Clinical Case Report

Medicine®

OPEN

Diagnostic value of using multiplanar reformation images

Case report for rare endotracheal hamartomas

Zhiming Xiang, MD[a,*], Zhu Ai, MD[a], Guimian Zhong, MD[a], Yu Deng, MD[b], Harshawn Malhi, MD[c], Suzanne Palmer, MD[c], Chishing Zee, MD[c]

Abstract

Rationale: Pulmonary hamartomas are the most common benign tumor of the lung. Two types of pathologically similar hamartomas exist based on their location. These tumors have a low incidence, are rarely reported and frequently misdiagnosed because of lack of familiarity and/or understanding concerning their imaging features.

Patient concerns: Seventeen patients received treatment between June 2007 and May 2013 and had complete medical records. All of them had different degrees of cough and expectoration. Other symptoms include fever (5 cases), hemoptysis (4 cases), chest pain (3 cases), shortness of breath (2 cases), and dyspnea (1 case).

Diagnoses: These patients all have pathologically confirmed, and informed the diagnosis of endobronchial hamartoma.

Interventions: Unenhanced and enhanced CT scans were performed using Toshiba Aquilion 64-slice and GE Lightspeed 64-slice CT scanners. The scan was performed from the superior thoracic aperture to the lateral costophrenic angle. The transaxial CT data was inserted into a Volume Wizard workstation to reconstruct images using MPR technique.

Outcomes: The relationship between the location of the tumor and bronchi was clearly displayed on the axial images in only 2 patients. In all 17 patients, reconstructed MPR images were able to display the tumor parallel to the long axis of bronchi, thus facilitating in tumor identification and positioning along the bronchial tree.

Lessons: MPR images are valuable tools in the diagnosis of endobronchial hamartomas. Chiefly, these reconstructions aid in the detection of intratumoral fat/calcification and clearly demonstrate the tumors relationship and effect with the adjacent bronchi.

Abbreviations: MPR = multiplanar reformation, MSCT= multislice computed tomography.

Keywords: body section radiography, computed tomography, computer-assisted, endotracheal hamartoma, image processing, x-ray computer

1. Introduction

Pulmonary hamartomas are the most common benign tumor of the lung. They account for 1.5% to 3.0% of all lung tumors and are either parenchymal or endobronchial in location.[1] Endobronchial hamartomas are rare and easily misdiagnosed owing to their similar CT appearance of other endobronchial lesions, such as central lung cancer, endobronchial tuberculosis, bronchial polyps, bronchial adenomas, and foreign bodies in the bronchus. With recent advances in CT post-processing technology, spiral 3-dimensional CT reconstruction technique has been increasingly applied in the evaluation and diagnosis of tracheobronchial lesions. It has been suggested that multiplanar reformation (MPR) technique of multislice CT (MSCT) can help elucidate the relationship between the location of the tumor and bronchi, in addition to better characterizing the lesion itself, thus facilitating in narrowing the differential diagnosis and diagnosis of tracheobronchial lesions.[2–5] This study retrospectively analyzed the original axial images and the reconstructed MPR images of 17 patients with pathologically confirmed endobronchial hamartoma, with the primary aim to discover what features of this specific lesion are better characterized using MPR techniques.

2. Materials and methods

2.1. Clinical data

This study was approved by the Ethical Committee of Guangzhou Panyu Central Hospital.

Seventeen patients with pathologically confirmed endobronchial hamartoma were retrospectively analyzed. These patients received treatment between June 2007 and May 2013 and had complete medical records. Among these 17 patients, 13 were male and 4 were female, with an average age of 70 (range, 25–81) years. All of them had different degrees of cough and

Editor: Sergio Gonzalez Bombardiere.

This research was supported by grants from National Natural Science Foundation of China (No. 81671853), Natural Science Foundation of Guangdong (No. 2015A030313753), Science and Technology Program of Guangzhou (No. 201510010002), and Panyu Science and Technology Program of Guangzhou (No. 2014-Z03-24; No. 2017-Z04-12).

The authors have no conflicts of interest to disclose.

