

## CHAPTER 1

# Introduction: ABCs and Rules of Two

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### OVERVIEW

- Request the correct investigation
- Use a systematic approach to interpretation – ABCs
- Fundamental principles to avoid errors – Rules of two
- Always ASK for help – if in doubt!

Emergency medicine often brings together critically ill patients and inexperienced and tired doctors – a dangerous combination at the best of times with potentially serious clinical and medico-legal consequences. Virtually any medical condition can present in the emergency department (ED) and so the volume of medical knowledge needed to manage these patients satisfactorily is enormous.

There have been major technological advances in the past decade which have had a major impact on the management of patients in the ED, not least picture archiving and communication systems (PACS), digital radiography (replacing conventional plain to X rays), portable ultrasound (US; which is now readily available and often, but not often enough, performed by clinicians in the ED) and multidetector computed tomography (MDCT) in the ED. Despite all these advances, plain to X rays (whether conventional or digital) remain the mainstay of initial and successful management of most sick and traumatised patients in the ED.

### Radiological investigations

- Plain to X rays (conventional or digital)
- Portable US
- MDCT
- MRI

The correct selection of imaging modality, rapid acquisition and the accurate interpretation of these investigations is often the key to quick and successful management of patients in the ED. Unfortunately these investigations are often done and interpreted

by medical staff who have little, if any, training in radiology and the usual safety net of a specialist radiological service is not available at the time of presentation, when it is most needed. This leads to delays and invariably results in increased morbidity and mortality! The selection of the correct imaging modality on admission saves time and saving time, saves lives! Ideally there should be a seamless 24/7 service.

### MDCT – initial imaging modality of choice in the ED

Head injuries/headaches or epilepsy	Skull X-ray (SXR) no longer done. CT head ± contrast
Facial injuries	MDCT with multiplanar reconstructions (MPR) and 3D are essential
Chest pain (suspected aortic aneurysm (AA), myocardial infarction (MI), pulmonary embolus (PE) or pneumothorax (Px))	Triple rule out CT scan
Severe abdominal pain (obstruction)	CT has replaced abdominal X-ray (AXR)
Renal/ureteric colic	CT kidneys, ureters and bladder (KUB) has replaced Intravenous urogram (IVU) in ED
Suspected leaking abdominal aortic aneurysm (AAA)	CT has replaced US and AXR
Suspected gastrointestinal (GI) bleeding	Initially CT angiography instead of angiography
Major trauma (adults)	Whole body CT instead of chest X-ray (CXR), AXR and US

The Rules of Two (Ro2) is a helpful, simple set of guidelines, which relate to who, what, when and how to radiograph and how to get help or get out of trouble and therefore minimise the chances and the consequences of errors.

The ABCs systematic assessment is a simple systematic approach, which starts with basic essential normal radiographic anatomy, common normal variants, which may mimic pathology and in

particular how to interpret imaging using a systematic approach, which is logical and easy to remember and therefore hopefully helps to minimise interpretive errors.

### Rules of Two

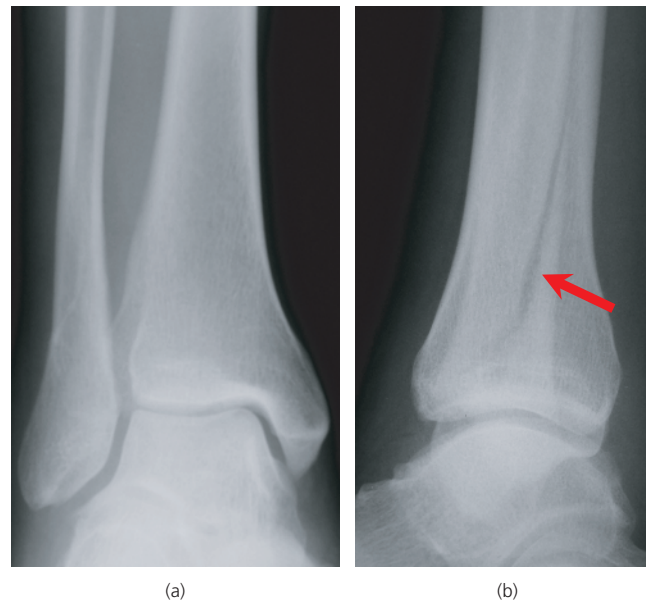
These rules represent a simple set of guidelines, most are obvious, some relate to specific clinical problems, but most are common sense useful general principles which should help in avoiding errors in interpretation and management of patients in the ED.

