Early detection of acute radiation-induced lung injury with multi-slice CT perfusion imaging: an initial experience

Poster No.: C-0021
Congress: ECR 2013
Type: Scientific Exhibit
Authors: X. Hu¹, X. Fang², H. Chen³, C. Hu⁴; ¹Wuxi, Ji/CN, ²Wuxi city, ji/CN, ³Wuxi, Jiangsu/CN, ⁴Suzhou/CN
Keywords: Lung, Thorax, CT, CT-Quantitative, Image manipulation / Reconstruction, Computer Applications-Detection, diagnosis, Radiation therapy / Oncology, Radiation oncology in Developing Nations
DOI: 10.1594/ecr2013/C-0021

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 is 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 injury (RILI) is one of the important common complications occurring during or after the thoracic radiotherapy, and it is a major limiting factor for radiation therapy demanding increased awareness and early clinical recognition of this entity (1-3). The acute RILI (ARILI) is defined by the US Radiation Therapy Oncology Group (RTOG) as RILI occurring within 90 days after commencement of radiotherapy(4). Manifestations of ARILI on HRCT images are considered to be the most objective and reliable evidence for diagnosis of this entity(5-8). However, major challenges exist in using serial CT scanning for assessing pulmonary changes after radiation(7). In most cases when ARILI is detected by HRCT, the radiotherapy course is in its final stages or has been completed. It is frequently too late to modify or readjust the therapeutic schedule, and consequently irreversible changes in lung tissue are already present incurred. It has been recently noted that morphological change usually occurs later than functional alteration or metabolic response in this entity(9,10). Furthermore, it is often difficult to predict the true extent of pneumonitis after completion of therapy in individual patients, and this may limit reliability of CT in early diagnosis of ARILI for treatment planning(11). Hence, early detection of ARILI is instrumental for early intervention or therapy modification. Our clinical research has found that functional imaging, especially CT perfusion metrics such as pulmonary vascular permeability, allow for earlier and more accurate RILI diagnosis. To date, there are no reports of early diagnosis of RILI using CT perfusion in the literature. The purpose of this study is to evaluate the feasibility of early detection of ARILI with CT perfusion imaging (CTPI).

Methods and Materials

1. Study subjects

Patients with upper esophageal cancers or malignant thymomas scheduled for post-operative radiotherapy during the period June 2007 to May 2012 were screened and selected, and then underwent HRCT and CTPI examinations for this study. All patients received 3 dimensional conformal radiotherapy (3D-CRT). Inclusion criteria were as follows: #total irradiation dose 60 - 62Gy; #radiation dose per time: 2Gy/2 days; #course of radiotherapy approximately 8 weeks; # V20 ( defined as the percentage of pulmonary volume irradiated to >20 Gy, i.e. percentage of lung volume receiving more than 20 Gy dose in total lung volume) was limited between 20%-25%; #no combined chemotherapy history; #no pulmonary diseases such as chronic bronchitis, emphysema, pulmonary tuberculosis, acute inflammation, hilar lymph node metastasis, involvement of pulmonary hilar vessels, congenital or acquired disease of pulmonary blood vessels. Therapy was completed as scheduled in all cases.

All selected patients underwent HRCT and CTPI examination pre- and post-radiotherapy, namely on week 0, week 4, week 8, and week 12.
This study was approved by the ethics review committee and all the patients have agreed to and signed the informed consent form. 51 patients were selected according to the criteria mentioned above. All patients survived longer than 12 months (after radiotherapy) and were examined on follow-up visits.

2. HRCT and 64-slice CTPI scanning

Using Siemens SOMATOM Sensation 64 spiral CT scanner, lung scan was performed with the standard Body CTPI application. In order to make sure that there was no motion during the CTPI procedure, all patients were given respiratory training prior to the scans so that they were able to maintain about 18 seconds breath-hold.

CTPI was performed after acquiring the thoracic topogram and choosing the DynMulti protocol for Body Perfusion. 18 seconds end-inspiratory breath hold was used when the scan was performed simultaneously. The CT scan region was limited to the radiotherapy region, including main pulmonary artery or level 1 and level 2 branches when possible. 40 ml of Omnipaque (300 mg/ml) was injected intravenously via antecubital vein at 6.0 ml/s with 5 seconds delay. Scanning parameters of CTPI: tube voltage 120kV, tube current 80mAs, rotation speed 0.33 S/R, 360 degree per rotation, scan period 1.0 second, recon 4 slices per period, slice width and increment 7.2mm, matrix 512×512, and FOV 320 mm×320 mm. HRCT scan was performed immediately after the CTPI scan with the following parameters: volume scan of the whole lung was completed within 5-7 seconds of quiet end-inspiratory breath hold, with tube voltage of 120 kV and tube current of 100mAs. 8 mm and 2 mm slice thickness were used for reconstruction of chest CT and HRCT images, respectively.

