RESPIRATORY SYSTEM

MUSEUM CATALOGUE

Department of Pathology, University of Adelaide, 2004

INTRODUCTION

Respiratory disease is an important cause of morbidity and mortality, being especially common in smokers. One of the most useful ways of examining a lung is to pick it up in the fresh state, as its weight and texture can be very helpful. The normal lung weight in the adult ranges from around 400g (300-500) for the left lung to 460g (350-550) for the right lung: in a patient dying from acute pulmonary oedema a single lung may weigh more than 1000g, and be full of frothy fluid that can be easily expressed. Unfortunately, this cannot be demonstrated in a pot specimen and as the macroscopic appearance is otherwise unremarkable, no specimens of pulmonary oedema are present in the museum (a useful tip for exams). Nonetheless, there are a number of interesting and important patterns of macroscopic pathology in the lung that are demonstrated in the museum collection.

Any comments on this catalogue are welcome. Please contact a member of the department.

HOW TO USE THIS CATALOGUE

This catalogue can be used as a tool to develop your knowledge, as well as provide an opportunity for revision.

It is divided into:

- Introduction and approach to specimens (pages 2-4).
- Index (pages 5-8). Examples of specific diagnoses can be found via the index.
- Core and classic disease processes (pages 9-28). This gives examples and discussion of core and/or classic diseases of the respiratory system. These are the specimens that students should focus on being able to identify initially. However, it depends to some extent on what you have covered in lectures and practical classes or resource sessions as to what you should know. Some of the specimens and discussion are directed more towards clinical medical students.
- Main catalogue (pages 29- 72). This section covers the specimens in numerical order. Questions and/or comments accompany some of the specimens to help you expand your knowledge. In order to fit more specimens in the museum, not all of the pots are in numerical order on the shelves, and large specimens are often found on the bottom shelves.

You might find it useful to work quietly with a few friends and to have a few textbooks handy (e.g. pathology, medical, anatomy). As well as learning pathology, you will also find that you can learn and revise some anatomy and clinicopathological correlation from the specimens and information given.

You do not have to examine every specimen in the museum. However, just as in clinical practice, you will not become proficient in diagnosing something if you have only seen one case. Exposure to a variety of cases (specific diagnoses can be found via the index) to experience the variability in morphology will help your learning greatly.

In general the red and blue dots on the pots indicate basic and straightforward pathology, whereas yellow dots tend to indicate less readily diagnosable conditions. This is not a hard and fast rule, and you will find yellow dot specimens turning up in resource sessions/practical classes and even exams, if they represent classic pathology.

In general

- read the clinical information given
- look at the entire specimen, not just the front
- identify and orientate the organ or tissue

- from your knowledge of pathology (which will come with time) look for relevant features to help you make the diagnosis. Of course to appreciate the abnormal you first need to have an appreciation of normal anatomy to be able to recognise and orientate the organ/tissue and the abnormalities
- make a diagnosis or differential diagnosis using any clinical information given to you – it is often relevant – sometimes the diagnosis is only made with a knowledge of the clinical features. Even when you know the diagnosis, attempt to identify relevant features in the specimen and understand why this is the diagnosis.
- attempt to correlate the pathological features with the clinical features (clinico-pathological correlation) i.e. explain how the pathological features have caused the patients symptoms and signs (when relevant)
- try to answer any questions presented yourself before reading the answers.

You may prefer to look at the specimen 'blind', without reading the clinical information given first.

Remember that some of these specimens are very old, and some of the investigations and treatments mentioned may be out of date.

Limits to diagnosis on macroscopic examination

In all cases a diagnosis is given in the catalogue, sometimes it was made based on the stated clinical history and histopathological findings. In some cases the macroscopic appearance is classic and even without the clinical information and histopathological findings you should be able to make the diagnosis from the appearance, in others, it might only be possible for you to give a list of differential diagnoses or a more general diagnosis.

BASIC APPROACH TO INTERPRETATION AND DESCRIPTIONOF RESPIRATORY SPECIMENS

Orientation and identification of the specimen

Starting at the most basic level: always look at the front of the specimen first (the one with the number and the coloured dot on the top). Having said this, it is a well-known fact that you should always look at the back and sides of a pot as well. The specimens are mainly portions of lungs, with occasional laryngeal and pharyngeal specimens, and specimens of pleural pathology, which should not be too hard for you to identify. If you can, identify which lung you are looking at, left or right, on the basis of the number of lobes (two on the left and three on the right……). Take note of the appearance of normal structures (bronchi, vessels, hilar lymph nodes etc). Also note that on close examination you can see the alveolar spaces. Appreciating the normal appearance of these is important for recognising consolidation, emphysema and fibrosis later on. Also note the size of the lungs. Certain diagnoses may be more likely in children.

Many of the specimens demonstrate anthracosis: the accumulation of carbon or coal dust pigment in the lungs. This can be seen as small black spots in the pulmonary parenchyma. Macrophages in the alveoli phagocytose the pigment and carry it via the lymphatics that are concentrated around bronchovascular bundles, in interlobular septa and beneath the pleura, to regional lymph nodes that also become blackened.

You may also note that some of the lung specimens demonstrate vaso-congestion posteriorly. This is due to gravitational movement of blood post-mortem.

Nature of the lesion

Focal

Focal lesions are probably the easiest to identify. They are single abnormalities to which any one can point with confidence and say "This is the abnormality". That's the easy bit: the next thing is to describe it in an appropriate degree of detail. To do this you need to know what the important features of a focal lesion are (and the ones that will help you with the diagnosis) and concentrate on them:

- Colour: What colour is it? Is it all one colour or is it variegated (many colours/shades)? Does it look homogenous (i.e. the same all the way through)? Pulmonary infarcts are often haemorrhagic.
- Size: You can give a measurement, but don't get too obsessive.
- Shape
- Position: Infarcts are generally peripheral and pleural based. Many malignancies arise from large bronchi.
- Consistency: This can be quite difficult to assess in a specimen in a pot that you can't touch, but even just by looking you can get some idea. Does it look solid rather than spongy? Does it look friable (as if it's falling to pieces) suggesting necrosis? Is there cavitation – indicating necrosis, with the necrotic material having drained away?
- Margins
    - The best way to think of margins is are they well-defined or well-demarcated – is there a clear line that you can trace between normal tissue and the lesion - or are they diffuse or irregular – the line between normal and abnormal is harder, perhaps impossible to trace.
    - Malignant tumours typically have infiltrative, irregular or invasive margins. Benign tumours tend to have well defined margins. There are of course exceptions to this rule: sometimes malignant tumours, especially secondary or metastatic tumours, can have deceptively well defined margins. Often these are particularly aggressive tumours that grow so quickly they just push tissue out of the way, rather than bother infiltrating it in the normal manner. On the other hand, non-neoplastic lesions such as infarcts and areas of consolidation may have poorly defined margins.
      It is also important to differentiate between a well-defined/well-demarcated lesion and an encapsulated lesion. To describe something as encapsulated means that there is a definite fibrous rim surrounding the lesion. Encapsulation implies that the lesion is benign, but not necessarily neoplastic.

