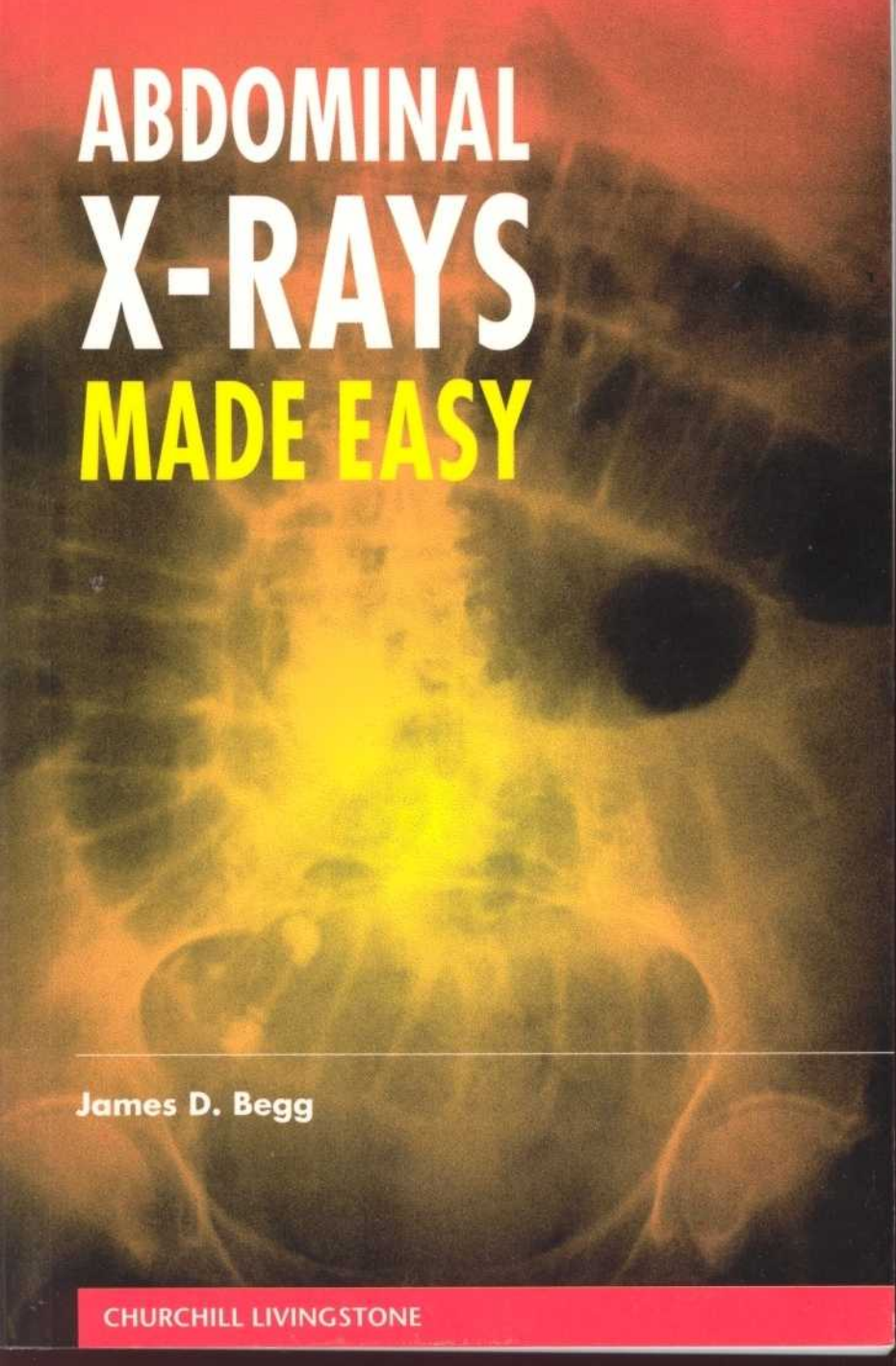
ABDOMINAL X-RAYS MADE EASY



James D. Begg

CHURCHILL LIVINGSTONE

Abdominal X-Rays Made Easy

James D. Begg MB BS FRCR

Consultant Radiologist,
Royal Victoria Hospital,
Dundee
and Honorary Senior Lecturer in
Diagnostic Radiology,
University of Dundee,
Scotland, UK

CHURCHILL
LIVINGSTONE

EDINBURGH LONDON NEW YORK PHILADELPHIA ST LOUIS SYDNEY TORONTO 1999

Contents

Chapter 1

How to look at an abdominal X-ray

Approach to the film

- The initial inspection of any X-ray begins with a technical assessment. Establishment of the name, date, date of birth, age and sex of the patient at the outset is crucial. There are no prizes for making a brilliant diagnosis in the wrong patient! Further information relating to the ward number or hospital of origin may give an idea as to the potential nature of the patient's problem, e.g. gastrointestinal or urinary, all of which information may be visible on the name badge, so never fail to look at it critically. This can be very helpful in exams. You will notice, however, that the data on the patients' name badges in this book have had to be removed to preserve their anonymity.
- Establish the projection of the film, Virtually every abdominal X-ray is an AP film, i.e. the beam passes from front to back with the film behind the patient, who is lying down with the X-ray machine overhead, but these are frequently accompanied by erect or even decubitus views (also APs). Usually the radiographer will mark the film with a badge or write on it by hand 'Supine' or 'Erect' to guide you, so seek this out and use it.
- Later on you must **learn** to work out for yourself how a given film was taken, from the relative positions of organs, fluid, gas etc.

NB the standard 35×43 cm cassette used to X-ray an adult is tantalisingly smaller than the average normal human abdomen, and usually two films are required to get the entire anatomy included from the diaphragm to the groins. Make sure this has been done before accepting any films for diagnosis. If you don't, you will miss something important and you won't know you've done it! In obese patients cassettes may have to be used transversely, i.e. in 'landscape' as opposed to 'portrait' mode. Rotation is not usually a problem as most patients are happy to lie on their backs.

Underpenetration is not usually such a problem as in the chest. If you can see the bones in the spine, then most of everything else you need to see will

probably be visible as well. However, any overexposed (i.e. excessively dark) areas on an X-ray must be inspected again with a bright light behind them (built into many viewing boxes for this purpose, or available as a separate device), as failure to do so may cause you to miss something very important, such as free air under the diaphragm, representing a potentially fatal condition.

It is worth knowing that only five basic densities are normally present on X-rays, which appear thus:

Gas	black
Fat	dark grey
Soft tissue/fluid	light grey
Bone/calcification	white
Metal	intense white

so you can tell from its density what something is made of. There is, however, a summation effect with large organs such as the liver which, because of their bulk, can approach a bony density.

In the abdomen the primary structures outlined are the solid organs, such as the liver, kidneys and spleen; the hollow organs (i.e. the gastrointestinal tract); and the bones. These structures can be classified as:

1. Visible or not visible, and therefore whether present or potentially absent;
2. Too large or too small;
3. Distorted or displaced;
4. Abnormally calcified;
5. Containing abnormal gas, fluid or discrete calculi.

- Take a systematic approach and work your way logically through each group of structures as a checklist. Initial inspection may reveal one or two major and obvious abnormalities, but you must still drill yourself to look through the rest of the film – and you will frequently be surprised by what you find.
- Think logically. You should be able to integrate your knowledge of anatomy, radiographic density and pathology with the findings on the X-ray, and work out what things are and what is going on.
- Look upon X-rays as an extension of physical examination, and regard radiological signs as the equivalent of physical signs in clinical medicine.

The abdominal X-ray: scanning the film

The supine AP film

This is the film most frequently taken and shows most of the structures to the best advantage. The optimum information can only be obtained from it by using the correct viewing conditions. An X-ray should only ever be seriously inspected by uniform transmitted light coming through it, i.e. a viewing box. There is no place for waving it about in the wind as irregular illumination and reflections will prevent 10–20% of the useful information on it being visualized.

Look for (Fig. 1.1):

- The bones of the spine, pelvis, chest cage (ribs) and the sacro-iliac joints
- The dark margins outlining the liver, spleen, kidneys, bladder and psoas muscles – this is intra-abdominal fat
- Gas in the body of the stomach
- Gas in the descending colon
- The wide pelvis, indicating that the patient is female
- Pelvic phleboliths – normal finding
- Minor joint space narrowing in the hips (normal for this age)
- The granular texture of the amorphous fluid faecal matter containing pockets of gas in the caecum, overlying the right iliac bone
- The 'R' marked low down on the right side. The marker can be anywhere on the film and you often have to search for it. All references to 'right' and 'left' refer to the *patient's* right and left. Note the name badge at the bottom, not the top.
- Check that the 'R' marker is compatible with the visible anatomy, e.g.
  - liver on the right
  - left kidney higher than the right
  - stomach on the left
  - spleen on the left
  - heart on the left, when visible.
- The dark skinfold going right across the upper abdomen (normal).

Fig. 1.1 – Adult supine AP radiograph in a 55-year- old woman.

Fig. 1.2 – Supine AP radiograph of a child with left-sided abdominal pain.

Look at (Fig. 1.2):

- The 'right' marker at the top left-hand corner of the film
- The heart shadow on the same side above the right hemidiaphragm (dextrocardia)
- The outline of the stomach gas and rugal folds on the *right*
- The liver on the *left*
- Unfused epiphyses in the femora. This is a child whose growth is incomplete, his small size leading to the inclusion of the lower chest and upper thighs as well as all of the abdomen – representing a partial 'babygram' as it is known in radiology.

NB This was *not* a radiographic error but a genuine situs inversus with *left-sided appendicitis*.

As with the chest or a limb, establishment of left and right is essential. You do not want to remove a normal kidney from the right side when it is the one on the left that is diseased, because of a faulty X-ray (and this has been done!). Both in exams and in clinical practice situs inversus, or mirror transposition of the abdominal contents, may only be diagnosable from the apparent incompatibility of the L/R marker and the visible anatomy when it has been overlooked clinically.

The L/R marker may of course be incorrectly placed itself as a result of radiographic error, and this happens with disturbing frequency (especially with limbs in casualty). You must then go back and check with the radiographer first before misdiagnosing situs inversus, or unnecessarily requesting a further X-ray, as a faulty film can be corrected with a pen. If in doubt, re-examine the patient.

Moral: Always check left and right on every film, consciously and routinely – especially just before surgical operations.

Look at the bones

These provide a useful starting point with which most students are familiar, and are relatively constant in appearance. The lowermost ribs, lumbar spine, sacrum, pelvis and hips are all usually visible to a greater or lesser degree.

The shape of the pelvis will indicate the sex of the patient. The bones may also show evidence of secondary malignant disease, cortical thinning may reflect osteoporosis, and degenerative changes will increase with the age of the patient.

Overlying gas can be a problem in the abdomen, obscuring genuine bone lesions and generating false ones (especially over the sacrum).

The discovery of Paget's disease, myeloma or metastatic disease, however, will often make your search worthwhile.

Look at (Fig. 1.3):

- The bones: the initial routine inspection of the bones showed an incidental finding of extensive sclerosis in the right side of the pelvis compared with the other normal side, and some slight bony expansion.

This is Paget's disease, a premalignant condition in 1% of patients.

Moral: Always check the bones.

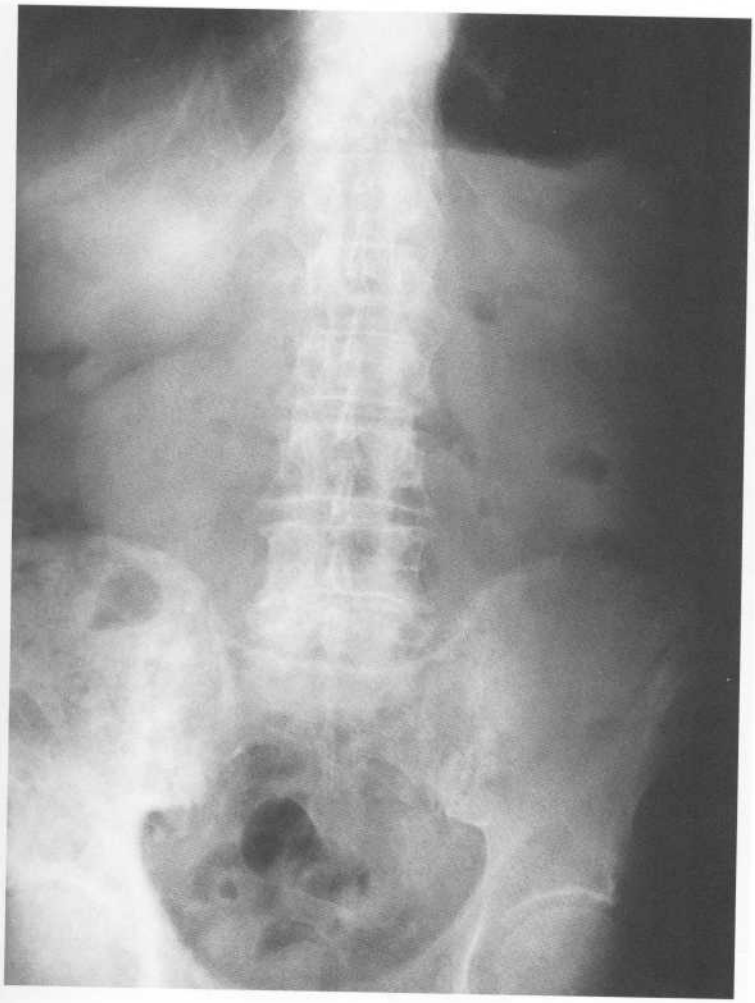


Fig. 1.3 – ***Unilateral sclerosis – right hemipelvis*** *This is a 62-year-old male patient X-rayed for unexplained abodominal pain. No radiological cause was found on the plain films but endoscopy showed a duodenal ulcer.*

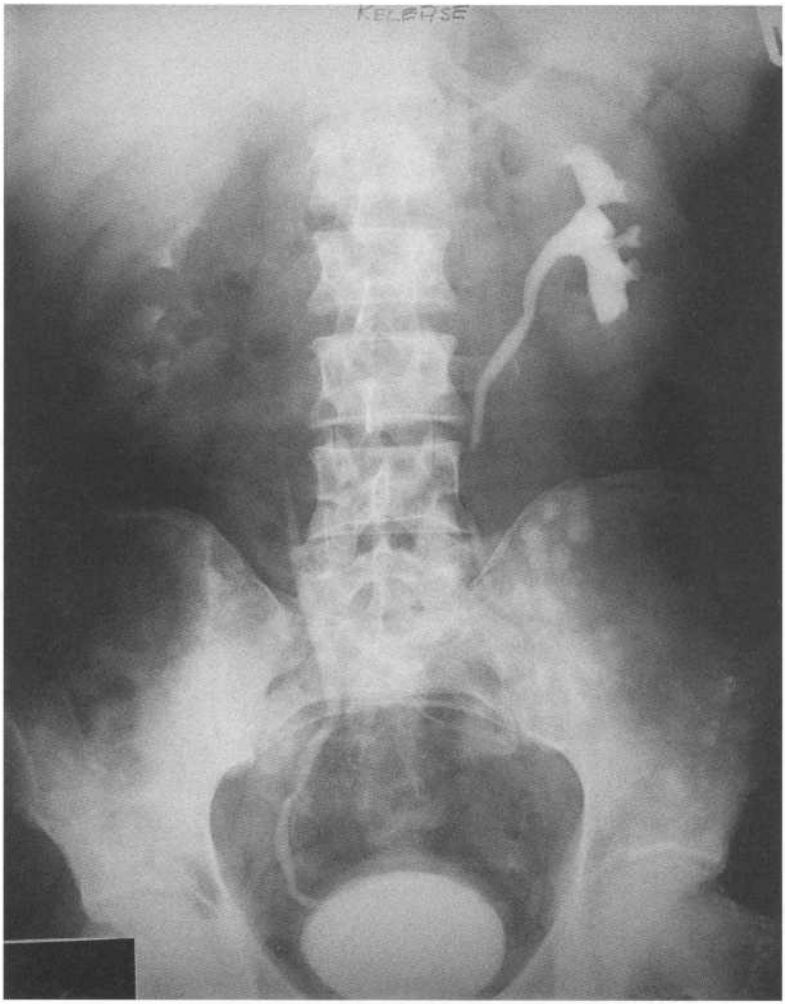


Fig. 1.4 This is a 20-minute IVU film from a 68-year-old man with a craggy mass palpable anteriorly on PR and haematuria.

Look at (Fig. 1.4):

- The bones: there are multiple dense foci in the pelvis and vertebrae of the lumbar spine.

These are typical sclerotic metastases from a carcinoma of the prostate.

Moral: Always check the bones.

Look at (Fig. 1.5):

- The extensive dark material surrounding and starkly contrasting with the gut and especially the kidneys, psoas muscles, liver and spleen.

This is the intraperitoneal and retroperitoneal fat and it is *this* that renders the kidneys and psoas muscles visible on conventional X-ray films. Conversely, replacement of this fat by, for example, haemorrhage or tumour, will obscure these margins.

NB The more fat that is present, the further the kidneys tend to be located away from the spine. This should not be misinterpreted as pathological displacement.

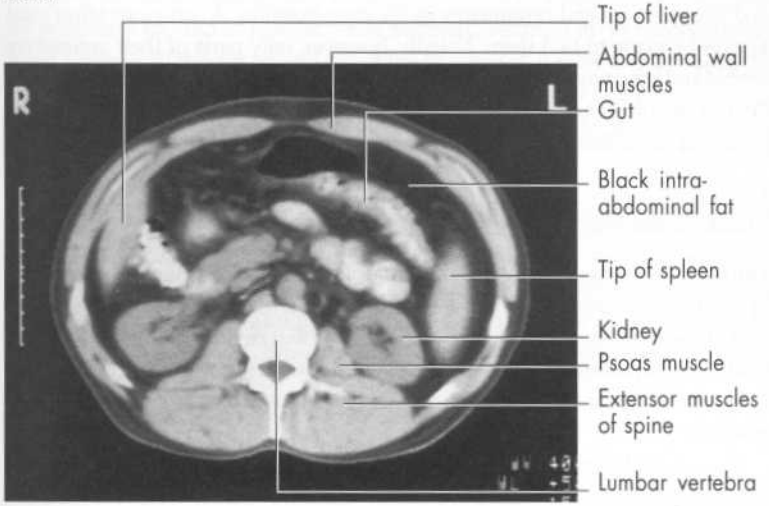


Fig. 1.5 ***Intra-abdominal fat*** *This is a normal abdominal CT scan at the level of the kidneys.*

Look for the psoas muscles (Fig.1.1)

These form two of the few straight lines seen in the body. They form diverging and expanding interfaces extending inferolaterally from the lumbar spine to insert on the lesser trochanters of the femora, and are very important retroperitoneal landmarks. Their non-visualization may reflect serious disease, but there are many benign reasons why they may not be visible, such as an excess of overlying gas, curvature of the spine or a lack of surrounding fat. Always look hard for them but interpret their absence with caution.

Look for the kidneys (Fig. 1.1)

These are usually seen as bean-shaped objects of soft-tissue density high in the upper part of the abdomen. They are usually smooth in outline, extending from the upper border of T12 on the left side to the lower border of L3 on the right side, with the left kidney lying slightly higher than the right and about 1.5 cm bigger. Both kidneys incline slightly medially about 12° towards the spine at their upper poles. Normally they are very mobile, moving down with inspiration, and dropping several centimetres in the erect position. A conscious effort must always be made to find them. Usually, however, only parts of their outlines are visible and you may have to look very hard to try and deduce exactly where they lie and how big they actually are. Occasionally the kidneys may normally be lobulated in outline. This 'fetal lobulation' may then pose diagnostic problems.

Look for the liver (Fig. 1.1)

The liver, being a solid organ in the right upper quadrant, presents as a large area of soft-tissue density, its bulk usually preventing any bowel from occupying this area. Therefore, anywhere that bowel is not present in the right upper quadrant is likely to represent the liver. On occasions, however, bowel can get above the liver and simulate a perforation, i.e. 'Chilaiditi's syndrome', or colonic interposition.

Occasionally an anatomically large extension of the right lobe may occur, looking like a shark's fin, down into the right flank or iliac fossa (a Riedel's lobe). This may well be palpable clinically, but is not a true abnormality. Chronic

obstructive pulmonary disease may push the diaphragm and liver down, creating spurious hepatomegaly. Note basal lung markings are often visible through the liver.

Look for the spleen (Fig. 1.1)

This forms a soft tissue mass in the left upper quadrant about the size of the patient's fist or heart. It may be seen well or partially obscured, but in fact is often not seen at all.

Considerable enlargement is necessary to detect it clinically (e.g. up to three times normal), although smaller degrees of enlargement may be shown on a radiograph under favourable conditions. Splenic enlargement greater than 15 cm will tend to displace adjacent structures and has many causes.

Look for the bladder (Fig. 1.1)

Within the pelvis a large mass of soft-tissue density (radiographically water density = soft-tissue density) may be present as a result of a full bladder outlined by perivesical fat, and in females, even normally, volumes up to two litres may occur, pushing all the gut up and out of the true pelvis. If there is doubt as to the nature of such a mass a post-micturition film may be taken or an ultrasound scan done. Being full of fluid, the bladder behaves radiographically like a solid organ.

Look for the uterus

This radiographically solid structure sits on top of and may indent the bladder. It may occasionally be seen spontaneously and is often well demonstrated indirectly at an IVU examination, causing a distinct concavity on the upper edge of the bladder. In many patients, however, it cannot be identified on plain films.

The hollow viscera (gas-containing gastrointestinal tract)

On a normal film, any structure outlined by gas in the abdomen will be part of the gastrointestinal tract. Remember: on a supine AP radiograph the patient is lying on his back, so under gravity any fluid will lie posteriorly within the gut and the gas in the bowel will float anteriorly on top of it.

NB Fluid levels do not appear on supine AP films.

Failure to appreciate this may lead to gross misunderstanding and errors in diagnosis. To demonstrate fluid levels you need an *erect* film or a *decubitus* film taken with a horizontal beam. Think systematically and work your way down through the gastrointestinal tract, identifying structures from the stomach to the rectum.

