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Rounded atelectasis of the lung: A pictorial review

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Summary

Rounded atelectasis of the lung is well described in medical literature, but still difficult to diagnose. Since lesions give no clinical symptoms in patients, radiologists are often the first to recognize the round lesion in an X-ray picture or a CT scan. Rounded atelectasis is an atypical form of lung collapse that usually occurs adjacent to scarred pleura and can be mistaken for lung cancer. Patients with rounded atelectasis have a history of asbestos exposure or pleural effusion due to various causes. When characteristic imaging findings are present, the diagnosis is rarely dubious and no further investigation is necessary. However, differential diagnosis of rounded atelectasis poses a challenge to pulmonary specialists and radiologists.

Keywords: Rounded Atelectasis • Computed Tomography • Lung Cancer

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Background

Rounded atelectasis is a rare form of peripheral alveolar collapse that develops as a result of pleural diseases [1–4]. The lesion is always adherent to the surface of the pleura and may suggest a carcinoma of the lung. Due to incomensurability between the radiological image and clinical presentation, the lesion may lead to unnecessary extension of diagnostic scope, exposure of the patient to invasive diagnostic techniques and oncological anxiety and unnecessary costs to health care units.

Rounded atelectasis has been described many times in the literature [5]; however, it may still be difficult to diagnose, particularly by radiologists not experienced in everyday pneumological diagnostics and not able of consulting pneumologists directly. The goal of this work is to present the image of rounded atelectasis in CT scans and X-rays, along with basic clinical data and differentiation.

Etiology and Clinical Presentation

Rounded atelectasis is more common in men (80%) than in women. The most common cause of rounded atelectasis

is occupational exposure to mineral dusts: asbestosis, pneumoconiosis, inhalation of mixed mineral dusts [1,6]. Frequent incidence of rounded atelectasis was also demonstrated in exudative pleuritis due to various causes: in the course of tuberculosis, hemothorax, following cardio-surgical procedures, in chronically dialyzed patients. Rounded atelectasis is less common in pulmonary diseases directly affecting pleura, such as in legionellosis, histoplasmosis and in patients with end stage renal disease. Atelectasis may also occur in the course of sarcoidosis and in young adults without history of pulmonary diseases [1,7,8]

The direct mechanism for the development of rounded atelectasis has not been fully explained. According to one of the theories, pleural fluid causes local atelectasis due to the pressure on the adjacent lung. If the rate of fluid pleural accumulation exceeds the absorptive capacity of adjacent alveoli, visceral pleura damage occurs with formation of a fissure and translocation of the lung towards that fissure. As a result of this process, the lung folds in a concentric shape maintained by developing adhesions. When the effusion is resorbed, the lung fills in the space around rounded atelectasis. According to another theory, the lesions are initiated by local pleuritis due to irritant agents, such as asbestos. Local

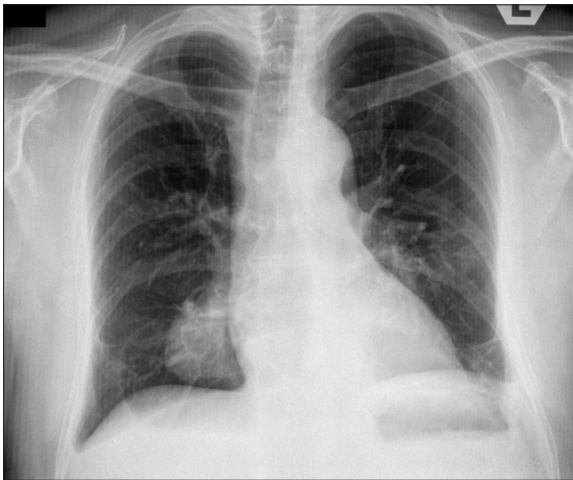


Figure 1. Posteroanterior chest radiography: peripheral, well-defined opacity (round atelectasis).

accumulation of pleural fluid or irritant dusts in the course of asbestosis, leads to shrinkage and thickening of pleura. The adjacent lung also shrinks and rounded atelectasis develops [9]. This theory, albeit most popular at this time, does not account for all cases of rounded atelectasis, and therefore multifactorial etiology is often mentioned [2,4,10,11].

