Emergency radiology

I. Surgical emergencies

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THE CASUALTY OFFICER is commonly faced with the problem of requesting X-rays and making an initial interpretation in emergency cases. As most of these requests will be for plain films, the emphasis of this paper will be directed to the correct films to be taken and their interpretation. Occasionally contrast examinations are necessary and some points regarding emergency intravenous pyelograms and emergency barium or gastrograffin examinations will be touched upon.

In cases of acute venous obstruction or aortic and peripheral embolization the contrast examination will be performed by the radiologist and the interpretation is comparatively simple. These cases will not be discussed. Fractures have been dealt with elsewhere and will also be omitted. The remainder of the common emergencies will be divided into surgical and medical groups, although it is appreciated that many conditions such as hydropneumothorax may fall into either section. This first paper will deal with some common surgical emergencies.

Swallowed foreign body

The most commonly impacted foreign body is a fish or meat bone. The accurate localization radiologically depends on its density. Many have insufficient density to be recognized readily and this applies especially when they are impacted below the thoracic inlet. To detect a pharyngeal or upper oesophageal foreign body, good quality antero-posterior and lateral films of the neck should be taken. When examining these it is important to appreciate the appearance of the normal hyoid bone, the thyroid, cricoid and laryngeal cartilages. When possible a normal film should be available for comparison.

Fig. 1 shows a small fish bone which was hidden by the hyoid bone and only visible on moving the tongue.

Dense foreign bodies are usually readily seen in the pharynx. Even though a foreign body is

FIG. 1. Lateral of neck with head more extended; fish bone visible.

not identified, it is important to look for signs of complication such as: (1) air in the prevertebral space, indicating perforation (Fig. 2); (2) increase in width of the prevertebral space, sometimes with anterior displacement of the larynx or trachea (Fig. 3). This indicates either a diffuse cellulitis or abscess formation.

If there is still doubt about the presence of a foreign body then a contrast examination may be necessary. A barium swallow with micropaque is not likely to localize a small foreign body such as a fish bone. Pledgets of cotton wool soaked in barium may be given in the hope that they are held up by the sharp edge of the impacted bone.

In the case of an impacted non-opaque foreign body such as a lump of meat, the routine micropaque swallow will usually be successful and demonstrate a filling defect. It is important that

after removal of this type of foreign body the barium examination should be repeated to exclude any underlying cause such as a benign or malignant stricture. However oesophagoscopy examination at the time of removal of the impaction may be conclusive.

It is not uncommon for a small mucosal tear in the pharynx to cause dysphagia for some days even though the foreign body has passed through the alimentary tract quite successfully.

Solid radiopaque foreign bodies such as buttons, coins, hairgrips, etc., which pass into the stomach can be followed radiologically by plain antero-posterior abdominal films at intervals. Having passed the stomach they rarely give rise to any trouble. Occasionally an open pin or a hair grip may become impacted and require surgical removal.

Inhaled foreign body

There is little difficulty in localizing dense metallic foreign bodies if films are taken in both the antero-posterior and lateral planes. More trouble is met with in localizing non-opaque foreign bodies such as peanuts. The following films will often be required:

FIG. 2. Air in the prevertebral space after pharyngeal perforation.

FIG. 3. Retropharyngeal mass following the perforation of a foreign body.

1. Postero-anterior of chest.
2. Lateral.
3. Films in inspiration and expiration.
4. Rarely, oblique views or over-penetrated postero-anterior views.

The following changes may be noted;

(1) Collapse of a lobe or lung. An area of consolidation may be seen. The lung vascular pattern may be altered secondary to collapse and there may be a shift of the mediastinum to the affected side.

(2) Patchy inflammatory changes may occur distal to the obstruction.

(3) Obstructive emphysema may occur. This gives rise to 'over-inflation' of one lung with hypertranslucency. The mediastinum may be displaced to the opposite side and the diaphragm may be flattened. Screening, or films in both inspiration and expiration may demonstrate the 'swinging mediastinum'. It moves across towards the central area on inspiration and to the unaffected side on expiration (Figs. 4 and 5).

FIG. 4. Inspiration with shift of the heart to the left.

FIG. 5. Expiration with return of the heart to a central position.

