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Contribution of Imaging to the Management of Pelvic Trauma: A Study of 31 Cases

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Abstract | **Case Series**

Introduction: Pelvic trauma represents a potentially life-threatening condition, frequently associated with multiple injuries. Its management requires rapid clinical assessment, accurate injury evaluation and early multidisciplinary care. Imaging plays a crucial role in diagnosis, fracture characterization, assessment of pelvic ring stability, detection of associated injuries and treatment planning. The aim of this study was to analyze the clinical and radiological features of pelvic trauma, including acetabular fractures, and to assess the role of imaging in their management in our Moroccan setting, particularly in the context of the 2023 Al Haouz earthquake. ***Materials and methods:*** We conducted a retrospective descriptive study including 31 patients admitted to the Traumatology and Orthopedic Surgery Department of Avicenne Military Hospital in Marrakech between January 2022 and December 2023 for pelvic trauma. Patients aged 15 years or older with pelvic fractures, including acetabular fractures, who underwent clinical and radiological follow-up were included. Patients with incomplete medical records or who left the hospital against medical advice were excluded. Data were collected retrospectively from medical records using a standardized data collection form. ***Results:*** The mean age was **40 years**, ranging from 15 to 75 years. There was a slight male predominance, with 55% men and 45% women, corresponding to a sex ratio of 1.21. The main mechanism of injury was the Al Haouz earthquake, accounting for 20 of 31 patients (64.5%), followed by road traffic accidents in 29% of cases. Falls from height accounted for 8% of cases and parachuting accidents for 3%. Anteroposterior compression was the predominant injury mechanism, accounting for 53% of cases, followed by lateral compression in 31%. Vertical shear accounted for 10%, while combined mechanisms accounted for 6%. Sixteen patients had isolated pelvic ring fractures, six had isolated acetabular fractures, and nine had combined pelvic ring and acetabular fractures. According to the Tile classification, 24% of fractures were type A, 16% type B and 60% type C. All patients underwent standard pelvic radiography and pelvic CT. Abdominopelvic ultrasound was performed in 35% of cases, while whole-body CT was performed in 54.8% of patients, particularly in the setting of polytrauma. Nine patients (29%) presented with life-threatening conditions at admission and required intensive care management. Associated injuries mainly involved the perineum, thorax and abdominal viscera. ***Conclusion:*** Imaging plays a central role in the management of pelvic trauma. Standard radiography provides an initial assessment, whereas CT is the reference imaging modality for fracture characterization, evaluation of pelvic stability and detection of associated injuries. Whole-body CT is particularly valuable in polytrauma patients, providing a rapid and comprehensive assessment. In our post-earthquake setting, imaging played a decisive role in initial assessment and therapeutic planning.

Keywords: Pelvic trauma; pelvic fracture; acetabular fracture; imaging; computed tomography; polytrauma; Al Haouz earthquake.

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INTRODUCTION

Pelvic trauma encompasses osseous injuries involving the pelvic girdle, particularly the pelvic ring and acetabulum. Its clinical and radiological presentation is highly variable, ranging from stable injuries that may be managed conservatively to complex and unstable fractures that may be life-threatening.

The severity of pelvic trauma is related not only to the osseous injuries themselves but also to the frequency of associated injuries, particularly vascular, visceral, thoracic, urinary, neurological, and perineal injuries.

These injuries usually occur in the setting of high-energy trauma, particularly road traffic accidents,

falls from height, and occupational accidents. However, natural disasters may also cause severe pelvic trauma, particularly through crush mechanisms or structural collapse.

In 2023, Morocco was affected by the Al Haouz earthquake, which occurred on September 8 and resulted in a large number of complex traumatic injuries and an exceptional influx of patients into healthcare facilities in the Marrakech region.

In this context, imaging plays a fundamental role. Standard radiography allows an initial rapid assessment of the pelvic ring, whereas computed tomography provides a more detailed evaluation of bone injuries and adjacent anatomical structures. In polytrauma patients, whole-body CT allows comprehensive assessment for associated injuries.

The aim of this study was to analyze the clinical and radiological characteristics of pelvic trauma managed in our department and to assess the contribution of different imaging modalities to diagnosis, classification, and therapeutic decision-making.