In most cases, rounded atelectasis is asymptomatic [1,8,11] and clinicians are usually surprised by incommensurability between clinical presentation and radiological lesions. Some patients may complain of chest pains, dyspnoea or cough [1,8]. Symptoms are more common in atelectasis associated with asbestosis is more common, although they are probably due to the underlying disease. Physical examinations reveal no abnormalities or minimum abnormalities (crackling in the affected region upon deep inhalation). Rounded atelectasis without concomitant pleural lesions shows no changes in functional lungs tests [1,8].



Figure 2. CT examination of the chest after administration of contrast medium (pulmonary and mediastinal window) in the patient shown in Figure 1. Oval soft tissue density in both lower lobes. Lesions adhere to the pleura, forming acute angles. "Comet tail" sign better visible on the right side (arrow head). The volume of both lower lobes is reduced, both oblique fissures are displaced (arrows). Bilateral pleural effusion.

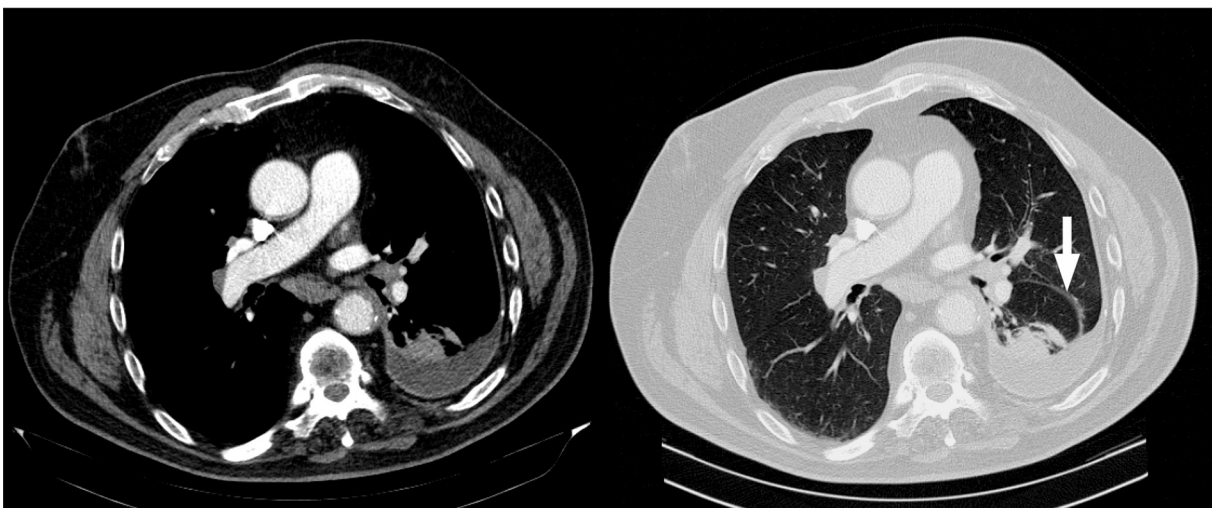


Figure 3. Rounded atelectasis in the left lower lobe, the volume of the lobe is reduced and the left major fissure is displaced (arrow).



Figure 4. Pleural effusion and rounded atelectasis affecting most of the lower right lobe and adjacent to the distorted and displaced oblique fissure. Air bronchogram in proximal part of RA is also visible.