#### Rules of Twos

- Two views – one view is always one view too few
- Two abnormalities – if you see one abnormality, always look for a second
- Two joints – image the joint above
- Two sides – if not sure or difficult X ray, compare with other side
- Two views too many – CT (and rarely US) has replaced plain X rays in many clinical situations
- Two occasions – always compare with old films IF available
- Two visits – bring patient back for repeat examination
- Two opinions and two records – always ask a colleague if not sure and record findings
- Two specialists – always get your ED specialist and also a radiologist's opinion
- Two investigations – always consider whether US, CT or MRI would help in diagnosis

### Rule 1 – two views ('One view is always one view too few')

Two views should be taken, preferably perpendicular to each other (Figure 1.1). This applies to all radiographs except the chest, abdomen and pelvis. It is not uncommon for a fracture or an abnormality to be visible only on one view (Figure 1.2).



**Figure 1.2** (a) Anteroposterior shows no obvious abnormality; (b) lateral shows oblique fracture of fibula.



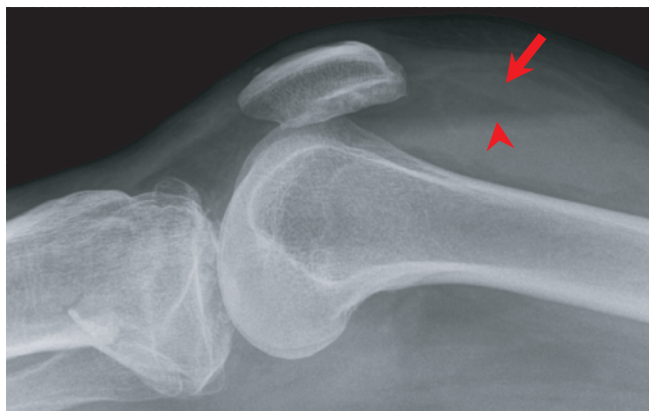
**Figure 1.1** (a) Anteroposterior shows minimal overlap of proximal interphalangeal joint (PIPJ) of little finger; (b) lateral shows obvious dislocation of PIPJ.



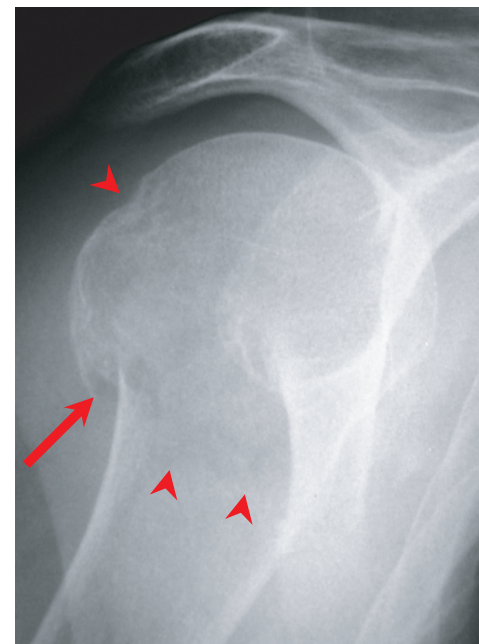
**Figure 1.3** Lateral elbow: anterior (arrow) and posterior fat pads (arrowhead). Anteroposterior view was normal so additional views of radial head were requested.



**Figure 1.5** Salter–Harris II of proximal tibia (large arrow for fracture of proximal tibial metaphysis, arrowhead for separation of epiphyseal growth plate) and fracture of shaft of proximal fibula (small arrow).



**Figure 1.4** Lateral horizontal beam: lipohaemarthrosis fat above (arrow); blood below (arrowhead).



**Figure 1.6** Fracture of proximal humerus (arrow) with subtle lytic metastases (arrowheads).

In addition, if the two views fail to show an injury when there is a radiological suspicion of an injury (such as the presence of a fat pad sign (Figure 1.3) in the elbow or a lipohaemarthrosis (Figure 1.4) of the knee or if the findings don't fit in with the clinical presentation, then further views are warranted.

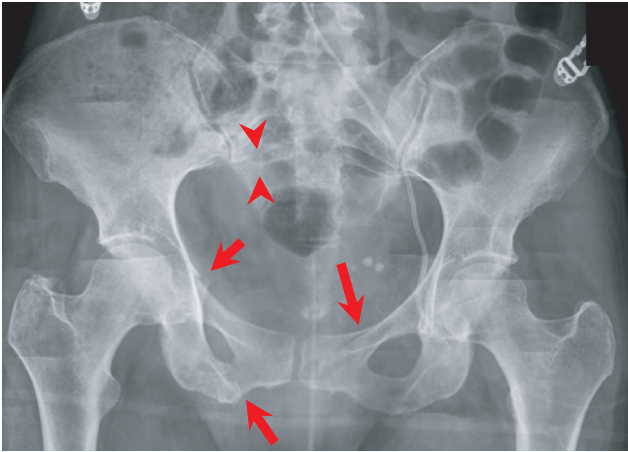
#### **Rule 2 – two abnormalities**

Do not stop looking after detecting one abnormality; always keep looking for a second abnormality. There may be more than one fracture (Figure 1.5) or there may be an underlying predisposing abnormality, such as metastases (Figure 1.6). In addition, if there is a fracture in a ring-like structure such as the pelvis (Figure 1.7),