•Other: If you think it could be an infarct, look at the pulmonary arteries

Multifocal

This means that there is more than one distinct lesion in the specimen. All the comments regarding the description of focal lesions apply here as well. In addition, it may be important to note any variation between lesions.

Diffuse

These are probably the hardest abnormalities for students to come to terms with. There is nothing worse than the sinking feeling that comes from looking at a pot in an exam, and not being able to identify areas of obvious abnormality. As you get a better understanding of lung pathology, you'll realise that there are only a few things that it's likely to be. Look at:

- Lung texture: as mentioned earlier, the consistency of a lung can be very useful in determining the nature of the pathology. Even though you cannot palpate a specimen in a pot, you can get an idea from looking at it, whether it is more or less solid than normal. The alveolar spaces may appear 'filled in' or consolidated. This happens when they become filled with cells or cellular exudate and occurs primarily with infection and infarction. Diffuse involvement of one lobe is seen in lobar pneumonia. Collapse may give a similar picture but this can be recognised as the lobe will be smaller than normal. In bronchopneumonia the consolidation is patchy and generally involves more than one lobe.
- Size of airspaces: diffuse or patchy enlargement of airspaces is generally caused by emphysema or fibrosis. In emphysema the alveolar walls will not be thickened, in fibrosis they will be.
- Multiple nodules: numerous large pale solid nodules generally represent metastatic tumour. Numerous tiny nodules (in a miliary pattern) suggest miliary tuberculosis, diffuse permeation of pulmonary lymphatics by malignancy (lymphangitis carcinomatosis) or bronchopneumonia (sometimes).

INDEX

CASE 25583	Bronchopneumonia with abscess formation
CASE 25176/99	

Bronchiectasis

CASE 6155	
CASE 7191	
CASE 7412	
CASE 11369	
CASE 22946A and B	Emphysema and bronchiectasis
CASE 23103	
CASE 25037	With pneumonia

Tuberculosis

CASE 105	Miliary TB
CASE 485	Miliary TB
CASE 4183	Tuberculous broncho-pleural fistula and empyema
CASE 4207	Primary tuberculosis: Ghon complex
CASE 4322	Miliary TB
CASE 5176	Encysted tuberculous empyema
CASE 6253	Chronic pulmonary tuberculosis with an encysted empyema
CASE 7002	Cavitating pulmonary tuberculosis with tuberculous bronchopneumonia
CASE 8920	Primary tuberculosis with miliary spread
CASE 9538	Primary tuberculosis with miliary and bronchopneumonic spread
CASE 12623	Cavitating pulmonary tuberculosis with tuberculous bronchopneumonia
CASE 16086	Cavitating pulmonary tuberculosis with tuberculous bronchopneumonia
CASE 16294	Inactive secondary tuberculosis
CASE 16322	Tuberculosis, probably primary
CASE 22090	Cavitating pulmonary tuberculosis with tuberculous bronchopneumonia
CASE 22102	Encysted tuberculous empyema
CASE 23326	Healed tuberculosis
CASE 24592	Inactive secondary tuberculosis
CASE 25295	Encysted inactive tuberculous empyema
CASE 25323	Widespread inactive tuberculosis
CASE 50597/82	Inactive tuberculosis

Pulmonary embolism/infarction

CASE 751	Massive pulmonary embolus
CASE 16024	Pulmonary embolism with infarction
CASE 16653	Pulmonary embolus with resolving pulmonary infarct
CASE 22204	Pulmonary embolus with healing infarcts
CASE 22912	Pulmonary embolism with infarction
CASE 24529	Pulmonary embolism with infarction
CASE 24986 a and b	Cavitating pulmonary infarcts
CASE 25300	Pulmonary embolism with infarction
CASE 25431	Pulmonary embolism with infarction
CASE 25587	
CASE 50127/81	
CASE 50473/82	Pulmonary embolism with infarction
CASE 50035/83	
CASE 50473/83	

Emphysema

CASE 9028	
CASE 15698	
CASE 22946A and B	Emphysema and bronchiectasis
CASE 23390	
CASE 25010	
CASE 25481	

Pulmonary fibrosis

CASE 5582	Probably related to sarcoidosis
CASE 7946	
CASE 20685	Related to asbestosis
CASE 22587	
CASE 23346	Probable pneumoconiosis
CASE 50029/83	
CASE 50450/83	

Primary carcinoma

CASE 6935	
CASE 10976	Bronchioloalveolar carcinoma
CASE 15860	
CASE 16380	With extensive pleural spread
CASE 19979	With extensive pleural spread
CASE 20813	
CASE 21280	Bronchioloalveolar carcinoma with lymphangitis carcinomatosis
CASE 21348	With bronchiectasis secondary to obstruction
CASE 22392	
CASE 22830	
CASE 23496	
CASE 23671	
CASE 24517	
CASE 24544	With lymphangitis carcinomatosis
CASE 24757	With bronchiectasis and pneumonia
CASE 25114	
CASE 25257	
CASE 25361	
CASE 25395	With distal lung collapse
CASE 25448	
CASE 25662	
CASE 13938/82	
CASE 50578/82	
CASE 50384/83	

Lymphoma

CASE 16205	
CASE 19571	
CASE 24068	
CASE 50052/83	

Metastases

CASE 18892	
CASE 19618	
CASE 20642	
CASE 20680	Metastatic carcinoma (primary breast) with lymphangitis carcinomatosis
CASE 24236	
CASE 24715	Metastatic chondrosarcoma
CASE 50435/82A	
CASE 50517/82	Malignant teratoma