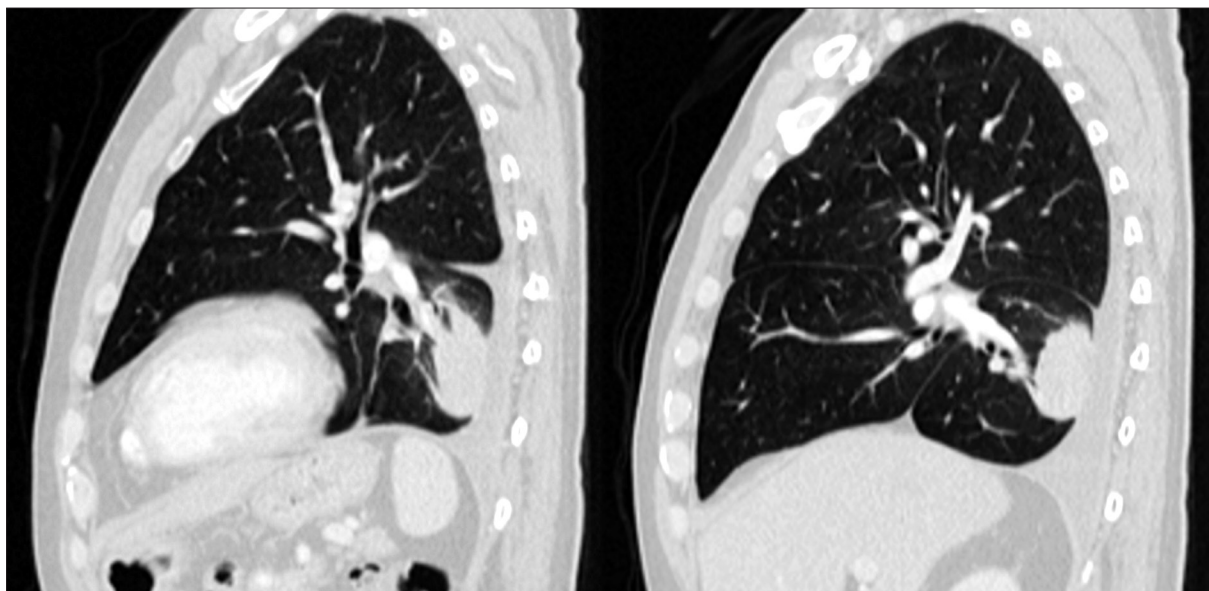


Figure 5. Sagittal projections. Round atelectasis with "comet tail" signs visible on both sides. Displacement of the oblique fissure on both sides and reduced volume of the lower lobes.

Radiological Image

A major part of lesions is detected accidentally in X-rays taken for other reasons [1,2,3,8] (Figure 1). Rounded atelectasis is usually an isolated lesions, also cases of multiple lesions are possible (Figure 2). It is typically found in lower lung lobes, particularly in posterior regions. Usually, atelectasis has the form of peripheral round, oval or fusiform lesion of diffuse outline. according to the literature, the size of the lesion ranges from 2.5 to 8 cm. Usually, the lesion does not adhere to the diaphragm, being separated by pulmonary parenchyma. Pleural thickening at the level of atelectasis is typical. The volume of the affected lobe is reduced (Figure 3).

In computed tomography scans, rounded atelectasis is visualized as a mass with a soft tissue density, usually with air bronchogram in the centre or in the proximal part [1,6-11] (Figure 3). Contrast enhancement is not typical, although

higher density of lesion periphery may sometimes be observed as compared to the lesion centre. The lesion is also characterized in that it is never completely surrounded by pulmonary parenchyma, forming an acute angle with the pleura (Figure 4). Vessels and bronchi entering the mass are compressed and bent – this is the so-called "comet tail" or "crab nippers: symptom characteristic for rounded atelectasis and observed in most cases (Figure 5 and 6B). Pleural thickening is common at the level of the mass, although this is not a pathognomic symptom, particularly in patients with history of asbestos exposure; pleural fluid may also be observed. Typical features of rounded atelectasis are summarized in Table 1.

Distant (up to 1 year) follow up usually reveals no change in the nature of the lesion or an increase in its mass; less commonly, partial regression may be observed [1,2,6,10] (Figure 6). Rounded atelectasis associated with asbestosis