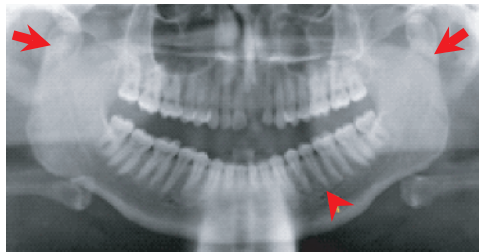
mandible (Figure 1.8), radius/ulna or tibia/fibula, there will usually be a second fracture (a polo mint will always break in two places; see Figure 1.9).

#### **Rule 3 – two joints**

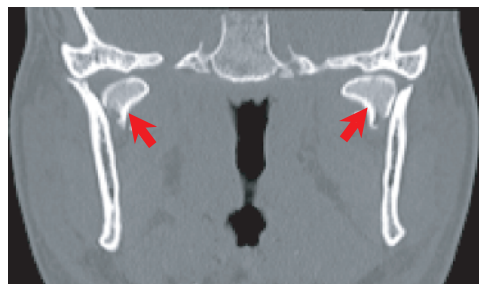
In the forearm (Figure 1.10) and in the lower leg (Figure 1.11), always image the joint above and below the injury.



**Figure 1.7** Numerous pelvic fractures (arrows), several in each ring with subtle right sacral foramina fractures (arrowheads – compare with intact left side).

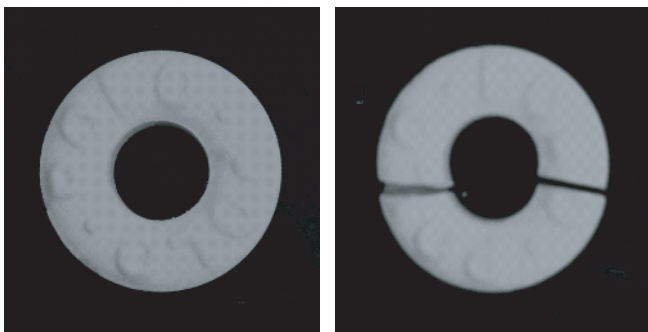


(a)



(b)

**Figure 1.8** (a) Left mandibular fracture with bilateral displaced condylar neck fractures, better seen on CT (b).



(a)

(b)

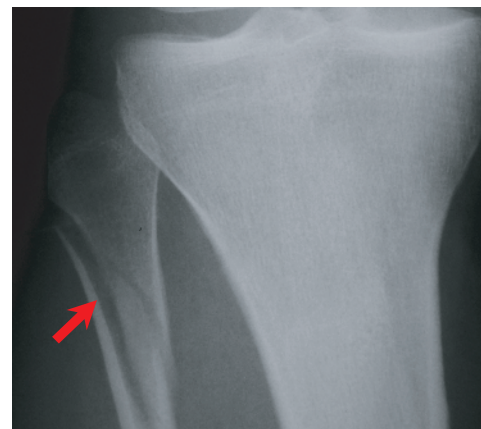
**Figure 1.9** (a) Intact Polo mint and (b) broken mint shows there are at least two fractures in a ring.



**Figure 1.10** Monteggia fracture-dislocation: fractured proximal ulnar shaft (arrow) with dislocated radial head (arrowhead).



(a)



(b)

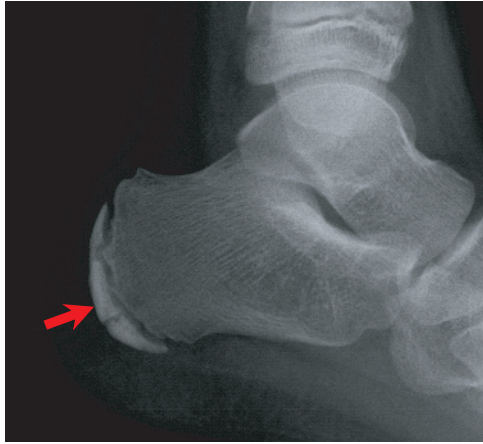
**Figure 1.11** Maisonneuve fracture: (a) right ankle anteroposterior shows minimal widening of the medial joint margin (arrow); (b) this is associated with a proximal fibula fracture (arrow).

