Pelvic ring fractures: what to expect

Poster No.: C-0690
Congress: ECR 2014
Type: Educational Exhibit
Authors: A. L. Popirtac¹, I. G. Filimon²; ¹Cluj-Napoca, Cl/RO, ²Cluj-Napoca/RO
Keywords: Trauma, Diagnostic procedure, Conventional radiography, CT, Pelvis, Emergency
DOI: 10.1594/ecr2014/C-0690

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Learning objectives

This paper tries to reveal the spectrum of CT findings associated with the pelvic trauma initially assessed using plain radiographic examination in order to, theoretically, evaluate the link between bone lesions and soft tissue injuries.
**Background**

The pelvis is essentially a **ring** of bones.

The five bones that comprise the pelvis are the ilium, ischium, pubis (innominate bones), sacrum, and coccyx [1].

The sacrum joins to the innominate bone by the sacroiliac joints (the posterior arch). The two innominate bones join frontally by the symphysis pubis (the anterior arch) [2].

**Pelvis fracture** are secondary to massive force, such as a road traffic accident or fall from a height [3].

These represent only a small percentage of all skeletal injuries.

Their importance lies in the significant morbidity and mortality associated with them, which is usually caused by accompanying injury to the major blood vessels, nerves, and lower urinary tract.

Severe pelvic trauma is associated with **hemorrhage** in approximately 60% of cases [1].

The injury patterns seen in the pelvis are generally related to certain specific force patterns, and are divided into stable and unstable injuries [4].

The pelvic ring must remain intact for the fractures to be considered stable. If the ring is compromised, it is an unstable pelvic fracture [1].

Also it is important to assess the pelvic 'rings' (smaller rings exist around the obturator foramina) for steps or asymmetry [3].

**Stable** fractures ([Fig. 1](#)) involve one portion of the ring or the margins of the bony pelvis. The most common stable fracture of the pelvis involves the pubic ring. It may involve one or both rami or the body of the pubis. Transverse fractures of the sacrum ([Fig. 2](#)) and coccyx and fractures of the iliac wing or apophyseal avulsions are uncommon.

**Unstable** fractures consist of fractures involving both the anterior and posterior ring, usually a fracture through the pubic rami and a fracture of the sacrum ([Fig. 3](#)) or dislocation of the sacroiliac joint on the same side of the pelvis. Injuries involving the two rings are on opposite sides of the pelvis [5].

**Pennal, Tile, and colleagues** have elaborated a system based on the direction of the force that produces pelvic injuries. They identified four patterns of force as underlying mechanisms of injury that produce distinctive radiographic appearances:
1. **Anteroposterior** compression, in which the force vector in the anteroposterior or posteroinferior direction produces vertically oriented fractures of the pubic rami and disruption of the pubic symphysis and sacroiliac joints, which often results in bilateral pelvic "dislocation" ("open book" injury).

2. **Lateral** compression, in which the lateral force vector often results in horizontally or coronally oriented fractures of the pubic rami, compression fractures of the sacrum, fractures of the iliac wings, and central dislocation in the hip joint as well as varying degrees of pelvic instability caused by displacement or rotation of one or both hemipelvises, depending on whether the compressive force is applied more anteriorly or more posteriorly [6].

3. **Vertical** shear forces often result in a particular pattern of injury (Malgaigne complex) in which a fracture of the medial ilium or sacrum is seen in conjunction with fractures of the superior and inferior rami on the ipsilateral side with superior displacement of the affected hemipelvis ([Fig.4/Fig.5])[4].

4. **Complex** patterns, in which at least two different force vectors have been delivered to the pelvis, the patterns produced by anteroposterior and lateral compression being the most commonly encountered [7].

Pelvic fractures often involve the acetabulum (approximately 20% of all pelvic fractures), with or without an associated dislocation of the hip. **Acetabular fractures** are generally described in terms of involvement of the anterior or posterior columns, or may be centrally located ([Fig.6-Fig.9]). They are often associated with dislocation of the hip [4]. **Dislocations of the hip** may occur either posteriorly or anteriorly. Posterior dislocation accounts for more than 90% of all hip dislocations. The most common mechanism for a posterior dislocation is with high energy trauma, such as during an automobile accident when the knees impact the dashboard ([Fig. 10]) [1].