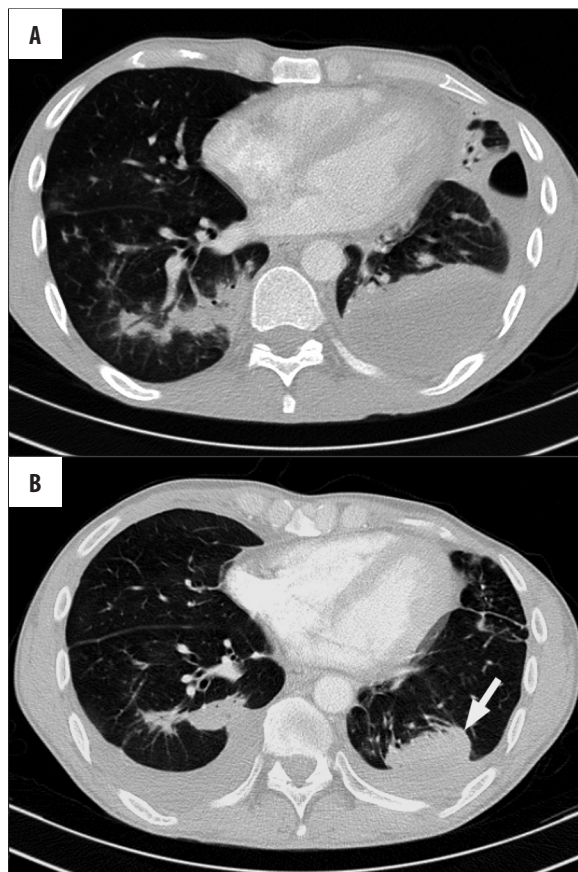


Figure 6. Formation and evolution of round atelectasis. The original image (A): bronchovascular airspace consolidation and ground-glass opacity in the right lung; airspace consolidation and dilated bronchi in the lingula, loculated pleural effusion on the left. (B): Follow up chest CT taken after 2 months showing partial regression of lesions within the right lung and the left lung lingula. Round atelectasis adjacent to pleural effusion in the lower left lobe (arrow). (C): Another follow up after next two months showing significant, spontaneous regression of round atelectasis.

most commonly adheres to pleural thickenings, has lentiform or cuneiform shape with a “comet tail” sign and leads to a reduction in the volume of the affected lobe [1]. If the lesion is concomitant to pneumoconiosis, pneumoconiotic nodules may be visible within the mass contour [1]. Enlargement of hilar lymph nodes should always rise suspicion of cancer [1]

Differentiation

Rounded atelectasis requires differentiation from subpleural rounded masses. Of highest importance is differentiation of rounded atelectasis from lung carcinoma or lung metastasis [1,2,3,6].

Typical features of lung carcinoma that differentiate the disease from rounded carcinoma include poorly defined edges, polycyclic or nodular outline and spicules referred to as *corona radiata* or radial bands overlapping the pleura (pleural tail) (Figures 7 and 8). Some forms of cancer may be accompanied by the air bronchogram symptom [8]. In larger lesions, ground-glass or air regions may occur in lesion centre as symptoms of central necrosis. The volume of cancer-affected lung is unchanged; the volume may be changed if the neoplastic lesion is accompanied by atelectatic lesions associated with bronchial obstruction. If the pathological mass is accompanied by inflammatory lesions (with or without atelectasis), the volume of the lobe may be increased. Cancer lesions are usually accompanied by enlarged lymph nodes within the hila and/or the mediastinum [12,13]. Differentiation between atelectasis and carcinoid is facilitated by clinical symptoms associated with hormonal release. In addition, carcinoids differ from rounded lung lesions by intense enhancement following contrast administration. A similar radiological image may be

Table 1. Diagnostic features of rounded atelectasis in CT.

Typical features	Additional features
<ul style="list-style-type: none"> • Round, cuneiform or lentiform lesion of soft tissue density, air bronchogram • Size: usually 2.5–8 cm • Location: usually lower lobes, middle lobe and lingula, rarely right upper lobe, nearly never in the left upper lobe • Folded vessels and bronchi presenting as “comet tail” or “crab nippers” sign • Subpleural location, acute angle between the mass and the pleura, thickening of adjacent pleura • Pleural effusion 	<ul style="list-style-type: none"> • Reduced volume of the affected lung, displacement of interlobar fissure or primary bronchus • Reduced density of the affected lobe • Higher density at the periphery, lower density in lesion's centre • Concomitant pleural calcifications, segmental bilateral pleural thickening (in asbestosis) • Pneumoconiotic nodules within the lesion

