Common and uncommon manifestations of Organizing Pneumonia: Radiologic-Clinical-Pathologic Correlation

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Learning objectives

Patients with OP generally present with subacute illness, including shortness of breath, fever, malaise, and weight loss.

The main histopathologic feature is characterized by granulation tissue plugs lying within small airways, alveolar ducts and alveoli and by chronic inflammatory cell infiltration in alveolar walls.

The radiographic appearances of OP are multiple. Common chest X-ray and CT findings include bilateral patchy areas of consolidation with subpleural or peribronchial distribution that have a tendency to migrate, changing location and size, even without treatment. Other less specific imaging signs are irregular linear opacities, solitary focal lesions that resemble lung cancer, or multiple nodules that may cavitate.

Our purpose is to describe the clinical, pathologic, and imaging features of Organizing pneumonia (OP).
Background

The OP radiological manifestation is often secondary to a known cause such as rheumatoid arthritis, viral pneumonia, or drug reactions. The diagnosis of Cryptogenic Organizing pneumonia (COP) is based on typical pathologic and clinicoradiologic features and the exclusion of a determinable causes and disorders.

The radiological findings are multiple and variable, therefore, for a proper diagnosis is essential its correlation to clinical and pathological findings.

From January 2009 through September 2013 we have retrospectively reviewed the histopathologically diagnosed OP cases in our center and have correlated with clinical and radiological findings.
Findings and procedure details

Introduction

Organizing pneumonia (OP) is a nonspecific pathologic pattern of response by the lung to injury, with many causes and associations, including infection, drugs, connective tissue disease, and aspiration. The diagnosis of cryptogenic organizing pneumonia is based on typical pathologic and clinicoradiologic features and the exclusion of a determinable cause or associated disorder.

It is one of the reparative reactions to acute injury by the lung and reflects the incomplete resolution of inflammation within the alveoli and to a lesser extent in the distal bronchioles.

It was first described in the early 1980s as a clinicopathological syndrome characterised by a subacute/chronic respiratory illness and histopathologically by the presence of granulation tissue in the bronchiolar lumen, alveolar ducts and some alveoli.

The term bronchiolitis obliterans organizing pneumonia (BOOP) emphasizes the pathological distribution of the pneumonic process in both the alveoli and terminal bronchioles, however it is predominantly an airspace process in which the terminal bronchioles may be filled with granulation tissue but the airways are not necessarily obliterated.

Conditions causing OP

Multiple clinical conditions may cause an OP of which the most common ones are drugs, infection, lung and bone marrow transplantation, and connective tissue disease.

In 30-44% of cases an underlying disease or condition can be identified.

The term Cryptogenic Organizing Pneumonia is used when no underlying cause can be identified.

The presence of pleural effusion is the only significant differentiating imaging feature between Cryptogenic OP (in which pleural effusion is not associated) en and OP (in which pleural effusion is present in about 60% of cases).
Clinical features

Presentation is commonest in the middle age, with a peak incidence in the 6th decade. Women and men are equally affected.

Patients present with mild dyspnea, cough, and fever that have been developing over a few weeks. They typically report a short period of illness including myalgia, fever, chills and weight loss. Because of the presence of consolidation on chest radiographs, the initial diagnosis often is pneumonia, but the patients fail to respond to treatment with antibiotics.

There is no association with cigarette smoking; in fact, most patients are nonsmokers or ex-smokers.

Localized or widespread crackles on auscultation are frequent.

Elevated levels of erythrocyte sedimentation rate, C-reactive protein, and peripheral blood neutrophils are common.

Pulmonary function tests show a mild to moderate restrictive defect but normal gas transfer. Airflow obstruction is not a feature.

Bronchoalveolar lavage fluid contains an increased number and proportion of lymphocytes.

OP is mostly a diagnosis of exclusion based on imaging and clinical findings. However, cases with atypical imaging findings may require more invasive diagnostics and histology remains the gold standard.

Histological features

The term BOOP was previously used for this condition but was considered inaccurate by the ATS/ERS, since the majority of the pathology is localized mainly in the airspaces and distal airways.

The main histopathologic feature of organizing pneumonia is the presence of granulation tissue polyps in the alveolar ducts and alveoli. Fibroblast proliferation results from organization of inflammatory intraalveolar exudates. Typically, there is patchy lung
involvement with preservation of lung architecture. The granulation tissue is all the same age and contains few inflammatory cells.

**Imaging features**

The radiographic appearances of organizing pneumonia are multiple, and often mimics several other lung pathologies.

*Typical Imaging Findings*

**Chest radiograph** Fig. 1 on page 11

Usual findings in chest radiograph are uni or bilateral patchy opacities with subpleural and peribronchovascular distribution, resembling pneumonic infiltrates, with tendency to progress and change location over time.