Ruptured oesophagus (Fig. 6)

When this is suspected, postero-anterior and lateral films of the chest should be taken. The following signs may be found:

1. Pleural effusion, most often left-sided but sometimes bilateral.
2. Pneumothorax or hydropneumothorax. Films in expiration more readily show a pneumothorax.
3. Pneumomediastinum. This gives rise to a fine translucent zone around the heart and great vessels.
4. Surgical emphysema in the neck.

All of these signs may not be present. The most common sign is a hydropneumothorax, but this together with the history is often diagnostic.

The site of the tear may be demonstrated by a gastrografin swallow. This should be performed supine and care taken to posture the patient adequately. It is better, however, to inject small quantities of gastrografin at different levels in the oesophagus through an oesophageal tube. This can be done under screen control and oblique spot films can be taken.

Chest trauma

The correct films to request when rib fractures are suspected are a postero-anterior of the chest and the appropriate oblique views.

In any major chest injury the fractures may be so severe as to cause a 'floating sternum' or flail chest. No matter how mild the injury a careful search for the following should be made:

1. Pneumothorax.
2. Haemopneumothorax.
3. Surgical emphysema.
4. Pneumomediastinum.

Surgical emphysema may indicate rupture of the trachea or main bronchus. A pericardial effusion may also occur. This alters the contour of the heart, and causes 'filling in' of the normal pulmonary bay and straightening of the left heart border. The heart may become globular in shape with sharp angulation at the cardio-phrenic angles. Occasionally closed chest trauma results in 'butterfly' perihilar shadows similar to those of pulmonary oedema and due to intra-alveolar

FIG. 6. P.A. chest showing left hydropneumothorax and collapse of the left lower zone following rupture of the oesophagus.

haemorrhage. Localized pulmonary haemorrhage may cause a rounded lung opacity similar to a peripheral carcinoma or a secondary deposit. Follow-up films demonstrate a slow resolution.

Ruptured diaphragm

This may follow concussion of the thorax or abdomen or both together. The left hemidiaphragm in its posterior part is the area most often injured. The stomach is the most frequent organ to herniate into the thorax. This may produce a confusing X-ray as the contour of the fundus can be mistaken for an elevated dome of the diaphragm.

When a fluid level is present in the stomach it is not unusual to mistake the appearance for a hydropneumothorax. Either gastric aspiration or a gastrografen swallow will settle the diagnosis. It is possible to have two fluid levels, one in the herniated stomach, and a second in a hydro-pneumothorax. In these cases it is important to have erect films and both posteroanterior and lateral views. The lateral decubitus antero-posterior (A.P.) view may be substituted for the erect film when necessary. For this the patient lies on one or other side, and an A.P. view is taken with the X-ray beam horizontal.

Other organs may herniate, such as the spleen or large bowel. If gas is present in the large bowel then its haustral markings will identify it and provide a diagnosis.

On the right side the liver may herniate.

Cases of abdominal and chest trauma are increasing daily and it is the object of the X-ray examination to demonstrate the extent and nature of these injuries. In the abdomen the liver, kidneys and spleen are most prone to injury. Rupture of the stomach, small intestine, caecum and urinary bladder are also frequent injuries. It is important to search the X-ray for signs of: (1) free gas, (2) free fluid, (3) retroperitoneal bleeding, which may cause large soft-tissue opacities with displacement of normal structures; and (4) meteorism.

Later there may be signs of peritonitis with the picture of a paralytic ileus. X-rays of the spine, ribs and pelvis may be required separately where associated bony injury is suspected.

The acute abdomen

Every acute abdomen justifies two films, one supine and one erect. If the patient is too ill to stand for the erect film then the lateral decubitus film with the antero-posterior projection should be taken.

Perforation of a hollow viscus

The most common perforations result from peptic ulceration of the stomach or duodenal

cap. However, an inflamed diverticulum or appendix may perforate. Cases of acute perforation of a large bowel carcinoma have been described. Closed abdominal injury may also result in perforation of stomach, duodenum, or caecum.

