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MedEst|2026 | Vol.6: e544| ISSN: 2789-7567 |RNPS: 2524| RESEARCH ARTICLE

Clinical behavior of traumatic fractures of the pelvic ring. Matanzas, 2021-2024

Comportamiento clínico de fracturas traumáticas del anillo pélvico. Matanzas, 2021-2024

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Palabras Clave: Fracturas de Pelvis, Trauma Pélvico, Clasificación de Tile, Lesiones Asociadas, Estabilidad Hemodinámica.

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RESUMEN

Introducción: Las lesiones del anillo pélvico constituyen traumatismos de alta complejidad que disminuyen la calidad de vida del individuo. El incremento de traumas de alto impacto ha elevado su incidencia, representando entre el 3 % y el 8 % de todas las fracturas, con mortalidad del 10 % al 16 %. **Objetivo:** Determinar el comportamiento clínico de las lesiones traumáticas del anillo pélvico atendidas en el Hospital Provincial Clínico Quirúrgico Docente "Comandante Faustino Pérez Hernández" de Matanzas, durante 2021-2024. **Métodos:** Estudio observacional, descriptivo, retrospectivo y transversal. Se incluyeron 37 pacientes con fractura traumática del anillo pélvico confirmada por imagen, mediante muestreo consecutivo. Se analizaron variables epidemiológicas, clasificación de Marvin Tile, lesiones asociadas y estabilidad hemodinámica. El procesamiento estadístico se realizó con SPSS 21.0. **Resultados:** Predominó el sexo masculino (59,5 %) y el grupo de 26-45 años (54 %). Los accidentes de tránsito fueron el principal mecanismo (83,8 %). Las fracturas tipo B de Tile predominaron (59,5 %). El 100 % presentó lesiones no ortopédicas asociadas (promedio 2,1 por paciente) y el 62,2 % lesiones ortopédicas. La inestabilidad hemodinámica (PAS < 100 mmHg) se observó en el 64,9 %, pero solo el 21,6 % requirió transfusión masiva. **Conclusiones:** Las fracturas traumáticas del anillo pélvico en Matanzas predominaron en varones jóvenes, por accidentes de tránsito de alta energía, con clasificación Tile tipo B más frecuente. La alta prevalencia de lesiones asociadas y la inestabilidad hemodinámica parcialmente compensada evidencian la necesidad de manejo multidisciplinario y control de daños ortopédico.

ABSTRACT

Introduction: Pelvic ring injuries constitute high-complexity trauma that diminishes individual quality of life. The increase in high-impact trauma has elevated their incidence, representing 3 % to 8 % of all fractures, with mortality of 10 % to 16 %. **Objective:** To determine the clinical behavior of traumatic pelvic ring injuries treated at the Provincial Clinical Surgical Teaching Hospital "Comandante Faustino Pérez Hernández" in Matanzas, during 2021-2024. **Methods:** Observational, descriptive, retrospective and cross-sectional study. Thirty-seven patients with image-confirmed traumatic pelvic ring fracture were included through consecutive sampling. Epidemiological variables, Marvin Tile classification, associated injuries and hemodynamic stability were analyzed. Statistical processing was performed with SPSS 21.0. **Results:** Male sex (59.5 %) and the 26-45 years age group (54 %) predominated. Traffic accidents were the main mechanism (83.8 %). Tile type B fractures predominated (59.5 %). All patients presented associated non-orthopedic injuries (average 2.1 per patient) and 62.2 % orthopedic injuries. Hemodynamic instability (SBP < 100 mmHg) was observed in 64.9 %, but only 21.6 % required massive transfusion. **Conclusions:** Traumatic pelvic ring fractures in Matanzas predominated in young males, due to high-energy traffic accidents, with Tile type B classification most frequent. The high prevalence of associated injuries and partially compensated hemodynamic instability evidence the need for multidisciplinary management and orthopedic damage control.