**Computed tomography** Fig. 8 on page 17 Fig. 9 on page 18 Fig. 10 on page 19

Typically, the appearance of the lung opacities varies from ground glass to consolidation; in the latter, air bronchograms and mild cylindrical bronchial dilatation are common finding. These opacities have a tendency to migrate, changing location and size, even without treatment. They are of variable size, ranging from a few centimeters to an entire lobe.

The lung abnormalities show a characteristic peripheral or peribronchial distribution, and the lower lungs are more frequently involved. In some cases, the outermost subpleural area is spared.

*Peripheral subsegmental consolidations* Fig. 2 on page 11 Fig. 5 on page 14 Fig. 6 on page 15 Fig. 7 on page 16 Fig. 11 on page 21 Fig. 12 on page 22 Fig. 13 on page 23

The best known and most common presentation of OP consists of bilateral, patchy or peripheral, subsegmental consolidations with or without air bronchograms. There might be a variable degree of ground glass opacities associated. This pattern generally shows, if untreated, progression and consolidations may change in location over time. In a few cases the abnormalities resolve spontaneously.
**Peribronchovascular consolidations** Fig. 3 on page 12 Fig. 4 on page 13 Fig. 15 on page 24 Fig. 16 on page 26 Fig. 17 on page 27 Fig. 18 on page 28

Consolidations are oriented along the bronchovascular bundle. They frequently contain air filled bronchi, which do not show signs of volume loss. Bronchovascular consolidations are the dominant feature and are present in about one third of OP. This pattern is frequently described in patients with OP and collagen vascular disease, e.g., polymyositis and dermatomyositis, lupus erythematoses or rheumatoid arthritis.

**Atypical Imaging Findings**

The most common CT findings of organizing pneumonia consist of bilateral areas of patchy air-space consolidation, often subpleural and/or peribronchial, with or without ground-glass opacities, typically in mid and lower lung zones. However, these findings are seen in only approximately 60% of patients.

Other less specific imaging patterns include: "reversed-halo" sign, focal organizing pneumonia, a variety of nodular patterns (the first may be located peripherally or bronchovascular, the latter centrilocular or with a tree-in-bud pattern), a perilobular pattern, band-like opacities and progressive fibrotic form of organizing pneumonia.

**Reversed halo sign** Fig. 13 on page 23 Fig. 14 on page 24 Fig. 15 on page 24 Fig. 16 on page 26 Fig. 17 on page 27 Fig. 18 on page 28

The reversed halo sign is characterised by a central ground-glass opacity surrounded by more dense air-space consolidation of crescentic and ring shapes.

The central ground-glass opacity corresponds histopathologically to the area of alveolar septal inflammation and cellular debris in the alveolar spaces, whereas the ring-shaped or crescentic peripheral air-space consolidation corresponds to the area of organizing pneumonia within the alveolar ducts.

Multiple of these lesions resemble multiple islands (Atoll sign).

The "Atoll sign" or "Reversed halo sign" is not specific for OP: it has also been reported in sarcoïdosis en other granulomateous infections like tuberculosis, schistosomiasis or cryptococcus infections.

**Focal (solitary) OP** Fig. 29 on page 38
Focal OP presents with a solitary consolidation most frequently in the upper lobes. Cavitation and even irregular and spiculated margins of the lesions may be seen making a distinction from bronchogenic carcinoma based on imaging findings impossible and diagnosis is mostly determined by biopsy.

Helpful features for differentiating from lung cancer include:

- Presence of air bronchogram.
- Location of the lesion in contact with the pleura (relative broad pleural base) or along the bronchovascular bundle with some contraction and convergence of vessels.
- The presence of flat, oval or trapezoidal-shape masses instead of a rounded lesion.
- Coexistent parenchymal bands and subpleural lines.
- Presence of satellite lesions.

Focal OP has no specific features and it can also present as *multiple mass-like opacities* that are usually peripherally located. Pulmonary vessels may be seen leading to the nodular opacities and small bronchi may enter the centre of the opacities.

*Nodular Opacities* Fig. 19 on page 29 Fig. 20 on page 30 Fig. 21 on page 31 Fig. 22 on page 32 Fig. 23 on page 32 Fig. 24 on page 33 Fig. 26 on page 35

Both, macronodular and micronodular patterns are described in OP. Nodules vary in size between several mm and cm and usually randomly distributed within the lungs. They may be surrounded by a rim of ground glass or show the reversed halo sign. Multiple nodular lesions surrounded by a complete or incomplete rim of consolidations is also described as Atoll sign. Both features are not specific but quite suggestive for OP in an appropriate clinical situation.

Rarely nodules can be small and well defined in a centrilobular distribution. If the granulocytes are confined to the small bronchioli before floating over into the alveolar spaces, the imaging findings consists of a diffuse tree-in-bud pattern that is indistinguishable from a panbronchiolitis or a diffuse infectious bronchiolitis. Inappropriate response to antibiotics and heavy dyspnea despite broncholytic and antibiotic therapy might be suggestive, though open lung biopsy might be necessary to determine the diagnosis.