[a] Department of Radiology, Panyu Central Hospital of Guangzhou, Guangzhou, P. R. China, [b] Department of Radiology, The First Affiliated Hospital of Guangzhou Medical University, Guangzhou, P.R. China, [c] Department of Radiology, Keck Medical Center of USC, Los Angeles, CA.

[*] Correspondence: Zhiming Xiang, Department of Radiology, Panyu Central Hospital of Guangzhou, 8 Fu Yu Dong Road, Panyu District of Guangzhou, Guangzhou 511400, P.R. China (e-mail: xzmgz@126.com).

Medicine (2017) 96:40(e8231)

Received: 13 January 2017 / Received in final form: 16 August 2017 / Accepted: 14 September 2017

http://dx.doi.org/10.1097/MD.0000000000008231

expectoration. Other symptoms include fever (5 cases), hemoptysis (4 cases), chest pain (3 cases), shortness of breath (2 cases), and dyspnea (1 case).

2.2. CT technique

Unenhanced and enhanced CT scans were performed using Toshiba Aquilion 64-slice and GE Lightspeed 64-slice CT scanners. Scanning parameters: both slice thickness and interval 1.25 mm; collimation width 64 × 0.5 mm or 64 × 0.625 mm; field of view 35 × 35 cm; voltage 125 kV; current 100 to 500 mA (noise index 8, current automatically adjusted). The scan was performed from the superior thoracic aperture to the lateral costophrenic angle. An optimal amount of nonionic contrast medium (iopromide or iopamidol at 370 mgI/mL; 1.5 mL/kg body weight), followed by 30 mL of physiological saline was intravenously injected at a flow rate of 3 mL/s into the dorsal metacarpal vein using a double-tube high pressure syringe. The transaxial CT data was inserted into a Volume Wizard workstation to reconstruct images using MPR technique. The standard level of bronchi was designated as the oblique section that passes through bronchial central long axis.

2.3. Image analysis

All CT images were reconstructed and retrospectively evaluated in consensus by 2 experienced radiologists with expertise in chest radiology. Tumor size, shape, density, and its location in relation with adjacent bronchi, mediastinum, and adjacent pulmonary tissue were recorded.

3. Results

3.1. CT findings of tumor foci

Location: Ten patients had an endotracheal hamartoma located in the right lung (3 in the intermediate bronchus, 3 in the upper lobe bronchus, 3 in the middle lobe bronchus, and 1 in the lower lobe bronchus), and 7 patients had an endotracheal hamartoma located in the left lung (2 in the main bronchus, 2 in the upper lobe bronchus, and 3 in the lower lobe bronchus) (Table 1). Tumor size (a minimum trans-sectional diameter): 8 (range, 6–15) mm. Tumor focus morphology: mainly round, quasi-circular, or elliptical in appearance with a smooth surface (Fig. 1). Density: most foci exhibited soft tissue density (CT values of 30–75 HU), fat density (13 cases; CT values −25 to −56 HU), and punctate calcifications (13 cases; Fig. 2). Enhancement degree: the enhancement value in all 15 patients was <15 HU (Fig. 3).

3.2. Relationship between the location of tumor focus and bronchi

The relationship between the location of the tumor and bronchi was clearly displayed on the axial images in only 2 patients. In these 2 cases, the tumor was parallel to the long axis of the bronchi, aiding the location detection. In particular, it is more difficult to determine the precise relationship between tumor and bronchi on the axial images in cases of bronchial wall thickening (especially obstructive pneumonia) because small foci are easily concealed in these scenarios, but interestingly, no case demonstrated bronchial wall thickening in our series.

In all 17 patients, reconstructed MPR images were able to display the tumor parallel to the long axis of bronchi, thus facilitating in tumor identification and positioning along the bronchial tree. MPR images showed that most of the hamartomas are attached to the bronchi with a narrow base. Most of the tumors demonstrated acute angles in relation to the bronchi. Finally, MPR reconstructions showed that most tumors existed along bronchial walls that were not thickened and that bronchial fragmentation was not observed (Fig. 4) (Tables 2 and 3).