Lymphangitis carcinomatosis

CASE 7585	
CASE 15459	
CASE 16066	
CASE 20680	Metastatic carcinoma (primary breast) with lymphangitis carcinomatosis
CASE 24544	Primary lung carcinoma with lymphangitis carcinomatosis

Mesothelioma

CASE 50577/82 (3 specimens)

Miscellaneous

CASE 3139	Aspergilloma
CASE 4409	Lipoid pneumonia
CASE 4479	Invasive aspergillosis
CASE 4617	Cryptococcosis
CASE 4760	Intralobar sequestration
CASE 4946	Intrabronchial tumour
CASE 5177	Hydatid cyst
CASE 6585	Foreign body in trachea
CASE 7204	Patchy fibrosis, possibly Wegener's granulomatosis
CASE 10305	Intrabronchial tumour
CASE 10660	Silicosis with cavitation
CASE 10839	Cryptococcosis
CASE 11369	Intrabronchial tumour
CASE 11843	Intralobar sequestration
CASE 11948	Asphyxial petechial haemorrhages
CASE 12293	Wegener's granulomatosis
CASE 12805	Hamartoma
CASE 19942	Invasive aspergillosis and cryptococcosis
CASE 20240	Purulent laryngo-tracheitis from prolonged intubation

CORE AND CLASSIC DISEASE PROCESSES

CARCINOMA OF THE LARYNX

CASE 24133

Clinical information
The patient was a man aged 65 whose voice had been hoarse for 10 months.

Describe the specimen
The specimen consists of the larynx, epiglottis and the upper 1cm of trachea opened from behind. There is an irregular pale ulcerated lesion 35x15mm involving the left vocal cord and mucosa beneath that extends across the midline anteriorly. The right vocal cord appears normal.

What is the diagnosis?
Carcinoma of the larynx

What is the pathogenesis of this condition?
Cigarette smoking is the main risk factor, with alcohol being another important predisposing factor (as for squamous cell carcinomas of the pharynx and oral cavity). Smoking promotes hyperplasia and keratinisation of the normally non-keratinising squamous epithelium of the vocal cords. Elsewhere in the larynx, smoking induces squamous metaplasia in the normal respiratory epithelium. Eventually dysplasia ensues due to genetic alterations developing in squamous cells induced by the carcinogens in cigarette smoke with progressive mutations leading to invasive carcinoma. Early lesions begin as white plaques.

What would be seen on histological examination of the lesion?
These tumours are typically squamous cell carcinomas. One would thus see invasive nests and masses of cells with enlarged pleomorphic nuclei and prominent nucleoli and showing features of squamous differentiation: eosinophilic cytoplasm, keratinization and intercellular bridges. There may be dysplasia of the adjacent squamous epithelium.

What is the natural history of this disease?
Patients typically present with hoarseness. Metastases are initially to local lymph nodes and may be present on diagnosis. The tumour spreads by local invasion. Distant metastases occur late. Recurrent tumours following treatment may lead to respiratory obstruction or aspiration causing pneumonia.

BRONCHOPNEUMONIA

CASE 17485

Clinical information
The patient was a woman aged 26 who died from a brain abscess from which a microaerophilic streptococcus was grown. She was unconscious for many days and was maintained on a respirator requiring tracheostomy.

Describe the specimen
The specimen shows a slice of left lung in which there are many scattered areas of pale consolidation, most evident in the apical segment of the lower lobe and in the adjacent region of the upper lobe. The lung is otherwise normal.

What is the diagnosis?
Bronchopneumonia

Comment
This specimen shows the classic features of bronchopneumonia with patches of consolidation throughout one or more lobes of lung. This is in contrast to lobar pneumonia (see next case). Bronchopneumonia is an extremely common disease that typically affects individuals at the extremes of life. It is a common cause of death in the elderly, particularly those with serious debilitating diseases such as cancer and heart failure.

What is consolidation?
It's basically what it sounds like: the lung tissue becomes solid instead of spongy.

Why does consolidation occur?
Consolidation occurs when the alveoli, instead of being filled with air, become filled with cells such as in an inflammatory exudate.

What is bronchopneumonia and why does consolidation occur in this pattern in bronchopneumonia?
Bronchopneumonia is a pattern of pneumonia caused by a variety of respiratory infections. The infection spreads via the bronchi and bronchioles, often starting off as an acute bronchitis or bronchiolitis involving airways in many areas of lung, with infection then extending down into alveolar spaces resulting in a patchy distribution of inflammation. Extensive bronchopneumonia may become confluent and be indistinguishable from lobar pneumonia. In most cases it is an acute process with acute inflammation. The acute inflammatory exudate filling the alveoli includes many cells (mainly neutrophils) in addition to fibrin and protein rich fluid.

What organisms cause bronchopneumonia and from where do they come?
Most organisms causing pneumonia arise in the oropharynx. Bronchopneumonia may be caused by a variety of organisms including Staphylococcus aureus, Strep. pneumoniae, Haem. influenzae and various other gram negative organisms. Tuberculosis can also affect the lung in a bronchopneumonic pattern (though here the inflammation will be granulomatous not acute).

What are the risk factors for developing bronchopneumonia?
Bronchopneumonia typically arises in patients with

- general immunocompromisation (e.g. elderly, infants, chronically debilitated)
- impaired humoral immunity
- pulmonary congestion and oedema

- increased or retained mucus which provides a medium for bacterial growth in airways e.g.
  -impaired cough reflex (e.g. coma, certain drugs, post operative pain)
  -bronchial obstruction (e.g. tumour, cystic fibrosis)
  -impaired cilial activity (e.g. viral infection)
  -chronic bronchitis in smokers

It may also follow aspiration.

LOBAR PNEUMONIA

CASE 20778

Clinical information
The patient was a man aged 50 who was admitted with a history of increasing shortness of breath associated with a productive cough. He died soon after admission.

Describe the specimen
The specimen of right lung shows the lower lobe to be almost completely consolidated and pale in colour. There is fibrinous pleurisy overlying the lower and middle lobes and some of the upper lobe.

