Lines and tubes - A Radiological Review

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Learning objectives

- Recognise commonly placed lines and tubes on conventional radiography (primarily chest and abdominal X-Ray),
- Interpret and evaluate placement and position,
- Learn about common mistakes and pitfalls when interpreting tube placement,
- Recognise less common tubes which may only be encountered occasionally and understand their usage
Background

Hospital patients will often have 'lines' or 'tubes' inserted as part of their medical care. Many of these require some form of imaging post insertion to check they are in the correct place. Even if they don't require checking, the lines will all be visible on radiographs taken as part of other diagnostic workups.

For these reasons it is important to know how to interpret tubes and lines on radiographs - how to tell what something is, and how to know if it is in the right place?

We review the placement of common and uncommon lines, tubes and drains, with accompanying pictorial reference for all the tubes we describe. These range from NG tubes to ECMO catheters and chest drains to VP shunts.

By the end of our review the reader should have a firm understanding of the commonly placed lines and tubes. They will also have a useful pictorial reference for some of the more unusual types which may be encountered in practice.
Findings and procedure details

Chest Radiography

Chest radiographs are very commonly requested, either for line checking or as part of a diagnostic work-up. It is important to note misplaced tubes. For this reason, it is convention when 'presenting' radiographs to evaluate the lines and tubes first.

Nasogastric tubes

Nasogastric tubes are inserted for gastric decompression or for administration of enteral nutrition and medication. Upon insertion, passage into the trachea and to one of the bronchi (usually the right main bronchus due to its more vertical position) is relatively common. If feeding commences at this time serious harm or death can occur\(^1\). Upon insertion, pH testing of aspirate will confirm location in the stomach. If no aspirate can be obtained, a chest radiograph is performed. When correctly positioned, the NG tube should pass to the left of the midline and be seen to \textbf{transect the carina} before passing below the left hemidiaphragm (Figure 1). Occasionally an NG tube may pass into the left main bronchus and beyond, with the tip apparently lying below the diaphragm (Figure 2). It is therefore vital evaluate the relationship of the carina to the tube before allowing feeding to commence.

ET tubes

ET tubes are used to aid artificial ventilation when a patient is not maintaining an airway. The optimum position in an adult is midline (in the trachea), with the tip 5-7 cm above the carina (Fig 3). The patient is usually very unwell and there may be multiple other lines visible on the radiograph (as in figure 3).

It is not necessary to perform radiography after uncomplicated removal of the ET tube\(^2\).

Chest Drains

Chest radiography may be performed following chest drain insertion for a number of reasons. These include (a) to assess for pneumothorax or other complications and (b) to assess resolution of underlying problem. There are several different types of chest drain. A moderately large bore tube with an additional radiopaque line is inserted at surgery or for complex effusions (Figure 4) and is referred to as a 'surgical chest drain'. A 'pigtail' type
narrow bore catheter is usually inserted under radiological guidance, and has a curled end (Figure 5).

The tip of any chest drain should be well inside the pleural space, pointing superiorly for pneumothorax and inferiorly for drainage of fluid. Checking the position of side-holes (seen as interruptions along the tube) is also vital to reduce risk of pneumothorax and surgical emphysema.

Central venous catheters

Several types of central venous catheters (CVC) are inserted in clinical practice, and it is normal practice to check position and for pneumothorax post insertion with plain radiography. The catheters are usually named after vein in which they are sited. Tunnelled lines are used for longer term venous access, and the 'tunnelling' refers to a long passage under the skin which reduces risk of infection and provides stability. Central venous catheters are fully opaque and smaller in calibre than chest drains, measuring approximately 2-3mm. Ideally, the tip of all central lines should be lying in the superior vena cava or right atrium (depending on institution), and a check should be made for pneumothorax and haemothorax post insertion. Figure 3 shows a correctly sited internal jugular vein catheter, and Figure 6 shows a correctly sited PICC line.

Permanent Pacemakers

Cardiac pacemakers and implantable defibrillators are common in an elderly population and are often seen at chest radiography. All pacemakers will have a pulse generator and battery pack, usually seen overlying the left pectoral muscle. One to three wires will be extending from the control pack. In a single lead type pacemaker, a wire will pass through the subclavian vein and superior vena cava into the right ventricle (Figure 7). This is an older type of pacemaker. An additional lead may be seen in the right atrium, which are more common (dual lead-type) and increase the end cardiac output by allowing atrial systole. A biventricular pacemaker synchronises the ventricles and a third wire is inserted into the coronary sinus for left ventricular wall pacing (Figure 8). A defibrillating wire is insulated with a radio-opaque sheath, also visible in Figure 8.

Post-insertion, checking for pneumothorax is necessary. On all subsequent films, a quick check for lead migration and fracture is necessary.

Abdominal Radiographs
Ascitic drains

Pigtail type catheters, often similar in appearance to chest drains, are used to drain ascitic fluid. Ascitic drains do not require a post placement radiograph. However, you may see them on films take for other reasons and therefore should be able to recognise them (Figure 9).

Ureteric stents and nephrostomy tubes

Ureteric stents are often inserted in cases of retroperitoneal fibrosis or lymphoma, where there is extrinsic compression of the mid portion of the ureter. The stent allows passage of urine from the renal collecting system to the bladder, and can be misplaced or migrate. Stent position should be checked by radiograph initially (Figure 10).