3. Post-processing for the data of CTPI

All raw data acquired via Syngo CT workstation were processed with Body CTP software, using the maximum slope model to calculate perfusion parameters. Drawing of the region of interest (ROI) was performed based on radiation field: ROIs were separately drawn in irradiated- and non-irradiated lung tissue with the consistent margin spacing of 5 mm with respect to pleura, heart and edges of radiation field, while avoiding great vessels. Regional blood flow, volume and permeability surface (rBF, rBV, and rPS) of regional lung tissue of irradiated and non-irradiated area were measured, respectively. Individual measurement differences, measurement errors, and other background factors were eliminated by introducing normalized regional perfusion values, which were defined as the ratio of the perfusion values in irradiated area to the perfusion values in non-irradiated field, namely rrBF, rrBV, rrPS, etc... The changes in normalized lung tissue perfusion values over the course of the study were monitored (including irradiated and non-irradiated tissue). This comparison was performed on both ARILI and non-ARILI patients. CTPI results and HRCT results were also evaluated.

4. Criteria of clinical comprehensive diagnosis for RILI, and evidences of positive judgments in HRCT and CTPI

ARILI is a clinical comprehensive diagnosis described in the RTOG standard, and its severity is classified as 5 levels: Grade 0 - Grade 4[4]. Positive RILI results of any HRCT scan during the overall course of study (12 month after beginning of radiotherapy) are considered as diagnostic evidence of RILI. This diagnosis is also supported by clinical manifestations, laboratory examinations and follow-up to exclude the possibility of lung
inflection. The key goal of this study is to evaluate perfusion characteristics of the lung affected by RILI at the time when only half of overall radiation dose has been delivered (week 4). Patients diagnosed with RILI on HRCT within 12 months were placed into RILI group, and those with HRCT negative for RILI were placed into non-RILI group. Positive HRCT was determined on the basis of Libshitz's[12] study of x-ray and CT manifestations, in which RILI was diagnosed if any one of the following was observed in the irradiated lung field: a) patchy exudation; b) patch of consolidation; c) atelectasis; d) chronic fibrosis. In other words, these radiologic features actually include ground-glass opacities, patchy consolidation, pleural reactions, and lung fibrosis[13].

5. Statistical analysis
All Data acquired were represented by means ± standard deviations (x±s) and analyzed using SAS (version 8.01). Data acquired before irradiation (week 0) was compared to that acquired after irradiation (week 4-12) using t-test to find the difference in Mean values. One-way ANOVA (F-test) was used to find the difference in mean values of data from the same patient obtained at different acquisition times and Dunnett-t test was used to compare in different groups. The results of diagnostic accuracy by CTPI and HRCT were compared using Chi-square test (χ²) and Fisher' exact method. A P<0.05 was considered indicative of significant difference.

Results

1. ARILI diagnosis overview:

According to the the RTOG criteria for ARILI diagnosis, ARILI was observed in 18 patients out of 51 within 12 weeks after administration of radiotherapy. Among the 18 patients with ARILI, 11 cases (11/18) occurred in the middle of the radiotherapy course (in week 4, about 30 Gy dose), 7 cases (7/18) occurred at the end of radiotherapy course (in week 8) and one month later (in week 12). Typical HRCT manifestations of ARILI (all in the irradiated lung area) were observed on follow-up 12 months after radiotherapy, only 7 out of the 18 patients presented positive HRCT results prior to 12 weeks post therapy ( one diagnosed in week 4, six diagnosed in weeks 8 and 12).

Patients with ARILI manifestations were placed in ARILI group (18 patients) and the rest in non-ARILI group.

2. Variances of the CTPI parameters in non-irradiated lung areas:

There was no statistically significant differences in CTPI parameters in non irradiated area measured prior to commencement of the radiotherapy and after completion of the therapy (Table 1). Additionally, there was no statistical significant differences in CTPI parameters in the non-irradiated area between ARILI group and non-ARILI group.

