

Understanding Clinical Radiology of Fracture Acetabulum

U K Sadhoo¹

Abstract

Acetabulum is one of the most anatomically complex regions of the body. Fractures in this area are difficult to visualise due to complex anatomy and overlapping of radiological shadows. Plain radiology of acetabular and pelvis fractures require detailed understanding of the imaging techniques and anatomy. Newer advances like 3-D CT etc have added new dimensions to the radiological assessment of acetabular fractures. Current review focusses on basic radiological principles to help the readers understand and categorised acetabulum fractures and also plan the surgical intervention.

Keywords: Acetabular fractures, radiological assessment, CT Scan

Introduction

Acetabulum is a major weight-bearing joint, connecting Axial skeleton to lower limbs. Therefore a fracture of Acetabulum has implications for the mobility and disability for rest of life. Until the pioneering work of Judet and Letournal (1), these injuries were poorly understood and inadequately treated. Now this subspecialty has come of age.

The difficulty in understanding the nature of these injuries is the complex shape of Pelvis anatomy. Radiology not only provides an accurate assessment, it also gives a pointer to the approach and definitive treatment. Judet and Letournal classification is based on the lines produced by xray beams on the cortical surfaces in AP and two 45 degree oblique projections. Though advent of CT has enhanced our understanding, this classification remains the de facto standard. The other classifications are AO/OTA classification and the CT based Harris et al classification (3,4)

Anatomy

Acetabulum is formed by confluence of Ilium, Ischium and Pubis into an inverted horse-shoe shaped structure that is deficient inferiorly, bridged by Transverse Acetabular Ligament. The central

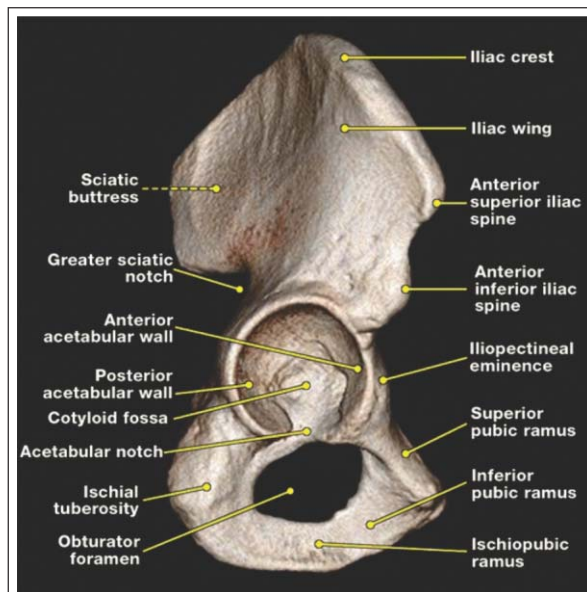


Figure 1: Judet and Letournal classification lines refer to a lateral facing, and not anatomically oriented acetabulum.

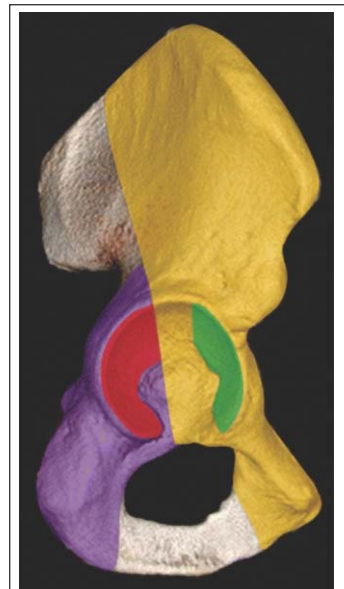


Figure 2: Yellow : Ant. Column, Purple : Post. Column, Green : Ant. Wall, Red : Post. wall

non-articular part is known as cotyloid fossa which houses fat (Pulvinar) and Ligamentum Teres (Fig 1).

Bony Acetabulum has inclination of 55-60 degrees to horizontal. This is deepened by Labrum, a soft fibro-cartilagenous structure not unlike meniscus. This increases the load-sharing area and provides additional check against dislocation.

Radiology

X-rays (Fig. 3):

Look for 6 landmarks :

1. Post. Wall : Lateral-most projection on AP and Obturator view x-ray. Seen clearly because of anteverted Acetabulum.
2. Ant. Wall : Superimposed on post. Wall, still visible as undulation line on good quality x-ray.
3. Dome : weight-bearing area of acetabulum.

3 variants :

TransTectal : through weight-bearing area

Juxta Tectal : at roof of cotyloid fossa where it joins articular area

Infra Tectal : Through floor Cotyloid fossa. Juxta and infra-Tectal don't involve weight bearing surfaces so rarely need operative