What is the diagnosis?
Lobar pneumonia

Comment
This specimen shows the typical features of another pathological pattern of pulmonary infection: lobar pneumonia, with consolidation affecting an entire lobe or most of a lobe. Acute inflammation of the adjacent pleura is characterised by fibrinous or fibrinopurulent exudate. The reasons for the consolidation are the same as those for bronchopneumonia: a cellular acute inflammatory infiltrate is filling the alveolar air spaces. The main difference is in the nature of the causative organisms and the vulnerability of the individual. High doses of very virulent organisms may evoke this pattern in healthy adults. Less virulent organisms may cause disease in vagrants, alcoholics and persons with impaired respiratory defences such as previous viral bronchial infection. Various strains of Streptococcus pneumoniae are the cause in most cases. Infection starts in and spreads between alveoli. Sometimes bronchopneumonia may be so extensive as to give a lobar pattern.

The classic macroscopic changes of lobar pneumonia describe its development:

- congestion: there is prominent vasodilation but little exudate yet
- red hepatisation: consolidation has developed making the lung appear solid like liver (hence the term hepatisation), the vessels are still very congested and leaky with red cell extravasation making it appear red
- grey hepatisation: there is breakdown of red cells and less vasodilation, however, the exudate persists so the lung is still solid, but now appears grey
- resolution

The classic macroscopic stages of lobar pneumonia are now uncommon in the age of antibiotic treatment, which halts or slows the progression, that's why a lot of the specimens are from the older part of the collection (lower numbers) since they date from the pre-antibiotic era – yes, there really was such a time…..

Lobar pneumonia is sometimes accompanied by pleuritic chest pain. How does pleuritic chest pain develop?
Pleuritic chest pain arises from acute inflammation of the visceral pleura spreading across to the parietal pleura, whose somatic pain fibres are stimulated with the rubbing of the inflamed pleural surfaces on respiration. The fibrinous or fibrinopurulent pleural exudate is often seen macroscopically.

What are the possible outcomes of pneumonia?

- Resolution: particularly in cases of lobar pneumonia diagnosed and treated promptly: neutrophils die, macrophages phagocytose debris, fluid and macrophages drain via lymphatics, damaged tissue (in uncomplicated cases only epithelial cells) regenerate i.e. resolution occurs and there is no scarring.
- With slightly more tissue damage there may be some clinically insignificant organization and scarring
- Pleural exudates will heal by scarring
- Lung abscess formation
- Development of empyema due to spread of infection into the pleural cavity
- Development of septicaemia due to spread of bacteria in the blood, +/- metastatic abscess formation or septic shock

Apart from lobar and bronchopneumonia, what is the other common morphological pattern of inflammation in the lung caused by infection?

The other main pathological pattern of infective pneumonia is interstitial pneumonia, which is generally seen in selected viral, Chlamydial (C. pneumoniae) and Mycoplasma (M. pneumoniae) pneumonias. The inflammatory cells in these cases are mainly mononuclear i.e. lymphocytes, macrophages and plasma cells, with fewer neutrophils, and the infiltrate is predominantly in the interstitium rather than the alveolar spaces, and thus cause a different clinical pattern (e.g. dry cough and fewer signs of pulmonary consolidation on physical examination). The risk factors depend on the organism. Mycoplasmas are a common cause of pneumonia in young healthy persons.

N.B. There can be overlap between the patterns of pneumonia but the features detected on clinical history and examination and the pattern seen on chest x-ray, in addition to the circumstances surrounding acquisition of infection (e.g. community acquired, hospital acquired, immunocompromised patient, aspiration) and the age of the patient, give strong hints as to the causative organism.

LUNG ABSCESS

CASE 17909

Clinical information

The patient was a man aged 73. Two years previously he had a stroke from which he made a good recovery. Six hours before his last admission he was found semiconscious in the garden. He had vomited. He quickly became more deeply unconscious and was admitted comatose. The right pupil was fixed and dilated and the left pupil was contracted. Neither reacted to light. Both plantar reflexes were extensor. He remained unconscious but could move the right side in response to painful stimuli. The left side remained flaccid. He continued in this state for 2 weeks, but during the last week there was a high fluctuating fever up to 104°F (40°C).

Describe the specimen

The specimen consists of a portion of lung sectioned to show two cavities 20 - 25mm in diameter that are lined by exudate and necrotic lung tissue. Elsewhere in the lung there are patchy pale areas of consolidation. The overlying pleura shows an acute fibrinous reaction (see back of pot)

What is the diagnosis?

Bronchopneumonia with lung abscesses

What do you understand by the term abscess?

An abscess is a localised suppurative process associated with tissue necrosis and is caused by certain types of bacteria (pyogenic). Abscesses in the lung may cavitate as the necrotic material can drain away via the airways.

What are the possible risk factors for developing a lung abscess?

- aspiration i.e. of gastric contents and oropharyngeal organisms. Risk factors for this include alcohol intoxication, coma, anaesthesia and debilitation from whatever cause resulting in poor cough reflex and airway defences
- a complication of a primary bacterial infection i.e. associated with pneumonia, especially infection with aggressive organisms such as Staph. aureus, Klebsiella pneumoniae, type 3 pneumococcus
- bronchiectasis
- immunosuppression
- septic embolism
- neoplasia: either a primary or secondary tumour that leads to obstruction of a bronchus and pneumonia
- septicaemia
- direct extension from infection in adjacent organs
- penetrating trauma

BRONCHIECTASIS

CASE 6155

Clinical information

The patient was a man aged 32 whose health had been poor for 12 years, with a chronic cough and the production of 250-350ml of purulent sputum each day. His respiratory reserve was limited and he had repeated attacks of pleurisy and pneumonia. There were many crackles and wheezes to be heard in the chest. A bronchogram showed dilated airways in the collapsed right middle and lower lobes and to a lesser degree in the left basal segment. The right middle and lower lobes were resected (this specimen) and there was marked improvement in his general health, with a reduction of sputum to about 50-75ml/day, and a considerable increase in the respiratory reserve. Six months later resection of the left basal segments was performed with further symptomatic improvement.

Describe the specimen

The specimen consists of the right middle and lower lobes. Abnormally dilated airways can be seen extending from the central part of the specimen, out to just beneath the pleural surface. The walls of these dilated airways are lined by fibrous trabeculae. The intervening lung is collapsed and focally scarred.

What is the diagnosis?

Bronchiectasis

What do you understand by the term bronchiectasis?

Bronchiectasis refers to the irreversible dilation of bronchi and bronchioles as a consequence of the destruction of the muscular and elastic elements of their walls.

What are the risk factors for developing bronchiectasis and what is its pathogenesis?

