Evaluation of the role of MSCT Airway Mapping in guiding trans-bronchial lung biopsy in cases of inaccessible lung lesions

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Authors: Y. Sabri, M. A. Fouad, K. Kamel, S. M. Saleh; Cairo/EG  
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Aims and objectives

Peripheral pulmonary lesions are constant clinical challenge so many endobronchial sampling techniques were represented to reach these inaccessible lesions safely and accurately [1]. Conventional fiber-optic bronchoscopy (FOB) is a well established successful technique in achieving biopsies, yet it cannot reach beyond the fourth generation of bronchial airway division [2,3]. A major problem with transbronchial biopsy is the difficulty in guiding the bronchoscope and biopsy instrument to the lesion [4].

This work aimed for using multislice computed tomography (MSCT) to map the bronchial tree and assess the exact site, direction, airway findings and bronchial measurements to guide trans-bronchial lung biopsy from an inaccessible lung lesion and avoid disappointing histo-pathological results.
Methods and materials

Patients:

This prospective study was carried on 26 patients, 21 males and 5 females with age range between 35-85 years (mean age 55.88 years).

A signed informed consent was obtained from all patients according to the guidelines of the Medical Research Ethics Committee at the Cairo University hospital.

It was conducted in the Radiology Department, in collaboration with Chest Department in the period from January 2015 to April 2016

Inclusion criteria:

Patients showing pulmonary mass lesion on CT examination, which was considered inaccessible to routine fiber-optic bronchoscopy; as peripheral lesions or lesions in a bent or small caliber proximal bronchi to conventional bronchoscope, or patients with failed routine trans-bronchial biopsy.

Exclusion criteria:

Included the contraindications to bronchoscopy as patients with coagulopathy, thrombocytopenia, percutaneous oxygen saturation less than 90%, patients with a known or discovered uncontrolled cardiac disorder as recent myocardial infarction or recent cerebrovascular insult, and patients who unfit for procedure (e.g. severe hypoxia, type II respiratory failure, etc)

Methods:

All patients were subjected for the following:

Complete history taking (including residence, occupation and smoking history), full clinical examination, and relevant laboratory investigation.

The following steps were followed:

First: previous contrast enhanced CT chest were assessed for details of the pulmonary mass lesion and the results of previous unsuccessful FOB reviewed.

Second: Virtual Bronchography examination done as follows:

Virtual Bronchography (VB) was done with no contrast administration using a 16 multidetector CT scanner with the patient’s position: supine, helical volume data sets of the chest were acquired at end-inspiration during single breath-hold inhalation. The
following parameters used: FOV: 25cm, collimation: 0.5 mm, rotation time: 0.5, helical thickness: 1 mm, and scanning direction: from bottom to top.

Images were then reconstructed from helical CT scans and transferred to a two dimensional (2D) images in the form of lung window (WW -700, WL 1000) and average intensity projection (AIP) images in mutiplanar reformation (axial, coronal and sagittal planes) and minimum intensity projection (MinIP) images (axial, coronal and sagittal planes) were obtained in every case.

Three dimensional (3D) internal surface-rendering virtual bronchoscopic (VB) images which combines helical CT data and virtual reality computing techniques were built by autosegmentation, and fly-through images were acquired. Navigation though trachea, then main stem bronchus, then lobar bronchus and bronchiole till reaching the targeted lesion, the assessment of distal bronchioli to the lesion performed (distal aeration.

**Third**: The VB images were analyzed by three radiologists separately, the experience of whom was 28 years, 10 years and 5 years respectively.

1-The site of the lesion relative to the bronchial tree was assessed as follows: Laterality: right or left, lobar, segmental and subsegmental bronchus affected up to the seventh generation.

2-The route of bronchoscope were drawn with the length of each bronchus or bronchiolus passed measured.

3- Accessibility and the diameter of the required bronchus as no proximal acute bent or bronchus less than 4 mm in diameter.

4- Distal airways assessed.

**Fourth**: CT map was drawn or video sequence saved, and the findings were compared and discussed with the bronchoscopist to determine the route for accessing the mass lesion and the feasibility of the biopsy.

**Fifth**: Trans-Bronchial lung biopsy was attempted guided by the VB results and mapping.

**Sixth**: Pathological examination was done. Trans-bronchial lung biopsy samples were taken and preserved in formalin containing cups then sent for histopathological examination.
Results

This study was carried on 26 patients, 21 males (80.7%) and 5 females (19.3%), age range 35-85 (Mean 55.88 and Standard deviation 11.904) and 21 of them were smokers.

Clinical complain ranged from chest pain, dyspnea, cough, expectoration in twenty two patients, hemoptysis in three patients and history of primary tumor in one patient.

All patients had a CT chest examination, which showed pulmonary mass lesions that was considered inaccessible to routine fibre-optic bronchoscopy in twenty-one patients (80.8%) or with previously failed routine trans-bronchial biopsy in five patients (19.2%).

3.1 Considering lesion’s site and distribution:

Bronchial generation reached were 3rd to 7th generation (mean 4.9).

(Figure 1) Table showed the virtual bronchographic lesion distribution.

MSCT-VB navigated through 30 bronchial lesions in 26 patients and seventh bronchial generation reached in 3 patients (10%) (Figure 2, 3), the sixth bronchial generation in 6 patients (20%), the fifth bronchial generation in 9 patients (30%), the fourth bronchial generation in 5 patients (16.7%) (Figure 4) and the third bronchial generation in 7 patients (23.3%), with mean 4.90 and standard deviation 1.334. This CT map was able to plan further management and/or direct trans-bronchial biopsy (Figure 5).

