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17(9) 2022  
Research Article

## Acetabular fractures mechanism of injury initial stabilization and associated injuries in a Mexican level 2 hospital

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Received: 20.09.2022; Manuscript No. jotsrr-22-75214;  
Editor assigned: 21.09.2022, 75214(PQ);  
Reviewed: 2.10.2022, QC No. 75214(Q);  
Revised: 3.10.2022, Manuscript No. 75214(R);  
Published: 8.10.2022, DOI.10.37532/1897-2276.2022.17(9).75

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### Abstract

**Objectives:** To determine the relationship between surgically treated acetabular fractures, their associated injuries, and the need for pelvic stabilization before definitive fixation.

**Methods:** Review of records of patients with acetabular fractures treated surgically at the Central Hospital of the Mexican Red Cross between August 2013-January 2016. Descriptive statistical analysis in frequencies and proportions,  $\chi^2$  to determine the dependence between qualitative variables with a  $p < 0.05$  denoting significance. **Results:** 32 patients in the sample: 26 males, average age of 36.3 years. Mechanism of injury 75% due to accident related to a motor vehicle ( $P=0.0052$ ). Damage control in orthopaedics was performed in 68.7% with a positive association between this and the surgical treatment of these injuries ( $P=0.0052$ ). According to Letournel, anterior wall fractures occurred in 28.1%, followed by injuries to both columns and the anterior column and posterior wall in a tied 15.6%. All cases presented some non-orthopaedic injury associated mainly with contusion of the chest; abdomen and pelvis (40.6%) followed by head trauma (21.8%), kidney and sciatic nerve injuries (6.25% both). The most frequent orthopaedic injury was sacroiliac dislocation in 40.6%, statistically significant ( $P=0.0019$ ). **Conclusions:** We found a significant association between these injuries and high-energy mechanisms, as well as the presence of aggregate injuries and the need to perform some stabilization due to the disruption of the pelvic ring.

**Keywords:** Acetabular fractures, Judet and Letournel classification, polytrauma, external fixation, pelvic fractures, unstable pelvic ring, orthopaedic damage control

## INTRODUCTION

### LEVEL OF EVIDENCE: LEVEL OF EVIDENCE IV SERIES OF CASES

The purpose of the study is to determine the relationship between acetabular fractures treated surgically, associated lesions, and the need for pelvic stabilization before definitive fixation.

Retrospective revision of patients with acetabular fractures treated surgically at the Central Hospital of the Mexican Red Cross between Aug. 2013 and Jan 2016. Descriptive statistical analysis was performed in terms of frequency, proportions, and X2 to determine qualitative dependency amongst variables with a P value <0.05 to determine significance.

32 patients were sampled 26 males, age average of 36.3 years. 75% were caused by an accident in which a motor vehicle was related (P=0.0052). Damage control orthopaedics was performed in 68.7% with a positive association between this and further surgical treatment (P=0.0052). According to Letournel's classification, most fractures presented were 28.1% anterior wall, followed by both columns, anterior column, and posterior wall tied. All cases presented some non-orthopaedic associated lesion mainly thoracic abdominal and pelvic contusion (40.6%), head trauma (21.8%), and renal and sciatic nerve injury (both 6.25%) Most frequent orthopaedic-related injury was Sacroiliac dislocation in 40.6% being significant (P= 0.0019).

We found a significant association between these injuries and high energy mechanisms as well as the presence of associated injuries and the need to perform some stabilization due to the pelvic ring disruption. Disruption of the pelvic ring due to a traumatic event is associated with a high risk of mortality due to haemorrhage and is an indicator of severe trauma [1-5]. Formerly they were considered extremely rare lesions. Homer in the Iliad describes a passage where Diomedes throws a stone on Aeneas's thigh "where the hip turns toward the pelvis at the cup joint." Mechanism classically reproduced by Pearson 2800 years later in cadaveric models and which is still valid in terms of the direct impact of the femoral head on the joint surface by a vectorial force in the manner of a medieval battering ram (The femoral head) against a curved gate (the articular cup) [6].