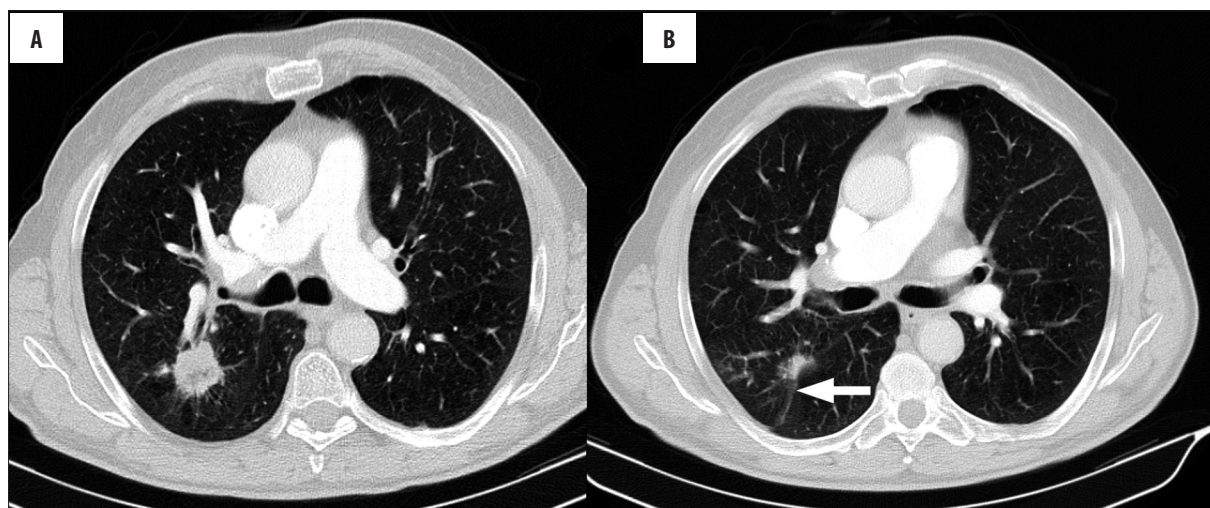


Figure 7. Contrast-enhanced chest CT (lung window) demonstrates spiculated right upper lobe mass (A) with irregular margins, (B) which makes a focal major fissure retraction (arrows).

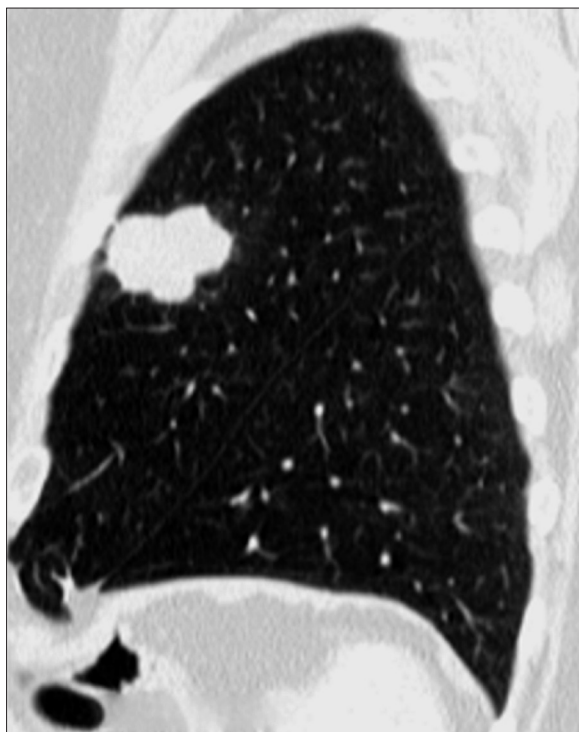


Figure 8. Peripheral lung cancer, sagittal reconstruction. Well-defined mass with lobular margins in the left upper lobe. Some tumor spicules extend to the pleural surface. Lobe volume and pleura are normal.

observed in round pneumonia, Wegener's granulomatosis, pulmonary abscess as well as in fungal or mycobacterial lung diseases – in such cases, the medical history and clinical symptoms are decisive in differentiation [1].