*Perilobar pattern* Fig. 8 on page 17 Fig. 10 on page 19

The perilobular region comprises the structures bordering the secondary lobule. In this context, accumulation of organizing exudate in the perilobular alveoli, with or without
interlobular septal thickening at histologic examination, contributes to the ill-defined perilobular pattern.

The perilobular pattern consists of bowed or polygonal opacities with poorly defined margins bordering the interlobular septa, i.e. the peribronchovascular interstitium of the larger bronchi and accompanying pulmonary arteries which are located in the periphery of the lobule.

It has to be noted that the opacifications are not confined to the interlobar septa as in lymphangitis carcinomatosa but only follow the interlobular septa and "flow over" into the adjacent alveolar spaces at the periphery of the secondary lobule.

This pattern may also be seen in chronic eosinophilia, lymphoproliferative disorders and bronchoalveolar cell carcinoma.

No obvious relationship between perilobular opacities and CT findings are indicative of established fibrosis.

*Linear or band-like pattern* Fig. 25 on page 34 Fig. 26 on page 35 Fig. 27 on page 36

A linear or band-like pattern of OP is unusual and striking and has been described in insolation or in combination with other patterns.

They are usually more than 2 cm long and more than 8 mm in width and their borders may be smooth or irregular. Air bronchograms are often present.

These linear opacities may form arcades and are usually associated with multifocal areas of consolidation.

The linear opacities may extend in a radial manner along the line of the bronchi toward the pleura, usually intimately related to the bronchi or they may occur in a peripheral location with no relationship to bronchi.

It is associated with increased risk of persistent or progressive disease.

*Progressive fibrosis* Fig. 27 on page 36 Fig. 28 on page 37

Some cases of OP have an unfavorable outcome and can even lead to death. Mortality is related to progressive fibrotic OP. HRCT shows a bibasal reticular pattern with architectural distortion in a peribronchovascular distribution at the lung bases. Traction
bronchiectasis and honeycombing may also be seen. Frequently combinations with consolidation and nodules are encountered.

This entity seems to be associated with connective tissue diseases, especially polymyositis and dermatomyositis.

**Therapy and prognosis**

The therapy of OP consists of prolonged administration of high doses of corticosteroids, which are gradually reduced over months.

The majority of patients recover completely after administration of corticosteroids, but relapses occur frequently within 3 months after corticosteroid therapy is reduced or stopped.

Overall, OP has a favourable prognosis. In 70-80% complete clinical and radiological remission is achieved. 10-15% of the OP cases are self-limiting. A minority of the cases are progressive resulting in irreversible fibrosis. In patients with underlying connective tissue disease, OP outcome tends to be less favorable.
Fig. 1: 89 year old male with increased cough, sputum and fever that was initially diagnosed as respiratory infection. Frontal chest radiograph images confirmed predominantly middle and lower zone air space opacities areas.

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**Fig. 2:** Axial CT image in a 56 year old female with organizing pneumonia characterized by a predominantly subpleural distribution of consolidation.

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**Fig. 3:** Patchy peribronchovascular consolidations with associated ground glass opacities.

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**Fig. 4:** Patchy areas of peribronchial consolidation in both lower lobes, with confluent aspect and peripheral predominance. Most of them presented irregular bronchial dilation inside without distortion of the vascular structures. Ground-glass density surrounding the area of lung consolidation (halo sign) was also noted. All findings required a differential diagnosis of a bacterial infectious process, neoplastic process such as lymphoma or lung adenocarcinoma or an inflammatory processes such as organizing pneumonia. The possibility of a neoplastic process given radiographic progression compared to the previous radiography was less probably. Transbronchial biopsies of the lateral segment of the right lower lobe bronchus were performed confiming OP (lung parenchyma showing conserved structure, occupation of alveolar spaces by masses of loose fibroblastic tissue without inflammatory component. Alveolar septa did not present signs of fibrosis and presence of inflammatory component. No signs of vasculitis and granulomas were evident. No evidence of infiltration by neoplastic process were detected).

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Fig. 5: 81 year old men who came to the hospital with a clinical history of sweating, trembling and feverish sensation during the last 3 days. He referred dyspnea with great efforts prior to the current episode. Auscultation respiratory included crackling bibasilar. In chest radiography, it can be appreciated bibasilar pulmonary infiltrates predominantly in the right lung. Diagnostic approach was an infectious process and antibiotic treatment was started, showing no clinical or radiological improvement. Chest CT: Bilateral lung consolidations predominantly in both lower lobes and peripheral distribution, with discrete irregular bronchial dilation and increased ground-glass density associated. The findings could correspond to an infectious process but it should be ruled organizing pneumonia. Bronchoscopy: macroscopically normal. Transbronchial biopsies of the posterior segment of the right lower lobe bronchus were performed confirming OP.

