INTRODUCTION

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Pelvic fracture is a serious injury that is associated with significant morbidity and mortality. This is a result of the high energy transfer to the pelvic region. Road traffic accidents and falls from height are by far the most common mechanisms of injury.[1] Where the incidence in Motor vehicle crash is (50-60%), Motorcycle crash (10-20%) Pedestrian versus car is (10-20%) Falls from height is (8-10%) and Crush is (3-6%).[2]

Fractures of the pelvic ring have been reported to comprise 2% to 8% of all skeletal injuries.[3-5] Patients are most often young males in their early 30s, and motor vehicle collisions are the most common inciting cause.[6,7] Because of the high energy involved, patients with pelvic ring disruptions usually have multiple injuries.[6] Morbidity and mortality is also high, with overall mortality rates of 17% for patients with pelvic fractures.[7]

Pelvic fractures are frequently complex and the precise pathological anatomy is not easily demonstrated by routine radiographs.[8] Plain radiographs alone have limited sensitivity for detection of pelvic fractures compared with CT.[9] Fractures of the sacrum and acetabulum are most easily overlooked.[8, 9]

Digital radiography and Computed Tomography are valuable for evaluating pelvic fractures.[10] In most poly trauma patients, the first imaging study today is MDCT. Although axial CT images have a higher diagnostic accuracy in detecting and characterizing pelvic injuries than radiography, evaluation with MPR images has been shown to increase diagnostic accuracy.[11] Pelvic trauma is where 3-D imaging first made a significant clinical impact, and it is now a standard requisite for surgical planning, being a valuable complement to axial and MPR images.[12]

Normal anatomy

The bony pelvis consists of a ring formed by the paired bones (ilium, ischium, and pubis), the sacrum and the coccyx. The ring is completed by the paired sacroiliac joints posteriorly and the pubic symphysis anteriorly. [13]

The paired bones are composed of three parts: the ilium, ischium, and pubis. These meet at the triradiate cartilage, visible in the immature skeleton as a Y-shaped irregular lucency at the acetabulum. [13]

The ilium is a curved, flat bone with the iliac crest superiorly. At either end of the crest are the anterior and posterior superior iliac spines. Below these lie the anterior and posterior inferior iliac spines, respectively. [13]

The ischium has a body with a tuberosity inferiorly. From this, the ischial ramus runs anteriorly to join the inferior pubic ramus at a synchondrosis. Posteriorly, the ischial spine divides the greater sciatic notch above from the lesser sciatic notch below. [13]

The pubis consists of a body and superior and inferior rami [13] (Fig 1)

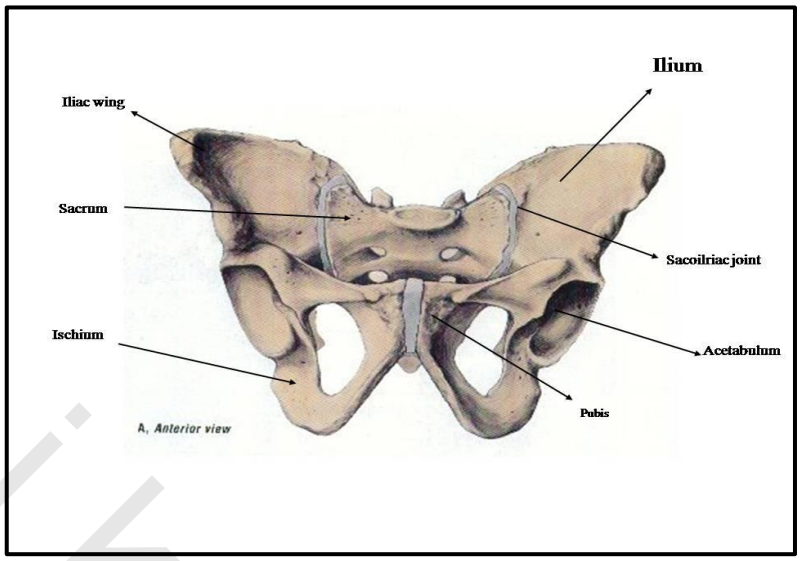


Fig. (1): Normal pelvis anatomy [14]

The plane of the pelvic inlet separates the greater pelvis (part of the abdominal cavity) from the lesser pelvis (pelvic cavity).The anterior superior iliac spine and the anterior aspect of the pubis lie in the same vertical plane , the sacrum is located superiorly, the coccyx posteriorly and the pubic symphysis anteroinferiorly [14] (Fig 2).

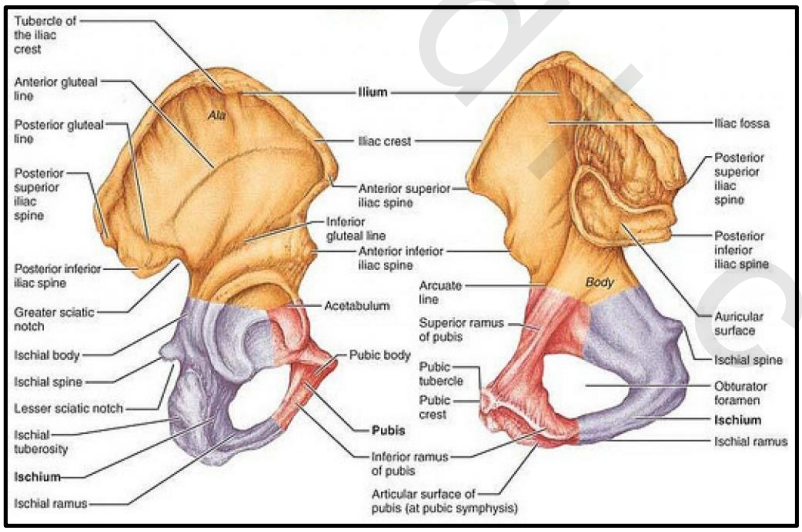


Fig (2): Bony and Parts of the pelvis [14]

The acetabulum is supported by two columns: (1) larger anterior column and (2) smaller posterior column. The two columns form an inverted "Y" to support the hip [15,16] (Fig.3)

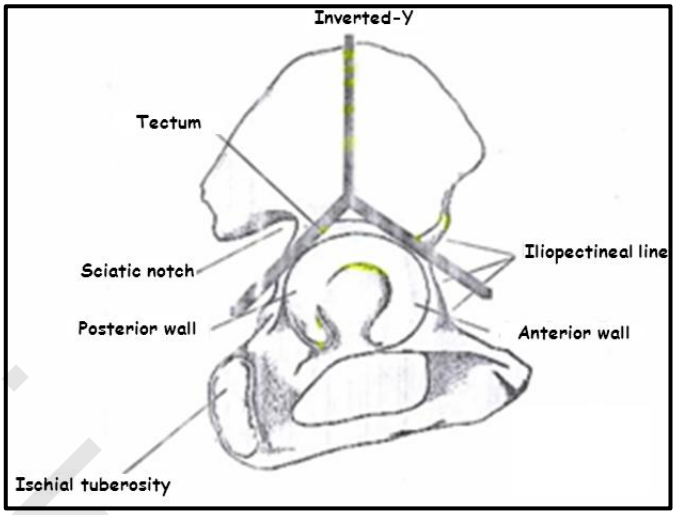


Fig. 3: Normal acetabular anatomy [16]

The anterior column begins at the inferior pubic ramus and extends well above the acetabulum into iliac wing. The posterior column is composed predominantly of the ischium and extends to the greater sciatic notch and the sacroiliac joint below the acetabulum, the anterior and posterior columns are joined at the Ischiopubic junction.[17]

The medial wall of the acetabulum is called the quadrilateral plate and consists of a thin layer of bone separating the hip joint from the pelvis.Posteriorly, the sacrum articulates with the iliac bones at the sacroiliac joints. [18]

The posterior and interosseous sacroiliac ligaments form the so called posterior hinge or posterior tension band, which resists verticle translation of the ilia on the sacrum and is essential to pelvic stability [16] (Fig 4).

The normal width of sacroiliac joint (SI) space is 2.5-4mm. Anterior and posterior sacroiliac ligaments (SI) bridge the sacroiliac joints (SI). The posterior sacroiliac ligaments are quite thick whereas their anterior counterparts are much thinner. In addition, the iliolumbar ligaments connect the posterior iliac crest to the transverse process of L5. The sacrotuberous (ST) and sacorspinous ligaments (SS) connect the inferior aspect of the sacrum to the ischial tuberosity and ischial spine receptively [19] (Fig.4).

The medial end of the pubies articulates to from the pubic symphysis, bridged by superior and arcuate pubic ligaments. The inferior pubic rami, as they diverge from the symphysis form the pubic arch. The pubic and ischial rami fuse to form the obturator ring.[20]