Currently, the increase in motor vehicle accidents, the incidence of falls from great heights, and the improvement in medical services and quality of life of the general population have managed to stage these injuries in adults in a bimodal frequency: Classically, patients are male in age productive who receive trauma from a high-energy mechanism or mixed elderly population who suffer a low-energy fall [1-29]. In the pediatric population, it is extremely rare and is considered an unequivocal indicator of intra-abdominal haemorrhage [23]. They are also associated with automobile accidents, running over and sports injuries as the causal agent and with a high incidence of accompanying brain, thoracic or orthopaedic injuries [15, 17, 18, 23, 25, 29, 30]. The anatomical and histological discrepancies between a pediatric and an adult pelvis, as well as the anatomical peculiarities of the main joint of the legs, cause difficulty in reaching a consensus regarding the diagnosis, classification, and management of these injuries [14, 15, 17, 18, 23, 25]. We define a high-energy mechanism as an injury resulting from a traffic accident of any kind, falls from more than one level of height, and industrial

and agricultural injuries [5]. In a frontal collision, a minimum acceleration of 48 km/h (30 mph) is needed to cause a pelvic ring disruption, and the kinetic energy dissipated in the event is responsible for the concomitant injuries that these cases present in the whole body economy [1, 2, 5-7, 9, 11, 13-16, 26, 27, 28]. The majority of acetabular fractures caused by automobile crashes are related to the direct contusion of the knee on the dashboard or a direct lateral impact that causes a path mechanics of the fracture that has remained valid since Judet's description (Table 1) [14].

Path mechanics of acetabular fractures described by Judet et al 14.

It is derived from this scenario that there may be a need to perform damage control in orthopaedics to stabilize the pelvic ring before definitive fixation to attend to the accompanying priority injuries [14]. Non-invasive methods are the gold standard for pelvic stabilization to date, invasive methods such as the use of external fixators or staples (except C-Clamp) have the risk of compromising abdominal access routes in surgical treatment as well as complicating definitive fixation due to inadequate acetabular reduction [4, 14].

The objective of this study is to determine the association between surgically treated acetabular fractures, the mechanism of injury, the type of preoperative pelvic stabilization, and concomitant orthopaedic and non-orthopaedic injuries. Specifically, to estimate the incidence of surgically treated acetabular fractures and to identify the association, if any, between patients with acetabular fractures, associated pelvic ring injuries, and pelvic ring stabilization before the definitive fixation of these fractures.

## JUSTIFICATION

Fractures of the acetabulum constitute a potentially serious traumatic condition, which the orthopedist must deal with more and more frequently in his practice and the emergency services.

Its production mechanism is closely related to highly reproducible high-energy trauma in urban settings, which, in addition to causing acetabular fractures, are associated with other injuries that can cause the death of the patient, both immediately and late. Diagnosis is based on a suspected traumatic mechanism, clinical symptoms, and subsequent imaging studies; It is worth mentioning that using the Judet and Letournel classification allows the patient to be approached in a protocol manner, however, the risk of haemorrhage and injuries associated with blunt trauma, especially of the lungs, complicate the clinical picture.

Therefore, the present study is carried out with the purpose of determining the association between the lesions classified with the Judet and Letournel criteria plus their associated lesions and determining the method of pelvic stabilization before the definitive fixation of these cases. The results are intended to contribute to the body of knowledge of these injuries and in the future to support specific management protocols for the specific needs of these injuries.

## PROBLEM STATEMENT

Acetabular fractures are produced bimodal by high-energy and low-energy trauma depending on the age and sex of the patient. Studies on pelvic blunt trauma with pelvic ring disruption, associated type and its mechanism. injuries, elevated ISS or AIS, patient age, and the presence of the "fatal triad" are some prognostic factors for outcome and mortality.

**Table 1:** Difference between frac

Fracture Type	Mechanism
Back Wall	A direct force to a flexed knee with the hip at 90° and in neutral abduction. The greater the abduction, the greater the fracture line
Back Column	A force directed posteriorly to the anterior aspect of the knee with 10°-15° hip abduction and 95°-100° flexion
Previous Column	A direct lateral force to the greater trochanter with an externally rotated hip less than 30°
Transverse	A direct lateral force to the greater trochanter with 15°-20° internal rotation and variable abduction. Alternately direct trauma to the posterior pelvis with the hip rotated
Transverse plus Posterior Wall	A direct force to the flexed knee or foot with the hip flexed approx 90° and abducted 20°-25°
T-Fracture	A lateral force directed at the greater trochanter with the limb neutral or slightly externally rotated
both columns	not described

Despite the existence of Latin American literature on the relationship between the mechanism of injury and the incidence of these fractures, very little focus has been placed on the need for pre-hospital pelvic stabilization or before definitive surgical treatment of these patients in whom usually concomitant orthopaedic and non-orthopaedic injuries in other systems, which complicates its treatment and prognosis landscape.

