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Rare findings in high resolution computed tomography (HRCT) in interstitial lung diseases

High resolution computed tomography (HRCT) is an imaging method, achieving an optimal resolution of lung interstitium images. HRCT enables more accurate diagnosis of interstitial lung diseases, in which it is a diagnostic method of choice. A lot of pathological findings specific only for HRCT were described. Some of them are relatively rare, and therefore not well known. In some cases good knowledge of them is essential in making the correct diagnosis based on HRCT results.

The aim of the study was assessment of rare findings on HRCT, their morphology and diagnostic value in interstitial lung disease.

MATERIAL AND METHODS

The material comprises a group of 44 patients, 27 men and 17 women, aged between 26 and 71 years, in which the HRCT examination was performed because of interstitial lung diseases. The scanning was performed in prone, supine and lateral positions, from lung apices to the level of the diaphragm. The collimation of the scans was 2 mm, and the intervals measured 1 cm. Scans were performed at full inspiration; in cases of inhomogeneous lung densities additional expiratory sections were obtained.

RESULTS

In 9 patients with bronchiectases, the dilated bronchi parallel to the scan plane form the characteristic tram tracks sign (Fig. 1). In two of them the dilated bronchi with thickened walls extended from the hila to the lung periphery, without normal tapering. In all patients with bronchiectases, dilated bronchi with adjacent pulmonary artery branches form a characteristic signet-ring sign (Fig. 2). In 8 patients bronchiolitis was found, with the presence of tree-in-bud sign at the lung periphery (Fig. 3). Among 13 patients with tuberculosis, 5 have active process with typical tree-in-bud pattern in subpleural lung areas (Fig. 4). In 5 patients with asbestosis subpleural lines were visible, about 1 cm from the surface of the pleura (Fig. 5). In one of them rounded atelectasis was seen. In 4 patients with pulmonary fibrosis the honeycombing pattern was seen (Fig. 6), indicating irreversibility of changes. In 4 patients the areas of mosaic

perfusion were seen. In these patients the diameter of vessels in the area of density were larger than diameter of vessels in lucent areas, reflecting the differences in perfusion (Fig. 7).

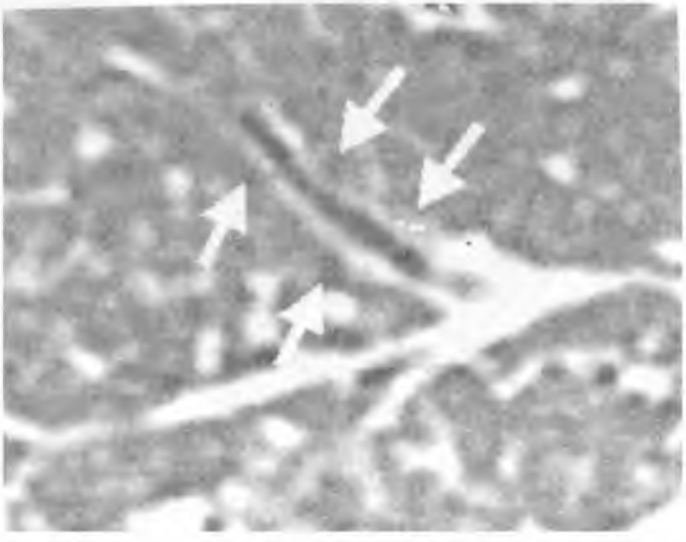

Fig. 1. Magnified image of dilated bronchus with thickened walls (arrows), so-called tram tracks sign

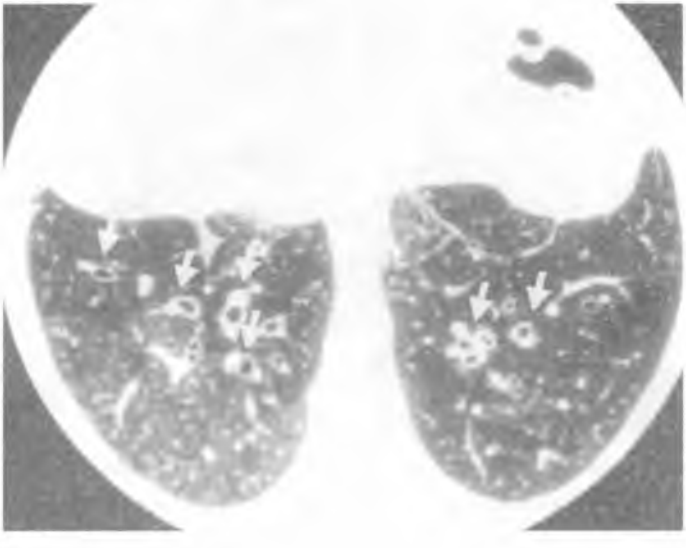

Fig. 2. Bronchiectases perpendicular to the section plane. The dilated bronchi with thickened walls with adjacent artery form signet-ring signs (arrows)