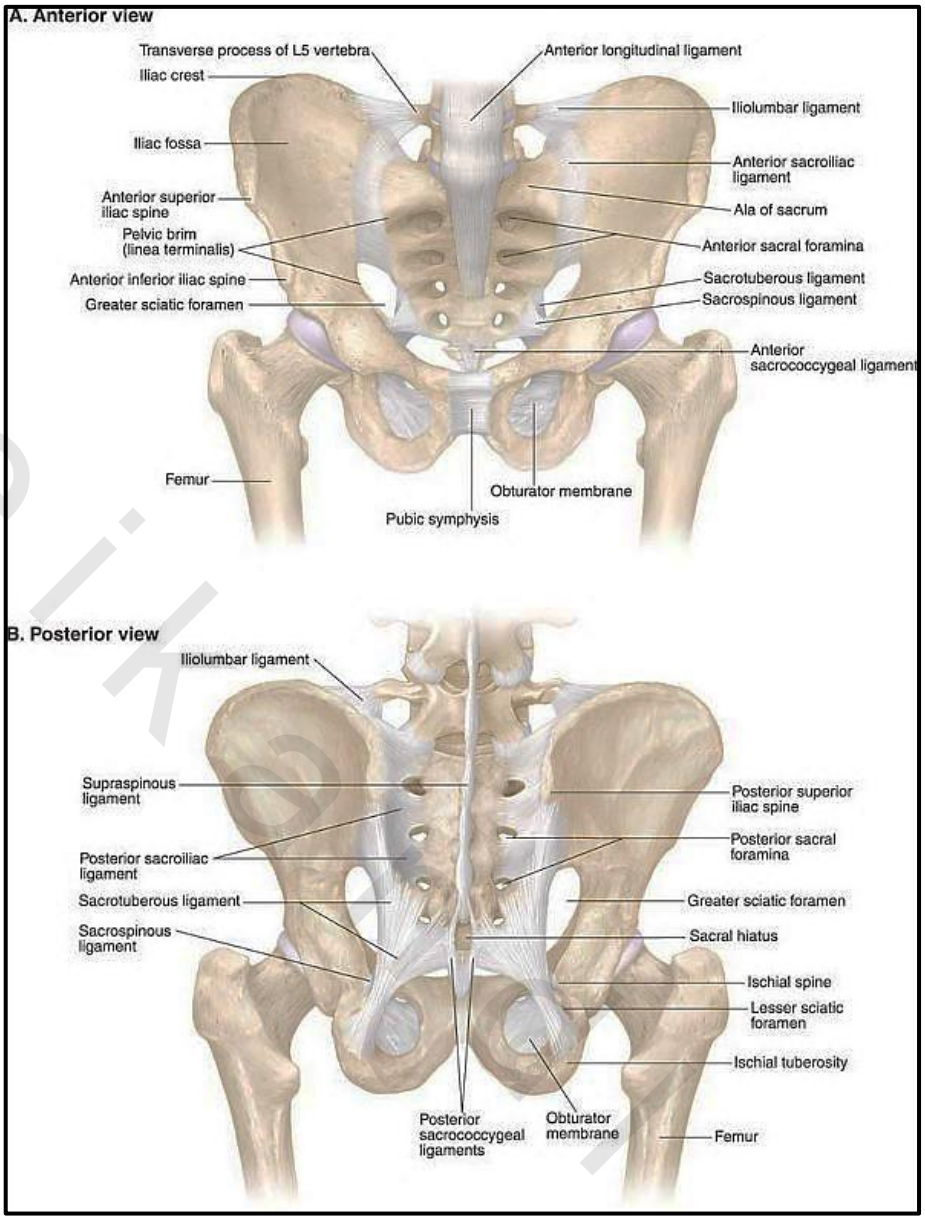


Fig. (4): Ligament of the pelvis (Ant. Post.) [14]

The female pelvic girdle is relatively wider and shallower than that of the male, related to its additional roles of bearing the weight of the gravid uterus in late pregnancy, and allowing passage of the fetus through the pelvic outlet during childbirth (parturition). [14,21] (Fig 5)

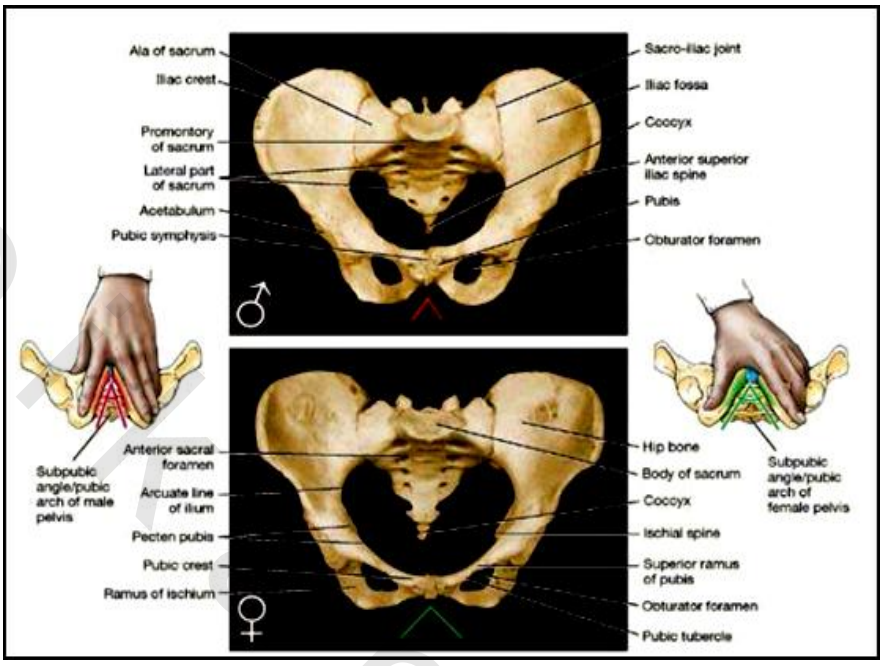


Fig. (5): Comparison of male and female pelvis**.** [21]

A routine anteroposterior view of the pelvis is taken with the patient in the supine position and with the cassette underneath the tabletop. A somewhat distorted view of the lower part of the sacrum and coccyx is obtained, and these bones may be partially obscured by the symphysis pubis. A better view of the sacrum and coccyx can be obtained by slightly tilting the x-ray tube. An anteroposterior radiograph should be systematically examined. The lower lumbar vertebrae, sacrum, and coccyx may be looked at first, followed by the sacroiliac joints, the different parts of the hip bones, and finally the hip joints and the upper ends of the femurs. And soft tissue shadows of the skin and subcutaneous tissues may also be visualized. [22] (Fig 6)

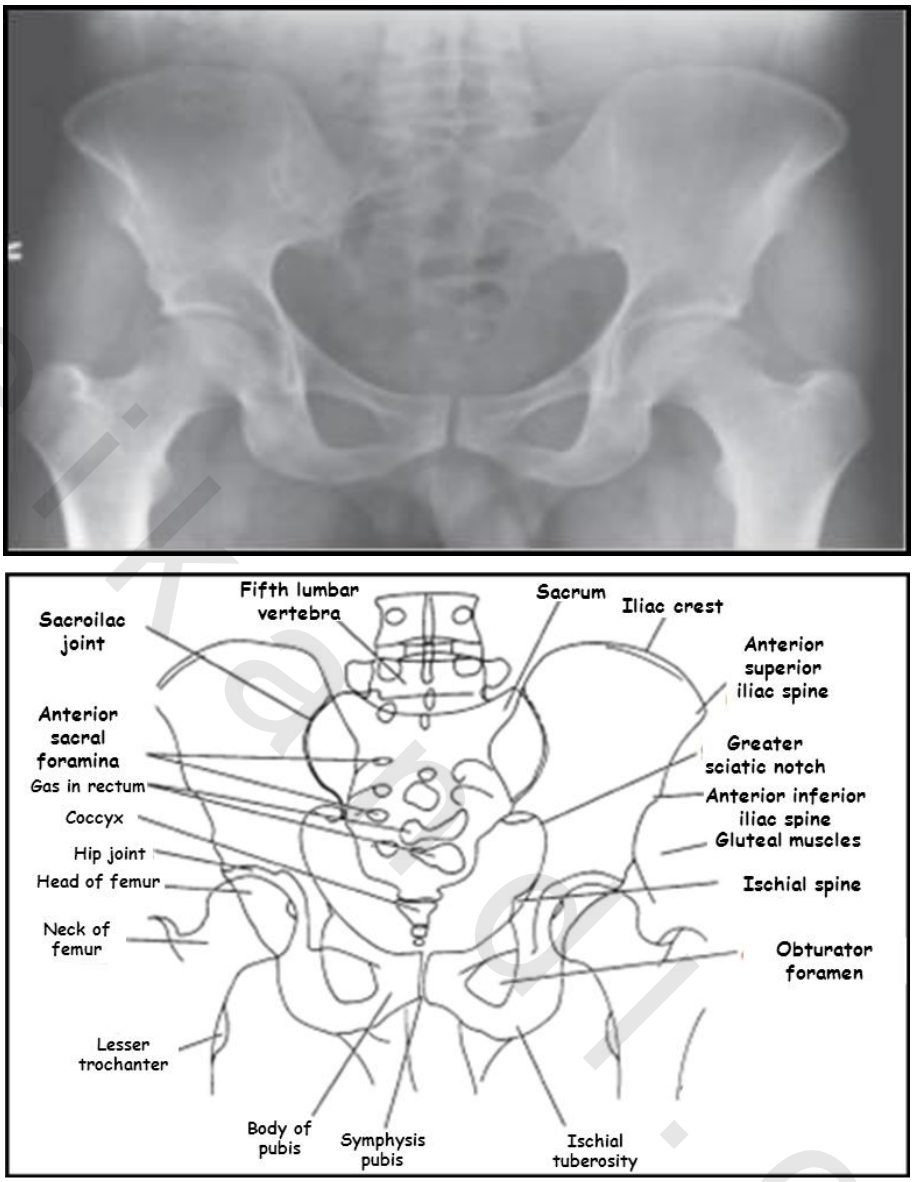


Fig. (6): Representation of the radiograph of the pelvis seen in the Anteroposterior radiograph of the pelvis.[22]

The pelvis contains convex bony structures, which form borders and surfaces that are difficult or impossible to demonstrate via the standard projections of conventional radiograph. Computed tomography, with its transverse scanning plane, can provide additional images of structural contours that are essential for diagnosis. The horizontal circumferences of the acetabulum and head of the hip joint, including the anterior and posterior borders of the hip Joint, are demonstrated in detail**.** However, the roof of the acetabulum and the upper Joint space are masked by partial volume artifacts when scan sections are thick sections of 2-3mm thickness should therefore be scanned for better demonstration of these regions in patients with certain diagnostic problems. In more caueded sections. The image detail of cortical structures increases muscle orientation of the structures becomes axial, and a detailed evaluation of the sacrum is therefore possible. The anterior sacral foramina normally form unequivocal images. The capsule of the hip Joint appears on CT scan as a narrow strip of soft tissue that extends from the anterior and posterior acetabular margins and ends directly contiguous withthe head [23] (Fig 7,8)