3. Variance in normalized CTPI values in irradiated areas:

In non-ARILI group rrBF, rrBV, rrPS rose gradually from week 4, week 8 after radiotherapy, and dropped slowly after the therapy was completed (week 12), representing a trend of "slow-rise to slow-fall" (Figure 1). Statistical significance was
found in comparing the rrBF and rrBV acquired pre- and post-radiotherapy (t = 4.56 and 5.21, P = 0.000 and 0.000 respectively) by week 4, but not in rrPS (t = 1.63, P = 0.117). No statistical significance has been found for rrBF, rrBV and rrPS in week 4, 8 and 12 with P>0.05 (in One-way ANOVA, F-test).

In the ARILI group, rrBF, rrBV and rrPS rose in the irradiated lung area by week 4, showing statistically significant difference in comparison to those acquired before therapy, respectively (t = 3.29, 5.04, 7.53, P = 0.003, 0.000 and 0.000). The rrBF, rrBV and rrPS continued to rise with the increase in radiation time and dose during therapy. All perfusion parameters maintained rapid continued rise until 1 month after completion of radiotherapy (week 12), presenting as either "rapid-rise to slow-rise" trend or "rapid-rise to flat" trend. The variances at each evaluation in CT perfusion parameters are shown in Table 2 and Figure 1.

An increasingly significant difference in CTPI parameters acquired after commencement of radiotherapy was observed between the ARILI group and non-ARILI group. Especially in rrPS, statistically significant difference was demonstrated (P<0.05) in week 4, week 8 and week 12. Similarly statistically significant difference was demonstrated in rrBF, rrBV and rrPS in week 12 (P<0.05, using Dunnett t-test, see Table 2 and Figure 1).

### 4. Comparison of diagnostic efficacy for ARILI between CTPI and HRCT

Only one out of the 11 ARILI demonstrated positive HRCT manifestation in week 4 (half overall irradiation dose), which appeared as a small patchy exudate in the irradiated lung field. However, in all these 11 ARILI patients significant abnormal perfusion was observed on CTPI in week 4 (Figure 2), with 6 of them diagnosed with level 3 to 4 ARILI in week 8 or week 12, and demonstrative findings of ARILI on HRCT (Figure 3 - 5). Setting rrPS = 1.28 as a threshold in week 4 (higher than 1.28 was considered ARILI positive) sensitivity, specificity, positive predictive value and negative predictive value of CTPI for ARILI diagnosis were 90.9%, 90.0%, 71.4% and 97.3% respectively, which were significantly higher than those of HRCT (9.1%, 92.5%, 25.0% and 78.7% respectively). However, these differences in test specificity and sensitivity decreased in week 8 and week 12 while still showing statistical significance. Comparison of ARILI diagnosis by CTPI and HRCT at different time points was shown in Table 3.

### Table 1 Variances of CTPI parameters in non-irradiated lung area at different time points pre- and post-radiotherapy

<table>
<thead>
<tr>
<th></th>
<th>rBF</th>
<th>rBV</th>
<th>rPS</th>
<th>rrBF</th>
<th>rrBV</th>
<th>rrPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0w(n=51)</td>
<td>141.8±27.5</td>
<td>13.49±2.77</td>
<td>9.36±2.88</td>
<td>1.00±0.09</td>
<td>1.00±0.10</td>
<td>1.00±0.12</td>
</tr>
<tr>
<td>4w(n=51)</td>
<td>143.5±28.3</td>
<td>13.54±2.65</td>
<td>9.41±2.53</td>
<td>1.02±0.16</td>
<td>1.00±0.14</td>
<td>1.03±0.09</td>
</tr>
<tr>
<td>8w(n=25)</td>
<td>142.7±37.9</td>
<td>12.63±2.99</td>
<td>9.02±2.96</td>
<td>1.01±0.13</td>
<td>1.05±0.13</td>
<td>0.99±0.11</td>
</tr>
<tr>
<td>12w(n=26)</td>
<td>143.3±28.4</td>
<td>13.80±3.12</td>
<td>9.57±2.66</td>
<td>1.04±0.12</td>
<td>1.02±0.14</td>
<td>1.01±0.13</td>
</tr>
</tbody>
</table>
Table 2 CTPI parameters in the ARILI group and non-ARILI group in irradiated lung area at different time points pre- and post-radiotherapy