MedEst. 2026| Vol. 6: e544
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INTRODUCTION

Pelvic trauma constitutes one of the most complex challenges in the care of polytraumatized patients. Pelvic ring fractures account for 3% to 8% of all bone fractures [1,2], but their clinical significance transcends this proportion: in patients with multiple trauma, their incidence reaches up to 25% [3]. The pelvis houses high-caliber vascular structures, abdominopelvic viscera, and elements of the peripheral nervous system, so that its injury compromises multiple systems simultaneously [4].

Mortality associated with these fractures ranges from 10% to 16% in global series, but can exceed 50% in unstable fractures with hemorrhagic shock [5,6]. Active bleeding, present in up to 40% of cases, constitutes the main cause of early death and requires interdisciplinary management integrating general surgery, orthopedics, urology, and interventional radiology [7]. Early transarterial embolization has proven to be the most effective procedure for controlling arterial bleeding, improving survival [7].

The Tile classification, developed on the basis of the concept of posterior ligamentous stability, divides injuries into three fundamental types: A (stable), B (partially stable or rotationally unstable), and C (rotationally and vertically unstable) [8,9]. This classification not only guides surgical management —where open reduction and internal fixation (ORIF) has become the standard for displaced fractures— but also allows estimation of functional prognosis and the likelihood of associated injuries [9]. However, the interobserver reliability of the Tile classification is variable, and its application requires experience in image interpretation [10].

Epidemiologically, these fractures present a bimodal distribution: a first peak in young adults (15-35 years), predominantly male, victims of high-energy trauma (traffic accidents, falls from height); and a second peak in older adults (50-70 years), with a higher proportion of females, secondary to falls from standing height on an osteoporotic basis [11,12]. In Kazakhstan, a recent study at a level I trauma center reported a mean age of 34.5 years, with male predominance and high-energy mechanisms in 92% of cases; overall mortality was 7.1%, with type C fractures having the highest lethality [13].

In the Latin American and Caribbean context, epidemiological information is limited. Previous studies in Cuba have described the behavior of these injuries at the provincial level [14], but data updating is necessary given the sustained increase in road traffic trauma morbidity in the region. The identification of local patterns —injury mechanisms, distribution by Tile classification, frequency of associated

MedEst. 2026| Vol. 6: e544
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injuries, and hemodynamic compromise— is essential for designing institutional care protocols and allocating resources in emergency services.

For these reasons, the present investigation was conducted with the aim of determining the clinical behavior of traumatic pelvic ring injuries treated at the "Faustino Pérez" University Clinical Surgical Provincial Hospital in Matanzas, during the period 2021-2024.

METHODS

Study design

An observational, descriptive, retrospective, cross-sectional study was conducted in patients diagnosed with traumatic pelvic ring fracture, treated by the Orthopedics and Traumatology Service of the "Faustino Pérez" University Clinical Surgical Provincial Hospital of Matanzas, during the period from January 1, 2021, to December 31, 2024, inclusive.

Population and sample

The study population consisted of all patients admitted with a confirmed diagnosis of traumatic pelvic ring fracture to the Orthopedics and Traumatology Service during the specified period. A non-probability convenience sample of 37 patients was determined, selected through consecutive sampling, who met the established inclusion and exclusion criteria.

Inclusion criteria

1. Patients of any sex and age, admitted to the Orthopedics and Traumatology service of the study hospital.
2. Confirmed diagnosis of traumatic pelvic ring fracture by plain pelvic radiography and/or computed tomography (CT).
3. Complete medical record with available data regarding the study variables.
4. Admission during the period from January 1, 2021, to December 31, 2024.

Exclusion criteria

1. Pathological pelvic ring fractures (neoplastic, severe osteoporotic without significant trauma).
2. Pelvic fractures due to low-energy mechanisms in non-admitted outpatients.
3. Medical records with incomplete data that prevented the collection of main variables.

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

4. Patients who died within the first 24 hours after trauma without completing diagnostic evaluation.

Methodological note: Inclusion/exclusion criteria were defined a priori, before access to medical records, to minimize selection bias.

