 1 mm may ensure an adequate CTV coverage in most treatment sessions of spine SBRT. Combined with a shortened treatment time, the small extent of intrafraction motion seems to obviate the need of treatment interruption for additional intrasession image guidance. A minimum PTV margin is still necessary to address intrafraction motion, even with 6DoF corrections.

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Dosimetric Feasibility of the Hybrid Magnetic Resonance Imaging (MRI)-Linear Accelerator System for Brain Metastases: The Impact of the Magnetic Field

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Purpose/Objective(s): The hybrid MRI-Linear accelerator (MRL) system consists of an integrated diagnostic-quality 1.5 T MRI and a 6-MV Linac to allow for online position verification, treatment monitoring, and potential real-time MR imaging during irradiation. We aimed to investigate the feasibility of delivering stereotactic radiosurgery (SRS) or hypofractionated stereotactic radiation therapy with the MRL for patients with single brain metastases and to characterize the dosimetric impact at tissue-air interfaces resulting from the electron return effect (ERE).

Materials/Methods: A total of 24 patients treated for intact single brain metastases between January and October 2015 were selected for analysis. Three radiation therapy plans with the same prescribed dose were generated for each case: (1) standard noncoplanar volumetric modulated arc therapy (VMAT) as per institutional protocol, (2) coplanar step-and-shoot intensity modulated radiation therapy (IMRT) on the MRL in the absence of (MRL_B=0), and (3) in the presence of the transverse magnetic field (MRL_B=1.5). All plans were optimized to achieve at least 98% coverage of the planning target volume (PTV) with 100% of the prescription dose (V100% > 98%) while meeting all organs-at-risk (OARs) constraints. The plans were evaluated using cumulative dose-volume histograms (DVHs) and by calculation of Paddick conformity index (PCI), V100%, V12Gy minus gross tumor volume (V12Gy - GTV), and V2Gy. The dosimetric impact of ERE to the skin and air cavities were quantified using a 5-mm rim of tissue around tissue-air boundaries.

Results: All plans met the objectives with respect to target coverage and OAR constraints. The mean PTV was 10.05 cm³ (range 0.13-63.05 cm³). Differences between all investigated dosimetric parameters significantly favored the VMAT plans as compared to the MRL_B=0 and MRL_B=1.5 plans, except for V2Gy. The VMAT plans showed a higher mean (± standard deviation) PCI compared to the MRL_B=0 and MRL_B=1.5 plans (0.85 ± 0.08 vs. 0.79 ± 0.09 vs. 0.78 ± 0.11). The mean V12Gy - GTV and V2Gy marginally favored the MRL_B=0 plans compared to the MRL_B=1.5 plans (mean difference: 0.45 cm³, P=0.0019 and 16.46 cm³, P≤0.0001, respectively). In the presence of the magnetic field, ERE resulted in a statistically significant but small increase in mean dose and D_{2cc} in the skin (0.08 Gy, P<0.0001 and 0.66 Gy, P<0.0001, respectively) and around air cavities (0.07 Gy, P=0.0092 and 0.25 Gy, P=0.0004, respectively).

Conclusion: Stereotactic radiation to single brain metastases is feasible using the MRL Monaco treatment planning system; however, in its current iteration, application to small targets deserve careful consideration given the technical limitations resulting in less favorable plan quality compared to that of a noncoplanar standard VMAT technique. The dosimetric impact of ERE at tissue-air boundaries is minor and does not compromise target conformity or dose gradient.

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Adjusted Dose and the Relation to Radiation-Induced Liver Disease During Liver 3-Dimensional Conformal Radiation Therapy

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Purpose/Objective(s): Many patients with technically unresectable or medically inoperable hepatocellular carcinoma (HCC) had hepatic anatomy variations as a result of interfraction deformation during fractionated radiation therapy. This study aimed to investigate the relationship between adjusted dose and radiation-induced liver disease (RILD) in HCC patients receiving 3-dimensional conformal radiation therapy (3DCRT).

Materials/Methods: Twenty-three HCC patients who received conventional fractionated 3DCRT were enrolled in this retrospective investigation. Among them, 7 patients had been diagnosed with RILD following radiation therapy, including 4 cases of grade 2 and 3 cases of grade 3, according to the Common Terminology Criteria for Adverse Events, version 3.0. Daily cone beam computed tomography (CBCT) scans were acquired throughout the whole treatment process for each patient. To reconstruct the daily dose to a patient considering the interfraction anatomy variations, the planned beams from his/her treatment plan were first applied to each daily modified CBCT (mCBCT). The daily doses were then summed together with the help of deformable image registration to obtain the adjusted dose (D_{adjusted}) of the patient. Finally, the dose changes in normal liver between planned dose (D_{plan}) and D_{adjusted} were evaluated by V20, V30, V40, and the mean dose to normal liver (MDTNL). Univariate analysis was performed to identify the significant dose changes.

Results: Among the 23 patients, the adjusted liver V20, V30, V40, and MDTNL showed significant changes from the planned ones (P<0.05) and increased on average by 4.1%, 4.7%, 4.5%, and 3.9 Gy, respectively. The adjusted liver doses in 21 patients (91%) were higher than planned value, and 6 patients with RILD had MDTNL increase >5% relative to the hepatic radiation tolerance. As for patients with and without RILD, the adjusted MDTNL had an average increase of 3.5 Gy and 4.7 Gy relative to planned ones, and NTCP increased on average by 2.8% and 7.5%, respectively.

Abstract 3541; Table 1. Dosimetric Parameters for D_{plan} and D_{adjusted} in patients with and without RILD.

Parameter		pts with RILD	pts without RILD	P value
MDTNL	D _{plan}	25.4±2.9	15.1±5.9	<0.001
	D _{adjusted}	30.1±2.2	18.6±5.6	<0.001
V20(%)	D _{plan}	40.1±5.6	29.3±5.1	<0.001
	D _{adjusted}	45.9±6.1	32.5±5.0	<0.001
V30(%)	D _{plan}	29.8±5.2	21.6±5.8	0.004
	D _{adjusted}	35.7±5.6	25.7±6.5	0.002
V40(%)	D _{plan}	22.3±5.8	14.9±4.3	0.003
	D _{adjusted}	28.6±4.3	18.7±4.1	<0.001

Conclusion: Our study indicates that the adjusted dose of all the studied patients significantly differs from planned dose, and the adjusted dose of patients with RILD (6/7) exceeds to the hepatic radiation tolerance. Furthermore, mCBCT-based dose reconstruction can aid in evaluating the robustness of the planning solutions, and adjusted dose has the potential to reduce the risk of RILD.