<table>
<thead>
<tr>
<th></th>
<th>Non-ARILI group</th>
<th></th>
<th>ARILI group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rrBF*</td>
<td>rrBV*</td>
<td>rrPS</td>
<td>rrBF*</td>
</tr>
<tr>
<td>0w</td>
<td>1.03±0.09</td>
<td>1.02±0.08</td>
<td>0.99±0.11</td>
<td>1.05±0.11</td>
</tr>
<tr>
<td>4w</td>
<td>1.23±0.21</td>
<td>1.20±0.13</td>
<td>1.05±0.17</td>
<td>1.32±0.33</td>
</tr>
<tr>
<td>8w</td>
<td>1.27±0.32</td>
<td>1.24±0.24</td>
<td>1.08±0.19</td>
<td>1.41±0.21</td>
</tr>
<tr>
<td>12w</td>
<td>1.19±0.12</td>
<td>1.21±0.26</td>
<td>1.06±0.26</td>
<td>1.44±0.22</td>
</tr>
</tbody>
</table>

F/P value

Non-ARILI group  ARILI group
0.67/0.57  0.10/0.96  0.35/0.78  0.87/0.45  0.96/0.41  0.39/0.75

MSD: Minimum Significant Difference, Dunnett test. *There were significant differences for CT perfusion parameters in irradiated lung field between pre-radiotherapy (0w) and post-radiotherapy (4w, 8w, 12w), P<0.05. #There were significant differences for CT perfusion parameters between ARILI AND non-ARILI in irradiated lung field at the same time point (P<0.05).

Table 3 Comparison of positive cases of ARILI diagnosed by CTPI and HRCT at different time points

<table>
<thead>
<tr>
<th></th>
<th>0 w</th>
<th>4 w</th>
<th>8 w</th>
<th>12 w</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTPI (n)</td>
<td>0</td>
<td>10</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>HRCT (n)</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

P / 0.0003*  0.0090*  0.0294*

*: by the Fisher exact test with bilateral cumulative probability. The results indicated each P < 0.05, suggesting the significant differences for diagnosing ARILI between CTPI and HRCT.
**Fig. 1**: Trend chart of changes in relative parameters at pre- and post-irradiation time points in non-ARILI and ARILI groups. The upper three lines represent the changing trend of rrPS, rrBF, rrBV, respectively, in ARILI group. And the lower ones represent those in non-ARILI. The differences between trend lines progressively increased after radiation, particularly in rrPS, between the two groups. The differences of rrPS between the two groups were always statistically significant at every time point (t=6.625, 4.959, 4.048, respectively; each P< 0.05).

**References**: - Wuxi/CN

**Images for this section:**
**Fig. 1:** Trend chart of changes in relative parameters at pre- and post-irradiation time points in non-ARILI and ARILI groups. The upper three lines represent the changing trend of rrPS, rrBF, rrBV, respectively, in ARILI group. And the lower ones represent those in non-ARILI. The differences between trend lines progressively increased after radiation, particularly in rrPS, between the two groups. The differences of rrPS between the two groups were always statistically significant at every time point (t=6.625, 4.959, 4.048, respectively; each P< 0.05).
**Fig. 2:** A 50 year-old male with post-operative radiotherapy for esophageal cancer. The total dose was 60 Gy (2 Gy/qod). The patient suffered from chest pain and cough, and was diagnosed ARILI (RTOG, Level 1) in clinic. Fig 2a. Plain CT image (lung window) showed an intrathoracic stomach with no significant abnormalities found in bilateral lung fields. Fig 2b-2d (BF, BV, PS map, respectively) demonstrated yellow-green or orange-yellow regions corresponding to hemodynamic changes found in irradiated fields (near mediastinal region), which indicated regional increased perfusion. The mean rrBF, rrBV and rrPS were 1.39, 1.28 and 1.31, respectively.
**Fig. 3:** Fig 3. A 49 year-old male with thymoma resection. Fig 3a (BF map) and 3b (PS map) show no abnormal perfusion in both lung field before irradiation (0 Gy).

**Fig. 4:** Fig 4. The same patient as in Fig 3. At 4 w (30 Gy) time point after radiation, the clinical comprehensive diagnosis was ARILI (RTOG, level 2). The BF and PS maps (Fig 4a and 4b) showed inhomogeneous areas of high perfusion (red-yellow or yellow-green colour) in the irradiated field (rrBF=1.40, rrPS=1.37), especially in the area near the mediastinum. However, at the same time point, HRCT (Fig 4c) showed clear lung fields with no abnormal findings.

