Radioanatomical study of the bronchovascular anomalies of the middle and lower lobes of the right lung using multidetector computed tomography

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Radioanatomical study of the bronchovascular anomalies of the middle and lower lobes of the right lung using multi-detector CT

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Abstract

Objective

Preoperative evaluation of bronchovascular structures is useful for prevention of accidents in pulmonary lobectomy. The purpose of this study was to examine the frequency and multi-detector row-computed tomography (MD-CT) appearances of bronchovascular anomalies between the right middle and lower lobes.

Methods

1116 consecutive chest CT examinations were analyzed in the present study. On display, the bronchovascular anomalies between the right middle and lower lobes were searched. When anomalous structures were observed, three-dimensional images were reconstructed.

Results

Sixty-seven cases with anomalous findings (6.0%) were observed. In 20 patients (1.79%), the right middle lobe bronchus and artery supplied the lower lobe, while the lower lobe artery supplied the right middle lobe in 46 patients (4.12%). In one patient (0.09%), the above two patterns were observed concomitantly.

Conclusions

Anomalous bronchovascular structures between the right middle and lower lobes were

identified by MD-CT with an incidence of 6.0%. Knowledge of the frequency and CT features is useful for preoperative CT evaluation.

Introduction

In general, the pulmonary artery and bronchus supply each segment. Occasionally, some bronchovascular structures cross a boundary and enter into the adjacent lobe. Preoperative evaluation of the bronchovascular structures may be useful for prevention of accidents in pulmonary surgery [1, 2]. Computed tomography (CT) is used for evaluation of intrathoracic structures [3–5]. With the development of multi-detector row-CT (MD-CT), large volume data of the lung with thin slice thickness can be obtained in a short scan time. In addition, three-dimensional observation can be performed easily using the data [1, 2, 6–8].

As there are many bronchovascular anomalies between the right middle and lower lobes, knowledge of these anomalies is important. In the present study, we examined the frequency and MD-CT appearances of the anomalies.

Materials and Methods

In our hospital, routine chest CT examinations are performed by 8 Data Acquisition System (DAS) MD-CT (Aquilion, Toshiba Medical Systems, Tokyo, Japan) using a contiguous slice thickness of 2.0 mm with skip reconstruction of 1.0 mm and helical pitch of 7.0. Scan parameters were 2.0mm collimation, 120 kVp, and appropriate mAs due to automatic tube current modulation technique. No contrast material was used in most of the chest CT examinations. In the present study, we performed a retrospective analysis of 1116 consecutive chest CT examinations from January to June 2007. These CT examinations were performed for many reasons, including evaluation of lung metastasis, chest abnormal shadow, and great vessel disease. Patients with previous lung surgery were excluded from this study.

The raw data were transferred to a workstation. On display, two of the authors searched for bronchovascular anomalies between the right middle and lower lobes after consultation. In cases in which abnormal vessels and/or bronchi were detected on axial images, multiplanar reformation (MPR), maximum intensity projection (MIP), minimum intensity projection (MinIP), and volume rendering (VR) of the bronchovascular structures were performed. Three hundreds to four hundreds axial images per patient were analyzed.

Results

Of 1116 routine MD-CT examinations of the chest, 67 anomalous cases (6.0%) were observed. In 20 patients (1.79%), the middle lobe bronchus and artery supplied the right lower lobe, including the accessory inferior lobe (table1). In 16 of these patients, both branches A5 (medial segment artery of the middle lobe) and B5 (medial segment bronchus) descended into S7 (medial basal segment of the right lower lobe) in which A7 (medial basal segment artery) and B7 (medial basal segment bronchus) were present except for one patient (Fig. 1). In this latter case, A8 (anterior basal segment artery of the right lower lobe) and B8 (anterior basal segment bronchus) supplied S7. In one patient, only a branch of A5 descended into S7, while in one patient, not only branches of A4 (lateral segment artery of the middle lobe) and B4 (lateral segment bronchus) but also branches of A5 and B5 descended into the right lower lobe. In three patients, an anomalous bronchus originating from the middle lobe bronchus before B4 and B5 branching descended perpendicularly into the right lower lobe. The right lower pulmonary artery branch followed the bronchus (Fig. 2).