Derived from the above, the following research question is posed that aims to answer and provide information about the following question:

What is the relationship between surgically treated acetabular fractures and their associated injuries and what is their relationship with the need for pelvic stabilization before definitive fixation in patients treated at the Central Hospital of the Mexican Red Cross?

## MATERIAL AND METHODS

The medical records of those patients who have presented acetabular fractures surgically treated at the Central Hospital of the Mexican Red Cross in the period from August 2013 to January 2016 are obtained. Sociodemographic variables such as age, sex, weight, height, comorbidities, and injuries associated with fractures were integrated, obtaining staging, Judet classification, and their incidence. For the statistical analysis, descriptive statistics, frequencies, and proportions,  $\chi^2$  were used to determine the dependence between qualitative variables with a  $p < 0.05$  denoting statistical significance. Patients treated in the established period with a diagnosis of acetabular fracture that required definitive surgical management were taken as the study population.

## TYPE OF RESEARCH: CLINICAL, EPIDEMIOLOGICAL

### DESIGN TYPE

Observational, Descriptive, Retrospective, Transversal.

### SAMPLE SIZE

Based on international medical literature, it has been documented that the incidence of acetabular fractures is 2% of general fractures. Making

a calculation adjusted to losses, 31 patients are needed to carry out the research study, having obtained a total of 32 cases by non-probabilistic sampling method of consecutive cases.

## SELECTION CRITERIA

### INCLUSION CRITERIA

Patients of any age and indistinct sex with an acetabular fracture are treated surgically.

### EXCLUSION CRITERIA

Patients who do not have an acetabular fracture. Patients with acetabular fractures are treated conservatively. Patients who do not have a complete clinical file and it is not possible to obtain the corresponding information.

### ELIMINATION CRITERIA

Those patients whose clinical records have been purged due to situations of death and/or transfer.

### ETHICAL ASPECTS

In accordance with the Current General Health Law on Research, this study was classified as a study without risk, since the information was collected retrospectively.

## RESULTS

A sample of 32 patients with acetabular fractures treated surgically in the period between August 2013 and January 2016 with a mean age of 36 years ( $SD \pm 15$ ) was obtained. 81.2% ( $n=26$ ) of the reported cases correspond to the male gender and included 6 female patients (18.7%). 26 of the patients (81.2%) were received in the shock room for protocolization and stabilization after hospital arrival.

The predominant mechanism of injury is a car crash in 34.3% ( $n=11$ ), followed by a run in 28.1% ( $n=9$ ), falls in 15.6% ( $n=5$ ), motorcycle crash in 12.5% ( $n=4$ ), and other 3 cases due to less frequent causes. It should be noted that, in total, more than 75% of cases are secondary to high-energy accidents involving motor vehicles (Figure 1).