Lung metastases are usually multiple and bilateral; however, isolated lesions may occur in ca. 5% of patients. Metastases are usually smoothly defined and located mostly in peripheral region of the lungs. A blood vessel entering the lesion – known as the supplying vessel symptom – is visible in 40% of cases. Most common tumors with lung

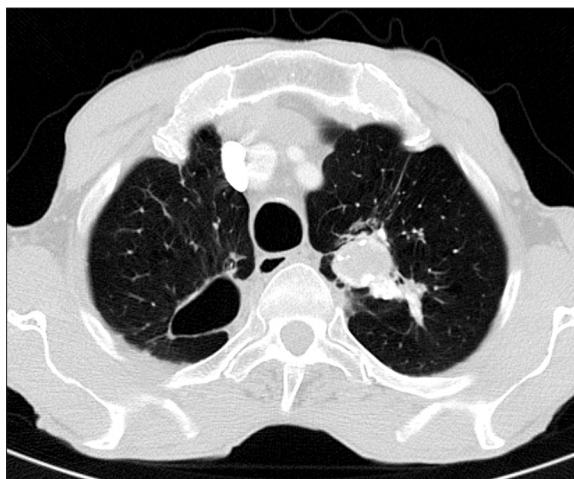


Figure 9. Granuloma. Rounded mass with peripheral calcifications in the left upper lobe. Areas of lung distortion in both apices and secondary subpleural bulla on the right side.

metastases are melanoma, sarcoma and testicular cancer [12]. In case of a single subpleural lung carcinoma, patients usually present with clinical symptoms of the underlying disease and differentiation is made on the basis of investigations.

Calcifications within rounded atelectasis may be present in patients with pneumoconiosis; however, in such cases, multiple nodules with calcifications are present in entire lungs. Basically, calcifications within the rounded lesion suggest its benign nature. However, such calcification must be located centrally or for a ring; in case of multiple calcifications, they should be uniformly distributed in the lesion – these are the features of granuloma (Figure 9). Nodular calcifications with accompanying adipose tissue are suggestive of hamartoma [12,13]. Round lesions in Wegener's granulomatosis may present with spicules or supplying vessels; most commonly, however, these are multiple lesions (Figure 10). In the active phase, these are accompanied by ground glass symptoms corresponding to alveolar bleeding; in chronic disease, these are accompanied by

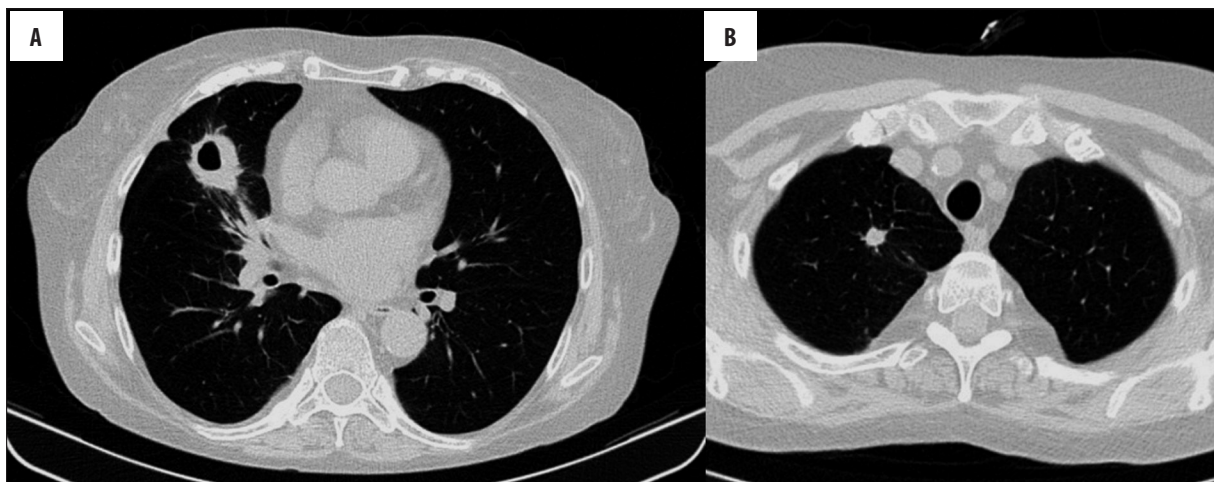


Figure 10. (A) Peribronchovascular thick-walled cavity and well-defined nodule (B) in the apex of the right lung in the same patient. Both lesions and clinical findings suggest the diagnosis of Wegener's granuloma.