#### Rule 4 – two sides

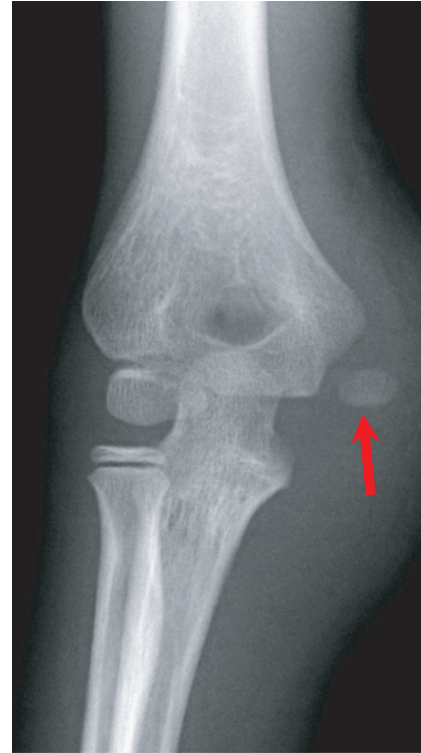
There are certain circumstances, where it is difficult to ascertain whether something is normal (Figures 1.12 and 1.13), or abnormal (Figures 1.14–1.16), in particular in children and on these occasions it is worth imaging the asymptomatic side for comparison.

#### Rule 5 – two views too many

The advent of MDCT and the siting of MDCT scanners in the ED, has made MDCT the INITIAL imaging modality of choice in many



**Figure 1.12** Normal dense calcaneal apophyses (arrow) – same on both sides.



**Figure 1.14** Mild avulsion of right medial epicondyle ossification centre (arrow) when compared with left elbow.



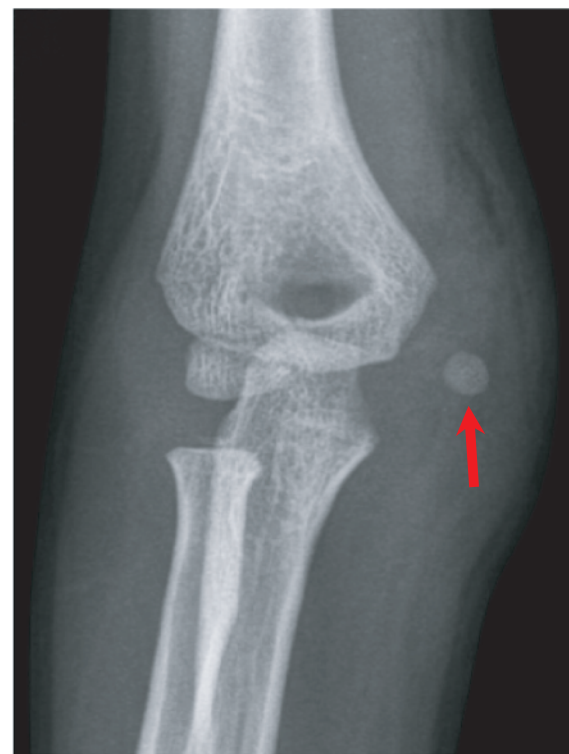
**Figure 1.13** Suspected avulsion of right medial epicondyle ossification centre, but identical on the left elbow (arrow).

clinical presentations (Figures 1.17 and 1.18). This is emphasised in each relevant chapter, but it is critical that the correct imaging modality is chosen to save time and to avoid the increased morbidity and mortality of delayed management.

*Save time, saves lives!*

Furthermore, there are clinical situations which mandate immediate treatment of the patient to 'save life or limb' and clearly in these circumstances, imaging is inappropriate!

The extreme example is a patient with a penetrating injury to the chest, who clinically has all the signs of a cardiac tamponade and



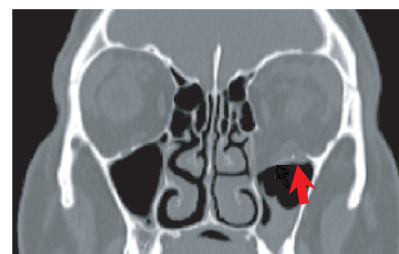
**Figure 1.15** Huge avulsion of right medial epicondyle ossification centre (arrow).



**Figure 1.16** Completely displaced avulsion of left medial epicondyle ossification centre (arrow).



(a)



(b)

**Figure 1.18** (a) OM view with left tear drop – classic blow-out fracture; (b) Cor CT shows orbital floor fracture with inferior rectus muscle displaced.

who clearly needs an immediate open thoracotomy and instead the clinical team request a multiple X-rays! The other extreme is when a patient has an open bleeding wound, which just needs dressings and compression initially and instead the clinical team request plain X-rays to look for a fracture! Sadly, both of these examples occur commonly!