Table 1

The distribution of the endotracheal hamartoma.

Location	Intermediate bronchus	Main bronchus	Upper lobe bronchus	Middle lobe bronchus	Lower lobe bronchus
Right lung	3		3	3	1
Left lung		2	2		3

3.3. Other findings

MPR images showed that various degrees of obstructive pneumonia and atelectasis developed near the tumor focus in 15 of the patients (Fig. 5). The reconstructions also displayed various degrees of tumor-related bronchial lumen narrowing. Of note, no pulmonary hilar or mediastinal lymphadenopathy was observed in the 17 patients studied.

3.4. Pathological findings

Optical microscopy results showed that the hamartomas in all 17 patients consisted of cartilage, smooth muscle, bronchial gland, and fibrous connective tissue (Fig. 6). Fifteen of the tumors contained fat and 14 of the tumors contained calcifications. Of note, the fat and calcifications in these tumors were able to be detected on the MPR images.

4. Discussion

Pulmonary hamartoma, first described by Albrecht in 1904, is defined as “tumor-like malformations” because it is a benign lesion which consists of a heterogeneous mix of tissue that normally resides at the site. Two types of pathologically similar hamartomas exist based on their location: parenchymal (ie, lung) and endobronchial.[6] These tumors have a low incidence, are rarely reported and frequently misdiagnosed because of lack of familiarity and/or understanding concerning their imaging features.[5,7]

Using MPR images can be advantageous in the evaluation of endobronchial lesions.

Based on axial images, MPR images are harvested by reconstructing 2-dimensional volume elements in the region of interest. MPR images can be reconstructed secondarily in arbitrary planes from the stack of 2-dimensional images. Therefore MPR images can enhance the visualization of the various tracheobronchial pathways. This in turn aids in displaying not only characteristics of the tumor, but also the tumors relationship and location with the trachea and bronchi. In addition, features of the adjacent bronchi are also more clearly demonstrated. This includes possible bronchial wall thickening, bronchial wall deformity and improved delineation of the more distal or downstream bronchi.[8,9] The reconstructions also aid in evaluating tumor bulk and any associated degree of bronchial luminal narrowing.[3,10]

4.1. Value of MPR in the diagnosis and differential diagnosis of endobronchial hamartoma

MPR images were superior to the original axial CT images in demonstrating hamartoma morphology, size, and relationship

