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Abstract

Stereotactic MRI-Guided Adaptive Radiotherapy (SMART) for Adrenal Metastases

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Objectives: SABR for isolated adrenal metastases can result in high local control rates and long-term survival. However, the proximity of critical normal organs (OAR's) limits the dose that can be delivered. We studied inter-fractional organ motion during MR-guided SABR for adrenal metastases, and evaluated the dosimetric advantages of daily online plan adaptation.

Methods: 8 pts with adrenal metastasis underwent video-assisted, respiratory-gated SMART for a total of 41 fractions. For each fraction, a shallow breath-hold was performed, Contour deformation, PTV (GTV+3mm) expansion and planning structures were automatically generated according to the anatomy-of-the-day. Depending on tumor volume and OAR proximity either 5 x10Gy and 8 x7.5Gy. Treatment plans were generated using a novel strategy to minimize high doses to OARs. Inter-fractional changes in the stomach, bowel and duodenum were quantified according to the volume of OAR change (within a 3 cm from PTV), center of mass (COM) displacements and the maximum Hausdorff distance. We compared volumes of GTV and PTV receiving 95% of prescribed dose, and V35 for of all OARs (using paired t-tests).

Results: In all patients, important inter-fractional changes were observed for each OAR. Mean COM displacements from baseline were 5.4 (range 1.9 – 9.8), 6.4 (range 1.1 – 18.2) and 6.6 (range 1.4 – 12.3) mm for the stomach, bowel and duodenum, respectively. Maximum OAR displacements were 34.1 mm, 28.2 mm and 23.4 mm for stomach, bowel and duodenum, respectively. Maximum volume changes for stomach, bowel and duodenum within a 3 cm distance from the PTV surface were 74.1, 58.9 and 27.8 cc, respectively. Baseline plans recalculated on the anatomy-of-the-day (defined as 'predicted plans') led to marked underdosage of target volumes and variable OAR sparing. In predicted plans, GTV and PTV objectives for V95% were unmet in 32% and 76% of all fractions, respectively. Plan re-optimization significantly improved target coverage, and the percentage of fractions not meeting the V95% objective was reduced to 12% and 39% for GTV and PTV, respectively ($p<0.01$). Re-optimized plans exhibited significantly better sparing of OAR and achieved a reduction of 2.1, 2.1 and 2.8 cc for stomach, bowel and duodenum at V35Gy, with respect to predicted plans (all: $p<0.01$).

Conclusions: Despite breath-hold SABR delivery under MR-guidance, significant volumetric

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changes and displacements were observed for OARs. As re-optimization of treatment plans significantly improved target coverage and OAR sparing, our results indicate that daily online plan adaptation will be beneficial in adrenal SABR, even under MR-guidance.