The most important film in these cases is the erect projection showing the diaphragmatic areas. The film is examined for the translucent line of free gas under each dome. Where the X-ray does not reveal free gas, but the clinical picture is highly suggestive of perforation, then a lateral film of the diaphragmatic areas should be requested. This will show smaller quantities of gas that may not have been visible on the routine view. Hepatic interposition of the transverse colon may occasionally suggest free air but the presence of haustral markings will identify large bowel. If the haustral markings are not obvious then a lateral decubitus film with the right side raised is helpful. Free gas will form a layer between the abdominal wall and the liver.

A sign is sometimes seen on the supine film usually indicating a small duodenal perforation. This consists of a small crescent-shaped gas shadow beneath the lower edge of the liver.

In the latter stages of perforation paralytic ileus may occur and add to the radiological picture. Very rarely the soft-tissue shadow of an abdominal mass may be seen, e.g. a diverticular abscess or appendix mass. Contrast examinations do not have an established place in the investigation of perforations from peptic ulceration.

Intestinal obstruction

The salient features are gas-distended intestinal coils with fluid levels and absence of gas in the bowel distal to the obstruction. Both erect and supine films are necessary. The lateral decubitus film already described may replace the erect view in patients too ill to stand. The supine film enables the extent of gaseous stasis to be judged and the areas of absence of bowel gas are noted. The pattern of the bowel involved is noted. The jejunum has a 'coiled spring' appearance. The ileum may be structureless. The large bowel has a haustral pattern.

Jejunal coils are usually situated centrally and high in the abdomen. Ileal coils are central and low. The large bowel coils are distributed around the flanks.

By observing the pattern of the coils involved, their position and the areas of stasis, the diagnosis both of the obstruction and of its site can be judged.

Figs. 7 and 8 show dilated jejunum and ileum due to an ileal obstruction. Figs. 9 and 10 show the appearance of a large-bowel obstruction.

The presence of fluid levels does not invariably indicate a bowel obstruction. Especially in children, multiple fluid levels may occur in gastroenteritis. Diverticulosis of the small bowel may give rise to multiple short fluid levels. A water enema may result in large bowel fluid levels, and should never be given before the radiological examination.

When an obstruction is diagnosed a careful search should be made for any possible cause. The soft-tissue density of a neoplastic mass or a diverticular abscess may be seen. Rarely the gas pattern may outline a stricture.

Examine the liver area for signs of 'liver gas'. This may be either in the portal system or biliary tree. When in the biliary tree the branching hepatic ducts may be recognized (Fig. 11). Portal gas, unlike biliary gas, may extend right to the periphery of the liver. Gas in the portal system indicates bowel gangrene. Gas in the biliary tree may be due to a fistula and associated with intestinal obstruction may indicate a 'gall-stone ileus'. The stone usually lodges in the terminal ileum.

Contrast examination has no part to play in cases of acute intestinal obstruction. In subacute small-bowel obstructions gastrografen or even barium meal examinations may be helpful. In subacute large-bowel obstruction a barium enema may be performed.

Paralytic ileus

This may be post-operative or result from intra-abdominal sepsis either local or generalized. Generalized paralytic ileus involves both the large and small bowel with distension and fluid levels. It must be differentiated from a mechanical obstruction. In paralytic ileus there is often no 'cut-off' to the bowel involvement and when ascitic fluid is present the loops of bowel are separated by a soft tissue shadow that is wider and more dense than normally. There may be loss of the normal translucent flank line on one or both sides.

A gastrografen examination may be misleading as the contrast may diffuse through the bowel in the absence of peristalsis.

Volvulus of the sigmoid

This presents as a large gas-distended loop rising out of the pelvis and occupying most of the

abdomen. Fluid levels may be present in the loop. The appearance is normally that of an inverted U and the medial limbs of the loop can be traced downwards to the point of torsion.

Volvulus of the caecum

This can present similar appearances and at times the differentiation is difficult. Fluid levels are present in the loops or, if there is an axial torsion, only one fluid level in the caecum. An important sign is the presence of distended small-bowel loops which are usually absent in sigmoid volvulus. The loop of a caecal volvulus is usually open medially and the appearances resemble a kidney with the open end representing the kidney pelvis.

Acute appendicitis

It is usually only in doubtful cases that radiological examination is requested. Erect and supine films of the abdomen should be taken. The following plain film signs may be present:

(1) Local ileus with stasis of gas and fluid levels in neighbouring coils of ileum. More extensive changes due to paralytic ileus may be seen when peritonitis occurs.