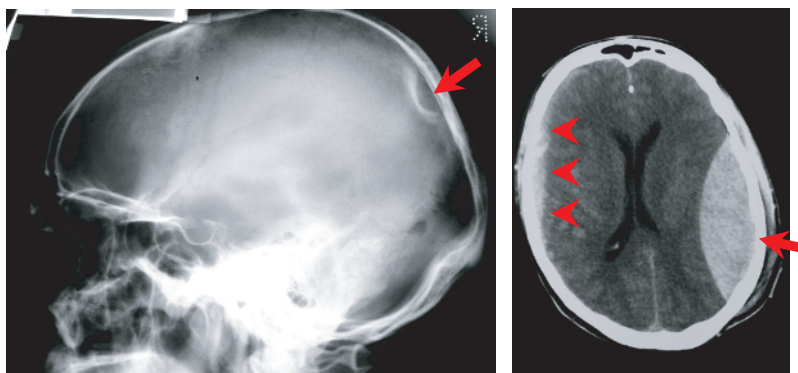
#### Rule 6 – two occasions

ALWAYS look for old films for comparison, in particular if there is an abnormality. Old films are the cheapest and best investigation, in particular CXRs (Figure 1.19). Similarly, if there is a bony abnormality, an old film will not only confirm whether this is an

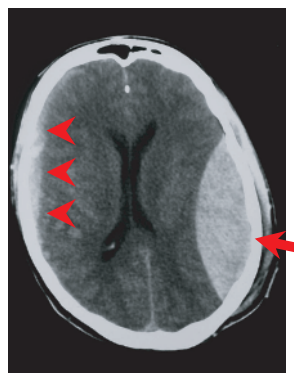
old or new finding, but also the speed of change will help in the diagnosis (Figure 1.20).

#### Rule 7 – two visits

ALWAYS repeat the X ray after a patient has undergone an intervention, in particular after insertion of a line or tube (central lines, endotracheal (ET) tubes, chest drains, etc.), reduction of a dislocation, putting a plaster of Paris (POP) (Figure 1.21) or cast or removal of a foreign body (FB).

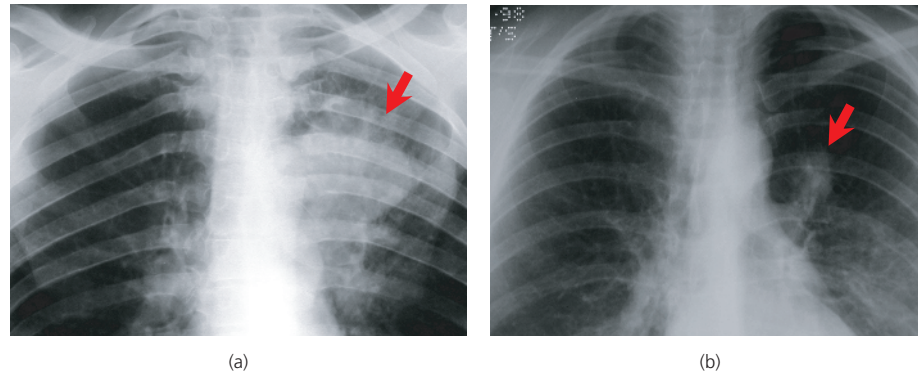


(a)