Look for the stomach

In the supine position, depending on how much is present, the gas in the stomach will rise anteriorly to outline variable volumes of the body and antrum of this structure, to the left of and across the spine around the lowermost thoracic or upper lumbar levels. Simultaneously the resting gastric fluid will form a pool in the fundus beneath the diaphragm, posteriorly on the left-hand side, creating a circular outline – the 'gastric pseudotumour' – which should not be mistaken for an abnormal renal, adrenal or splenic mass, although occasionally it is and requests are received in X-ray to 'investigate the left upper quadrant mass'. Try to avoid this mistake. The mass can be made to disappear by turning the patient prone or sitting him upright, when the familiar fundal gas bubble, commonly best seen on chest X-rays, will appear with a fluid level directly beneath the medial aspect of the left hemidiaphragm (erect film).

Look at (Fig. 1.6):

- The gas lying anteriorly in the body of the stomach
- The fluid pool posteriorly – the gastric pseudotumour.

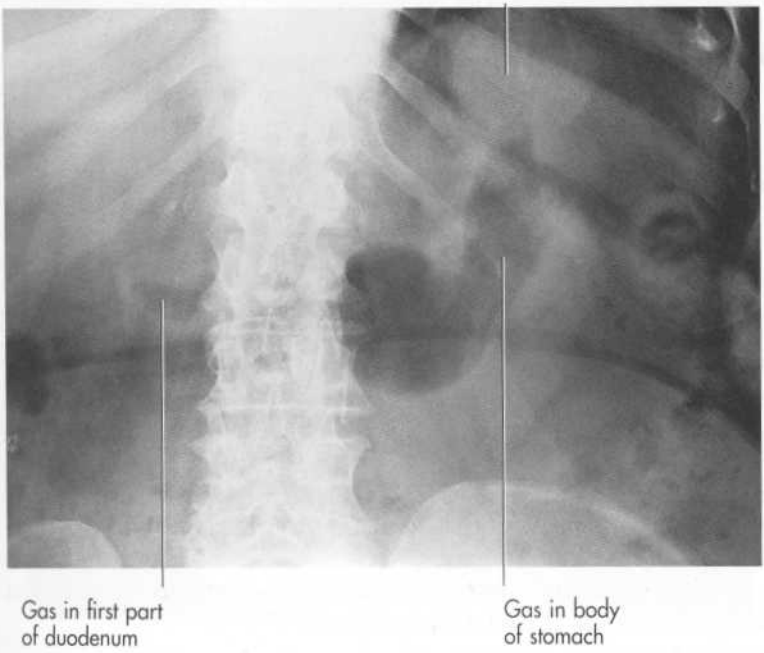


Fig. 1.6 – This is the supine radiograph of an adult, outlining the stomach.

Look at (Fig. 1.7):

- How the barium pools in the fundus, exactly as the resting gastric juice does on the plain film
- The large amount of gas present, again in the body of the stomach. The patient has in fact been given effervescent powder to generate excess carbon dioxide to distend the stomach and generate 'double contrast', i.e. an outline of the mucosa with barium and gas .
- How the fundus is seen only in 'single contrast' on this view, i.e. barium alone.

Look for the small bowel

Because of peristalsis the outline of the gas in the normal small bowel is often broken up into many small pockets which form polygonal shapes, but occupy a generally central location in the abdomen. When more distended, the characteristic 'valvulae conniventes', or coiled spring-shaped folds, crossing the entire lumen may be seen in the jejunum, although the normal ileum tends to remain featureless. The calibre of the normal small bowel should not exceed 2.5cm–3cm, increasing slightly distally.

Often very little is seen of the small bowel on plain films, as in Figure 1.1, and it only becomes well visualised when abnormal.

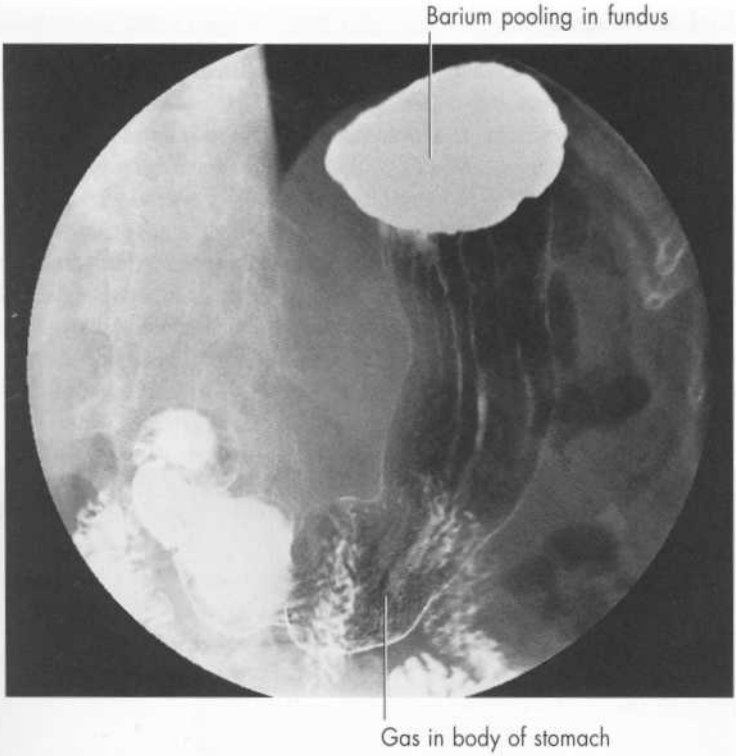


Fig. 1.7 – This is a spot film from a barium meal study with the patient supine – exactly the same position as the preceding film.

Look for the appendix

You'll be lucky to find it! Occasionally this structure will contain an 'appendicolith' (i.e. calcified faecal material) which may predispose the patient to appendicitis Less commonly gas will be present in the appendix, sometimes barium from a recent GI study, or even pieces of lead shot which have been ingested and impacted themselves there.

If you see this (Fig. 1.8) you can then have a little bit of amusement with your patients, who will be amazed to know how you have figured out from their abdominal X-ray that they have recently eaten game (e.g. a rabbit or a pheasant).

Note: Retained barium in the appendix implies the previous administration of barium, either orally or per rectum, and implies suspected GI tract disease. If barium enters the appendix, however, it implies that this organ is normal.

Fig. 1.8 – Lead shot in appendix

Look for the colon (Figs 1.1 and 1.9)

1. Start with the caecum in the right iliac fossa. The caecum is the most distensible part of the colon and receives fluid material directly from the ileum through the ileocaecal valve. The caecum therefore normally contains semifluid material containing multiple pockets of gas and, like much of the right side of the bowel, assumes a granular appearance on X-rays, creating mottled areas of gas seen best against the background of the iliac bone. On occasions the normal caecum may be empty.
2. **NB** The classic anatomical layout of the colon is often found to be deviated from by tortuous and redundant bowel, but the hepatic and splenic flexures should be identifiable as the highest fixed points on the right and left sides, respectively. The transverse colon may dip down deeply into the pelvis, but the faecal content of the bowel becomes increasingly solid and formed as one passes distally, eventually generating discrete masses which may be individually identified, but which always contain many tiny pockets of gas.
3. Learn to identify faecal material on abdominal X-rays (see Fig. 3.10). Find *that* and you've found the *colon*, which may be very important in film analysis, particularly in differentiating small bowel from large bowel. These findings can best be appreciated in severe constipation with gross faecal overload. Sometimes this will involve the rectum (which is usually empty in normal individuals), when a large faecal plug may be present associated with overflow incontinence.
4. When visible the haustral folds of the colon may be seen, only partially visualized across part of the large bowel lumen, although in some patients complete crossing of the lumen by haustra may occur.

The AP erect film

Under the effects of gravity much changes when an abdominal X-ray is taken in the **erect** position. The major events are:

- Air rises
- Fluid sinks
- Kidneys drop
- Transverse colon drops
- Small bowel drops
- Breasts drop (females: they lie laterally when supine)
- Lower abdomen bulges and increases in X-ray density
- Diaphragm descends causing increased clarity of lung bases.

The liver and spleen, being fixed, tend to become more visible, the remaining mid and lower abdominal contents less so. When the lower abdomen bulges under gravity this reduces the clarity of its contents owing to the crowding together of organs and the consequent increased density of the soft tissues. Depending on the original height of the colon and their own descent in the erect position, the kidneys may become more or less visible.

The erect film, however, may now show **fluid levels** (see Fig. 3.4), which can be very helpful in confirming the diagnosis of obstruction and abscesses, but fluid levels on normal films tend to be very small or invisible. In perforation of the bowel an erect film may confirm a pneumoperitoneum, when gas has risen to the classic subdiaphragmatic position.

Look at (Fig. 1.9 — NB that this is a different patient from Fig. 1.1):

- The 'ERECT' marker over T11
- The dependent position of the breasts, causing increased densities over the right and left upper quadrants. Do not mistake these for the liver or spleen – their edges pass laterally beyond the confines of the abdomen
- The gas in the gastric fundus – typical of the erect position
- Small quantities of trapped gas between and outlining the gastric rugal folds in this patient
- The film is centred high, showing the lung bases but missing part of the pelvis
- The position of the colon, which has dropped under gravity, and bulging of the lower abdomen anteriorly, causing the increased density in the lower third of the abdomen and obscuring the anatomy.

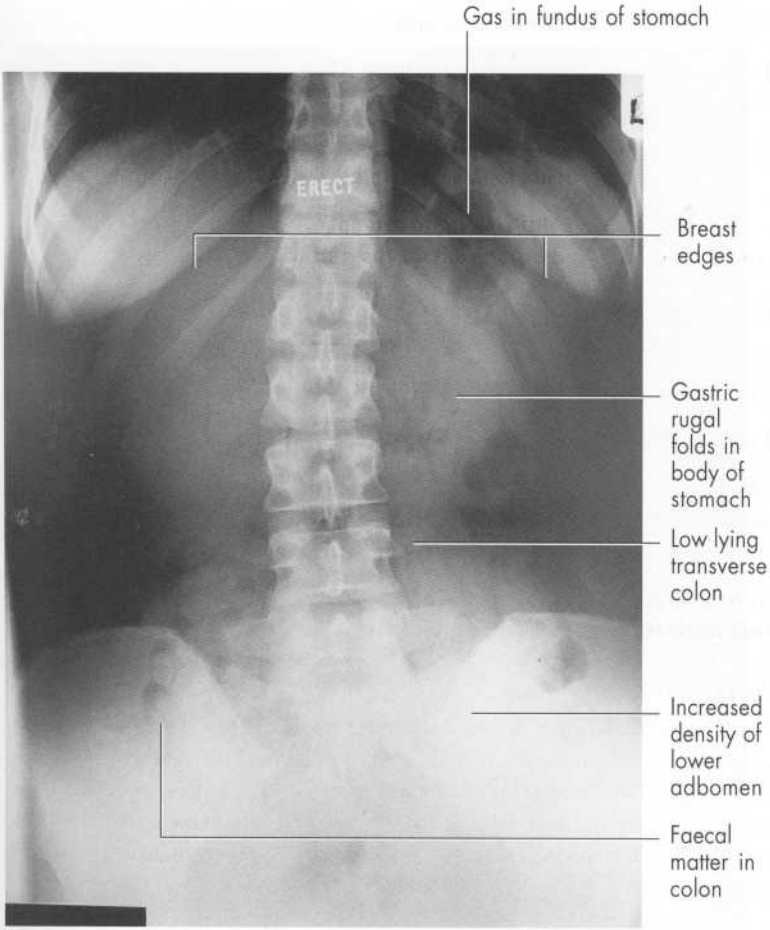


Fig. 1.9 – This is a typical normal erect abdominal radiograph of a female patient but there is insufficient fluid to form fluid levels.

Look for normal calcified structures

Learn to recognize the following structures, which can normally calcify and cause diagnostic confusion:

Costal cartilages may be mistaken for	Biliary and renal calculi Hepatic and splenic calcification Old TB in lung bases
Aorta may be mistaken for	Aortic aneurysm (if tortuous or bent)
Iliac arteries may be mistaken for	Iliac aneurysms (if tortuous or bent)
Splenic artery, 'The Chinese dragon sign', may be mistaken for	Splenic artery aneurysms
Pelvic phleboliths may be mistaken for ..	Ureteric/bladder calculi
Mesenteric lymph nodes may be mistaken for	Renal/ureteric calculi/sclerotic bone lesions over spine/sacrum/ilium.

Red faces all round and serious consequences for the patient from misdiagnosis may occur from misinterpreting these normal findings. Don't let it happen to *you!*

Costal cartilages

On abdominal and chest X-rays look at the rib ends. In many patients they often appear to stop suddenly and nothing is seen of the costal cartilages. Keep looking, however, and in others a continuation of the ribs will clearly be seen. This can be marginal, heavy and distinctive in males, or more punctate and central in females, and the phenomenon increases with age, but occasionally can be startlingly heavy in the young.

Look at (Fig. 1.10):

- The multiple dense foci over the upper and middle abdomen. This is costal cartilage calcification, which both simulates and can obscure genuine associated areas of calcification in the underlying organs, such as TB or calculi in the liver, kidneys or spleen.

What to do? Oblique films, tomograms or CT scanning may be required for further elucidation or the exclusion of calculi. Tomograms are X-ray films which select out slices at different levels and blur the backgrounds.

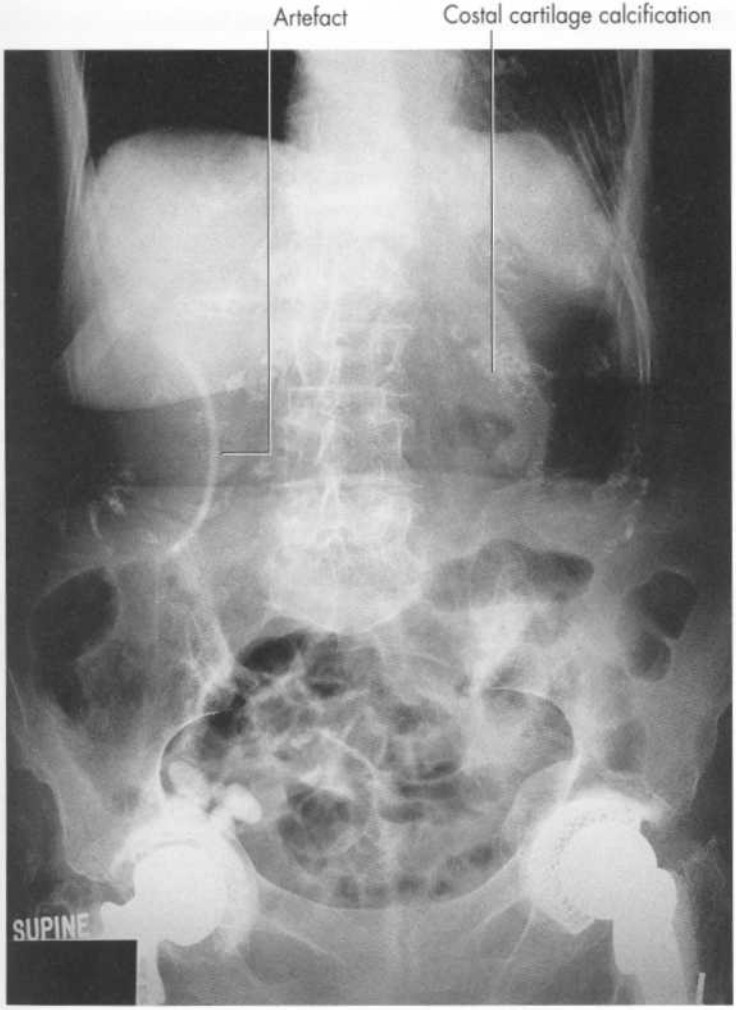


Fig. 1.10 – AP radiograph of a 75-year-old woman.

Aorta

Look at (Fig. 1.11):

- The calcified aorta over the lumbar spine, dividing at the inferior body of L4 into the iliac arteries, which cross L5 and both sacral wings. You will often also see interrupted linear calcification in both walls of the common and external iliac arteries, which may continue across the true pelvis to the femoral arteries in the groins, representing arteriosclerotic changes.
- With increasing age the aorta shows increased calcification, just like the aortic knuckle in the chest, and starts to become visible over the age of 40. Look carefully over the lumbar spine area for flecks of parallel or slightly converging plaques of calcification which may be seen: **you must train yourself to look for this routinely on every film in order to exclude an aneurysm.** Be careful, however, not to mistake a curving osteophyte in an osteoarthritic spine for the aorta or an aneurysm.
- In some patients the aorta can become tortuous and bent to the left or the right of the spine, but without becoming aneurysmal.
- Look at **both** calcified walls for loss of **parallelism** before diagnosing an aneurysm, as simple tortuous vessels and aneurysms can look like each other.
- Note the **age** of every patient carefully. Premature calcification in the aorta can be a very significant medical finding – e.g. in diabetes or chronic renal failure – and is not always due to physiological changes of ageing.

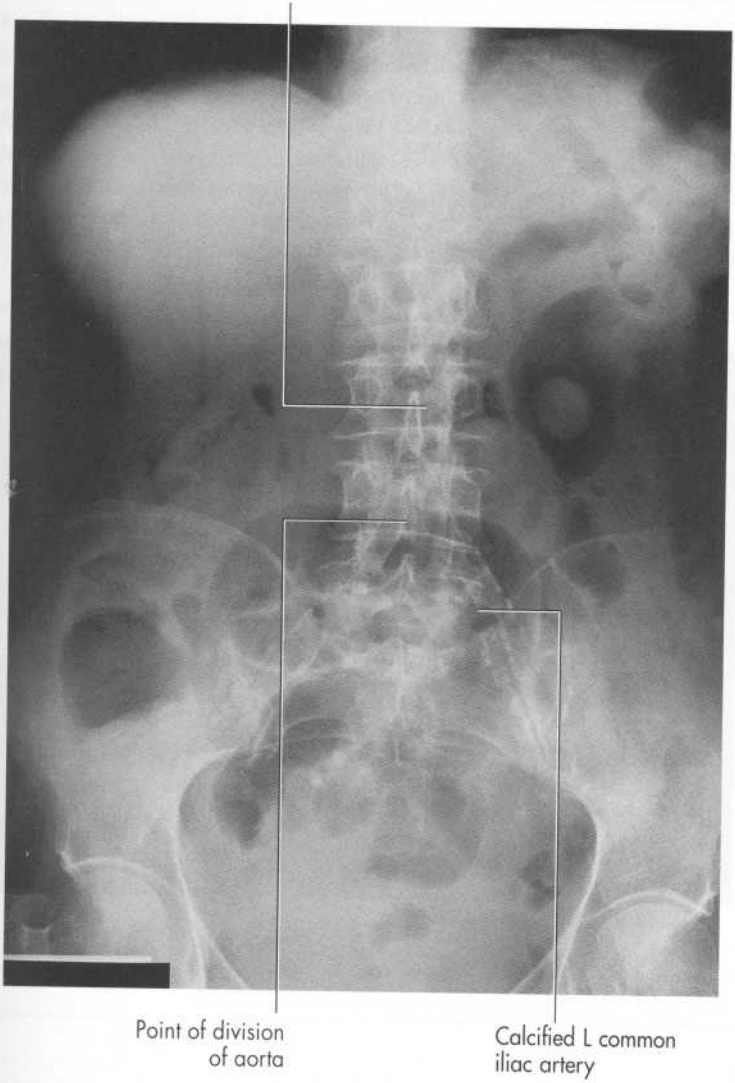


Fig. 1.11 – Supine AP radiograph of a 68-year-old woman.

Pelvic phleboliths

Look at (Fig. 1.12):

The true pelvis. There are small round smooth opacities, some of which contain lucent centres. These are phleboliths. There may be just one or two of these 'vein stones' (literal translation from the Greek) or a great number of them. In themselves they are usually without clinical significance, but they may require exclusion as ureteric calculi by an IVU in patients who present with renal colic, and not every pelvic opacity is by any means a urinary tract stone. Rarely they may be part of a pelvic haemangioma.

Fig. 1.12 – AP view of the pelvis in a 53-year-old woman.

Look at (Fig. 1.13):

- The small opacity in the L true pelvis: phlebolith or calculus?

A control film (p. 28) has several purposes:

- To try to locate the position of the kidneys before injection
- To look for calculi
- To exclude an aortic aneurysm – compression by a tight belt is often applied across the lower abdomen during IVUs, but not in renal colic, other acute abdomens, postoperative states or trauma. The purpose is to prevent inadvertent compression of an aneurysm
- To demonstrate any incidental findings
- To check the radiographic and processing quality prior to the contrast injection and taking of further films
- To look for evidence of metastases in suspected malignancy.

Fig. 1.13 – This is the supine AP radiograph of a 45-year-old male who presented with suspected L renal colic. Urologists refer to such radiographs as 'KUB' films, for Kidneys, Ureters and Bladder. Other names include 'SCOUT' films and 'PRELIM' films, but the correct radiogical term is a 'CONTROL' film. This means an X-ray taken to assess the patient before any contrast medium has been given.

Fig. 1.14 – Same patient following the injection of contrast. Note how the left ureter has bypassed the pelvic opacity, which is now shown not to be a calculus but a phlebolith. The cause of the patient's pain was at a much higher level, i.e. the left pelviureteric junction, which is narrowed and causing dilatation (hydronephrosis) of the left renal pelvis.

Splenic artery

The splenic artery may only be intermittently calcified, the discontinuity making it more difficult to identify its true nature than in Figure 1.15. Partial splenic arterial calcification must not be misinterpreted as a splenic artery aneurysm.

Do not mistake it for renal artery calcification: this may of course coexist and will often be present bilaterally, but usually only the splenic artery shows such a degree of tortuosity as it wends its way towards the splenic hilum. Heavy overlying costal cartilage calcification (Fig. 1.15) may make it difficult to isolate the splenic arterial calcification.

Fig. 1.15 – ***Calcified splenic artery*** *This is the left upper quadrant of a 78-year-old woman. Note the serpiginous parallel-walled calcified lesion in the left flank, resembling a 'jumping jack' firework or 'Chinese dragon' extending towards the hilum of the spleen. This is the splenic artery.*

Calcified lymph nodes

Look at (Fig. 1.16):

- The incidental finding of a collection of granular opacities in the flanks
- The partially coalescent cluster of opacities over the L3/4/5 lumbar spine levels
- Some further small opacities in the epigastrium.