The two main factors that can lead to bronchiectasis are obstruction and infection. Specific risk factors include:

- bronchial obstruction: e.g. tumours, foreign bodies, mucus plugs (e.g. in cystic fibrosis)
- congenital conditions such as Kartagener's syndrome

Chronic bronchial obstruction with mucus retention leads to recurrent infection with acute and chronic inflammation and subsequent damage to supportive smooth muscle and elastic tissue leading to weakening and dilatation of the bronchial walls. Fibrosis also develops in association with chronic inflammation leading to permanent dilation.

Bronchial dilation with chronic inflammation and fibrosis may also develop in the setting of recurrent necrotizing pneumonias leading to non-obstructive bronchiectasis (now uncommon), particularly in children.

What symptoms are typical of bronchiectasis?

Retained mucus and recurrent infections lead to episodes of fever and cough productive of large amounts of foul smelling sometimes blood tinged sputum. The cough is often worse in the morning when changes in position lead to drainage of pools of infected mucus into the airways.

What are the potential complications of bronchiectasis?

- obstructive ventilatory problems and destruction of lung tissue lead to chronic respiratory failure and cor pulmonale
- metastatic brain abscesses
- amyloidosis (rare)

TUBERCULOSIS

After HIV, tuberculosis is the single most common infective cause of death worldwide, flourishing where there is crowding, poverty and poor health, being particularly prevalent in the 3rd world, the spread of HIV/AIDS now also contributing to its high incidence. Although effective antibiotic therapy was introduced in the 1950s, the incidence is also increasing in developed countries largely because of the increasing numbers of immunosuppressed people (including HIV/AIDS) and immigration. However, the treatment regime is complicated and prolonged, so there are problems with compliance and drug resistant strains have developed worldwide.
There are a number of important patterns of tuberculous infection in the lung that are demonstrated in the museum. To fully understand them and the natural history of tuberculosis you should refer to a pathology textbook.

CASE 4207: Primary Tuberculosis (Ghon complex)

This is the typical pattern of infection seen in individuals following initial exposure to Mycobacterium tuberculosis. It comprises the primary or Ghon focus (peripheral lung lesion) and related lymph node lesions. Primary tuberculosis is typically asymptomatic but may cause fever and pleural effusion. Although the lesions frequently heal with a small fibrocalcific scar, viable organisms may remain dormant within for years.

Clinical information

No clinical information is available.

Describe the specimen

The specimen consists of the lungs and attached mediastinal structures of a baby, viewed from the front. There is a well-circumscribed, uniform pale yellow lesion 15mm in diameter beneath the pleura of the upper segment of the left lower lobe (on the right in the pot). It has a thin fibrous capsule. More irregular pale consolidated tissue is present medially. Within the hilar and paratracheal regions there are enlarged lymph nodes, with a similar uniform pale appearance.

CASE 485: Miliary tuberculosis

This is the pattern of infection seen with massive haematogenous dissemination of Mycobacterium tuberculosis, as a complication of either primary or secondary tuberculosis, and typically developing in young poorly nourished children or immunocompromised patients. Patients are generally gravely ill.

Clinical information

No clinical information is available.

Describe the specimen

The specimen is of both lungs of a child with trachea and portions of spleen and a kidney. All lobes of both lungs are uniformly studded with tiny pale solid nodules up to 2mm in diameter, which occasionally coalesce. Nodules can be seen beneath the pleura. The hilar lymph nodes and those alongside the trachea are enlarged and show areas of caseous necrosis. On the reverse side of the jar similar scattered tiny nodules are present within both the spleen and kidney.

CASE 24592: Inactive secondary tuberculosis

This is the pattern of infection seen in individuals who are either re-infected with Mycobacterium tuberculosis or have re-activation of a latent infection, but in whom the disease has been limited by treatment or by an adequate immune response.

Clinical information

This patient was a man aged 73 who died from a cerebral metastasis originating in a carcinoma of the right lung. The lesion was an incidental finding at post-mortem.

Describe the specimen

The specimen is a portion of left lung sectioned to show an oval encapsulated calcified white lesion at the apex of the upper lobe measuring 2x3cm. The overlying visceral pleura is thickened with adhesions to the parietal pleura. There is moderate focal emphysema with anthracosis throughout the remainder of the lung.

CASE 12623: Tuberculous bronchopneumonia "galloping consumption"

This is the pattern of infection seen in individuals who have dissemination of infection through the airways resulting in a bronchopneumonic pattern, as a complication of either primary or secondary infection. Patients are generally gravely ill. Cavitation is common particularly in secondary TB even in the absence of pneumonia.

Clinical information

The patient was a man aged 52 who had been losing weight for a year, and for the past 3 weeks he had a severe cough, malaise and marked anorexia. Chest x-ray showed gross scattered opacities throughout both lung fields. Acid-fast bacilli were present in the sputum. He died 5 weeks after admission.

Describe the specimen

The specimen consists of both lungs, the trachea and main bronchi. Throughout both lungs are numerous scattered solid coalescing areas of caseous necrosis. There is a large cavity 5x3mm, filled with caseous exudate in the apical segment of left lower lobe. Cavitation is commencing within a lesion in the right upper lobe.

CASE 4183: Tuberculous empyema

This pattern of disease can be seen in individuals who have spread of infection into the pleural cavity.

Clinical information

The patient had been treated for tuberculosis by the induction of a right artificial pneumothorax. This was not entirely successful and was complicated by a pleural effusion and a tension pneumothorax.

Describe the specimen

The specimen consists of lung, pleura and oesophagus. From the front the cavity of a chronic empyema, lined by thick, creamy exudate and surrounded by thickened fibrotic pleura is seen. There is a central hole 18mm in maximal diameter, which represents the opening of a fistula extending between the pleura and the lung. The lung is collapsed.

See also: Bone and joint 173, 6058; CNS 2586, 6718, 7611; Renal 18218, 19359, 24377 and others; Female genital 2210; Male genital 19700.

PULMONARY EMBOLISM AND INFARCTION

Pulmonary embolism is important because it is still a common cause of death for which the risk factors are well known and for which effective preventive treatment is available. You should know about pulmonary embolism in detail.

CASE 751

Clinical information
No clinical information is available.

Describe the specimen
The specimen consists of the heart and lungs. The right ventricle and the pulmonary artery have been opened to display a large ante-mortem thrombo-embolus blocking the main trunk of the pulmonary artery and extending into the main right and left pulmonary arteries. On close inspection, the thrombo-embolus can be seen to be coiled and folded up on itself.

