Mosaic attenuation: a confusing or a helpful pattern?

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Authors: M. S. C. Rodrigues¹, R. Correia¹, C. Esteves², J. Pereira¹; ¹Porto/PT, ²Braga/PT
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Learning objectives

The purposes of this work are to review the causes of mosaic attenuation and its distinguishing features.

Background

Mosaic attenuation represents areas of heterogeneous lung densities with patchy configuration. It is a non-specific pattern, which may be seen in small airways, pulmonary vascular and parenchymal diseases.

After mosaic attenuation recognition, the complexity is to find out which part of the lung is abnormal, "the white", "the black" or both. The clues to reach the pathologic cause are in the air trapping detection and appearance of the pulmonary vasculature.

Imaging findings OR Procedure details

In small airway disease and pulmonary vascular disease, the pulmonary vessels within the less dense regions of the lung are small compared with the vessels in the more dense regions. The difference in vessel size is due to local hypoxic reflex vasoconstriction in small airway disease, while in primary vascular lung disease the variation in vessel size is caused by the underlying hypoperfusion.

In parenchymal diseases, the vessels are more uniform in size throughout the different regions of lung attenuation.

Therefore, the early step to distinguish the causes of a mosaic attenuation should be the analyzing the size of the pulmonary vessels. Expiratory CT scans are useful to differentiate a small airway disease from a pulmonary vascular disease. The presence of air trapping excludes primary parenchymal disease, except if there is a suspicion of hypersensitivity pneumonitis, which has mixed features of both parenchymal and small airways disease.

Pulmonary vascular disease:

The mosaic attenuation is a CT feature that is most frequently depicted in secondary pulmonary hypertension and less often in primary pulmonary hypertension and acute pulmonary embolism.
The classic CT features of pulmonary hypertension are right ventricular enlargement, bulging of the interventricular septum and central pulmonary arterial enlargement with peripheral tapering.

-Chronic pulmonary embolism:

The CT vascular features associated with chronic pulmonary embolism include weblike pulmonary arterial filling defects, serpiginous pulmonary arteries and hypertrophic bronchial arteries.

The lung parenchymal findings include segmental and subsegmental distribution of mosaic attenuation and scarring at the site of previous infarcts (Fig. 1 on page 5).

-Primary pulmonary arterial hypertension:

The distribution of mosaic attenuation in this condition is heterogeneous or patchy with a perivascular distribution. Occasionally, it is also associated with peripheral serpiginous pulmonary vessels (which do not arise from pulmonary veins).

-Pulmonary venoocclusive disease:

The characteristic findings of this disease include centrilobular ground-glass nodules, septal thickening and pleural effusions. Mosaic attenuation is also a common CT feature associated with this condition.

Small airways disease

The mosaic attenuation pattern is a consequence of air trapping, consisting of regional hypoattenuation where air trapping has occurred, mixed with regions of hyperattenuation demonstrating normal ventilation. This finding may be observed on inspiratory scans and is accentuated at the end of expiration. The lung that retains air does not decrease in volume in comparison to adjacent normal lung on paired inspiratory and expiratory images.

-Asthma:

The principal features include bronchial wall thickening, bronchiectasis and emphysema. Mosaic attenuation and air trapping are indirect findings (Fig. 2 on page 5).

-Constrictive bronchiolitis:
The direct signs of bronchiolitis are uncommon because the amount of bronchiolar inflammation is small. The indirect signs predominate, which includes heterogeneous distribution of mosaic attenuation, bronchial dilation and extensive air trapping.

The most common infections that can result in constrictive bronchiolitis are viral and *Mycoplasma* pneumonia (Fig. 3 on page 6). In lung transplant receivers, the constrictive bronchiolitis is known as "bronchiolitis obliterans syndrome", representing the most common cause of chronic rejection (Fig. 4 on page 6).

- **Cellular bronchiolitis:**

  The most common CT findings are centrilobular and branching tree-in-bud nodules, which represent cellular remains within the bronchiole. Mosaic attenuation and air trapping can be found in cellular bronchiolitis of all causes, but occur most typically in subacute hypersensitivity pneumonitis. This disease affects both small airways and lung parenchyma, and it will be further discussed.

**Primary Parenchymal Disease**

In the context of primary parenchymal disease, the mosaic attenuation is related to the interstitial involvement or filling of air spaces (with fluid, cells or fibrosis) mixed with normal less dense lung.

- **Pneumocystis pneumonia:**

  The diagnosis of this pulmonary infection can only be made in a proper clinical condition (immune-compromised patients). The distinctive CT feature is ground-glass attenuation that may be diffuse, perihilar or have a mosaic pattern (Fig. 5 on page 6).

- **Hypersensitivity Pneumonitis:**

  The characteristic CT finding is the presence of poorly defined centrilobular nodules with a lower lobe distribution in the acute phase. In the chronic stage the characteristic features are heterogeneous ground-glass attenuation with upper or lower lobe fibrosis.

  Mosaic attenuation is the most common finding and it can be seen at any stage of the disease (Fig. 6 on page 7). When air trapping is present, it is related to the cellular bronchiolitis process. The main differences of hypersensitivity pneumonitis from the other bronchiolitis are in the nodules, which are less well circumscribed, and a lower frequency in tree-in-bud pattern.

- **Desquamative interstitial pneumonitis:**
The mosaic pattern is more frequently in this disease than in other idiopathic interstitial pneumonias. Other CT findings associated with this condition are scattered ground-glass opacities and small cystic spaces (Fig. 7 on page 7).

Images for this section:

**Fig. 1:** Chronic pulmonary embolism in two patients. A and B, Axial CT scans show segmental and subsegmental distribution of mosaic attenuation.

**Fig. 2:** Air trapping in patient with acute exacerbation of asthma. A and B, Axial CT in inspiratory (A) and expiratory (B) CT scans reveals air trapping.
**Fig. 3:** Constrictive bronchiolitis secondary to viral pneumonia. A and B, Axial (A) and coronal (B) CT scans reveals heterogeneously distributed mosaic attenuation and bronchiectasis.

**Fig. 4:** Bronchiolitis obliterans syndrome in patient who had received left lung transplant. A and B, Axial inspiratory (A) and expiratory (B) CT scans show mild bronchial wall thickening and mosaic attenuation with regional hyperlucency that is more prominent at held expiration, indicating air trapping.
**Fig. 5:** Pneumocystis pneumonia in an immunocompromised patient. A, Axial CT image displays a ground-glass attenuation with a mosaic pattern.

**Fig. 6:** Hypersensitivity pneumonitis. A and B, Axial inspiratory (A) and expiratory (B) CT scans show mosaic attenuation and regional areas of hyperlucency accentuated at expiration, representing air trapping. Additionally, there are poorly defined centrilobular nodules.
**Fig. 7:** Desquamative interstitial pneumonitis. A, Axial CT scan displays a mosaic attenuation pattern, more expressive in lower lobes.
Conclusion

Mosaic attenuation pattern can represent different causes, nevertheless with additional CT and clinical findings it is possible to determine the underlying major pathological category responsible and in some cases even propose a specific diagnosis.

References


Personal Information

Márcio Rodrigues, M.D.
Department of Radiology, Centro Hospitalar de São João, Porto, Portugal
marciorodri@sapo.pt