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Fig. 6: 61 year old man with a history of asthma, which was presenting toxic syndrome with loss of 3 kg, fever and mucous expectoration of one month duration. Chest radiography showed bibasal parenchymal involvement with loss of lung volume in both bases compatible with inflammatory / infectious process. Chest CT: Bilateral pulmonary parenchymal involvement predominantly affecting the lower lobes, especially in the posterior areas associated with air bronchogram and increase in ground-glass density. Differential diagnosis should include pneumonia, bronchial alveolar carcinoma and even primary pulmonary lymphoma. The fact that there were minimally dilated bronchi in the areas of condensation, reinforce that the diagnosis of OP. Bronchoscopy with transbronchial biopsy and bronchoalveolar lavage was performed without any conclusive results. CT guided lung biopsy was also performed. Pathology revealed an organizing pneumonia: fragments of lung parenchyma of conserved structure without evidence of fibrosis. Alveolar walls were discreetly thickened in some areas, showing lymphoplasmacytic inflammatory infiltration. Presence of numerous accumulations of loose connective tissue with myxoid appearance occupying alveolar lúmens were also observed.

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Figure 7: 61 year old man with a history of asthma, which was presenting toxic syndrome with loss of 3 kg, fever and mucous expectoration of one month duration. Chest radiography showed bibasal parenchymal involvement with loss of lung volume in both bases compatible with inflammatory / infectious process. Chest CT: Bilateral pulmonary parenchymal involvement predominantly affecting the lower lobes, especially in the posterior areas associated with air bronchogram and increase in ground-glass density. Differential diagnosis should include pneumonia, bronchial alveolar carcinoma and even primary pulmonary lymphoma. The fact that there were minimally dilated bronchi in the areas of condensation, reinforce that the diagnosis of OP. Bronchoscopy with transbronchial biopsy and bronchoalveolar lavage was performed without any conclusive results. CT guided lung biopsy was also performed. Pathology revealed an organizing pneumonia: fragments of lung parenchyma of conserved structure without evidence of fibrosis. Alveolar walls were discreetly thickened in some areas, showing lymphoplasmacytic inflammatory infiltration. Presence of numerous accumulations of loose connective tissue with myxoid appearance occupying alveolar lúmens were also observed.

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Fig. 8: Images from the same patient Fig.2: 56 year old woman, admitted for fever and bilateral pulmonary infiltrates that did not improve after antibiotic treatment. Chest CT scan showed bilateral patchy areas of lung consolidation, with ground glass associated predominantly in the middle lobe, lingula and both lower lobes. Some interlobular septal thickening predominantly in the bases and thickening of the bronchial walls were also observed. There are some images showing perilobular pattern. Bilateral pleural effusion was also noted. If infectious disease is ruled out, it could be a cryptogenic organizing pneumonia. Transbronchial biopsy confirmed COP.

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Fig. 9: 89 year old male from Fig. 1 with chronic bilateral pulmonary infiltrates and diagnosed with cryptogenic organizing pneumonia in 2009. He was admitted to the hospital with fever and worsening infiltrates in the context of fever, cough and purulent sputum of 1 month duration. Axial CT images demonstrated peribronchial and subpleural consolidations with air bronchogram, characterized by a predominantly subpleural distribution and associated with some bronchial dilatation. Furthermore, bilateral pleural effusion was also observed. All these findings were compatible with NOC. Transthoracic needle biopsy was performed confirming NOC. Antibiotic treatment was removed according guidance diagnosed with organizing pneumonia without respiratory infection. Prednisone was performed at a rate of 1mg/kg/day, confirming clinical and radiological improvement.

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Fig. 10: 65 year old man who presented with fever, non-productive cough, dyspnea after minimal effort and pleuritic pain of around 15 days evolution that did not improve with antibiotic treatment. He also presents a soft tissue density mass, well-defined margins with a central hyperdense area without calcifications and cystic-necrotic areas or fat. The mass observed could correspond to a thymic pathology or an adenopathic conglomerate. The lung parenchyma presented multiple bilateral areas of consolidation affecting all lung fields but predominantly located on bibasal and peripheral area with a peribronchial distribution with some ground glass adjacent areas. Note also that images show the perilobular pattern characterized by polygonal and bowed opacities with poorly defined margins involving structures that border the interlobular septa. Radiological findings could be compatible with a lymphoma with mediastinal and pulmonary involvement or mediastinal timoma and inflammatory / infectious pulmonary involvement (NOC?). Bronchoscopy did not confirmed any endobronchial significant alterations. In CT guided mediastinal tumor biopsy results thymic carcinoma. A lung biopsy (minithoracotomy) of left lower lobe and lingula was also performed. Pathology revealed an organizing pneumonia (fragments of lung parenchyma of conserved structure showed an irregular distribution pattern with areas of lung parenchyma without alterations and organizational areas consisting of loose connective tissue filling bronchioles, alveolar ducts and alveoli. Alveolar walls did not present any signs of interstitial fibrosis but mild inflammatory infiltrate corresponding to lymphocytes and plasma cells was observed. No infiltration
was evidenced by the neoplastic process), so corticosteroid therapy was initiated. Patient is operated practicing an sternotomy and a resection of mediastinal tumor was practiced to the patient confirming a thymic carcinoma without signs of differentiation.