What is the diagnosis?
Massive pulmonary thrombo-embolus - so called saddle embolus

On the basis of the pathological findings, what symptoms and signs would the patient have had during life?
The patient would have collapsed suddenly and died rapidly. Immediately before death there will have been severe hypotension with no pulse or a rapid weak pulse and pallor or cyanosis.

Large pulmonary emboli not large enough to cause sudden death will cause acute cor pulmonale with chest pain, severe tachypnoea, a raised JVP, right ventricular heave and shock.

CASE 50473/82

Clinical information
No clinical information is available for this case.

Describe the specimen
The specimen consists of a section of right lung. Scattered pulmonary arteries are blocked by ante-mortem thrombo-embolus and there are scattered areas of haemorrhagic consolidation, some pleural based. Anthracotic hilar lymph nodes are noted.

What is the diagnosis?
Pulmonary thrombo-embolism with infarction

What symptoms might the patient have had during life?
Pleuritic chest pain (as a result of pleural inflammation secondary to the infarction), dyspnoea, cough and possibly haemoptysis.

Comment

Remember that infarction is an infrequent consequence of pulmonary embolism due to the dual blood supply to the lung: the pulmonary and the bronchial circulations.
The main symptom of medium sized pulmonary emboli is dyspnoea, though there may be cough, haemoptysis and pleuritic chest pain. Classic signs are tachycardia, tachypnoea, low-grade fever, neck vein distention and an accentuated pulmonic component of the second heart sound.

Apart from sudden death and infarction other possible complications of pulmonary embolism include chronic pulmonary hypertension (following recurrent showers of multiple small emboli). Infarcts can occasionally cavitate or become secondarily infected.

What are the risk factors for this disease?

The vast majority of pulmonary emboli arise from thrombi formed in the systemic veins, particularly from pelvic and deep femoral veins.
Risk factors include:

- Slowing of blood flow e.g.
    - Restricted mobility e.g. elderly, post surgical, unconscious, long plane flights
    - Cardiac failure
    - Hyperviscosity e.g. polycythaemia
    - External pressure on veins
    - Leg fractures in plaster cast (may be trauma also)
- Hypercoagulability of blood e.g.
    - Post-operative and post-traumatic states
    - Certain genetic abnormalities including mutations in the factor V and prothrombin genes
    - Certain malignancies, probably via the release of procoagulant substances
    - Myocardial infarction
    - Certain chemotherapeutic agents
    - High oestrogens: peri-partum, oral contraceptives
    - Antiphospholipid antibody syndrome
- Local endothelial injury e.g.
    - Trauma
    - Surgical injury
    - Smoking

Some patients may have several risk factors.

Pulmonary infarction is typically haemorrhagic. Why do haemorrhagic infarcts occur a) in the lung b) in other organs?

a) In the lung, obstruction of a pulmonary artery does not necessarily lead to infarction as oxygenated blood is still being delivered via the bronchial arteries. However, if there is underlying cardiac or pulmonary disease, the bronchial circulation may be insufficient and obstruction of a pulmonary artery leads to infarction. However the blood coming in from the bronchial arteries haemorrhages into the infarcted lung.
b) Red or haemorrhagic infarcts mainly occur as a result of any of:

- venous occlusion (e.g. strangulated bowel or volvulus)
- in tissues with a double blood supply (e.g. lungs)
- reperfusion of an infarcted area (e.g. some cerebral infarcts)

EMPHYSEMA

CASE 15698

Clinical information

The patient was a man aged 55 in whom pulmonary tuberculosis was found 8 years before his death. Thereafter he had repeated episodes of chronic bronchitis and asthma and for the last 3 months had been severely breathless. On examination there was marked finger clubbing and minimal chest expansion with central cyanosis. There was ECG evidence of cor pulmonale. The sputum on two occasions was negative for acid-fast bacilli. He died of respiratory failure.

Describe the specimen

The specimen is a section of right lung. No normal lung tissue is evident. The alveolar air spaces are grossly enlarged, giving the lung a loose, sea-sponge like quality. There is a thin rim of consolidation in the posterior basal segment of the lower lobe.

What is the diagnosis?

Advanced emphysema

What do you understand by the term emphysema?

Emphysema is a condition where there is abnormal permanent enlargement of the airspaces distal to the terminal bronchioles resulting from destruction of their walls in the absence of fibrosis. The latter is important in differentiating emphysema from the changes seen in pulmonary fibrosis and honeycomb lung.

What is the aetiology and pathogenesis of this condition?

That is, what causes emphysema and what are the mechanisms involved.

The main cause of emphysema is smoking. A rare cause is the genetic condition of α-1-antitrypsin deficiency.

These two causes are linked by the protease-anti-protease hypothesis that proposes that the destruction of alveolar walls in emphysema results from an imbalance between the amounts of proteases, particularly elastase, that normally occur in the lung in low level, and anti-proteases, such as α-1-antitrypsin (a circulating glycoprotein produced in the liver).

In smokers chronic irritation of the lower airways leads to increased numbers of inflammatory cells such as neutrophils and macrophages, which produce a lot of elastase. Cigarette smoke also contains substances that inhibit α - 1 – antitrypsin.

With increased amounts of elastase and inhibition of anti-elastase mechanisms, destruction of the elastin containing alveolar walls ensues $\rightarrow$ emphysema.

In individuals with inherited α-1-antitrypsin deficiency, the normal defence mechanism against protease digestion of the alveolar walls is absent or reduced, so even the normal low levels of protease are enough to damage the alveolar walls. And if someone with α-1-antitrypsin deficiency also smokes…well, it's the emphysema express.

PULMONARY FIBROSIS

CASE 5582

Clinical information
The patient was a woman aged 58 who died after having been ill for 4 years with cough with white sputum, night sweats and marked loss of weight. On examination there were signs in the chest, a third heart sound and a grossly enlarged liver and spleen. A lymph node biopsy showed granulomatous inflammation, but no acid-fast bacilli were identified.

Describe the specimen
The specimen consists of a portion of the left lung that shows patchy thickening of alveolar walls.