(2) A calcified faecolith may be detected free in the abdomen, in the appendix, or in a local

FIG. 7. Supine film of abdomen. Gas-distended bowel showing the 'coiled spring' appearance of jejunal loops and the structureless appearance of ileal loops.

FIG. 8. Erect film of abdomen. Multiple fluid levels in the jejunal and ileal coils. A case of low ileal obstruction.

FIG. 10. Erect film. Multiple fluid levels in the large bowel and a few in the small bowel. A case of large bowel obstruction.

FIG. 9. Supine film showing predominantly large bowel distension.

FIG. 11. Gas in the biliary tree.

abscess. Calcified faecoliths are more common than is appreciated and up to 10% of acute appendices contain one. When a calcified faecolith is found in the presence of clinical appendicitis, it indicates an obstructive element.

(3) Loss of the psoas outline. There may be a scoliosis.

(4) A soft-tissue opacity due to an appendix abscess.

Fig. 12(a) shows a calcified faecolith and a fluid level in the transverse colon. The combination of a calcified faecolith much higher than usual and the local ileus in the transverse colon, suggested a retrocaecal subhepatic appendicitis. This was confirmed at operation. Fig. 12(b) is an X-ray of the faecolith taken after its removal.

Subphrenic abscess

Patients with subphrenic abscess may occasionally be admitted with the diagnosis of an acute abdomen or lobar pneumonia. The subphrenic abscess may lie anteriorly or posteriorly on the right or left side.

Where subphrenic inflammation is suspected erect films in both the antero-posterior and lateral planes should be taken.

FIG. 12. (a) Erect film showing calcified faecolith and fluid in the transverse colon due to subhepatic appendicitis. (b) The calcified faecolith X-rayed after removal.

Fluoroscopy is often helpful and this may show elevation of one dome of the diaphragm with diminished movement.

The films may show:

1. An elevated hemidiaphragm.
2. Displacement of liver or stomach.
3. A gas and fluid level.
4. Pulmonary collapse and consolidation at the adjoining lung base.
5. Pleural effusion.

On the left side the gas and fluid level may be mistaken for the stomach. Contrast examination of the stomach will differentiate. There may be confusion with free gas under the diaphragm but unlike gas in an abscess this moves freely on changing posture.

A gas-filled abdominal abscess other than a subphrenic collection is more uncommon.

Abdominal calcifications

Calcified costal cartilages and calcified lymph nodes should not be mistaken for visceral calcification. The most common calcified opacities associated with an acute emergency are in the biliary tract or the renal tract. Curvilinear calcification may be seen in the wall of an abdominal aneurysm and lying to the left of the spine.

Biliary tract

Only about 30% of gall-stones are radiopaque. They are usually found in the right hypochondrium, but may rarely be in the right iliac fossa when there is gall-bladder ptosis or distension. For accurate localization prone, oblique and lateral films should be taken. Cholesterol stones are usually single and non-opaque. The inflammatory mixed stones are usually multiple and contain calcium. They may have a central translucency. They are frequently faceted. One type of gall-stones is shown in Fig. 13.

A search should be made along the course of the common bile duct in cases of biliary colic.

Acute cholecystitis may show the following signs on the plain films:

- (1) A soft tissue mass in the right hypochondrium. Empyema of the gall-bladder may produce quite a dense opacity.
- (2) Stones in the gall-bladder or in Hartmann's pouch.
- (3) Local ileus in the hepatic flexure or transverse colon.

Biliary sludge or limy bile may produce a dense opacity in the right hypochondrium (Fig. 14).

FIG. 13. Gallstones.

FIG. 14. Biliary sludge — plain film.

In emphysematous cholecystitis gas may be seen in the lumen or in the wall of the gall-bladder.

Gas in the biliary tree may result from: (1) the recent passage of a stone, (2) operative dilatation of the ampulla or a short circuit operation, (3) fistula formation due to stone, duodenal ulcer or neoplasm, and (4) gas-forming organisms in the gall-bladder.

Acute pancreatitis

There are three main types of acute pancreatitis.

