Radiation-induced lung disease (RILD) after 3D Conformal (3D-CRT) and Stereotactic Body Radiotherapy (SBRT) in patients treated for non-small cell lung cancer (NSCLC): correlation with dosimetric parameters and pulmonary function tests (PFTs)

Poster No.: C-1408
Congress: ECR 2012
Type: Scientific Exhibit
Authors: S. I. Santoro, A. R. Larici, A. del Ciello, F. De Rose, G. Mantini, V. Valentini, L. Bonomo; Rome/IT
Keywords: Neoplasia, Radiation therapy / Oncology, CT, Thorax
DOI: 10.1594/ecr2012/C-1408

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method ist strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Purpose

Radiation-induced lung disease (RILD) is the most common side-effect after radiotherapy treatment for lung cancer (1). Radiologic manifestations are usually confined to the lung tissue within the radiation port and are dependent on the interval after completion of treatment. Two distinct clinical, pathologic, and radiologic phases of radiation-induced lung injury are recognized: an early phase of radiation pneumonitis, which usually occurs between 1 and 6 months after the completion of radiation therapy, and a later phase of chronic radiation fibrosis, which usually occurs between 6 and 12 months after the completion of radiation therapy (2, 3) (Fig. 1).

As reported in literature, significant pulmonary injuries have been observed in 13-37% of patients with lung cancer treated with radical radiation dose. Many factors have been identified in the development of the risk of pulmonary toxicity: factors related to patient (status performance, pulmonary function capacity), to treatment (radiation dose, irradiated lung volume, fractionation of dose, portal size, chemotherapy administration), and to tumor site (near vessels and/or nervous structures). It is possible but not necessary the association with symptoms (4).

The objective of our study is to correlate the appearance of RILD to dosimetric parameters and pulmonary function tests (PFTs) in patients with Non-Small Cell Lung Cancer (NSCLC) after Three-Dimensional (3D) Conformal Radiation Therapy (CRT) and Stereotactic Body Radiation Therapy (SBRT).
Fig. 1- Temporal evolution of RILD in lung cancer treated with 3D technique (total dose of 42 Gy): a) Chest CT scan shows a consolidation larger than and indistinguishable from the initial tumor (radiation pneumonitis), in the area of the maximum dose (red area); b) Chest CT scan demonstrates shrinkage of consolidation with progression to fibrosis.

Fig. 1

© - Rome/IT
Methods and Materials

66 patients with NSCLC (stage I-IIIB) treated with 3D CRT or SBRT with exclusive, neoadjuvant or adjuvant finality, were retrospectively included. Each patient underwent:

- at least one chest Computed Tomography (CT) scan before radiation treatment;
- one or more chest CT scans after treatment (follow-up of at least 1 year);
- pulmonary function tests (PFTs) before and 2-4 months after the completion of radiation treatment.

The following dosimetric parameters were calculated by using a commercial software (Eclypse, Varian TPS), for each patient: total dose (Gy), mean lung dose (MLD) and the percentage of lung volume exposed to 20 Gy (V20). Also, the following pulmonary function tests were calculated for each patient: FEV1 (forced expiratory volume in the 1st second), FVC (forced vital capacity), VC (vital capacity), TLC (total lung capacity) and FRC (functional residual capacity).

RILD was classified on the basis of appearance time (acute/chronic) and CT findings. In the acute phase, RILD typically may manifest as focal or nodular ground-glass opacity, consolidation, or both, with the findings usually limited to the area immediately surrounding the treated tumor. In the later phase, RILD has been classified according to one of three patterns described in literature as modified conventional pattern (consolidation, volume loss, and bronchiectasis), masslike pattern (focal consolidation with traction bronchiectasis limited to the site of the original tumor), and scarlike pattern (linear opacity in the region of the original tumor associated with moderate to severe volume loss) (5).

The incidence of RILD was calculated. PFTs before and after treatment were compared to each other and correlated to dosimetric parameters and the appearance of RILD. Dosimetric parameters in patients with and without RILD were compared to each other.
Results

RILD was present in 35/66 (53%) patients; considering the appearance time after the completion of radiation therapy, 9/35 (26%) patients showed RILD in acute phase, 12/35 (34%) in chronic phase and 14/35 (40%) in both.

