

Relationship Between Pulmonary Hamartoma and Bronchus: Multislice Spiral Computed Tomography Findings

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Abstract

Objective

The aim of the present study is to investigate the relationship between pulmonary hamartomas (PHs) and bronchi on multislice spiral computed tomography (MSCT) images.

Methods

The MSCT scans of 218 PHs from 216 pathologically confirmed patients were reviewed. The PHs were divided into two groups, namely, the central endobronchial and intraparenchymal groups, in accordance with location. Multiplanar reconstruction was used to demonstrate PH–bronchus relationship patterns. The PH–bronchus relationships in the intraparenchymal group were classified into five patterns: type I, the bronchus was cut off by the tumor; type II, the bronchus was contained within the tumor (air bronchogram sign); type III, the bronchus ran at the tumor periphery or was compressed by the tumor; and type IV, no tumor–bronchus relationship was observed.

Results

Nine (4.1%) PHs were assigned to the central endobronchial group and 209 (95.9%) PHs were assigned to the intraparenchymal group. In the endobronchial group, 1 (11.1%) PH was located in the trachea with the partial stenosis of the trachea, whereas the remaining 8 (88.9%) PHs were located in the lobar or segmental bronchus with the complete occlusion of the corresponding bronchus. In the intraparenchymal group, type IV (147, 70.3%) was most common pattern, followed by type III (54, 25.8%). Type I (8, 3.8%) was rare, and type II was not observed.

Conclusion

Central endobronchial PHs often obstructed bronchi, whereas only a few intraparenchymal PHs cut off bronchi. No air bronchogram sign was observed.

1. Introduction

Pulmonary hamartomas (PHs) are the most common benign tumors; they account for approximately 6–8% of all solitary pulmonary nodules [1]. They are clinically divided into two types in accordance with location: intraparenchymal and endobronchial, with the latter being more frequent than the former [2]. If PHs are diagnosed through imaging, surveillance, rather than resection, is recommended given the absence of the evidence of malignant transformation during follow-up. Resection is considered if a lesion is clinically present or when a malignancy cannot be excluded [3]. Therefore, the imaging diagnosis of PHs is crucial, and the presence of detectable fat and/or popcorn calcification within the lesion on CT is

the most suggestive finding of PHs [1, 4]. However, approximately 50% of PHs show neither fat nor calcification on CT, complicating the differentiation of PHs from lung cancer or other benign nodules [1].

Multislice spiral computed tomography (MSCT) with thin-section scanning and multiplanar reconstruction postprocessing can clearly show grades 1–6 bronchi [5, 6]. The relationship between solitary nodules and bronchi on MSCT can reflect the pathological changes of nodules to some extent and is valuable for differentiating between benign and malignant nodules [5–14]. However, previous studies on benign nodule–bronchus relationships have some deficiencies [5–9]. First, the number of benign nodules is small. Second, benign nodules, including benign tumors, granulomatous inflammation, and other inflammatory lesions, are analyzed together and present at different proportions; this situation accounts for the different results for nodule–bronchus relationships obtained by different researchers [6–10]. Although PHs are common in clinical work, no large-sample study on PH–bronchus relationships on MSCT exists. Therefore, we performed a systematic study on the relationship between PHs and bronchi. We hope to provide further value for the diagnosis or exclusion of PHs.

2. Methods And Methods

2.1 Study Population

This retrospective study was approved by the institutional Ethics Committee, and the requirement for informed consent was waived. We collected 218 PHs from 216 cases (2 of the cases had 2 PHs each) that had been histologically proven through surgery (213) or bronchoscopy (5) between May 2008 to April 2020. The patients (110 males and 106 females) ranged in age from 28 years to 76 years (average age of 56.4 years).

2.2 Imaging Protocols

CT studies were routinely performed with an MDCT scanner (GE Light Speed 16, GE Light Speed 64, SIEMENS Somatom Sensation 64, PHLIPS Brilliance 64, or PHLIPS iCT 256). CT parameters were as follows: voltage of 120 kV; tube current of 240–300 mA; matrix of 512 mm × 512 mm, layer thickness of 5 mm; reconstruction thickness of 1 or 1.25 mm; lung window width of 1500 HU; lung window level of 550 HU; mediastinum window width of 350 HU; and mediastinum window level of 40 HU.

2.3 Evaluation of CT features

The locations of the PHs were recorded, and the PHs were divided into two groups, namely, the central endobronchial and intraparenchymal groups, in accordance with their location. Multiplanar reconstruction was used to demonstrate the patterns of PH–bronchus relationships.

