Advanced dose calculation algorithms in lung cancer radiotherapy: Implications when treating in deep inspiration breath hold

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Purpose. Modern dose calculation algorithms model absence of lateral charged particle equilibrium to a limited extent. The resulting dose calculation uncertainties are most noticeable in strongly heterogeneous regions, like the thorax, and will increase in deep inspiration breath hold (DIBH) due to decreased lung tissue density.

Methods. For 17 stage I and 17 stage III lung cancer patients, a plan in free breathing (FB, based on midventilation) and in DIBH were generated with Anisotropic Analytical Algorithm (AAA). Stage I disease was treated with 3D-conformal stereotactic radiotherapy (SBRT), 45 Gy in 3 fractions, prescribed to 95% isodose covering 95% of PTV and aiming for 140% dose centrally in the tumour. Stage III disease was treated with volumetric modulated arc therapy (VMAT), 66 Gy in 33 fractions, prescribed to mean PTV dose. Calculation grid size was 1 mm for stage I and 2.5 mm for stage III. All plans were recalculated with AcurosXb with same MU as in AAA, for comparison on target coverage and dose to risk organs.

Results. Lung volume increase in DIBH resulted in 6% decreased lung density for stage I (from median –757 HU to −811 HU) and 12% for stage III (from median −723 HU to −822 HU). In stage I, AAA overestimated all PTV parameters (p-values <0.01) compared to AcurosXb, with largest impact in DIBH. Mean dose and D98% were underestimated by 2.0/2.3 Gy in FB and 3.1/4.0 Gy in DIBH. These clinically relevant differences may be a combination of small targets and large dose gradients in the SBRT treated volume. In stage III, AAA systematically overestimated the target coverage compared to AcurosXb. D98% was overestimated by median 1.1/1.2 Gy in CTV and 1.5/2.1 Gy in PTV, in FB and DIBH respectively (p < 0.01). Hot spots (estimated as D2%) did not differ between AAA and from AcurosXb, in both FB and DIBH. No significant difference was observed for lung and heart dose parameters between the algorithms, for both FB and DIBH, in the two patient cohorts.

Conclusions. Choice of calculation algorithm impacts the calculated dose distribution in the target. AAA overestimated target coverage compared to AcurosXb, especially in DIBH for stage I lung cancer treated stereotactically.

Contouring and dose reporting for lower urinary tract sub-structures in cervix cancer

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Purpose. Radiotherapy related bladder morbidity include various clinical endpoints (i.e. frequency, cystitis, incontinence, bleeding, fistula) that may be related to various anatomical sub-structures.