The posterior dislocations are frequently associated with fractures of the posterior rim of the acetabulum. The femoral head is displaced superiorly and lateral. Internal rotation of the femoral head and neck and adduction of the femoral shaft are clues to the diagnosis [5].

Affected femoral head may appear smaller secondary to magnification [1].

One or more fragments may become entrapped in the hip joint [5].

CT is frequently able to demonstrate small fragments inside and outside the joint after relocation ([Fig. 11]). Anterior dislocations are uncommon, and tend to result in displacement of the femoral head into the obturator foramen [4]. **Femoral head fractures** are commonly associated with posterior dislocation secondary motor vehicle accident.
Most pelvic visceral injuries involve bladder and urethra, whereas gastrointestinal tract and gynecological injuries are rare following blunt trauma. In patients with unstable pelvic fractures, injuries of the lower urinary tract occur in 25% of these cases, compared with only 6% for patients with stable pelvic fractures [8].

Urinary bladder injury is seen in 8% of patients with pelvic fracture, and typically occurs following severe trauma with other visceral injuries (Fig. 12) [9].

Haematuria, almost always accompanies significant bladder injury. Clinical presentation includes gross haematuria in 90-95% of patients, suprapubic pain, paralytic ileus, absent bowel sounds, ascites and inability to void [4].

Extraperitoneal bladder rupture is caused by perforation of the bladder by a bony fragment or by pulling of fascial connections between the bladder and pelvis during pelvic deformation. The rupture often involves the anterior bladder wall near the neck. Contrast extravasation into the surrounding extraperitoneal tissues creates a flame-shaped appearance. The urine can dissect through adjacent fascial planes into the anterior prevesical space of Retzius, the anterior abdominal wall, the inguinal regions and upper thighs, the lateral paravesical space and the presacral space. Contrast can also extend into the perineum and scrotum. CT can often directly demonstrate the exact site of bladder wall disruption [4].

Intraperitoneal bladder rupture usually occurs at the anatomically weak bladder dome and results from blunt impact to a full bladder or transmission of hydraulic pressure waves in a partially full bladder. Intraperitoneal bladder rupture accounts for 10-20% of all bladder ruptures and requires surgical repair [4]. The rupture site is often plugged by the omentum or bowel loops, making it difficult to detect [8]. Free contrast-enhanced urine pooling in the paravesical spaces has been described as having a 'molar tooth' appearance on radiography and CT.

Intraperitoneal bladder ruptures occur more frequently in small children in motor vehicular accidents than adults as the seat belt fits over the anterior lower abdomen and the bladder is positioned in the lower abdomen rather than deep in the pelvis [4].

Urethral injuries occur in about 10% of major pelvic fractures and typically involve the proximal (posterior) portion. Most urethral injuries occur in men, but have been described in women, particularly those with major peritoneal soft tissue and vaginal injury. In men, urethral injury is associated with blood at the urethral meatus, elevation of the prostate on digital rectal examination, perineal swelling and haematoma [4]. The CT findings of elevation of the prostatic apex, extravasation of contrast material, distortion or obscuration of the uro-genital diaphragm fat plane, hematoma of the ischiocavernosus muscle, distortion or obscuration of the prostatic contour, distortion or obscuration of the bulbocavernosus muscle, and hematoma of the obturator internus muscle were more
common in patients with pelvic fractures and associated urethral injuries than in patients with uncomplicated pelvic fractures [10].
Fig. 1: Patient 1: - AP view: stable pelvic fractures of the four pubic rami; - Axial CT scan: fracture of the right sacral wing (at SI-S2 level) and right superior sacroiliac joint (red arrow); fractures of the left pubic rami and bony fragments adjacent to pubic symphysis (orange arrow); - Axial and coronal CT scan with administration of contrast material: the bladder has a thin wall; the wall is displaced to the right by a left wall hematoma. There is no evidence of contrast extravasation in the peritoneal spaces; - 3D reconstruction CT scan: fracture of the right sacral wing (red arrow); fractures of the left pubic rami and bony fragments adjacent to pubic symphysis (orange arrow).