The PH–bronchus relationships in the intraparenchymal group were classified into five patterns: type I, the bronchus was cut off by the tumor; type II, the bronchus was contained within the tumor (air bronchogram sign); type III, the bronchus ran at the tumor periphery or was compressed by the tumor; and type IV, no tumor–bronchus relationship was observed.

The internal fat and internal calcification of PHs in the central endobronchial group and in types I and II patterns in the intraparenchymal group were evaluated.

Two radiologists (with 10 and 12 years of experience in thoracic radiology) retrospectively reviewed the MSCT scans from PACS independently. Consensus was reached after mutual discussion in case of disagreement.

3. Results

Nine (4.1%) PHs were assigned to the central endobronchial group, and 209 (95.9%) PHs were assigned to the intraparenchymal group. For the endobronchial group, 1 (11.1%) PH was located in the trachea with the partial stenosis of the trachea (Fig. 1), whereas the remaining 8 (88.9%) PHs were located in the lobar (4 PHs) or segmental (4 PHs) bronchus with the complete occlusion of the corresponding bronchus. For 8 PHs in the lobar or segmental bronchus, 2 PHs were in the right upper lobe bronchus, 1 PH was in the right middle lobe bronchus, 1 PH was in the left upper lobe bronchus, 1 PH was in the posterior segment of the right upper lobe bronchus, 2 PHs were in the lingual segment of the left upper lobe bronchus, and 1 PH was in the dorsal segment of the left lower lobe bronchus. Two PHs contained fat and calcification (Fig. 1), 3 PHs contained fat only, 2 PHs contained calcification only, and 2 PHs contained no calcification or fat.

For the intraparenchymal group, 46 (22.0%) PHs were in the upper lobe of the right lung, 20 (9.6%) PHs were in the middle lobe of the right lung, 53 (25.4%) PHs were in the lower lobe of the right lung, 47 (22.5%) PHs were in the upper lobe of the left lung, 37 (17.7%) PHs were in the lower lobe of the left lung, and 6 (2.9%) PHs grew across lobes (3 PHs spanned the middle and lower lobes of the right lung and 3 PHs spanned the upper lobe and lower lobes of the left lung). A total of 114 (54.5%) PHs were peripherally located at distances of less than 5 mm from the pleura, and 76 (36.4%) PHs were attached to the pleura. Among the patterns of intraparenchymal PH-bronchus relationships, type IV (147, 70.3%) was most common pattern, followed by type III (54, 25.8%) and type I (8, 3.8%) (Fig. 2) patterns. No type II pattern was observed. For the type I pattern in the intraparenchymal group, 1 PH contained fat and punctate calcification; 1 PH contained fat only; 5 PHs contained calcification only (3 of which contained popcorn-like calcification [Fig. 2B], 1 contained scattered punctate calcification, and 1 contained striate calcification), and 1 PH contained no calcification or fat.

4. Discussion

This was the first large-sample study on the visualization of the PH-bronchus relationship on MSCT. We found that 88.9% (8/9) of central endobronchial PHs obstructed the bronchus, whereas only 3.8% (8/209) of intraparenchymal PHs obstructed the bronchus. No air bronchogram sign was observed.

Previous studies found that the sign wherein the bronchus is cut off by a lesion (type I) is significantly more common in lung cancers than in benign lesions [5, 6, 11]. Qiang et al. found that the type 1 pattern