Study variables

Nominal qualitative variables:

- Sex (male, female).
- Mechanism of trauma production (motor vehicle traffic accident, motorcycle traffic accident, bicycle traffic accident, pedestrian hit, fall from height, crushing, sports, others).
- Marvin Tile classification of traumatic pelvic injuries (type A: stable; type B: partially stable; type C: unstable), with their respective subtypes.
- Presence of associated orthopedic injuries (upper limb fractures, lower limb fractures, spinal fractures, others).
- Presence of associated non-orthopedic injuries (thoraco-abdominal injuries, craniocerebral injuries, vascular injuries, genitourinary injuries, others).
- Hemodynamic stability upon admission (systolic blood pressure < 100 mmHg: yes/no; need for ≥ 4 transfusions in < 48 hours: yes/no).

Quantitative variables:

- Age (in completed years, categorized into groups: 19-25, 26-45, 46-60, 61-75, > 75).
- Number of associated non-orthopedic injuries per patient (discrete variable).

Data collection procedure

Documentary review of the medical records of patients who met the inclusion criteria was performed, accessing the records of the Clinical Archive and Documentation service of the hospital. Data were extracted by the principal investigator using an ad hoc data collection form that included the variables described above. The information was entered into a coded database in Microsoft Excel 2013, guaranteeing confidentiality by assigning a numerical code to each patient, suppressing personal identification data (name, medical record number, address).

Statistical analysis

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

Data were processed using Microsoft Excel 2013 and the Statistical Package for Social Sciences (SPSS) version 21.0 for Windows (IBM Corp., Armonk, NY, USA).

Descriptive analysis was performed according to variable type and distribution:

For qualitative variables: absolute (n) and relative percentage frequencies (%) were calculated.

For quantitative variables: arithmetic mean, standard deviation, median, interquartile range (IQR), minimum and maximum values were calculated. Normality of distribution was assessed using the Kolmogorov-Smirnov test.

Quantitative variables with normal distribution were expressed as mean ± standard deviation; those with non-normal distribution, as median [interquartile range]. Comparisons between groups were performed using Pearson's Chi-square test or Fisher's exact test for qualitative variables, and Student's t-test or Mann-Whitney U test for quantitative variables, as appropriate. A statistical significance level of $p < 0.05$ was considered. Frequency distribution tables were prepared for presenting results, with simple design without colors or shading, in accordance with the journal's editorial standards.

Bioethical considerations

The study protocol was conducted in accordance with the ethical principles established in the Declaration of Helsinki of the World Medical Association. The project was submitted for evaluation and received a favorable opinion from the Research Ethics Committee of the "Faustino Pérez" University Clinical Surgical Provincial Hospital of Matanzas.

Given the retrospective nature of the study and the impossibility of obtaining informed consent from all patients due to the time elapsed since care, the Ethics Committee authorized a waiver of individual informed consent, following data pseudonymization and guarantee of confidentiality, in accordance with health data protection regulations. The researchers signed a commitment statement not to re-identify patients and to use the data exclusively for scientific purposes. Data collection was limited to the minimum necessary for the study objectives.

RESULTS

During the study period, a total of 37 patients met the inclusion criteria and were diagnosed with traumatic pelvic ring fractures. The mean age

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

of the sample was 41.2 ± 14.5 years (median: 38 years; range: 19-74 years; IQR: 28-52 years). Of the patients, 59.5% (n = 22) were male and 40.5% (n = 15) were female, with a male/female ratio of 1.5:1. The distribution by age group and sex is presented in Table 1. Predominance was observed in the 26-45 year age group with 20 patients (54.0%), followed by the 46-60 year group with 12 patients (32.4%). No cases were recorded in the >75 year group. Comparison between sexes showed that in the 26-45 year group, males predominated (13 vs. 7; p = 0.312, Chi-square test), without reaching statistical significance