Nephrostomy tubes are used to drain urine from an obstructed kidney by passing a needle from the back, through the parenchyma of the kidney and into the renal collecting system. A bag is then attached to the catheter. These are inserted under imaging guidance, so do not need a check position radiograph, however should be recognised on plain radiography (Figure 10).

Ventriculoperitoneal shunts

Drainage of excess CSF in a number of disorders is performed with a tube or 'shunt' connecting usually a lateral ventricle to the sterile peritoneal cavity. A 'shunt series' is a series of radiographs of the head, neck, chest and abdomen to assess for fractures or migration of the tube. The shunt will be coiled in the abdomen and should be compared to previous films even if the radiograph has not been performed as part of a dedicated shunt series.

Biliary stents and percutaneous transhepatic cholangiography

When the biliary tree becomes obstructed with stones or tumour, percutaneous drainage of bile may be necessary until a more permanent solution can be performed. This is a drain placed in the intrahepatic biliary tree under image guidance.

A stent is a diagonally angled mesh tube in the CBD. This will only be visible if it is a metallic stent (Figure 9). Again, checking the position of the biliary stent on serial radiography is good practice.
Other tubes

**Percutaneous endoscopic gastronomy tubes and jejunostomy tubes** perform a similar function to an NG tube when an oral route is unsafe or a long term feeding solution is required.

**Urinary urethral or suprapubic catheters** are also often visible on radiography.

**Unique paediatric tubes**

**Umbilical arterial and venous catheters (UAC and UVC)**

These catheters allow convenient minimally invasive arterial and venous access in the first 7-10 days of life. They are particularly prone to malposition due to the anatomy of the vessels cannulated, and the line should always be checked by abdominal radiography\(^2\,^7\).

An umbilical arterial catheter dips down into the pelvis to enter the systemic arterial system at the internal iliac artery. It then passes through the common iliac artery to the aorta. Ideal position is either above the mesenteric and renal arteries at spinal level T7-T9 (preferred in the UK - 'high line' position), or below them at L3-L4 (preferred in the US 'low line' position)\(^7\,^8\).

An umbilical venous catheter enters the umbilical vein and into the left portal vein, ductus venous and then either the left or middle hepatic vein to the IVC. Ideally, the tip should be at the right atrial-inferior vena caval junction at around T8-T9\(^7\,^9\). The venous catheter does not dip down into the pelvis at the origin, easily distinguishing it from the arterial catheter.
Fig. 1: An NG tube, with the tube clearly transecting the carina before passing below the diaphragm. There are also external wires overlying the left hemithorax and right apex for monitoring the patient.

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**Fig. 2:** Misplaced NG tube. The tip appears to lie below the left hemidiaphragm, but the tube is not clearly demonstrated to transect the carina - in fact, it can clearly be seen passing down the left main bronchus

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**Fig. 3:** ET tube in correct position. There is also a right internal jugular vein catheter and an NG tube in situ, all correctly sited.

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**Fig. 4:** A patient with a large pneumothorax post a lobectomy for lung carcinoma. The patient has a large right sided surgical chest drain in situ, pointing towards the apex as is appropriate for a pneumothorax. Note the large calibre and the easily visible side holes, seen as interruptions of the radiopaque tube. All side holes must be in the pleural space to avoid surgical emphysema/air leak.

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**Fig. 5:** The same patient as Figure 4. Since the previous Xray, a pigtail catheter has been inserted under ultrasound guidance for a loculated effusion. The curled end can be seen more medial than the surgical-type chest drain.

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Fig. 6: Right sided PICC line in situ, appropriately sited.

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**Fig. 7:** A single lead permanent pace maker in situ, with the lead in the right atrium. There is also a mitral valve replacement and an NG tube in situ.

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Fig. 8: Biventricular pacemaker, with insulated wire indicating a defibrillating-type pacing system. Note the relative cardiomegaly.

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**Fig. 9:** An ascitic drain has been inserted. This particular drain is not a pigtail type, although it was inserted using radiological guidance. An alternative appearance is of a drain in the abdomen which has the appearance of a pigtail. This type of drain can be seen as the medial drain in Figure 5. The patient also has a metallic biliary stent lying in the distal CBD to allow drainage of bile. The patient was suffering with pancreatic cancer and had previously been treated with the stent for biliary obstruction.

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**Fig. 10:** A right sided nephrostomy and a left sided ureteric stent. On this image, the ureteric stent cannot be visualised into the pelvis, and therefore the Xray is inadequate for assessment of stent position.

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**Fig. 11:** An Xray of a neonate, showing a umbilical arterial catheter passing down into the pelvis before passing up the aorta to rest in a 'high line' position. A umbilical venous catheter is also seen without dipping into the pelvis and with the tip lying at the junction between the inferior vena cava and the right atrium. An ET tube and an NG tube are also present, appropriately sited.

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Conclusion

Multiple lines and tubes are visible on plain radiography. This review gives a short rundown of the most common types, with some pictoral examples.

This guide should serve as a useful reference for junior doctors who are unsure what they are looking at, or should be looking for when confronted with an Xray in an acute setting.

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