These are calcified lymph nodes. Usually the patient is asymptomatic in regard to these. Lying in the mesentery they tend to be quite mobile and show dramatic changes in position from film to film. Conversely, an apparently sclerotic lesion in a lumbar vertebra can be shown by an erect or slightly rotated oblique film to be mobile and due to an overlying calcified lymph node. Always remember that on an X-ray you are looking at three-dimensional structures lying on top of each other shown in only two dimensions. Calcified mesenteric lymph nodes are often attributed to previous ingestion of TB bacilli to the gut, which have been halted at the regional lymph nodes. On occasion they will require to be excluded a renal or ureteric calculi, and can be a real diagnostic nuisance.

NB Calcified *retroperitoneal* lymph nodes, or such nodes opacified by contrast medium at lymphography, may also overlie the spine but show less relative motion, being very posterior. Calcified nodes require to be differentiated from calculi and calcification in underlying organs right alongside the spine or iliac vessels.

Fig. 1.16 – This is a supine AP abdominal radiograph of a 45-year-old male X-rayed for abdominal pain.

A word about decubitus films (Fig. 3.9)

- The Latin word *decubitus* comes from the Latin *decumbere:* 'to lie down', like a Roman patrician lying on his side eating at a banquet, and means with the patient lying on his left or right side. Its purpose is to obtain further information, such as confirmation of a small amount of free gas, or to demonstrate fluid levels in a patient too ill to be sat up. A horizontal cross-table beam is used rather than the usual vertical beam from overhead for supine films.
- Such films require very close and careful interpretation and should not be taken blindly without a very clear idea of what is being sought, usually in conjunction with the radiologist, or as a reasonable alternative to an erect view for the radiographer. Such films, however, may be very valuable and clinch the diagnosis – if 5 or 10 minutes are spent with the patient in the appropriate position to allow any free gas to track up to the flank. If you take it too early you may miss the gas, as the amount is sometimes very small.
- Decubitus films can be identified by fluid levels lying parallel to the long axis of the body, as opposed to at right-angles to it on conventional erect films (see film of the scrotum on p. 71). They are also used routinely during conventional barium enema examinations, and to demonstrate free pleural fluid in the chest, e.g. to differentiate a 'subpulmonary' effusion from a raised hemidiaphragm, and to optimize the view of the uppermost lung bases in patients who cannot inspire fully.

NB A 'right decubitus' means the patient is lying with his right side down. A 'left decubitus' means the patient is lying with his left side down.

For technical reasons decubitus films tend to come out very dark (i.e. over exposed) and frequently require bright lights behind them to allow them to be studied properly.

They are best shared with, and interpreted by the radiologist *at the time they are taken.* Getting a report of a perforation (which you have missed) the next day when the patient is dead is too late.

Chapter 2
Solid organs

Big liver

- Like feet and noses, livers come in different shapes and sizes. Just as a liver may appear to be significantly enlarged clinically by palpation, it may also look enlarged on an abdominal X-ray when in fact neither is the case, and such assessment is often subjective.
- As already mentioned, livers pushed down by lungs chronically overinflated by chronic obstructive pulmonary disease, or having an anatomically more extensive right lobe (see Fig 6.19), can both create this illusion, and these facts must be remembered. Conversely, true hepatomegaly must be suspected when there is evidence of displacement of adjacent organs or, as a rough guide, when the length of the liver exceeds around 16 cm from the apex of the right hemidiaphragm in the parasagittal plane, but clinical and radiological findings may not concur.
- Liver enlargement is of course a very non-specific sign, and serves only as a reason for launching further investigations of both liver function and imaging – usually ultrasound to begin with.

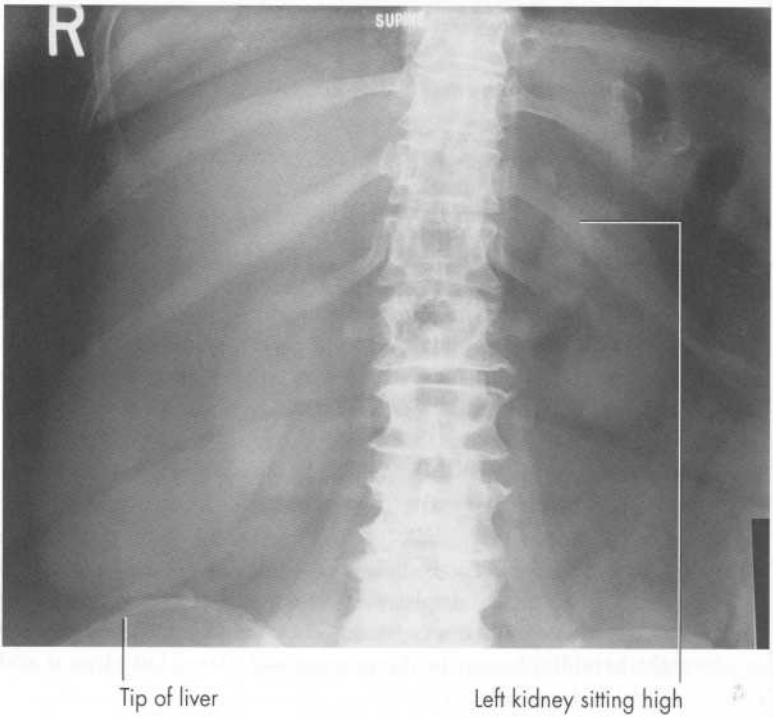


Fig. 2.1 – Abdominal radiograph of a 68-year-old woman with a large palpable mass in the R side of the abdomen.

Look at (Fig. 2.1):

- The huge mass in the R side of the abdomen reaching to the level of the iliac crest
- The absence of gut in the R side of the abdomen which has been displaced
- The increased density of the R side of the abdomen
- The rounded configuration of the lower edge of the mass
- The entire margin of the normal R kidney remaining clearly preserved by its surrounding fat, indicating that the mass is not renal
- The R marker confirming this is consistent with the liver
- The left kidney sitting high (upper margin T11).

This is gross hepatomegaly. Occasionally elevation of the R hemidiaphragm or downward displacement of the R kidney are other signs to look for on chest and abdominal films. The high left kidney causes spurious apparent downward displacement of the left one.

Point to ponder: in children the normal liver takes up a disproportionate amount of space compared with the adult.

Liver enlargement

The main causes are:

Malignant	Metastases, hepatoma, cholangiocarcinoma
Metabolic storage diseases	Glycogen, amyloid, fat
Inflammatory	Hepatitis, abscesses, parasites etc.
Cirrhosis	Early stages
Vascular	Heart failure, pericarditis
Haematological	Myelofibrosis, leukaemia

Small liver

The liver may look to be on the small side and yet be normal anatomically and functionally, e.g. in a small individual, and declaring a liver to be pathologically shrunken from a plain abdominal X-ray is not normally attempted.

A secondary effect of shrinkage of the liver, however, may be that a loop of colon – or, less frequently, small bowel – may slip above it and become visible directly beneath the right hemidiaphragm (see Colonic interposition, Fig. 4.5). The appearance of such a loop does not, however, prove that the liver has reduced in size, as this phenomenon may occur in an otherwise normal individual. It is also more likely to be seen in patients with large thoracic outlets (COPD), or postoperatively when the surgeon has pushed the viscera aside to get at something else.

The usual cause for shrinkage of the liver is the late stage of cirrhosis, this itself having a number of causes, e.g.:

- Alcohol
- Hepatitis
- Drugs
- Obstruction.

Coexisting enlargement of the spleen may occur, with associated portal hypertension.

Big spleen

Frequently the spleen cannot be seen on an abdominal X-ray. When enlarged (>15cm), as with other intra-abdominal masses, this is detected by an increase in size and density, and by displacement of adjacent structures. A normal spleen can indent the left kidney, causing a 'splenic hump' just below the point of contact (which must not be mistaken for a true renal swelling), and small accessory spleens can sometimes be present.

NB Occasionally a patient will have no spleen, due either to congenital absence or surgical removal.

Splenomegaly can, however, be enormous, especially when the patient comes late to medical attention. This finding, like hepatomegaly, is non-specific and has many causes.

Look for (Fig. 2.2):

- A soft tissue mass extending downwards and medially from the left upper quadrant
- Elevation of the left hemidiaphragm
- Medial displacement of the stomach
- Downward displacement of the left kidney
- Inferior displacement of the colon
- Evidence of associated liver enlargement and lymph node enlargement.

NB Occasionally the spleen will enlarge selectively down the ⓛ flank lateral to the ⓛ kidney.

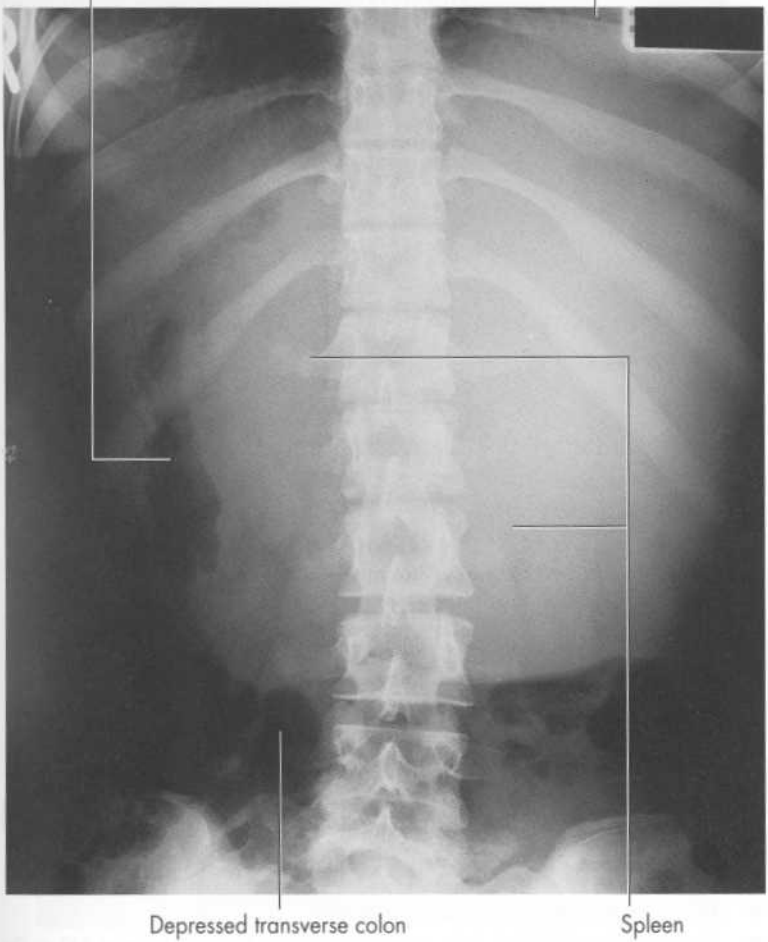


*Fig. 2.2 – **Splenomegaly** This is the film of an adult female who presented with generalized ill health and a large mass in the left upper abdomen. Examination of the blood showed changes of leukaemia. The mass was shown on ultrasound to be a large spleen. The liver was not enlarged. Note the R marker just visible at the top left-hand corner of the film.*

Causes of splenomegaly

Trauma	Rupture of spleen, causing apparent splenomegaly from a subcapsular haematoma	
Infection	Acute:	Infectious mononucleosis
		Infective endocarditis
	Chronic:	TB
		Brucellosis
		HIV
		Malaria
Neoplasm	Secondaries from bronchus, breast, gut, prostate	
Lymphomatous	Hodgkins' disease	
	Non-Hodgkins' disease	
Haematological	Leukaemia	
	Polycythaemia	
	Myelosclerosis	
	Haemolytic anaemia	
Storage disorders	Gaucher's disease	
Portal hypertension		
Cystic masses	Polycystic disease	
	Hydatid cyst	
	Developmental cysts	
Others	Rheumatoid	
	Amyloid	
	Sarcoid	
	Collagen vascular diseases	

Big kidneys

Note (Fig. 2.3):

- The bulky but smoothly outlined kidneys
- Normal kidneys extend from approximately the lower margin of T12 on the left to the upper margin of L3 on the right, or about 3.5 vertebral bodies (plus discs)
- These kidneys extend from the upper margin of T12 on the left to the upper margin of L4 on the right, or 4.5 vertebral bodies (and discs) in this patient.

*Fig. 2.3 – **Enlarged kidneys** This is the film of a patient presenting clinically with symptoms and signs of acute glomerulonephritis with fever, blood and protein in the urine.*

- Kidneys vary in size and shape and the left one is usually slightly larger than the right by up to 1.5 cm, although a duplex kidney (i.e. one with a double drainage system) may look abnormally big but still be histologically normal.
- Kidneys are usually larger in men than in women, and each individual kidney should not normally be more than about 3.5 vertebral bodies long, including the intervening lumbar discs in a given patient, measured in their long axes, i.e. from pole to pole inclined towards the spine. Kidneys over 12 cm and under 9 cm are usually regarded as pathologically large and small, respectively. Kidneys in young children normally appear disproportionately large just as the liver does.
- Bilaterally enlarged or unilaterally enlarged kidneys may be present with one normal size or shrunken on the contralateral side. Enlargement of each kidney may also be generalized due to global disease or something more focal, such as a cyst, tumour or localized hypertrophy. So-called compensatory hypertrophy of a remaining kidney may also occur if the other one ceases to function or is removed, but this response reduces in the elderly.
- The importance of detecting large kidneys is that there may be the potential for recovery when this finding is associated with renal failure, although biopsy will be required for definitive diagnosis, almost invariably preceded by ultrasound to help exclude renal obstruction and assess the parenchyma.
- Conversely, small kidneys usually reflect end-stage renal disease and an irreversible state, making biopsy somewhat academic and potentially hazardous.
- Look carefully too at the edges of the kidneys, whether smooth, lobulated or irregular – important points in differential diagnosis.

Causes of bilateral big kidneys

- Acute glomerulonephritis
- Diabetic renal disease (glomerulosclerosis)
- Adult polycystic disease
- Acute tubular necrosis
- Acute cortical necrosis
- Bilateral acute pyelonephritis
- Leukaemic infiltration
- Lymphomatous infiltration

- Amyloid
- Secondary renal disease in gout.
- Excessive beer drinking – medical students please note!

Some causes of unilateral big kidney

- Acute obstruction
- Acute infarction: renal artery occlusion, renal vein thrombosis
- Acute pyelonephritis
- Radiation nephritis
- Duplex system
- Compensatory hypertrophy from contralateral nephrectomy or dysfunction
- Renal mass.

Small kidneys

Establishing the presence of small kidneys may be very difficult or impossible on plain films owing to overlying faeces and gas. However, if the patient is clearly alive and not on dialysis there must be functioning renal tissue somewhere, and occasionally it is visible.

Remember: The kidneys shrink or atrophy with age, compensatory hypertrophy may not occur in the elderly, and X-ray measurements will always give a 20–25% magnification, so that X-ray measurements will always be larger than sizes obtained on ultrasound, CT or MRI examinations, for example; the apparent size of the kidneys may also increase even more after i.v. contrast administration for IVUs.

Causes of small kidneys

- Chronic glomerulosclerosis (usually bilateral)
- Chronic ischaemia (e.g. renal artery stenosis, arteriosclerosis)
- Chronic pyelonephritis
- Reflux nephropathy
- Infarction
- Senile atropy
- Congenital hypoplasia (usually unilateral).

NB Always remember that an unknown patient may have only one functioning kidney. This is especially important when investigating trauma: more than one patient in medical history has had his only kidney taken out, and kidneys have a remarkable capacity for healing and regeneration.

NB A patient who is known to have only one functioning kidney and who is passing urine cannot be completely obstructed. This is sometimes forgotten by young doctors requesting 'urgent' IVUs for '? obstruction' when one kidney has been removed.

Two important congenital renal abnormalities

Pelvic kidneys

When investigations fail to demonstrate kidneys in the renal beds, one or more of them is usually found at a lower level in the pelvis. This is called an ectopic kidney (Greek *ek*, out of, *topos*, place). Inflamed pelvic kidneys can simulate appendicitis or gynaecological problems. Remember: transplanted kidneys may be put into the pelvis and even a normally sited kidney may be invisible.

Horseshoe kidneys

These can sometimes be suspected or diagnosed on plain films. They tend to lie lower than normal and tend to lack the usual medial inclination relative to the spine at their upper poles. The pathognomonic radiological sign is to see the renal cortices of the lower kidneys crossing the margins of the psoas muscles medially to connect with the other side. This part of a horseshoe kidney system is known as the isthmus. The drainage systems in this condition tend to be malrotated forwards. The isthmus may contain either functioning or just fibrous tissue.

Look at (Fig. 2.4):

- The cortical margins of the kidneys crossing the psoas muscles
- The associated developmental spinal anomaly at the L3/4 level on the left and the scoliosis convex to the left.

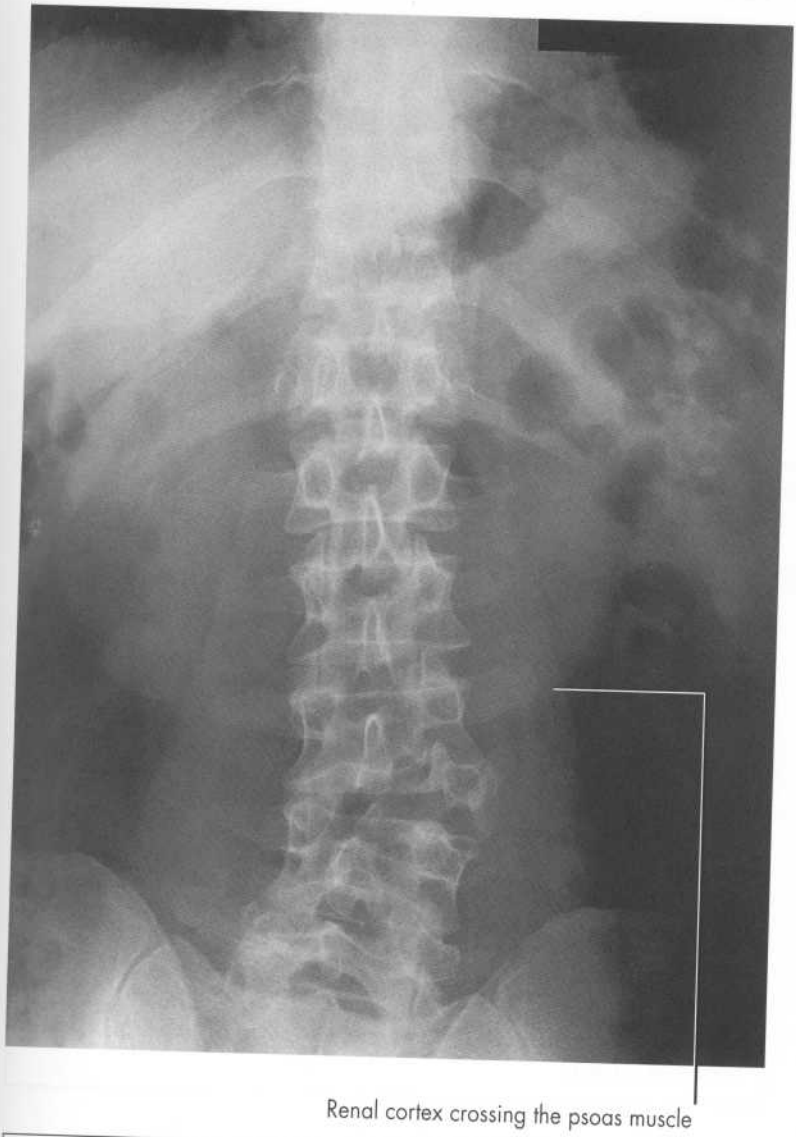


Fig. 2.4 – Horse shoe kidneys

*Fig. 2.5 – **Horseshoe kidneys** Same patient following i.v. contrast confirming horseshoe kidneys.*

Look at (Fig. 2.5):

- The abnormal fused renal collecting systems overlying the spine and the isthmus
- The malrotated right kidney with its collecting system facing antero-laterally instead of medially.

Complications

Horseshoe kidneys are more susceptible to infection, stone formation and trauma.

The isthmus may also get in the way in radiotherapy planning. Horseshoe kidneys may occur in Turner's syndrome.

Renal masses

Renal masses may be found during the investigation of a patient with urinary tract symptoms, such as haematuria, or as an incidental finding when the patient is being X-rayed for some other purpose, e.g. backache, but even a large one may be invisible on a standard film. A significant renal mass may however:

- Distort the position of the anticipated renal outline
- Actually displace the kidney from which it arises
- Displace overlying gas-containing loops of bowel
- Cross the midline to the opposite side.

Having detected a mass the primary requirement is then to establish whether it is solid or cystic, and this can usually be easily achieved with ultrasound. Further careful inspection of the plain films in the initial phase, however, to look for loss of psoas outlines or bony destruction of part of a vertebra, may indicate malignancy from the outset. Looking into the lung bases on an abdominal X-ray may also on occasion reveal pulmonary metastases, and should be routine on all abdominal X-rays where these are visible, although a full chest X-ray will already be indicated.

The next task is staging with CT of the mass, MRI etc.

Fig. 2.6 – Close-up view from abdominal film of L flank in a 56-year-old male presenting with backache.

This patient (Fig. 2.6) initially had his lumbar spine and abdomen X-rayed to look for a cause for his backache. Apart from minor degenerative change no skeletal abnormality was found, but careful inspection of the film showed the edge of a large mass in the left flank which was clearly too big to represent part of a normal kidney. An ultrasound scan confirmed a solid mass arising from the left kidney. On biopsy this was found to be a renal carcinoma.

Moral: Do not confine yourself to the area of primary interest alone on an X-ray film, but look at all of it. Always be ready for the unexpected incidental finding.

A word about 'displacing masses'

Obviously an abnormal mass can arise anywhere and its general effect will be the same, i.e. to produce a dense area with displacement of bowel loops around it. Sophisticated investigations will be necessary to establish the exact cause (ultrasound, CT, MRI, barium etc.). Should the mass itself contain a lot of gas this will usually indicate part of the bowel itself (e.g. volvulus) or perhaps an abscess (see Figs 4.13 and 4.14). The density of a mass may also be increased by the presence of calcification within it.