**Fig. 5:** Fig 5. The same patient as in Fig 3. One month after radiation therapy of 62 Gy in total (at 12 w), the clinical comprehensive diagnosis was ARILI (RTOG, level 3). The BF and PS maps (Fig 5a and 5b) showed increasing inhomogeneous elevated perfusion (red-yellow colour) in the irradiated field, more obvious than those at 4 w (rrBF=1.66, rrPS=1.59). HRCT (Fig 5c), at the same time point, showed that there were patchy opacities in bilateral lung fields, particularly in the right lung field. These findings denoted the patchy exudation type of ARILI.
Conclusion

1. Early detection and diagnosis of ARILI

At present comprehensive clinical diagnosis (history of radiotherapy, signs and symptoms, peripheral blood test and imaging examination) and follow-up evaluation are commonly used, where the imaging examination, especially HRCT, provides the most direct evidence for the diagnosis of ARILI [7,8,14]. However, studies indicate that when positive ARILI diagnosis is made by HRCT, the RILI in most patients has progressed into irreversible phase [15]. HRCT visualizes the general morphological changes of lesions. However, according to studies in brain tissue and other organs, morphological changes imaged with CT have relatively low sensitivity and significantly lag behind alterations in perfusion metrics. Therefore, HRCT is mainly useful to detect RILI in the late phase and to evaluate the effectiveness of radiotherapy and the diagnostic and prognostic capabilities of HRCT are very limited. Although ECT can perform lung perfusion and morphological examination [16-17], its specificity, sensitivity and spatial resolution are low, and has disadvantages such as mono-index, complicated computation and radiation pollution that limit its application in RILI diagnosis. The effectiveness of TGF and TNF in peripheral blood for ARILI diagnosis is still controversial and with points of disagreement and opposing conclusions [18-19].

Studies of RILI with CTPI, to our knowledge, have been rarely reported in literature, and in this study we attempted to determine the hemodynamic patterns of regional lung tissue using quantitative analysis of regional lung tissue CTPI metrics before and after irradiation.

2. General trend in CTP parameters at different time point after irradiation

In this study, comparison of the perfusion parameters of the non-irradiated lung field, in either ARILI or non ARILI group, showed no statistically significant differences, indicating that radiotherapy did not affect the non-irradiated field. This is concordant with the fact that ARILI occurs in the irradiated field, where radiation induced injuries resulting in direct impairment of cells in the region.

In the non-ARILI group, the relative perfusion parameters of irradiated lung field increased along with the dose administered and time of therapy (week 4 to week 8), then decreased gradually after completion of the radiotherapy. On the whole, the perfusion curve demonstrated a pattern of "slow-rise to slow-fall". Given this pattern, the rrBF and rrBV obtained before and after radiation were compared and statistically significant differences were found. However, rrPS demonstrated no statistically changes. This change likely represents hyperemia seen at the level of capillary vessels, possibly along with mild exudation and mild edema, occurring in lung tissue during the course of radiation in this non-ARILI group. However these mild changes could not be detected by HRCT imaging. At the same time, capillary endothelial cells and alveolar cells also had minor damage[17,20], which most likely lead to the slightly increased rrPS. However, the change in pre- and post-radiotherapy was not statistically significant. The most important point here is that most of these minor changes were reversible, and that tissue repair occurred after radiation (in week 8). The perfusion parameters started to return to
normal level and finally became normal, which illustrates that there was no fundamental impairment in capillary endothelial cells or alveolar cells and they were repaired, as the cellular injury was within repair capability of the tissue.

