It is possible for the non-specialist to interpret pelvic radiographs accurately

This chapter describes a system by which non-specialists can interpret pelvic radiographs. It requires an awareness of the basic anatomy of the region and an understanding of the possible mechanisms of injury. These two aspects will be discussed first.

**Important anatomical considerations**

**Adult**

The pelvis is composed of three bones (the sacrum and the two innominate bones) held together by several extremely strong ligaments. These are crucial for maintaining pelvic stability.

A large complex of ligaments covers the interior and exterior surface of the posterior aspect of the pelvis (fig 1). In addition, there are two ligaments that originate from the side and back of the sacrum and insert into the ischial spine and ischial tuberosity.

Branches of the internal iliac vessels and lumbosacral nerve plexus are closely aligned to the sacrotuberous, sacrospinous, and anterior sacroiliac ligaments and the underlying sacroiliac joint (fig 2).

The pubic symphysis is a fibrocartilagenous joint which is supported by ligaments and adds only a little to the overall stability of the pelvis. However, the urethra and bladder lie close to the pubic symphysis and are consequently damaged in a fifth of cases when this area is disrupted.

The three bones of the pelvis can separate only when the ligaments are torn. When this happens, the nerves and vessels running close to them will also be damaged. The bleeding is usually venous and extraperitoneal and can be life threatening. If bones fracture but the ligaments remain intact, a tamponade effect can be achieved and the degree of haemorrhage limited.

**Developmental**

Epiphyseal lines may be misinterpreted as fractures because the apophyses of the ischial tuberosity, lesser trochanter and iliac crest do not unite until the end of the late teens.
Mechanism of injury

There are four patterns of force leading to pelvic damage (fig 3).

**Anteroposterior compression**

Anteroposterior compression causes one or both sides of the pelvis to open up like a book, with the spine of the “book” running down the sacrum. A diffuse force will disrupt the pubic symphysis, while a more direct force fractures the pubic rami in a vertical plane. Occasionally a combination occurs.

For the pubic bones to separate by over 2.5 cm, one or both of the ligaments associated with the sacroiliac joints have to be torn. If the sacroiliac ligaments are stronger than their bony insertion an avulsion fracture of the ilium will be produced.

An anteroposterior force can also push the flexed femur backwards so that the femoral head impacts and fractures the posterior margin of the acetabular rim.

**Lateral compression**

Lateral compression produces a horizontal fracture through the ipsilateral pubic symphysis and a momentary medial displacement of the hemipelvis. The extent of this movement depends on the amount of force and the point of impact.

A lateral compression force can also impinge on the upper femur causing central dislocation of the hip (see later).

**Vertical shear force**

This forces the hemipelvis upwards and towards the midline and can tear all the sacroiliac ligaments on the affected side as well as the pubic symphysis ligaments. Because of the ligamental damage a vertical shearing injury is associated with severe pelvic instability and vascular damage.

**Complex pattern**

In less than a quarter of cases, the pelvis is subjected to two or more of the forces mentioned above. A combination of injuries results in a complex radiological picture. Nevertheless, the radiograph can usually still be interpreted by using the principles mentioned in this article.

Radiological interpretation of the anteroposterior view

A disciplined approach is important when interpreting pelvic radiographs. Once the adequacy of the film has been determined, we recommend using the ABCs system.

In 94% of cases a correct diagnosis can be made from only an anteroposterior radiograph of the pelvis.

**Check the adequacy and quality of the film**

Ensure that the whole of the pelvis can be seen, including the iliac crests, both hips, and the femurs distal to the lesser trochanters. The adequacy of the penetration should also be assessed. Pelvic rotation is determined by lining up the symphysis pubis with the midline of the sacrum.

**Alignment**

The pelvis encloses three circles. One is created by the pelvic brim and the other two by the obturator foramina (fig 4).
Pelvic brim—Trace around the edge of the large circle. Normally this has a smooth edge which is not disrupted by the sacroiliac joint or pubic symphysis unless the patient is very old. Once a fracture or diastasis is found, check for a second disruption in the circle (fig 5). As the pelvis is not completely rigid, this disruption may take the form of a minimal diastasis, which can be difficult to see.

The pelvic brim cannot be disrupted in only one place.

Avulsion fractures due to ligamental strain have the same effect as a rupture of the corresponding ligament. They are therefore important to detect on the plain radiograph. For example, avulsion of the ischial spine indicates that there has been an anteroposterior compression force sufficient to compromise the sacroiliac ligament.

If the pubic symphysis is wider than 2.5 cm all or part of the ligaments associated with the sacroileal joint are torn.

Obturator foramina—The inner margins of both obturator foramina should then be inspected in the same way as the pelvic brim. Again these are rarely broken in only one place. Complete the examination of the foramina by tracing along its superior border to the inferior surface of the neck of the femur. This is known as Shenton’s line. Disruption of this normally smooth line indicates that the femoral neck is broken (fig 6).