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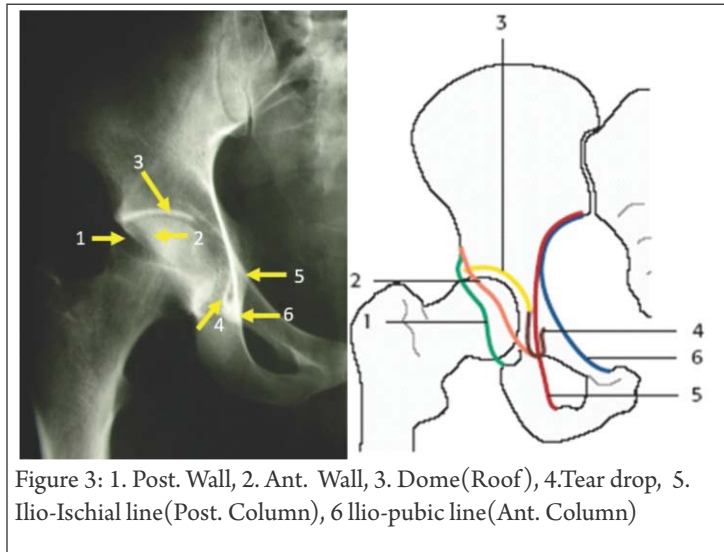


Figure 3: 1. Post. Wall, 2. Ant. Wall, 3. Dome (Roof), 4. Tear drop, 5. Ilio-Ischial line (Post. Column), 6 Ilio-pubic line (Ant. Column)

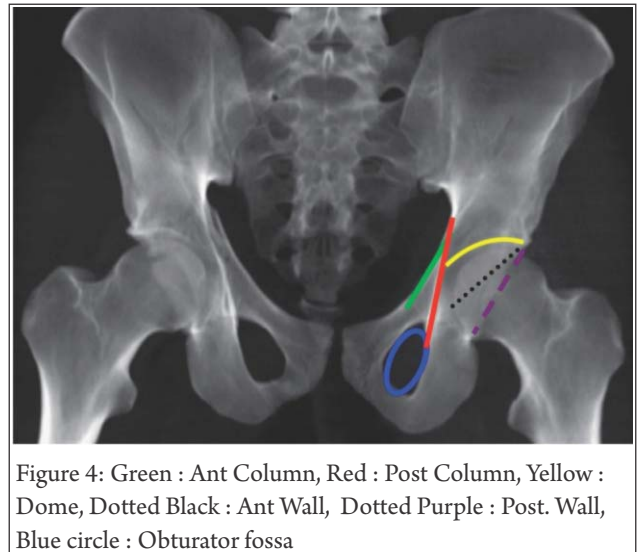
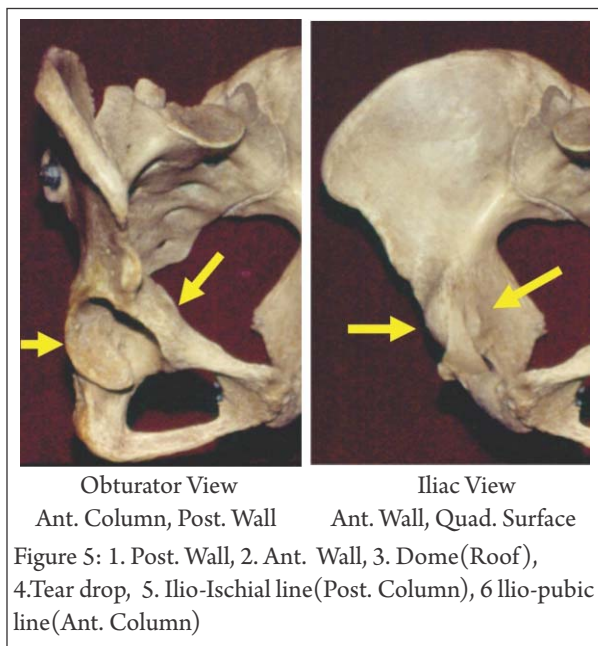


Figure 4: Green : Ant Column, Red : Post Column, Yellow : Dome, Dotted Black : Ant Wall, Dotted Purple : Post. Wall, Blue circle : Obturator fossa



Obturator View
Ant. Column, Post. Wall

Iliac View
Ant. Wall, Quad. Surface

Figure 5: 1. Post. Wall, 2. Ant. Wall, 3. Dome (Roof), 4. Tear drop, 5. Ilio-Ischial line (Post. Column), 6 Ilio-pubic line (Ant. Column)

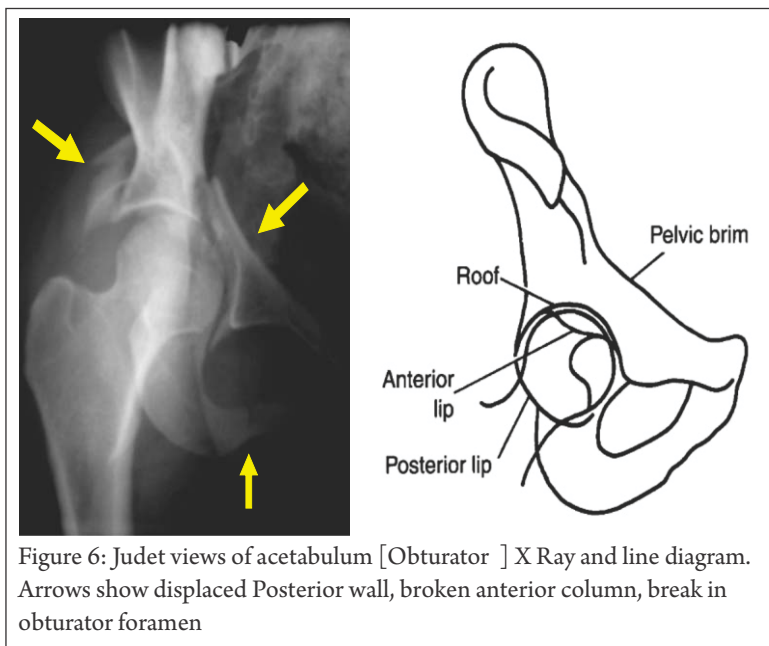


Figure 6: Judet views of acetabulum [Obturator] X Ray and line diagram. Arrows show displaced Posterior wall, broken anterior column, break in obturator foramen

measures.

