Image analysis of pediatric post-infectious bronchiolitis obliterans on 128-slice dual source CT by using high-pitch flash scan

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Aims and objectives

Bronchiolitis obliterans (BO) is a rare form of chronic obstructive lung disease following a severe insult to the small airways. It is characterized by inflammation and fibrosis of the terminal and respiratory bronchioles resulting in narrowing or obliteration of the airway lumen, which traditionally be confirmed by bronchography or histology from a lung biopsy [1-3]. The most frequent clinical manifestations are progressive dyspnea and dry cough, and various aetiologies including lower respiratory infection, organ transplantation, connective tissue disease, toxic fume inhalation, chronic hypersensitivity pneumonia, aspiration, drugs and Stevens-Johnson syndrome (SJS) had been reported. However, the pathogenesis of BO is not well known [4-6].

Post-infectious bronchiolitis obliterans (PBO) is generally the most common type of BO in children, it was first described in 1901 by German pathologist Lange and adenoviral (AV) infection was suggested as the most common etiology [3,7]. Although there was great harm of PBO on children, early diagnosis of this disease is difficult because of the scarce clinical data, poor imaging examination and laboratory tests. It can be misdiagnosed as asthma, pneumonia and other diseases. As reported, PBO can be first detected on CT in patients with no apparent symptoms or with symptoms secondary to associated conditions such as bronchiectasis or asthma [2]. High-resolution CT is now recognized as an important tool in the assessment of patients with suspected or proven BO [8,9,10]. However, due to the inevitable respiratory effects and radiation dose, it has not been widely used in small children.

The second generation dual-source CT with high pitch Flash scanning mode can finish a chest scanning in 0.5-0.7 second, so as to effectively eliminate pediatric respiratory and cardiac motion artifacts, and obtained high quality images. Besides, radiation dose was also obviously decreased [11]. Therefore, we retrospectively analyzed the radiological features of PBO on DSCT images, our purpose was to suggest a new effective method for PBO diagnosis, and try to describe the key aspects on HRCT imaging.
Methods and materials

This study was approved by our institutional review board and written informed consent was obtained from the parents of all the children. From January 2011 to August 2014, a total of 37 cases diagnosed with PBO in our hospital were retrospectively reviewed. Children included in the study were range from 4 months to 4 years (mean age: 18 months, 27 boys, 10 girls). The diagnosis of PBO was based on previously published criteria [5], and all patients had an acute lower respiratory infection (ALRI) with persistent obstructive respiratory disease after the initial event, which was not responsive to treatment for a period longer than 6 weeks. Other causes of chronic obstructive pulmonary disease, including tuberculosis, bronchopulmonary dysplasia, cystic fibrosis, aspiration of foreign bodies, AIDS, cardiac diseases, and other immune function defects were excluded.

All patients were examined on a 128-slice DSCT by using high-pitch flash scan mode. Scanning parameters were as follows: tube voltage 100kV, tube current with automatic tube current adjustment technology (Care dose 4D on), pitch = 3.0, 128×0.6mm slice acquisition, 0.28 seconds gantry rotation time. All children were conducted effective radiation protection. CTDIvol and DLP were recorded and the ED was calculated.

The main abnormal signs were detailed analyzed by two radiologists. If there is a dispute, agreement was obtained through consultation. The whole lung was divided into six lobectomys and seventeen lung segment (left lung tongue lobe as a separate lung segment). The radiological features on DSCT images were analyzed as following: bronchial wall thickening, bronchiectasis, hyperlucency, air trapping, pulmonary vascular attenuation and areas of collapse, bronchiolectasis and/or accompanied inflammation. Degree of the air trapping was divided into four grades: grade # more than 12 lung segment, grade # 50 ~ 75% (8 ~ 12 lung segment), grade # 25-50% (4 ~ 7 lung segment), grade # < 25% (4 lung section below).
Results

All patients were successfully examined with a low radiation dose (ED: 1.36 ± 0.25mSv), without any artifacts caused by breathing and heart beat (Fig.1). Air trapping was the most common finding that performed as mosaic sign (100%) (Fig.2,3), followed by bronchial wall thickening (97.30%) (Fig.4) and inflammatory exudative lesions(83.78%) (Fig.5).

The frequencies of main signs were as following: bronchial wall thickening in 36 cases (97.30%), bronchiectasis in 11 cases (29.73%), air trapping in 37 cases (100%), mucus plugging in 24 cases (64.86%), bronchiolectasis in 12 cases (32.43%), accompanied with inflammatory exudative in 31 cases (83.78%). There were three types of lung markings change in air trapping areas: attenuation in 22 cases (59.46%) (Fig.6), normal in 11 cases (29.73%) (Fig.7) and slightly increased in 4 cases(10.81%) (Fig.8).

The lesion distribution characteristics were: bronchial wall thickening involve all lung segments in 32 cases (86.49%), lower lobe was the most commonly occurred part; bronchiectasis most commonly occurred in the posterior basal segment of the left lower lobe (8/37,21.62%); air trapping involve 12 or more lung segments in 30 cases (81.54%), while involving all lung segments in 25 cases (67.57 %), similar to mucus plugging, the posterior basal segment of the left lower lobe was their most commonly involving part, which were in 37 cases (100%) and 18 cases (48.65%).
Fig. 1: Comparing to regular HRCT image there is no artifacts caused by breathing and heart beat on DSCT imaging scanning with flash mode.

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**Fig. 2:** Fig.2 Air trapping displayed as mosaic sign on axis images.

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Fig. 3: Fig.3 Air trapping displayed as mosaic sign on minMIP image.

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**Fig. 4:** Fig.4 Bronchial wall thickening of the right lower lobe.

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**Fig. 5:** Fig.5 Inflammatory exudative lesion accompanied in a PBO patient with diffuse air trapping.

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Fig. 7: Lung markings demonstrated attenuation in air trapping areas.

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**Fig. 6:** Fig.6 Lung markings displayed normal in air trapping areas.

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**Fig. 8:** Lung markings displayed slightly increased in air trapping areas.

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Conclusion

Our results suggest that air-trapping signs, period of bronchial wall thickening, bronchiectasis, enlargement of bronchi, and bronchioles expansion are the main CT signs of pediatric PBO, which can be accurately displayed with a low radiation dose. DSCT with high-pitch flash scan mode can be an accurate and very useful tool for pediatric PBO diagnosis.
References