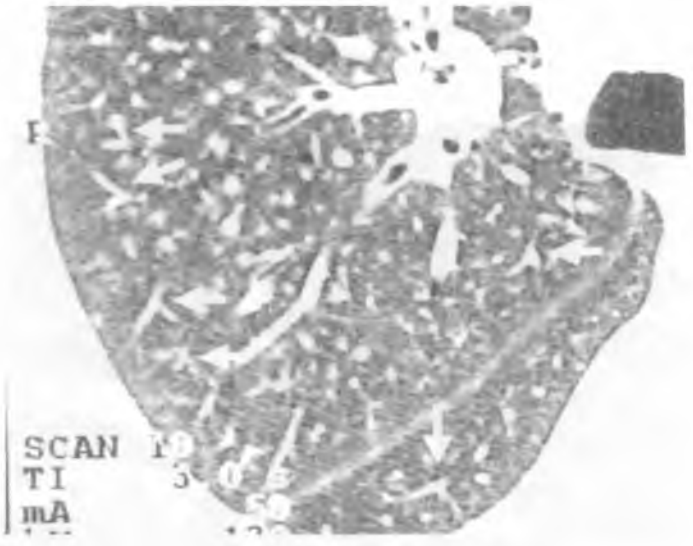

Fig. 3. Bronchiolitis. The liquid-filled small bronchioles in the lung periphery, with bulbous tips of branches, form typical tree-in-bud pattern (arrows). The peribronchovascular thickenings, small nodules and tram tracks sign are also present

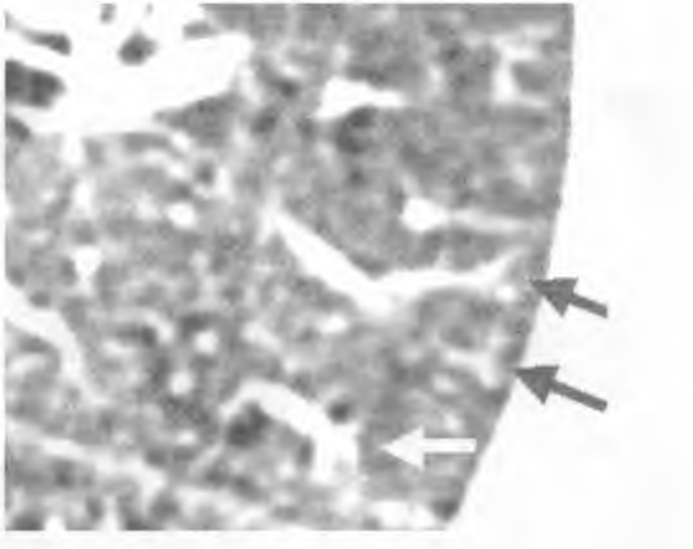

Fig. 4. Magnified picture. The subpleural tree-in-bud findings (arrows) in a patient with active tuberculosis

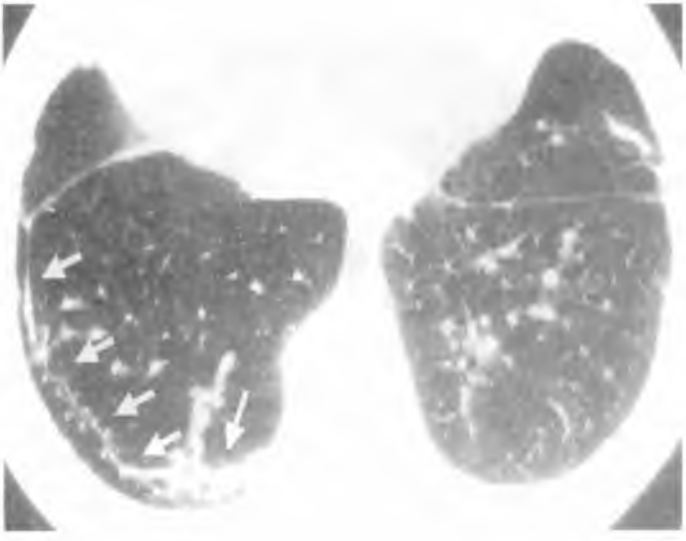

Fig. 5. Patient with asbestosis. Subpleural line is visible parallel to the pleural surface of the right lung (arrows)