The lower lobe artery supplied the middle lobe in 46 patients (4.12%) (table2). The anomalous artery originated from the basal artery in 19 patients, the common trunk of A7 and A8 in 16 patients, A7 in 6 patients, and A8 in 5 patients (Fig. 3). The anomalous artery originating from the proximal portion of the right lower pulmonary artery was observed more frequently.

The anomalous artery supplied S4 in 20, S5 in 20, and both S4 and S5 in 6. No lower lobe bronchus entering the middle lobe was found. In most patients with the anomalous artery, the relevant middle lobe bronchus passed near the interlobar fissure and the anomalous artery followed it.

In one patient (0.09%), the above two patterns were observed concomitantly; an anomalous bronchus originating from the middle lobe bronchus before primary branching descended perpendicularly into the right lower lobe, A8 followed the bronchus, then divided into two branches, and one of these branches entered the middle lobe (Fig. 4).

In four patients (0.36%), the middle lobe bronchus descended into the inferior accessory lobe with the right lower lobe pulmonary artery (Fig. 5).

MPR images indicated a relationship between the major fissure and bronchovascular structures in each anomalous case. In addition, the anomalous artery and bronchus were well observed on MIP and MinIP images with an appropriate thickness. VR was useful for three-dimensional visualization of the anomalous arteries.

Discussion

Recently, MD-CT has been used as a useful diagnostic modality for whole-body imaging including the thorax. Large volume data with high *z*-axis resolution can be obtained by MD-CT with a short scan time. MPR or three-dimensional images with high quality can be obtained easily from these data [1, 2, 7, 8]. Therefore, MD-CT is used frequently for assessment of tumor extension, vascular lesions, and coronary disease in the thoracic cavity. In addition, the frequency of intrathoracic anomalies in a large series can be examined using MD-CT.

In the present study, retrospective analysis was performed in a large number of patients to determine the frequency of anomalies of the pulmonary artery and bronchus between the right middle and lower lobes. Although no anomalies were confirmed by surgical procedures because this was a retrospective study, a good correlation between CT appearance and pathological findings of the segmental abnormalities in the chest was reported previously by Otsuji et al. [3].

The right lung is composed of three lobes—the upper, middle, and lower lobes—with two interlobar fissures [9]. Each lobe of the lung is subdivided into several segments supplied by the pulmonary artery and bronchus and drained by the pulmonary vein. Video-assisted thoracoscopic surgery (VATS) is gaining in popularity as a technique for lobectomy in patients with lung cancer [10–15]. VATS lobectomy for lung cancer with a largely fused fissure was performed previously by Nomori et al. [16]. McKenna et al. concluded that VATS lobectomy with anatomic dissection could be performed with low morbidity and mortality rates [13]. They also reported minimal risk of intraoperative bleeding or recurrence. However, the authors experienced intraoperative bleeding in rare cases and converted to open thoracotomy [11–14]. Their reports included no description regarding the interlobar anomalous vessels and/or bronchi. However, preoperative recognition of interlobar anomaly may be required for reduction of the intraoperative risk.

Many anatomical and surgical manuscripts concerning the pulmonary artery and bronchus of the middle and lower lobe have been reported [17–19]. To our own knowledge, there have been three reports about interlobar abnormal vessels and/or bronchi [3, 6, 20]. Cory reported three cases in which the middle lobe received separate branches from the descending trunk of the pulmonary artery [20]; their report included no description of an incomplete interlobar fissure. Otsuji et al. reported the CT appearances of some cases in which the middle lobe bronchus entered the lower lobe or the arterial branch from the basal artery entered the middle lobe [3], while Ghaye et al. reported the CT appearance in a case with an anomalous bronchus from the middle lobe bronchus entering the lower lobe [6]. These two studies included descriptions of incomplete interlobar fissure.

In the present study, abnormalities of the vessels or bronchi between the middle and lower lobes were observed in 6.0% of cases. The frequency of the anomalous basal pulmonary arterial branch entering into the middle lobe was not particularly low at 4.2%. In middle lobe lobectomy, it is also necessary to dissect such anomalous arterial branches, while in lower lobe lobectomy, conservation of such branches is required to prevent middle lobe devascularization. Preoperative CT assessment of the interlobar abnormalities of the vessels and bronchi seems useful to reduce intraoperative risk. Especially, recognition of the anomalous arterial branch from the distal basal artery, such as A7and A8, may be valuable. Knowledge of the relatively high frequency of about 1% is also important.