Figure 11. Organizing pneumonia. Chest CT, contrast-enhanced (axial and frontal scans in pulmonary window). An oval mass adjacent to the pleura in the lower left lobe. Air bronchogram visible. Ground-glass opacity in the right lung.

the thickening of interlobar septa [14]; such lesions are not observed in rounded atelectasis.

Pulmonary abscess may be mistaken for rounded atelectasis only in the infiltration phase. A mature abscess is encapsulated in a wall with the thickness not exceeding 15 mm. Walls having the thickness of up to 4 mm suggest benign lesions; walls having the thickness of 15 mm suggest malignant lesions with the intermediate values being non-specific [12]. Rounded atelectasis has also to be differentiated from round pneumonia, which occurs mainly in children and is very rare in adults. Round pneumonia has the form of round, spiculated mass accompanied by pleural thickening and satellite lesions. Air bronchogram image may be observed. Clinical symptoms of pneumonia facilitate differentiation of the disease from rounded atelectasis [15,16]. The lesions resolve following anti-inflammatory treatment.

Organizing pneumonia (OP) should also be taken into account when making the differential diagnosis of rounded atelectasis. Nodular densities of different sizes are observed in 30–50% of OP cases; these sometimes occur as isolated findings (Figure 11). The lesions may be of peribronchial or subpleural location. Air bronchogram image is typical. In 30% of cases, lesions are spiculated; small amounts of pleural fluid or pleural thickening are possible. Differentiation is facilitated by concomitant presence of parenchymal densities and

ground glass in both lungs. Patients with organizing pneumonia present with respiratory tract symptoms [14].

Invasive Diagnostics and Treatment

Most experts believe that computed tomography is an ideal tool for making the correct diagnosis and avoiding exploratory thoracotomy or surgical resection of the lesion [1,5,6,11]. It should be kept in mind that cytological confirmation is not required in case of radiological diagnosis of rounded atelectasis [1].

Therefore, in most cases of typical tomographic picture of rounded atelectasis, transbronchial or transthoracic thin-needle biopsy is inexpedient. Biopsy should only be considered when radiological criteria for diagnosis are not met or when radiological image does not allow for exclusion of malignant growth [1,11]. Negative result of lesion biopsy is of little value as it does not rule out growth process and requires further, more detailed diagnostics [1,6,10]. Therefore, in cases when rounded atelectasis does not present with typical picture, surgical videothoracoscopy (VATS) is the method of choice in patients at high risk of cancer. VATS permits the correct diagnosis and is associated with less complications than open lung biopsy. In patients with respiratory or cardiac insufficiency, thoracoscopy is recommended as being less invasive than VATS [1,8].

No method for the treatment of rounded atelectasis is available [1,10,11]. Surgical intervention should be considered only in cases of deep lung function impairment or when concomitant malignant growth is suspected [1].

Radiological Practice

Rounded atelectasis is not a rare finding in chest CT scans; however, it is often not properly diagnosed by radiologists. In our review of examinations consulted in the Kuyavian and Pomeranian Pulmonology Centre in Bydgoszcz over the period of last 3 years (6 cases), the predominant descriptions included: "solid lesion of unknown nature", "lesion for further diagnostics", "contrast-enhanced lesion" or "regressing inflammatory lesion".

Each of these radiological reports forces the pneumologist to take up a specific diagnostic route, most typically transthoracic biopsy. In histopathological examination of rounded atelectasis, the biopsy result does not reveal tumor cells; however, the clinician should not rely on such result as there always exist a risk that tumor cells have not been properly collected. This in turn may lead to repeated biopsy or other invasive examinations (e.g. VATS or thoracotomy). Thus, the radiologist contributes to unnecessary extension of diagnostic procedures, increasing costs and potential risks to the patient.

On the other hand, when radiological summary description reads: "regressing inflammatory lesions", there is a discrepancy between negative history, clinical presentation and lack of abnormalities in physical examination and the radiological picture; this requires the clinician to consider

initiation of antibiotic treatment which is not necessary. The treatment does not lead to regression in follow up examination or the regression is in fact spontaneous.