Fig. 11: Patient refering asthenia, 5 kg weight loss during last two months, dry cough and left rib pain in last 48 hours. Pain observed was increasing with breathing and coughing. No related dyspnea or fever was observed. Patient became ex-smoker 8 years ago (1 pack of cigarettes a day since 18 years old). Chest radiography showed bilateral and patchy parenchymal infiltrates with a dense pseudonodular image superimposed on D8 in the lateral radiography. In the absence of infectious condition may explain pattern observed, chest CT should be performed to complete the study. Patchy areas of consolidations in both upper and lower lobes predominantly peripheral location, with cylindrical bronchiectasis inside and also associated with extensive ground glass opacities. Radiological findings were compatible with OP. Bronchoscopy was performed confirming a discrete bilateral inflammatory component. Transbronchial biopsy of the posterior and lateral segment of the right lower lobe bronchus was also done. Pathological result confirmed pieces of lung parenchyma showing conserved structure with, alveolar septa with no signs of fibrosis or inflammatory infiltrate. Inside some alveolar spaces was
confirmed the presence of loose aggregate of fibrous tissue filling the alveolar lumen. Granulomas were not observed. Diagnosis: lung parenchyma with changes of focal organizing pneumonia.

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Fig. 12: Patient referring asthenia, 5 kg weight loss during last two months, dry cough and left rib pain in last 48 hours. Pain observed was increasing with breathing and coughing. No related dyspnea or fever was observed. Patient became ex-smoker 8 years ago (1 pack of cigarettes a day since 18 years old). Chest radiography showed bilateral and patchy parenchymal infiltrates with a dense pseudonodular image superimposed on D8 in the lateral radiography. In the absence of infectious condition may explain pattern observed, chest CT should be performed to complete the study. Patchy areas of consolidations in both upper and lower lobes predominantly peripheral location, with cylindrical bronchiectasis inside and also associated with extensive ground glass opacities. Radiological findings were compatible with OP. Bronchoscopy was performed confirming a discrete bilateral inflammatory component. Transbronchial biopsy of the posterior and lateral segment of the right lower lobe bronchus was also done. Pathological result confirmed pieces of lung parenchyma showing conserved structure with, alveolar septa with no signs of fibrosis or inflammatory infiltrate. Inside some alveolar spaces was
confirmed the presence of loose aggregate of fibrous tissue filling the alveolar lumen. Granulomas were not observed. Diagnosis: lung parenchyma with changes of focal organizing pneumonia.

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**Fig. 13:** 69 years old male who was attended by the emergency department several times last year with dyspnea. Chest CT: patchy areas of ground-glass peripheral and subpleural predominantly in the lower lung fields. Some of them were surrounded by a rim of consolidation (reverse halo sign). There were no signs of fibrosis (traction bronchiectasis or honeycomb) and lung architecture was preserved. Radiological findings determined an organizing pneumonia pattern, correlating with the clinical and medical history of the patient (OP secondary to drugs, infectious disease, collagen disease or COP). Bronchoscopy with transbronchial biopsy in left basal pyramid were performed. Results: pulmonary parenchyma with preserved structure showing in some alveoli the presence of foci of fibroblastic proliferation. No signs of inflammation, granulomas or vasculitis. No evidence of neoplastic infiltration. Morphological changes observed were compatible with organizing pneumonia.

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**Fig. 14:** Patient with T lymphoblastic lymphoma patient was attended at the emergency department for dyspnea. Fever was not referred. In chest radiography, an increased density was detected in the right lower lobe. Chest CT: Image showing a nodular glass opacity surrounded by a ring of consolidation (reversed halo sign) in the right lower lobe. In the clinical context, patient's findings could be related with an angioinvasive aspergillosis, tuberculosis, cryptogenic organized pneumonia, etc. The final diagnostic was OP.

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Fig. 15: 36 year old woman from Fig. 3 presenting a 9 days evolution progressive dyspnea of evolution accompanied by cough, scant sputum expectoration and fever. In last visit to the emergency department two days ago the symptoms were oriented as respiratory infection so antibiotics were prescribed without improvement. Sputum culture and urine antigen were negative. Past medical history: repetition pneumonia (2006-2010). Chest radiography shows bilateral patchy lung consolidations predominantly located at the middle and lower pulmonary fields. Chest CT: extensive bilateral and diffuse parenchymal involvement with multiple areas of peribronchial consolidation, predominantly in the upper fields associated with endobronchial impaction and thickening of the bronchial walls. Peribronchial consolidation areas exhibit adjacent ground glass density (halo sign) and air bronchogram. There are also multiple patchy areas of increased density ground glass in both upper and lower fields also with peribronchial distribution and radiolucent images with hyperdense periphery (reversed halo sign). Findings described could correspond to OP being an infection less probable. Another possible diagnostic is lymphoma. Bronchial and transbronchial biopsies of the middle bronchial lobe were performed as they were slightly thickened and OP was confirmed. Corticosteroid treatment was started 60mg/day and showing clinical and radiological improvement. 