The usefulness of VR in the management of lung cancer patients with arterial anomalies was reported previously [21]. In the present study, MIP, MinIP, and VR images of patients with such abnormalities were obtained. Visualization of continuity of the abnormal artery was difficult on MPR images alone. MIP images of various thicknesses were useful to show the arterial continuity and to visualize an interlobar fissure as a thin line with a surrounding avascular area. Bronchial structures were well visualized on MinIP images. In addition, VR showed the three-dimensional appearances of the abnormal bronchovascular structures. Prior to image reconstruction, careful observation of the axial CT images is required to obtain adequate preoperative information.

In conclusion, the pulmonary artery and bronchi rarely passed thorough the adjacent lobes. Sixty seven anomalous cases (6.0%) were observed in a total of 1116 routine MD-CT examinations of the chest. Knowledge of these abnormalities may be useful for the preoperative MD-CT evaluation of patients with planned lobectomy. More information of the bronchovascular anomalies can be obtained by use of image reconstruction methods, such as MPR, MIP, MinIP, and VR

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Legends

Table1　The frequency of anomalous branching

Table2　The origin of anomalous artery

Fig. 1 A 60-year-old man

Branches of the middle lobe artery and bronchus were seen to descend into S7 on axial CT images. The right B7 was absent. MPR image indicated a relationship between the major fissure and bronchovascular structures. The anomalous artery (short arrow) originating from the middle lobe artery was well visualized on MIP images, while a descending bronchus (long arrow) was visualized well on MinIP images. (Arrowheads indicate the major fissure).

Fig. 2 A 51-year-old woman

The anomalous bronchus (long arrow) originating from the middle lobe bronchus descended into the right lower lobe. A small arterial branch (short arrow) from the basal artery followed the bronchus.

Fig. 3 Origin of the lower pulmonary arterial branch supplying the middle lobe

(a) The basal artery. (b) The common trunk of A7 and A8. (c) A7. (d) A8.

Fig. 4 A 50-year-old man

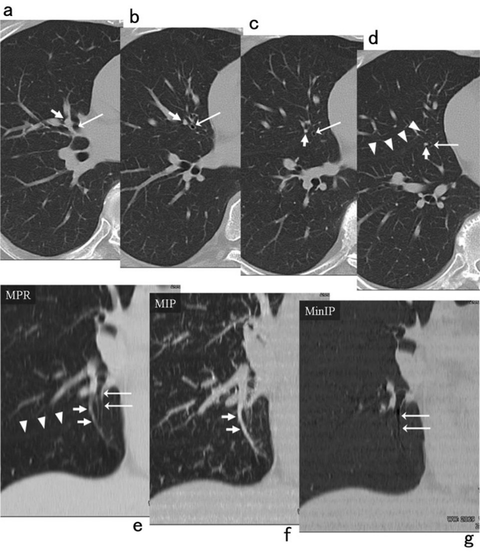
The middle lobe bronchus descended into S7. B7b was observed. The small artery (short arrow) originating from A8 bifurcated; one branch followed the descending bronchus (long arrow), while the other supplied the middle lobe. Although an incomplete major fissure was seen, the major fissure (arrowheads) was visualized at the more caudal level in which the above arterial branches were seen on both sides of the fissure. MPR and MIP images clearly showed both arterial branches (short arrow). The two arterial branches were observed more clearly on VR.

Fig. 5 A 41-year-old man

An artery (short arrow) originating from the basal artery and a bronchus (long arrow) from the middle lobe bronchus before primary (B4 and B5) branching descended perpendicularly into the accessory inferior lobe. MPR, MIP, and MinIP clearly showed the accessory fissure (arrowheads), anomalous artery, and bronchus.

