Comparative study of pulmonary nodule detection with 1.25mm and 2.5mm slice thickness in 16-slice low dose helical CT

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For the low-dose lung screening performed with a 16-channel multi-slice CT in our hospital, two detector slice thickness configurations of $8 \times 2.5\text{mm}$ and $16 \times 1.25\text{mm}$ may be used. The use of the $8 \times 2.5\text{mm}$ will have the lower dose advantages over the thinner slice configuration but lower spatial resolution. The purpose of this study is to compare the performance of detecting and characterizing pulmonary nodules of various sizes with $1.25\text{mm}$ and $2.5\text{mm}$ reconstruction slice thickness.
Methods and Materials

Patients

Low-dose lung scans were performed in 102 patients who were diagnosed or suspected having small pulmonary nodules during Feb. 2009 and Apr. 2009. Among these 102 patients, 15 patients, who were accompanied by chronic bronchitis, emphysema, obsolete pulmonary tuberculosis and other chronic pulmonary diseases, were excluded. The small nodules which were situated in subpleura or inter-lobar pleura were also excluded.

Scanning Technique

Low-dose lung scan was performed using a 16-slice CT scanner (GE BrightSpeed). The scan parameters were 1.25mm collimation, 120kV, 50mA, pitch of 1.75, 0.8s gantry rotation speed. These images were reconstructed into two groups of 1.25mm and 2.5mm image slice thickness. These images were transferred to an Advanced Workstation for analysis.

Image analysis

Images were displayed on either GE AW4.3 or AW4.4 workstations. Both the lung window (WL -650, WW 1500) and the mediastinal window (WL 50, and WW 350) were used. The lung window was for detecting small nodules, whereas the mediastinal window was used for determining calcification. A nodule is defined as with long diameter less than 3cm, and the ratio of long diameter and short diameter less than 3/2. Nodules were characterized into 3 groups by their diameters: group 1, #5mm; group 2, 5-10mm; group 3, #10mm.

Lobulation is defined as lesion surface exist incisure. Speculation is defined when lesion surface exist short cord.

Calcification is defined when the CT value of lesion is larger than 120HU. Cavity is defined when there is lower density in small nodule.

The image quality were graded using a three-point scale: excellent, the images do not exhibit artifacts and nodules can be clearly delineated; fair, images demonstrate small amount of artifacts in apex and base of lungs but are sufficient for delineating nodules; not acceptable, the images exhibit artifacts that interfere with the diagnosis. The clarity of the lesion boundary is classified into five grades#1, the nodular boundary is very clear; 2, the boundary is clear; 3, the boundary is somewhat clear; 4, the boundary is vague; and 5, the boundary cannot be identified.
Three experienced radiologists reviewed and graded image quality with consensus and recorded the detection and characterization of lung nodules. The reviewers also recorded the number of nodules detected with 1.25mm and 2.5mm image thickness respectively. The boundary (lobulation and spiculation) and density (calcification and cavity) of each nodule were graded and recorded.

**Statistical analysis**

Statistical analysis was performed on the number of lung nodule detected and their characteristics (lesion boundary and density) by using the paired sample rank sum test provided by the statistical analysis software (SPSS14). A p-value of less than 0.05 was considered to indicate a statistically significant difference for all statistical tests.
Results

Data for a total of 80 patients (53 men, 27 women; ages, 44-81 years) were analyzed. The image quality for all patients was judged acceptable for the evaluation of pulmonary nodules. In the 80 patients, a total of 235 nodules were detected with the 1.25mm image slice thickness, and 239 nodules with 2.5mm slice thickness (p#0.05). The majority of the detected nodules were small ones with diameters less than 5mm (214 and 229 with 1.25mm and 2.5mm slice thickness, respectively). The comparisons of the number of lung nodules detected and their characteristics (lesion lobulation, spiculation, boundary clarity, calcification and cavity) with the 1.25mm and 2.5mm slice thickness images were listed in tables 2-6. The 1.25mm thickness was not superior to the 2.5mm thickness in depicting pulmonary nodules of all sizes (Table 1). 1.25mm thickness was superior to 2.5mm thickness in depicting boundary, lobulation and calcification, if the pulmonary nodule was less than 5mm in diameter. The cavities and speculations in the pulmonary nodules with diameter equal to or larger than 5mm were well depicted with both 1.25mm thickness and 2.5mm thickness images (Tables 2-6).