4. Tear Drop : Not an anatomical structure. Seen on AP projection.

Lateral wall represents inferior-most Acetabulum articular surface, medial boundary by Quadrilateral plate.

5. Ilio-Ischial line : representing Posterior column

6. Ilio-Pectineal line : representing Anterior column

AP View 1-minute assessment (Fig. 4) : Basic, quick, cheap investigation. Look at 4 lines, 1 curve, 1 circle; it gives lot of information, enough to make a considered decision about the severity of injury and urgency of treatment. It may not pick up subtle fractures, small intra-articular fragments, marginal impaction. There is virtually nil to be deduced from x-ray about the soft tissue component of injury.

Judet Views (Fig. 5,6,7) : Patient is tilted 45 degree to horizontal, once with injured side up, then normal side up, at right angle to each other. The x ray beam is perpendicular to Horizontal, focused on affected hip in both views.

Obturator : shows Iliac wing seen end-on, Obturator foramen

in full profile. (highlights Anterior column, Posterior Wall)

Iliac : shows Iliac blade, Posterior column, Ant. wall (most lateral

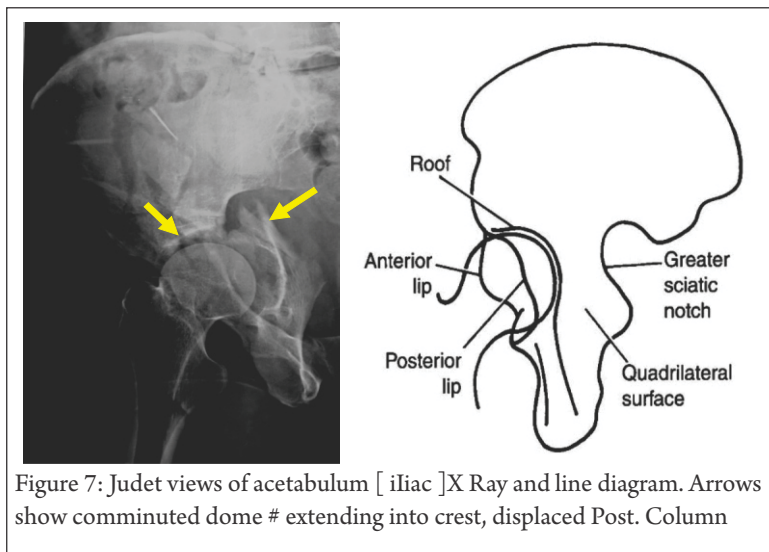


Figure 7: Judet views of acetabulum [iliac]X Ray and line diagram. Arrows show comminuted dome # extending into crest, displaced Post. Column

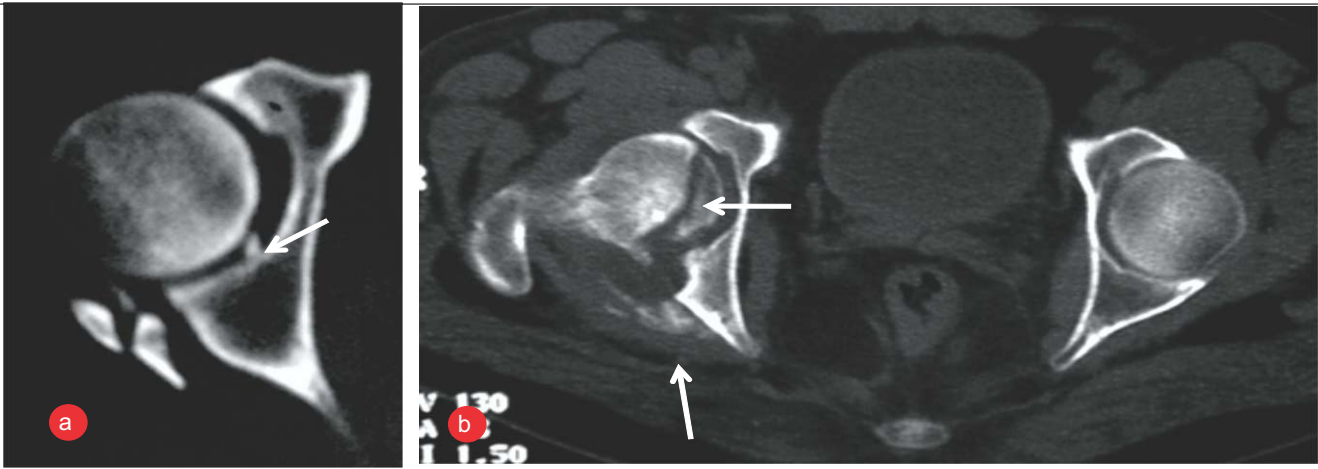


Figure 8:CT Scans of Acetabulum: Axial and Coronal Views. a- Arrow shows intra-articular fragment. b-Arrows show comminuted dome fracture extending into crest, displaced posterior. column

