Impact Of Stomach Filling Variation On Radiation Dose Delivered To Gastro-esophageal Junction Tumors

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Purpose/Objective(s): The position of distal esophageal tumors may vary with gastric filling, leading to potential radiation therapy target miss. The purpose of this study was to analyze the impact of gastric filling variation on target coverage of gastro-esophageal junction (GEJ) tumors irradiated via three radiation treatment techniques: three-dimensional conformal radiation therapy (3DCRT), intensity-modulated radiation therapy (IMRT) and IMRT with simultaneous integrated boost (IMRT-SIB).

Materials/Methods: Four-dimensional computed tomography (4DCT) image datasets from 5 patients previously treated with radiation therapy for esophageal cancer were analyzed. These patients all had a full stomach at the time of initial 4DCT simulation. The simulation was repeated with 3 hour nil per os (NPO) instruction. For each case, end-expiration phases from full and empty-stomach 4DCT (FS, ES-CT) datasets were registered based on bony anatomy. We generated 3 separate plans (described above) for each patient first on the ES-CT, then on the FS-CT. The final dose for the 3DCRT and IMRT plans was 50.4 Gy to the planning target volume (PTV), and for the IMRT-SIB was 50.4 Gy to the PTV and 63 Gy to the planning gross tumor volume (PGTV). Target coverage was evaluated using the resultant dose-volume histogram data for patients simulated with an ES and assuming treatment with a FS for an entire treatment course, and vice versa.

Results: Full stomach volumes increased by a mean factor of 3.5 (range 1.7 to 7.5) over empty volumes. For all 3DCRT and IMRT plans based on ES-CT, FS gross tumor volume (GTV) receiving ≥ 50.4 Gy (V_{50.4Gy}) was 100%. However, for the same plans, FS PTV V_{50.4Gy} was 84.7 ± 4.0% and 86.6 ± 6.3%, with a minimum dose of 37.2 ± 13.5 Gy and 32.5 ± 10.9 Gy to the FS clinical target volume (CTV) for 3DCRT and IMRT plans respectively (mean ± STDEV). For IMRT-SIB plans, FS PGTV V_{63Gy} was 80.6 ± 9.1%. Planning on FS-CT volumes also resulted in suboptimal dose to the ES PGTV, but adequate coverage for other ES target volumes for all plans.

Conclusions: Stomach filling has negligible impact on the standard prescribed dose delivered to GTV located at the GEJ, using either 3DCRT or IMRT planning. Thus, local relapses are not likely to be related to variations in gastric filling. However, changes in stomach filling result in boost target miss using IMRT-SIB planning, suggesting caution be taken when IMRT-SIB dose escalation for GEJ tumors is attempted without adequate tumor visualization and close monitoring of reproducible stomach filling. Since a ≥ 2-fold gastric volume change results in inadequate PTV coverage, further investigation is needed to evaluate the frequency of such gastric volume change over a standard treatment course to assess its clinical significance.

Author Disclosure: M. Bouchard, None; M. McAleer, None; G. Starkschall, Research support from Philips Medical Systems, C. Other Research Support.