What is the diagnosis?
Diffuse interstitial pulmonary fibrosis, probably related to sarcoidosis

Comment
Pulmonary fibrosis is a disease of many causes but is sometimes idiopathic. In this patient there was apparently no significant occupational history or history of rheumatoid arthritis. The night sweats, cough, loss of weight and the lymph node biopsy result suggest tuberculosis but the appearance of the lung is not that of tuberculosis. This is probably a case of sarcoidosis, a systemic disease characterised by the presence of non-caseating granulomas, particularly in lungs and hilar lymph nodes but often also involving other organs. Enlargement of the liver and spleen are thus also in keeping with this diagnosis. Typically patients have bilateral hilar lymphadenopathy. Inflammation in the lungs can progress to fibrosis.
Though the aetiology is unknown there is evidence to suggest that the disease results from disordered immune regulation in genetically predisposed individuals and is probably initiated by some unknown environmental agent i.e. that it is autoimmune.

What is meant by the term granulomatous inflammation?
Granulomatous inflammation is a form of chronic inflammation characterised by clusters of activated epithelioid macrophages that develop in response to certain persistent or non-degradable antigens under the influence of CD4 T lymphocytes.

What are the possible causes of granulomatous inflammation?
Causes include tuberculosis, sarcoidosis, Crohn's disease, fungal infections, leprosy, syphilis, cat-scratch disease, lymphoma, suture material, keratin, amyloid and urate crystals.

CASE 20685

Clinical information
This patient was a man who had been exposed to asbestos in a mine at Wittenoom Gorge, Western Australia. Shortly before his death he suffered recurrent spontaneous pneumothoraces. On the last occasion the pneumothorax was complicated by mediastinal and subcutaneous emphysema around the neck, right chest and axilla. He became more breathless and died. Post-mortem was performed in the Coroner's mortuary. The heart weighed 450g and there was marked dilatation and hypertrophy of the right ventricle. There was gross surgical emphysema of the neck, chest, mediastinum and retroperitoneal tissues.

Describe the specimen

The specimen is of both lungs and the mediastinum sectioned in the coronal plane and viewed from behind. The lungs show patchy involvement, most marked in the upper lobes, by fibrosis with the formation of large airspaces. There is associated pigmentation. Hilar nodes are enlarged. Fibrous adhesions containing loculated air spaces are present in the pleural cavity particularly on the right. There is no evidence of carcinoma or mesothelioma.

What is the diagnosis?

Diffuse interstitial pulmonary fibrosis related to asbestos exposure: “asbestosis”

Why was this patient’s right ventricle hypertrophied?

As a result of chronic pulmonary hypertension developing secondary to pulmonary fibrosis.

What are the different pathologies that can arise as a result of asbestos exposure?

The main ones are fibrous pleural plaques, malignant mesothelioma (pleural and peritoneal), lung carcinoma and pulmonary fibrosis. Asbestos may also predispose to laryngeal and perhaps some other extrapulmonary malignancies.

What is the pathogenesis of diffuse interstitial pulmonary fibrosis?

Pulmonary fibrosis is characterised by patchy destruction and fibrosis of alveolar walls often resulting in the formation of variably sized cystic spaces, hence the term honeycomb lung. It is the end-stage of a variety of disorders that cause chronic inflammation in the interstitial tissues of the lung. Inflammation is associated with the release of mediators that injure parenchymal cells and stimulate fibrosis. The disease is also known as cryptogenic fibrosing alveolitis and idiopathic pulmonary fibrosis.
Known causes include:

- Occupational diseases e.g. asbestosis, silicosis
- Collagen vascular diseases
- Sarcoidosis
- Certain drugs e.g. bleomycin, busulfan, amiodarone
- Hypersensitivity pneumonitis/extrinsic allergic alveolitis e.g. farmers lung

Clinically, patients develop progressively worsening dyspnoea, initially on exertion. A non-productive cough is often present. Fine crepitations are heard throughout the lungs. Finger clubbing is common. Cor pulmonale and chronic respiratory failure eventually develop.

PRIMARY LUNG CARCINOMA

Primary lung carcinoma may have a variety of patterns.

CASE 24757

Clinical information
The patient was a man aged 77. He was a reformed heavy smoker. Four months previously he had been in hospital with a lung cavity and a month later bronchoscopy revealed stenosis of the right upper lobe bronchus. He also had a 3 month history of anorexia and loss of weight. His last admission was precipitated by a large haemoptysis and right sided chest pain. There were signs of right apical consolidation and there was a cough with profuse foul sputum from which Klebsiella organisms were grown. The right arm was weak. He died a month later.

Describe the specimen
The specimen comprises a portion of right lung. Within the upper lobe is a large cavitating pale lesion with irregular borders measuring approximately 12cm in maximum dimension. The lesion surrounds a large bronchus (seen from back of pot). Lung distal to the lesion appears collapsed and consolidated and contains dilated mucus filled bronchi and a 1cm abscess cavity. Several hilar lymph nodes are enlarged and appear to be infiltrated by similar material to the main lesion. The rest of the lung shows patchy anthracotic pigment and emphysematous change.

What is the diagnosis?
Primary lung carcinoma with bronchiectasis and pneumonia

Comment
Histology reportedly showed squamous cell carcinoma. These are the tumours most likely to undergo necrosis and cavitate. They typically arise in the main bronchi in the dysplastic metaplastic squamous epithelium of smokers.

CASE 50578/82

Clinical information
The patient was a man aged 55.

Describe the specimen
The specimen of right lung shows an apical, pale, spherical mass 35mm in diameter with irregular margins that contains anthracotic pigment. Anthracotic hilar lymph nodes show replacement by pale tumour. The pleura is fibrotic especially at the base of the lung.

What is the diagnosis?
Primary lung carcinoma with metastases in the hilar lymph nodes

Comment
Histology reportedly showed adenocarcinoma. These tumours typically arise peripherally in the lung.

CASE 22830

Clinical information

This patient was an alcoholic man aged 53. Three years previously he had been severely concussed after a blow on the head by a bottle. Nine months before his death he developed Strep. viridans endocarditis, from which he recovered after prolonged treatment. Two months before his death he had grand mal epilepsy after a drinking bout, which settled with anti-convulsants but left him with residual weakness and incoordination of the right arm and leg with some dysarthria. On his last admission he was found unconscious and was admitted confused and disorientated with a large liver, marked ataxia and a positive Romberg's sign. He remained febrile and confused. Blood cultures and brain scans were negative but liver scan showed multiple areas of reduced uptake. Biochemical studies showed inappropriate secretion of ADH. He died essentially undiagnosed.