© Spitalul Clinic Judean de Urgen# CLUJ-NAPOCA 2013
Fig. 2: Patient 2: - AP and lateral view: transverse fracture of the sacrum (red arrow); - Sagital CT view: oblique fracture of vertebral body of S4 with an anterior bony fragment (red arrow).

© Spitalul Clinic Judean de Urgen# CLUJ-NAPOCA 2013
Fig. 3: Patient 3: - AP view: parcelar fracture of the left pubic rami (red arrow); comminuted fracture of the right pubic rami (orange arrow); fractures of the right ilioischiopubic rami (yellow fracture); fracture of the right sacrum (blue arrow); - Axial CT scan: comminuted fracture of the pubic rami, bilateral (red arrow); fractures of the right ilioischiopubic rami (yellow fracture); comminuted fracture of the right sacrum (blue arrow).

© Spitalul Clinic Județean de Urgență CLUJ-NAPOCA 2013
Fig. 4: Patient 4: - AP view: left pubic rami fractures (yellow arrows). Symphyseal diastasis (white arrow). Left anterior sacral fractures-vertical shear fracture of sacrum (orange arrow). Fracture of the left transverse process of L5 (red arrow).

© Spitalul Clinic Jude#ean de Urgen## CLUJ-NAPOCA 2013
Fig. 5: Patient 4: - Coronal and sagittal CT scan: left anterior sacral fractures which runs to the left articular facet process of S1 (orange arrows); - Axial CT scan: left pubic rami fractures (yellow arrows); - Axial CT scan: parcelar fracture of 3mm of the right pubis; symphyseal diastasis of 6mm (white arrow); - 3D CT scan confirms the fractures. - Sagital CT scan: there is no coccygeal fracture - the coccyx points directly forward to form a right angle. This is a normal developmental variant, and it should not be confused with traumatic displacement.

© Spitalul Clinic Jude#ean de Urgen## CLUJ-NAPOCA 2013
Fig. 6: Patient 5: - AP view: Complex fracture of the left acetabulum (red arrow); - Coronal CT scan: soft tissue injury - hemarthrosis (blue arrow).

© Spitalul Clinic Jude#ean de Urgen## CLUJ-NAPOCA 2013
**Fig. 7:** Patient 5: Axial CT scan at the level of the roof of the acetabulum: two-column fracture of the acetabulum (yellow arrows).

© Spitalul Clinic Judean de Urgen# CLUJ-NAPOCA 2013
**Fig. 8:** Patient 6: - AP view: fractures of the right iliac wing which run to the roof of the right acetabulum (red arrows). Fracture of the right pubic rami (blue arrow).

© Spitalul Clinic Judean de Urgen## CLUJ-NAPOCA 2013
Fig. 9: Patient 6: -CT scan: multiple fractures of the right pubic rami and the right (central and posterior) acetabulum which run to the right iliac wing (red arrow). Marked thickening of the obturator internus muscle secondary to hemorrhage and edema (yellow arrow). There is no evidence of free intra-abdominal fluid and no wall bladder injury (green arrow).

© Spitalul Clinic Judean de Urgen## CLUJ-NAPOCA 2013
**Fig. 10:** Patient 7: - AP view: Posterior dislocation - left femoral head lies lateral and superior to the acetabulum; femur in internal rotation and adduction (blue arrow). Interruption of acetabular osseous column cortices: fracture of the anterior wall and posterior rim of the acetabulum (red arrows); -Axial CT scan shows the posterior hip dislocation (blue arrow), the fracture of left iliac wing which runs to the acetabular roof and to the ischiopubic rami (red arrow).

© Spitalul Clinic Jude#ean de Urgen## CLUJ-NAPOCA 2013
Fig. 11: Patient 8: - AP view: Posterior hip dislocation - right femoral head lies lateral and superior to acetabulum (orange arrow); fracture of the acetabulum and comminuted fracture of the right iliac wing (yellow arrow); - CT scan obtained after reduction of the fracture demonstrates fracture of the roof of the acetabulum (yellow arrow) and a small fragment on the posterior wall of the right acetabulum (red arrow). There is no evidence of intra-articular fragments.