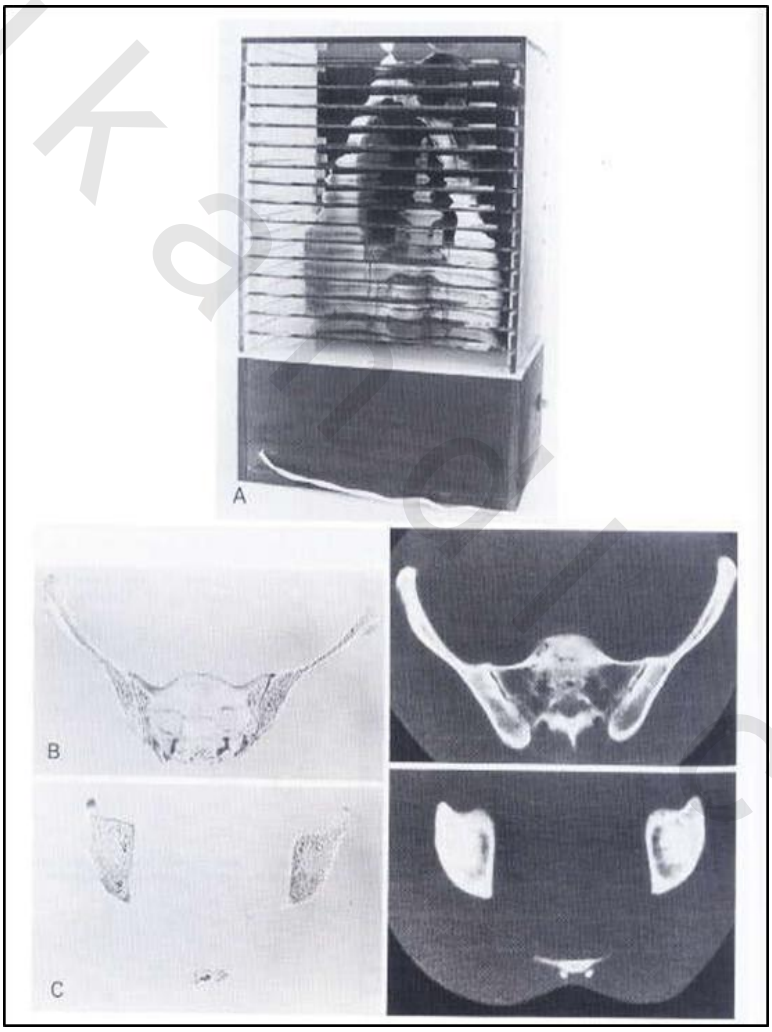


Fig. (7): (a) Embedded in clear acrylic and then sliced, (b) the segment through the sacroiliac joints. (c) Cephalad to the dome of the acetabulum, (d) through the dome of the acetabulum.[24]

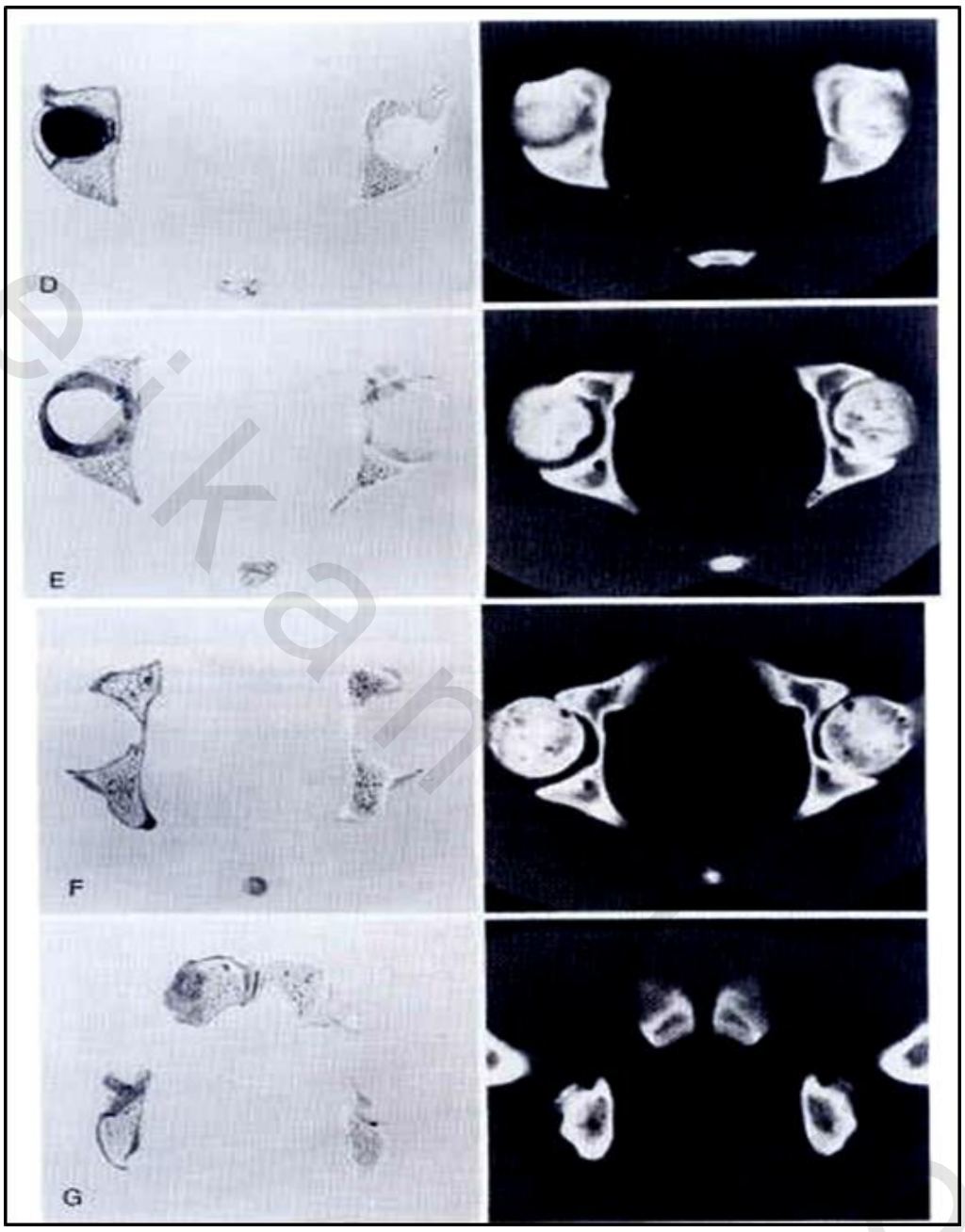


Fig. (7): (d) The articular cartilage of dome is clearly outlined, the anterior column the posterior column. and the medial wall of the acetabulum. (e) Abone slice 1cm from the dome. (f) a slice through the central portion of the acetabulum. (g) The pelvis beyond the acetabulum.[24]

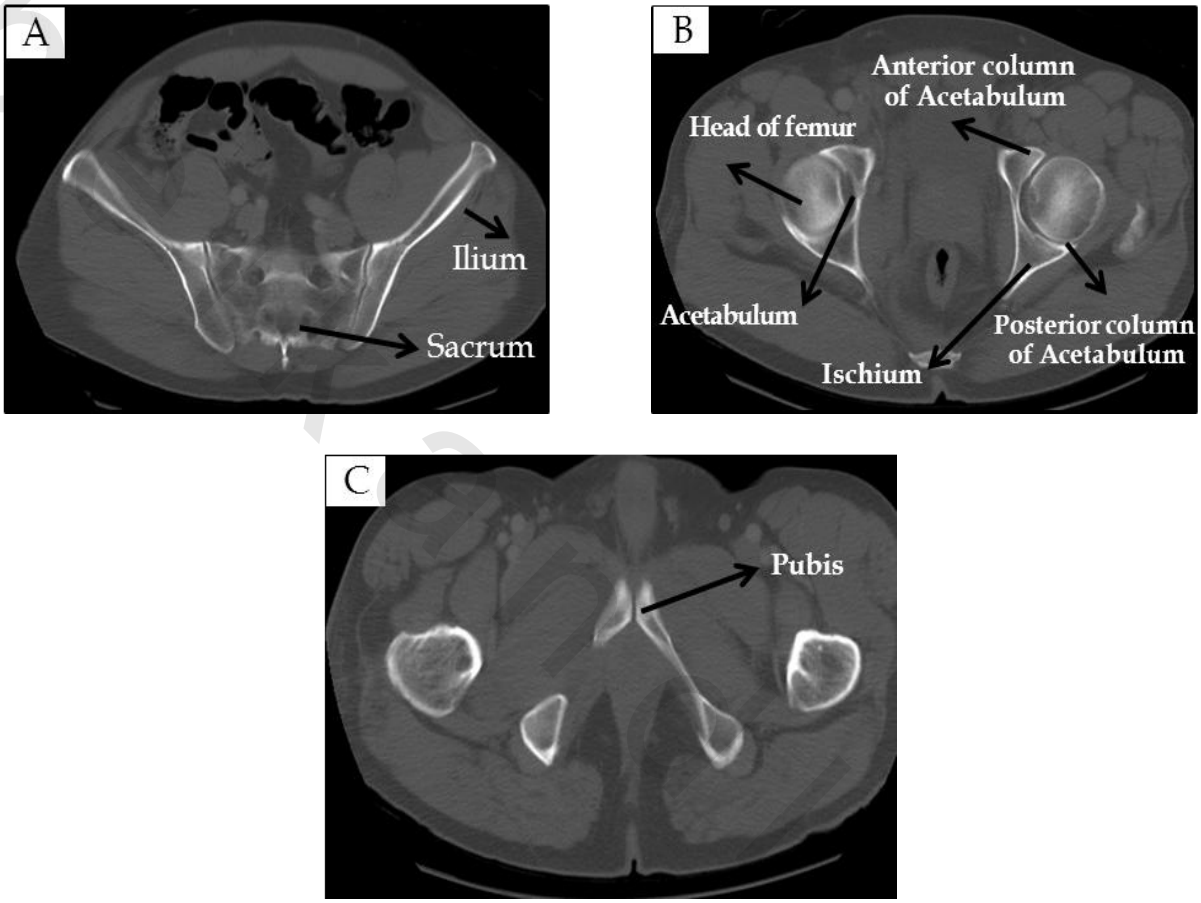


Fig. (8): Anatomical axial CT scan of the pelvis.[22]