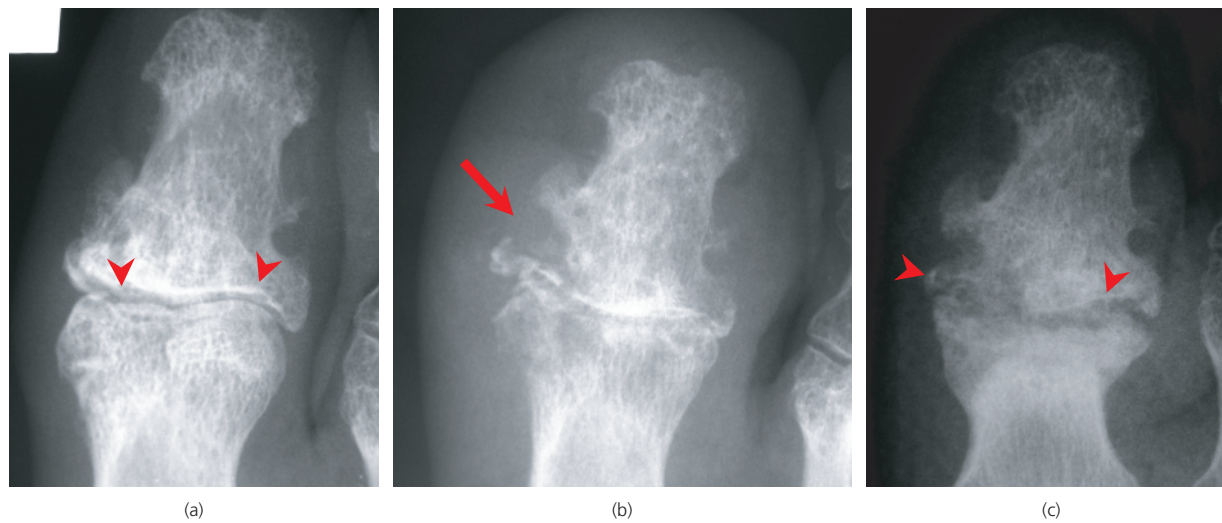


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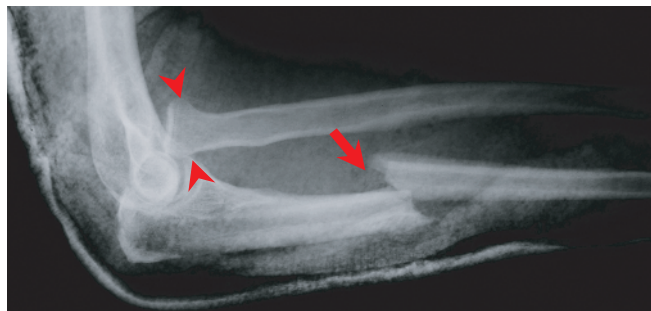
**Figure 1.17** (a) Depressed fracture seen on SXR (arrow); (b) Large left extradural haematoma (arrow) and subtle right subdural collection (arrowhead) and numerous right intraparenchymal contusions seen on CT.



**Figure 1.19** (a) CXR showing large left hilar mass. (b) CXR one year earlier shows much smaller mass, so a confident diagnosis of a primary bronchogenic carcinoma can be made with old CXR available.



**Figure 1.20** (b) Initial film showed loss of joint space a large erosion (arrow) and a huge amount of soft tissue swelling, which was not present on X ray taken (arrow) 1 week earlier (a) or after treatment 1 month later (c). Confident diagnosis of a septic arthritis was made with old film available showing rapid progression.

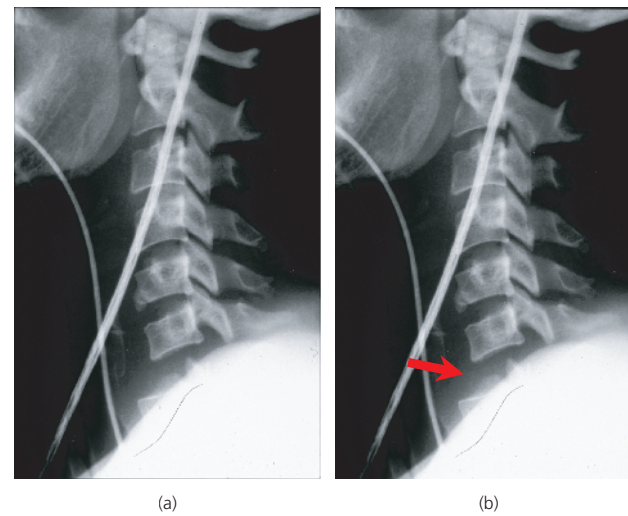


**Figure 1.21** Patient with fractured ulna (arrow) put in plaster of Paris, but follow-up check X-ray reveals a dislocated radial head (arrowhead) – a Monteggia fracture dislocation.

### Rule 8 – two opinions and two records

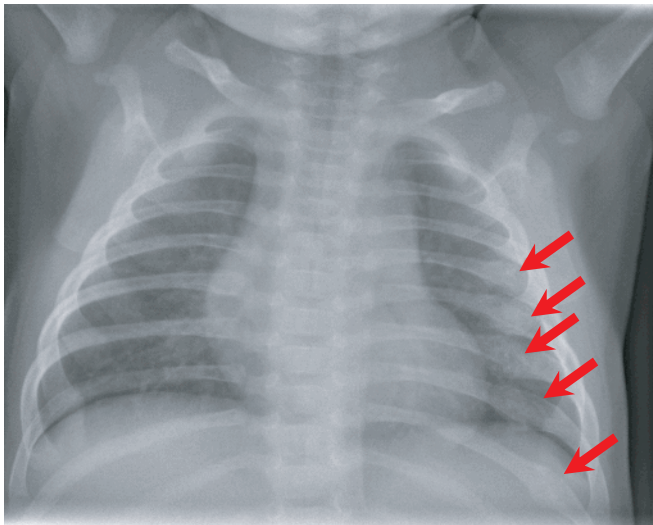
If you are not sure, get a second opinion from a colleague or the radiographers (who are extremely knowledgeable). The red dot system is a form of a second opinion.