Pelvic masses

The urinary bladder

In practice the most common reason for finding a large mass on X-ray in the pelvis is a full bladder (Fig. 1.1), and there are a number of reasons for this:

1. Patients often have to wait to be brought to X-ray and their transit may be delayed.
2. Further waiting periods are common in busy X-ray departments.
3. Some patients will have genuine outflow obstruction, e.g. due to prostatic disease, and be unable to empty their bladders completely. Some patients who come back for KUB films and renal ultrasound are specifically asked to attend with a full bladder.

In seeking the bladder, look for:

- A smooth rounded or transversely orientated oval mass of uniform density in the pelvis. Its outline, when visible, is due to perivesical fat (see Fig. 1.1)
- Upward displacement of small bowel loops, which are freely mobile and can easily be shifted completely out of the pelvis
- Excessive indentations in addition to the normal ones (sigmoid and uterus) caused by pathologically enlarged masses (e.g. fibroids) or faecal overload.

Common causes of pelvic masses

- Physiologically full bladder: male or female
- Pathologically full bladder indicating outflow obstruction, e.g. prostate in an adult male or a blocked catheter in a female
- Bulky uterus (pregnancy) – look for fetal parts! Did you check the LMP (last menstrual period) before requesting this film?

The majority of significant abnormal pelvic masses occur in females, including:

- Leiomyomas – fibroids, often calcified
- Ovarian cysts – can be the size of a football
- Ovarian tumours (benign or malignant)
- Pelvic inflammatory disease/abscesses
- Haematometra (blood collection in uterus)
- Endometriosis
- Haematocolpos (blood collection behind imperforate hymen)
- Dermoids, containing fat, teeth, hair.

Fig. 2.7 – AP pelvis: IVU examination, bladder area. Look at the effect of a huge pelvic mass severely compressing the bladder from above. This was an ovarian cyst. It is also partially obstructing both ureters.

Non-gynaecological

- Abscesses from appendix, diverticula, lymphocoele (postoperatively)
- Pelvic kidney (congenital)
- Renal transplant.

Retroperitoneal masses

These usually obscure the psoas muscle on the affected side or show a displaced fat line convex and beyond the margins of the anticipated position of the psoas muscle. They may show displacement of the kidneys (see Fig. 2.8) or aorta, are often malignant, e.g. lymphadenopathy, and require further investigation.

Do not mistake slight convexity of the normally straight psoas margins for pathology. These can hypertrophy in very athletic individuals, just like the gastrocnemius muscles. Such individuals may also show incipient degenerative changes in the hips in early adult life and medial deviation of the ureters on an IVU – signs to seek in confirmation.

Look at (Fig. 2.8):

- The absence of the normally positioned psoas edge on the left side and convex mass more lateral to it
- Normal spleen
- Upward and lateral displacement of the left kidney.

This is retroperitoneal lymphadenopathy, due to lymphoma.

Fig. 2.8 – This is an IVU film showing renal excretion in a young man who presented with a mass in the neck, weight loss and backache.

Acute pancreatitis

There are no plain film signs that confirm or exclude acute pancreatitis. The diagnosis is a clinical one supported by high serum amylase levels. Chest and abdominal films will, however, usually have been taken on admission while the diagnosis is being sorted out. Imaging this condition and its complications is a job for ultrasound or CT, but underlying causes and secondary effects may occasionally be identified.

Look for:

- Gallstones (may be a predisposing factor)
- Calcification in the pancreas (chronic pancreatitis may be complicated by recurrent bouts of acute pancreatitis). Occasionally a tumour containing calcification may precipitate pancreatitis
- Pleural effusions, basal atelectasis, diaphragmatic elevation
- Signs of secondary ileus
- Rarely in severe disease gas bubbles may appear in the pancreas as abscess formation supervenes
- Retroperitoneal gas/pneumoperitoneum – rarely and usually in severe disease. May be confused with perforation
- Ascitic fluid
- Bone infarcts e.g. head of femur (very rare).

Chapter 3

Hollow organs

The stomach

Look at (Fig. 3.1):

- Abnormally large size of the gastric outline
- Excessive quantity of semidigested food in the stomach
- Small quantity of gas in the small bowel.

Look at (Fig. 3.2):

- The two fluid levels, that on the left representing the gastric fundus and that on the right the duodenum – the so-called 'double-bubble sign'.
- The actual level of obstruction is in the duodenum, caused by scarring and stenosis from ulcer disease.

NB This sign may also be seen in neonates with duodenal atresia.

Causes of gastric outflow obstruction

- Peptic ulcer disease in distal stomach/duodenum with scarring
- Gastric carcinoma in antrum
- Lymphoma
- Gastritis
- Crohn's disease (stomach or duodenum)
- TB
- Impacted foreign bodies
- Bezoar (furball, vegetable matter)
- Metastases.

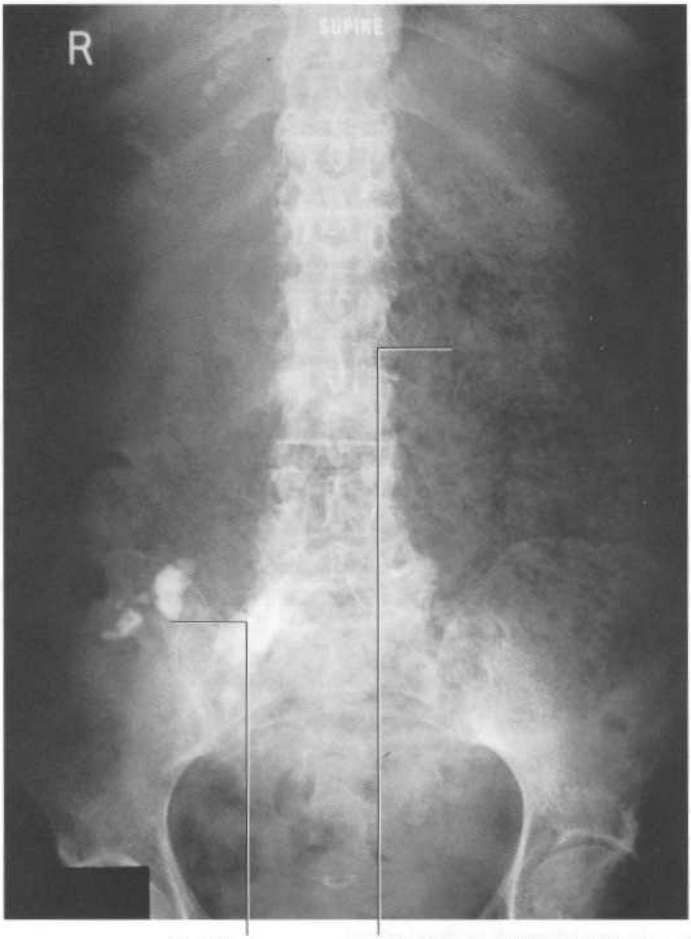


Fig. 3.1 – A 54-year-old man with a 2-year history of dyspepsia who presented with upper abdominal distension, a succussion splash and vomiting. This was due to outflow obstruction and retention of food residue and fluid. A 'bezoar' looks similar – retained vegetable matter (phytobezoar), or hair in the stomach (trichobezoar or hairball, more common in animals).

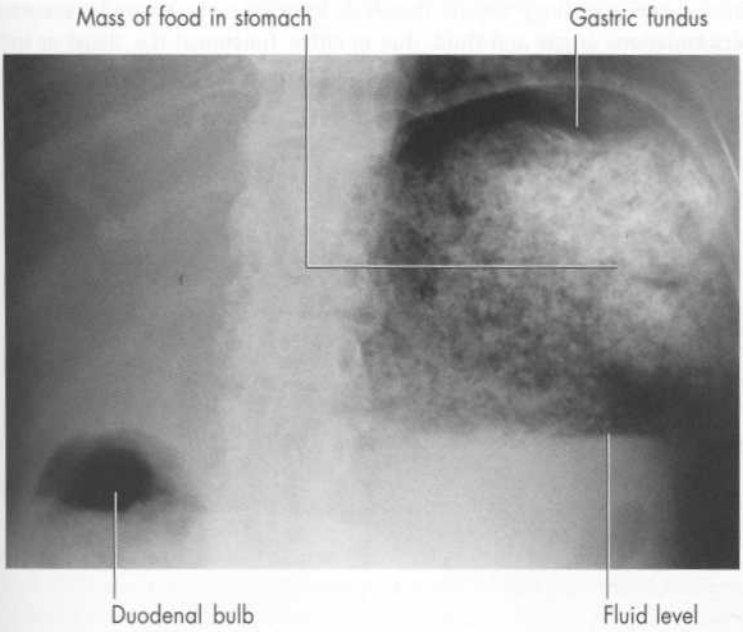


Fig. 3.2 – Same patient: erect view.

Gastric neoplasms

Sometimes tumours may be visible in the fundus of the stomach on abdominal films and chest X-rays, this being an occasional presentation of gastric carcinoma.

Such an appearance must, however, be interpreted with great caution, as a physiologically contracted stomach can look very similar, the left lobe of a normal liver can indent the stomach here, and postoperatively fundoplication procedures produce filling defects medially that simulate abnormal masses. In the appropriate clinical setting (weight loss, anaemia, dyspepsia), however, patients causing concern over this appearance should be investigated.

Distended small bowel

Small bowel pathology usually manifests itself on plain X-rays by abnormal accumulations of gas and fluid, due to either functional (i.e. ileus) or truly mechanical obstruction. The main problem lies initially in trying to differentiate small bowel from large bowel.

Once the small bowel starts to dilate the small irregular pockets of gas that may be seen normally increase and coalesce, so that eventually the interior of the distended loops becomes completely outlined in continuity where the lumen is not occupied by fluid and complete mucosal folds appear.

Remember:

- The colon is peripheral and contains faeces and gas
- The small bowel is central and contains fluid and gas
- The more distal the obstruction, the more loops you will see
- The longer the duration of the obstruction, the bigger the fluid levels
- Fluid levels can only be seen on erect or decubitus films, and small fluid levels can occur normally
- It is not necessary to be obstructed to have fluid levels.

The standard series of films in the acute situation is a minimum of a supine abdomen and an erect chest X-ray. Experienced radiologists claim to make do with these alone, but most mortals are reassured by an erect abdomen as well.

NB The entire abdomen should be visualized, ideally on both the supine and erect films but certainly on the supine films from the top of the diaphragm to the hernial orifices in the groins, as these may be the site of an obstruction in an inguinal hernia. But remember that the presence of a hernia does not prove it is *causing* an obstruction. Two films may be required in each position to show the entire abdomen.

Look at (Fig. 3.3):

- The multiple centrally placed loops of bowel distended with gas
- The outlines of folds crossing the entire lumen in places
- The absence of any fluid levels.

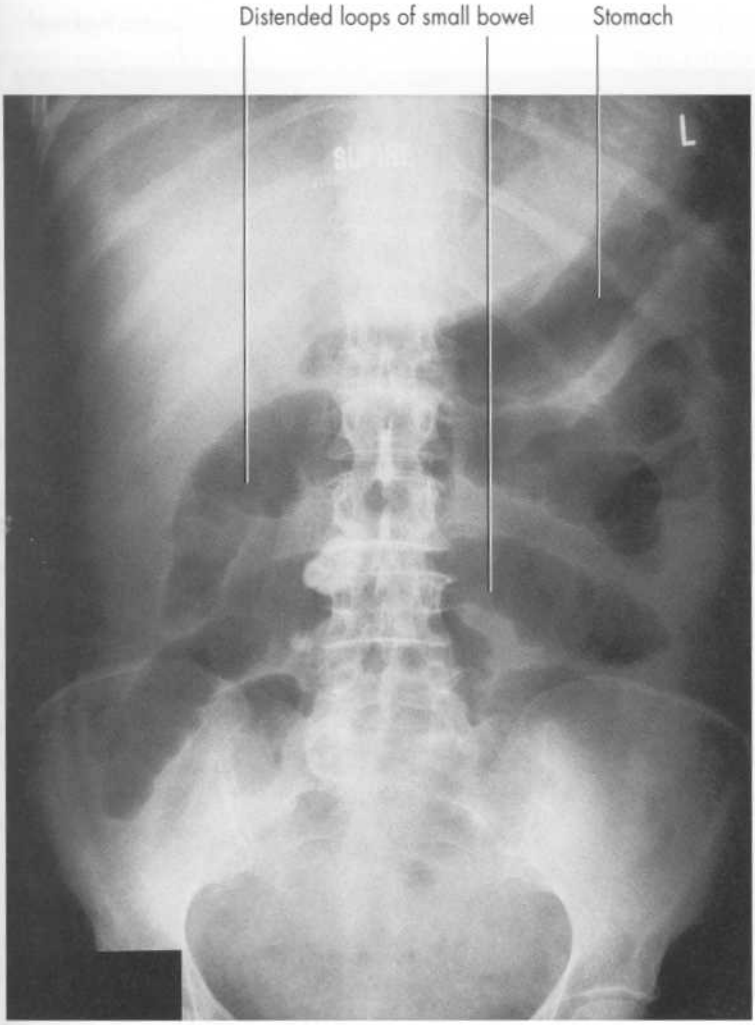


Fig. 3.3 – This is the supine abdominal radiograph of a patient presenting with abdominal pain, distension, nausea and vomiting. Note absence of fluid levels.

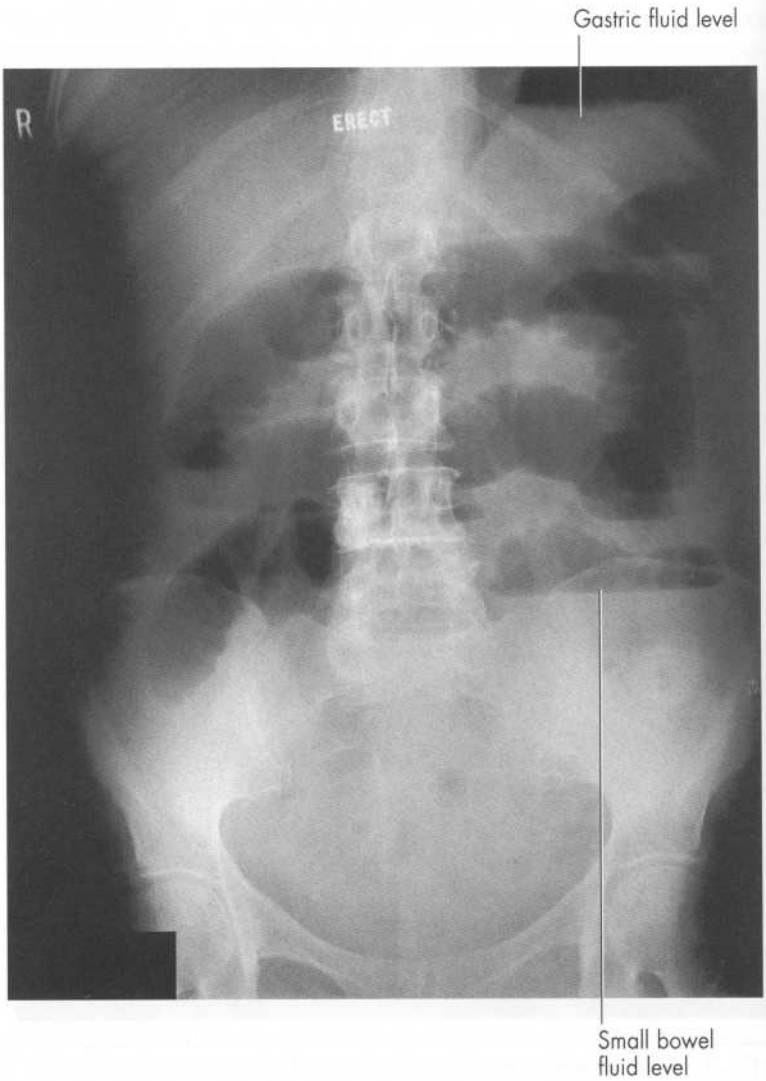


Fig. 3.4 – This is the same patient in the erect position. Note now the presence of fluid levels.

This (Fig. 3.4) is the classic appearance of a small bowel obstruction. The relatively small number of loops indicates a mid small bowel rather than a distal small bowel obstruction. The cause was adhesions from previous surgery some years before.

NB In order to demonstrate fluid levels you need fluid, overlying gas and a horizontal beam erect or decubitus film. Without the gas you won't see the fluid!

Although obstruction and perforation usually present separately and clinically differently, always check to make sure the patient has not sustained a perforation as a complication of an obstruction. This is a rare but important event.

NB The differential diagnosis of small bowel obstruction includes paralytic ileus and it may be hard to differentiate between the two on radiological grounds. The clinical context is usually crucially helpful, e.g. immediately postoperatively.

Remember: Both generalized and localized ileus may occur, e.g. the latter with 'sentinel loops' adjacent to an appendix abscess.

Causes of small bowel obstruction

- Postoperative adhesions (up to 80% of cases in western countries)
- Internal strangulation of bowel (band or internal hernia)
- External hernia (e.g. inguinal)
- Lymphoma
- Crohn's disease
- Intraluminal tumour
- Gallstone ileus (see page 64)
- Intussusception – usually children; in adults often associated with a tumour. Tends to begin in the ileum
- Congenital atresias – newborns.

Update: Recently spiral CT scanning of the abdomen has shown itself to be a very elegant way of demonstrating peritoneal adhesions causing obstruction, but the actual cause of most small bowel obstructions is not apparent from plain films alone.

Confounding factor: An inflamed or obstructed colon may contain fluid, in addition to the presence of small bowel fluid levels. Differentiating loops of small bowel from large bowel can then be exceptionally difficult.

Distended small bowel *continued*

A bit of epidemiology

As has already been stated, in the developed world, most small bowel intestinal obstruction is caused by adhesions. In places such as Africa, however, hernias are by far the most likely cause, as relatively little in the way of previous surgery will have been carried out to cause adhesions.

Vascular catastrophes

A mesenteric artery thrombosis or embolism is a critical event presenting as an acute abdomen. Radiologically the signs are those of ileus in the bowel, moving on to infarction and possibly gas formation in its walls. The clinical setting, e.g. atrial fibrillation, previous myocardial infarction etc., is important in suspecting this diagnosis. Occasionally mesenteric vein thrombosis will be the underlying cause associated with pancreatic carcinoma.

Ileus

Combined small and large bowel dilatation may form the classic radiological signs of paralytic ileus which, as stated, may be hard to differentiate from obstruction.

Causes

- Postoperative – after handling of the gut
- Hypokalaemia
- Drugs, e.g. L-dopa
- Intra-abdominal sepsis (peritonitis)
- Bowel infarction
- Trauma
- Reflex ileus from acute abdomen (renal colic, leaking aorta).

Gallstone ileus (a special form of obstruction)

This condition is recognized by abnormally distended gut and gas in an abnormal location, i.e. the biliary tract. It is in fact a misnomer, being due to genuine mechanical intestinal obstruction, caused by a large gallstone impacting in the gut, usually at the terminal ileum where the bowel is narrowest. This occurs usually after fistula formation between the gallbladder and the duodenum. It is one of the causes of intestinal obstruction where the actual cause may be inferred. Undiagnosed and untreated it carries a high mortality.

Look for (Fig. 3.5):

- Multiple dilated loops of small bowel, i.e. centrally placed loops where the folds go right across the lumen. The colon remains normal. This indicates small bowel obstruction.
- The number of distended loops: the more there are, the more distal the obstruction.
- Gas in the biliary tree. In this patient the entire bile duct is outlined and dilated. Gas is present in the lumen of the gallbladder. However, large recognizable quantities of gas will not always be present, and only in about a third of cases will the bile duct be fully displayed.
- The gallstone. Most commonly this is not seen, but may be located in the right iliac fossa or over the sacrum. It frequently consists of radiolucent cholesterol with only a thin calcified rim, making it hard to see, but in around 30% of patients it is visible. Most obstructing stones are over 1 inch (2.5 cm) in diameter, and may in fact be larger than they look if more cholesterol has been deposited beyond the calcified rim. If the patient was previously known to have had a gallstone in the gallbladder, look to see if it has gone from that location.

NB No stone was visible in this patient.

Causes of gas in the biliary tree

- Previous biliary surgery, e.g. Whipple's operation or anastomoses to the gut
- Instrumentation, e.g. ERCP/sphincterotomy
- Fistula formation, e.g. gallstone ileus
- Posterior perforation of an ulcer
- Malignant spread to the bile duct
- Emphysematous cholecystitis (diabetics)
- Lax sphincter (physiological).

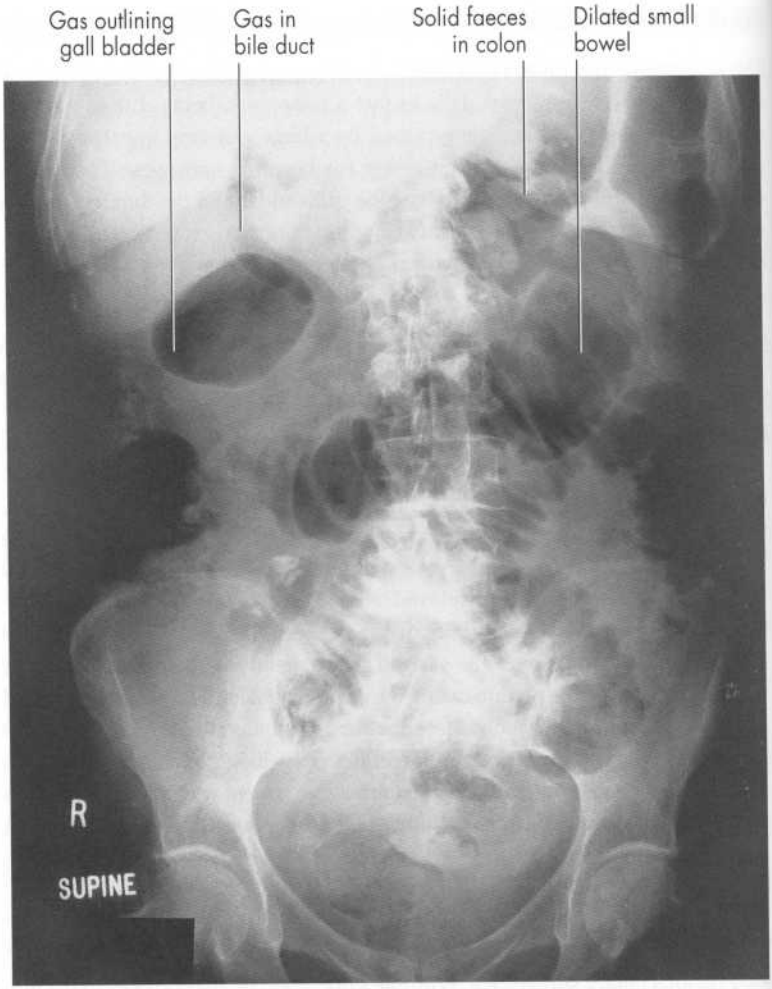


*Fig. 3.5 – **Gallstone ileus** This is a supine AP abdominal X-ray of a 55-year-old woman with a history of right upper quadrant pain, who now presents with more severe pain, fever, nausea and vomiting. The X-ray shows distended small bowel and gas in the bile ducts. You can also see gas in the gallbladder.*

Distended large bowel

Figures 3.6 and 3.7 show a distal large bowel obstruction caused by a carcinoma of the descending colon in an elderly woman who presented late with rectal bleeding, weight loss and, latterly, increasing swelling of the abdomen.