One patient had common obstruction of both right middle and lower main bronchi, one patient had common obstruction of both left upper and lower main bronchi, one patient had obstruction of the left upper main bronchus only, one patient had obstruction of both left upper and lingular bronchi and one patient had obstruction of segmental bronchi of the left upper and lingular bronchi.

Normal variants noticed in three patients as in two patients, the left upper lobe bronchus was divided into anterior, apical and posterior segmental bronchi, and in one patient right upper lobe bronchus gave only two segmental branches anterior and apico-posterior.

3.2 Considering airway distance and diameter:

The distance of airway from the central bronchi (3rd bronchial generation) was measured in the 26 patients giving the range of 3.2- 65 mm (mean distance was 21.3 mm). The diameter of the target bronchus was measured, giving range of 1.1-3.5 mm (mean diameter was 1.9 mm).

3.3 Considering distal airways were patent in 24 (92%) of cases, however blocked distal airways encountered in 2 (7%) of cases were the tumor infiltrations reach peripheral to subpleural region.
3.4 All the specimens were sent for *histo-pathological examination* and positive results obtained from all specimens as shown in (Figure 6).

3.5 **Follow up** of cases after one month by CT virtual bronchographic examination showed stationary course of lesions in twenty-one cases, progression of the pulmonary mass lesions compared to the previous CT study in three cases, however, in five cases of inflammatory infiltrates who were put under an umbrella of antibiotics, CT bronchography showed evident marked regression of the lesion regarding the size and degree of opacity.
Fig. 1: Lobar and segmental distribution of mass lesions, and bronchial generation affected.

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**Fig. 2:** 52-year-old male, heavy cigarette smoker, presented by dyspnea on moderate exertion and dry cough MSCT images: (A) Non-contrast axial and coronal CT images of the chest (lung window) reveal an irregular outlined supra-hilar mass at the right upper lobe (B) Coronal 2D reconstruction lung window shows the related segmental bronchus was the apical bronchus of the right upper lobe. Virtual and fiber-optic bronchoscopic images: (C-F), the described lesion was traced through right main bronchus # right upper lobe bronchus # upper lobe apical segment (figures C-D) # superior # anterior # medial divisions bronchioli (seventh bronchial generation) (figures E-F). Histopathological result was undifferentiated carcinoma grade II-III.

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**Fig. 3:** 53-year-old male, heavy cigarette and hashish smoker, presented by cough expectoration, dyspnea and right infra-scapular chest pain. CT images: (A-B) two consecutive axial cuts and 2D coronal reconstruction (lung window) non-contrast CT images of the chest revealed a well defined ovoid mass lesion in the right middle lobe, the target bronchiolar diameter was 1.2 mm. Virtual bronchoscopic (C) and fibreoptic bronchoscopic (D) images: The described lesion was traced. It was in the right middle lobe lateral segment (for distance of 2.3 cm) # superior # superior (for 1.36 cm)# posterior division (for 1.08 cm) (seventh bronchial generation). Histopathological result was mild chronic inflammatory cellular infiltrate with no evidence of neoplasia or specific granulomatous reaction.

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Fig. 4: 62-year-old male, heavy cigarette smoker, presented by hemoptysis, cough and expectoration, dyspnea and right infra-mammary chest pain. CT images: (A) Axial non-contrast CT images of the chest (lung window) revealed right apical heterogenous cavitating mass lesion with surrounding thickened inter-lobular septa denoting lymphatic permeation, the target bronchial diameter was 2.2 mm. Virtual and fiber-optic bronchoscopic (C, D) and Coronal MinIP (B) images: The described lesion was traced through the right main bronchus # upper lobar bronchus # obstructing its apical segmental bronchus 2.5 cm far from the upper lobe bronchus as shown in figure A (fourth bronchial generation). Histopathological result was primary large (non-small) cell carcinoma.

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**Fig. 5:** Showed biopsy planning according to the site of the lesion in relation to the bronchial tree in the virtual bronchography (VB).

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<table>
<thead>
<tr>
<th>VB findings</th>
<th>Number of patients</th>
<th>Recommended management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass lesion obstructing single lobar bronchus</td>
<td>1</td>
<td>FOB– guided trans-bronchial biopsy</td>
</tr>
<tr>
<td>Mass lesions obstructing more than one lobar bronchus</td>
<td>3</td>
<td>FOB– guided trans-bronchial biopsy</td>
</tr>
<tr>
<td>Mass lesions obstructing single segmental bronchus</td>
<td>3</td>
<td>FOB– guided trans-bronchial biopsy</td>
</tr>
<tr>
<td>Mass lesions obstructing more than one segmental bronchus</td>
<td>1</td>
<td>FOB– guided trans-bronchial biopsy</td>
</tr>
<tr>
<td>Mass lesions obstructing single subsegmental bronchus</td>
<td>12</td>
<td>FOB– guided trans-bronchial biopsy</td>
</tr>
<tr>
<td>All bronchi are patent</td>
<td>1</td>
<td>CT– guided biopsy</td>
</tr>
<tr>
<td>Regressed lesion regarding size or degree of opacity</td>
<td>5</td>
<td>Follow up</td>
</tr>
</tbody>
</table>

**Fig. 6:** Showed the results of histo-pathological examination.

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Conclusion

Multiplanar reconstruction images together with virtual bronchographic images were accurate CT map, in detection of lesion's site, degree of narrowing, and distal visualization of airways. So, it should be used to guide bronchoscopy or to direct trans-bronchial needle biopsy to guarantee positive histopathological results.
Personal information

Mona Ahmed Fouad Hafez, MD

Lecturer of radiodiagnosis at Cairo university medical school- Cairo- Egypt

Kasralainy street, Cairo, Egypt

Postal code: 11562

Phone: +201006856286

e-mail: mona.fouad@kasralainy.edu.eg
References


