Acetabular Fractures: What Every Radiologist Needs to Know

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Learning objectives

To understand important radiographic and CT features of acetabular fractures.

To understand how different mechanisms, including low energy injuries, can result in characteristic fracture patterns.

To view examples of common acetabular fractures in the context of the Judet and Letournel classification system.
Background

Acetabular fractures are rare injuries with a bimodal age distribution. Typically, these fractures are seen in high energy trauma and often as part of a constellation of injuries including pelvic visceral trauma and neurovascular injury. As such, multidetector computed tomography (MDCT) is becoming more important in diagnosing and classifying these fractures. However, low energy fractures in the elderly are increasingly being encountered (1). The reading radiologist should be familiar with the basics of accurate diagnosis as these fractures can have serious implications for patient mobility, joint stability and pain if not correctly managed.
Imaging findings OR Procedure Details

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Section: Imaging findings OR Procedure Details

A) ANATOMY

The column principle describes the acetabulum as being formed by the coalition of anterior and posterior columns of bone (figs 1, 2 and 3). Broadly, the anterior column includes the anterior iliac wing and superior pubic ramus and the posterior column consists of the ischium. Two laterally projecting shelves arising from these columns form the anterior and posterior acetabular walls (fig 4) resulting in the inverted cup in which the femoral head sits. This femuroacetabular unit permits load transmission from the axial skeleton to the lower limbs when standing (2).

Another key pelvic axial load bearing structure is the sciatic buttress (2), a continuation of the iliac bone that communicates with the sacroiliac joint (fig 1 and 2). Although separate to the acetabulum, it is often employed as an anchor point in acetabular reconstruction.

B) IMAGING TECHNIQUES

Traditionally, suspected acetabular fractures are examined with supine AP hip radiographs to establish any discontinuity in six key lines; iliopectineal line, ilioischial line, anterior acetabular wall, posterior acetabular wall, acetabular roof and acetabular floor (fig 3). Additionally, the entire pelvis should be interrogated to look for concurrent injuries.

Supplementary iliac oblique and obturator oblique 'Judet' views of the pelvis are also performed (fig 5). These 45 degree oblique images require careful patient rotation to obtain en face views of the ilium and obturator ring, so permitting clearer visualisation of the constituent acetabular margins. The iliac oblique view enhances the iliac wing, anterior wall and posterior column. In contrast, the obturator oblique view improves obturator ring, posterior wall and anterior column delineation.
The vast majority of acetabular fractures are due to high energy trauma (1) where the femoral head is driven into the pelvis for example, in motor vehicle accidents. Increasingly, whole body MDCT is being employed in polytrauma and consequently, MDCT and 3D surface rendering are more readily available for acetabular fracture categorisation. At our institution, a level 1 trauma centre and regional pelvic and acetabular unit, plain film is routinely used for triage in conjunction with CT for fracture classification and management decisions. Some authors advocate using 3D reconstructions as the primary method of fracture classification (3).

C) FRACTURES

Acetabular fractures are rare with a reported incidence of 3 per 100,000 population per year (4). Typically, high energy trauma forces the femoral head into the acetabulum to produce anatomically complex injuries. To aid decision making, various fracture classifications exist for example, the AO (5) and Harris classification (6). Currently, the Judet and Letournel classification is most commonly used in radiology and orthopaedics (7, 3). Whilst issues regarding completeness, nomenclature and reproducibility have been described (3) it is beyond the remit of this poster to review the system. Nevertheless, we will present multimodality images of acetabular fractures using this classification as a reference.

Diagnosing fractures on plain film radiography requires careful evaluation of the pelvic along with Judet views. Where any diagnostic uncertainty exists, CT should be performed. And, as already described, surface rendered images with the acetabulum seen enface can be helpful. Some authors have produced flowcharts to assist the reading radiologist in making fracture classification (3,8) but these do not replace optimal imaging and complete image evaluation. If uncertainty persists, case discussion with the orthopaedic team is always recommended.

Of the ten patterns described by Judet and Letournel (fig 6), five account for 90% of acetabular fractures (8,9). These are both column, T-shaped, transverse and posterior wall, transverse and isolated posterior wall fractures.

Examples:
Posterior wall fractures (figs 7,8)
Transverse fractures (figs 9,10)
T-shaped fractures (figs 11,12)
Anterior column fractures (fig 13)

Both column fracture (fig 14)

**Low energy acetabular fractures**

Specific mention of this fracture should be made. These can be traumatic, however a subset of patients incur acetabular fractures from low energy mechanisms such as falling from standing. In this group there is a disproportionate number of fractures involving the anterior column in comparison to high energy fractures (1). Here, the femoral head impresses the acetabulum along the long axis of the femoral neck to cause anterior column fractures (9). These patients are older and usually suffer with osteoporosis or low bone density. Currently it is estimated that low energy- anterior column fractures account for up to 12% of acetabular fractures (1). In the context of an ageing population, it is thought these will be become increasingly common (1). Careful scrutiny of the initial plain film is essential in order to not miss these fractures.