Colonic obstruction can assume a number of appearances, depending on the position of the obstruction and whether or not the ileocaecal valve is competent. If it is, the caecum, being the most distensible part of the large bowel, will distend, but if not the back-pressure will be transmitted through the valve into the small bowel, and that too will distend, as in a small bowel obstruction, but without caecal distension.

Distension of both of these parts of the bowel together can of course occur without obstruction, owing to ileus, and isolated colonic distension ('colonic pseudo-obstruction') may also occur associated with medical conditions such as MI (myocardial infarction), and the radiologist may be asked to exclude organic obstruction by running in some contrast medium retrogradely. The critical diameter for the caecum is 9 cm, beyond which it is in great danger of perforation.

Look for:

- Dilated loops (>6 cm)
- Marked distension of the caecum
- General peripheral position of bowel
- Several incomplete haustral folds, typical of the colon, and a few complete ones — normal variation!
- Fluid faeces on the left (erect film), indicating colonic malfunction
- Involvement down to the level of the descending colon
- A lack of distension of the small bowel, indicating a competent ileocaecal valve.

NB Most colonic obstructions in the UK are caused by tumours (up to 60%), but in some other countries torsion of the bowel (volvulus) is the commonest cause.

Fig. 3.6 – Supine AP film of abdomen. Female patient aged 72, presenting with severe abdominal distension. Note the absence of fluid levels.

Fig. 3.7 – Same patient showing big fluid levels in the erect position.

Causes of large bowel obstruction

- Carcinomas (unlike the small bowel, where adhesions are the most common cause)
- Diverticular disease
- Volvulus – most commonly sigmoid and caecum (see below) in parts of the bowel with a long mesentery
- Inflammatory bowel disease (e.g. Crohn's)
- Appendix abscess
- Metastases
- Lymphoma
- Pelvic masses.

Causes of colonic pseudo-obstruction (may require contrast study to exclude true obstruction and intervention to decompress caecum)

- MI (with pulmonary oedema)
- Pneumonia
- Myxoedema.

Abdominal hernias

Apart from being an interesting incidental finding, the presence of external hernias is important because they may be the site of intestinal obstruction. From the diagnostic radiological point of view the most significant application of this knowledge lies in ensuring that when a patient presents with intestinal obstruction the inguinal and femoral regions are clearly demonstrated on the films – preferably in both the erect and the supine positions.

If an obese patient has a strangulated hernia in the region of the groin this may be a good way to help confirm it.

NB The presence of a hernia in the context of intestinal obstruction does not prove that the hernia is the cause of the obstruction. However, if there is directional continuity of a loop of bowel straight towards a cut-off segment of gut in a hernia, for example, true cause and effect are most likely. Remember, if a herniated loop of bowel does not contain gas it will not be visible.

Scrotal hernias

Appearance of hernias in the groin

Look for:

- Loops of gas-filled bowel extending below the level of the inguinal ligaments on both sides
- Continuity of these loops with another loop in the true pelvis
- Enlargement of the scrotum to accommodate these loops (auscultation of the scrotum may render bowel sounds audible).

Fig. 3.8 – Scrotal hernias in a 50-year-old man. The X-ray shows bilateral hernia formation in the groin, extending into the scrotum. This was an incidental finding and the patient was not obstructed at the time.

Look at (Fig. 3.9):

- The massive scrotum containing multiple gas/liquid levels
- Longitudinal fluid levels, indicating that this is a decubitus film (patient lying on his right side).

Causes of massive scrotal enlargement are rare. Filariasis is one, but herniation of bowel is another. It is this sort of gross pathology that gives rise to the old medical jokes about patients having to carry their scrotums around in a wheelbarrow!

Do not forget:

- A Richter's hernia may be causing a severe obstruction at the inguinal level with only a small partial knuckle of bowel inside it.
- Hernias can occur in other locations, e.g. at and around the umbilicus, and contain small and/or large bowel.
- Internal hernias can also occur – for instance into the lesser sac.

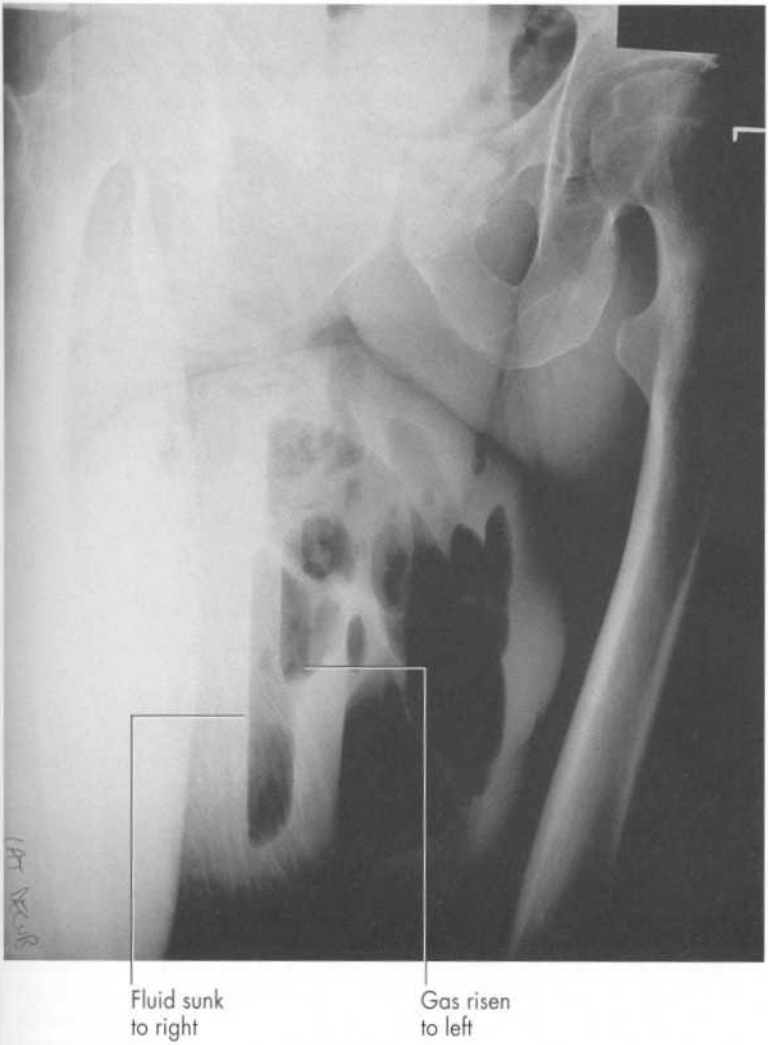


Fig. 3.9 – A patient with a huge scrotal hernia. NB This is a decubitus film with the patient lying on his right side and large fluid levels present with the gas lying uppermost.

Constipation

Look for (Fig. 3.10):

- The characteristic appearance of inspissated faecal matter – rounded masses of mottled or granular texture – due to tiny pockets of gas which they always contain. Find these and you've found the colon.
- Larger quantities of surrounding gas, with occasional haustral folds crossing part of the lumen and outward-billowing folds primarily in the periphery of the abdomen. The transverse colon may, however, be very tortuous and dip down towards the pelvis as it does here.
- Formed faeces in the right side of the colon. This usually indicates constipation, as the material here is usually fluid, mobile and amorphous.
- Distension and loading of the rectum and sigmoid (not in this patient). But these too can be grossly distended in severe constipation. In some individuals the colon may be distended to truly enormous proportions e.g. institutionalized patients who are relatively asymptomatic but who pose considerable anxiety when first X-rayed.

Causes of constipation

- Painful conditions – anal fissure, haemorrhoids
- Social – irregular work patterns, hospitalization, travel (long flights)
- Psychological – institutionalized individuals/defectives, depression
- Elderly – immobility, poor diet, altered routines
- Colonic disease – carcinoma, slow transit, excessively long colon
- Postoperative – childbirth, pelvic floor repair
- Paraplegia – autonomic dysfunction
- Drugs – analgesics, opiates, antidepressants, iron
- Parkinsonism – retardation
- Hypothyroid disease – generalized reduction in bodily functions
- Chagas' disease – trypanosomiasis infection with megacolon
- Hirschsprung's disease, in children. In this condition look for huge mottled masses and gas in the surrounding periphery of the colon.

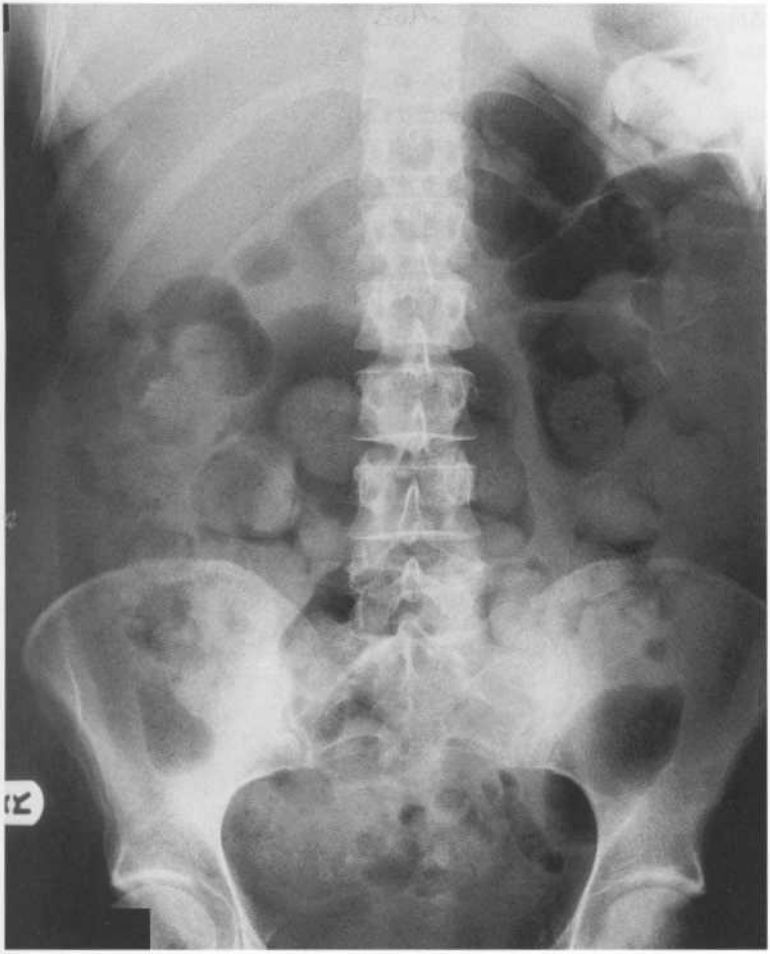


*Fig. 3.10 – **Constipation** This is a 55-year-old woman who presented with increasing abdominal pain, distension, and complaints of reduced bowel frequency. You can see faecal overloading in the large bowel.*

The appendix

Appendicitis is the most common acute surgical emergency, but most appendices are not visible on abdominal X-rays.

Often the diagnosis and treatment are straightforward, but occasionally difficult or atypical presentations occur and under these circumstances abdominal films may be helpful. First check that any woman of reproductive age is not pregnant, as appendicitis often occurs in the young, i.e. ask about the LMP: your patient may have dysmenorrhoea.

NB A normal X-ray does not exclude appendicitis and no one radiological sign confirms it. However, when certain radiological signs occur together in the appropriate clinical setting, the likelihood of appendicitis being the correct diagnosis greatly increases.

A word about pathology

Appendicitis is caused by blockage of the mouth of this organ with inspissated faeces or a calcified mass thereof (faecolith), leading to distension and infection, surrounding inflammatory reaction, bowel stasis and potential rupture – reflected over time from normality to established radiological changes.

This (Fig. 3.11) is appendicitis complicated by abscess formation.

Look for:

- Calcified faecoliths. These may occur in normal people but also occur in around 14% of patients with acute appendicitis, and as they grow may take on a laminated appearance. They are different from calcified lymph nodes. A cluster of four faecoliths is present here.
- Mass effect around the appendix. The bowel loops are displaced away from the primary focus of infection due to oedema, rupture and abscess formation, with walling off by the greater omentum – 'the abdominal policeman'.
- Distended loops of bowel – 'sentinel loops'. These are due to localized ileus from the inflammation or matting with adhesions, going on to complete intestinal obstruction. It is the adjacent colon that is distended here.

Fig. 3.11 – Localised view of erect film of a patient with abdominal pain commencing centrally and then localizing to the right iliac fossa, followed by increasing toxicity, fever and a palpable mass in the lower right abdomen and tenderness PR on the right.

Another appendicitis

This (Fig. 3.12) is the lower right quadrant detail from the film of a 60-year-old febrile patient with initial central abdominal pain, later localizing to the lower right.

Look at:

- The curved C-shaped object in the right flank
- The black density of its interior.

This is gas in the lumen of an inflamed and turgid appendix. It is a rare sign and must be interpreted with caution, as it may also occur in normal people.

Other radiological signs to look for in appendicitis include:

- Free gas – a very serious sign of perforation – either intraperitoneally or in the retroperitoneum (the appendix can lie in either space), but this is rare.
- Loss of the right psoas margin, but again this is a non-specific sign.
- Flexion or scoliosis concave to the affected side. This is nature's way of relieving spasm in the muscles on the painful side. It may also be seen in trauma or renal colic, but does not always occur.
- Other indirect signs of inflammation/intra-abdominal pathology causing loss of clarity to the right properitoneal fat stripe in the flank. Much is often made of this sign.

But:

- This area should be included on abdominal films but often it is not.
- You will often need a bright light to see it, but often it is too dark to see anyway even when the relevant area is included.

Other radiological manifestations of the appendix

- Remember that the appendix may retain barium from a recent enema or oral barium study for many weeks or months. Failure to fill does not necessarily indicate disease; also, most patients are nil-by-mouth as emergencies, thereby precluding oral barium as a test, although were it to fill up with contrast that would rule out appendicitis as the cause, thus requiring alternative pathology to be sought.

Point of interest: Colonic diverticula may retain barium for many weeks or months after a barium enema or meal, causing possibly dozens of very dense

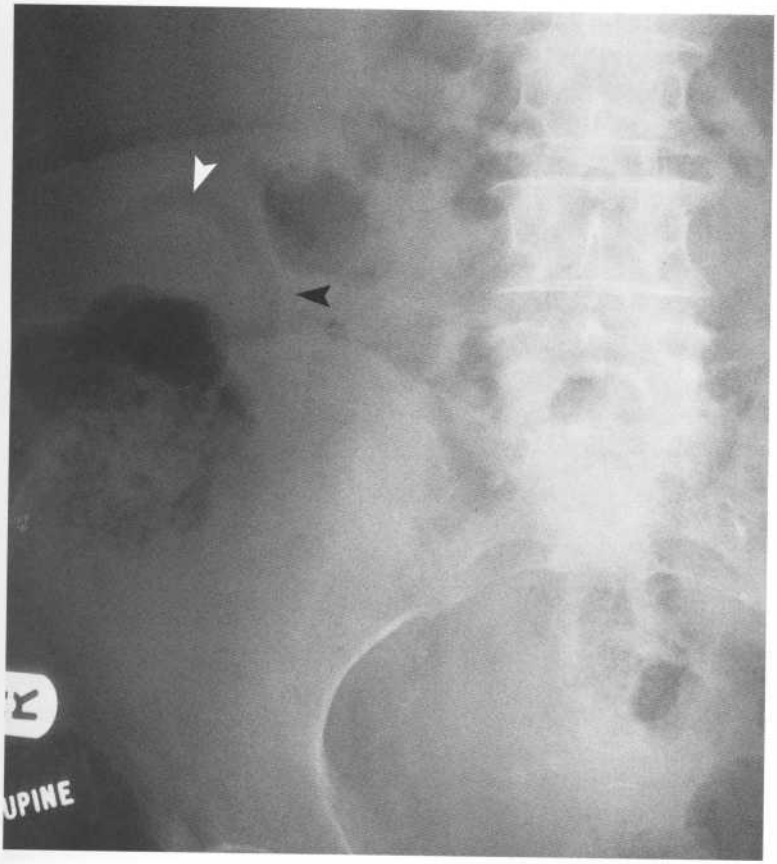


Fig. 3.12 – Finding of gas in the lumen of the appendix (arrows).

opacities around the colon. If you can see what looks like this, look in the notes or X-ray packet for the culprit.

Remember: Retained barium from radiological studies is a rare but recognized cause of appendicitis.

Footnote: Non-invasive preoperative imaging assessment for appendicitis may now be sought by ultrasound and CT, looking for an appendicolith, a distended appendix >6 mm in diameter, and surrounding inflammatory signs of oedema or fluid.

Volvulus

Volvulus or 'twisting' can affect any part of the intra-abdominal gastrointestinal tract, including the stomach and small bowel, but this is relatively rare.

More common, but still relatively rare compared with all other causes of obstruction of the large bowel, is volvulus of the sigmoid colon and the caecum in western countries, although it tends to be more frequent in Africa, for example.

Sigmoid volvulus

This (Fig. 3.13) usually occurs in elderly patients who have redundant loops of sigmoid colon on a long mesentery and a history of constipation. Subacute manifestations or vague symptoms may occur but in the acute form the patient may become severely ill with abdominal pain, complete constipation and, on PR, an empty rectum. Delay in diagnosis may lead to ischaemia, gangrene, perforation and death.

Look for:

- A grossly distended loop of sigmoid colon extending from the pelvis to under the diaphragm. Compression together of the two medial walls produces the 'coffee bean sign'. Erect films may show excessive quantities of gas relative to fluid > 2:1.
- A lack of haustra. These are effaced by the enormous distension, but other loops of colon underlying it may simulate haustra in the distended loop.
- Apex above the 10th vertebra in the thoracic spine, again a measure of the severity of distension that occurs in a true volvulus. This point is off the top of this film, which was only one of several needed to demonstrate the entire abdomen and chest.
- Convergence of lower margins of the distended loops on the left.
- Liver overlap sign – indicative of the degree of distension of the bowel, i.e. a colonic loop to the height of the liver or above it on the right.
- Left flank overlap sign – indicative of distension of the same, i.e. the left limb of the 'coffee bean' overlies the descending colon, which may be seen behind it.
- 'Free air' – sign of perforation (not present here yet).

These are the classic signs of a sigmoid volvulus, but in some patients the radiological signs are atypical and therefore less obvious. Retrograde running-in of contrast medium per rectum may show a twisted beak-like or 'bird of prey' sign at the point of convergence of the distended loops and confirm the diagnosis.

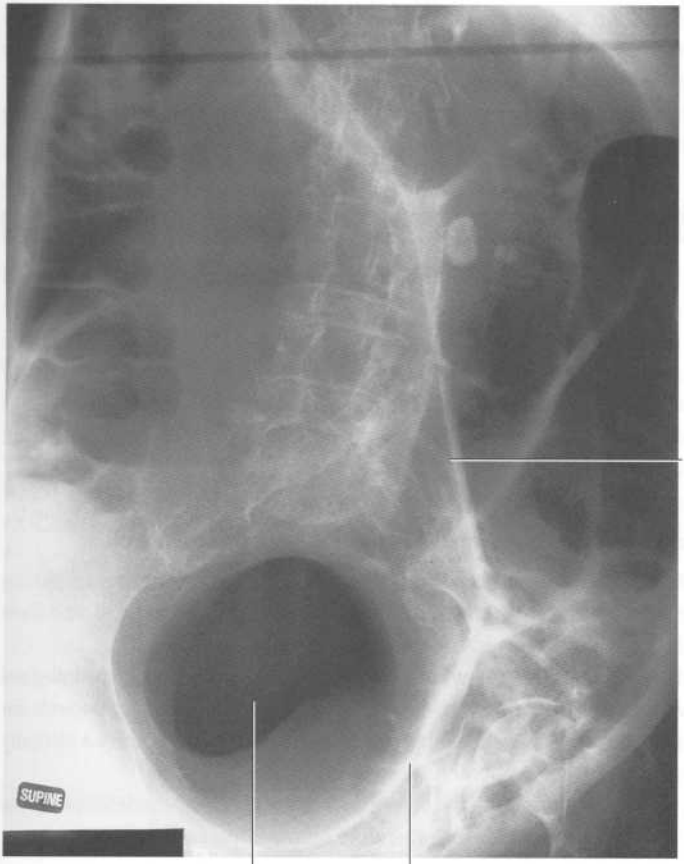


Fig. 3.13 – Supine AP radiograph. Sigmoid volvulus. An elderly institutionalized woman aged 76 with an acute exacerbation of long-standing intermittent abdominal symptoms of pain and distension, and prior constipation. Note the distended sigmoid. This is the famous 'coffee bean' sign.

This condition may respond initially to endoscopic tubal manipulation and decompression, but most will recur. Definitive surgery with partial colonic resection may then be required.

Perforation and gangrene constitute an acute emergency and require immediate surgical intervention.

Inflammatory bowel disease

It is not the job of plain film radiology to establish the diagnosis of mild inflammatory bowel disease, which requires tissue biopsy, but rather to evaluate patients presenting with exacerbations or complications thereof, and other than in obstruction it plays little part in the assessment of small bowel disease, for which barium studies are required. The normal colon, however, usually contains semifluid faecal matter on the right-hand side and more solid faecal matter on the left-hand side.