Because bone attenuates the X-ray beam so much, its CT attenuation value (around +1000 HU) is much greater than that of the surrounding soft tissues. Thus, the bones can be 'extracted', with no overlying artifacts, to provide information equivalent to that from a cadaveric skeleton. [25] (Fig 9)

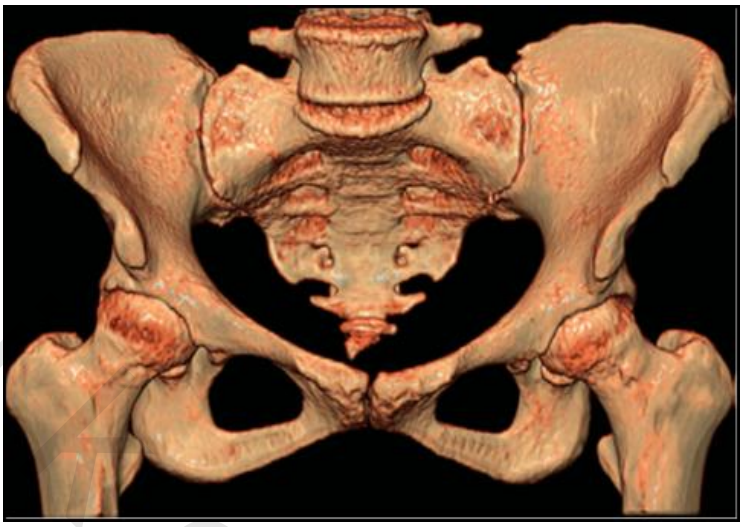


Fig. (9): 3D Computed Tomogram of the pelvis [25]

Pelvic fracture

Pelvic fractures involve fractures that are, by definition, limited to the pelvic ring (pelvis and sacrum), whereas acetabular fractures (commonly caused by high-impact trauma, such as falls and automobile accidents) are described and classified separately [25]

Fractures of the pelvic ring have been reported to comprise 2% to 8% of all skeletal injuries .3-6 and are often associated with high-energy trauma, most commonly, motor vehicle accidents and falls from a height. The incidence of pelvic fracture appears to be increasing, secondary to increases in the number of high-speed motor vehicle accidents and the number of patients surviving these accidents, due to airbag and safer car designs. Among multiply injured patients with blunt trauma, almost 20% have pelvic injuries.[26]

Pelvic fractures can either be stable fractures resulting from low energy trauma, for instance iliac wing or isolated ramus fractures, or more importantly, unstable fractures from high energy injury. Most of these results from road traffic accidents, falls from height, or occasionally, workplace crushing accidents.[27]

Classification of pelvis fracture

Pelvic fractures are common among patients who sustained multiple injuries.[28] Sacral injures make up a major component of pelvic ring fractures and reach up to 74% of patient with pelvic fracture.[29]

Much confusion arisen over pelvic fracture due to lack of a logical and meaningful to classification system. Traditionally, pelvic fractures were classified by reference historical descriptions of individual fractures, without any connection between them.This classification included single fractures of the pelvis and thus was largely outdated by the work of Certzbein and Chenoweth (1977) who demonstrated that there was always a second site of injury even in apparently single pelvic fractures. This is due to the fact that the pelvis is a bony ring, held together by ligamentous groups posteriorly. A search for a second site of injury should therefore always be made in fracture involving the pelvic ring.[31]

The classification system of Young and Burgess (1986) developed from work by pennal and Tile which describes fractures relative to the force of injury.

Tile classification

Tile (1980) further proposed a classification system using radiographic criteria to decide which injuries are mechanically stable and which are not, and therefore which pelvic injuries require stabilization and which can be managed nonoperatively. He divided pelvic ring injuries into types A, B, and C. With type A injuries, the pelvic ring is still intact; with type B injuries, the ring is rotationally unstable but vertically stable; and with type C injuries, both rotational instability and vertical instability of the pelvis are present.[32]

1- Type A (stable)

Type A fractures are stable, and are not pelvic ring disruptions. Small chip or avulsion fractures of the innominate bone are termed Type A1 fractures. Stable, minimally displaced fractures of the pelvic ring or iliac wing fractures are termed Type A2 injuries. Type A3 injures is transverse sacrum or coccygeal fractures. [33] (Fig 10)

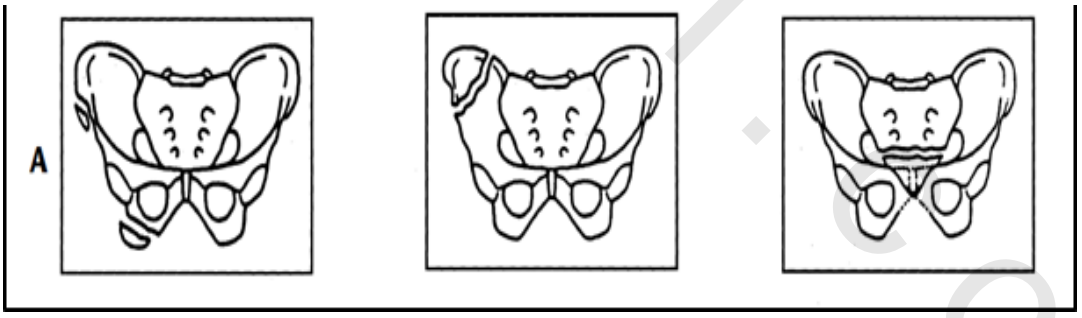


Fig. (10): Diagraph show the Type A fractures of the pelvis (stable) [34]

2- Type B (rotational instability)

Type B fractures are unstable with respect to rotation, but are vertically stable. The simplest example is an open-book fracture (B1) of the pelvis, with pubic symphysis diastasis or obturator ring fractures in the anterior pelvis, and anterior sacro-iliac diastasis in the posterior pelvis (Fig. 12). This fracture pattern is unstable with respect to external rotation, but the posterior sacroiliac ligaments remain intact and provide vertical stability. The second type of rotationally unstable pelvic fractures is LC injuries. These are Type B2

fractures, and involve transverse fractures through the obturator rings and impaction fractures across the sacroiliac joint. Finally, complex pelvic fractures may involve an open-book appearance on one side, but a LC of the opposite side. These bilateral rotational injuries are Type B3 [33] (Fig 11).

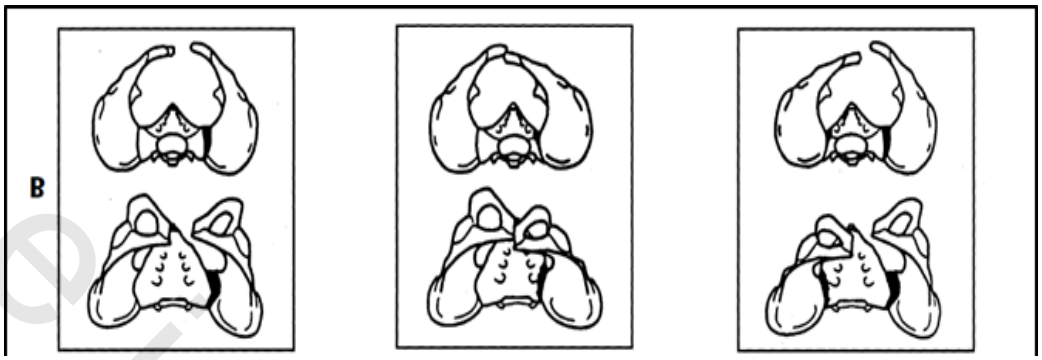
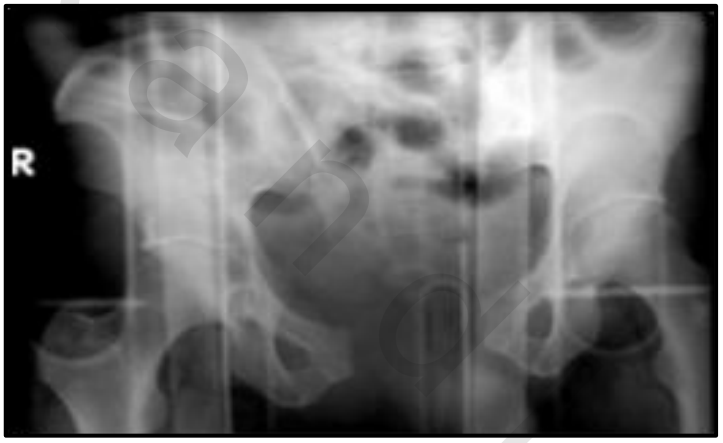
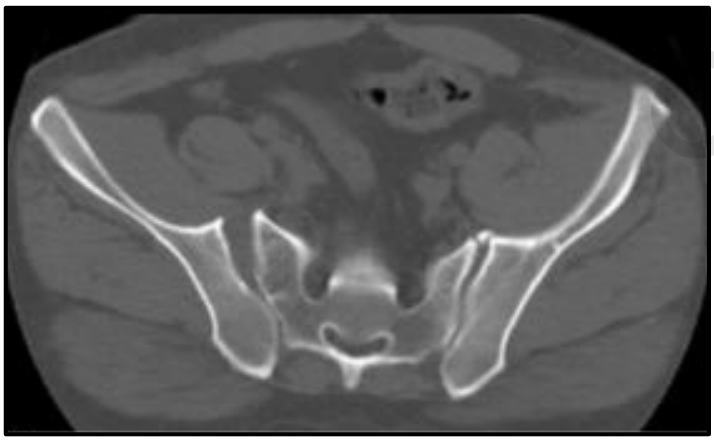