There are particular X-rays which are more challenging (children with unfused epiphyses and AXRs) or where missing an abnormality may have serious consequences (cervical spine X-rays (Figure 1.22) and suspected non-accidental injury (NAI) (Figure 1.23)). Under



**Figure 1.22** (a) Lateral CS reported normal initially! (b) Lat CS clearly shows a hugely displaced C6 on C7 with marked separation.

these circumstances, you should ALWAYS get a second opinion and record both your interpretations, both in the notes and also in the radiology information system (RIS). If at a later date, a major abnormality has been missed or overlooked, it means that you



**Figure 1.23** CXR thought initially to be 'normal'; review shows clearly at least 5 left rib fractures consistent with NAI – referred immediately to paediatricians as suspected NAI.

can share the blame! The mere fact that you sought out a second opinion and recorded it, shows common sense and insight (even if it's not the case!).

#### Rule 9 – two specialists

The report and the X-rays should be checked (Figure 1.23) both by your seniors (first specialist) and also a formal report should ALWAYS be sought from the radiologists (second specialist). If two specialists have missed the abnormality, the likelihood of the case of ending up in court in the UK is virtually zero!

#### Rule 10 – two investigations

There are times when the initial X-ray has helped to exclude an obvious abnormality, but the history or clinical findings warrant further investigations (Figure 1.24). These investigations should be done as soon as possible but often are done the following day on a routine list. The problem is that delaying these investigations often leads to the investigation not being done or the team that looks after the patient forgetting about it!

Patients with head injuries and with suspected facial injuries often have a CT scan of the head but the facial injuries are not scanned at the time. Similarly, major trauma patients often have multiple intra-articular fractures detected on the plain X-rays and then have whole body CT, but the intra-articular fractures are not included in the CT scanning protocol. In both these groups of patients, the patient has to be brought back to the CT room. This is clearly not efficient use of CT and it is dangerous to move the 'stable' polytraumatised patient!

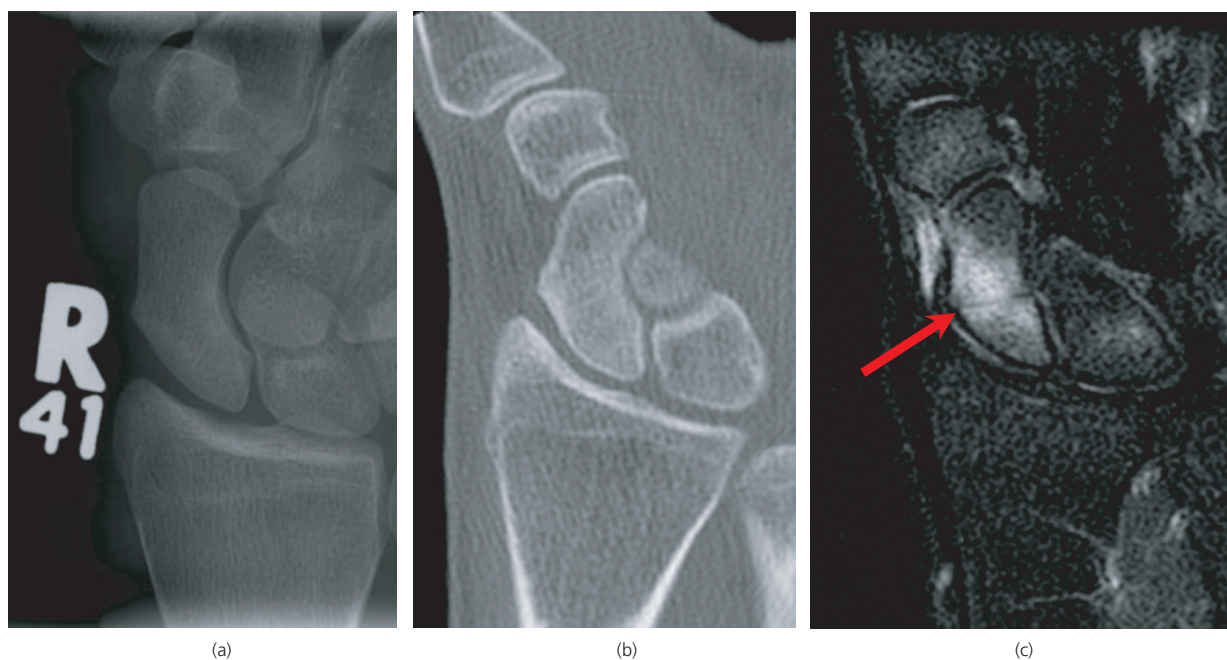
#### ABCs systematic assessment

The ABCs systematic approach is without doubt the simplest and worldwide the most popular and widely used system for the assessment of plain X-rays. However, in the context of patients in the ED, the ABCs systematic approach is equally effective for the interpretation and assessment of whole body CT and seamlessly incorporates an advanced trauma life support (ATLS) approach in trauma.

