160mm wide volume scan vs. 160-detector row helical scan vs. 64-detector row helical scan on low-dose CT using 320-detector row CT: capability for airway parameter and airflow limitation assessments in postoperative lung cancer patients

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Purpose

Chronic obstructive pulmonary disease (COPD) is the fourth leading cause of death worldwide. COPD is described as a slowly progressive disease characterized by airflow limitation. This airflow limitation is not fully reversible, and is caused by a mixture of abnormal inflammatory responses in small airways and parenchymal destruction of the lungs, and the diagnosis of COPD largely relies on a history of exposure to noxious stimuli (mainly cigarette smoke) and abnormal lung function test results.

During last decade, several investigators have suggested that CT is useful for assessment of COPD. For high-resolution or thin-section CT, detailed evaluation of lung parenchyma and bronchial walls have been proposed as useful for assessment or management of COPD.

320-detector row CT (or area-detector CT: ADCT) is clinically installed, and could perform 64-detector row helical scan (64-HS), 160-detector row helical scan (160-HS) an 160mm step and shoot wide volume (WVS) scan without helical scan.

No one has directly compared the influence of CT scanning techniques to the assessment of airflow limitation in patients with COPD.

The purpose of this study was to determine the difference of airway parameter and airflow limitation assessment capabilities among 64-detector row helical scan (64-HS), 160-detector row helical scan (160-HS) and 160mm step and shoot scan (i.e. wide volume scan; WVS) techniques on 320-detector row CT in postoperative lung cancer patients.
Methods and Materials

A total of 50 postoperative patients of lung cancers (30 men and 20 women; age range 52-87 years) prospectively underwent the FEV₁% test, MDCT.

All ADCT examinations were performed with a 320 detector-row CT scanner (Aquilion One; Toshiba Medical Systems) by means of wide volume scanning (WVS), 160 detector-row helical scanning (160HS), and 64 detector-row helical scanning (64HS). WVS examinations were performed by using the step-and-shoot technique with the following parameters: 320 ×0.5-mm collimation, three to four time scans. 160HS examinations were performed by using the helical scan with the following parameters: 160 ×0.5-mm collimation, beam pitch 0.869. 64HS examinations were performed by using the helical scan with the following parameters: 64 ×0.5-mm collimation, beam pitch 0.828. All CT images were reconstructed as contiguous slices of 1.0mm thickness by means of a standard algorithm for each system.

For a quantitative assessment of ADCT, all ADCT data were transferred to a workstation (Fujin; AZE Ltd., Tokyo, Japan), while evaluated ratio of WA to total airway area (WA%) was determined using a commercially available software;

\[
WA\% = (\text{the outer area} - \text{the inner area}) / \text{the outer area of the bronchus.}
\]

First, a three-dimensional airway tree was automatically reconstructed with a given threshold level expressed in Hounsfield units (HU) to obtain airway images at the level of the subsegmental bronchus that was maximally distal. The selected bronchial pathway was then automatically converted into a curved MPR image. Rays fanning out over 360 degrees from the centroid of the lumen were examined to determine airway wall thickness along the rays using the full-width-at-half-maximum principle.

To measure airway dimensions, we selected a bronchus at each lobe randomly. Then, the WA% of sixth-generation bronchus at each selected bronchus was measured.

To determine the agreement in all scan techniques the correlation and reproducibility coefficients of each parameter were determined by means of the Bland-Altman's analysis. Finally, to compare the efficacy of the three methods for pulmonary functional assessment in postoperative lung cancer patients, WA% of each scan technique was correlated with FEV1%. 
Fig. 1: (A) Accurate bronchial skeleton. (B) MPR image of the selected airway (B10) from the left lower lobe. (C) Short-axis image obtained from the curved MPR image are precisely perpendicular to the long axis of sixth generation bronchus.

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Results

We evaluated 244 sixth bronchi from 50 patients. All quantitative thin-section CT measurements were successfully performed.

The results of Bland-Altman's analysis are shown in Figure 2. The limits of agreement of WA% were as follows: 64-HS vs. 160-HS, 0.6% ± 10.6%; 64-HS vs. WVS, 0.3% ± 11.4%; 160-HS vs. WVS, -0.3% ± 10.2%, respectively. All limits of agreements were considered as small enough for clinical purpose.

Correlations between WA% of each modalities and FEV1% are shown in Figure 3. WA %s of 64-HS (r = -0.19, p = 0.0024), 160-HS (r = -0.19, p = 0.0033) and WVS (r = -0.20, p = 0.0021) had significant and fair correlation with FEV1%.
Fig. 2: This is the results of Bland-Altman’s analysis between two scan technique each other. A; Comparison between 64-HS and 160-HS. B; Comparison between 64-HS and WVS. C; Comparison between 160-HS and WVS. The limits of agreement of WA% were as follows: 64-HS vs. 160-HS, 0.6 +/- 10.6%; 64-HS vs. WVS, 0.3 +/- 11.4%, 160-HS vs. WVS, -0.3 +/- 10.2%, respectively.
Fig. 3: This is the results of the capability of airflow limitation of each index on each scan technique, which was correlated with FEV1%. A; Correlation of FEV1% and WA% on 64-HS. B; Correlation of FEV1% and WA% on 160-HS. C; Correlation of FEV1% and WA% on WVS. WA% of 64-HS (r=-0.193, p=0.0023), 160-HS (r=-0.187, p=0.0033) and WVS (r=-0.196, p=0.0021) had significant and fair correlation with FEV1%.
Conclusion

160mm step-and shoot (i.e. wide volume) scan, 160-detector row helical scan and 64-detector row helical scan on low-dose CT using 320-detector row CT system had similar capability for airway parameter and airflow limitation assessment in postoperative lung cancer patients.
References


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