**D) POSTOPERATIVE**

Where the decision is made for open reduction the approach is determined by the column that is injured. In anterior column injuries, iliofemoral or ilioinguinal approaches are used (fig 15). Posterior column injuries employ a posterior approach (fig 16) for example, the Kocher-Langenbeck. More complex injuries require combinations of the above or extended incisions. Post-operative CT may be used to assess fracture healing, position and complications including metal work failure.
**Fig. 1:** Annotated lateral surface rendered 3D CT of the pelvis with femoral head subtraction. The Acetabulum is shown en face. Blue= anterior column, Green= posterior column, Purple= sciatic buttress.

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Fig. 2: Annotated anterior surface rendered 3D CT of the pelvis with femoral head, sacral and left hemipelvis subtraction. Blue= anterior column, Green= posterior column, Purple= sciatic buttress.

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Fig. 3: (a) anterior posterior plain film acquisition of the pelvis (b) magnified view of the right acetabulum (c) annotated magnified view of the right acetabulum. Blue line; iliopectineal line- border of the anterior column. Green line; ilioischial line- border of the posterior column. Red line; anterior acetabular wall. Orange line; posterior acetabular wall. Yellow line; acetabular roof. Black line; acetabular floor.

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**Fig. 4:** Axial pelvic CT demonstrating the normal anterior and posterior acetabular walls.

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**Fig. 5:** Judet views. Iliac oblique views require the pelvis to be turned 45° towards the injured side so allowing the iliac wing to be viewed. The patient is turned 45° towards the uninjured side to obtain obturator oblique views.

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**Fig. 6:** Schematic representation of the ten fracture types described by Judet and Letournel. Fracture lines (black lines) are superimposed over 3D surface rendered images of the en face acetabulum. Blue= anterior column, Green= posterior column, Purple= sciatic buttress.

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Fig. 7: Posterior wall fracture. A fracture line traversing the right posterior wall is well seen on the AP film (a). As expected the iliac oblique Judet view does not show the posterior wall well (b). The fracture disrupting the posterior wall is clearly seen on the obturator oblique view (c). These fractures are amongst the most common acetabular injuries and are typically secondary to dashboard injuries.

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Fig. 8: Axial CT images (a)-(c) demonstrate an isolated, displaced posterior wall fracture. 3D surface rendered images (d)-(f) provide a more detailed overview and more clearly delineates the comminuted nature of the injury.

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Fig. 9: Frontal right hip view (a) and iliac oblique Judet view (b) demonstrates a fracture disrupting the anterior and posterior walls in addition to the iliopectineal line. A vertical component is not seen. Appearances either represent a T-shape fracture with an occult vertical component or a transverse fracture. A CT is indicated for clarification.

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Fig. 10: Axial and saggital CT images demonstrate a fracture line which, relative to the plane of the acetabulum, is transverse. No inferiorly projecting component is seen and, as such, the CT confirms a transverse acetabular fracture.
Fig. 11: T shaped acetabular fracture. (a) The fracture line disrupts the right anterior wall, posterior wall and ileopectineal line. Judet views demonstrate anterior and posterior wall fractures but a transverse component is not seen (b) and (c). The axial CT, however, clearly shows an inferomedially projecting component (d). These fractures require more extensive surgery than transverse fractures and it is crucial for the radiologist to identify the vertical component.
Fig. 12: Sagittal CT images of the acetabulum demonstrate a vertical component on the most lateral image (a) with a transverse component coming in to view on medial images (b) and (c). This confirms a T-shaped fracture and highlights the value of CT over plain film imaging in fracture classification.

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Fig. 13: Anterior column fracture in an 82 year old male sustained from a low energy injury (fall from standing). (a) frontal plain film demonstrates disruption of the left iliopubic line. Sagittal CT (b) and axial CT (c) confirms anterior column injuries. Note background osteopenia.

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Fig. 14: Both column fracture: Coronal CT image (a) demonstrates a posterior column injury and sagittal image (b) shows injuries to the anterior column.
Fig. 15: Anterior column reconstruction with recon plates (green arrow) and screw (blue line) fixation along the ileopectineal line and the ilac wing. Note that the iliac wing fixation has been extended back to the sciatic buttress (yellow arrow).

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Fig. 16: (a-c) Posterior approach posterior acetabular wall internal fixation shown on AP and Judet views. Reconstruction plates (green arrow) and screws (blue arrow).

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Conclusion

Acetabular injuries are rare and have a bimodal distribution. Most commonly these are caused by high energy trauma however, a subset of patients consisting of the elderly and those with osteoporosis incur a higher proportion of anterior column fractures from low energy insults.

The reading radiologist should have a good understanding of the basics of diagnosis and classification systems in order to ensure timely diagnosis and appropriate management.
References


Personal Information

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