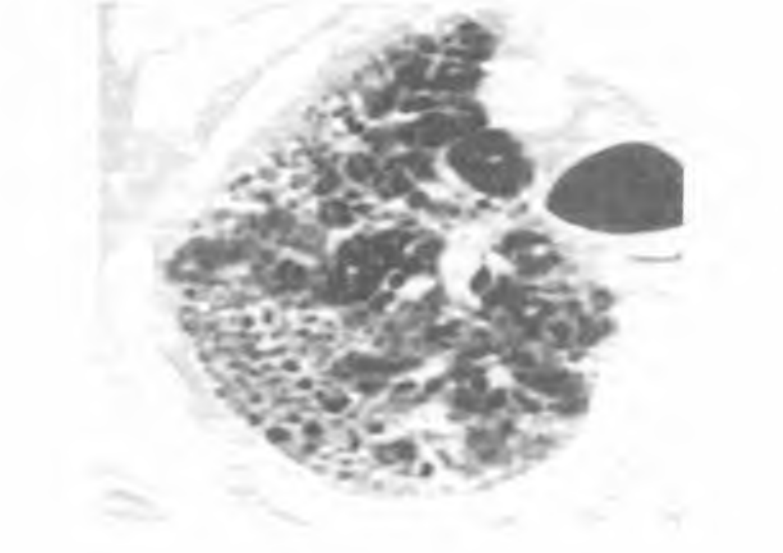

Fig. 6. The honeycombing in patient with pulmonary fibrosis indicating irreversibility of changes

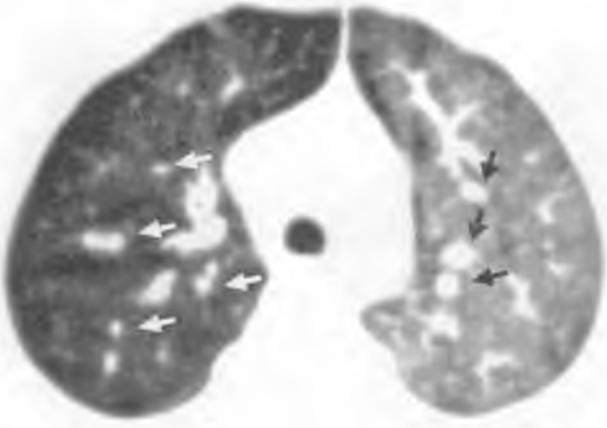

Fig. 7. The mosaic perfusion. The diameters of vessels in areas of increase density (black arrows) are larger than in normal, less dense areas (white arrows), reflecting the differences in perfusion

DISCUSSION

Most of HRCT findings are well described and are usually easy to diagnose. However there is a group of findings which are relatively rarely seen on HRCT of well-known diagnostic value. Some of them are typical, or indicate specific interstitial disease with high probability. They include, among others, interface sign, tree-in-bud sign, air-trapping or angiogram sign.

The presence of irregular interfaces between the aerated lung parenchyma and bronchi, vessels or visceral pleural surface has been termed the interface sign. The interface sign is usually visible in interstitial changes, regardless of their causes (4,16). The interface sign is usually associated with an increase of reticulations, the presence of thin linear opacities contacting bronchi, vessels or pleural surface form their irregular or spicular appearance on HRCT. Linear opacities represent interlobular interstitial thickening or thickened interlobular interstitial fiber. The interface sign is most frequent in lung fibrosis (16).