I- MATERIALS AND METHODS

1- Study design and setting

We conducted a retrospective descriptive study of pelvic trauma cases managed in the Traumatology and Orthopedic Surgery Department of Avicenne Military Hospital in Marrakech.
The study was conducted over a two-year period, from January 2022 to December 2023.

2- Study population

Our study included 31 patients with pelvic trauma who underwent imaging evaluation and specialized management.

3- Inclusion criteria

The following patients were included:

- patients aged 15 years or older;
- patients presenting with pelvic fractures, including acetabular fractures;
- patients hospitalized in our department;
- patients who underwent clinical and radiological assessment;
- patients who were followed up during subsequent consultations.

4- Exclusion criteria

The following patients were excluded:

- patients younger than 15 years;
- patients with incomplete medical records;
- patients who left the hospital against medical advice.

5- Data collection

Data were retrospectively collected from medical records using a standardized data collection form.

The collected data included:

- epidemiological characteristics;
- circumstances of trauma;
- injury mechanism;
- initial clinical findings;
- osseous injuries;
- associated injuries;
- imaging examinations performed;
- radiological classifications;
- therapeutic management.

Ethical principles regarding patient confidentiality and anonymity were respected.
Imaging assessment

The imaging work-up was performed according to the clinical context and included:

- standard pelvic radiography;
- additional radiographic views;
- chest radiography;
- abdominopelvic ultrasound, particularly as part of the initial assessment of polytrauma patients;
- pelvic CT;
- whole-body CT in patients requiring comprehensive trauma assessment;
- brain or spinal CT according to the clinical circumstances;
- radiographs of the peripheral limbs according to associated injuries.

Standard pelvic radiography mainly consisted of an anteroposterior view. Additional views were obtained according to clinical and radiological indications.

Pelvic CT allowed detailed analysis of the pelvic ring and acetabulum, with multiplanar reconstructions and, when necessary, three-dimensional reconstructions.

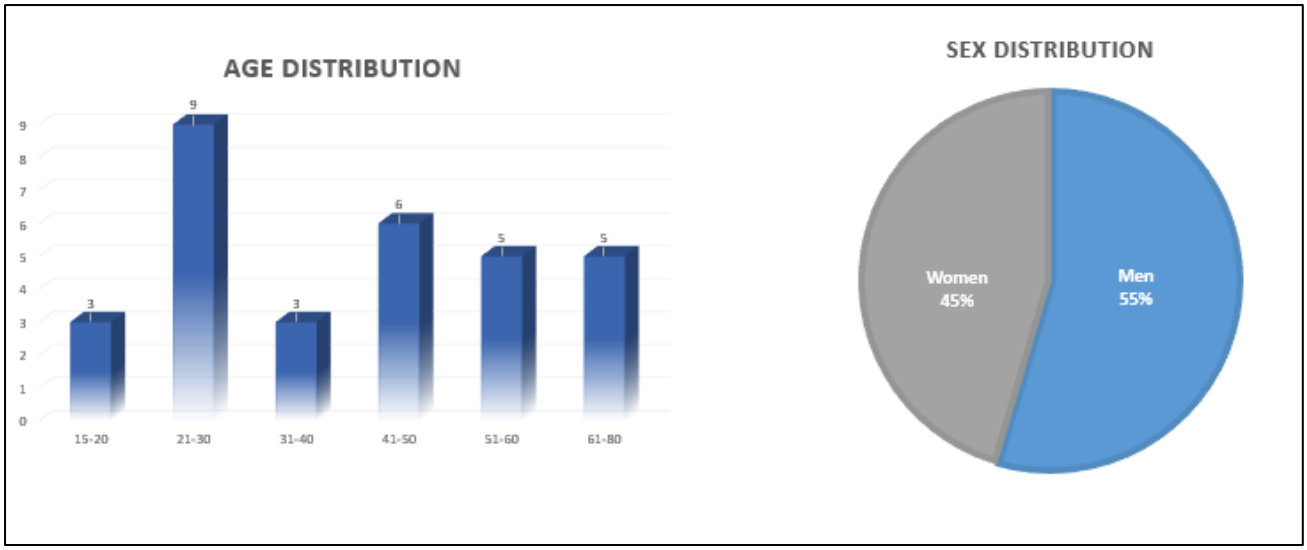
Pelvic ring fractures were classified according to the Tile classification.