projection), Sciatic notch, Quadrilateral plate. Sometimes, it is not possible to do Judet views because of patient discomfort. In such cases, angiographic C-arm can be tilted, instead of the patient, to gain necessary information (7). Planar CT scan (Fig 8,9,10) : Thin-slice scans, axial, coronal and

be picked up on CT (or MRI) 3D CT (Fig.11): It is a reformatted image from thin sections into 3D surface-rendered images. These images are easy to understand, easy to manipulate in any direction, with or without femoral head in acetabulum. No doubt finer details like intra-



Figure 9a: 14 year female, Post injury pain, limp but X-ray “normal”

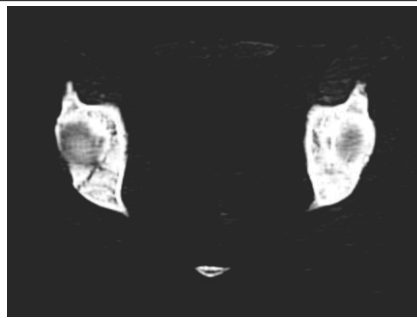


Figure 9b: The CT shows stellate fracture of dome acetabulum

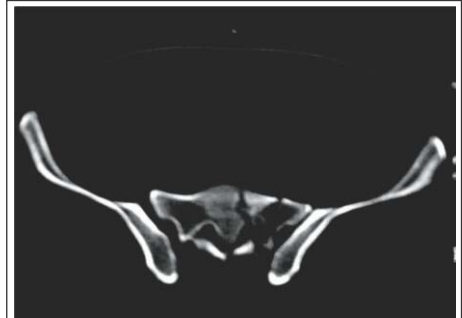


Figure 10: Axial CT showing post element injury which was not seen on X-ray

sagittal, are invaluable tool for complete evaluation of Acetabulum fractures. It can show marginal impaction, intra-articular fragments, subtle fracture lines, and posterior Sacro-Iliac injury. It thus complements the information gained on x-rays. In addition, soft tissue injury like Morell-Lavalle lesion can

articular bone pieces, impaction, and fine fracture lines are lost but it remains a powerful tool to have a bird's eye-view of a very complex anatomy and injury. One major advantage is the ability to process data into reformatted images (Fig.12) to appear as planar AP or Judet views without the need to move or tilt the patient (5).



Figure 11: 3D Reconstruction of Acetabular fracture gives overview, can be viewed from many angles, fine details e.g. impaction, intra-articular fragments not visible.



Figure 12: Reformatted AP image from 3D Recon

CT can show fracture in coronal or sagittal planes; it can also be used with artefact-suppression software for post-op evaluation of adequacy of reduction, intra-articular metal or loose bone pieces (Fig 13). The fracture lines through the Dome need understanding to interpret the diagnosis correctly (Fig 14). Proximal 10mm of Axial CT also corresponds to the

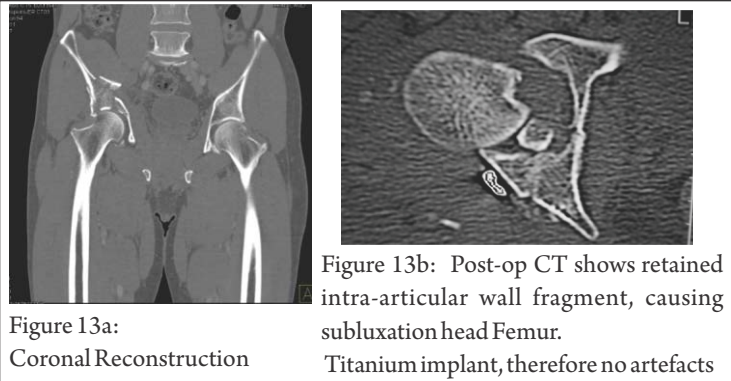


Figure 13a: Coronal Reconstruction
Figure 13b: Post-op CT shows retained intra-articular wall fragment, causing subluxation head Femur. Titanium implant, therefore no artefacts

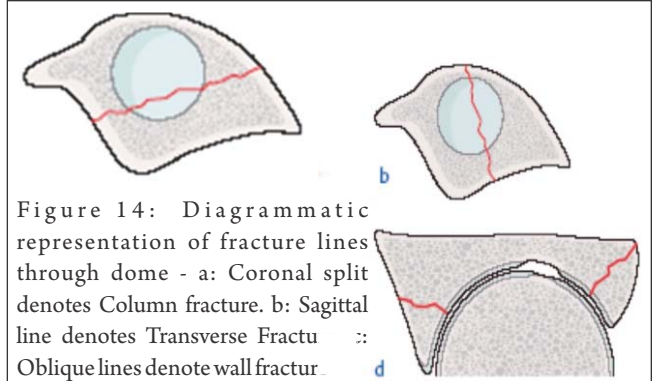


Figure 14: Diagrammatic representation of fracture lines through dome - a: Coronal split denotes Column fracture. b: Sagittal line denotes Transverse Fracture. c: Oblique lines denote wall fracture.

weight-bearing Dome (6). Therefore, if a fracture does not involve the proximal 10mm of Acetabulum, conservative treatment is indicated.