Describe the specimen

The specimen is of the left lung sectioned to show a mass of pale tumour tissue arising from the main lower lobe bronchus, that extends distally around the narrowed bronchus along its length. There is a thin line of infiltration of tumour along the pleura of the interlobar fissure of the upper lobe. The reverse of the specimen shows the tumour to have spread directly into the oesophagus, which demonstrates an ulcerating pale mass protruding into the lumen at the junction of its upper and middle thirds.

What is the diagnosis?

Primary lung carcinoma with direct spread to the oesophagus

Comment

Histology reportedly showed undifferentiated small cell (oat cell) carcinoma. At post-mortem metastases were found in mediastinal nodes, liver and para-aortic nodes. The brain was small but coronal sections reportedly showed no focal abnormalities. Mitral valve fibrosis with stenosis was found and the aortic valve was slightly thickened. The fibrosis may have resulted from his previous infective endocarditis or from earlier chronic rheumatic valve disease.

Clinically it is important to know if a lung carcinoma is small cell or non-small cell (squamous cell carcinoma, adenocarcinoma and undifferentiated large cell carcinoma, the latter probably just being very poorly differentiated squamous cell carcinomas or adenocarcinomas) carcinoma. Small cell carcinomas are treated with chemotherapy.

What is the likely pathogenesis of the patient's inappropriate ADH secretion?

In this case it has probably resulted from 'paraneoplastic' secretion of ADH by the lung tumour. Other causes include a variety of central nervous system disorders such as trauma, meningitis, encephalitis, tumours and haemorrhage, various pulmonary disorders (e.g. empyema, tuberculosis, acute respiratory failure) and a variety of drugs.

What problems result from inappropriate ADH secretion?

Inappropriate ADH secretion results in water retention and hyponatraemia causing confusion, irritability, nausea and ultimately fitting and coma.

What are carcinoid tumours?

Carcinoid tumours are low grade neuroendocrine tumours. (Small cell carcinomas of lung are essentially high grade or poorly differentiated neuroendocrine carcinomas). There are a variety of subtypes. The other main sites of origin of carcinoid tumours are the appendix and small intestine.

METASTASES TO THE LUNG

CASE 20642

Clinical information

This woman aged 54 had a total hysterectomy for sarcoma of the uterus 6 months before her death. Postoperatively she was given cyclophosphamide and radiotherapy. On her final admission there were bilateral pleural effusions and x-ray evidence of pulmonary metastases. At post-mortem there were also metastases in the right iliac bone.

Describe the specimen

The specimen is a portion of right lung. There are numerous round, well-demarcated lesions throughout both lobes, measuring up to 40mm in diameter. Their cut surface is pale and fleshy with areas of necrosis and haemorrhage. There is mild patchy overlying brown coloured fibrinous pleurisy. Tumour focally invades through the pleura.

What is the diagnosis?

Metastatic tumour (primary uterine sarcoma)

Comment

The lesions demonstrated have the typical appearance of secondary or metastatic tumours in the lung. The deposits are often multiple and have deceptively well demarcated margins. Metastases can also occur as single lesions when it will be impossible to differentiate them from a primary carcinoma on the basis of the macroscopic appearance alone. It may also be impossible to differentiate a primary cancer from a single metastasis on histological examination (e.g. they may both be adenocarcinoma). The patient's history may help (previous diagnosis of cancer) or subtle histologic features – not all adenocarcinomas look the same. Primary squamous cell carcinomas in the lung sometimes demonstrate squamous metaplasia and dysplasia in the adjacent bronchial epithelium from which they have arisen.

The clinical history of pleural effusion in this case is not surprising in view of the way the tumour is invading through pleura.

LYMPHANGITIS CARCINOMATOSIS

CASE 15459

Clinical information

A man aged 54 was admitted with a 2-week history of weakness, breathlessness, a productive cough and pain in the right side of the chest, worse on inspiration. He had a one week history of vomiting and anorexia, with weight loss but no haemoptysis. Examination showed diminished air entry in the right mid-zone with wheezes and crepitations. The ESR was 70mm. Chest x-ray showed widespread opacities. Marked anorexia and vomiting after food continued and he became very breathless. He died after a month in hospital.

Describe the specimen

The specimen is a section of the right lung. The lung demonstrates diffuse pale speckling with pale tissue forming thick collars around air passages and infiltrating interlobular septa and pleura. Through the back of the pot an enlarged hilar lymph node containing nodules of the same pale tissue, clearly outlined against the “normal” black of the node, is seen. A discoloured brown fibrinous pleural exudate is present, predominantly on the lower lobe.

What is the diagnosis?

Lymphangitis carcinomatosis

Comment

Lymphangitis carcinomatosis arises from extensive lymphatic spread in the lungs of either a primary or metastatic tumour. Pulmonary lymphatics run alongside bronchi, bronchioles and vessels, in interlobular septa and subpleurally. Widespread lymphatic permeation thus results in numerous subpleural deposits, the outlining of interlobular septa and thickening of bronchial and vascular walls. Post mortem examination in this case identified a primary carcinoma of the stomach.

MESOTHELIOMA

CASE 50577/82 (3 specimens)

Clinical information

The patient was a man aged 60 who had a strong history of exposure to asbestos and also smoked 10 cigarettes per day. He died nine months after presentation.

Describe the specimen

The specimen is presented within 3 pots. In all cases the pleura is abnormally thick and pale and encases the lung, also extending down the interlobar fissures and focally invading underlying lung. The hilar nodes are grossly enlarged and extensively replaced by pale tissue.

What is the diagnosis?

Mesothelioma - a primary malignant tumour of the pleura

Comment

This pattern of solid tumour encasing the lung is characteristic of mesothelioma but it may be mimicked by a primary adenocarcinoma of the lung or breast which invades through to the pleural surface (or pleural metastases from other tumours) and then spreads in a transcoelomic manner over the pleura.

The main risk factor for mesothelioma is asbestos exposure. The risk for mesotheliomas peaks 30 to 35 years after initial asbestos exposure. Patients tend to present with shortness of breath and chest pain. Pleural effusions are common. Death tends to result from extensive local spread though tumours may metastasise.

What other conditions are related to asbestos exposure?

Other diseases related to asbestos exposure include:

- Localised fibrous pleural plaques
- Diffuse pulmonary fibrosis (asbestosis)
- Lung carcinoma
- Laryngeal and perhaps some other extrapulmonary malignancies