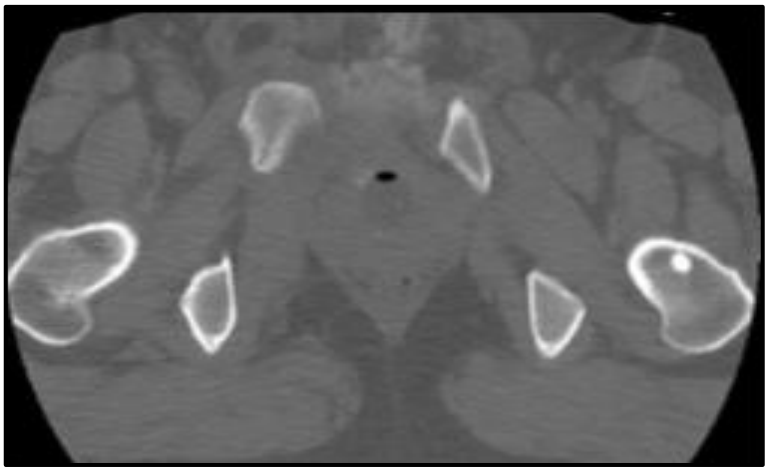
Fig. (11): Diagraph show the Type B fractures of the pelvis (unstable).[34]



(A)



(B)



(C)

Fig. (12): (a) AP radiograph shows greater than 2.5 cm symphysis Diastasis. The posterior SI joints are likely intact, but the anterior right SI joint looks wide; (b) axial CT image demonstrates right anterior SI diastasis and small avulsion fracture of left anterior SI joint indicating anterior ligament injury on this side (c) axial CT image of symphysis diastasis. This Tile B1 fracture is rotationally unstable, but vertically stable. [33]

3- Tile Type C (rotational and vertical instability)

Type C fractures are unstable to both rotational and vertical forces and are among the most severe pelvic fractures. Anterior pelvis injuries include vertical fractures through one or both obturator rings. These fractures are often limited to one side of the pelvis, and are then Type C1. More complex patterns exist, and Tile defines additional subcategories for each combination. Type C2 fractures are vertically unstable on one side, and rotationally unstable on the other (Figs14.). Type C3 fractures are vertically unstable on both sides. [33] (Fig 13)

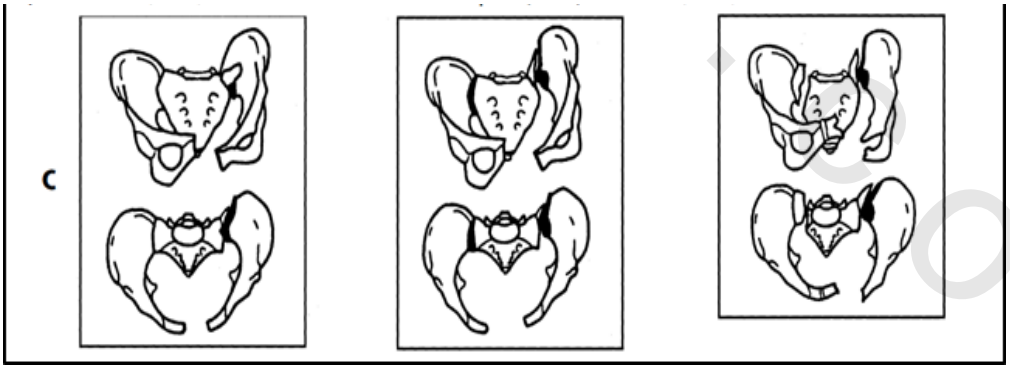


Fig. (13): Diagraph show the Type C fractures of the pelvis (unstable). [34]

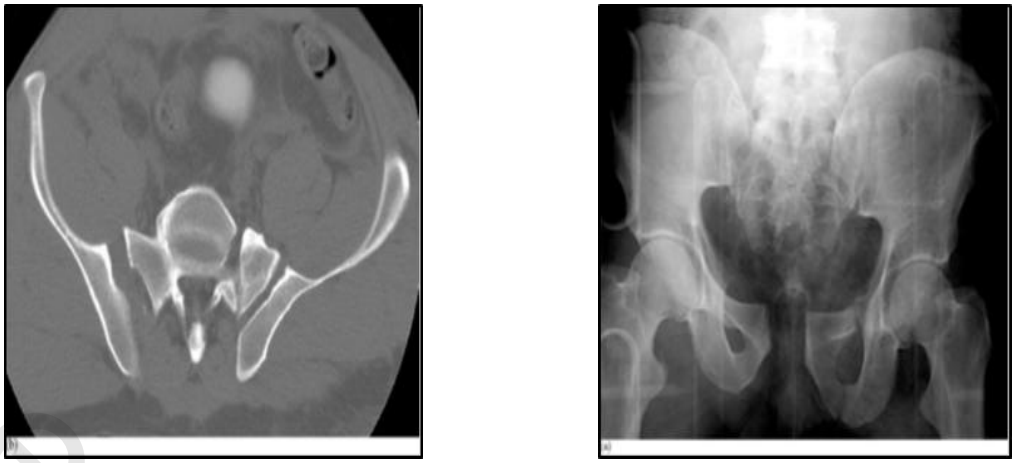


Fig. (14): (a) AP radiograph reveals vertical displacement of the right hemipelvis with a symphysis diastasis, left obturator ring fractures, and right sacroiliac diastasis/disruption; **(b)** CT confirms right SI diastasis and shows vertical and posterior displacement of right hemipelvis, as well as left anterior SI diastasis. This is a Tile C2 with right vertical instability and left rotational instability. [33]

Young and burgess classification

Young had expanded Tile's classification and created a classification system to predict the mechanism of injury. The Young-Burgess classification system divides pelvic ring disruptions into 4 major types: anterior-posterior compression, lateral compression, vertical shear, and combined mechanism injury. Based on radiographic appearance, the authors further subdivided anterior-posterior compression injuries into anterior-posterior compression I, II, and III and lateral compression injuries into lateral compression I, II, and III [32]

1- Lateral compression fractures

These are subdivided into three types depending upon the severity of the injury, and progressive involvement of the posterior pelvis (Fig. 15). Pubic rami fractures are invariably present and generally run horizontally, or in the, coronal plane. Alternatively they may present as a buckle fracture. A common association is a crush fracture of the sacrum. Fracture of the medial wall of the acetabulum with or without central dislocation of the femoral head is also associated. [35]

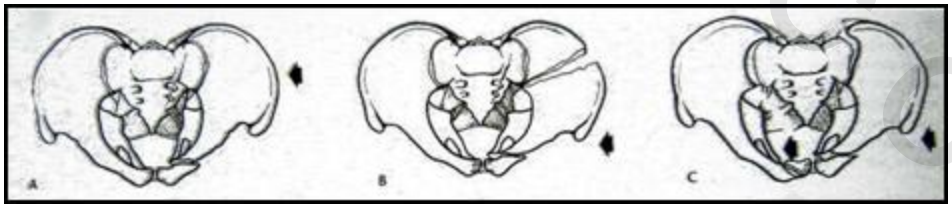


Fig. (15): Lateral compression pelvic fracture classification. Posteriorly lateral force causes compression of the sacrum, or buckle fractures of the pubic rami. The force is delivered more anteriorly, causing inward rotation of the anterior pelvis around the anterior aspect of the sacroiliac joint. Fracture of the iliac wing (shown here). (C) Type III. The lateral force on one side is transmitted to the contralateral side, causing an externally directed force to 'open' the contralateral pelvis [35]

Type I: Fractures there is no ligamentous damage, and no posterior pelvis instability. (Fig 16)

Type II: Fractures there is medial displacement of the anterior pelvis on the side of injury with either a fracture through the sacroiliac joint and iliac wing, or rupture of the posterior sacroiliac ligaments (Fig.17) this allows some posterior instability.

Type III: Fractures, the lateral force on one side of the pelvis is transmitted through to the contralateral side, so that the fracture is directed outward .This causes "opening" of the pelvis on the contralateral, side, with associated posterior ligamentous disruption AP compression fracture [35] (Fig.18).

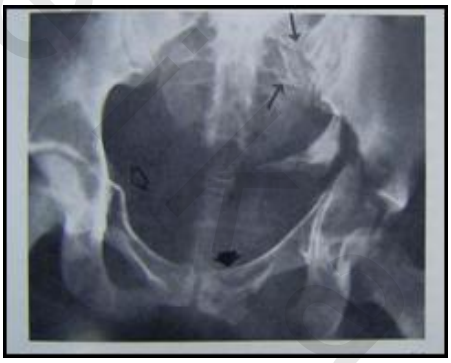


Fig. (16): Type I lateral compression fracture. A horizontal fracture of the left (closed arrow) and a buckle fracture of the right (open arrows) superior pubic ramus are seen. There is a crush fracture of the left sacrum (long arrows), and a fracture predominantly of the medial wall of the left acetabulum.[35]

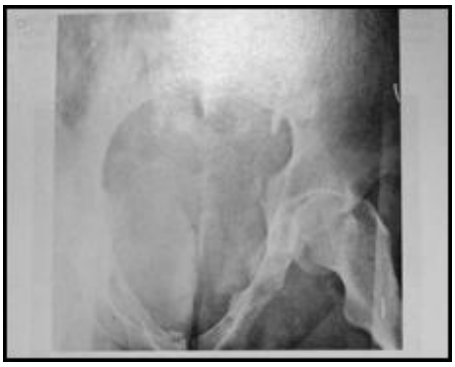


Fig. (17): Type II B lateral compression fracture. 'Horizontal' fracture of the right symphysis, and oblique fracture of the left iliac wing. There is moderate medial displacement of the left anterior pelvis.(Reproduced with permission of Urban and Schwartzenberg from Young and Burgess (1987) [35]

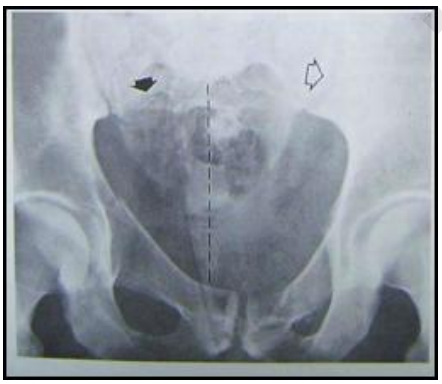


Fig. (18): Lateral compression Type III. There are crush fractures of the right sacrum (closed arrow) and left pubic rami. Sacroiliac joint (open arrow) and lateral displacement of the whole of the anterior pelvis to the left, Fractures of the right pubic rami are also seen.[35]

AP compression fracture

The damaging force in the AP or (PA) direction tends to cause "opening" of the anterior pelvis (Fig. 19), with splaying of the symphysis pubis (SP) and or fractures of the pubic rami. Which however, are in the vertical plane, in contrast to lateral compression fractures. The more sever type II and III fractures relate to increasing posterior ligamentous injury and hence increasing instability [35] (Fig 20).