Acetabular fractures were analyzed according to the Judet-Letournel classification, distinguishing elementary from associated fracture patterns.

II- RESULTS

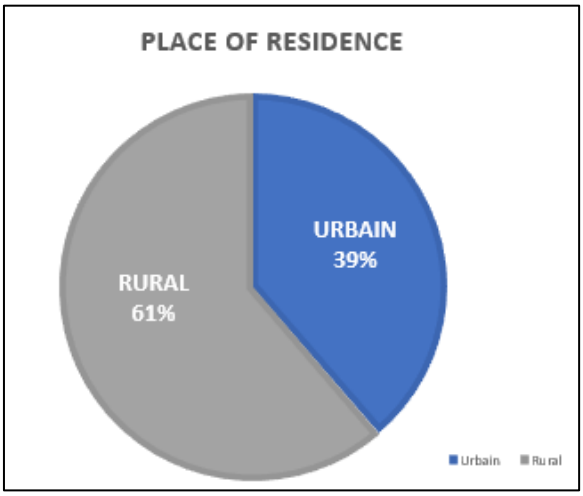
1- Epidemiological data

The mean age of the patients was 40 years, with an age range of 15 to 75 years.
The most represented age group was 21–30 years.
There was a slight male predominance, with 55% men compared with 45% women, corresponding to a male-to-female ratio of 1.21.



2- Place of residence

The majority of patients came from rural areas, accounting for 61% of the study population, compared with 39% from urban areas.



3- Circumstances of trauma

- The main circumstance of trauma was the Al Haouz earthquake, involving 20 of the 31 patients, corresponding to 64.5% of the series.
- Road traffic accidents accounted for 29% of cases.
- Falls from height were responsible for 8% of the trauma cases.
- Parachuting accidents accounted for 3% of cases.

This distribution highlights the particularity of our series, characterized by a predominance of trauma related to the exceptional context of the Al Haouz earthquake.

4- Injury mechanisms

- Anteroposterior compression (APC) was the predominant mechanism, observed in 53% of cases.
- Lateral compression (LC) accounted for 31% of cases.
- Vertical shear was observed in 10% of cases.
- Combined mechanisms accounted for 6% of injuries.
- Injury patterns

From an anatomical standpoint, the trauma cases were distributed as follows:

- 16 patients (52%): isolated extra-articular pelvic ring fractures;
- 6 patients (19%): acetabular fractures;
- 9 patients (29%): combined pelvic ring and acetabular fractures.

Thus, acetabular involvement was present in a total of 15 patients.

5- Clinical findings at admission

- At admission, 9 patients (29%) presented with life-threatening conditions requiring intensive care management.
- The remaining patients had stable vital signs on admission.
- Pain was the main symptom and was associated with functional impairment suggestive of pelvic and/or lower-limb involvement.
- Clinical examination revealed pelvic bruising, skin wounds, and various local signs reflecting the severity of the trauma.



6- CONTRIBUTION OF IMAGING

i- Standard radiography

- All patients underwent standard pelvic radiography, mainly using an anteroposterior view.
- Additional views were obtained according to clinical and radiological requirements.
- Radiography provided an initial assessment of pelvic ring integrity and allowed identification of pubic symphysis diastasis, sacroiliac joint abnormalities, and major fractures of the pubic rami.
- However, bony superimposition and the complex anatomy of the pelvis limit the sensitivity of radiography, particularly for complex fractures and acetabular injuries.

ii- Pelvic computed tomography

- Pelvic CT was performed in 100% of patients.
- It represented the reference imaging modality for detailed assessment of osseous injuries.

It allowed:

- precise identification of the location and orientation of fracture lines;
- assessment of fracture displacement;
- evaluation of pelvic ring stability;
- analysis of the sacroiliac joints and pubic symphysis;
- characterization of acetabular fractures;
- detection of associated osseous injuries;
- evaluation of visceral and retroperitoneal structures.