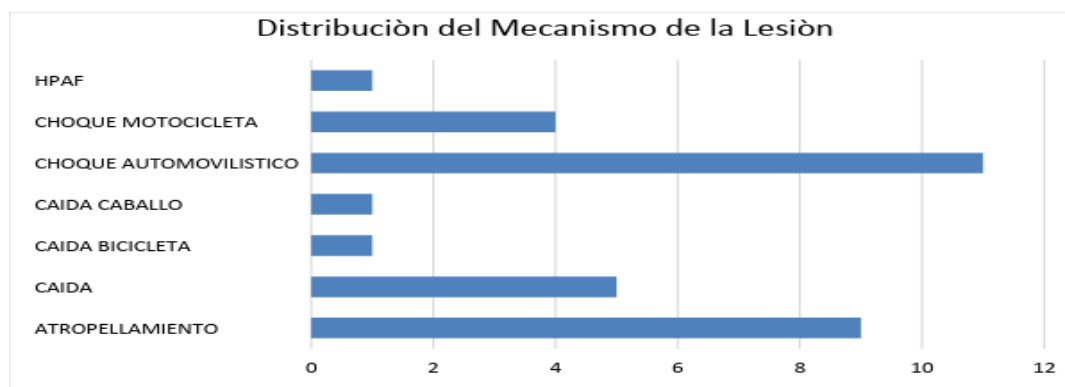


Fig.1 Distributions of the mechanism of injury

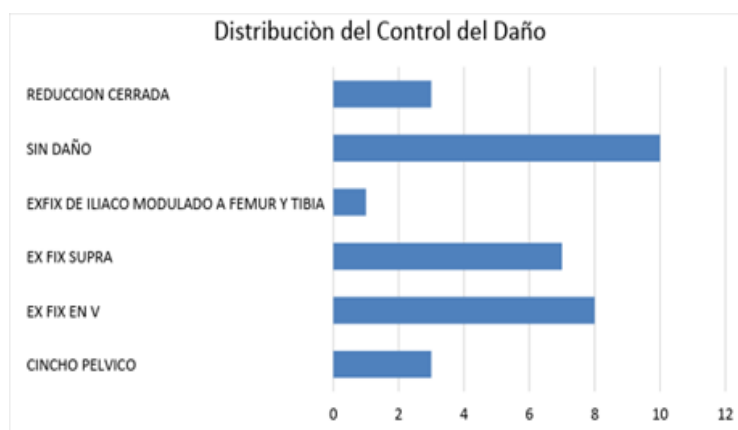


Fig.2 Distribution of damage control

Orthopaedic damage control was performed in 68.7% of patients (n=22). 25% required external fixation modulated in V (n=8), 21.8% (n=7) received supra acetabular external fixation, the pelvic strap was used in 9.3% (n=3) and only one case underwent external iliac fixation modulated to femur and tibia by a floating hip (Figure 2).

The non-orthopaedic associated injuries reported by frequency were contusion to the chest, abdomen, and pelvis in 40.6% of cases (n=13), head trauma in 21.8% (n=7), 6.2% (n=2) had grade I kidney injury and in the same %, they presented with sciatic nerve injury. Other associated injuries: hypovolemic shock, left hemopneumothorax, bladder injury, injury to the small intestine, chemical pneumonitis, flail chest, blunt chest trauma, and Morell Lavalleé syndrome occurred in the same statistical proportion of 3.1% (n=1) (Table 2).

Regarding the distribution of lesions according to the Letournel classification, 28.13% (n=9) of the patients presented with anterior wall lesions, and the same proportion of patients presented with posterior wall lesions, both columns and anterior columns 15.6% (n=9), (n=5), 9.3% (n=3) of the patients presented fractures of the posterior wall and

column, and the same proportion of patients presented with a posterior transverse anterior column fracture (Table 3).

The concomitant fractures associated with these patients were mostly concentrated in the pelvic ring: The most frequent injury found in 40.6% (n=13) of the cases was the dislocation of the sacroiliac joint, followed by 25% (n= 8) of patients accompanied by ipsilateral coxofemoral dislocation, of which 3 cases were reduced secondarily. The same percentage of patients who presented fracture of the 4 branches also presented left clavicle fracture 12.5% (n=4). The latter is probably related to the seat belt. One patient presented a fracture of the left ischiopubic ramus in addition to the acetabular injury. No other injuries were reported and two patients had a single acetabular injury (Figure 3).

Studying the relationship between the mechanism of injury and the type of fracture, we found a significant positive association (P=0.0052) coinciding with the world literature, grouping accidents involving motor vehicles as the main responsible for an acetabular fracture occur and require surgical management for its definitive treatment (Table 4).

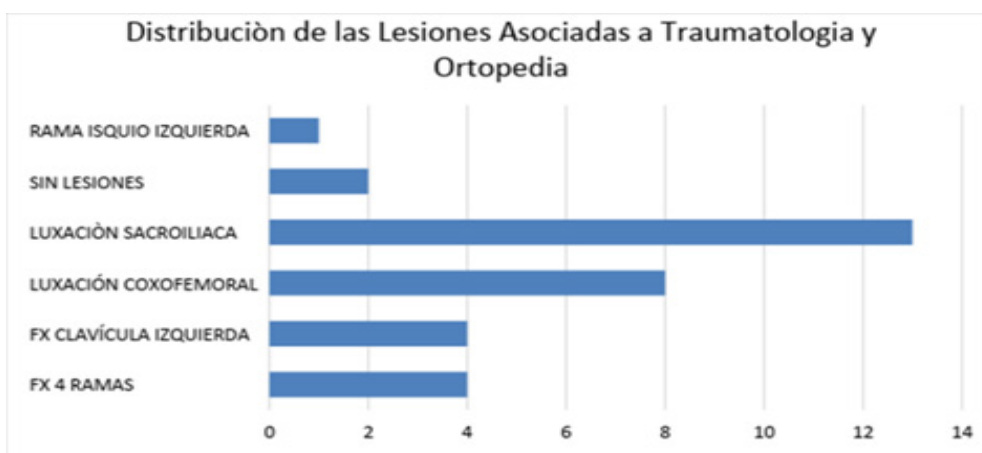
The multivariate statistical analysis found a positive association between