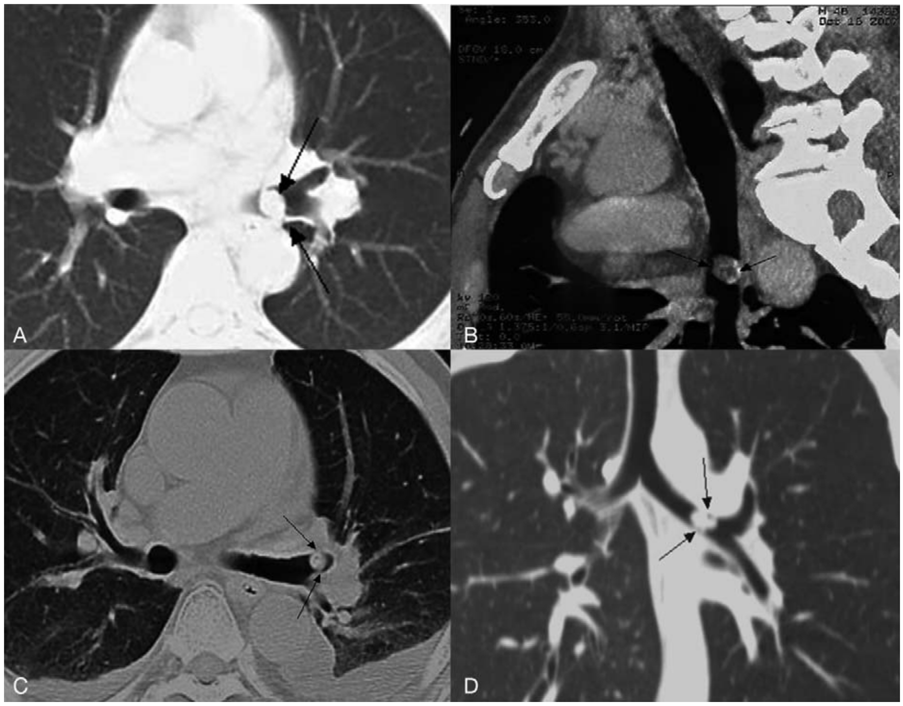

Figure 1. (A–D) Example of an endobronchial hamartoma (arrows). Note the smooth surface and well-defined border, narrow base/stalk connection to the bronchial wall and absence of the adjacent bronchial wall thickening.

with the tracheobronchial wall in all 17 of the patients in this study.

The axial CT images (with the exception of those just parallel to the bronchial long axis) are sufficient in simply showing that a tumor is present. The axial images were suboptimal in demonstrating the relationship with the adjacent bronchial wall, especially tumor extension into the wall.

Another limitation of evaluating hamartomas on axial CT images only is in the setting of secondary obstructive atelectasis. Often, depending on the degree of consolidation, the tumor can

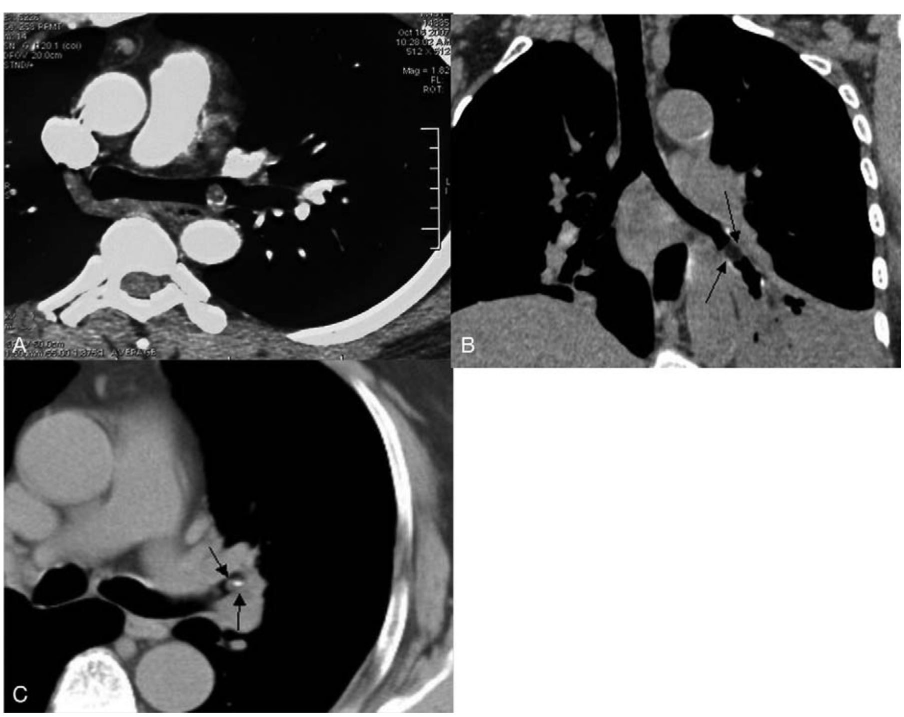

Figure 2. (A) Fat and/or calcified components within a hamartoma (arrows) (B) punctate calcification in the tumor focus, and (C) fat component in the tumor focus. Note the post-obstructive atelectasis (white arrow).