Multiplanar and three-dimensional reconstructions improved understanding of complex injuries and contributed to therapeutic planning.

iii- Abdominopelvic ultrasound

- Abdominopelvic ultrasound was performed in 35% of patients.
- It was mainly used as part of the initial assessment of trauma patients, particularly to detect intraperitoneal free fluid.
- It represented a rapid and accessible examination, particularly useful in unstable patients.

iv- Whole-body CT

- Whole-body CT was performed in 54.8% of patients, mainly in the setting of polytrauma or severe trauma.
- It allowed comprehensive assessment of the patient for thoracic, abdominal, pelvic, spinal, and peripheral injuries.
- In the context of the Al Haouz earthquake, this examination was of particular value given the high frequency of multiple traumatic injuries.

7- FRACTURE CLASSIFICATION

i- Tile classification

The Tile classification was used to assess the stability of pelvic ring fractures.

It distinguishes:

- type A fractures, considered stable;
- type B fractures, characterized by rotational instability with preservation of a certain degree of vertical stability;
- type C fractures, corresponding to complete rotational and vertical instability.

In our series:

- 6 fractures (24%) were type A;
- 4 fractures (16%) were type B;
- 15 fractures (60%) were type C.

The predominance of type C fractures reflects the high proportion of unstable injuries in our population.

CASE 1



AP pelvic radiograph showing bilateral fractures of the iliopubic and ischiopubic rami (arrow).



Axial pelvic CT images and 3D (VR) reconstructions showing displaced bilateral fractures of the ischiopubic rami (arrows), classified as Tile B.

CASE 2



AP pelvic radiograph showing an overlapping fracture of the right obturator ring (arrows) with pubic symphysis diastasis (arrowhead), associated with a fracture of the left iliac wing (asterisk).



Pelvic CT with 3D (VR) reconstruction showing an overlapping fracture of the right obturator ring (arrows) with pubic symphysis diastasis (arrowhead), associated with a fracture of the left iliac wing and ipsilateral sacroiliac joint diastasis (asterisk), classified as Tile C.

ii- Judet-Letournel classification

Acetabular fractures were analyzed according to the Judet-Letournel classification, which distinguishes elementary from associated fracture patterns.

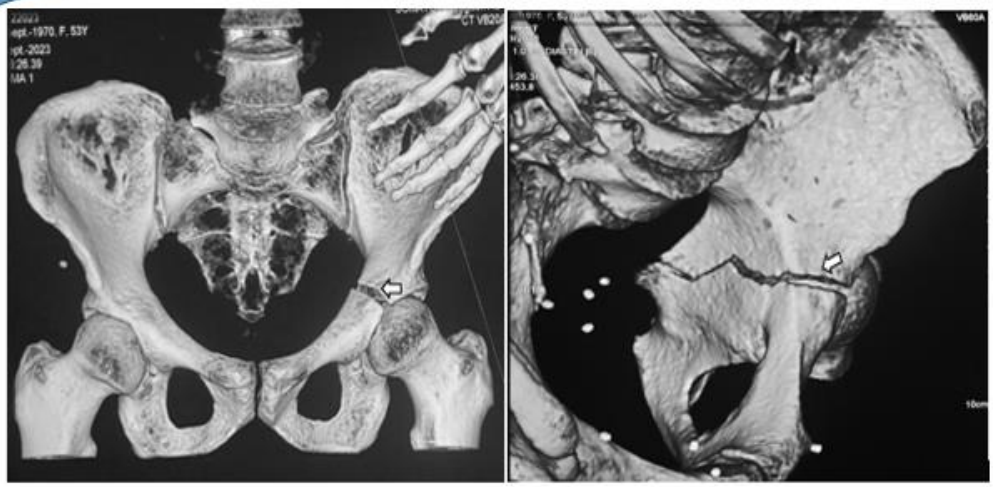
In our series, 15 patients presented with acetabular involvement.

Elementary fractures included injuries involving the anterior wall, posterior wall, columns, and transverse fractures.