Its as simple as ABC!

#### Anatomy

The ABCs starts in ALL the chapters with a short section on 'basic' radiological anatomy, which is the 'bread and butter' of radiology!



**Figure 1.24** (a) Initial X ray reported normal, but patient symptomatic, so (b) CT performed which was also normal and (c) an MRI was then performed confirming fracture through the waist of the scaphoid.

The images are colour coded, so that ALL “normal” anatomy diagrams, lines and annotations are shown in white or shades of blue.

Know your anatomy and you know radiology!

### Adequacy

Anatomy is followed in ALL the chapters by adequacy. Under adequacy, we have included the imaging investigation of choice and either basic knowledge necessary to understand the modality and the ‘standard views’ and also the other views available.

### Peripheral and axial skeleton

The ABCs for the bony skeleton are the same, although from an interpretive point of view, the order should be changed so that soft tissues are looked at first in the elbow (looking for the displaced fat pad sign) and the knee (looking for fat-fluid levels indicating a lipohaemarthrosis). Both these signs are easy to detect and immediately alert the clinician to the presence of a probable fracture.

### Alignment

- Exclude subluxations and dislocations

### Bone

- Follow the bony contour very carefully and exclude a fracture
- Check for disruption of the trabecular pattern, linear sclerosis or lucency indicating a fracture

### Cartilage and joints

- Check for even joint spaces and uneven loss of joint width

### Soft tissues

- Bright light X-rays or change ‘window setting and contrast on The PACS system
- Look for FBs

### Head CT scan

#### Airspaces

- Sphenoid sinus – look for fluid level
- Frontal sinus/mastoids/middle ear – look for fracture or infection
- Pneumocephalus – look for sinus or vault fracture

#### Bones

- Look on bone windows and thin sections
- Look carefully over areas with soft tissue swelling

#### Brain parenchyma

- Look for low density lesions
- Look for high density lesions

- Blood density and implications
- Look for signs of brain swelling

#### CSF spaces

- Look for blood
- Look for mass effect
- Look for hydrocephalus

#### Dura

- Look for subdural and extradural collections

#### Eyes

- Globe injuries
- Optic nerve injuries
- Fractures
- Extraconal spaces

#### Face

- Fractures
- Foreign body

#### Survey (review areas)

- Scout
- Symmetry
- SAH
- Subtle
- Skull vault

#### Face

##### Alignment

- Check Dolan’s, McGrigor’s and Campbell’s lines

##### Bones

- Check all bones in the mid face and upper and lower third of the face.

##### Cartilage and joints

- Check the ZF sutures and TMJs

##### Sinuses and soft tissues

- Check for local swelling of the soft tissue
- Surgical/orbital emphysema
- Air-fluid levels and opaque sinuses
- Teardrop injuries
- FBs such as glass and metal

#### Chest – CXR

##### Airways

- Check endotracheal tube (ETT)
- Exclude FB in airway
- Position of trachea

**All lines**

- ETT position
- Nasogastric (NG) tube position
- Venous catheters
- Chest drains

**Breathing**

- Check lungs are clear

**Circulation**

- Cardiac silhouette size
- Mediastinal position and contour
- Widening of mediastinum
- Hila: evaluate size, shape, and position

**Diaphragm**

- Position
- Below the diaphragm

**Edges (pleura)**

- Pneumothorax
- Effusion
- Empyema

**Skeleton**

- Fractures
- Paraspinal lines
- Spine

**Soft tissues**

- FB
- Emphysema
- Swelling/asymmetry

**Abdomen****Air**

- Exclude free intraperitoneal or abnormally sited air

**Bowel gas**

- Check size, distribution and pattern

**Calcification**

- Check for normal and abnormal calcification

**Densities**

- Check for inserted or ingested foreign bodies

**Edges**

- Check the hernial orifices
- Check the lung bases and pleural spaces

**Fat planes**

- Check presence and symmetry of psoas shadows
- Check presence of perivesical fat plane
- Check that properitoneal fat planes are present

**Soft tissues**

- Check for enlarged or absent organs. Confirm with US

**Skeleton**

- In trauma, check that there are no obvious fractures
- If malignancy is suspected, exclude bony metastases

**Further reading**

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