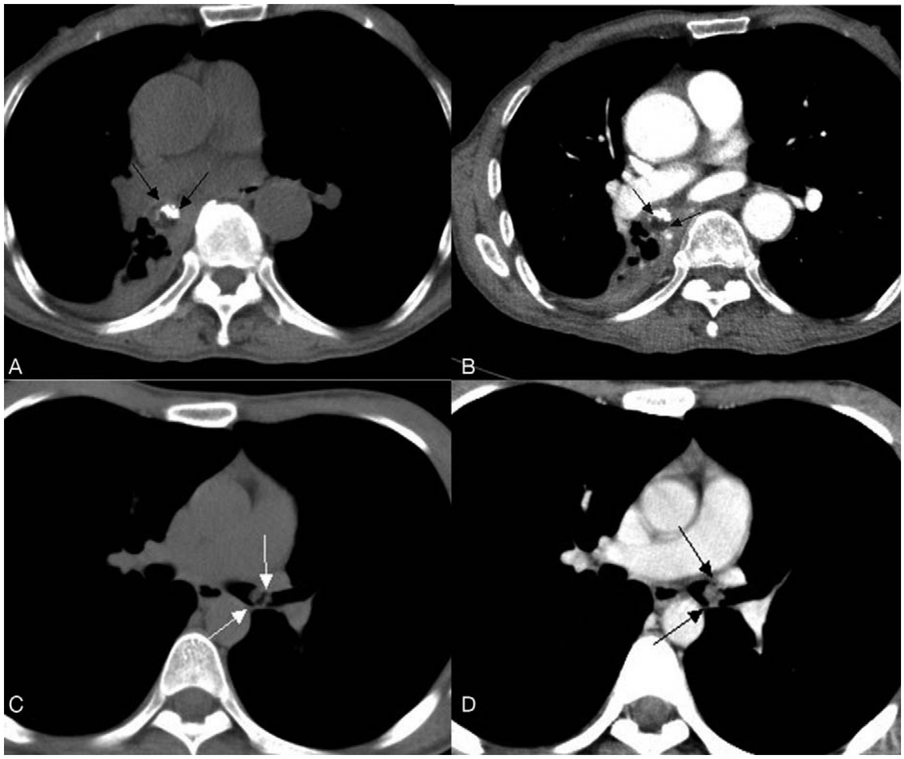

Figure 3. (A–D) Endobronchial hamartoma demonstrating patchy areas of enhancement after intravenous contrast administration (A and B from one case, and C and D from another case).