Judet and Letournal Classification:

Before discussing Classification, it is important to keep the following points in mind:

-Fractures are described with respect to a lateral-facing Acetabulum (Fig 1). This is quite different from real-life situation in which Acetabulum is tilted anteriorly and inferiorly. Therefore, a

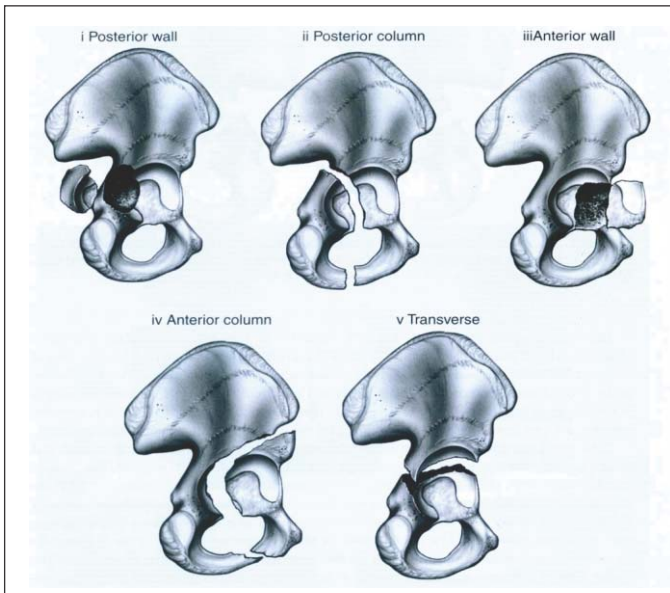


Figure 15: Judet-Letournal Classification - Elementary Patterns. [Illustration taken from internet for representative purposes]

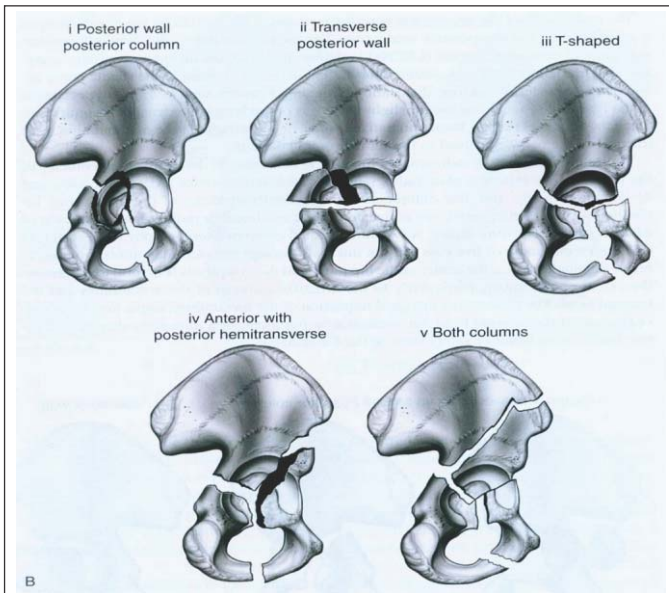


Figure 16: Judet-Letournal classification with associated patterns [Illustration taken from internet for representative purposes]

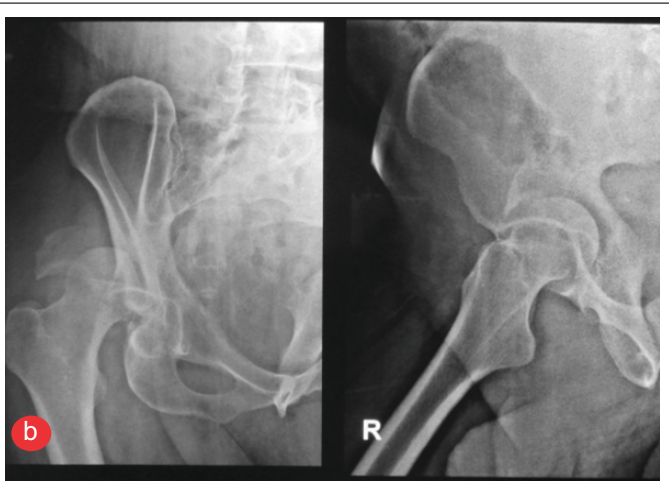


Figure 17: Posterior Wall fracture: a-AP view showing Posterior Wall, displaced fracture. b- Judet views showing Post Wall fracture,