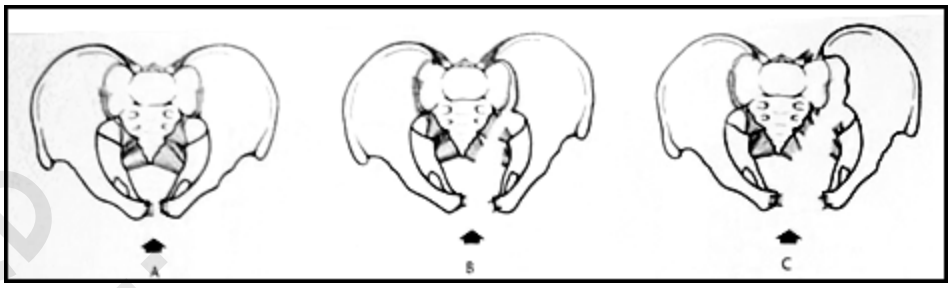


Fig. (19): Anteroposterior (AP) compression fracture classification. I. Diastasis of the symphysis pubis only. Type II. Diastasis of the symphysis pubis, disruption of the sacrospinous and sacrotuberous ligaments, and anterior sacroiliac ligment. Type III. Total ligamentous disruption, including the posterior sacroiliac ligaments. [35]

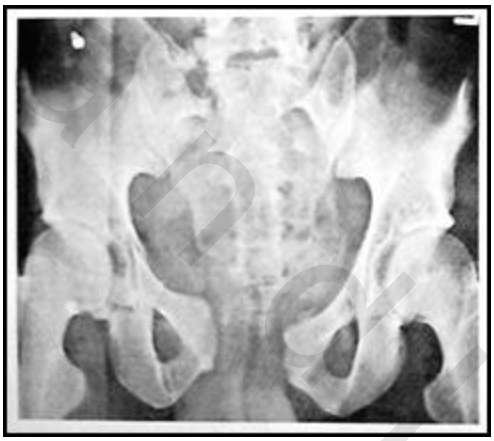


Fig. (20): Type II AP compression fracture. There is wide diastasis of the symphysis pubis and anterior left sacroilliac joint.[35]

In type II fractures, the anterior sacroiliac, (SI) sacrospinous (SS) and sacrotuberous (ST) ligaments are disrupted, allowing wide splaying of the anterior pelvis.

Type III fractures, there is total disruption of sacroiliac joint (Fig.21) fractures of the anterior and posterior acetabular pillars are common, and posterior hip dislocations are also associated, in contrast to lateral compression fractures, when the medial wall of the acetabulum is at risk.[35]

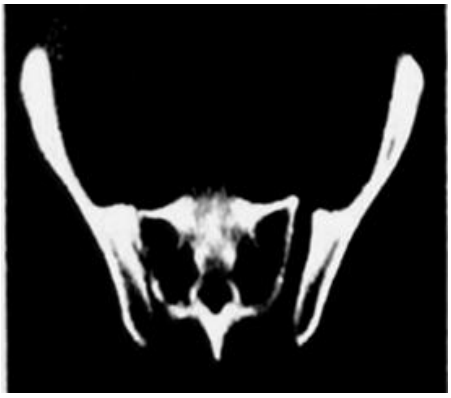


Fig. (21): Type III AP compression fracture. CT scan demonstrates complete diastasis of the left sacroiliac joint.[35]

Vertical shear fractures

These commonly result from falls from a height fractures occur though the pubic rami and posterior pelvis. And are vertically oriented (Fig.22). The large lateral hemipelvic fracture fragment containing the acetabulum is displaced superiorly.

Fractures of the posterior and superior acetabula are often associated with superior displacement of the femoral head. These injuries are associated with fractures of the lumbar vertebrae and calcaneus.[36] (fig.23)

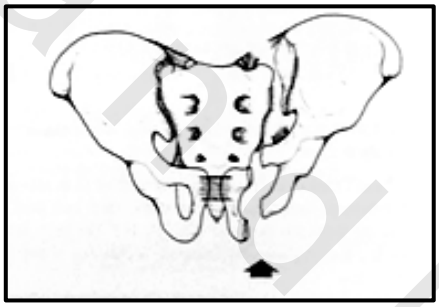


Fig. (22): Vertical shear fracture pattern. A superiorly directed force disrupts the left hemipelvis, with diastasis through the left sacroiliac region. [35]

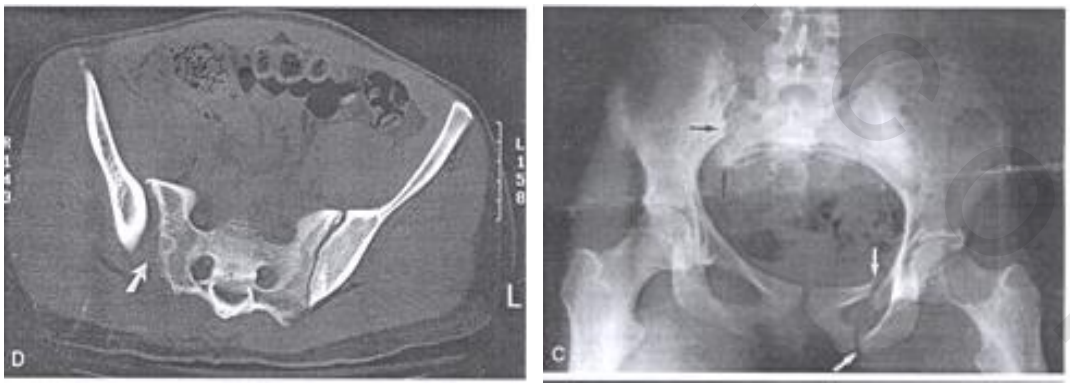


Fig. (23): AP pelvis shows dislocation of the right sacroiliac joint (black arrows) and contralateral obturator ring fractures (white arrows). The right hemipelvis is displaced superiorly on the sacrum. D, Direct coronal CT scan shows the sacroiliac dislocation (arrow).[16]

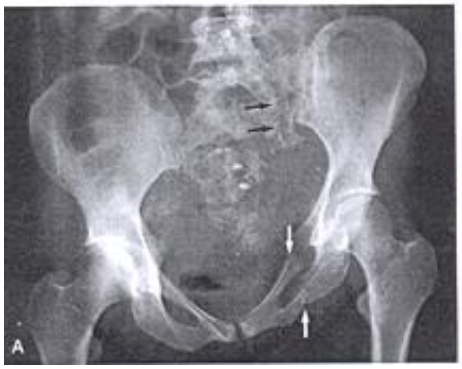


Fig. (24): Vertical shear pattern. A, AP pelvis shows left sacral (black arrows) and ipsilateral obturator ring (white arrows) fractures. The left iliac crest and hip are displaced superiorly compared with the right, the radiographic hallmark of the vertical shear injury pattern. B, Direct coronal CT scan of the sacrum shows the comminuted fracture (closed arrows) and superior displacement of the left ilium (open arrow).[16]

Mixed fracture pattern

These arise from a combination vector of the forces causing injury and give rise to a mixed pattern of fracture, the commonest being a mixed antero-lateral pattern (Fig.25), with signs of both AP and lateral compression.[35]

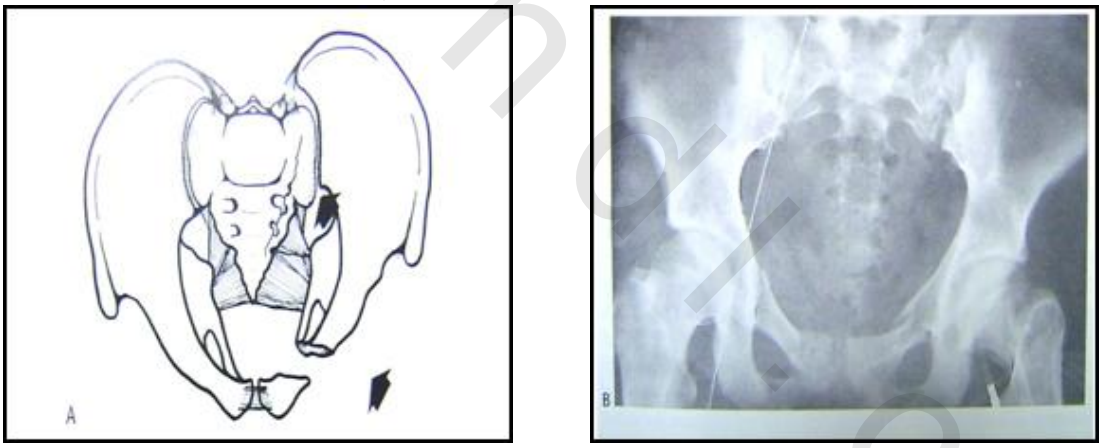


Fig. (25): A) Combined fracture pattern. (B) AP and lateral compression. Fractures of the left pubic rami, lateral compression, but disrubtion of the left sacroiliac joint, indicating AP compression[35]

Plain radiography

Plain radiographs are the initial means of evaluating a patient with suspected pelvic fracture an AP view of the pelvis is one of the film that every traumatized patients receives on admission [16] (Fig 26)