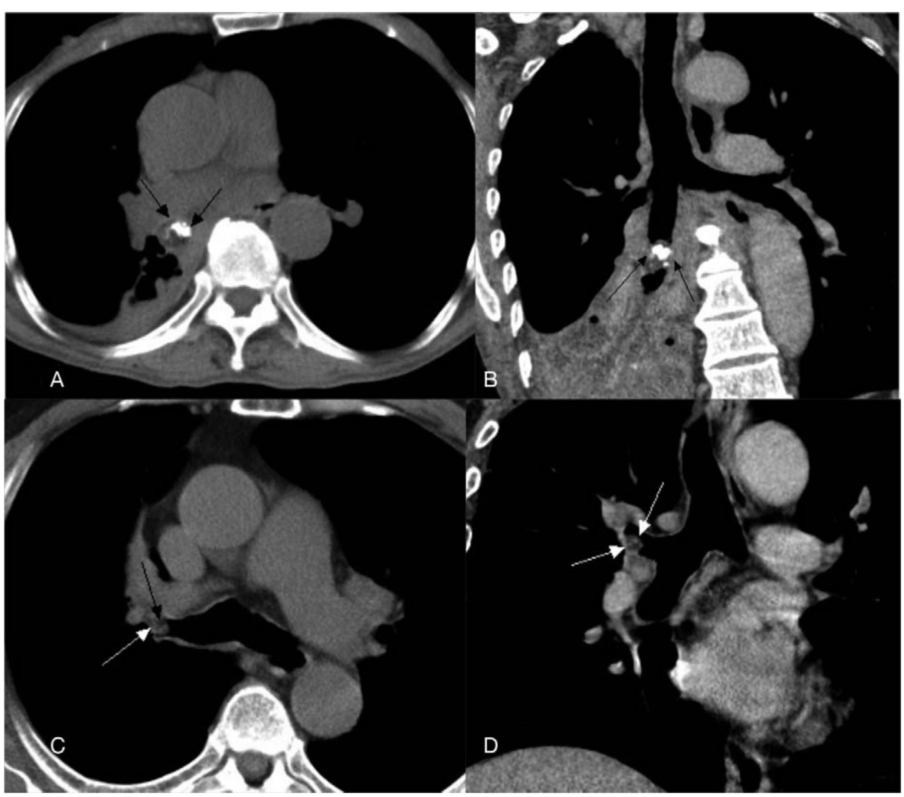

Figure 4. (A–D) Advantages of using MPR images (A and B are from one case, and C and D are from another case). (A) and (C) are axial CT images that demonstrate the hamartoma, but the axial images cannot clearly display the relationship between the location of the tumor focus and adjacent bronchus and the lack (or presence) of bronchial wall thickening. (B) and (D) are MPR images which are parallel to the bronchial long axis and clearly display the acute angles included between the tumor focus and adjacent bronchial wall. These images also help demonstrate lack of adjacent bronchial wall thickening or discontinuity, features that aid in the diagnosis of a benign hamartoma. MPR = multiplanar reformation.

Table 2

The comparison of 2 techniques for tumor relationship and possible involvement with the adjacent bronchial wall.

Group	Clear display	Display deficiency
Routine scan	2	15
MPR	17	0

MPR = multiplanar reformation.

be obscured in the axial planes. MPR images can help elucidate the degree of tumor narrowing within the bronchi and thus cause of the obstructive atelectasis.

In all 17 of the patients, the MPR images were useful in defining some of the typical benign features of hamartomas. These include: the presence of well-defined borders, a smooth surface, narrow stalk connection to the bronchial wall, lack of disruption of the adjacent bronchial wall, presence of an acute angle between tumor and bronchial wall, and incomplete bronchial occlusion. These findings are in keeping with the benign characteristics previous studies have described.[5,7,11] Finally, the MPR images aided in detecting fat and calcification which the tumors. These features are diagnostically important in that their presence suggests lesion benignity.[7]

4.2. Malignant endobronchial tumors

Other studies have demonstrated MPR images also aid in differentiating malignant versus benign endobronchial tumors. Features of malignant tumors include: wide base, irregular borders, and adjacent bronchial wall thickening. Specifically, a previously study reported that the mean increased thickness of

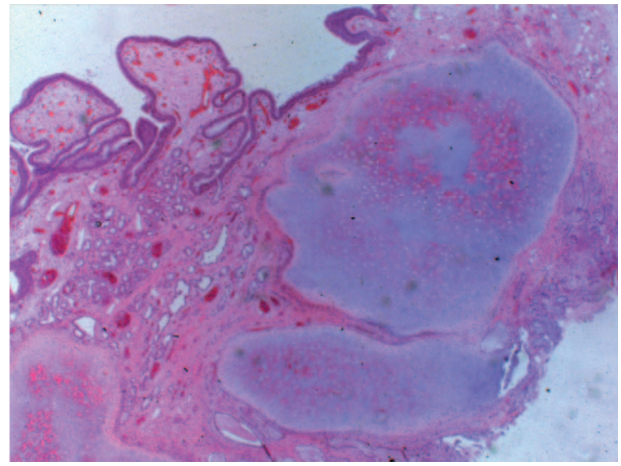

Figure 6. Pathological slide of the hamartoma, which consists of a large amount of cartilage and a small amount of bronchial gland and smooth muscle tissue (hematoxylin-eosin staining, ×25).

adjacent tracheobronchial wall in malignant endobronchial tumor patients was about 5.83 mm.[3]

4.3. Differential of hamartomas

The primary differential consideration for a benign hamartoma is an endobronchial polyp or adenoma. On imaging in general, it can be difficult to differentiate between these 2 entities. MPR images can assist in differentiating these lesions in that polyps and adenomas do not contain fat and/or calcifications. In the scenario

Table 3

The comparison between axial images and MPR.