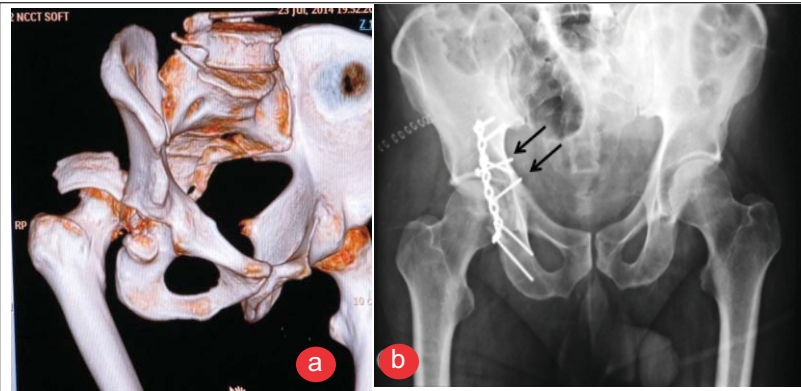


Figure 18: Posterior Wall fracture - a-3-D Reconstruction. b. post operative x ray showing lag screws (arrows) holding fragment, buttressing plate

a working classification as any. 5 patterns of these 10 constitute 80% of all Acetabulum fractures: Post Wall, Transverse, Transverse with Post wall, T shaped and Both Columns (Fig. 30). (5,6)
 Post. Wall (Fig.17,18) : A part of the rim with articular surface is broken. Often, it is displaced with subluxed/dislocated head Femur and best seen on Judet Obturator view (Fig 5,6). Comminution is not uncommon. Sciatic involvement is not infrequent and subtle injury even more common. On CT, marginal impaction can be picked up easily (Fig. 8).
 Ant. Column (Fig 19) : Uncommon. Pure Ant. Wall fracture is even less common. It generally is a hallmark of elderly, osteoporotic individuals.

Transverse fracture orients in oblique-sagittal plane in a Pelvis-AP x-ray than a horizontal line. -Walls are part of the column (Fig 2). Therefore, it is possible to break either wall or column or both simultaneously. For a column to break, exit line is through Obturator oval in most, but not all, cases. Add to this, part or complete Transverse # element and many possibilities emerge. 10 fracture patterns are recognized (fig. 15, 16); 5 elementary and 5 associated which are combination of one or more of elementary pattern. All of them are based on the walls getting separated

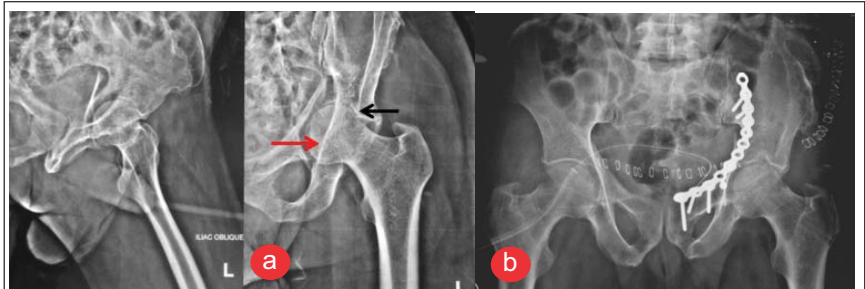


Figure 19: X Rray of Anterior Column - a-Judet Views : note intact Ilio-Ischial line (Red arrow), punched-in part of dome (Black arrow) carrying adverse prognosis. b - x-ray post surgical fixation using modified Stoppa's approach.



Figure 20: AP, Judet views of Transverse fracture in a 28 male, Both Ilio-Pectineal, Ilio-Ischial lines broken, medially subluxed head (arrow). Intact obturator ring leaves Transverse # as only possible diagnosis.

Transverse # (Fig. 20) : The fracture runs obliquely and can exit through weight-bearing Dome, at junction with Cotyloid fossa or through fossa itself. The distal fragment displaces medially and rotates. Both these factors need to be taken into account at ORIF. Though the fracture line traverses both Ilio-Pectineal and Ilio-Sciatic line, thus involving Anterior AND Post Columns, it still is not a "Both Column"

from columns and columns getting broken at Sciatic buttress, with transversely oriented fracture through Acetabulum completing the picture. 5 elementary types are Anterior Wall, Anterior Column, Posterior Wall, Posterior Column and Transverse fracture (Fig. 15). 5 Associated patterns (Fig. 16), as name suggests, are combination of two or more Elementary patterns. These are: Posterior wall and Column fracture, Transverse with Post Wall, T Shaped, Ant Wall/Column with Posterior Hemi-transverse and associated both column. Not every fracture can be pigeon-holed in these 10 patterns, but it is as good

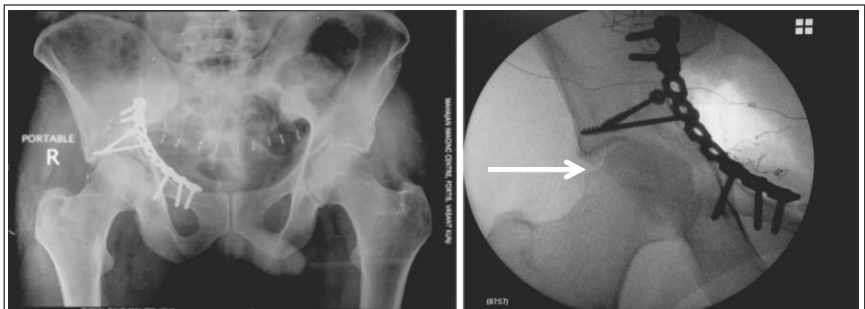


Figure 21: post op x ray of Transverse fracture by Modified Stoppa's approach Indirect reduction with buttress plate. Ensure no metal is intra-articular. Note the damage to Femoral head (white arrow) caused by medial subluxation