On the basis of morphological CT appearance, among 23 patients with RILD in acute phase, 10 (43.5%) demonstrated lung consolidations, 7 (30.5%) ground-glass opacities and 6 (26%) both. Among 26 patients with RILD in chronic phase, 23 (88%) showed a modified conventional pattern, 1 (4%) scarlike pattern and 2 (8%) masslike pattern (Fig. 2).

The mean total dose received by our population was 44.2 Gy, the mean MLD was 9.2 Gy and the mean V20 was 16.6%; all values were within the allowed limits.

A statistically significant worsening of PFTs, in particular of VC (p<0.04), TLC (p<0.001) and FRC (p<0.0003), was observed after radiotherapy (Fig. 3).

There was not a significant correlation between PFTs and dosimetric parameters and between PFTs and the presence of RILD (Fig. 4).

Dosimetric values were significantly higher in patients with RILD than in those without (total dose: 47.6 vs 40.4 Gy, p <0.02; MLD: 10 vs 8 Gy, p <0.04; V20: 19% vs 13%, p <0.01) (Fig. 5).
Fig. 2

35/66 Patients (53%) with RILD

9/35 Patients (26%) in ACUTE phase
14/35 Patients (40%) in ACUTE and CHRONIC phase
12/35 Patients (34%) in CHRONIC phase

23 Patients in ACUTE phase
- 10 (43.5%) consolidations
- 7 (30.5%) ground-glass opacities
- 6 (26%) both

26 Patients in CHRONIC phase
- 23 (88%) modified conventional pattern
- 1 (4%) scarlike pattern
- 2 (8%) mass-like pattern

Fig. 2 - Patients of our study population with RILD
<table>
<thead>
<tr>
<th></th>
<th>Mean values pre-treatment (%)</th>
<th>Mean values post-treatment (%)</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEV1</td>
<td>67.06</td>
<td>64.25</td>
<td>0.11</td>
</tr>
<tr>
<td>VC</td>
<td>92.39</td>
<td>88.86</td>
<td>0.04</td>
</tr>
<tr>
<td>FVC</td>
<td>92.33</td>
<td>88.64</td>
<td>0.07</td>
</tr>
<tr>
<td>TLC</td>
<td>86.62</td>
<td>81.46</td>
<td>0.001</td>
</tr>
<tr>
<td>FRC</td>
<td>89.70</td>
<td>81.69</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

*Fig. 3*- Comparison of PFTs performed before and after radiotherapy

**Fig. 3**

© - Rome/IT
Fig. 4  
© - Rome/IT
<table>
<thead>
<tr>
<th></th>
<th>TOTAL DOSE (Gy)</th>
<th>MLD (Gy)</th>
<th>V20 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients with RILD</td>
<td>47.6 Gy</td>
<td>10 Gy</td>
<td>19 %</td>
</tr>
<tr>
<td>Patients without RILD</td>
<td>40.4 Gy</td>
<td>8 Gy</td>
<td>13 %</td>
</tr>
</tbody>
</table>

*p < 0.02  p < 0.04  p < 0.01*

*T-test*

**Fig. 5** - Comparison of dosimetric parameters in patients with and without RILD

© - Rome/IT
Conclusion

Radiation therapy is widely used to treat NSCLC patients, and may be used with various goals, depending on the disease stage. Evidence suggests that higher doses of radiation improve local tumor control that is important to prevent metastatic dissemination and prolong survival. 3D CRT and SBRT are designed to deliver the maximum therapeutic radiation dose to the tumor, allowing improved local disease control, while minimizing irradiation of surrounding normal structures. This is possible because in both 3D CRT and SBRT, multiple beams are used to generate a dose distribution that conforms tightly to the target volume (3).

Knowledge of treatment timelines and radiation field locations, as well as familiarity with the full spectrum of possible radiation-induced lung injuries after radiation treatment, is important to correctly interpret the abnormalities that may be seen at CT (2).

In our study, the incidence of RILD was quite high despite the use of dosimetric values within the allowed limits. The dosimetric parameters were significantly higher in patients who developed RILD, therefore dosimetric parameters seemed to be the most useful predictor of pulmonary toxicity.

According to our data, the worsening of the PFTs after radiation treatment didn't seem to be related to dosimetric parameters or to the appearance of RILD.
References

Personal Information

e-mail:
silvia.santoro@hotmail.it