Lung cancer

“Slow” CT scan for incorporating lung tumor mobility in radiotherapy planning
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Introduction/objective. Assessment of the use of planning CTs with slow revolution (4s/slice) that captures tumor movement in comparison to “fast” CT in the procedure of radiotherapy planning for lung cancer patients. Additionally, we evaluate the impact on CTV-PTV total margin.

Methods. A total of 13 patients treated for NSCLC Stage I have been included. Each patient was scanned with slow CT and a fast CT (slice thickness 2.5 mm) during free breathing. CTVs were contoured in both CTs. The Internal Target Volume (ITV) was generated as the Boolean union of CTV-fast and CTV-slow. 3D displacement vectors of the individual CTV, related to the ITV from two scan were obtained by comparing the volumes as seen in orthogonals beam’s eye beam projections. Systematic and random setup errors were evaluated by comparing orthogonal portal visions to the corresponding DRRs, and margins were calculated using van Herk’s formula.

Results. In 11/13 patients the mean CTV captured by slow-CT were larger than those captured by fast-CT scan. The mean ratio between the slow CTV and the ITV was 0.80 ± 0.9 vs. 0.73 ± 0.18 for fast CTV. The maximum margins in x, y and z axes which were needed to ensure coverage the ITV when using a fast CT were (mm, 1SD): x1 0.46 ± 0.29, x2 0.24 ± 0.16, y1 0.33 ± 0.31, y2 0.18 ± 0.2, z1 0.3 ± 0.3, z2 0.34 ± 0.27, showing an important individual tumor movement variability. Systematic random setup errors resulted (mm): LAT = 2.0 ± 2.7; VRT = 1.3 ± 1.5 and LONG = 1.5 ± 1.8, resulting in the following setup margins (mm): LAT = 5.4; VRT = 3.3 and LONG = 3.9 mm.

Conclusions. Individualized assessment of tumor mobility is needed and is possible when CTV derived from single slow scan is used for RT planning. The use of slow planning CT allows the reduction of margins in external beam treatment planning.

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Analysis of trachea as surrogate marker for delivering 3D lung radiotherapy
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Purpose. To evaluate the suitability of the trachea contours for patient set-up verification in patients with lung cancer.

Methods and materials. A total of 56 lung cancer patients were included in this study. For all patients a CT scan were acquired and delineation of the target volumes were performed and just in 31 patients the trachea were drawn and planned using the treatment planning system (TPS Eclipse-Aria, Varian Inc.). Setup variations were determined in both groups with and without contoured trachea. The position of the trachea in the digitally reconstructed radiograph (DRR) was compared to the average position of the tracheal air column in the electronic porta images (EFIs) at initial set-up.

Results. Analysis of patient setup errors (mm) ± 1 standard deviations (1 SD) for anterior-posterior (AP), cranio-caudal (CC) and left-right (LR) were 1.8 ± 3.9, 0.4 ± 2.6 and 0.6 ± 3.0 in the trachea contoured compared to 0.6 ± 2.5, −1.7 ± 3.6 and 0.16 ± 2.8 in the no trachea contoured. The SD of the setup errors derived from both the contoured and no contoured trachea groups were not found to be significantly different.

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Conclusions. Measurement of patient setup using trachea contour is possible. We have identified the position of the trachea at DRR as a surrogate marker during 3D radiotherapy and it is possible to reduce the interobserver variability for verifying patient initial and the daily variation setup in lung cancer patients.

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Assessment of dose-volume histogram using lung-PTV or lung-GTV
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Introduction and objective. In the evaluation of the toxicity in the treatment of lung carcinoma parameters such as V13, V20, V30 and mean dose (MLD) are used (Biau et al., Pro 2012). Planning target volume (PTV) is usually subtracted from the lung volume although some studies subtract gross tumor volume (GTV). The aim of this study is to analyze the differences between the use of lung-PTV or lung-GTV in pulmonary toxicity evaluation. Relations between the parameters V13, V20, V30, and MLD using the volumes lung-PTV and lung-GTV are studied, as well as the possible relationship between these parameters and the volumes of GTV, PTV and lung volume.

