GROUND-GLASS OPACITY ON HRCT. A GUIDE TO DIAGNOSIS

Herráez Ortega I, Alonso Orcajo N*, López González L, Díez Fernández FL**, Rodríguez Morejón C, Bollo E**. Radiology, Pathology* and Respiratory Departments**. Complejo Hospitalario León. León. SPAIN. iherraez@hleo.sacyl.es

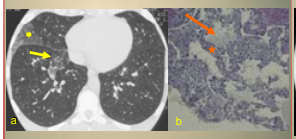
Objectives: To define ground-glass opacity (GGO) and to show how it can be detected on HRCT scans for diffuse lung diseases. To make diagnosis easier, by indicating the findings that narrow down the differential diagnosis. To develop a diagnostic algorithm.

Methods: GGO is the slight increase of pulmonary attenuation, which permits seeing the underlying vessels and walls of the bronchi. It occurs when there is a decrease in pulmonary air for partial filling or partial collapse of air spaces, moderate thickening of the alveolar interstice or an increase of the capillary volume. Therefore, it is a non-specific finding in which the underlying pulmonary alteration is below the limit of resolution of the HRCT.

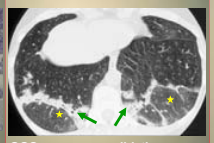
Usually, it indicates active disease that is potentially reversible with the appropriate treatment, but if it is associated with signs of fibrosis, such as honeycomb cysts, traction bronchiectasis, distortion of the parenchymal architecture and irregular thickening of the interlobular septa, it probably indicates fibrosis.

GGO is a very frequent finding in HRCT scans for diffuse infiltrative lung diseases. Detection is the first problem in its evaluation. GGO was detected by the 'dark bronchus' sign, which is a lower attenuation of air in the bronchus than in the lung surrounding it, and Minimum Intensity Projection (mIP) reconstructions. False diagnoses of GGO stem from technical errors, respiratory and cardiac movements, poor inspiration and hypoventilation in the dependent lung areas.

Subsequently, it was determined: 1) whether GGO is the predominant pattern of the disease (when the GGO is an associated finding, the differential diagnosis is based on the other dominant alterations); 2) whether its distribution is patchy, diffuse or nodular; 3) whether or not it is accompanied by signs of fibrosis; 4) whether the disease is acute, subacute or chronic.

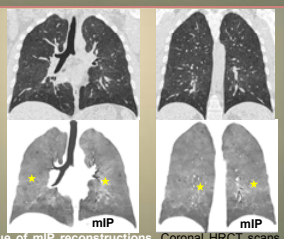


Ground-glass opacity (GGO).
a) Axial HRCT scan shows patchy GGO, with visible vessels *(asterisk)*. Interlobular septal thickening can also be seen *(yellow arrow)*.
b) The photomicrograph shows alveolar septal thickening *(star)* and partial airspace filling by macrophages and eosinophils *(orange arrow)*.
The patient was a 32-year-old man with chronic eosinophilic pneumonia.

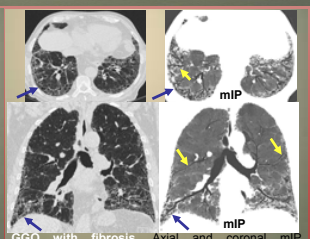


GGO versus consolidation. Axial HRCT scan shows bilateral areas of GGO involving the posterior regions of lower lobes *(stars)*. Note the consolidations, without visible vessels *(arrows)*. The patient was a 54-year-old women with cryptogenic organizing pneumonia.

Dark bronchus sign. HRCT scan shows diffuse ground-glass attenuation with the "dark bronchus sign" in a patient with nonspecific interstitial pneumonia. .



Value of mIP reconstructions. Coronal HRCT scans and mIP reformatted images show diffuse GGO, predominant in the middle lung zones *(stars)* in a patient with hypersensitivity pneumonitis.

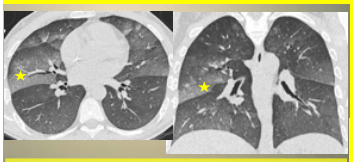


GGO with fibrosis. Axial and coronal mIP reconstructions help to detect honeycombing *(blue arrows)* and traction bronchiectasis *(yellow arrows)* in a patient with idiopathic pulmonary fibrosis.