Associated fractures combined several anatomical components and required detailed CT

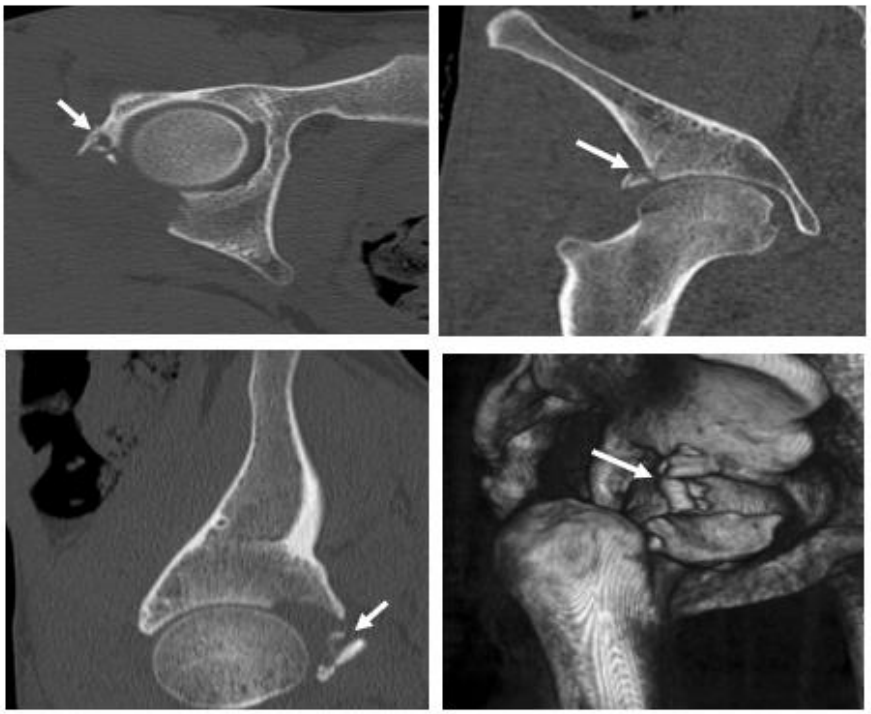
assessment to determine their extent and guide therapeutic strategy.

CASE 3



Pelvic CT showing a nondisplaced left acetabular fracture extending to the posterior wall (arrow).

CASE 4



Pelvic CT showing a fracture of the posterior wall of the right acetabulum (arrows), with detachment of multiple osseous fragments

8- ASSOCIATED INJURIES

- Pelvic trauma was frequently associated with extra-pelvic and visceral injuries.
- Perineal injuries were the most frequent, occurring in 51% of patients.
- Thoracic injuries were also frequent.
- Abdominal visceral injuries included hemoperitoneum as well as visceral lesions such as pancreatic contusions and splenic injuries.
- Urinary, neurological, and vascular complications were also observed.
- The detection of these associated injuries represents an essential component of the radiological assessment of pelvic trauma patients.

III- DISCUSSION

Pelvic trauma represents a complex clinical entity whose severity depends both on the nature of the fracture and on the frequency of associated injuries.

In our study, the mean age was 40 years, which is consistent with data reported in several published series. Kamaoui *et al.,*reported a mean age of 34 years, whereas Ameziane *et al.,*and Deruaz reported mean ages of 40 and 38 years, respectively.

Our series showed a slight male predominance, with a male-to-female ratio of 1.21. This trend has also been reported in several studies focusing on pelvic trauma.

Particularities of the Moroccan setting

The main particularity of our study was the predominance of trauma related to the Al Haouz earthquake.

Indeed, 20 of the 31 patients, corresponding to 64.5%, were victims of the earthquake that occurred in September 2023.

This distribution differs from the usual epidemiology of pelvic trauma, in which road traffic accidents generally represent the predominant cause.

The natural-disaster setting exposes patients to specific traumatic mechanisms, particularly crush injuries, structural collapse, and multiple trauma. These mechanisms may result in complex injuries requiring rapid and comprehensive radiological assessment.

This particularity gives our series specific relevance in the Moroccan context.

Standard radiography and CT

Standard radiography remains important in the initial assessment of pelvic trauma, particularly because of its availability and rapid acquisition.

It allows identification of the main pelvic ring injuries and detection of major abnormalities requiring urgent management.

However, its limitations are significant in complex fractures because of bony superimposition and the difficulty of assessing certain anatomical regions.

CT is currently the reference imaging modality for the evaluation of pelvic trauma.

In our series, its performance in all patients allowed precise characterization of injuries and better assessment of pelvic stability.
It also allows simultaneous evaluation of soft tissues, visceral structures, and retroperitoneal spaces.