Material and methods. From 09/2010 to 12/2012, 65 p NSCLC were treated with 3D-RT radical intent. Sex: 52 p (80%) male/13 p (20%) women, mean age 60 years (33–82). Histological type: 29 p (44.6%) adenocarcinoma/27 p (41.5%) squamous cell carcinoma/9 p (13.8%) other histologies. Stage distribution: 13 p (20%) IIIA/52 p (80%) IIIB. Primary tumor: 32 p (49.2%) upper-lobe/17 p (26.2%) lower-lobe/4 p (6.2%) middle-lobe. QT concurrent: 84%. GTV-medium: 149.66 cm³ (7–617) and PTV-medium: 13.8%. From 09/2010 to 12/2012, 65 p NSCLC were treated with 3D-RT radical intent. Sex: 52 p (80%) male/13 p (20%) women, mean age 60 years (33–82). Histological type: 29 p (44.6%) adenocarcinoma/27 p (41.5%) squamous cell carcinoma/9 p (13.8%) other histologies. Stage distribution: 13 p (20%) IIIA/52 p (80%) IIIB. Primary tumor: 32 p (49.2%) upper-lobe/17 p (26.2%) lower-lobe/4 p (6.2%) middle-lobe. QT concurrent: 84%. GTV-medium: 149.66 cm³ (7–617) and PTV-medium: 13.8%. From 09/2010 to 12/2012, 65 p NSCLC were treated with 3D-RT radical intent. Sex: 52 p (80%) male/13 p (20%) women, mean age 60 years (33–82). Histological type: 29 p (44.6%) adenocarcinoma/27 p (41.5%) squamous cell carcinoma/9 p (13.8%) other histologies. Stage distribution: 13 p (20%) IIIA/52 p (80%) IIIB. Primary tumor: 32 p (49.2%) upper-lobe/17 p (26.2%) lower-lobe/4 p (6.2%) middle-lobe. QT concurrent: 84%. GTV-medium: 149.66 cm³ (7–617) and PTV-medium: 13.8%. From 09/2010 to 12/2012, 65 p NSCLC were treated with 3D-RT radical intent. Sex: 52 p (80%) male/13 p (20%) women, mean age 60 years (33–82). Histological type: 29 p (44.6%) adenocarcinoma/27 p (41.5%) squamous cell carcinoma/9 p (13.8%) other histologies. Stage distribution: 13 p (20%) IIIA/52 p (80%) IIIB. Primary tumor: 32 p (49.2%) upper-lobe/17 p (26.2%) lower-lobe/4 p (6.2%) middle-lobe. QT concurrent: 84%. GTV-medium: 149.66 cm³ (7–617) and PTV-medium: 13.8%.

Results. We found significant differences between the parameters V13, V20, V30 of the volumes lung-PTV and lung-GTV, with mean differences of 3.5%, 4.0% and 4.3% higher for the V13, V20 and V30 lung-GTV than for lung-PTV. Mean difference in volume between lung and lung-PTV-GTV is 170 cm³ (21–334 cm³). The reduction in lung-MLD regarding lung PTV-GTV is 2.27 Gy (0.25–4.88 Gy). There is a strong correlation between the parameters V13, V20, V30 and mean dose. No relationship was found between total dose and V13, V20 and V30 neither between the volumes of GTV or PTV and V13, V20 and V30.

Conclusions. In the analysis of the relationship between the different dosimetric parameters to evaluate pulmonary toxicity we have found a strong correlation between V13, V20, V30 and MLD. Use of lung-PTV or lung-GTV for the evaluation of these parameters presents significant differences and thus it should be considered in the treatment plan evaluation.

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CBCT-guided RapidArc® for stereotactic ablative radiotherapy (SABR) in lung tumors
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Introduction. Stereotactic ablative radiotherapy (SABR) has emerged as a standard treatment option for stage I non-small cell lung cancer (NSCLC) in patients unfit for surgery, or who refuse surgery. An increasing number of prospective phase I/II trials, as well as large single and multicenter studies have reported local control rates to be in excess of 85% for early stage NSCLC.

Purpose/objective. Volumetric arc therapy (VMAT) RapidArc® with tumor-based image guidance technique will be presented as well as our preliminary observations.

Material and methods. Five selected patients (T1-2N0 NSCLC) were treated with SABR. No external rigid immobilization was used (only arm and knee support). Planning images were acquired with a free breathing slow CT and transferred to Varian Eclipse Treatment Planning System (TPS) for VMAT optimization and dose calculation. Planning objectives were set in accordance to RTOG and AAPM protocols. SABR was delivered using online cone-beam CT guidance to a total dose of 60 Gy, in 3, 5 or 8 fractions, depending on tumor size and location. Dose was prescribed to 80% isodose, where possible covering 95% of PTV.

Results. CBCT-guidance using soft-tissue matching on the tumor itself, rather than the bony anatomy of the patient, is essential because lung patients can have large set-up errors due to changes in anatomy between CT and treatment, weight loss, body rotations and arm positioning variability. In addition to excellent plan quality, RapidArc® allows for fast delivery improving the patient comfort and minimizing intrafraction motion. The SABR treatment was well tolerated with minimal acute side effects. Post-SABR lung acute patterns were observed on CT follow-up.


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