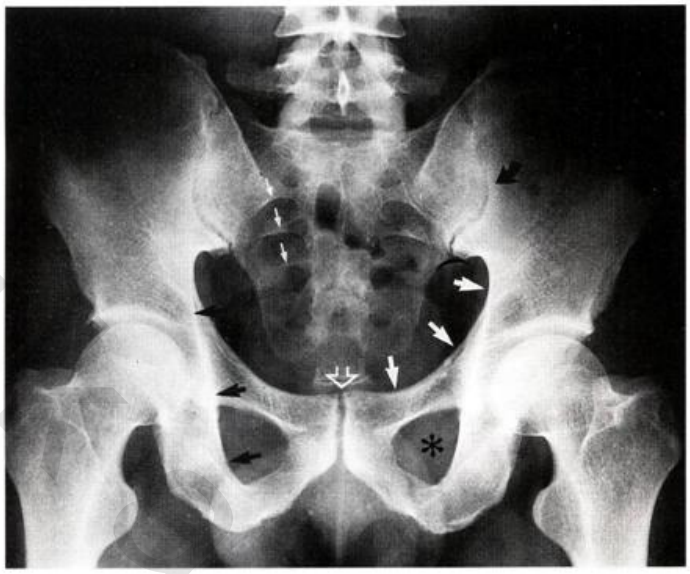
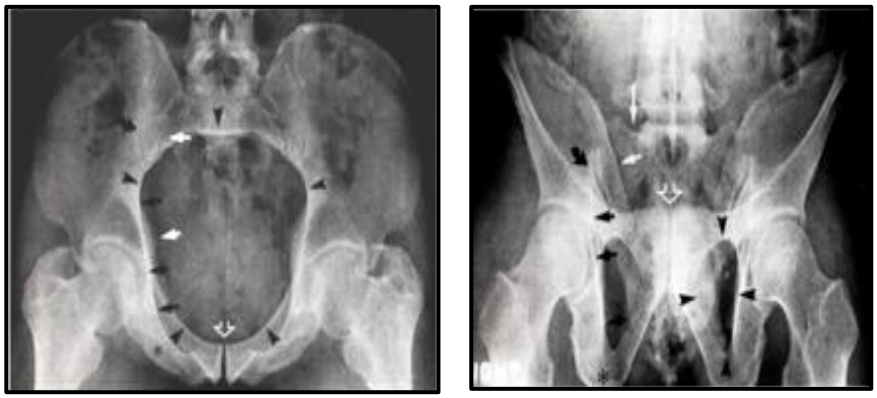


Fig. (26): AP radiograph of a normal adult pelvis: The principal skeletal anatomic landmarks include the sacroiliac joint (curved arrow), sacral arcuate lines (small white arrows), ilioischial line (black arrows), iliopectineal line (large white arrows), pubic symphysis (open arrow) and obturator foramen (asterisk).[37]

The vast majority of diagnosis can be made correctly by using (AP) radiograph alone. The inlet view of the pelvis (a view of the pelvic inlet with the patient supine, the x-ray tube angled 35C° caudally and beam centered mid-way between the (umbilicus and pubic symphsis) is of use for several reasons. It may demonstrate subtle compression the expansion of the pelvic ring seen in lateral or AP compression. It may also demonstrate the coronal nature of pubic rami fractures that appear vertically oriented on the AP view, enables us indicating of the effects of a lateral compression force. The inlet view identification of the sacrum fractures that is not identified on the AP view. [38] (fig.27)

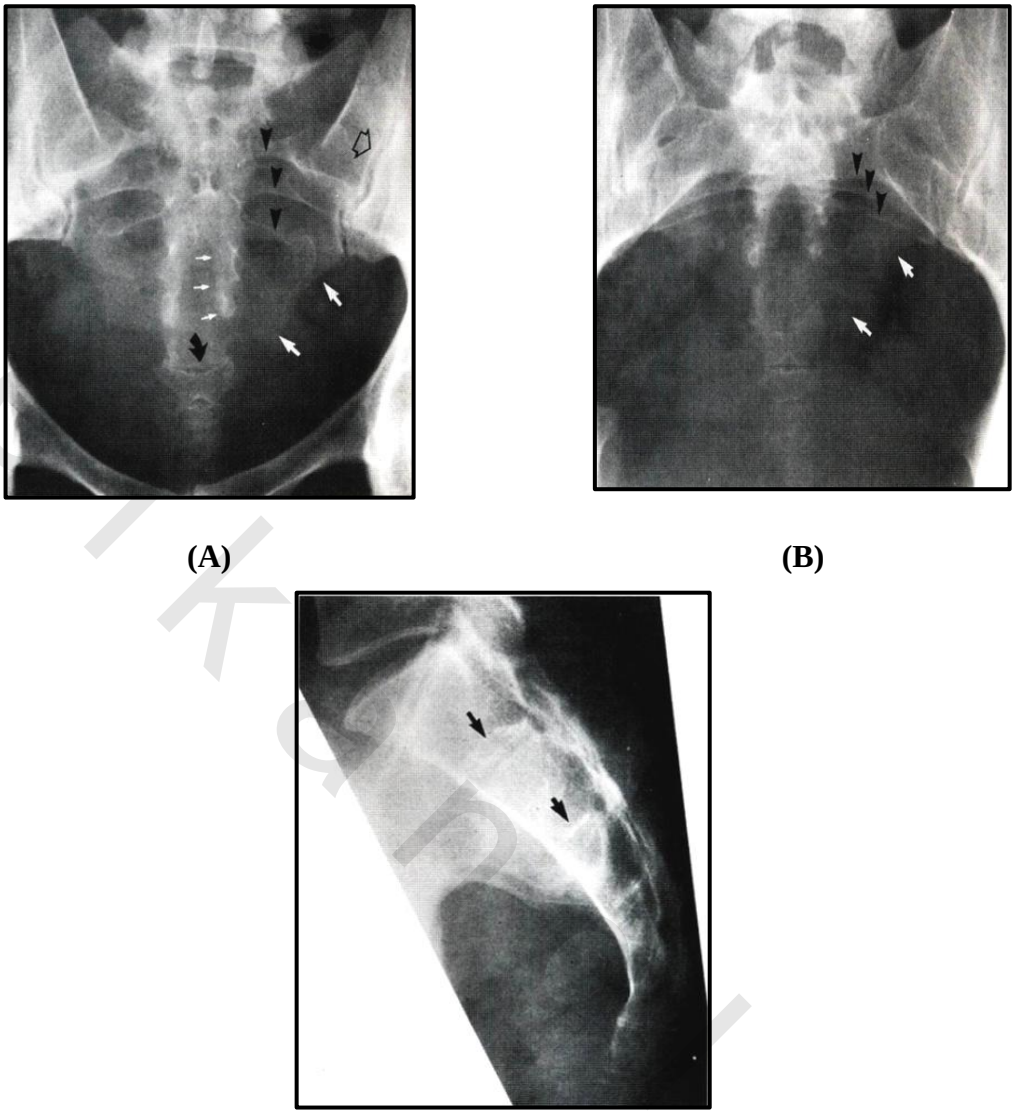


(A) **(B)**

Fig. (27): The inlet view (A) This projection shows the pelvic ring (plane of the intel to the true pelvis (arrowheads), the anterior (curved arrow) and posterior (short white arrow) margins of the sacioiliac joints, the ilioischial line, (black arrows), the ischial tuberosity (astarisk), the ischial spine (white arrow) and the symmetry of the pubic symphysis (open arrow) and the symmetry of the pubic symphysis (open arrow). The outlet view (B) including the ala (long white arrow), the anterior (curved arrow) and posterior (short white arrow) margins of the sacroiliac joint (curved arrow), the ilioischiat line (black arrows) and pubic symphysis (open arrow) in different, and the margins of the cbturator foramen (arrowheads).[37]

The outlet view of the pelvis (a view of the pelvic outlet with the patient supine and the x-ray tube angled 35°C cephald and the beam centered on the superior margin of the pubic symphysis) although it is not diagnostic of any pelvic fracture, it provides an indication of vertical displacement of the fracture fragment in cases of vertical shear. This is of some importance to surgeon in planning corrective treatment.[38] (Fig 28)

Unlike bones that may fracture in response to any type of deforming force. Ligaments fail only in tension. The pelvic ligaments play a critical role in normal pelvic stability and in stability after pelvic fractures.[39]



(A) **(B)**

(C)

Fig. (28): Shows the superior margin of the ala (broad arrow), the normal sacral arcuate lines (arrowheads), the sacral iliac joint (open arrow), the lateral margin of the lower sacral segments (white arrows), the sacrococcygeal joint (curved arrow), and adjacent coccyx. The small white arrows mark the lateral margin of commonly unfused sacral crest. The radiograph obtained with the central beam angled caudally shows the arcuate lines (arrowheads) and the lower sacral segments (white arrows). The lateral radiograph is the most useful projection of the sacrum and coccyx. The transverse linear densities represent to fused sacral disk spaces.[37]

Computed tomography

Although plain radiography is indicated for fracture classifications, CT is useful for detecting intra-articular fragments, fragment interposition, marginal impaction, occult pelvic ring fractures and evaluating the sacroiliac complex to determine if vertical instability is present.[16]

Multi-planar or reconstructions can facilitate detection and quantification of articular discontinuity, which is often important for deciding between operative and conservative treatment.[16]

MSCT has increased the speed, efficiency and accuracy of computed tomographic imaging in musculoskeletal trauma. Added advantages such as MPRs and 3D imaging have greatly enhanced the ability to evaluate complex anatomical areas such as the spine, pelvis and foot.[40, 41]

Three dimensional reconstruction's of the acetabulum although not usually needed to classify a given fracture a given fracture, do provide important preoperative information for the surgeon who is contemplating open reduction and internal fixation three dimensional rendering can be enhanced by electronic disarticulation prior to reconstruction, as well as reconstructing only the hemipelvis of interest. This minimizes interference by overlapping structures.[20]

CT scan delineates soft tissue and concomitant injury to soft tissue structures.. CT is particularly effective in the post-surgical assessment of the alignment of fragments and fracture healing.[42]

The nearly universal application of computed tomography (CT) into the initial assessment of patient with PRD and the increasing use of three dimensional CT (3 D CT) both accurately depict the orientation of components of PRD.[37]