In this study there were 18 patients in ARILI group, so the incidence of ARILI was 35%, which was consistent with the reports in the literature [21,22]. Using the perfusion values before radiotherapy as the benchmark, in the ARILI group, perfusion parameters demonstrated rapid increase within the first 8 weeks of radiotherapy, and continued increasing slowly in week 12, showing the patterns of "rapid-rise to slow-fall" or "rapid-rise to flat". By comparing the perfusion parameters before and after the radiotherapy, statistically significant differences were found, particularly for the difference of PS. The pathological process of ARILI includes alveolar epithelial cells and pulmonary capillary endothelial cell injury, causing exposure and damage to pulmonary capillary endothelium, basilar membrane, and alveolar membrane. Ultimately inflammatory exudate formation is gradually induced[17,23]. Pathologically, these changes result in pulmonary congestion and increase in permeability of capillaries. CTPI results in this study were consistent with the pathological process described above, especially the PS index changes. An interesting finding in this study indicates that ARILI did not occur in those patients with the increased BF and BV, but did occur, when PS increased together with BF and BV. This phenomenon suggests that the PS reflects the pathological process of ARILI, and is superior to HRCT in terms of detecting early ARILI. At week 8 and week 12 after radiotherapy, along with the continued impairment of capillary endothelial and alveolar epithelial cells, pulmonary capillary lumen becomes congested with substantial amount of monocytes, erythrocytes and leucocytes. Infiltration of lymphocytes, histiocytes and plasmacytes into the pulmonary interstitium also increases [24-25], and fibrocytes and fibroblasts increase in proliferation and differentiation, therefore at this stage abnormalities can be observed on HRCT images [26]. However, at this stage, RILI has entered the middle phase of pathological process (2 - 9 months after radiotherapy).

3. Value of CTPI for early diagnosis of ARILI

In ARILI group, comparison of rrPS in week 4, week 8 and week 12 with rrPS measured before radiation or with rrPS in non-ARILI group demonstrated statistically significant differences. This means that change in permeability of capillaries is the most significant change in ARILI, and the rrPS better reflects this pathological change. As a result, abnormality in rrPS may represent a reliable indicator of ARILI and represents a promising new method for early ARILI detection and prediction.

In this study, the sensitivity, specificity, positive predictive value and negative predictive value of ARILI diagnosis was high when using rrPS at half-dose stage of irradiation (week 4 after radiotherapy), which was statistically significantly superior to HRCT. In week 8 and week 12, the percentage of ARILI cases positive on HRCT increased but was still lower than cases positive on CTPI. 6 ARILI cases developed from level 0-1 (in week 4) to level 2-4 (in week 8) and presented typical HRCT manifestations, which indicated diagnostic reliability of CTPI for ARILI diagnosis at the half-dose stage of radiation. 7 cases presented with ARILI in week 8 and week 12 did not show positive CT manifestation in week 4. But the rrPS, rrBF, and rrBV increased to some degree in week 4, most evident
in changes of rrPS, which suggests that CTPI may diagnose and predict ARILI, though this predictive capability needs to be further investigated with a larger number of subjects.

4. CTPI protocols and radiation dose

Due to requirements of 3D-CRT, CT imaging is needed for selection of reduced radiation field for therapy, monitoring of short term therapy effectiveness and assessment of response to therapy. CT imaging is necessary at least three times: before, during and after the radiotherapy for patients with thoracic tumor. Non contrast and post contrast CT is usually obtained for this purpose. CT perfusion scan range covers the tumor region, and can serve as a substitute for post contrast CT, as reconstructed images similar to the post contrast CT can be obtained after acquisition of CT perfusion imaging. As a result, the CT examination in this study includes pulmonary parenchyma CT perfusion followed by whole lung CT scan, replacing the conventional non-contrast and post-contrast CT. In this way, hemodynamic parameters and conventional CT images are obtained at the same time. For lung perfusion scanning, the average dose length product (DLP) was 539mGy·cm, and the effective radiation dose was about 9.16 mSv, which are significantly lower than that of conventional examination (non contrast and post contrast CT) for which mean effective radiation dose was 14.21 mSv.

In conclusion, values of CTPI parameters may reflect hemodynamic changes in the lungs after radiation therapy, and may detect ARILI earlier than HRCT, representing a promising new technique for early diagnosis of ARILI.

References


**Personal Information**

Xiao-yun Hu MD, Imaging Center, Wuxi People's Hospital, Nanjing Medical University, Jiangsu, China;

wpdrhxy@hotmail.com

Xiang-ming Fang MD, Imaging Center, Wuxi People’s Hospital, Nanjing Medical University, Jiangsu, China;

drfxm@163.com

Hong-wei Chen MD, Imaging Center, Wuxi People's Hospital, Nanjing Medical University, Jiangsu, China;

54555154@qq.com

Chun-hong Hu MD,

Imaging Center, The First Affiliated Hospital of Suzhou University, Jiangsu , China