In suspected inflammatory large bowel disease therefore look for:

An absence of formed faecal matter in the left-hand side of the colon.

This indicates that the colon is not carrying out its function properly, i.e. storing its contents for a sufficiently long time and absorbing water from them, and these patients will usually have a history of diarrhoea.

Diarrhoea of course has many causes (see opposite), including gastrointestinal tract infections and the use of aperients e.g. in the preparation of patients for radiological procedures. At times this can be so marked as to produce a virtually faeces-free and 'gasless' abdomen.

The patient's history – e.g. of recent foreign travel, self-medication or the medical use of suppositories etc. – therefore becomes paramount.

Causes of diarrhoea

These are conveniently divided into acute and chronic.

Acute

- Infections, e.g. gastroenteritis, food poisoning
- Dietary excesses: lager and hot curries!
- Traveller's diarrhoea due to *E.coli, Entamoeba, Shigella* etc.

Note: The 'gasless' abdomen, where the X-ray shows a lack of faecal matter and almost total absence of gas, may indicate early obstruction, diarrhoea or laxative use.

Chronic

- Inflammatory bowel disease (Crohn's, ulcerative colitis)
- Malabsorption
- Infection (parasites)
- Malignancy in bowel
- GI surgery (vagotomy, partial bowel resection, blind loops etc.)
- Constipation (in the elderly) with 'overflow diarrhoea' and rectal plug
- Laxatives
- Endocrine causes
  - pancreatic insufficiency
  - pancreatic neoplasm
  - thyrotoxicosis
  - diabetic autonomic neuropathy.

Complications of inflammatory bowel disease

Small bowel

This usually involves Crohn's disease and plain films may show intestinal obstruction or signs of fistula formation leading, for example, to air in the urinary tract (bladder, ureter, renal pelvis) or the biliary system (i.e. bile duct). Rarely malignancy may supervene.

Large bowel

Look for (Fig. 3.14):

- The generalized lack of formed faecal matter
- The oedematous folds of mucosa, especially in the transverse colon.

This is called 'thumbprinting' and is usually a manifestation of acute and severe inflammation in the colon due to ulcerative colitis. There are, however, many causes of thumbprinting, the more common ones including:

- Crohn's disease
- Ischaemic colitis
- Intramural haematoma
- Metastases
- Lymphoma
- Pseudomembranous colitis
- Allergic reactions ('colonic hives').

Fig. 3.14 – A 43-year-old man with acute diarrhoea passing slime and bleeding per rectum. This is a supine AP film showing an acute exacerbation of ulcerative colitis.

This (Fig. 3.15) is a case of toxic megacolon or toxic dilatation of the colon. Look for:

- Generalized or localized dilatation of the lumen of the bowel (> 6 cm)
- Lobulated masses in the lumen (inflammatory pseudopolyps)
- Excessive gas
- Absent faeces (note that the intraluminal masses are smooth and contain no mottling due to pockets of gas)
- Gas in the wall of the bowel (not present here, but may indicate imminent perforation)
- Evidence of free gas – pneumoperitoneum – 'double wall sign' if the bowel has perforated. Not present here
- Evidence of gas in the portal vein. Not present here. When present this is usually an antemortem event.

Toxic dilatation of the colon is an acute surgical emergency and this patient required an emergency colectomy, which was carried out forthwith.

Fig. 3.15 – This is a 35-year-old man who was admitted in a state of shock with bloody diarrhoea. He had a history of ulcerative colitis.

Chapter 4

Abnormal Gas

- Gas is the body's own natural contrast medium and its appearance as the darkest density appearing on X-ray films should now be familiar to you, especially in the abdomen as well as in the chest.
- Most of the time it is confined to the lumen of the gut, where you can make great use of it to deduce the diameter, and mucosal state of the bowel wall. However, the problem is:
  (a) that the gut is usually undergoing peristalsis of varying degrees, so that
  (b) enormously variable quantities of gas may be present from patient to patient and from time to time, both of which tax the observer to try and interpret correctly. Often only ***parts*** of the bowel are visible.
  (c) adherent faecal residue may simulate mucosal abnormality in the colon, as may residual food in the stomach.
- Much less frequently, but most importantly from the diagnostic viewpoint, owing to a variety of pathological processes gas may escape from the lumen of the gut into the peritoneal cavity, as well as into the retroperitoneal space.
- More subtly, it may track into the wall of the bowel itself and, by fistula formation, further break into other systems such as the urinary or biliary tracts, or even out onto the surface of the skin (enterocutaneous fistula). Gas may also track down into the abdomen from the chest, form in abscesses as a result of infection with gas-producing organisms, appear in vessels such as the portal vein as a preterminal event, and also appear as a result of iatrogenic activities such as embolization procedures (e.g. in the kidney).
- It must be understood that extraluminal intraperitoneal gas is to be expected after surgery, laparoscopy or peritoneal dialysis, so that the radiologist *must* be given the relevant clinical information and not be misled into diagnosing pathology incorrectly as a result of failure by the clinician to provide it.

- Conversely, after an iatrogenic procedure such as endoscopy extraluminal gas should not be expected, and its presence in that situation indicates a catastrophe, i.e. perforation of the gut. **The procedure need not have been technically difficult for this to occur.**

Pneumoperitoneum

The radiological signs of a pneumoperitoneum are among the most important signs in radiology, indeed in medicine. Sometimes the amount of free gas is small and you may have to work to demonstrate it. **Miss it and the patient may die.**

Look for:

- Bilateral dark crescents of gas under both hemidiaphragms. NB Figure 4.1 was taken erect, so the gas has risen. This is a large pneumoperitoneum, but small amounts of gas require time to rise to the subdiaphragmatic position so it is a good idea to leave the patient upright for 10 minutes to allow this to happen before taking the X-ray
- Gas may appear on one side of the abdomen only, usually the right
- No gas may be seen if the perforation has been sealed off by the omentum
- If only a small amount of gas is present it may be missed unless the film is centred at the level of the diaphragms – usually a chest is centred around the fourth thoracic vertebra. With attention to detail as little as 1ml of free gas may be demonstrated.

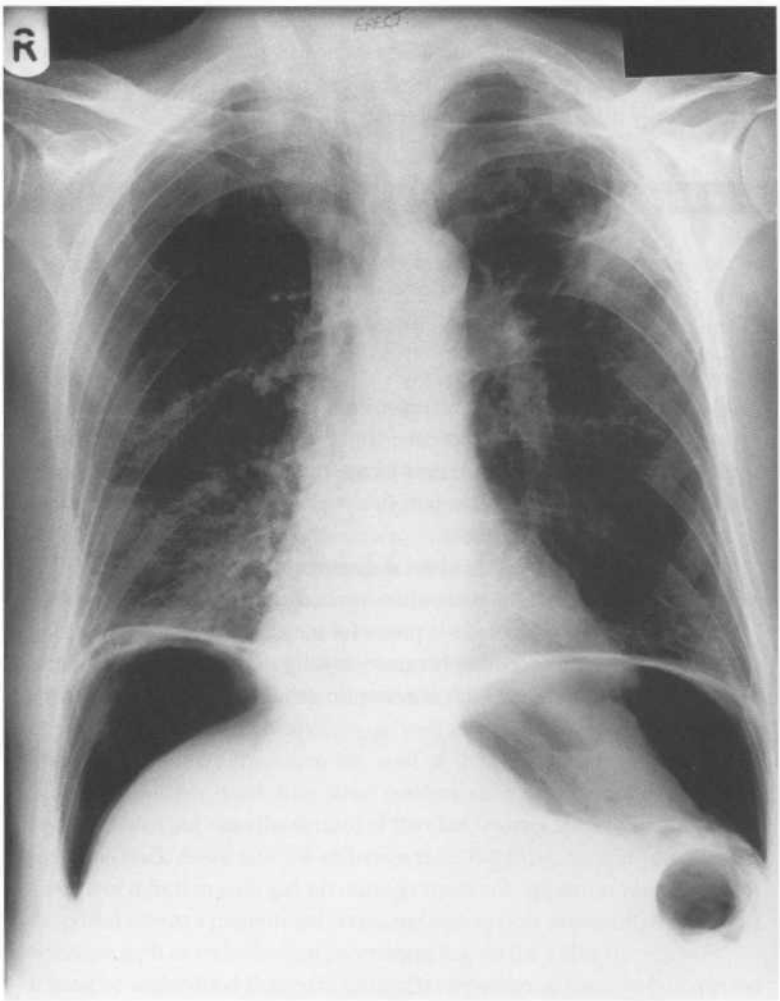


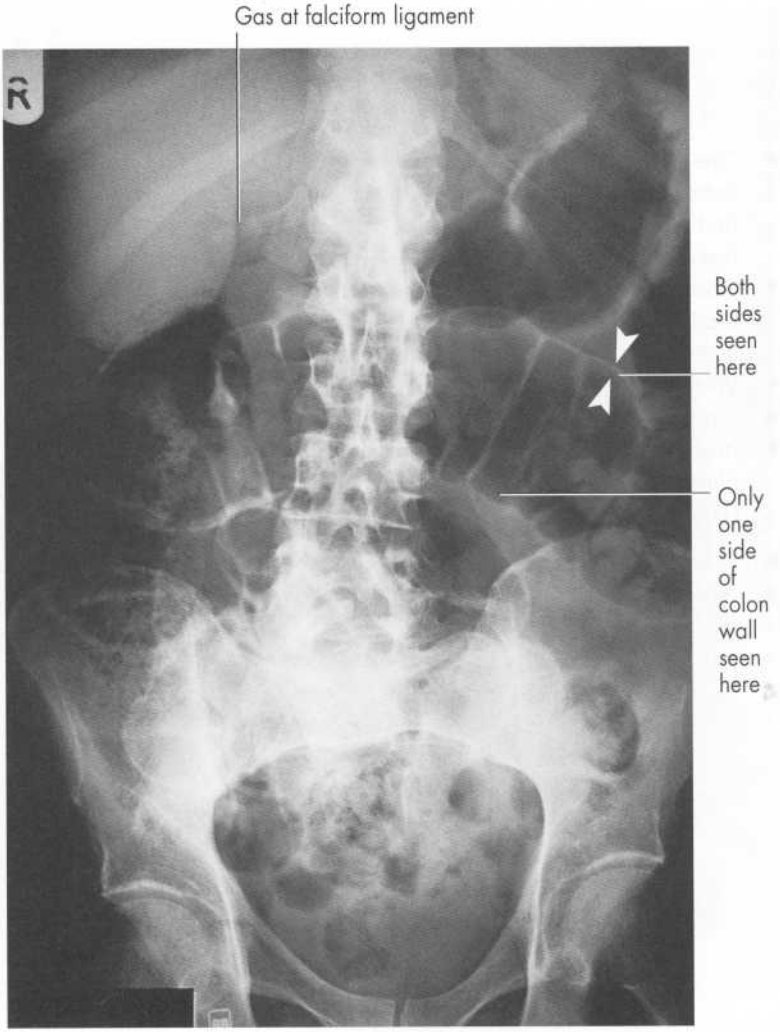
Fig. 4.1 – B.L. Erect chest film. 60-year-old patient with a history of ulcer disease, presenting with acute abdominal pain and board-like rigidity in the abdomen. Note the bilateral radiolucent collections of gas under each hemidiaphragm. This was due to a perforated duodenal ulcer. There is also a mass in the left lung.

Supine films will usually have been taken routinely with the erect ones, and certain more subtle signs of free gas in the peritoneal cavity have been described to enable the diagnosis to be established under these circumstances.

Look for:

- 'The double-wall' sign (Fig. 4.2), i.e. both sides of the wall of loops of bowel become visible because of air on the inside and air on the outside – try to find an isolated viscus such as the stomach or bowel loop, but remember that closely apposed loops may give a false positive 'double-wall' sign
- 'Football or dome sign'. With a large pneumoperitoneum the undersurface of the diaphragm may be surrounded by air, giving a dark dome-like appearance in the upper abdomen even on supine films
- Visualization of falciform ligament – 'Silver's sign'
- Gas in the scrotum in children
- In seriously ill patients the use of erect films may not be possible and decubitus films with the left side down centred on the right upper flank should be taken.

Bright lights may be required to see this area properly, as for technical reasons the films often come out very dark in this situation.



4.2 – Pneumoperitoneum – 'double-wall' sign. This is a supine abdomen showing some of the more subtle signs of a pneumoperitoneum.

The causes of a pneumoperitoneum are legion and are often divided into those with clinical signs of peritonitis and those without, although some of the latter may later develop signs of peritonitis.

Crucial fact: Special vigilance must be exercised in dealing with patients on larger doses of steroids. These drugs both predispose the patient to erosion and perforation of the upper GI tract and then mask the symptoms and signs. The diagnosis of perforation then relies entirely on the X-ray, so a high index of suspicion for this phenomenon must be maintained.

Note (Fig. 4.2):

- The diaphragms are not visible, nor any gas beneath them
- Free gas, however, is definitely present as both the inside and outside walls of parts of the colon are visible, i.e. the 'double-wall' sign
- Gas is tracking up the falciform ligament.

Causes of a pneumoperitoneum

With peritonitis

- Perforated peptic ulcer (stomach or duodenum)
- Intestinal obstruction
- Ruptured diverticular disease
- Penetrating injury – gunshots, knife-wounds etc.
- Ruptured inflammatory bowel disease (e.g. megacolon)
- Colonic infections (typhoid).

Without peritonitis

- Post laparotomy
- Post laparoscopy
- Jejunal diverticulosis
- Steroids
- Tracking from chest (pneumothorax)
- Peritoneal dialysis
- Vaginal insufflation (douching, squatting, oral sex, postpartum exercises, water-skiing)
- Pneumatosis coli.

Differential diagnosis of a pneumoperitoneum

Many important phenomena can simulate a pneumoperitoneum and lead to misdiagnosis and unnecessary surgery, with all its medical and medico-legal complications. A good selection of these is shown to emphasize their crucial importance.

Linear atelectasis (Fig. 4.3)

- Linear atelectasis is a phenomenon that occurs in the lungs, usually at the bases.
- It is frequently associated with infection or pulmonary embolism and is commonly seen after anaesthetics in the postoperative state. It forms dense horizontal or curved bands which may simulate the diaphragm.
- Note how the band at the right costophrenic angle curves up instead of down. Normally it resolves within days or weeks, but may persist for longer.

Note (Fig. 4.4, p. 94):

- The band of increased density running just above the medial part of the right hemidiaphragm, creating a lucent view of the air in the lung beneath it and simulating a pneumoperitoneum.
- This is a more subtle example of linear atelectasis following anaesthesia. Nothing had been done to the abdomen.

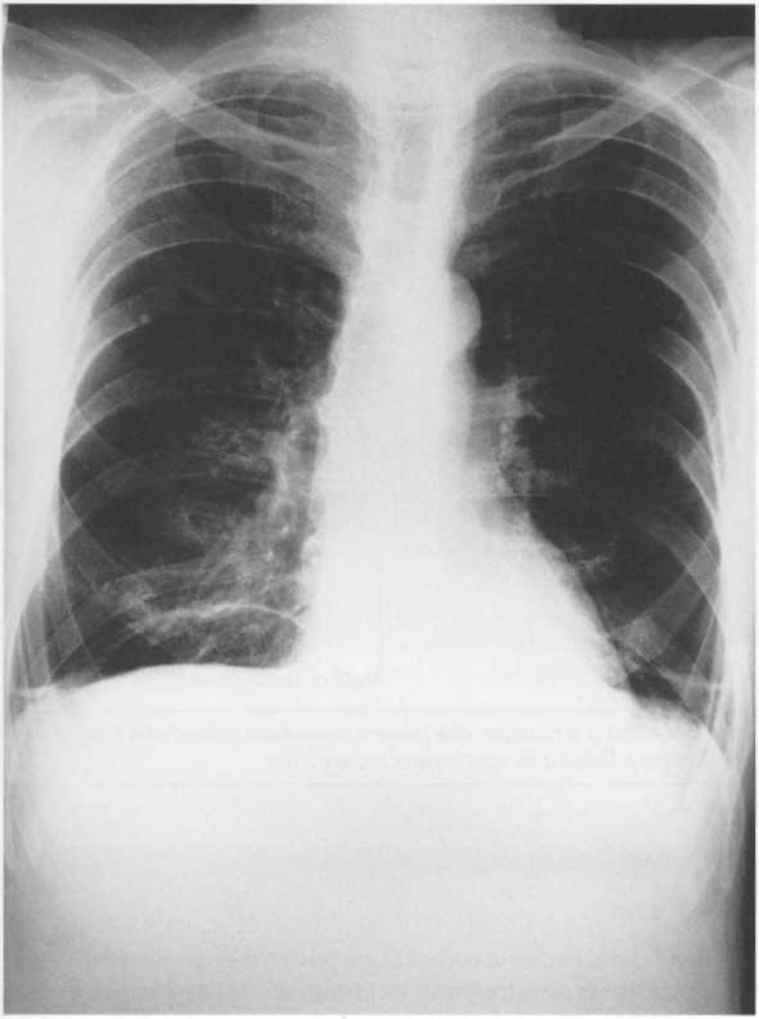


Fig. 4.3 – This is a case of bilateral linear atelectasis simulating a pneumoperitoneum.

Differential diagnosis of a pneumoperitoneum *continued*

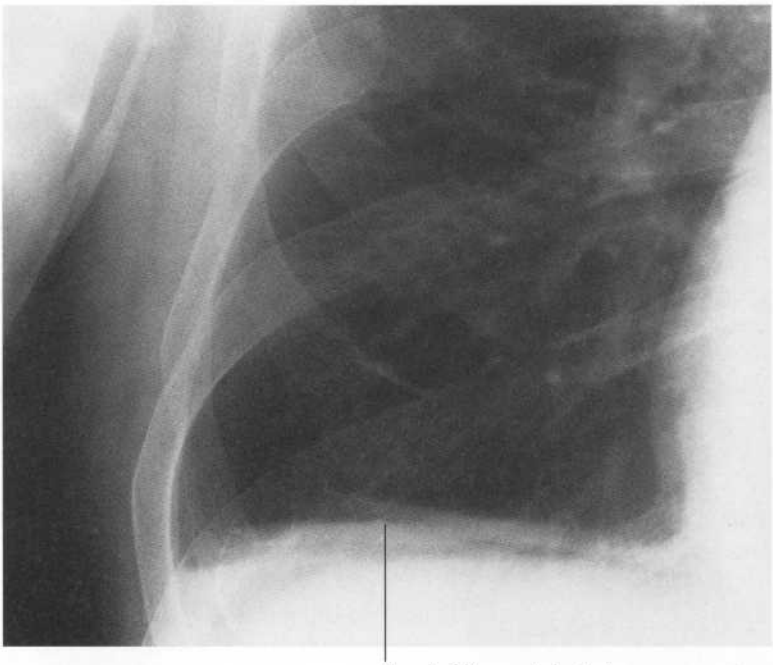


Fig. 4.4 – This is a postoperative general anaesthetic patient who has just had ENT surgery. Detail from right base of a chest X-ray.

Chilaiditi's syndrome – colonic interposition

Note (Fig. 4.5):

- The incidental finding of pockets of gas beneath the right hemidiaphragm
- Multiple bands of mucosal folds indicating gut. This is colonic interposition. An abdominal film showed continuity with the rest of the colon
- Rarely the small bowel may interpose as well
- This may be intermittent in nature, i.e. present on one occasion and gone the next.

It may be seen with shrunken livers (cirrhosis), in COPD with a large thoracic

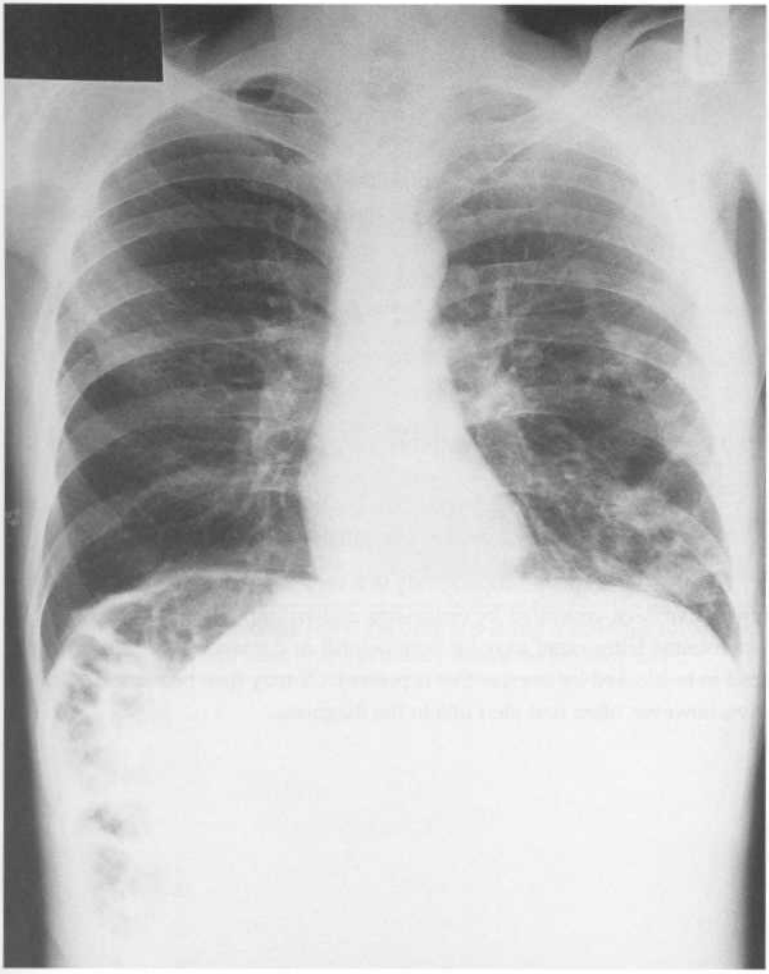


*Fig. 4.5 –**Chilaiditi's syndrome** Colonic interposition. This is the chest X-ray of a 60-year-old male with chronic lung disease.*

outlet, postoperatively when the surgeon has pushed the gut out of the way to get at something else, or spontaneously.