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Fig. 16: 36 year old woman from Fig. 3 presenting a 9 days evolution progressive dyspnea of evolution accompanied by cough, scant sputum expectoration and fever. In last visit to the emergency department two days ago the symptoms were oriented as respiratory infection so antibiotics were prescribed without improvement. Sputum culture and urine antigen were negative. Past medical history: repetition pneumonia (2006-2010). Chest radiography shows bilateral patchy lung consolidations predominantly located at the middle and lower pulmonary fields. Chest CT: extensive bilateral and diffuse parenchymal involvement with multiple areas of peribronchial consolidation, predominantly in the upper fields associated with endobronchial impaction and thickening of the bronchial walls. Peribronchial consolidation areas exhibit adjacent ground glass density (halo sign) and air bronchogram. There are also multiple patchy areas of increased density ground glass in both upper and lower fields also with peribronchial distribution and radiolucent images with hyperdense periphery (reversed halo sign). Findings described could correspond to OP being an infection less probable. Another possible diagnostic is lymphoma. Bronchial and transbronchial biopsies of the middle bronchial lobe were performed as they were slightly thickened and OP was confirmed. Corticosteroid treatment was started 60mg/day and showing clinical and radiological improvement.

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Fig. 17: 36 year old woman from Fig. 3 presenting a 9 days evolution progressive dyspnea of evolution accompanied by cough, scant sputum expectoration and fever. In last visit to the emergency department two days ago the symptoms were oriented as respiratory infection so antibiotics were prescribed without improvement. Sputum culture and urine antigen were negative. Past medical history: repetition pneumonia (2006-2010). Chest radiography shows bilateral patchy lung consolidations predominantly located at the middle and lower pulmonary fields. Chest CT: extensive bilateral and diffuse parenchymal involvement with multiple areas of peribronchial consolidation, predominantly in the upper fields associated with endobronchial impaction and thickening of the bronchial walls. Peribronchial consolidation areas exhibit adjacent ground glass density (halo sign) and air bronchogram. There are also multiple patchy areas of increased density ground glass in both upper and lower fields also with peribronchial distribution and radiolucent images with hyperdense periphery (reversed halo sign). Findings described could correspond to OP being an infection less probable. Another possible diagnostic is lymphoma. Bronchial and transbronchial biopsies of the middle bronchial lobe were performed as they were slightly thickened and OP was confirmed. Corticosteroid treatment was started 60mg/day and showing clinical and radiological improvement.

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Fig. 18: 36 year old woman from Fig. 3 presenting a 9 days evolution progressive dyspnea of evolution accompanied by cough, scant sputum expectoration and fever. In last visit to the emergency department two days ago the symptoms were oriented as respiratory infection so antibiotics were prescribed without improvement. Sputum culture and urine antigen were negative. Past medical history: repetition pneumonia (2006-2010). Chest radiography shows bilateral patchy lung consolidations predominantly located at the middle and lower pulmonary fields. Chest CT: extensive bilateral and diffuse parenchymal involvement with multiple areas of peribronchial consolidation, predominantly in the upper fields associated with endobronchial impaction and thickening of the bronchial walls. Peribronchial consolidation areas exhibit adjacent ground glass density (halo sign) and air bronchogram. There are also multiple patchy areas of increased density ground glass in both upper and lower fields also with peribronchial distribution and radiolucent images with hyperdense periphery (reversed halo sign). Findings described could correspond to OP being an infection less probable. Another possible diagnosis is lymphoma. Bronchial and transbronchial biopsies of the middle bronchial lobe were performed as they were slightly thickened and OP was confirmed. Corticosteroid treatment was started 60mg/day and showing clinical and radiological improvement.