Bones

Examine the outer edges of the pelvis and its bony structure for evidence of fractures. These may present as areas of increased density, lucency, or alteration of internal trabecular pattern. Fractures away from the three bony circles can occur in isolation.
Start the examination at the pubic symphysis and progress to either the right or the left. To prevent getting lost in all the radio-opaque lines of the acetabular fossa concentrate, in turn, on the posterior and anterior joint margin, the ilioischial line (posterior column), and iliopectineal line (anterior column) and finish with the tear drop sign (acetabular floor) (fig 7).

Next examine the anterior inferior iliac spine and progress to the anterior superior iliac spine and over the iliac crest to the sacrum. The sacrum should also be examined for symmetry of its foramina (fig 8). A break in the smooth border of a sacral foramina may be the only indicator of a lateral crush fracture.

The contralateral ilium, acetabulum, rami, and pubis are then examined. Finally the femoral heads and lumbar vertebrae are inspected. The cortical margins, trabecular pattern, and bone density should be assessed. Isolated fractures can occur.

**Cartilage and joints**

*Pubic symphysis*—Check for either widening or overlapping of bone. Such an injury will be associated with disruption elsewhere in the pelvic brim.

*Sacroiliac joints*—The right and left sides must be checked for widening, defects in the cortical surface, overlapping of bone, and lack of congruity of the joint margin.

**Acetabulum**—By tracing over the cortical margins fractures can be detected. Posterior and anterior acetabular rim fractures can be easily missed because they are covered by the shadow of the femoral head. Look for isolated bone fragments lying behind the femoral head (fig 9).

The commonest fracture to the acetabulum is in the posterior rim after a posterior dislocation of the hip. Occasionally a lateral force produces a central dislocation by pushing the femoral head through the floor of the acetabulum. However, this may have sprung back by the time the radiograph is taken, leaving only subtle soft tissue signs. Fractures of the anterior rim and column are rare.
### Radiological indicators of pelvic instability

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<th>Indicator</th>
<th>Description</th>
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<td>Pubic symphysis diastasis</td>
<td>&gt; 2.5mm</td>
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<tr>
<td>Double vertical fracture of pubic rami</td>
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<tr>
<td>Oephalad displacement of separate fragments (for example, Malgaigne fracture)</td>
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<td>Disruption of pelvic ring with a vertical fracture of the transverse process of L5</td>
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### Special views

**Inlet and outlet views**

Inlet and outlet views should ideally be requested if there is clinical or radiological evidence of a pelvic fracture.

An inlet view looks down the lumen of the true pelvis. It is better than the anteroposterior view for showing the orientation of fractures of the pubic rami. Outlet views are used to detect the degree of vertical displacement of the fracture fragments.

**Oblique (Fujet) views**

These are used to define acetabular fracture patterns. If a fracture or abnormality of the acetabulum is suspected computed tomography will usually be necessary once the patient has been adequately resuscitated and stabilised.

**Soft tissue—internal and external**

Check for soft tissue shadowing both inside and outside the pelvis because haematoma and tissue oedema can produce swellings which are visible on the anteroposterior radiograph.

Normally the obturator internus muscle is seen on both sides of the pelvis as a dark grey line, which is due to the muscle or fat plane (fig 7). Loss of this line indicates extraperitoneal haemorrhage or soft tissue oedema. Conversely, intraperitoneal haemorrhage can displace the line.

**Catches to avoid**

Make sure the radiograph is adequate. Commonly part of the iliac crest is missing or the film is poorly penetrated so that fractures cannot be seen. A rotated film causes asymmetry of the bony circles and the sacroiliac joints.

**FIG 13—Anteroposterior radiograph of a child’s pelvis. Notice the epiphyseal lines and the bilateral ischepublic knobs. The left capital epiphysis has slipped slightly compared with the right.**

Failing to trace around the bony edges, especially the iliac crests and sacral foramina, will lead to fractures being missed.

Epiphyseal lines may be misinterpreted as fractures. Remember that the Y-shaped (triradiate) cartilage separating the pubis, ischium, and ilium in the acetabular floor does not fuse until puberty. Accessory ossification centres (in particular the one in the posterior acetabulum) may also be mistaken for fractures. However, apophyses are usually bilateral, have a sclerotic margin, and are not associated with overlying soft tissue signs.

**Summary**

**Adequacy and quality**

Ensure that the whole of the pelvis is visible

**Alignment**

Assess the borders of the three circles—namely, the pelvic brim and the two obturator foramina

**Bones**

Check each of the following systematically:

- Pubis
- Sacrum
- Acetabulum
- Femoral heads
- Iliac crest
- Lumbar vertebrae

**Cartilage and joints**

Check the pubic symphysis
Check the sacroiliac joints
Check the acetabulum

**Soft tissues**

Check the disruption of fat planes inside the pelvis
Check for soft tissue shadows outside the pelvis

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