Results: Four groups were considered in the differential diagnosis of predominant GGO with a diffuse or patchy distribution. Two groups were considered in the differential diagnosis of predominant GGO with a nodular distribution.

PATCHY OR DIFFUSE GGO WITHOUT FIBROSIS, ACUTE DISEASE (1)

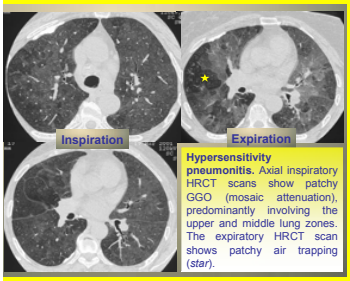
- Pulmonary oedema
- Pulmonary haemorrhage
- Neumocystis Jiroveci and viral pneumonias
- Acute eosinophilic pneumonia
- Radiation pneumonitis (acute phase)



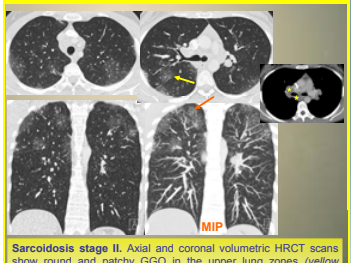
Permeability pulmonary oedema: ATRA syndrome. Axial and coronal volumetric HRCT scans show diffuse GGO with the "dark bronchus" sign. The same areas show superimposed interlobular septal thickening and intralobular lines ("crazy-paving pattern") *(stars)*. The patient was a 40-year-old man with acute promyelocytic leukaemia treated with transretinoic acid.

PATCHY OR DIFFUSE GGO WITHOUT FIBROSIS SUBACUTE-CHRONIC DISEASE (2)

- **Hypersensitivity pneumonitis**
- **IIPs:** Respiratory bronquiolitis/ILD
  - Desquamative interstitial pneumonia
  - Cryptogenic organizing pneumonia
  - Lymphoid interstitial pneumonia
- **Collagen vascular diseases**
- **Bronchoalveolar carcinoma**
- **Chronic eosinophilic pneumonia**
- **Alveolar proteinosis**
- **Sarcoidosis**

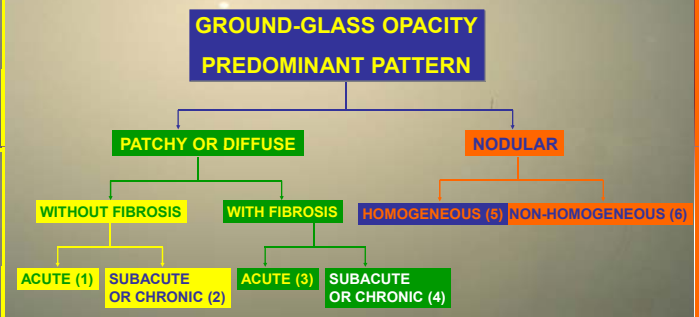


Hypersensitivity pneumonitis. Axial inspiratory HRCT scans show patchy GGO (mosaic attenuation), predominantly involving the upper and middle lung zones. The expiratory HRCT scan shows patchy air trapping *(star)*.



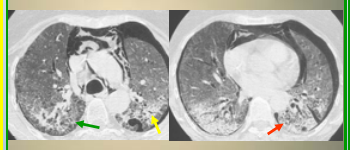
Sarcoidosis stage II. Axial and coronal volumetric HRCT scans show round and patchy GGO in the upper lung zones *(yellow arrow)*. A coronal Maximum Intensity Projection (MIP) image shows small superimposed centrilobular and subpleural nodules *(orange arrow)*. Note the mediastinal and hiliar lymphadenopaties *(star)*.