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Fig. 19: 19 year old man presenting a week of clinical evolution coughing, fever and pleuritic pain in the left hemithorax. Ganglion territories not objective pathologic lymph nodes, genitalia not presenting alterations were explored. It is a patient without history of toxic habits, recent trip, contact and comorbidity risk that could justify the symptoms. Chest radiography shows multiple poorly defined nodular opacities predominantly located at the lower pulmonary fields. Chest CT: Multiple bilateral pulmonary nodules with peribronchovascular distribution with air bronchogram inside, ill-defined margins and surrounded by a halo of ground-glass increased density (halo sign). Images were compatible with an infection by mycobacteria, vasculitis (granulomatous disease like Wegener), organizing pneumonia, lymphoma,... Bronchoscopy with transbronchial biopsy were performed and were negative for malignant cells. CT-guided biopsy of a nodule in the left upper lobe showed: Pulmonary parenchyma with an altered structure, showing an enlargement of the alveolar walls by the presence of fibrous tissue and limited lymphocytic inflammatory component with isolated eosinophils. Some of the alveolar lumens were occupied by a loose fibrous tissue, observed in some areas a slight alveolar macrophage desquamation and hyperplasia of pneumocytes. No signs of vasculitis and granulomas were confirmed. No evidence of neoplastic infiltration of the material was observed. Diagnosis: Organizing pneumonia pattern without neoplastic infiltration. Corticosteroid treatment was started 60mg/day and showing clinical and radiological improvement.
Fig. 20: 19 year old man presenting a week of clinical evolution coughing, fever and pleuritic pain in the left hemithorax. Ganglion territories not objective pathologic lymph nodes, genitalia not presenting alterations were explored. It is a patient without history of toxic habits, recent trip, contact and comorbidity risk that could justify the symptoms. Chest radiography shows multiple poorly defined nodular opacities predominantly located at the lower pulmonary fields. Chest CT: Multiple bilateral pulmonary nodules with peribronchovascular distribution with air bronchogram inside, ill-defined margins and surrounded by a halo of ground-glass increased density (halo sign). Images were compatible with an infection by mycobacteria, vasculitis (granulomatous disease like Wegener), organizing pneumonia, lymphoma,... Bronchoscopy with transbronchial biopsy were performed and were negative for malignant cells. CT-guided biopsy of a nodule in the left upper lobe showed: Pulmonary parenchyma with an altered structure, showing an enlargement of the alveolar walls by the presence of fibrous tissue and limited lymphocytic inflammatory component with isolated eosinophils. Some of the alveolar lumens were occupied by a loose fibrous tissue, observed in some areas a slight alveolar macrophage desquamation and hyperplasia of pneumocytes. No signs of vasculitis and granulomas were confirmed. No evidence of neoplastic infiltration of the material was observed. Diagnosis: Organizing pneumonia pattern without neoplastic infiltration.
Corticosteroid treatment was started 60mg/day and showing clinical and radiological improvement.

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Fig. 21: 19 year old man presenting a week of clinical evolution coughing, fever and pleuritic pain in the left hemithorax. Ganglion territories not objective pathologic lymph nodes, genitalia not presenting alterations were explored. It is a patient without history of toxic habits, recent trip, contact and comorbidity risk that could justify the symptoms. Chest radiography shows multiple poorly defined nodular opacities predominantly located at the lower pulmonary fields. Chest CT: Multiple bilateral pulmonary nodules with peribronchovascular distribution with air bronchogram inside, ill-defined margins and surrounded by a halo of ground-glass increased density (halo sign). Images were compatible with an infection by mycobacteria, vasculitis (granulomatous disease like Wegener), organizing pneumonia, lymphoma,... Bronchoscopy with transbronchial biopsy were performed and were negative for malignant cells. CT-guided biopsy of a nodule in the left upper lobe showed: Pulmonary parenchyma with an altered structure, showing an enlargement of the alveolar walls by the presence of fibrous tissue and limited lymphocytic inflammatory component with isolated eosinophils. Some of the alveolar lumens were occupied by a loose fibrous tissue, observed in some areas a slight alveolar
macrophage desquamation and hyperplasia of pneumocytes. No signs of vasculitis and granulomas were confirmed. No evidence of neoplastic infiltration of the material was observed. Diagnosis: Organizing pneumonia pattern without neoplastic infiltration. Corticosteroid treatment was started 60mg/day and showing clinical and radiological improvement.

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**Fig. 22:** 69 year old patient diagnosed with rectal neoplasia in 2006. In 2009 and 2011 CT considered the dissemination of his underlying disease. TC December 2013 determined: multiple bilateral pulmonary nodular lesions predominantly located in basal and peripheral areas, most of them have peribronchially distribution and in some of them pseudocavitation it was also appreciated. Patchy area of ground glass density and consolidation. Regarding some previous studies some of the lesions are newly emerging, others are stable and other is missing. Radiological characterisation and evolution were suggesting an inflammatory process so OP was ruled out.

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Fig. 23: 69 year old patient diagnosed with rectal neoplasia in 2006. In 2009 and 2011 CT considered the dissemination of his underlying disease. TC December 2013 determined: multiple bilateral pulmonary nodular lesions predominantly located in basal and peripheral areas, most of them have peribronchially distribution and in some of them pseudocavitation it was also appreciated. Patchy area of ground glass density and consolidation. Regarding some previous studies some of the lesions are newly emerging, others are stable and other is missing. Radiological characterisation and evolution were suggesting an inflammatory process so OP was ruled out.

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Fig. 24: 69 year old patient diagnosed with rectal neoplasia in 2006. In 2009 and 2011 CT considered the dissemination of his underlying disease. TC December 2013 determined: multiple bilateral pulmonary nodular lesions predominantly located in basal and peripheral areas, most of them have peribronchially distribution and in some of them pseudocavitation it was also appreciated. Patchy area of ground glass density and consolidation. Regarding some previous studies some of the lesions are newly emerging, others are stable and other is missing. Radiological characterisation and evolution were suggesting an inflammatory process so OP was ruled out.