Differential diagnosis of a pneumoperitoneum *continued*

Meteorism

Look for (Fig. 4.6):

- Excessive air swallowing often associated with crying, especially in children, causing gut distended with gas to crowd up underneath both hemidiaphragms. (Interposition again on the right.)
- Folds of the bowel crossing the gas-filled lumen, confirming the presence of gut
- Superimposition of bowel loops
- Continuity of loops with others in the abdomen.

This is meteorism. There were no abdominal symptoms and no perforation.

Subphrenic abscess (see Fig. 4.15)

Look for:

- Fluid levels under either hemidiaphragm, more commonly the right.

This usually occurs postoperatively in a very sick patient. Part of the gas will often have been generated by organisms and will not all be residual from the laparotomy. Ultrasound may be very helpful in demonstrating fluid, but will tend to be blocked by any gas that is present. CT may then be required. Plain X-rays, however, often first alert one to the diagnosis.

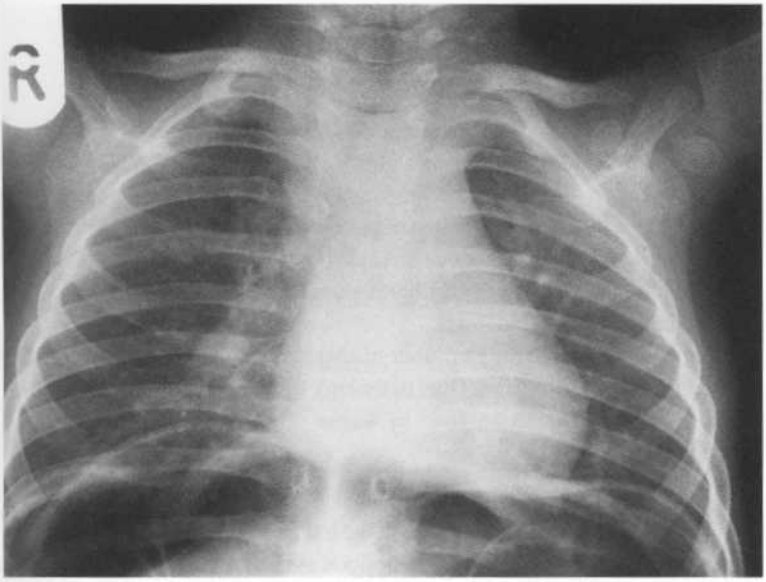


Fig. 4.6 – ***Child with meteorism*** *This is the X-ray of a young child with a suspected chest infection who had been crying profusely before the film was taken.*

- Skin folds, especially in the elderly, infants and severely dehydrated patients
- Cortical rib margins overlapping diaphragms
- Lobulated diaphragm with gut underneath one or more humps.

This is a matter for careful inspection and analysis of the films.

NB When there is doubt about a pneumoperitoneum or demonstrating the site of a leak is required, oral water-soluble contrast (but not barium) can be given to try and demonstrate a perforation, under screening control by a radiologist. Barium should not be used as it is harmful and dangerous should it escape through a perforation into the peritoneal cavity, exacerbating infection and causing barium granulomata.

NB Just occasionally one or other of these phenomena can coexist with a genuine pneumoperitoneum. Dual pathology is by no means unheard of.

Fat beneath the diaphragm

Look for (Fig. 4.7):

- Constant radiolucent stripe beneath the left hemidiaphragm
- Constancy in the size, shape and position over time and no movement with change of position, e.g. a decubitus film
- Associated cardiophrenic fat pad at the apex of the heart.

This is a lipoperitoneum, i.e. a collection of fat beneath the left hemidiaphragm. Note its similarity to a genuine pneumoperitoneum. A lipoperitoneum is more likely to occur in an obese patient or one with a cardiophrenic fat pad indicating tendency to form excess body fat. The lucent line however is not quite so dark as gas giving an important clue to the diagnosis.

Fig. 4.7 – Detail from one of a number of identical chest X-rays taken on this patient over several years.

Distended gastric fundus

This can form an extensive quantity of air apparently beneath the left hemidiaphragm.

Look for:

- A fluid level in the erect position, as seen on most normal chest X-rays
- Typical disposition of the stomach in continuity with gastric fundus on supine film
- The total thickness of the left hemidiaphragm. A 'naked' diaphragm with free air on either side of it measures only 2–3 mm. With the thickness of the gastric fundal wall beneath it the total thickness will approximate to more like 4–5 mm in total. Proceed with caution, however, as exceptions can occur.

Gas in the retroperitoneum

On occasion gas may collect in the retroperitoneal space and cause a so-called **pneumoretroperitoneum.** However, it is usually due to rupture of parts of the gut with retroperitoneal components, e.g. the duodenum or rectum, either spontaneously due to pathology or following instrumentation, such as endoscopy, or penetrating injury (e.g. a stab wound).

At one time the deliberate introduction of gas into the retroperitoneum was carried out as a diagnostic procedure, by inserting a needle through the perineum and injecting carbon dioxide – 'presacral pneumography' – to demonstrate renal or adrenal masses, but this is now completely obsolete. Nevertheless this illustration of the technique shows well what to expect and what you will see when it occurs.

Note:

- The intense black density surrounding the psoas muscle margins, the kidneys, adrenals and spleen
- Marked enlargement of the right adrenal and spleen
- Associated gas in the peritoneal cavity, which may or may not (as here) be present.

NB Gas in the retroperitoneum is a serious radiological sign and requires urgent assessment to find its cause, although the preceding history is usually obvious.

NB A lack of gas under either hemidiaphragm on erect films does not exclude a perforation, and air in the retroperitoneum will not necessarily be associated with air under either hemidiaphragm. A posteriorly perforating ulcer may lead to air only in the retroperitoneum. In *massive* perforations free gas may readily be seen under both hemidiaphragms, even on *supine* films.

Often, however, retroperitoneal gas is present only in small quantities and constitutes a subtle radiological finding.

But do not mistake streaks of dirt in the erector spinal muscles for retroperitoneal gas in the elderly.

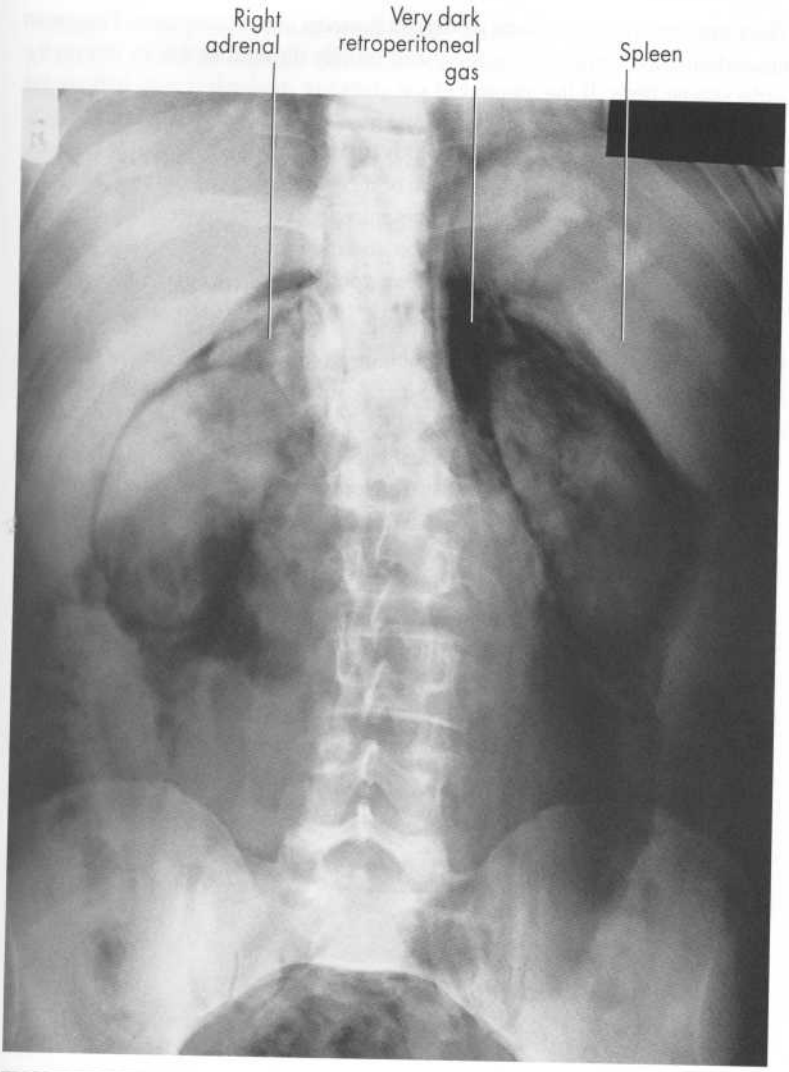


Fig. 4.8 – Retroperitoneal gas – old X-ray from a deliberate case of 'presacral pnuemography'. Note the intense 'negative contrast' highlighting of the kidneys. Note also the enlarged spleen and big right adrenal gland.

Postoperative abdominal X-rays

There are some important facts worth emphasizing about these films. Free gas in the abdomen is normal after surgery and usually diminishes day by day on the early supine films. If the amount of gas does not diminish it may indicate the breakdown of an anastomosis or leakage from the site of recent surgery.

After several days, when the patient is feeling better and sat up, the gas rises, and it may then appear that a lot more of it is suddenly present underneath the diaphragms when previous supine or semirecumbent films are compared with erect ones. Remember this phenomenon and monitor it before misdiagnosing a 'leak'. The patient's clinical state will be a good guide.

Tips:

- Take advantage of any view of the lung bases you get on abdominal films. The amount of energy required to demonstrate the abdomen is much greater than for a chest X-ray, and lung bases that 'cannot be shown' due to obesity or poor inspiration on conventional chest X-rays may show up particularly well on abdominal films – for basal atelectasis, effusions, cavities, metastases etc.
- Asking for 'an upper abdominal film' may be a subtle way of getting the radiographer to show the lung bases for you.
- On postoperative films look particularly closely for signs of left lower lobe and linear collapse. Colonic interposition may also occur postoperatively.
- Do not forget to look extremely critically at the position of all tubes, drains, stents and coils that may have been put into the abdomen and maintain a high index of suspicion for signs of infection, ileus, etc.
- Remember early post-operative films may have to be done on mobile machines and be technically less satisfactory and more prone to artefacts.

Gas in the biliary tree

This has already been touched on under gallstone ileus. Remember, the gallbladder and bile duct are not routinely visible on plain X-rays and, when illustrated in texts, have usually been injected with contrast medium so that they show up white. It is important, however, to learn to identify familiar anatomical structures presenting in an unfamiliar way, that is, when outlined by gas. This is known as 'negative contrast'.

The clinical state of the patient will be a good guide as to the potential seriousness of finding gas on X-ray in the biliary tree, e.g. very sick with gas-forming organism infection, or clinically well due to previous choledocho-duodenostomy surgery.

In the past carbonated drinks have been given to children with bile ducts anastomosed to the gut to fill them with CO_2 and monitor their subsequent size – a form of 'coca-colagram'– thereby avoiding the risks of iodinated contrast. Ultrasound would now be used, however, and can detect gas by bright echoes coming from the bile ducts.

Gas in the wall of the gallbladder

As opposed to gas in its lumen, gas can occur in the wall of the gallbladder itself– so-called 'emphysematous cholecystitis'– due to infection with gas-forming organisms, especially in diabetics. It looks similar to gas in the wall of the urinary bladder (see Fig. 4.12). Other than those stated on page 63, causes of gas in the biliary tree include:

- Crohn's disease
- Pancreatitis
- Parasites, e.g. ascariasis.

Gas in the urinary tract

As with gas in the biliary tract, the finding of gas in the urinary tract usually indicates recent instrumentation or else something serious going on, such as gas-forming infection or fistula formation.

Causes of gas in bladder lumen (see X-ray on p. 182)

- Iatrogenic, e.g. cystoscopy
- Due to fistula formation.

Causes of bladder fistula

- Malignancy of bowel, bladder, genital system
- Crohn's disease
- Diverticular disease
- Postoperatively ('controlled trauma')
- Trauma (uncontrolled)
- Radiotherapy
- Foreign body
- Ulcerative colitis.

Note (Fig. 4.9):

- The distension of both collecting systems from the obstructing effect of the bladder carcinoma
- The white outline of the left renal collecting system by contrast medium – the usual 'positive contrast' from the i.v. injection
- The black outline of the right renal collecting system, i.e. 'negative contrast' from intrapelvic and intracalcyeal gas on this side, plus the non-function of the right kidney.

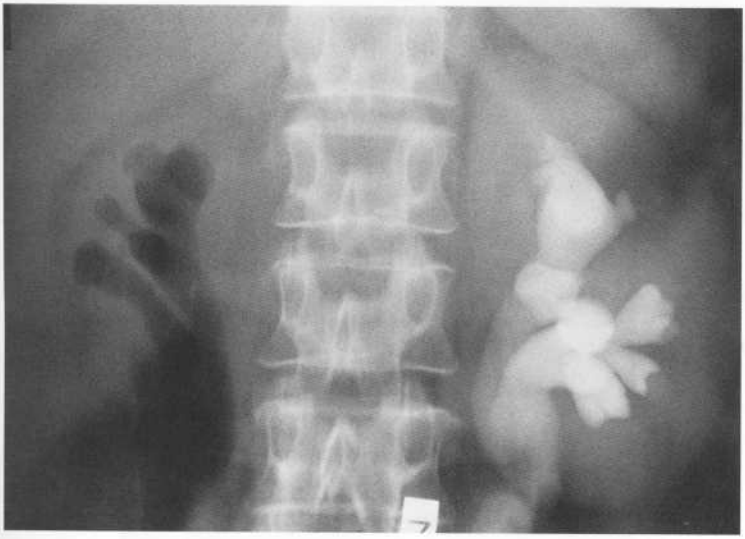


Fig. 4.9 – Gas in the collecting system. This is the film of an IVU sequence from a patient with a carcinoma of the bladder who, in addition to haematuria, complained of passing 'foam', with bubbles in his urine. A fistula had formed with the bowel, allowing gas to enter the bladder and the right ureter.

Intramural gas

Having assimilated the notion of gas as the body's natural contrast agent for the purposes of diagnosis within the bowel, and evidence of the very serious situation of escape and leakage from it, it is now necessary to recognize and understand the significance of gas in the **wall** of certain structures, where it may occasionally be found (see below), e.g. the bladder.

Intramural gas may appear virtually anywhere of course, but in practice a commonly important place to look for it is the colon, e.g. in children.

Necrotizing enterocolitis

Look for (Fig. 4.10):

- Intramural colonic gas, especially on the right-hand side – note the dark margins forming a continuous track
- A normal appearing loop of bowel in the left flank with a normal wall of soft-tissue density contrasting with gas in the lumen
- Cardiac leads. Monitoring of the child reflects the severity of its condition. The child has also been intubated (note the endotracheal tube).

There are many causes of intramural gas, a list of which is given after several more examples (page 110).

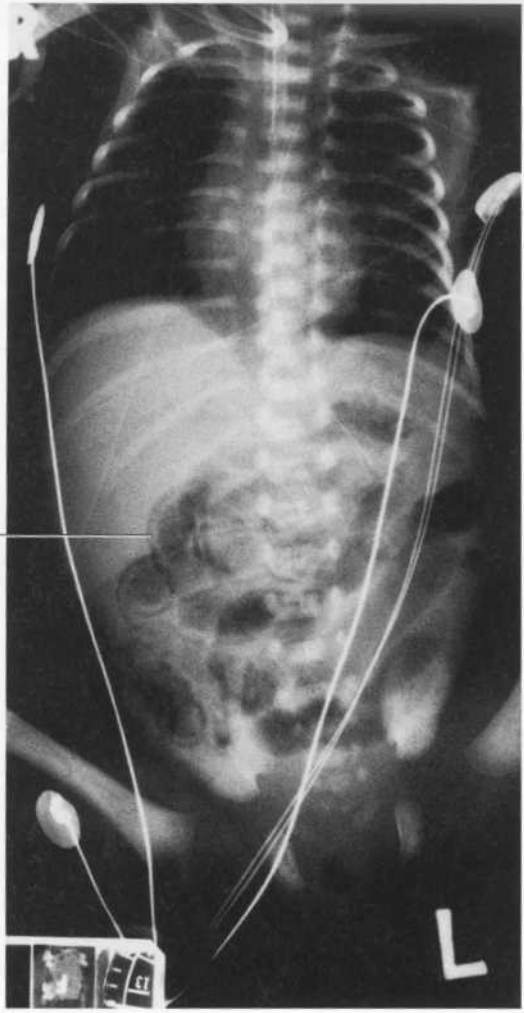


Fig. 4.10 – A young infant presenting with prostration and bloody diarrhoea. Note the very clear edge of the colon outlined by gas in the wall of the bowel. This is necrotizing enterocolitis.

Pneumatosis coli

Look for (Fig. 4.11):

- Gas cysts protruding into the lumen of the large bowel causing a multiplicity of small pockets, far in excess of normal in the right upper quadrant
- Distortion of the normal mucosal pattern
- Evidence of perforation (not present here) – this may be localized or generalized, i.e. a pneumoperitoneum, or tracking into the mesentery. These 'poppings' of the gas cysts are usually benign but present with recurrent bouts of abdominal pain.

There may be an associated colitis in these patients and occasionally a psychiatric history.

Fig. 4.11 – A 54-year-old woman with recurrent abdominal pain and diarrhoea. This is pneumatosis coli.

Gas in the bladder wall

Note (Fig. 4.12):

- The multiple irregular lucent pockets overlying the arc of the bladder outline
- This is 'emphysematous cystitis', associated with gas-forming organisms in the wall of the bladder
- A large rectal plug surrounded by gas can look similar, so careful analysis is necessary but the gas margin is usually smooth.

Fig. 4.12 – This is the lower abdominal X-ray of a 50-year-old man with severe urinary tract infection. The patient was diabetic.

Causes of intramural gas

Common

- Inflammatory bowel disease – may be a sign of impending perforation in toxic dilatation of the colon, a complication of ulcerative colitis
- Ischaemia of the bowel causing incipient necrosis/infarction, due to:
  - strangulation
  - volvulus
  - necrotizing enterocolitis
  - obstruction (premature infants)
- Pneumatosis cystoides. Usually benign. Often an incidental finding on X-ray (p. 108).

Rare

- Diabetes with infected gut wall (also gallbladder and urinary bladder)
- Iatrogenic (post endoscopy, biopsy, surgery)
- Obstructive pulmonary disease tracking down from chest (asthmatics, COPD patients)
- Peptic ulcer disease
- Penetrating injury
- Steroids (may be silent).

Approach to the problem

A **very high index of suspicion** must always be maintained for the possibility of intra-abdominal infection, especially in postoperative patients who do not recover quickly after surgery.

This is also true for patients who are just vaguely unwell but pyrexial on admission, as well as those with localizing signs.

Common major concerns are the subphrenic abscess after surgery, and pericolic abscess formation from rupture of the appendix or an infected colonic diverticulum, although these will usually be accompanied by pain. Penetrating injuries are also a potent source of transfer of bacteria into the abdomen (knives, bullets etc.), causing peritonitis.

Abscess formation leads to pus, and a large liquid collection may be readily detected by ultrasound or CT but remain only as a vague mass density or even undiagnosable on plain films. In the presence of gas-forming organisms, however, either multiple small bubbles or abnormal larger collections of gas and fluid may enable a plain film diagnosis of abscess formation to be suspected, and indeed the gas thus formed may block acoustic access and render the plain film superior to ultrasound for diagnosis in this regard, but not CT.

When an abscess is forming in a cavity the semisolid material mixed with gas bubbles may give it a granular texture like faeces, so caution must be exercised here. A good clue to the presence of an abscess is the **constancy of its position**, so 'look for the gas that has not moved' on serial films. Try to get erect or decubitus films with the affected side uppermost, in addition to supine films. Normal gut undergoing peristalsis causes changes in configuration minute by minute, although ileus may complicate the situation. Sentinel loops may appear around an abscess but will tend to lack mucosal folds. It is easy to mistake a fluid level in an abscess for just another loop of bowel in the early stages of its evolution.

Fig. 4.13 – This is the supine AP film of a 72-year- old man admitted with marked left lower abdominal pain and tenderness. The patient was known to have extensive diverticular disease, most profuse in the sigmoid. This is an anterior abdominal wall abscess caused by tracking out to the left from an infected ruptured sigmoid diverticulum, which had eroded into the lower left overhanging (obesity) anterior abdominal wall.

Look for (Fig. 4.13):

- The large left-sided circular lucent area over the left hip, left iliac blade and left pelvic region. This is gas lying anteriorly in a large abscess cavity
- The multiple dense opacities in the pelvis – this is retained barium in diverticula from a previous enema, indicating that the patient has diverticular disease, and indicating a likely cause for the current problem
- The large gas–liquid level over the left hip region on the second erect film (Fig. 4.14). The weight of the fluid and general downward movement of structures in this position is typical. It is too big, high and lateral to be either a femoral or an inguinal hernia. Needle aspiration confirmed pus.