Table 1. Nodule detection

<table>
<thead>
<tr>
<th>Nodule Size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5mm</td>
<td>20</td>
<td>25</td>
<td>35</td>
<td>0.218</td>
</tr>
<tr>
<td>5-10mm</td>
<td>12</td>
<td>9</td>
<td>59</td>
<td>0.508</td>
</tr>
<tr>
<td>#10mm</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td>0.157</td>
</tr>
<tr>
<td>TOTAL</td>
<td>20</td>
<td>23</td>
<td>37</td>
<td>0.676</td>
</tr>
</tbody>
</table>

A: number of patients that more nodules in the indicated size range were detected with 1.25mm thickness images.

B: number of patients that more nodules in the indicated size range were detected with 1.25mm thickness images.

C: number of patients that equal amount of nodules was detected with both slice thicknesses.

Table 2. Nodule Characterization: lobulation

<table>
<thead>
<tr>
<th>Nodule Size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5mm</td>
<td>11</td>
<td>3</td>
<td>66</td>
<td>0.024</td>
</tr>
<tr>
<td>5-10mm</td>
<td>6</td>
<td>10</td>
<td>64</td>
<td>0.253</td>
</tr>
</tbody>
</table>
#10mm | 0 | 2 | 78 | 0.157

<table>
<thead>
<tr>
<th>Nodule Size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5mm</td>
<td>14</td>
<td>11</td>
<td>55</td>
<td>0.152</td>
</tr>
<tr>
<td>5-10mm</td>
<td>7</td>
<td>10</td>
<td>63</td>
<td>0.193</td>
</tr>
<tr>
<td>#10mm</td>
<td>0</td>
<td>2</td>
<td>78</td>
<td>0.180</td>
</tr>
</tbody>
</table>

A: number of patients that 1.25mm thickness scanning detects more nodules with lobulation in the specified nodule size range.

B: number of patients that 2.5mm thickness scanning detects more nodules with lobulation in the specified nodule size range.

C: number of patients that same amount of nodules with lobulation was detected by both the 1.25mm and 2.5mm slice thickness images.

**Table 3. Nodule Characterization: spiculation**

A: number of patients that 1.25mm thickness scanning detects more nodules with spiculation in the specified nodule size range.

B: number of patients that 2.5mm thickness scanning detects more nodules with spiculation in the specified nodule size range.

C: number of patients that same amount of nodules with spiculation was detected by both the 1.25mm and 2.5mm slice thickness images.

**Table 4. Nodule Characterization: boundary clarity**

A: number of patients that 1.25mm thickness scanning detects more nodules with better boundary clarity in the specified nodule size range.

B: number of patients that 2.5mm thickness scanning detects more nodules with better boundary clarity in the specified nodule size range.

C: number of patients that similar nodule boundary clarity was observed with the 1.25mm and 2.5mm slice thickness images.
### Table 5. Nodule Characterization: calcification

<table>
<thead>
<tr>
<th>Nodule Size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5mm</td>
<td>19</td>
<td>6</td>
<td>55</td>
<td>0.005</td>
</tr>
<tr>
<td>5-10mm</td>
<td>6</td>
<td>10</td>
<td>64</td>
<td>0.79</td>
</tr>
<tr>
<td>#10mm</td>
<td>0</td>
<td>2</td>
<td>78</td>
<td>0.16</td>
</tr>
</tbody>
</table>

A: number of patients that 1.25mm thickness scanning detects more nodules with calcification in the specified nodule size range.

B: number of patients that 2.5mm thickness scanning detects more nodules with calcification in the specified nodule size range.

C: number of patients that same amount of nodules with calcification was detected by both the 1.25mm and 2.5mm slice thickness images.

### Table 6. Nodule Characterization: cavity

<table>
<thead>
<tr>
<th>Nodule Size</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5mm</td>
<td>9</td>
<td>10</td>
<td>61</td>
<td>0.629</td>
</tr>
<tr>
<td>5-10mm</td>
<td>6</td>
<td>9</td>
<td>65</td>
<td>0.439</td>
</tr>
<tr>
<td>#10mm</td>
<td>0</td>
<td>2</td>
<td>78</td>
<td>0.157</td>
</tr>
</tbody>
</table>

A: number of patients that 1.25mm thickness scanning detects more nodules with cavity in the specified nodule size range.

B: number of patients that 2.5mm thickness scanning detects more nodules with cavity in the specified nodule size range.

C: number of patients that same amount of nodules with cavity was detected by both the 1.25mm and 2.5mm slice thickness images.
Conclusion

For low dose CT lung nodule screening, images with 1.25mm and 2.5mm slice thickness demonstrated similar nodule detection accuracy and nodule characterization for nodules > 5mm in size. The reduced image noise with 2.5mm may be traded for same image noise as the 1.25mm to provide further dose reduction in the future.
References