is shown by 58.5% of malignant nodules and by only 16.0% of benign nodules [6]. Choi et al. reported that type I is most common pattern in squamous cell carcinoma; it is presented by 45.8% of squamous cell carcinomas and is especially common in central squamous cell carcinomas (55%) [11]. Bronchus amputation in lung cancer can be ascribed to two reasons. One is the destructive power of the tumor. Tumor cells proliferate and invade the surrounding lung parenchyma, destroying the lesion area and adjacent bronchi [6]. The other reason is that lung cancer arises mainly from the bronchial mucosal epithelium; therefore, the bronchus is easily cut off in the early stage [14]. Amputated bronchi also occur in inflammatory nodules, such as granulomatous inflammation or common inflammatory lesions, due to the filling of bronchi by mucinous or granulomatous tissue, the inflammation of bronchi, or the destruction of bronchi by the lesion [5, 6]. In this study, we found that the type I pattern was common in central endobronchial PHs (8, 88.9%) but was rare in intraparenchymal PHs (8, 3.8%). Central endobronchial PHs originate in the bronchi, leading to bronchial stenosis, peripheral inflammation, and the filling of bronchi by mucus. These phenomena lead to the type I sign. Only 1 central endobronchial PH in this study did not cut off bronchi because it was located in the trachea, which is wide, and the lesion itself was small. Moreover, no sign of infection was observed. We hypothesized that the bronchus might have been cut off by the intraparenchymal PH because of its origin in the bronchus. Specifically, as the tumor grew expansively, it amputated the small bronchus. Central endobronchial PHs should be distinguished from malignant tumors, especially squamous cell carcinomas. Other relatively rare diseases include infectious lesions and foreign bodies. Among the 9 central endobronchial PHs in this study, only 5 contained fat (2 of which were accompanied by calcification). This characteristic is helpful for the diagnosis of PHs on MSCT. Given that the type I sign was rarely observed for intraparenchymal PHs, we concluded that the presence of this sign in a solitary intraparenchymal lesion should preclude the first diagnosis of PHs. However, the presence of fat and/or popcorn-like calcification on CT is the suggestive finding of PHs. In this study, for type 1, fat was found in 2 intraparenchymal PHs and popcorn-like calcification was found in 3 intraparenchymal PHs. These characteristics are helpful for the diagnosis of PHs.

The air bronchogram sign is an important radiologic sign. Initial studies indicated that the presence of this sign is suggestive of pneumonia or benign nodules, but malignant tumors were also later found to be common [5–13]. The incidence of the air bronchogram sign in malignant solitary pulmonary nodules (28.7–81.5%) is usually higher than that in benign nodules (5–33.3%) [7–10]. In lung cancer, the air bronchogram sign is more common in adenocarcinoma, and different types of air bronchogram signs (normal, tortuous, and ectatic) are associated with the cell types and malignancy of adenocarcinoma [7, 8, 10–13]. In the early stage of adenocarcinomas, the growth pattern of tumors is mainly lepidic, tumor cells spread along the alveolar wall and the interalveolar septum, and the bronchi are surrounded but not destroyed, leading to an air bronchogram sign [6, 15]. Furthermore, with the retraction of tumoral fibrosis, the bronchi within the tumor are not only unobstructed and uncompressed but remain patent and even irregularly dilated [16, 17]. As their malignant degree increases, tumors may encroach on the walls of bronchi, causing the bronchi to become irregular, narrow, or truncate. In addition, the air bronchogram sign can be seen in inflammatory nodules, such as nodules associated with ordinary inflammation,

cryptococcus infection, and tuberculosis [6–9, 10, 18, 19]. Takanashi et al. reported that the air bronchogram sign is more frequently found in pneumonia (40%) than other lesions [8]. An air bronchogram sign is present in 63% of inflammatory pseudotumors in the findings of Qiang et al. [6]. Given that the early formation of inflammatory nodules is related to the exudation and consolidation of the alveolar space, bronchi can exist without being destroyed or filled, and some inflammatory nodules can produce contractile force due to the proliferation of fibrous tissue in the chronic stage; this effect causes bronchiectasis. Bronchi may be natural or dilated, narrowed, or amputated when filled with granulation tissue, mucus, or bleeding [20]. The present study included 209 intraparenchymal PHs, and none presented the air bronchogram sign likely because of the expansive, rather than invasive growth of PHs. Thus, changes to the bronchi were pushing rather than enveloping. Therefore, we concluded that PH should not be diagnosed if the air bronchogram sign is present in a solitary lesion.

Benign and malignant nodules can present the sign of bronchi run at the tumor periphery or are compressed by the tumor; compressed bronchi with walls that remain soft and intact are more common in benign tumors, whereas bronchi with rigid and thickened walls are more common in malignant tumors [6]. Given that PHs cannot invade the parenchyma, the bronchi around the nodule are usually patent or compressed, whereas in malignant nodules, tumor cells always infiltrate around the bronchial wall, resulting in wall rigidity and thickening [6]. In this study, 54 (25.8%) intraparenchymal PHs presented bronchi that ran at the tumor periphery or were compressed by the tumor. None of these PHs had rigid and/or thickened bronchi. In addition, the majority (147, 70.3%) of intraparenchymal PHs in this study lacked a tumor–bronchus relationship likely because most of the intraparenchymal PHs were located in the periphery of the lung, and the peripheral bronchi were small and difficult to observe on CT. In this study, 114 (54.5%) of the intraparenchymal PHs were located at distances of less than 5 mm from the pleura and 76 (36.4%) of the intraparenchymal PHs were attached to the pleura.