One could suppose that cautious descriptions of rounded atelectasis as e.g. solid lesion for further diagnostics is due on one hand to the realities of radiologists' work, as the radiologists must usually be specialists in all areas of medicine, and on the other hand, to frequent lack of sufficient clinical data. In addition, there is an increasing anxiety among physicians regarding possible medical errors. However, in case of typical radiological signs of rounded atelectasis, particularly in computed tomography scans, the summary should always include a suggestion of such diagnosis. This is particularly the case when the lesion is accompanied by pleural fluid, when the patient has positive history of exposure to asbestos or other dusts or in case when patient presents with no clinical symptoms and the lesion is "incidentally" detected in the X-ray image. Clinical diagnosis and further management of patient is at the discretion of the clinician who can base their decisions on the interview and physical examinations as well as laboratory investigations and should accordingly make their decisions regarding further diagnostics or discontinuation of diagnostic procedures on the basis of radiological image.

Conclusions

Thanks to its typical radiological features, rounded atelectasis may be in most cases diagnosed on the basis of computed tomography scan without the need of a biopsy. CT differentiation of rounded atelectasis should include in particular peripheral lung cancer, metastases, granulomas and organizing pneumonia.

References:

1. Stathopoulos GT, Karamessini MT, Sotiriadi AE, Pastromas VG: Rounded atelectasis of the lung. *Respir Med*, 2005; 99(5): 615–23
2. Batra P, Brown K, Hayashi K et al: Rounded atelectasis. *J Thorac Imaging*, 1996; 11(3): 187–97
3. Partap VA: The comet tail sign. *Radiology*, 1999; 213: 553–54
4. Woodring JH, Reed JC: Types and mechanisms of pulmonary atelectasis. *J Thorac Imaging*, 1996; 11(2): 92–108
5. Prokop M, Galanski M: *Spiralna i wielorzędowa tomografia komputerowa człowieka*. 2nd edition (Polish). Medipage, Warsaw, 2010; 320 [in Polish]
6. Doyle TC, Lawler GA: CT Features of rounded atelectasis of the lung. *Am J Roentgenol*, 1984; 143(2): 225–28
7. Thachil RT, Krishnan P, Lapidus C: Rounded atelectasis. *Clin Pulmon Med*, 2002; 9(1): 66–67
8. Tetikkurt C, Tetikkurt S, Ozdemir I, Bayar N: Round atelectasis in sarcoidosis. *Multidiscip Respir Med*, 2011; 6(3): 180–82
9. Woodring JH: Pleural effusion is a cause of round atelectasis of the lung. *J Ky Med Assoc*, 2000; 98(12): 527–32
10. Szydłowski GW, Cohn HE, Steiner RM, Edie RN: Rounded atelectasis: a pulmonary pseudotumor. *Ann Thorac Surg*, 1992; 53(5): 817–21
11. Younis WG, Dernaika TA, Jones KR et al: Round atelectasis with atypical computed tomography findings. *Respir Care*, 2006; 51(7): 761–63
12. Kowalewski J, Dancewicz M: Pojedynczy cień okrągły w płucu – ciałko aktualny problem diagnostyczny. *Pneumonol Alergol Pol*, 2005; 73(2): 198–201 [in Polish]
13. Kuziemski K: Cień krągły pojedynczy w płucu. Podejście praktyczne w podstawowej opiece zdrowotnej. *Forum Medycyny Rodzinnej*, 2011; 5(3): 217–21 [in Polish]
14. Bestry I, Oniszh K, Pawlicka L, Dobkowski P: Rola metod obrazowych w diagnostyce chorób śródmiąższowych chorób płuc. In: Wiatr E, Rowińska-Zakrzewska E, Pirożyński M (eds.): *Choroby śródmiąższowe płuc*. Alfa Medica Press, Warsaw, 2012; 62–89 [in Polish]
15. Wagner AL, Szabunio M, Hazlett KS, Wagner SG: Radiologic manifestations of round pneumonia in adults. *Am J Roentgenol*, 1998; 170(3): 723–26
16. Halkiewicz F, Kozielski J, Witkowska-Klinke J et al: Pojedynczy cień krągły w miąższu płucnym: rak płuca czy okrągłe zapalenie płuc? – problem diagnostyczny, różnicowanie. *Kardiochir Torakochi Pol*, 2012; 9(4): 477–80 [in Polish]