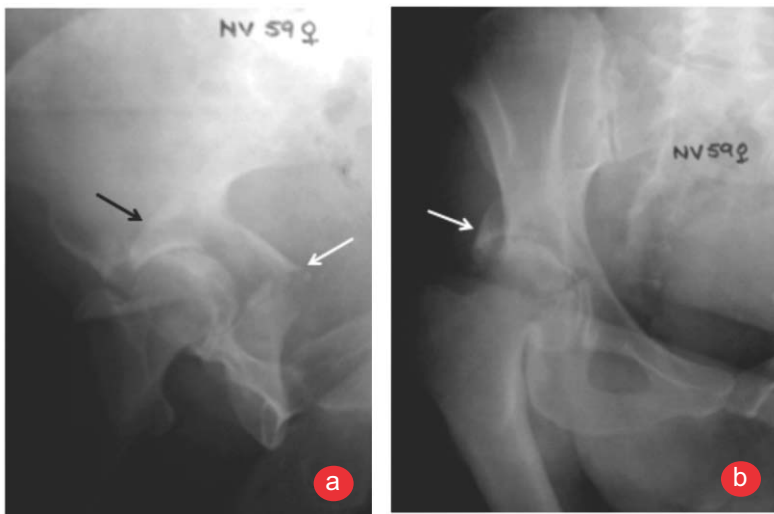


Figure 22: Post. Wall +Post column fracture. a-Iliac view shows # Post column(white arrow) & wall fragment clinging to head (black arrow). b- Obturator view shows intact Ilio-pectineal line & displaced wall fragment (arrow)



Figure 23: Post. Wall +Post Column fracture- same case as Fig22. ORIF with KL approach

Fracture, a term reserved for Post Wall and Column # (Fig 22, 23) : Post. Column break can occur in isolation or may be accompanied by Wall fracture. Column component exits proximally, Sciatic notch and distally, Obturator foramen. This is an unstable situation and at ORIF, Sciatic Nerve and Superior Gluteal neurovascular bundle are at risk.

Obturator fossa. This essentially separates Anterior and Posterior components. Therefore choosing appropriate approach is of paramount importance. Generally, the more displaced fragment decides approach. The other component is then reduced and held indirectly. Sometimes, two approaches may necessary. Transverse with Post. Wall # (Fig. 27, 28)

; As name indicates, the post wall component makes the head displace posteriorly, often with comminution. Both Column # (fig. 29) : No part of the weight-bearing Dome is connected to the Sciatic buttress. On Obturator view, "Spur" sign is characteristic of this pattern. Fragility Fractures : (Fig. 31, 32) : With increasing longevity, the fracture patterns

Ant. Column with Post. Hemitransverse # (Fig. 24) : Not to be confused with Transverse or T #. The fracture line of Ant. Component exits obliquely compared to the straight line in Transverse #. T-shaped # (fig. 25, 26) : The transverse component has additional break in



Figure 24: x ray and diagram of Anterior Column with Post. Hemitransverse - Differs from T Fracture in which transverse element is in straight line from anterior to post. component. [Illustration from aosurgery.org]



Figure 25: X ray T # of acetabulum in a 41F -. Note both Ilio-pectineal, Ilio-Ischial lines, Obturator foramen broken(Red arrows), part of weight-bearing dome intact(white arrow), distinguishing it from Both column #

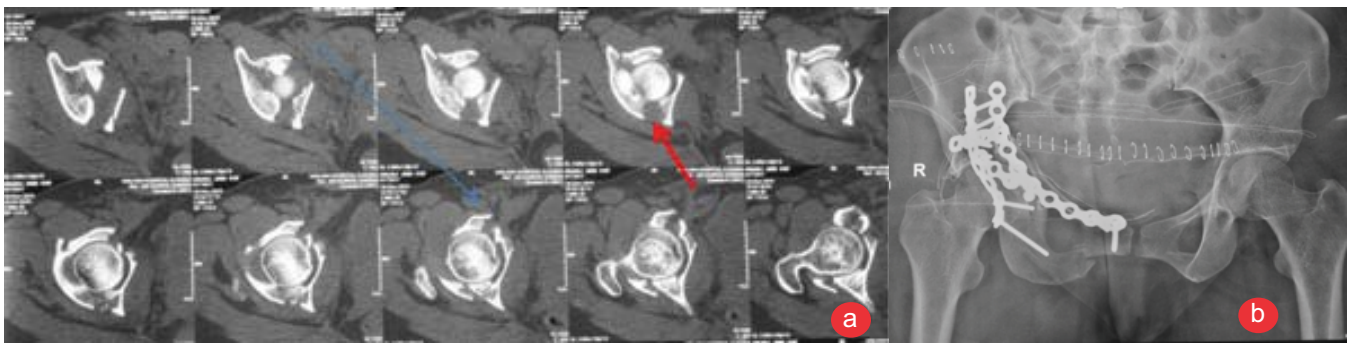


Figure 26: a- CT Scan showing T-shaped # Note near-vertical orientation (arrow) in axial CT denoting Transverse element of T shaped #. b- post op x-ray of fixation using same sitting Kocher-Langenbeck and Modified Stoppa's approach. Less-than-ideal reduction



Figure 27: X-ray of Transverse with post. wall fracture (Red arrow) in a 24male, involving left hip, subluxed head carrying displaced wall fragment. Note virtually undisplaced transverse # opposite side (white arrow)



Figure 28: 3D reconstruction of Transverse with Post. Wall # Transeverse # elements in both acetabulae evident on 3-D Recon(arrow).

