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Abstract

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Management of Cancer Patients presenting with Pleural Effusion in the Course of Stereotactic Body Radiation Therapy - Our Clinical Experience

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Abstract

Objective: Patients presenting with pleural effusion at any stage during stereotactic body radiation therapy (SBRT) of lung cancer pose a challenge. If not properly addressed, it could lead to inaccurate dose delivery. To the best of our knowledge, this is an area that has not been properly addressed by the radiotherapy community. We present our clinical experience on addressing this issue at our center as well as dosimetric consequences of ignoring pleural effusion all together.

Methods: This work was based on the management of seven (7) lung cancer patients that presented with pleural effusion and were treated via SBRT from June 2017 to January 2020. In all cases the pleural effusion was either observed during the initial simulation or in the course of treatment. Our department policy during CT simulation was to first acquire a 3DCT for evaluation. When present, the fluid was drained before acquiring the 4DCT utilized for motion assessment as well as planning/reference image. Then on each day of treatment, an initial CBCT was acquired to assess the pleural effusion. If present, the fluid was drained prior to initiation of the image guided radiotherapy (IGRT). In one of the patients, a right upper lung (RUL) target, at simulation, a pre 4DCT was acquired with pleural effusion, and a post 4DCT was acquired after drainage. We then evaluated the image sets with and without pleural effusion for changes in tumor volume, extent of motion, tumor center of mass displacement, and total lung volume. A reference treatment plan (1250cGy x 4) was developed based on the post 4DCT after drainage. On each of the treatment fractions, a pre-drainage 4DCT was acquired, evaluated for pleural effusion and then drained as needed before proceeding to treatment. By applying the treatment plan parameters from the reference plan to the pre-drainage 4DCT data from each fraction day, we evaluated the dosimetric consequences of what would happen if we proceeded with treatment and ignored the pleural effusion. In particular, we computed as per RTOG0915 the lung V20, lung MVS1160, and lung MVS1240 from each of the four plans based on pre-drainage 4DCT images and compared with the plan based on the reference 4DCT data. Here, lung MVS1160 (MVS1240) is the critical lung volume spared for a critical volume maximum dose of 1160cGy (1240cGy). Per RTOG0915, it is required that MVS1160 = 1500cc and MVS1240 = 1000cc. Also, lung V20 = 10% or = 15% (for minor but acceptable deviation).

Results: Given our policy to drain the fluid whenever pleural effusion was present, the patient geometry on the reference images and final treatment CBCTs was free of pleural effusion and thus we assured accurate treatments. We observed the following for the RUL case with pre (wet-) and post (dry-) 4DCT studies, i.e. with and without pleural effusion;

1. Target peak to peak motion was more in the dry-target, 5.2mm (superior/inferior -S/I), 2.0mm (anterior/posterior A/P), 2.0mm (left/right L/R) than in the wet-target, 1.0mm (S/I), 1.0mm (A/P), 1.0mm (L/R)
2. Internal Target volume (ITV) was comparable in both cases, approximately 17cc.
3. The ITV center-of-mass differed between the dry and wet image sets following registration to the spine by 0.4mm, 5.0mm and 7.2mm in the S/I, L/R and A/P directions respectively
4. The volume of fluid drained was measured as 490cc at simulation. The volume drained at treatment fractions was 660cc, 290cc, 470cc, and 180cc for fractions 1, 2, 3, and 4 respectively.
5. At simulation, the difference in the contoured total lung volume of the wet versus the dry image sets, which corresponds in effect to the volume of liquid drained was 486cc. Note that this is within 1% of the measured drained volume.
6. The lung V20 of the reference plan based on the dry 4DCT was 5.25%. This increased by 15.9% ± 0.6% (Range, 15% to 16.6%) if the plans were done on 4DCT data with pleural effusion.
7. The lung MVS1160 of the reference plan based on the dry 4DCT was 3429cc. This decreased by 15.2% ± 4.1% (Range, 11.4% to 21.9%) if the plans were done on 4DCT data with pleural effusion.

8. The lung MVS1240 of the reference plan based on the dry 4DCT was 3447cc. This decreased by $15.3\% \pm 4.1\%$ (Range, 11.5% to 22.0%) if the plans were done on 4DCT data with pleural effusion.

Conclusion: The patient anatomy and tumor characteristics for a patient with and without pleural effusion can be very different and caution must be exercised when handling such patients for radiotherapy. We have presented our clinical experience in addressing this issue together with dosimetric consequences for a single patient analysis if the pleural effusion were ignored. More patient data is needed for a general conclusion.