**Table 2.** Recorded Associated Injuries.

Recorded Associated Injuries	frequency	%	% Accumulated	Control Limits Exact 95%	
Hypovolemic shock	1	3.13%	3.13%	0.08%	16.22%
Contusion chest abdomen and pelvis	13	40.63%	43.75%	23.70%	59.36%
Hemoneumot or left rax	1	3.13%	46.88%	0.08%	16.22%
Sciatic nerve injury	2	6.25%	53.13%	0.77%	20.81%
Bladder injury	1	3.13%	56.25%	0.08%	16.22%
Int. grade III injury. of	1	3.13%	59.38%	0.08%	16.22%
Grade I kidney injury	2	6.25%	65.63%	0.77%	20.81%
Bilateral avalley Morell L	1	3.13%	68.75%	0.08%	16.22%
Pneumonitis chemistry	1	3.13%	71.88%	0.08%	16.22%
ECT	7	21.88%	93.75%	9.28%	39.97%
Flail chest	1	3.13%	96.88%	0.08%	16.22%
Blunt chest trauma	1	3.13%	100.00%	0.08%	16.22%
Total	32	100.00%	100.00%		

**Table 3.** Distribution of the Acetabulum Fracture.

Distribution of the Acetabulum Fracture	frequency	%	% Accumulated	Control Limits Exact 95%	
Fracture according to Letournel					
Both columns	5	15.63%	15.63%	5.28%	32.79%
Previous column	5	15.63%	31.25%	5.28%	32.79%
Previous column posterior transverse	3	9.38%	40.63%	1.98%	25.02%
Back column	1	3.13%	43.75%	0.08%	16.22%
T-Fracture	1	3.13%	46.88%	0.08%	16.22%
Anterior wall	9	28.13%	75.00%	13.75%	46.75%
Rear wall	5	15.63%	90.63%	5.28%	32.79%
Back wall and column	3	9.38%	100.00%	1.98%	25.02%
Total	32	100.00%	100.00%		



**Fig.3** Distribution of injuries associated with traumatology and orthopaedics

the sample and the performance of some type of pelvic stabilization with a value of  $P=0.0052$ . This is due to the protocolization and application of damage control in orthopaedics in the hospital where the study was held (Table 5).

Finally, we found a highly significant positive association for acetabular fractures plus other orthopaedic injuries ( $P=0.0019$ ), mainly injuries found within the pelvic ring itself (81.2%), proving a traumatic mechanism causing its disruption (Table 6).

During the in-hospital management of the patients and at the time of the study cut-off, only 9 patients suffered some type of complication: 1 patient was under follow-up 1 year after his injury, 2 patients were

transferred to another hospital, and 6 patients all died after the injury. its definitive fixation which, despite being outside the scope of the study, is consistent with the world literature that suggests better in-hospital prognoses after pelvic stabilization and application of damage control in orthopaedics.

### DISCUSSION

Acetabular fractures by themselves constitute a diagnostic and surgical challenge for the orthopedist [1-3, 5, 9, 14, 16, 23, 28]. In developing economies such as Mexico, the increase in motor vehicle traffic and the urbanization of cities will result in these injuries occurring with increasing frequency [2, 5, 6, 8, 9, 15, 19, 22, 24, 26].

**Table 4.** Acetabulum Fracture Type vs. Mechanism of Injury.

Acetabulum Fracture Type vs. Mechanism of Injury								
Fracture according to Letournel	mechanism of injury							Total
	run over	Drop	bicycle fall	caida horse	Car crash	motorcycle crash	HPAF	
Both columns	0	1	0	0	2	2	0	5
previous column	3	1	0	0	1	0	0	5
Posterior transverse anterior column	0	0	1	1	1	0	0	3
back column	0	0	0	0	0	0	1	1
T -Fracture	1	0	0	0	0	0	0	1
anterior wall	4	two	0	0	3	0	0	9
rear wall	0	1	0	0	3	1	0	5
Back wall and column	1	0	0	0	1	1	0	3
Total	9	5	1	1	eleven	4	1	32
$\chi^2$ _	Degrees of freedom			p				
6,91,401	42			0.0052				