5. Conclusion

This study systematically analyzed the PH–bronchus relationship on MSCT with a large sample. Central intrabronchial PHs were prone to cutting off bronchi because of their location within the bronchi. Intraparenchymal PHs, which were mostly located around the periphery of the lung, were mostly unrelated to bronchi. Only a few PHs cut off bronchi, and no air bronchogram sign was observed.

Abbreviations

PH: pulmonary hamartoma; MSCT: multislice spiral computed tomography

Declarations

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Not applicable.

Authors' contributions

Conception and design: QY, CZ. Data Collection: PW, HM. Drafting of Manuscript: PW, HM. Manuscript Revision: QY, CZ. The authors read and approved the final manuscript. All authors contributed to the article and approved the submitted version.

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Availability of data and materials

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Ethics approval and consent to participate

This retrospective study was approved by the institutional Ethics Committee, and the requirement for informed consent was waived.

Consent for publication

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Competing interests

The authors declare that they have no competing interests.

Author details

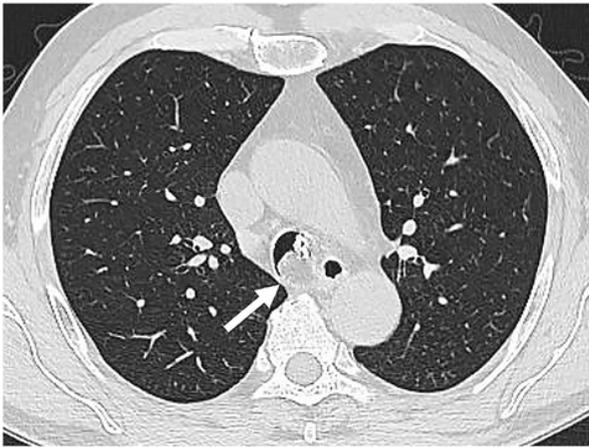
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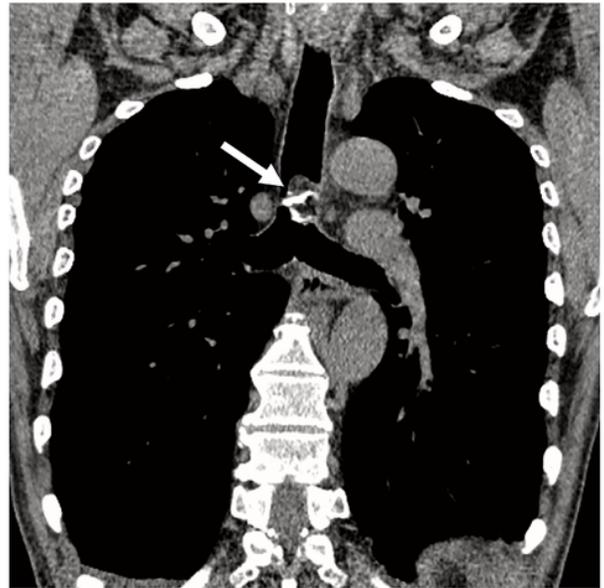
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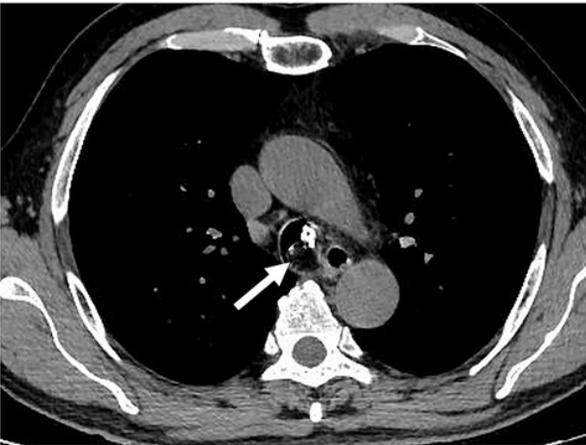
Figures