Table 1. Distribution of Pelvic Trauma by Age and Gender

Age groups (years)	Gender					
	Male		Female		Total	
	Number of cases	%	Number of cases	%	Number of cases	%
19-25	1	2,8%	-	-	1	2,8%
26-45	13	35,1%	7	18,9%	20	54%
46-60	6	16,2%	6	16,2%	12	32,4%
61-75	2	5,4%	2	5,4%	4	10,8%
Ages 75 and Over	-					
Total	22	59,5%	15	40,5%	37	100

Source: Medical Records

The mechanism of trauma production is described in Table 2. Traffic accidents constituted 83.8% (n = 31) of the total, with a predominance of motor vehicles (32.4%; n = 12) and motorcycles (29.7%; n = 11). Pedestrians hit represented 13.5% (n = 5). Falls from height accounted for 8.1% (n = 3). No significant differences in injury mechanism were observed according to sex (p = 0.456, Fisher's exact test).

Table 2. Distribution of pelvic trauma according to mechanism of action and etiology of trauma

Production Mechanism			Number of cases	%
High-energy impact	Fall from Height		3	8,1%
	Sports		1	2,8%
	Traffic Accidents	Pedestrian	5	13,4%
		Motorcyclist	11	29,7%
		Motor vehicle	12	32,4%
		Animal-drawn vehicle	2	5,4%
		Cyclist	2	5,4%

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

Crushed by vehicles	1	2,8%
Total	37	100%

Source: Medical Records

The classification of fractures according to Marvin Tile is presented in Table 3. Type B fractures (partially stable) predominated, involving 22 patients (59.5%), followed by Type A fractures (stable) with 9 patients (24.3%) and Type C fractures (unstable) with 6 patients (16.2%). Within Type B, subtypes B1.2 (external rotation, unilateral injury) and B2.1 (internal rotation, unilateral injury) were the most frequent, accounting for 9 (24.3%) and 6 (16.2%) cases, respectively. Type C2 fractures (vertically and rotationally unstable; unilateral sacroiliac injury with ipsilateral acetabular injury) accounted for 10.8% (n = 4).

Table 3. Distribution of pelvic trauma according to Marvin Tile's classification of traumatic pelvic injuries

Marvin Tile Classification of Traumatic Pelvic Injuries			
		Number of cases	%
A: Stable	A1	-	-
	A2	6	16,2%
	A3	3	8,1%
B: Partially stable	B1.1	5	13,5%
	B1.2	9	24,3%
	B2.1	6	16,2%
	B2.2	2	5,4%
	B3 Bilateral	-	-
C: Unstable: horizontally and vertically unstable (complete posterior injury)	C1	2	5,4%
	C2	4	10,8%
	C3	-	-
Total		37	100%

Source: Medical Records

Associated orthopedic injuries were present in 23 cases of pelvic trauma—a figure representing 62.2% of the total cases studied—with a marked predominance of lower extremity fractures, which were present in 14 patients (60.9%), followed by upper extremity injuries in 6 patients (26.1%). Significantly, all patients with pelvic injuries presented associated non-orthopedic injuries; thoracoabdominal trauma predominated, occurring in 31 patients (83.8%), followed by craniocerebral injuries in 18 (48.6%), genitourinary injuries in 11 (29.7%), vascular injuries in 9 (24.3%), and other non-orthopedic

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

injuries in 8 (21.6%), yielding an average of 2.1 associated non-orthopedic injuries per patient with pelvic trauma (see Table 4).

Table 4. Distribution of Pelvic Trauma According to Associated Orthopedic and Non-Orthopedic Injuries

Associated Orthopedic Injuries	**Number of cases**	**%**
Upper Extremity Fractures	6	26,1%
Lower Extremity Fractures	14	60,9%
Spinal Fractures	2	8,7%
Other	1	4,3%
Total: 23/37 (62.2%)	23	100%
Associated Non-Orthopedic Injuries	**Number of cases**	**%**
Thoracoabdominal Injuries	31	83,8%
Craniocerebral Injuries	18	48,6%
Vascular Injuries	9	24,3%
Genitourinary Injuries	11	29,7%
Other	8	21,6%
Total: 77/37 (2.1 injuries per patient)	37	100%

Source: Medical Records

Hemodynamic stability was assessed based on the presence of two defining criteria: a sustained systolic blood pressure below 100 mmHg—observed in 24 injured patients (64.9%)—and the need for four or more blood transfusions within less than 48 hours—observed in only 8 trauma cases (21.6%) (See Table 5).