	Tumor size, mm	Shape	Density	Punctate calcifications	Fat	Enhancement degree	Tumor relationship with adjacent bronchial wall
Axial images	8 (range, 6–15)	Mainly round, quasi-circular, or elliptical	Soft tissue	13 cases	13 cases	<15 HU	Display deficiency
MPR	8 (range, 6–15)	Mainly round, quasi-circular, or elliptical	Soft tissue	13 cases	13 cases	<15 HU	Narrow base, acute angles, bronchial walls were not thickened, bronchial fragmentation was not observed

MPR = multiplanar reformation.

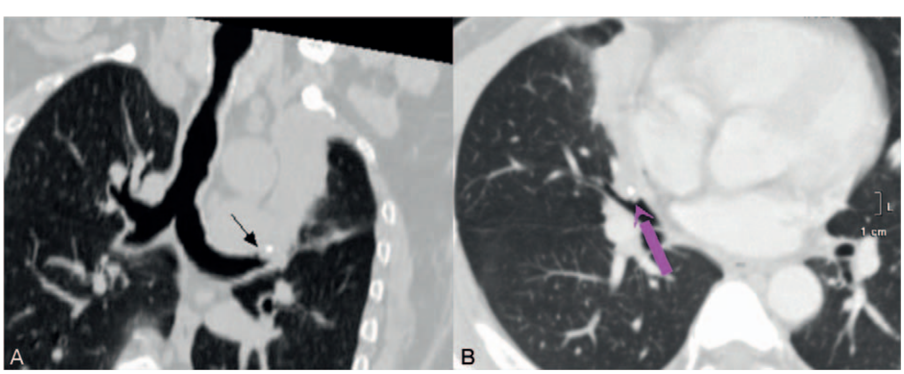

Figure 5. (A, B) Example of a partially calcified hamartoma resulting in complete luminal narrowing and secondary post-obstructive atelectasis, specifically the right middle lobe (white arrow).

where there is an atypical hamartoma (sans fat and or calcification), it can be very difficult to distinguish on imaging solely. In these situations, bronchofibroscopy is necessary for definitive diagnosis.

In summary, MPR images are valuable tools in the diagnosis of endobronchial hamartomas. Chiefly, these reconstructions aid in the detection of intratumoral fat/calcification and clearly demonstrate the tumors relationship and effect with the adjacent bronchi.

References

[1] Zhu YY, Chen WB. Respirology. 2003;People's Medical Publishing House, Beijing:1057–59.
[2] Cui Y, Ma DQ, Liu WH. Value of multiplanar reconstruction in MSCT in demonstrating the relationship between solitary pulmonary nodule and bronchus. Clin Imaging 2009;33:15–21.
[3] Han Y, Cai CZ, Ma DQ. Differential diagnostic value of MSCT with multi-planar reconstructions in rare intra-trachea and main bronchial tumor. Chin J Med Imaging Technol 2009;25:620–2.
[4] Luo MY, Shan H, Jiang ZB, et al. Diagnosis of multidetector spiral CT and its reconstruction techniques in trachea and principal bronchus tumors. Chin J Radiol 2003;37:1156–60.
[5] Zhang GM, Zhang JE, Zhao ZJ. CT findings of endobronchial hamartoma. Chin J Radiol 2011;45:594–6.
[6] Rosal J. Ackerman's Surgical Pathology. 2006;Peking University Medical Press, Beijing:406–7.
[7] Kim SA, Um SW, Song JU, et al. Bronchoscopic features and bronchoscopic intervention for endobronchial hamartoma. Respirology 2010;15:150–4.
[8] Siegel MJ. Multiplanar and three-dimensional multi-detector row CT of thoracic vessels and airways in the pediatric population. Radiology 2003;229:641–50.
[9] Chooi WK, Matthews S, Bull MJ, et al. Mutislice helical CT: the value of multiplanar image reconstruction in assessment of the bronchi and small air ways disease. Br J Radiol 2003;76:536–40.
[10] Boiselle PM, Reynolds KF, Ernst A. Multiplanar and three-dimensional imaging of the central airways with multidetector CT. AJR Am J Roentgenol 2002;179:301–8.
[11] Cosío BG, Villena V, Echave-Sustaeta J, et al. Endobronchial hamartoma. Chest 2002;122:202–5.