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Axial CT image shows a band-like opacity containing air-bronchogram in the right lower lobe.

Fig. 25

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Fig. 26: Patient diagnosed of OP by surgical biopsy treated with corticosteroids and recurrent respiratory infections. The cause of the OP can be related to aspiration because, despite the intervention of hiatus hernia, persisted with a significant acid reflux. Chest CT: Diffuse parenchymal involvement, more pronounced in the lower lobes, as pathology of distal airway and distal bronchial dilation, tree-in-bud and centrilobular nodules. Typical linear or band-like opacities some of them with air bronchogram. Bibasilar bronchiolectasis with thickening of the bronchial walls. Patchy areas of ground-glass predominantly in both upper lobes were also identified.

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Fig. 27: 77 year old woman referring productive cough with whitish sputum and dyspnea of 3 days of evolution, without fever, chest pain or other symptoms. She was evaluated by their primary care physician who initially oriented as pneumonia and was treated with levofloxacin without clinical improvement so she went to the emergency service. She is a patient with interstitial lung disease in study. Despite antibiotic treatment, fever without full resolution on the radiography was persisting occasionally. Chest CT: bronchial dilation predominantly bibasilar and in upper right lobe, but also seen in the middle lobe and upper left lobe. It was also confirmed some traction bronchiectasis associated with peribronchial consolidations. There were also increased density patchy areas in ground-glass and a thickened septum isolated but no honeycomb pattern and lower density areas suggesting air trapping were seen. Some of the images show band-like opacities containing air-bronchogram. Findings suggested a component of fibrosis associated with condensing areas but not showing the typical image of an usual interstitial pneumonia (UIP). If the patient did not present infectious clinical findings could correspond to a COP. The results of CT and bronchoscopy were compatible with inflammatory disease type cryptogenic organizing pneumonia (COP), so finally, it was decided to start treatment with corticosteroids and clinical improvement was observed.

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Fig. 28: 80 year old man who presented with dyspnea. Paroxysmal atrial fibrillation treated with amiodarone and, polymyalgia rheumatica treated with Urbason 4 mg / day. The patient referred dyspnea media efforts, paroxysmal nocturnal dyspnea and orthopnea of approximately one month of evolution. Also referred nausea, anorexia and decreased food intake. Chest CT: Bilateral diffuse parenchymal involvement predominantly in the upper lung fields, increasing in ground-glass density areas, peribronquial consolidation, bronchiectasis with bronchial wall and septal thickening. There were no areas of honeycomb pattern or clear pictures of air trapping. According these findings, infectious disease was ruled out and clinical signs were compatible with interstitial lung disease (OP, NSIP, ...). Bronchoscopy and transbronchial biopsy were performed and the results were: Fragments of lung parenchyma showed occupation of most of alveolar spaces by fibroblast colagenizadas masses. Desquamation of pneumocytes and intraalveolar macrophages with microvacuolated foamy cytoplasm were also observed. The lesions observed were morphologically consistent with clinical direction of organizing pneumonia by amiodarone toxicity.

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Fig. 29: 60 year old woman admitted for back pain refractory treated with opioids. Chest CT: Partial atelectasis of the left lower lobe, paravertebral, thickening and trabeculation of pleural fat was also appreciated with soft tissue density component associated, adjacent to vertebral bodies of D8 and D9. Such involvement was also described above on the right side and was associated with a permeative lesion at the aspect of cost-vertebral junction of 9th rib. Associated with the involvement increased vascularization was also observed. Findings were suggesting inflammatory/infectious process. Left posterolateral thoracotomy: biopsy of the paravertebral pleural thickening and lung. Microbiological analysis of paravertebral mass and lung biopsy detected the presence of S. Aureus. Pathology: The lung tumor was located in an area of acute and chronic inflammation with central abscess, related with medium-sized bronchus showing partial rupture of the wall and filling the lumen with polymorphonuclear and granulation tissue. In the area surrounding the abscess, dense lymphoplasmacytic inflammatory infiltration and fibrosis with parenchymal destruction was observed. Granulomas, fungi or parasites or other signs of inflammatory specificity were not identified. Surrounding the area described, lung parenchyma showed severe changes of organizing pneumonia, filling alveolar lumens by fibroblast masses and foamy macrophages, peribronchial inflammation and obliterative bronchial phenomena.

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Conclusion

OP is a nonspecific pathologic pattern of lung response to injury, with many causes and associations and in the case of COP the cause is idiopathic.

In the appropriate clinical context, like a consolidation that increases over several weeks despite antibiotics, the CT features of OP are often suggestive.

The classic CT features of OP are consolidations with air bronchograms that are sharply demarcated by lobular septa and mostly in peripheral and/or peribronchovascular distribution. However, apart from the typical imaging pattern of OP, other less specific imaging patterns can be encountered.

OP is mostly a diagnosis of exclusion. An integrated clinical, radiologic, and pathologic approach is necessary for accurate diagnosis of this entity.
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