© Spitalul Clinic Judean de Urgen# CLUJ-NAPOCA 2013
**Fig. 12:** Patient 9: - Antero-posterior view: There is a slightly displaced fracture of the left ischiopubic pubic rami (red arrow); - Serial axial images of CT scan: Left iliac wing fracture (orange arrow); fracture of the left inferior pubic rami (yellow arrow); fracture of the left sacral wing adjacent to the left sacroiliac joint (blue arrow); - CT scan with administration of contrast material shows a slightly deformation on the posterior wall of the bladder-wall hematoma (green arrow). There is no evidence of contrast extravasation in the peritoneal spaces.

© Spitalul Clinic Judean de Urgență CLUJ-NAPOCA 2013
Findings and procedure details

In our emergency unit the main radiologic modalities used in evaluation of the pelvic ring fractures include conventional radiography and computed tomography.

The routine radiographic assessment of the pelvis always begins with a standard anteroposterior view and can be augmented with a variety of oblique views.

With respect to pelvic plain radiography, CT provides superior detailing of fractures, position of fracture fragments and extent of diastasis of the sacroiliac joints and pubic symphysis. CT provides diagnostic information regarding the presence or absence of haematomas and can identify the site of bleeding [11].

The exact diagnosis of an injury is achieved most quickly if, in hemodynamically stable patients, CT scan is the initial examination. In hemodynamically unstable patients, the diagnostic procedure always begins with plain X-ray and ultrasound examination of the pelvis [12].

The validity of CT examination for identification of injury to the posterior ring of the pelvis is so high that, radiography of the pelvis has lost its importance. The information on the stability and type of injury provided by 2D and 3D CT reconstructions (Fig.1 and Fig.5) is so exact that, CT examination can replace AP radiography [13].

Pelvic injuries are an important issue in trauma patients, as a result of the major forces required to fracture the pelvic ring. Despite the growing influence of CT in the evaluation of pelvic trauma, conventional imaging remains important, especially in the initial detection of fractures. Several plain film incidences can be used to detect and evaluate a fracture, so that the exact diagnosis can be made in the emergency room. For operative planning CT and especially 3D reconstruction are very useful [14].
Fig. 1: Patient 1: - AP view: stable pelvic fractures of the four pubic rami; - Axial CT scan: fracture of the right sacral wing (at SI-S2 level) and right superior sacroiliac joint (red arrow); fractures of the left pubic rami and bony fragments adjacent to pubic symphysis (orange arrow); - Axial and coronal CT scan with administration of contrast material: the bladder has a thin wall; the wall is displaced to the right by a left wall hematoma. There is no evidence of contrast extravasation in the peritoneal spaces; - 3D reconstruction CT scan: fracture of the right sacral wing (red arrow); fractures of the left pubic rami and bony fragments adjacent to pubic symphysis (orange arrow).

© Spitalul Clinic Judean de Urgen## CLUJ-NAPOCA 2013
Fig. 5: Patient 4: - Coronal and sagital CT scan: left anterior sacral fractures which runs to the left articular facet process of S1 (orange arrows); - Axial CT scan: left pubic rami fractures (yellow arrows); - Axial CT scan: parcelar fracture of 3mm of the right pubis; symphyseal diastasis of 6mm (white arrow); - 3D CT scan confirms the fractures. - Sagital CT scan: there is no coccygeal fracture - the coccyx points directly forward to form a right angle. This is a normal developmental variant, and it should not be confused with traumatic displacement.

© Spitalul Clinic Jude#ean de Urgen## CLUJ-NAPOCA 2013
Conclusion

Based on the injury mechanism and the type, trajectory and complexity of the pelvic ring fracture seen on the plain radiography, the accompanying soft tissue lesions can be foreseeable.

Corroborating the two examination techniques, pelvic plain radiography becomes an anticipation point for the subsequent CT findings, when the latter is delayed or not reachable.
References


