Impact of Intra-fraction Motion Correction on Target and OAR Dosimetry in Single Fraction Lung Stereotactic Ablative Radiation Therapy

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Introduction

-Previous research indicates that intra-treatment motion correction helps to offset the impact of intra-fraction motion.

Objective

-To assess the impact of intra-fraction motion correction on target and OAR dosimetry in single-fraction lung stereotactic ablative radiation therapy (SABR).

Materials and Methods

-Thirteen NSCLC patients were treated with linac-based free-breathing single-fraction lung SABR.
-Cone-beam CT images were acquired surrounding each treatment arc and following any position changes.
-Images were matched to the reference CT simulation image and differences between the actual patient position and the reference position were obtained for three orthogonal directions. The movement of each patient in the treatment planning system was modelled given the omission (case 1) or application (case 2) of intra-fraction motion correction.
-Arc isocenters in each plan were specified to represent the calculated patient deviation for each modelled case and plans were forward-calculated using the original monitor units.
-OAR and target metrics were computed and compared for the original treatment plan and the modelled motion cases.
-The % isodose value that covered the full volume of the CTV was also determined for the treatment plan and modelled cases.

Results

-Modelling the impact of motion on the dose distribution yielded inferior target and OAR dosimetry compared to the original treatment plan (Figure 1).
-Not performing intra-fraction motion corrections yielded a 40% increase in the number of failed dosimetric objectives compared to completing corrections.
-Intra-fraction motion correction yielded fewer failed objectives in 9 of 13 patients and an equivalent number in the remaining patients.
-The PTV volume covered by the 90% isodose line was 13% higher on average with intra-fraction motion correction (Figure 2).
-Larger minimum dose values (14% on average) were observed in the PTV when corrections were applied (Figure 3).
-In 12 of 13 patients, intra-fraction motion corrections led to > 90% isodose line CTV coverage (Figure 4), suggesting that PTV margin reduction can be considered, based on vanHerk margin guidelines.

Conclusions

-Intra-fraction motion correction yields improved target and OAR dosimetry in single-fraction lung SABR.

References


Figure 1. Number of failed plan objectives and OAR constraints for each patient in treatment plan (a). Pie charts indicating distribution of failed objectives and constraints without (b) and with (c) intra-fraction motion correction.

Figure 2. % PTV volume covered by prescription isodose line for each patient.

Figure 3. PTV minimum dose for each patient.

Figure 4. % CTV volume covered by prescription isodose line for each patient.