In the interest of eliminating the unnecessary patients movement required to obtain oblique or tangential views, the AP radiograph of the hips and pelvis should be obtained initially and carefully studied from the point of view that the pelvis in fact, a three dimensional structure only when the AP radiograph of the pelvis is found to be inconclusive should additional views be considered.[37]

The routine radiographic examination of the sacrum and coccyx alone must include a straight AP projection and a true lateral radiograph of the sacrum and coccyx However, in the context of PRD, CT best demonstrates sacral and sacroiliac anatomy and traumatic pathology is best demonstrated by CT.[37]

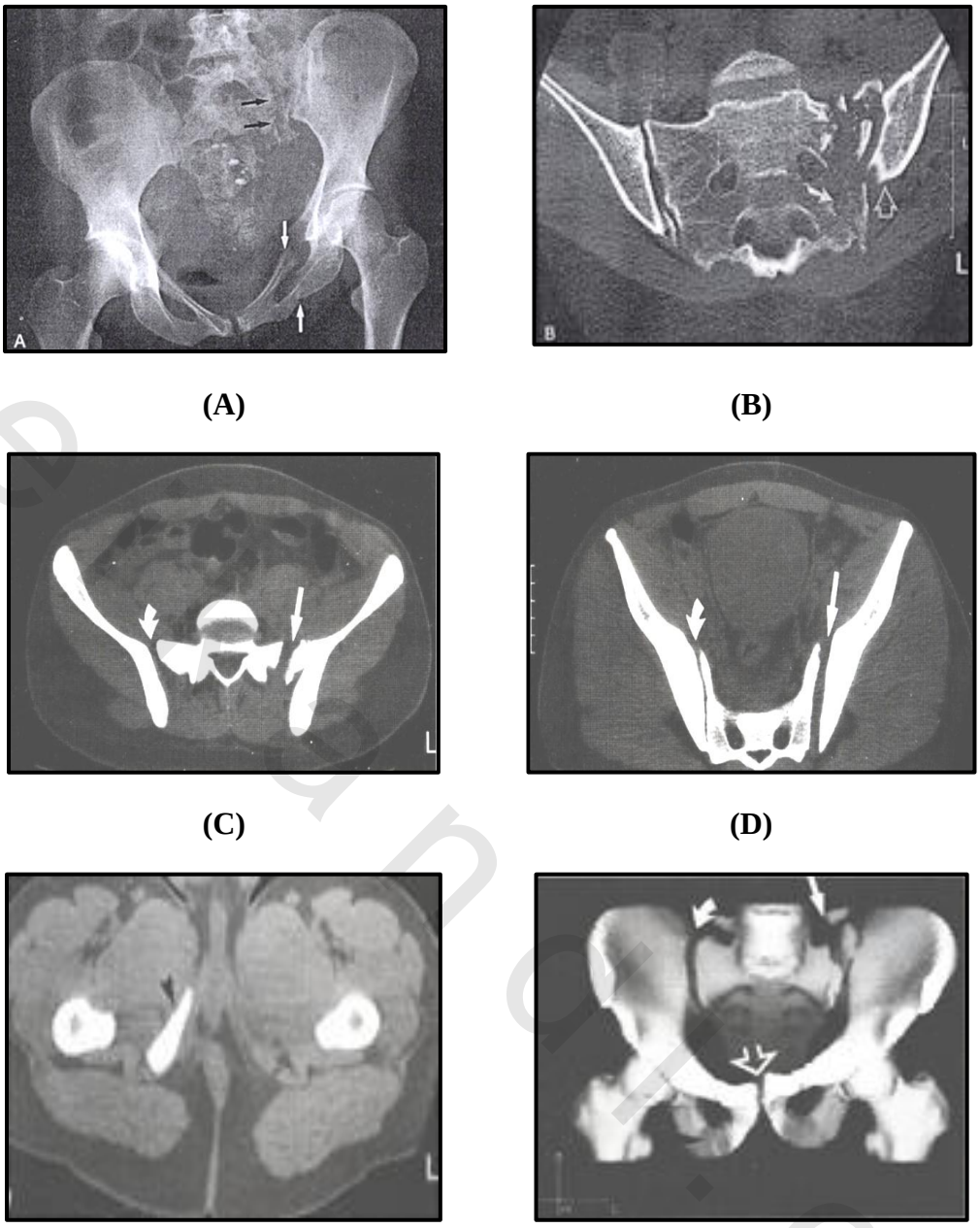


Fig. (29): Pubic diastasis, is evident on both AP (A) and inlet (B) views. Of two posterior sites of disruption the left sacroiliac joint separation-alar fracture (straight arrows) is easily recognized but the right sacroiliac joint separation (curved arrow) could easily be overlooked Axial CT clearly demonstrates the bilateral sacroiliac joint diastasis and the left sacral alar fracture (C and D) and confirms the right inferior public ramus fracture (arrowhead, E), The 3D CT images in frontal (F).[37]

Many authors reported that 10-31% of sacroiliac joint diastasis were misdiagnosed on plain film interpretations.[43]

With CT, all joint diastases were detected. Intra-articular gas was not seen on any of the plain films but was detected by CT. An intra-articular fragment was identified only on CT images. Alignment of the diastatic elements was well seen on CT.[44]

Over one half of the fractures were unsuspected on plain radiograph with CT, all fractures were clear detected. Confirmation of a suspected fracture was aided by CT, and with CT it was possible to delineate the site of origin of the fracture more precisely.[45]

In plain radiographs a high index of suspicion and a conscientious search for minute asymmetry or deformity of the sacral actuate lines may improve the detection of vertical shear fractures.[46]

Plain film interpretation failed to detect 25% of comminuted sacral fractures, with CT, all of these fractures were detected and more CT more clearly depicted the location rotation and dislocation of the fracture fragment. Reformation in a sagittal plane could be useful in delineating the anteroposterior relationships of fragments.[45]

In one third of patient with posterior pelvic injury the initial classification of the pelvic according to the specific Rchanged because of the additional anatomic information provided by the CT scan where some anteroposterior compression injures were reclassified as lateral compression injuries, and may lateral compression injuries was also reclassified as vertical shear injures.[47]

Furthermore, Buckley and Burkus in (1987) reported that the classification of pelvic injures was changed upon the CT scan finding in 67% of cases where these injuries, classified as single breaks in the pelvic ring depending on plain radiographs, were classified as double breaks in the pelvic ring because of identification of occult disruption within the posterior ring structures.[48]

Before the development of three dimensional CT reconstructions, experienced radiologists and orthopedic surgeons attempted to create a mental three-dimensional image after analysis of radiographs and axial CT scans.

Three dimensional CT has the advantage of providing an image that can be viewed and analyzed from many angles including those to be encountered during a given surgical approach. This can best be achieved by manipulation of the three-dimensional volume at the operator workstation. Precise angles and distances can be measured, and hard copies can be generated on film or videotape including dynamic.[49]

Computer subtraction of certain anatomic structures to improve visualization of other structure provides an advantage not available with other modalities.[15]

In the acute trauma setting patients motion is difficult to control and may severely compromise three dimensional reconstructions. However, with the use of newer scanners. That 1 to 2 second scanning times, motion artifacts can be reduced. Streak outfaces from metallic or high-density objects such as bullet fragments, external fixation device, or monitoring leads many also compromise CT scans (both two and three dimensional).[15]

Three-dimensional images may have computer generated-artifacts surface or edge-detection programs have difficulty in detection of non-displacing fractures or thin osteopenic bone. These artifacts are readily recognized if the three-dimensional image correlated with the original two-dimensional images. Newer volumetric rendering techniques better preserve surface detail with improved visualization of the non-displaced fractures.[49]

Occult injuries identified on CT scanning included sacroiliac joint disruption. Posterior iliac fractures and an avulsion fracture of the ilium at the attachment of the avulsion sacroiliac ligament.[48]

In many cases occult injures to the contralateral sacroiliac joints were revealed by CT scan unexpected extension of the hemi-pelvic fracture into the acetabulum was made visible by the CT scan.[50]

In contrast, apparent extension of the pelvic ring fractures into the acetabulum, suggested on plain films, can be excluded by CT scanning extension of the pelvic ring fracture into hip joint would change the treatment of the fracture and mobilization of the patient.[48]

A high rate of injures that originally had been classified as stable on plain radiographs were reclassified as unstable following CT scan demonstration of marked posterior pelvic ring injures. CT can show sever comminution of the sacrum or of the sacroiliac joint and can demonstrate previously unsuspected posterior displacement of the ilium at the sacroiliac joint. These finding influenced the treatment in the majority of the cases where internal fixation of sacroiliac joint disruption may not be possible with excessive comminution of the sacrum and anterior stabilization of the pelvis with and external fixation device or bed rest and traction may be only alternative.[48]

3D-CT images best showed the plane of the fracture, which can be difficult to assess on Axial CT images. Determining the precise plane of the fracture is important for planning the surgical approach. [15]

3D-CT images provided further insight into the degree of disruption of the articular surface and spatial relationships of the varies fragments when compared with axial scan, 3D-CT images provided better understanding of the relationships of the displaced columns and the position of the stable fragment (iliac fragment which is attached to the sacroiliac.[15]

Magnetic resonance imaging

Some studies have shown the superiority of MRI under particular circumstances such as the detection of intra-articular splinters, appreciation of the femoral head, and detection of hidden fractures mainly in the elderly however, its use remains minor with pelvic trauma in their acute phase [51]

MRI has revolutionized the investigation of bone, joint and soft tissue abnormalities. Multi-planar imaging capability and high contrast resolution mean that the presence and extent of pathology can be defined far more accurately.[52]

MRI demonstrates abnormal bone marrow changes and provides a cross sectional view of soft tissue anatomy [53], Magnetic resonance imaging is a very sensitive method for detecting insufficiency fractures; demonstrating characteristic bone marrow oedema and frequently also fracture lines MRI can be helpful in distinguishing insufficiency from pathologic fractures due to tumour infiltration.[54]

The ligaments are not appreciated on plain films and to some degree with the CT scan. But MRI is very useful for evaluating these ligaments when the pelvis is severely fractured.[55]