Diagnostic accuracy of ultra-low-dose chest CT with model-based iterative reconstruction (MBIR) in the detection of early pulmonary complications within the first six months following lung transplantation

Poster No.: B-1255
Congress: ECR 2015
Type: Scientific Paper
Authors: M.-P. Debray¹, G. Dauriat¹, A. Khalil¹, S. Leygnac¹, A. Grandjean², E. Schouman-Claeys¹, P. Ou¹; ¹Paris/FR, ²Buc/FR
Keywords: Thorax, Radioprotection / Radiation dose, CT, Diagnostic procedure, Radiation safety
DOI: 10.1594/ecr2015/B-1255

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

Early complications are frequent during the 6 first months following a pulmonary transplantation, requiring close monitoring for which CT has a key role (1). Patients may have repeated chest CTs during this time, leading to high radiation exposure.

Model-based iterative reconstruction (MBIR), a recently developed fully iterative reconstruction algorithm using modeling of the entire imaging system, reduces very substantially image noise, thereby allowing a dramatic reduction of the radiation dose while maintaining a good image quality (2-5). Image texture may however be modified and few studies have evaluated the diagnostic performance of ultra low dose (ULD)-Chest-CT with this technique (2,6-8).

The purpose of this prospective study was to assess the accuracy of ULD-Chest-CT with MBIR in detecting usual early abnormalities following pulmonary transplantation, using standard dose CT (SD-CT) with adaptative statistical iterative reconstruction (ASIR) as the reference standard.
Methods and materials

This prospective study was approved by the Institutional Review Board, and written informed consent was obtained from all patients.

It included 48 examinations in 20 patients (M:F 11:9 ; BMI 23.8±4.6 ; 52±11 y/o) performed routinely during the 6 first months following a lung transplantation from July 2013 to May 2014. Each examination consisted in the acquisition (GE Discovery CT750HD) of a SD-Chest-CT (0.625mm helical, 100kV, noise index 45, reconstructed with ASIR) immediately followed by an ULD-Chest-CT (0.625mm helical, 100kV, 16 or 24mAs/slice, depending on the BMI, reconstructed with MBIR).

Images were evaluated separately by two experienced thoracic radiologists for the detection of usual complications including infections, pleural effusion, pneumothorax and anastomotic complications, as well as elementary signs in the pulmonary parenchyma, including consolidations, ground-glass opacities, reticulations, centrilobular micronodules and bronchiectasis.

On a more clinical aspect of the study, readers assessed the answer to the main question raised by the physician in charge of the patient, which could be the detection of any complication and/or evolution of any abnormality.

Subjective image quality of ULD-CT was graded on a five-point scale (1: excellent image quality without artifacts, to 5: unacceptable image quality with major artifacts).

Objective image noise was assessed for ULD-CT and SD-CT by drawing a region-of-interest in the descending aorta and in the trachea.
**Results**

Mean CTDIvol were 4.17±0.93 and 0.66±0.1 mGy for conventional and ULD-Chest-CT, respectively. Significant complication was found in 41/48 (85%) examinations, including 33 cases suggestive or compatible with viral or bacterial pneumonia, 6 with fungal infection, 22 with pleural effusion, 19 with pneumothorax and 22 with bronchial fistula or stenosis.

Agreement between readers was good to very good (kappa 0.7-1).

Sensitivity, specificity, positive and negative predictive values of ULD-CT as compared to SD-CT are shown on Tables 1 and 2. Considering the answer to the main question raised by the physician, there were 5 cases of mild discrepancy between ULD-CT and SD-CT, all of them graded as higher probability for the complication with ULD-CT.

Mean subjective image quality of ULD-CT was graded as 2.4±0.7, with 34 cases graded as 2 (good quality with minor artifacts and sharp delineation of anatomic structures), 6 cases graded as 4 (poor image quality with substantial artifacts impairing delineation of some major anatomical structures and with minor loss of diagnostic information), and none as 5.