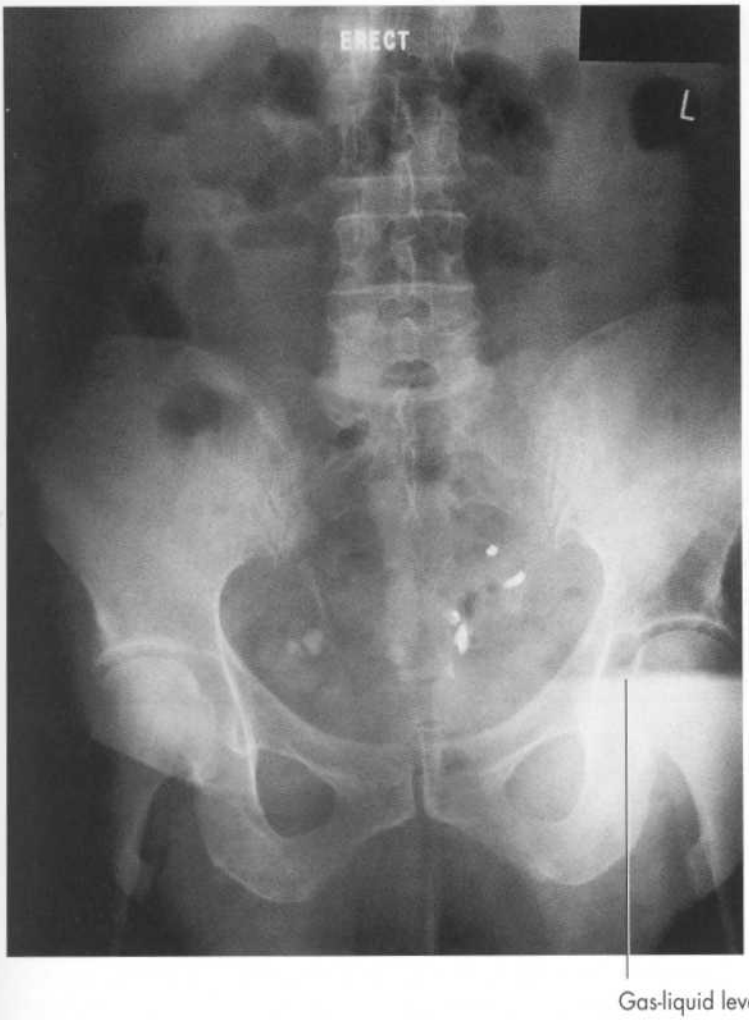


Fig. 4.14 – Left lower anterior wall abscess (erect film).

NB Occasionally an abscess may form within a solid organ, creating a gas – liquid level, e.g. in the liver, spleen, and of course the brain.

Look at (Fig. 4.15):

- The gas collection under the right hemidiaphragm
- The associated fluid levels. This is pus in the abscess, indicating multiple loculi and an erect film
- The thinness of the right hemidiaphragm, indicating this is a 'naked diaphragm'
- The absence of any mucosal folds, supporting the conclusion that this is not part of the gut, i.e. colonic interposition, or interposed small bowel.
- Elevation of the right hemidiaphragm. This may or may not be present. 'Splinting' of the right hemidiaphragm may also occur, i.e. paralysis on screening, but 'screening of diaphragms' is now an antiquated concept and does not rule out a subphrenic abscess.
- Evidence of an associated pleural effusion or lobar collapse on the same side, which may or may not be present (not here).

Confirmation and imaging guidance for drainage may be carried out under ultrasound or CT control.

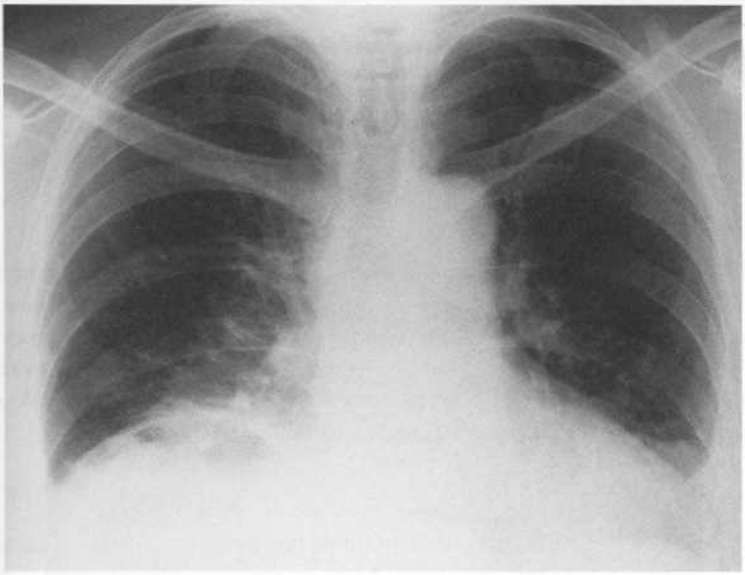


*Fig. 4.15 – **Right subphrenic abscess** A 63- year-old woman who had a cholecystectomy carried out 8 days before, who is now pyrexial and tender in the right upper quadrant. This is a large right-sided subphrenic abscess.*

Chapter 5

Ascites

The accumulation of free intraperitoneal fluid in the abdomen is an important clinical finding confirmed by the classic clinical sign of 'shifting dullness'. Radiologically a sign of massive free fluid includes distension of the abdomen.

In the supine position the bowel will tend to float on top of this pool of ascitic fluid and take up a central position. Some separation of the loops themselves may also occur because of the accumulation of fluid between them.

Also look for:

- A bulging shape to the abdomen
- A dense central grey part and sharp cut-off laterally, with dark flanks, due to the marked distension and abrupt change in curvature of the abdomen
- Greyness or 'ground-glass' appearance due to reduced contrast, and increased greyness caused by increased scattered radiation from the distension and fluid
- Medial displacement of the colon away from properitoneal fat stripes, of the inner abdominal wall. To be seen, this usually requires a bright light behind the film
- Loss of definition of liver tip, psoas margins, kidneys etc., due to surrounding fluid. As little as 7–10 ml of fluid may cause the liver tip to disappear
- Elevation of both hemidiaphragms (severe cases).

Causes of ascites

- Hypoproteinaemia (loss from gut or kidney)
- Cirrhosis of liver
- Congestive heart failure
- Inflammation (pancreatitis, tuberculous nodes)
- Malignancy with peritoneal metastases
- Lymphoma
- Occlusion of inferior vena cava

*Fig. 5.1 – **Ascites** Supine radiograph of a cirrhotic 48-year-old patient with centrally placed loops of small bowel and a distended abdomen. This is ascites.*

- Malnutrition
- Nephrotic syndrome
- Constrictive pericarditis.

Ascites usually starts to accumulate in the pelvis, tracks up the paracolic gutters, then gradually fills the abdomen.

Chapter 6

Abnormal intra-abdominal calcification

The causes of pathological calcification within the abdomen are many. Only the more common and important ones encountered in everyday clinical radiological practice will be described.

Abnormal vascular calcification

First remember that important medical conditions such as diabetes and chronic renal failure can cause premature vascular calcification – another good reason for checking the age of your patient both on the name badge from the date of birth and against any established degenerative changes in the spine.

Aorta/aortic aneurysms

If necessary, go back and revise the section on the normal aorta (pp 24–25). Get into the habit of looking for the aorta on *every* abdominal film, young or old. If necessary make it your 'favourite organ' (see hints at end of book).

Crucial fact: You must develop a very high index of suspicion for abdominal aortic aneurysm because this condition is so dangerous yet so potentially and eminently treatable by surgery or stenting, and it is frequently picked up as an incidental finding on plain abdominal X-rays.

The patient's life is then well and truly in the hands of those who see his films, and abdominal aortic aneurysms have repeatedly been missed on X-rays in the past, these patients subsequently dying suddenly when they ruptured.

If you learn nothing else from this book, learn to be ruthless in seeking out aortic aneuysms!! Ten seconds' searching may save the patient's life.

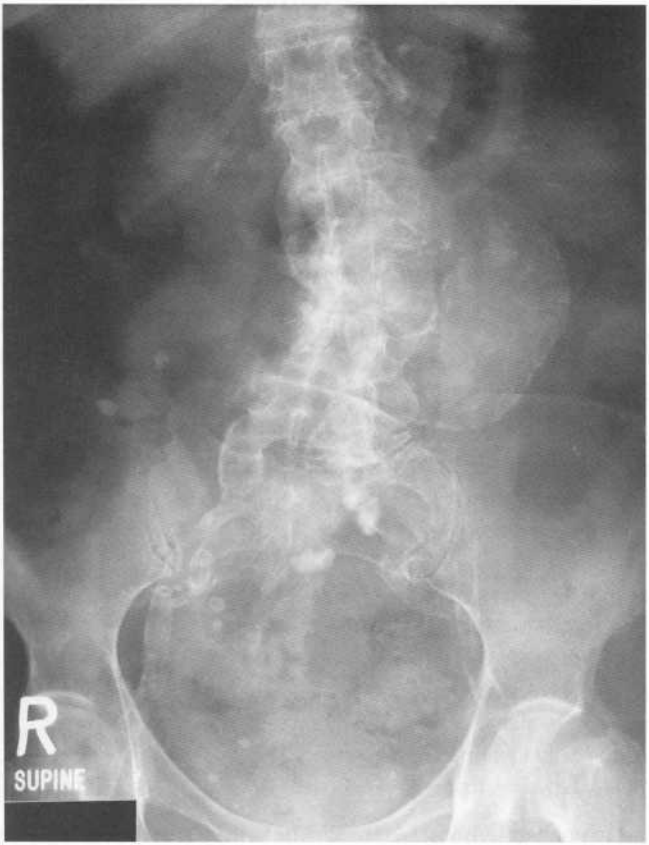


Fig. 6.1 – ***Aortic aneurysm*** *A 65-year-old diabetic and lifelong smoker. Note the large calcified mass bulging to the left. This is an abdominal aortic aneurysm.*

Look for (Fig. 6.1):

- The typical thin line of calcification in the wall of the aorta. Most aneurysms bulge to the left, but occasionally they may bulge to the right or symmetrically about the midline and still lie entirely over the spine
- Associated calcification in the iliac arteries, which is also present here. Aneurysms may form in these vessels as well.

Clinical/radiological problems

- The physician or surgeon may think he feels an aortic aneurysm in the abdomen and requests an X-ray 'to exclude it'. Thin patients, or patients with exceptionally lordotic spines, may well have a very palpable or 'thrusting' aorta, as may hypertensives, **so a normal aorta may simulate an aneurysm.**
- An obese patient may have a big aneurysm which cannot be confidently palpated, although you may be able to feel it when you know it is there!

NB Inability to palpate an aneurysm does not mean the patient has not got one. You should not be digging too hard anyway, in case you burst an undiagnosed aneurysm.

- Most aneurysms contain thin rims of calcification in their walls, but overlying gas, colonic material and X-ray scatter may make them very hard to find. The edge of the rim may lie just at the edge of the spine and be misinterpreted as part of the spine.
- Some aortic aneurysms have insufficient calcification in their walls to be seen, but normal anatomy may save the day.

Look for:

- A normally calcified aorta (patients over 40) over the spine with parallel or converging walls: this *does* exclude an aneurysm, but both walls must be unequivocally identified to do so.

  Be aware, however, that not *every* body's aorta calcifies – even in the elderly.

Points to ponder: 1. Around 6 000 men die in the UK each year from ruptured abdominal aneurysms, and some of them have already had abdominal X-rays taken.

2. Albert Einstein died of a ruptured abdominal aortic aneurysm.

Other more complex problems

- The aorta may be tortuous or bent but not aneurysmal, an aneurysm in an artery being defined as loss of parallelism in its walls.
- Only one of the two walls of a tortuous but parallel-walled aorta may be visible – usually on the left, looking like an aneurysm when one is not present.
- A true aneurysm may have one wall bulging to the right of the spine – get used to looking for it here as well.
- Rarely some aneurysms are so large (e.g. > 8 cm) and their calcified walls so far apart and atypical that they go undetected if the observer is unaware of this phenomenon, or they may blend with the sacroiliac joints lower down.
- Most aneurysms are asymptomatic.
- Very rarely the superior mesenteric artery may calcify and, taking a long curved course to the left of the spine, may simulate an aortic aneurysm. In this situation, however, the aorta itself is likely to be calcified and should be visible as well.

Look at (Fig. 6.2):

- The thin rim of calcification to the left of L4 and distal to it
- The even more subtle rim of calcification to the right of L4 adjacent to the lumbar spine.

The patient had non-opaque gallstones. This was the typical incidental radiological presentation of an abdominal aortic aneurysm, or 'triple A'. It was missed by the first two doctors who looked at the film.

Look at (Fig. 6.3):

- The unequivocal focal expansion of the calcified wall of the abdominal aorta, confirming the presence of an aneurysm.

NB All images on X-rays are slightly magnified and this includes aneurysms, but aortas over 3 cm are usually regarded as aneurysmal. Some aortas can be >3 cm in diameter (so-called 'ectatic'), but *not* aneurysmal, so look for departures from parallelism, i.e. look at the shape of the aorta.

Fig. 6.2 – This is the supine AP radiograph of a patient X-rayed for right-sided abdominal pain. The first two doctors missed the aneurysm.

Fig. 6.3 – This is a lateral view of the same patient. The third doctor who saw the previous film was suspicious and requested this further view, confirming the diagnosis.

What To Do?

As in many other situations the answer to the radiological problem lies in requesting further views. Do not struggle on with just one film if you are not sure what is going on, but it is best practice to seek help before re-irradiating the patient unnecessarily. However, if you are alone and still unsure you may:

1. Request a lateral view of the abdomen. This will get the aorta off the spine and you will have a clearer mental picture of what you are looking at.
2. Request a supine left posterior oblique view (= right anterior oblique view). This is often superior to the lateral and gives an excellent view of the aorta in isolation from the spine, although you may find it harder to interpret. Radiologists, however, find this view extremely valuable. The solution to the possible presence of an aneurysm may therefore be solvable with plain X-rays, but ultrasound or abdominal CT are the next investigations of choice.

Is it leaking?

An early decision must be made with an acute abdomen as to whether to proceed straight to theatre or whether there is time to image the aorta, even with plain films.

Are the renal arteries involved?

If the aneurysm extends as high as L2 this is likely, but accessory renal arteries may be present at a lower level and can never be excluded by plain films. CT angiography, magnetic resonance angiography or conventional angiography may be necessary to confirm or exclude these.

Look at (Fig. 6.4):

- The irregular convex edges of calcification to the right of the lumbar spine
- The clear right psoas margin
- Loss of the left psoas margin and increased soft-tissue density on the left side with a convex edge further out to the left.

This is a leaking abdominal aortic aneurysm, with a haematoma accumulating in the retroperitoneum on the left side.

NB Clear psoas margins do not prove an aneurysm is not leaking if there is clinical evidence to the contrary.

Fig. 6.4 – This is the abdominal X-ray of a 75-year-old woman admitted with severe abdominal pain and backache. The patient was in a state of shock with a rapid pulse and low blood pressure. This is a leaking aortic aneurysm. (NB the time at the top of the film. This is the sign of a very ill patient.)

? Leaking aortic aneurysm

Look for:

- A retroperitoneal mass effect with obliteration of the psoas muscle on one or either side
- Obliteration of one or other or both renal outlines
- Displacement of kidneys
- Displacement of the aorta by the haematoma
- Ileus in the gut
- Lumbar scoliosis
- The aortic aneurysm concave to the side of the leak which itself may or may not be visible.

Urgent ultrasound, or preferably spiral CT, should be carried out if there is time.

Non-urgent aneurysms should still be seen quickly by a vascular surgeon for further advice, depending on their size. The problem has then moved beyond the realm of plain films. Smaller aneurysms can be monitored every 6 months by ultrasound.

Other aneurysms: iliac/splenic/renal

Although a high index of suspicion must be maintained for abdominal aortic aneurysms in order to detect them, aneurysms in other vessels may also occasionally be seen.

Look for (Fig. 6.5):

- A biconvex calcified mass distal to the left or right of the point of division of the aorta at the inferior margin of L4
- Continuation of any aortic aneurysm distally, as here, into expanded iliac vessels. This is often (70%) the case, but not always so, and an iliac artery aneurysm can exist in isolation.

Remember: Although less common than abdominal aortic aneurysms, iliac artery aneurysms can kill you if they rupture. The diagnosis is readily confirmed with Doppler ultrasound if too much bowel gas does not intervene, or by CT/CT angiography. They are amenable to stenting or surgical repair.

Fig. 6.5 – ***Huge left iliac artery aneurysm*** *A 65-year-old man X-rayed for abdominal pain in whom an abdominal aortic aneurysm was found bulging to the right of the spine. Another calcified mass was noted in the left side of the pelvis. This is an iliac artery aneurysm.*

c. as they present as

lead to urgent further
but **the absence of a**
has not got one.

Liver calcification

Calcified lesions i
time. Of those that do

- Old granulomas
- Primary liver tu
- Secondary liver
  stomach
  Hydatid cysts wi
  'waterlily' sign.

Calcified gallblad

Occasionally the gall
bile within it may be

cified mass in spleen.

Calculi

Renal calculi (Fig.

The majority of stones
to their calcium con
opacities (nephrocal
collecting system (sta

The plain film prob
position in relation to
tomography, and diff
and gallstones, both
stones are posterior. L
renal by a penetrated

Other conditions,
may be associated wi

e right one is as yet
ve lithotripsy and

s are especially likely to

nd an ultrasound of the
ed side, thus excluding
men may show oedema
end of the ureter on the

Megahint: If shown
this is a film of the ab
will:

(a) Ensure that you d
completely after co
will not see it (see F

ephrosis and dilated left these were obstructing

Ureteric calculi a

Value of control f

lesion

nowing only a smaller calcareous debris in one. This patient had isposing to renal stone

different after its control

right round the film for

Bladder calculi

Stones in the bladder
the size of a hen's e
fortuitously in patien
bladder in patients b
(dysuria, haematuria

Look for:

- A calcified object
urine in the blad
position, i.e. the p
- Mobility. If you re
left dependent po
bladder calculus
to avoid unnecess
- Remember that a

and dysuria.

Ureteric/bladder cal

Something to be disti
calcification in the walls
phenomenon in UK p
neoplasms, but a very i
other countries where s
to be differentiated fro
calcification in its base.

Causes

- Neoplasms
- Postradiation
- Tuberculosis
- Schistosomiasis

he disease on the right
t calcify.

Prostatic calcifica

- In men aged 50
  punctate opaciti
  by calcification i
  is not usually th
  the gland, so is
- Prostatic calcifi
  malignancy in
  urethral calculu
  smooth and sol
  penis for a calci
  images and arte

Hint: Do not mist
calcification!

ote also the phlebolith

Biliary calculi

Since only around 10%
of looking for them. I
ultrasound is therefore
negative film certainly
to present with opaciti
requiring clarification
can be clarified with a

ant in a middle-aged

Biliary calculi *conti*

Biliary calculi *conti*

Helpful hints

- Ask for a prone
  calculi in the gall
  down scatter from
- Look lower down
  low-lying because
  it may even lie in
- A lateral view ma
  stones posteriorly
- An erect abdomin
  form a small hori
  contracted, howe
  patient has just ea
- Remember that s

le-aged man with long
f abdominal and back
creatitis.

Calcified lymph n

See Figure 1.16. Inci
unknown. Note the
calculi.

Because one or t
rays they are usually
significance, but the

Remember:

- Histoplasmosis
- Filariasis
- Lymphoma (pos
- Calcifying metas

Megahint: Mak
lymphogram within

rhouse – Friederichsen

Chapter

The f
abdo

Apart from its distin
childbirth, certain pat
themselves on plain a
or without calcificati
helping to narrow do

NB The LMP of a

palpable in the lower
This is due to multiple

r quadrant.

The female ab

The preferred initi
ultrasound throug
used as clinically i

Wandering fall

ıe patient's identity for
casualties may initially
name on the films as
ıly flood in, e.g. after a
ential mix-ups.
-rays may be required
ral sequence may be
films will be the same,

ıal liver for an injured
ıder the 'right; hemi-

diaphragm from
front. (Note hov
medical progra

- Make good use
as well; if not, t
abdominal findi
assisting the ana
- More than ever
fractures and **d**
findings will in
e.g. left lower ri

Look for:

- Free gas in the
viscus or a pene
urgent surgery

hy or arteriography may
-rays in the evaluation of

na.

ing kidney: he may only
stablish the presence or
g out the only one he or
e powers of regeneration.
still take out this injured

leeding to death in front
in some cases immediate

transfer to thea
then at the disc

Trauma: rupture

Note (Fig. 8.1):

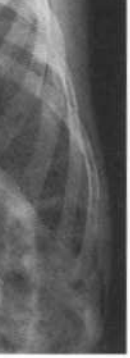
- The swelling o
- The escape of c
  the kidney. A la
- The scoliosis co
- And most imp
  side.

Footnote: Escape o

ht flank in a fight. The
es.

Abdominal traur

Old trauma



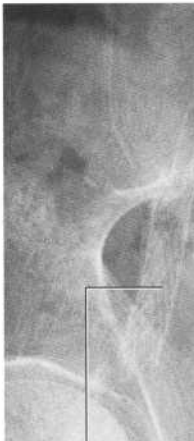
hen it hit a tree. No

Chapte

Iatrog

Radiological

In this age of well-de
to see objects that ha
in most systems. Be
enable you to deduc
position of these de
they are still in posi



k of the femur
rt of abdominal films

Medical/surgical

eat a ventral hernia.
hy repairs. It breaks

Chapter

Foreig artefa misle

There is no end to th abdomen, and this is include coins, beads, b

nercury and glass
uadrant – these are
ible radiologically.
thermometers kept
ury globules which
the thermometers.

Adults, especially
of course insert all ma

Criminals and dru
or stuff them in their

Occasionally mult
These can be anything
to lead paint – the la
being sought.

Apart from entert
ingested foreign body
will it not (e.g. an op
wait, watch and rev
endoscopically or s
appropriate in some

insurance company by definition it was eal, did not show up

pocket! The opacities
epeat film. Note the

on-opaque gallstones


R

o take a **chest X-ray**

te abdomen.

Remember also t
at the time of presen
or move on rapidl
appropriate to estab

Oral water-solul
exclude visible evid
but this should only

Remember also
gynaecological diso
torsion etc.

Remember in ad
an acute abdomen t
as porphyria, Addis

with new ones.

tion, i.e. on a viewing
nd will guarantee you

perly on the viewing
rmality in a very dark

n in terms of anatomy,

out what it is or go and
ill patient, do it **early**.
y.
rism. Life-threatening

illness may be pre

- 'Rules are for the c
  stick slavishly to p
  problems, and kee
- When in doubt, do
- 'Every woman is
  requesting X-rays.
- Keep an open min
- Do not be boxed i
- Learn to work out
  from vascular calci
  of epiphyseal clos
  date the film was
- Maintain a sceptic

from the film and if

ing for them.

arrive at and is the

ain area of interest.
nt than that which
are usually found

GI tract perforation

ccurate, full and all

Hints *continued*

relevant clinical in
diagnostic value o
your bleep and wa
with urgent findin
on X-ray forms. In
annoying and neg

- Memorize a temp
example: 'This is a
2001 when she wa
and this is consist
which the most lik
on your findings.

Then wait for the c