Table

20 (**1.79**%) middle → lower	16 (artery and bronchus)	1 (A7&B7 aplasia)
		1 (A4,B4&A5,B5)
	1 (artery only)	
	3 (bronchus only)	
46 (4.12%) lower → middle	19 (from the basal artery)	
	16 (from common trunk 7&A8)	
	6 (from A7)	
	5 (from A8)	
1 (0.09%) middle ⇆ lower		
total 67 (6.0%)		


a
b
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MPR
MIP
MinIP
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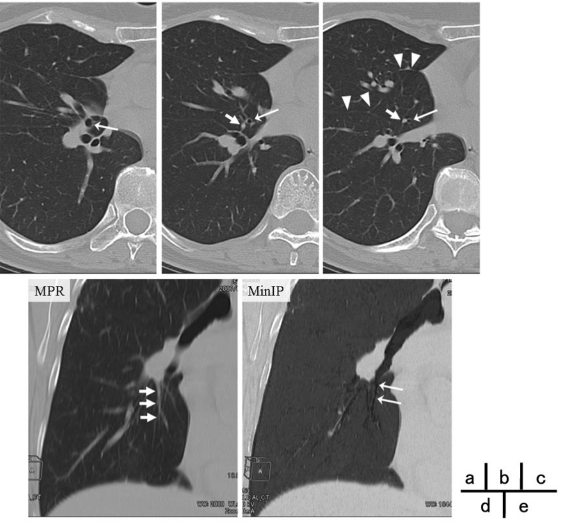
MPR
MinIP
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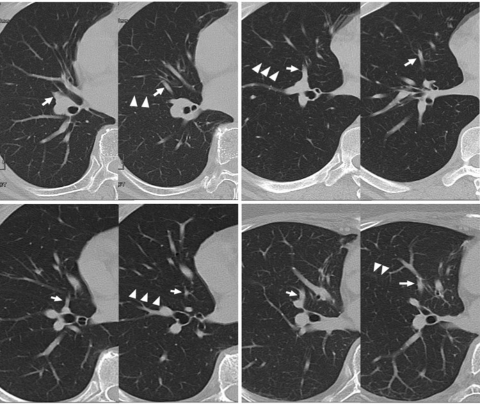
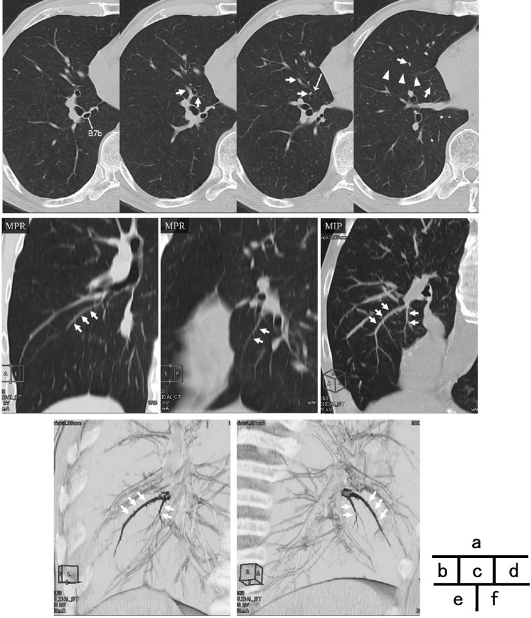


a	b
c	d


B7b
MPR
MPR
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a
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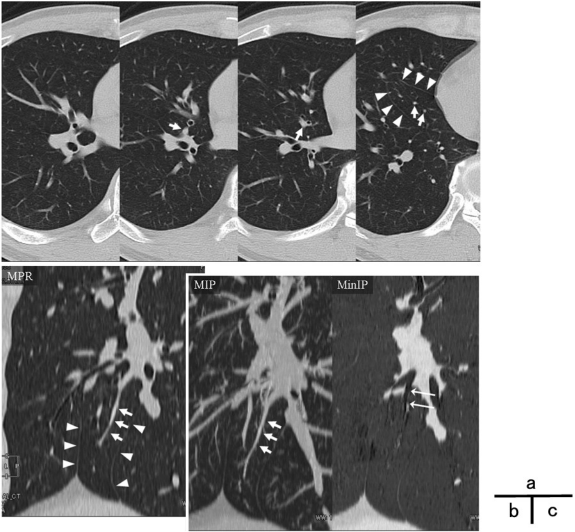

MPR
MIP
MinIP
a
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