Extensive interstitial and alveolar thickening that results in alveolar disruption and bronchiectasis produces the classic and characteristic appearance of honeycombing. It is defined by the presence of small air-containing cystic spaces, usually lined by bronchiolar epithelium, with thickened walls composed of dense fibrous tissue. The honeycombing indicates the presence of "end stage lung" and may be visible in almost all fibrotic lung disease (4,16). In honeycombing the cystic spaces usually measure about 1 cm in diameter, although their sizes may range from several millimeter to a few centimeters. The cystic walls measure from 1 to 3 mm in thickness, and typically share walls. The honeycombing usually predominate in lung periphery and subpleural areas, while parahilar parts of the lung appear normal (16). Subpleural honeycombing cysts typically form several contiguous layers, which enable differentiation from subpleural areas of emphysema (paraseptal lung emphysema), in which the subpleural cysts usually occur in a single layer. The honeycombing is often associated with other findings of pulmonary fibrosis, such a centrilobular interstitial thickening, traction bronchiectases, irregular subpleural thickening. Intense interlobular septal thickening are not visible in association with honeycombing, except sarcoidosis (16).

Linear opacity a few millimeters thick, less than 1 cm from the pleural surface and parallel to it, first described in asbestosis, has been called subpleural line. The presence of this finding is nonspecific and can be seen in a variety of lung diseases (4,12,16). The subpleural line may be seen in healthy people as a result of atelectasis in dependant lung areas. Such normal posterior lines are transient and disappear in prone position of patients (14,16). These findings closely mimic the appearance of fibrosis and honeycombing. Transient subpleural line with peripheral lucencies may reflect partial bronchial obturation with atelectasis and air-trapping (1,16).

Small airways dilated and filled with pus, mucus or inflammatory exudation form small, well defined centrilobular, nodular, linear or branching densities. These findings on HRCT have been called tree-in-bud. The coexistence of such changes and bronchiectases, history or pulmonary function tests can help distinguish small bronchiolar abnormalities from other causes of centrilobular reticulation (2,4,16). Abnormal bronchioles producing tree-in-bud pattern may be easily distinguished from normal centrilobular vessels because of their more irregular appearance, a lack of tapering or bulbous appearance at the tips of small branches. This appearance reflects the presence of bronchial dilatation or peribronchiolar inflammation (2,4,16). Centrilobular bronchiolar changes characterized by dilatation and tree-in-bud are visible in Asian panbronchiolitis, endobronchial spread of tuberculosis, cystic fibrosis, bronchopneumonia, bronchiectases of any cause and other diseases causing mucus or pus retention within small bronchioles (16).

In HRCT bronchi are invisible in peripheral 2 cm of the lung. In bronchiectases the thickening of bronchial walls, peribronchial fibrosis and bronchial dilatation make them visible in the lung periphery. Depending on their orientation relative to the scan plane they may simulate tram tracks or can show signet-ring sign, in which dilated, thick-walled bronchus and its accompanying lung artery branch are seen adjacent to each other (4,5,6,16).

The varicose bronchiectases are similar to cylindrical, but their walls are more irregular and may have nodular appearance. This pattern has been called the string of pearls. The traction bronchiectases are often varicose (5,16).

The cystic bronchiectases most frequent form the group or cluster of air-filled cysts. When they are filled with the fluid, they give the appearance of a cluster of grapes. The air-fluid levels in dependant portions of the cystic dilated bronchi are a very specific sign of the bronchiectases, enabling distinguishing from the lung cysts (16).

The density of lung interstitium depends partially on the amount of the blood present in lung tissue. Local differences in perfusion may result in inhomogeneous lung density. Because this phenomenon is usually patchy or mosaic in distribution, it has been called mosaic perfusion (4,16,17). The mosaic perfusion may be seen in patients with diseases that result in local decrease in perfusion. The differences in density between normal and abnormal lung areas, visible on HRCT are accented by the compensative increase in perfusion in normal or relatively normal lung areas (16). The mosaic perfusion is most frequent in diseases of airways that result in focal air-trapping with poor ventilation. The areas of poorly ventilated lung are poorly perused because of reflex vasoconstriction or permanent reduction in the capillary bed (3,16). The mosaic perfusion was described in pulmonary embolism (16).

In areas of decrease lung density the diameter of vessels appear smaller than in relatively dense lung areas. That reflects differences in local blood perfusion, and may be helpful in differentiating with ground glass attenuation, which also may be patchy in distribution. In ground glass opacities the diameter of vessels appear equal in size throughout the lung (16,17).