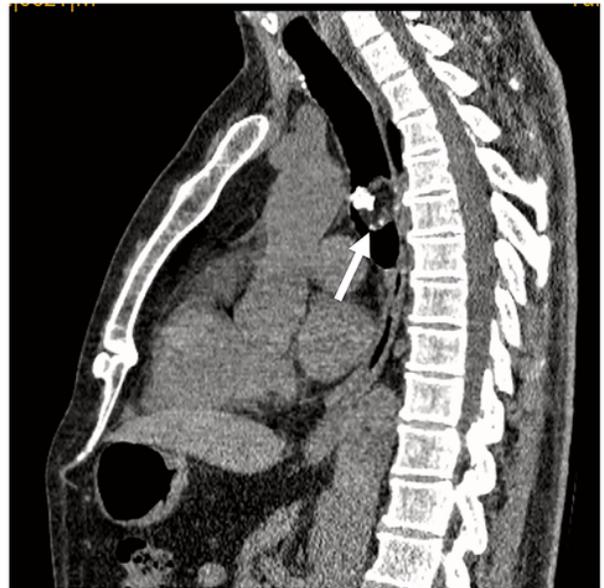
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C



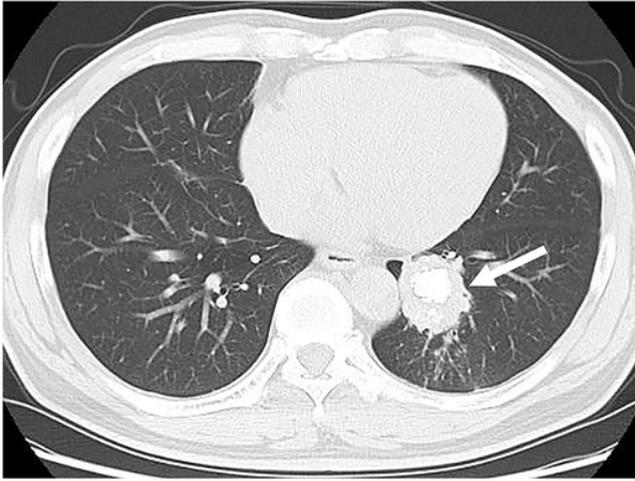
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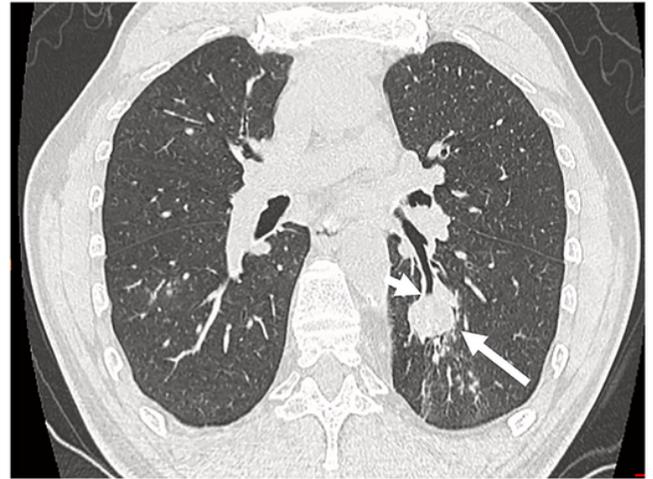
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Figure 1

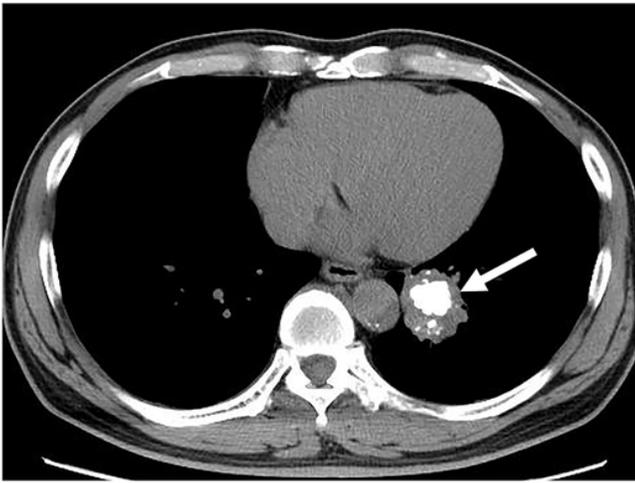
Endobronchial PH in a 62-year-old man. The PH was located in the trachea with the partial stenosis of the trachea (arrow). The PH was lobulated with a smooth border and contained fat and calcification



A



C



B

Figure 2

Intraparenchymal PH in a 55-year-old man. The PH was located in the lower lobe of the left lung (arrow), and the bronchus was cut off by the tumor (C, arrow head). The PH was lobulated with a smooth border and contained popcorn-like calcifications.