Table 5. Distribution of Pelvic Trauma by Hemodynamic Stability. Matanzas 2021–2024

Hemodynamic stability		**Number of cases**	**%**
Systolic blood pressure maintained below 100 mmHg.	Si	24	64,9%
	No	13	35,1%
Total		37	100%
Need for 4 or more transfusions in less than 48 hours.	Si	8	21,6%
	No	29	78,4%
Total		37	100%

Source: Medical Records

DISCUSSION

The epidemiological characteristics of the population treated in the present study with pelvic trauma are similar to those observed in the

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

international literature. The mean age of 41.2 ± 14.5 years and male predominance (59.5%) agree with high-energy trauma series reported in Europe, Asia, and Latin America [1,2]. The bimodal distribution described in the literature —with a first peak in young adults (15-35 years) and a second in older adults (50-70 years)— is partially reflected in our series, where the 26-45 year age group accounted for 54% of cases [3,4]. The absence of cases in the >75 year group may be due to the limited sample size (n = 37) or to differential healthcare patterns in the geriatric population of the region.

The most frequent injury mechanism in our series was traffic accidents (83.8%), particularly those involving motor vehicles (32.4%) and motorcycles (29.7%). This finding is consistent with the global literature, where high-energy trauma constitutes the main etiology of unstable pelvic ring fractures [5,6]. In contrast, in geriatric populations of developed countries, pelvic fractures due to falls from standing height on an osteoporotic basis represent a growing proportion, which was not observed in our sample [7]. This difference underscores the importance of local studies for emergency resource planning, given that trauma patterns vary according to the socioeconomic context and transportation system of each region.

The predominant Marvin Tile classification in our series was type B (partially stable, rotationally unstable) with 59.5%, followed by type A (stable) with 24.3% and type C (rotationally and vertically unstable) with 16.2%. This distribution has relevant prognostic and therapeutic implications. Type B fractures, although less lethal than type C, may be associated with significant visceral and vascular injuries that compromise hemodynamic stability [8]. In our series, 64.9% of patients presented with SBP < 100 mmHg upon admission, although only 21.6% required massive transfusion (≥ 4 units in < 48 hours). This discrepancy suggests that hypotension in many cases was transient and responded to crystalloid resuscitation, which is consistent with the predominant bleeding mechanism in type B fractures: injuries to venous plexuses and bone surfaces, rather than massive arterial injuries [9].

However, the reliability of the Tile classification should be interpreted with caution. Recent studies have shown that interobserver agreement of the Tile system is only moderate for main categories (kappa = 0.44) and fair for subcategories (kappa = 0.31), with better performance among radiologists than among surgeons [10]. Observer experience increases reliability, but even among senior specialists, classification of complex subtypes may vary [11]. In our study, classification was performed by the Orthopedics and Traumatology service without systematic evaluation of interobserver agreement, which constitutes a

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

methodological limitation that may affect the reproducibility of our findings.

Associated orthopedic injuries were present in 62.2% of cases, with a predominance of lower limb fractures (60.9% of orthopedic injuries). This finding is expected given the high-energy trauma mechanism, where the impact force is transmitted through the extremities toward the pelvis. Even more relevant was the high frequency of associated non-orthopedic injuries, present in 100% of patients, with an average of 2.1 injuries per patient. Thoraco-abdominal injuries (83.8%) and craniocerebral injuries (48.6%) were the most prevalent, followed by genitourinary injuries (29.7%) and vascular injuries (24.3%).