The term air-trapping refers to visible on HRCT areas of decrease density of lung interstitium, showing smaller inspiratory increase in density. They are caused by the retention of the air in some parts of the lung during expiration, because of obturation of airways (3,4,16). The reasons for air-trapping are diseases of airways, bronchitis obliterans, connective tissue abnormalities, bronchiectases, tuberculosis or cystic fibrosis (7,13). In patients with asthma areas of air-trapping are often associated with bronchiectases, emphysema, thickening of walls of airways or areas of mosaic perfusion (3,10). In many cases the areas of inhomogeneous

density are very subtle, so in diagnosis of air-trapping the expiratory HRCT is essential, in which the lung density of normal lung increase, and areas of air-trapping remain hyperlucent (9,16). In inhomogeneous lung density resulting from the presence of ground glass opacity in infiltrative lung disease, the proportional increase in density is evident in both areas of increased and decreased density (3,9,16).

The rounded atelectasis reflects the focal areas of collapsed lung. In most cases it is visible in pleural diseases, where the areas of rounded atelectasis contact pleural surface. The rounded atelectasis is visible in most cases in paravertebral areas of the lung (1,12). The interstitial densities, parenchymal bands or subpleural plaques may coexist (12,15).

The vessels and bronchi, which curve towards the mass form characteristic cone-shaped opacity, which has been described as a comet tail (11).

The areas of consolidation associated with the bronchoalveolar carcinoma may reflect intra-alveolar growth of the tumor and production of fluid and mucus. The air-bronchogram is often seen. Because fluid and mucus are of low densities, if CT is performed with contrast agent the angiogram sign may be seen. The contrast enhanced pulmonary vessels appear denser than surrounding masses of the tumor. This sign is very specific for bronchoalveolar carcinoma (4,8,16).

CONCLUSIONS

The tram track sign and signet-ring sign visible on HRCT are very specific findings in bronchiectases. The tree-in-bud pattern is a specific finding for diseases of small airways, especially involving small bronchioles. The differences in sizes of vessels in hyper-lucent and hyper-dense lung areas enable differentiation of mosaic perfusion from other reasons for inhomogeneous lung density. Rounded atelectasis and comet tail sign are specific findings for asbestosis. The angiogram sign is a very specific finding for bronchoalveolar carcinoma.

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SUMMARY

High resolution computed tomography (HRCT) is an imaging method, achieving an optimal resolution of lung interstitium images. HRCT enables more accurate diagnosis of interstitial lung diseases, in which it is a diagnostic method of choice. A lot of pathological findings specific only for HRCT were described. Some of them are relatively rare, and therefore not well known. In some cases good knowledge of them is essential in making a correct diagnosis based on HRCT results. The aim of the study was assessment of rare findings on HRCT, their morphology and diagnostic value in interstitial lung disease. The tram track sign and signet-ring sign visible on HRCT are very specific findings in bronchiectases. The tree-in-bud pattern is a specific finding for diseases of small airways, especially involving small bronchioles. The differences in sizes of vessels in hyper-lucent and hyper-dense lung areas enable differentiation of mosaic perfusion from other reasons for inhomogeneous lung density. Rounded atelectasis and comet tail sign are specific findings for asbestosis. The angiogram sign is a very specific finding for bronchoalveolar carcinoma.

Rzadkie objawy tomografii komputerowej wysokiej rozdzielczości w wybranych schorzeniach śródmiąższowych płuc

Tomografia komputerowa wysokiej rozdzielczości jest metodą diagnostyczną uzyskującą optymalną rozdzielczość przestrzenną obrazów miąższu płuc. Umożliwia ona dokładną ocenę chorób śródmiąższowych, w których jest metodą diagnostyczną z wyboru. Wiele objawów specyficznych jedynie dla TKWR zostało opisanych. Niektóre z nich są względnie rzadkie i dlatego słabiej znane. W pewnych przypadkach ich znajomość jest niezbędna do postawienia właściwej diagnozy w oparciu o wynik badania TKWR. Celem badania była ocena rzadkich objawów TKWR, ich morfologii i wartości diagnostycznej w śródmiąższowych schorzeniach płuc. Objaw torów tramwajowych i objaw sygnetu są specyficzne dla rozstrzeni oskrzeli. Objaw drzewa w pąkach jest typowy dla chorób małych dróg oddechowych, szczególnie zapalenia oskrzelików. Różnice średnicy naczyń w gęstych i przejaśnionych obszarach płuc umożliwiają różnicowanie perfuzji mozaikowej od innych przyczyn niejednorodnej gęstości płuc. Okrągła niedodma i objaw ogona komety są typowymi objawami TKWR dla azbestozy. Objaw angiogramu jest specyficzny dla raka oskrzelowopęchrzykowego.