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive predictive value (%)</th>
<th>Negative predictive value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonia, n=33 (Fig.1 and 2)</td>
<td>97</td>
<td>73</td>
<td>89</td>
<td>92</td>
</tr>
<tr>
<td>Fungal infection, n=6 (Fig.3 and 4)</td>
<td>100</td>
<td>98</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td>Pneumothorax (right or left), n=19 (Fig.3-6)</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 1. Diagnostic value of ULD-CT, compared to SD-CT for the detection of main complications in the 6 first months following lung transplantation.
<table>
<thead>
<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Positive predictive value (%)</th>
<th>Negative predictive value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consolidations</td>
<td>96</td>
<td>95</td>
<td>96</td>
<td>95</td>
</tr>
<tr>
<td>Ground-glass opacities</td>
<td>100</td>
<td>90</td>
<td>93</td>
<td>100</td>
</tr>
<tr>
<td>Centrilobular micronodules (Fig.1 and 2)</td>
<td>100</td>
<td>94</td>
<td>89</td>
<td>100</td>
</tr>
<tr>
<td>Reticulations (Fig.11 and 12)</td>
<td>71</td>
<td>100</td>
<td>100</td>
<td>86</td>
</tr>
<tr>
<td>Bronchiectasis</td>
<td>56</td>
<td>97</td>
<td>90</td>
<td>80</td>
</tr>
</tbody>
</table>

Table 2. Diagnostic value of ULD-CT, compared to SD-CT for the detection of elementary signs in the 6 first months following lung transplantation.
Fig. 1: ULD-CT in the axial plane showing centrilobular micronodules related to a bronchiolar infection

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
Fig. 2: Same examination as Fig. 2, SD-CT, showing centrilobular micronodules

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
**Fig. 3:** ULD-CT in the coronal plane, showing two lung nodules with ground-glass halo, suggestive of fungal infection. It clearly depicts also a small apical pneumothorax.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR

**Fig. 4:** Same examination as Fig. 4, SD-CT, showing nodules with ground-glass halo and left pneumothorax.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
**Fig. 5:** ULD-CT in the axial plane showing apical pneumothorax and subpleural emphysema.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
**Fig. 6:** Same examination as Fig. 8, SD-CT showing apical pneumothorax and subpleural emphysema.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR

![Image of SD-CT showing apical pneumothorax and subpleural emphysema.](image)

**Fig. 7:** ULD-CT in the axial plane showing an anterior anastomotic fistula and posterior loculated pleural effusion.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
**Fig. 8:** Same examination as Fig. 10, SD-CT showing an anterior anastomotic bronchial fistula and posterior loculated pleural effusion.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
Fig. 9: ULD-CT in the coronal plane, showing an inferior bronchial fistula and subtle basal septal réticulations.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
**Fig. 10:** Same examination as Fig. 12, SD-CT in the coronal plane, showing the inferior bronchial fistula and basal septal réticulations in the right lung graft.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
Fig. 11: ULD-CT in the axial plane showing right pleural effusion, right inferior lobe consolidation and subtle bilateral septal lines.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
**Fig. 12:** Same examination as Fig. 14, SD-CT showing right pleural effusion, right lower lobe consolidation and clearly depicting bilateral septal reticulatons.

© Radiology, Bichat Claude Bernard Hospital - Paris/FR
Conclusion

ULD-Chest-CT with MBIR, allowing a 6 fold reduction of radiation dose, is accurate, compared to SD-CT, for delineating most usual pulmonary complications in the 6 first months following a pulmonary transplantation.

Few discordances, as compared to SD-CT, with few cases of overdiagnosis with ULD-CT.

Image quality graded as good in the majority (70%) of cases.

Limitations :

- Study focused on the main question posed by the physician in charge of the patients and only the most frequent complications evaluated
- Comparison of ULD-CT to SD-CT for various elementary signs limited to the presence or absence of the sign
- Chest tubes or inability of the patient to lift the arms (patients addressed by the intensive care unit) not taken into account for the choice of the scanning parameters

In conclusion, ULD-Chest-CT might deserve to be used routinely instead of higher-dose standard-CT for the monitoring of pulmonary allograft in most patients.
References