The presence of genitourinary injuries in 29.7% of cases is particularly significant. The international literature reports that between 10% and 25% of pelvic ring fractures are associated with lower urinary tract damage, being more frequent in unstable type C fractures and in injuries with anterior displacement of the pelvic arch [12,13]. The diagnosis of urethral injuries remains challenging in the initial evaluation, and approximately 23% of them may be missed if systematic urological evaluation is not performed [14]. In our context, the high prevalence of genitourinary injuries underscores the need for multidisciplinary management protocols that include early urological evaluation in all patients with unstable pelvic fractures.

Overall mortality in our series was 5.4% (2/37), lower than that reported in the international literature (10-16% in global series, up to 30% in patients with hemodynamic instability) [15]. This difference may be explained by several factors: (a) the limited sample size, which reduces estimation precision; (b) the exclusion of patients who died within the first 24 hours without complete evaluation, which could introduce survival bias; (c) possible underestimation of severe cases that died before admission to the provincial hospital; and (d) the specific characteristics of the sample, with a predominance of type B fractures, which have lower mortality than type C.

Hemodynamic instability, defined by SBP < 100 mmHg, was observed in 64.9% of patients, but only 21.6% required massive transfusion. This apparent discrepancy may reflect the effectiveness of currently recommended resuscitation strategies: permissive hypotensive resuscitation, damage control with early external fixation, and selective transarterial embolization in centers with angiographic availability [16]. In resource-limited settings such as ours, temporary external fixation and preperitoneal pelvic packing constitute viable alternatives for controlling venous and bone bleeding, although arterial embolization remains the gold standard for active arterial injuries [17].

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

The management of pelvic ring fractures has evolved significantly in recent decades. Whereas in the past conservative treatment (bed rest, traction) was the norm, current evidence supports open reduction and internal fixation (ORIF) as the standard of care for unstable displaced fractures, with better long-term functional outcomes [18]. However, ORIF requires adequate facilities, specific osteosynthesis equipment, and surgical experience in pelvic surgery, resources that are not always available in secondary-level hospitals [19,20]. In our context, surgical planning based on the Tile classification becomes relevant for deciding the appropriateness of referral to higher-complexity centers.

The present study has limitations that should be acknowledged. First, the retrospective design exposes to information bias (quality of clinical documentation) and selection bias (patients with incomplete records excluded). Second, the sample size (n = 37) limits statistical power to detect significant associations between variables, particularly in Tile classification subgroups. Third, the absence of long-term follow-up prevents assessment of functional outcomes (Majeed score), return to work, or quality of life. Fourth, the Tile classification was performed by a single observer without interobserver agreement evaluation, which may affect the validity of categorization. Finally, the single-center nature limits generalizability of results to other hospital contexts in Cuba.

Despite these limitations, the findings have relevant implications for local clinical practice: (a) the high frequency of associated non-orthopedic injuries (100%) justifies a systematic multidisciplinary evaluation protocol in all patients with pelvic trauma; (b) the predominance of type B fractures suggests that most patients can benefit from definitive orthopedic management without requiring urgent referral, although they require close hemodynamic monitoring; (c) the high prevalence of genitourinary injuries (29.7%) supports the inclusion of urology in the trauma team from the initial evaluation.

CONCLUSIONS

Between 2021 and 2024, traumatic pelvic ring fractures treated at the "Faustino Pérez" University Clinical Surgical Provincial Hospital of Matanzas predominated in young adult males aged 26 to 45 years, with a mean age of 41.2 ± 14.5 years. High-energy traffic accidents constituted the main injury mechanism (83.8%), especially those involving motor vehicles and motorcycles. According to the Marvin Tile classification, type B fractures (partially stable) were the most frequent (59.5%), followed by type A (24.3%) and type C (16.2%). All patients presented associated non-orthopedic injuries, with an average of 2.1 injuries per patient and a predominance of thoraco-abdominal injuries (83.8%), demonstrating the need for a multidisciplinary approach from

MedEst. 2026| Vol. 6: e544
ISSN: 2789-7567 | RNPS: 2524

initial care. Although 64.9% of patients showed hemodynamic instability upon admission (systolic blood pressure < 100 mmHg), only 21.6% required massive transfusion, suggesting that most cases were manageable with conventional resuscitation and orthopedic damage control.

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