GROUND-GLASS OPACITY PREDOMINANT PATTERN

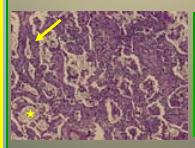


PATCHY OR DIFFUSE GGO WITH FIBROSIS, ACUTE DISEASE (3)

- Acute interstitial pneumonia
- ARDS



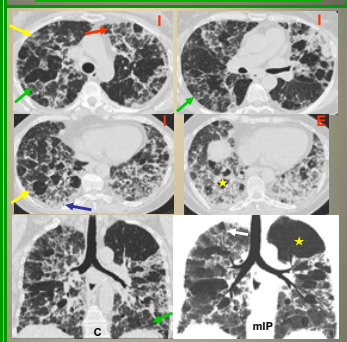
Acute interstitial pneumonia. Axial HRCT scans show diffuse bilateral GGO. Consolidations, reticular pattern *(green arrow)*, traction bronchiectasis *(yellow arrow)* and honeycombing *(orange arrow)* are all evident in the posterior lung zones. Bilateral pneumothorax and pneumomediastine can also be seen.



The photomicrograph shows airspace filled with proteinaceous exudate *(star)*. The alveolar septa are thickened *(arrow)* by fibroblastic tissue. Marked hyperplasia of type II pneumocytes can be observed.

PATCHY OR DIFFUSE GGO WITH FIBROSIS SUBACUTE, CHRONIC DISEASE (4)

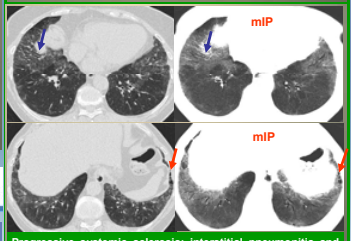
- **IIPs:** Nonspecific interstitial pneumonia
  - Desquamative interstitial pneumonia
  - Idiopathic pulmonary fibrosis
- **Collagen vascular diseases**
- **Hypersensitivity pneumonitis**
- **Radiation pneumonitis** (chronic phase)



Acute exacerbation of familial idiopathic pulmonary fibrosis. Axial volumetric HRCT scans (I) and expiratory image (E) show patchy GGO *(green arrows)* and crazy-paving pattern *(yellow arrows)*, irregular septal thickening *(orange arrow)*, traction bronchiectasis and honeycombing *(blue arrow)*. Patchy air trapping is also observed *(star)*. Coronal volumetric HRCT scan *(C)* and mIP reformatted image show bilateral, patchy air trapping (predominant in left upper lobe) *(star)*, patchy GGO *(green arrow)* and peripheral bronchiectasis *(white arrow)*, without predominant basal distribution.

CONCLUSIONS: The 'dark bronchus' sign and mIP reconstructions help to detect and quantify GGO.

Important criteria for narrowing down the differential diagnosis are: The predominance and distribution of GGO, the presence or absence of fibrosis and clinical information.



Progressive systemic sclerosis: interstitial pneumonitis and fibrosis. Axial volumetric HRCT scans and mIP images show diffuse GGO with fibrosis: traction bronchiectasis *(blue arrows)* and honeycombing *(orange arrows)*, in a predominant basal distribution.

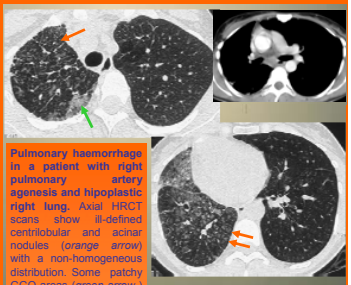
NODULAR GGO HOMOGENEOUS DISTRIBUTION (5)

- Hypersensitivity pneumonitis
- Respiratory bronchiolitis
- Respiratory bronchiolitis/ILD
- Siderosis
- Dental technician´s pneumoconiosis
- Aluminum exposure

Respiratory bronchiolitis-associated ILD: Axial volumetric HRCT scan and mIP coronal reformatted images show centrilobular nodular areas of GGO with a homogeneous distribution throughout both upper lung zones *(arrows)*. Diffuse GGO in the lower lung zones can be also observed. The patient was smoker.

NODULAR GGO NON-HOMOGENEOUS DISTRIBUTION (6)

- Infectious bronchiolitis
- Pulmonary oedema
- Pulmonary haemorrhage
- Vasculitis



Pulmonary haemorrhage in a patient with right pulmonary artery agenesis and hipoplastic right lung. Axial HRCT scans show ill-defined centrilobular and acinar nodules *(orange arrow)* with a non-homogeneous distribution. Some patchy GGO areas (*green arrow*) can be observed.

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