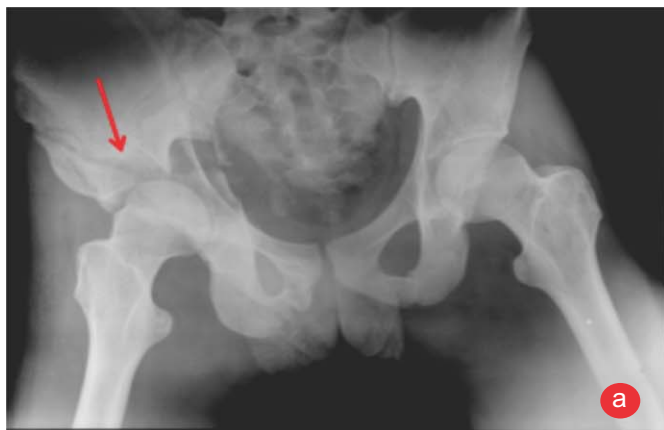


Figure 29a: Xray AP views of both Column fracture in a 18M.. Apart from disruption of both Ant. and Post. column lines, no part of weight-bearing Dome (arrow) remains attached to Sciatic buttress, thus distinguishing it from T-shaped #

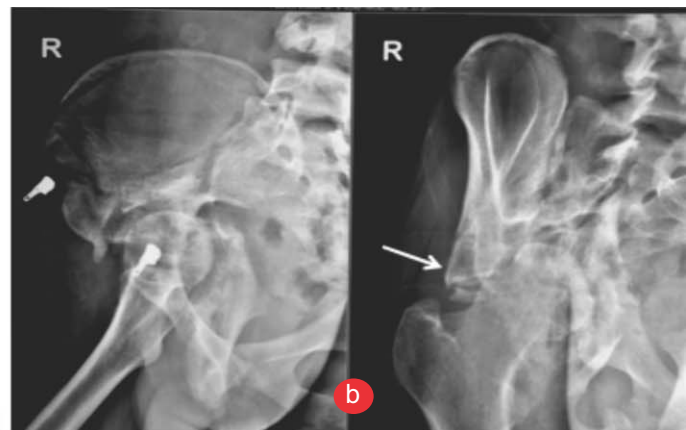


Figure 29b- Obturator oblique view shows pathognomonic "Spur" sign (arrow), representing the intact portion of Iliac crest still attached to Sacro-Iliac joint

Fig. 30 : 5 Commonest Patterns

- Post. Wall #
 - Transverse #
 - T shaped #
 - Transverse # with Post. Wall
 - Both Columns #
- }
- 90%

Fig. 31 : Fragility Fractures

- Elderly
- Osteoporosis
- Trivial Trauma
- Unusual pattern
- ? "Acute" THR

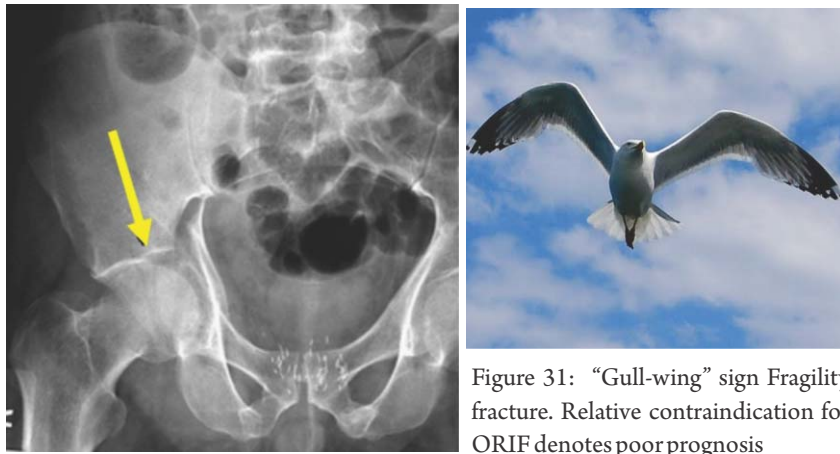


Figure 31: “Gull-wing” sign Fragility fracture. Relative contraindication for ORIF denotes poor prognosis

are also changing due to osteoporosis. Anterior wall, column injuries are common and many injuries are because of trivial fall on Greater Trochanter. “Gull wing” sign, which shows a depressed/punched-in part of weight bearing area, is a bad prognostic indicator. Some of these fractures can be picked only on MRI and if, despite negative X-ray, a strong suspicion prevails, MRI is indicated.

Conclusion

Acetabulum fractures need evaluation comprehensively by X-rays and CT Scans. Only then can this complex injury to a complex region be understood. Radiology not only provides assessment of injury, it helps choose best possible approach for stabilization, if indicated.

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