Role of whole-body CT

- Whole-body CT plays a major role in the management of polytrauma patients.
- In our series, it was performed in 54.8% of patients.
- Its value lies in its ability to rapidly provide a comprehensive map of traumatic injuries.
- In patients injured during the earthquake, this approach was particularly relevant because of the high frequency of multiple traumatic injuries.
- Whole-body CT can detect active bleeding, hemoperitoneum, visceral injuries, thoracic injuries, and spinal or peripheral injuries associated with pelvic trauma.

Associated injuries

- The frequency of associated injuries in our series emphasizes the need to consider every pelvic fracture as potentially associated with other traumatic injuries.
- Perineal injuries accounted for 51% of cases and represented the most frequent associated injuries.
- Thoracic and visceral injuries were also frequent.
- Imaging allows rapid detection of these injuries and assessment of their severity.
- FAST ultrasound is a useful tool for the initial assessment of unstable patients, particularly for the detection of intraperitoneal free fluid. However, when the patient's clinical condition permits, CT provides a much more comprehensive evaluation of the trauma.

Classification and therapeutic planning

- CT also allows more accurate fracture classification and contributes to therapeutic decision-making.
- In our series, Tile type C fractures represented 60% of injuries, reflecting a high proportion of unstable fractures.

- Multiplanar and three-dimensional reconstructions provide a better understanding of fracture geometry and facilitate planning of potential surgical management.
- Regarding acetabular fractures, the Judet-Letournel classification remains particularly useful for defining fracture anatomy and guiding therapeutic strategy.
- Thus, imaging is not merely a diagnostic tool; it directly contributes to therapeutic decision-making.

RECOMMENDATIONS

Based on the data collected in our study, several recommendations can be proposed.

1. Strengthen early diagnosis

CT should be prioritized in stable or stabilized patients presenting with severe pelvic trauma, with rapid radiological interpretation in collaboration with trauma and intensive care teams.

2. Optimize polytrauma management

Standardized management protocols should be available, particularly in the setting of a mass casualty event. Regular training of medical and paramedical teams is essential.

3. Individualize therapeutic strategy

Management should be adapted to the fracture pattern, its stability, associated injuries, and the patient's general condition, with appropriate access to external stabilization and internal fixation techniques.

4. Ensure rigorous post-treatment follow-up

Clinical and radiological follow-up should allow early detection of complications and adaptation of functional rehabilitation.

5. Strengthen disaster preparedness

The experience of the Al Haouz earthquake highlights the importance of developing hospital plans for managing mass casualties, conducting simulation exercises, ensuring adequate material resources, and establishing effective coordination systems between different specialties.

The establishment of a national registry for severe trauma could also contribute to improving epidemiological knowledge and the management of severe trauma in Morocco.

STUDY LIMITATIONS

- Our study has several limitations.
- First, it was a retrospective descriptive study involving a limited number of patients.
- Furthermore, the study period was marked by an exceptional event, namely the Al Haouz earthquake, which significantly modified the etiological profile of our population.
- These factors limit the generalizability of our findings to pelvic trauma occurring outside a disaster setting.
- However, this particularity also represents one of the strengths of our study, as it documents the experience of a Moroccan hospital center confronted with a substantial increase in pelvic trauma in a post-earthquake setting.

V- CONCLUSION

Pelvic trauma represents a potentially severe condition requiring rapid multidisciplinary management.

Our study highlights the central role of imaging throughout the diagnostic and therapeutic pathway.

Standard radiography remains important for the initial assessment, whereas CT represents the reference imaging modality for fracture characterization, evaluation of pelvic stability, and detection of associated injuries.

Whole-body CT provides a rapid and comprehensive assessment of polytrauma patients and is particularly valuable in mass-casualty and disaster settings.

Our series is characterized by the predominance of trauma related to the Al Haouz earthquake, which involved 20 of the 31 patients (64.5%). This particular situation highlights the importance of appropriate organization of healthcare facilities and the implementation of a rapid and comprehensive imaging strategy in disaster settings.

Close collaboration between radiologists, trauma surgeons, emergency physicians, and intensivists, combined with appropriate imaging protocols, is essential to improve the management of patients with pelvic trauma.

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