**Table 5.** Acetabular fractures vs. Pelvic stabilization.

acetabular fractures vs. Pelvic stabilization							
Fracture Type	pelvic strap	F. Ext. in V	F. Ext. supra	Modulating Ext. F.	no stabilization	closed reduction (fracture-dislocation)	Total
Both columns	1	2	0	0	2	0	5
Previous column	0	2	2	0	1	0	5
Posterior transverse anterior column	0	0	1	0	2	0	3
Back column	0	0	0	0	1	0	1
T-Fracture	0	0	0	1	0	0	1
Anterior wall	1	2	4	0	2	0	9
Rear wall	1	1	0	0	2	1	5
Back wall and column	0	1	0	0	0	2	3
Total	3	8	7	1	10	3	32
$\chi^2$ _	Degrees of freedom			(p=)			
6,00,753	35			0.0052			

**Table 6.** Type of Acetabulum Fracture vs Associated Injuries Traumatology.

Type of Acetabulum Fracture vs Associated Injuries Traumatology							
Fracture according to Letournel	Trauma-Associated Injuries						Total
	Fracture 4 branches	Left clavicle fracture	coxo femoral dislocation	Sacro iliac dislocation	Without injuries	Left ischiopubic ramus	
Both columns	2	0	1	1	0	1	5
Previous column	2	0	0	3	0	0	5
POSTERIOR transverse anterior column	0	2	0	1	0	0	3
Back column	0	0	0	0	1	0	1
T-Fracture	0	0	1	0	0	0	1
Anterior wall	0	2	0	7	0	0	9
Rear wall	0	0	3	1	1	0	5
Back wall and Column	0	0	3	0	0	0	3
Total	4	4	8	13	2	1	32
$\chi^2$ _	Degrees of freedom			(p)			
6,42,598	35			0.0019			

The diagnosis and management of these lesions are difficult, there is a direct correlation between the experience in detecting these lesions radiographically and the experience of the surgeon with the results obtained [9]. There is controversy in the staging between pediatric and adult patients because the anatomy and histology of the pediatric pelvis modify the kinematics of the injury in children and because there is controversy since all the classifications of pelvic and acetabular injuries are currently insufficient for the anatomical variability and presentation of these lesions [14, 17, 23, 29].

In the last 50 years, the treatment of pelvic injuries has improved significantly, which have gone from being a high risk for morbidity and mortality of patients due to internal bleeding and associated injuries to entities with better prognosis [1, 2, 4, 5, 7, 15, 16, 22, 30]. Characteristically, these injuries overload the health service due to the extensive amount of resources and personnel required to comprehensively treat these cases and provide follow-up, rehabilitation, and also attend to their sequelae and complications, which affects the economy of the health system and the patient's environment [6, 7, 12].

We observe here a direct association in most of the reported cases of some type of injury to another accompanying organ or system and the associated orthopaedic injuries were a direct consequence of the initial injury mechanism and the subsequent disruption of the pelvic ring. The registered patients were received mostly in the shock room and although it is not within the scope of the study, several underwent surgical procedures from other specialities (CAT, LAPE, Diagnostic Peritoneal Lavage, etc.), increasing the metabolic response of the patient. Patients and increasing their morbidity and mortality due to the effect of the second blow [7, 20, 21]. To allow these patients to be treated as a priority, orthopaedic damage control is necessary, which in this case consists of

pelvic stabilization either by invasive or non-invasive methods in polytraumatized patients with pelvic instability that does not allow fixation. Definitive in a period of 24 hrs [5, 7, 11, 20, 22].

In this study, we were able to find a direct association between the presence of these injuries and acute pelvic stabilization for in-hospital and symptomatic control while awaiting definitive surgical treatment. This is because the host hospital protocolizes damage control in orthopaedics during the scope of the study, the vast majority of registered files had some type of previous pelvic stabilization that the literature establishes improves in-hospital management prognosis [22].

The strength of the study is based on the fact that the Central Hospital of the Mexican Red Cross has direct contact with the emergency care centre in Mexico City, which gives the hospital priority in the management of trauma patients who require referral to level II/III care. The limitations of the study, in addition to the sample size and the adjusted losses, which are comparative with the world literature, are based on being a retrospective study based on a single trauma centre [8]. To date there is no national consensus for multicenter studies of this type of national implant registries, regional fracture registries or access to insurance records on automobile accidents as in other countries that would help in allowing not only an adequate multivariate statistical analysis but later contributes to defining management and prevention guidelines for these injuries based on the evidence studied [1, 2, 6, 10, 15, 16, 19, 22, 26].

## ACKNOWLEDGEMENT

Thanks to Dr Rosa María Ugalde Velázquez (QDEP) with special love and affection for all her logistical, theoretical, and practical support and fabulous euthymia, in general, all these years that made this document possible and many other achievements.

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