1. Acute haemorrhagic necrosis.
2. Gangrenous pancreatitis.
3. Suppurative pancreatitis often with abscess formation.

Erect and supine plain films are taken. The following X-ray signs may be present:

- (1) Distension of the duodenal loop with fluid levels present.
- (2) An 'inverted 3' may rarely be seen on the plain films (Epsilon sign). This is demonstrated best in prone films.
- (3) Retention of gas and fluid in neighbouring loops of large and small bowel. Local ileus may produce a sharp 'cut-off' in the gas pattern of the transverse colon.
- (4) Gas in the soft tissues behind the stomach due to gas-forming organisms.
- (5) Gall-stones may be present.
- (6) Pancreatic calculi may rarely be seen.
- (7) A soft tissue opacity due to abscess formation may be seen and may displace neighbouring organs.

In the less acute phase a barium examination may show some of these signs, namely widening of the duodenal loop, distortion and rigidity of the duodenal mucosa, an 'inverted 3' sign. There may be stasis of barium in the upper jejunal coils for a prolonged period, and the deficiency pattern may also be seen. An abscess may produce distortion of the stomach very similar to that produced by a pancreatic cyst.

Renal emergencies

Renal colic is the most common renal emergency. Approximately 90% of renal calculi are radio-opaque. The stone may be in the kidney or along the line of the ureter to the bladder. It may overlie one of the lumbar transverse processes or the sacral ala and not be readily seen. The relationship of renal calculi to the kidney can be seen by films on both inspiration and expiration and on the right side a lateral film will distinguish them from gall-stones. In the pelvis phleboliths are recognized by their smooth round outline and their central translucency.

An emergency intravenous pyelogram is justified in many doubtful cases of renal colic. It is not uncommon to find absence of excretion of dye on the affected side. Delayed films are taken up to 24 hr and these usually demonstrate a nephrogram (Fig. 15) on the affected side and contrast may fill the pelvis and pass down the ureter to the site of the obstruction (Fig. 16).

FIG. 15. Nephrogram on the right.

Rarely there may be extravasation of contrast medium from the renal pelvis into the perirenal or subcapsular tissues.

Renal trauma

Injury to the kidney may vary from a contusion up to a complete tear or transection. Rupture of the kidney may be subcapsular, parenchymal or pelvic. Bleeding may occur at any of these sites.

The plain film changes may be:

- (1) A soft-tissue mass in the renal area. The clear zone around the kidney may be obliterated. The opacity may be diffuse or conform to the outline of the kidney.
- (2) Large haematomata may result in loss of the psoas outline, and there may be a scoliosis convex to the opposite side.
- (3) Local meteorism may occur.

In all cases of renal trauma a search should be made for bony injury such as rib or pelvic fractures. Other associated visceral injuries, such as splenic rupture or intestinal perforation, should be considered.

Following the diagnosis of renal trauma it is mandatory to perform an intravenous pyelogram. This enables an assessment to be made of the type and degree of the injury and also checks on the presence and function of the opposite kidney.

FIG. 16. The ureter is dilated down to the level of a calculus in the pelvis.

FIG. 17. Extravasation of contrast medium around the kidney after an intravenous pyelogram.

FIG. 18. Small compressed left kidney following trauma and pericapsular bleeding.

FIG. 19. Return of left kidney to normal size after 2 months.

Depending on the type of injury the following may be found:

- (1) Extravasation of contrast from the renal collecting system into the soft tissues (Fig. 17).
- (2) Filling defects in the pelvis due to blood clots.
- (3) Distortion of the calyces and parenchymal spread of contrast at the site of a tear.
- (4) A space-occupying lesion in the kidney radiologically similar to a tumour and due to haematoma formation.
- (5) Subcapsular contrast extravasation.

Fig. 18 shows an interesting case of left renal trauma where the collecting system of the kidney was much smaller than that on the other side.

It seemed likely that this was due to sub-

capsular bleeding and renal compression, which may also have reduced the blood supply.

A follow-up contrast examination 2 months later (Fig. 19) showed a return of the renal size and pelvi-calycine filling to normal.

Summary

Some common surgical emergencies are discussed. The appropriate plain films, contrast examinations and their interpretation in each case are described.

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